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TABLE OF CONTENTS

Yong Sun, Southwestern University of Finance and Economics, Chengdu, China
Kyung Joo Lee , University of Maryland-Eastern Shore
John J. Jin, California State University – San Bernardino
Diane Li, University of Maryland-Eastern Shore

THE EXISTENCE OF NONARTICULATION IN THE FINANCIAL STATEMENTS OF SAUDI COMPANIES

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ABSTRACT

Bahnson et al. (1996), Krishnan and Largay (2000), and Ward et al. (2006, 2009) identified a problem with financial reporting statements in the United States (US). This nonarticulation problem occurs when the actual reported net operating cash flow on the cash flow statement differs from the estimated operating cash flow obtained by applying the indirect method to the balance sheet and the income statement. Miller (2002) also confirmed that nonarticulation existed among Hong Kong companies.

This study tests whether nonarticulation exists in the financial statements of Saudi companies, and if it exists, can one reconcile the differences using footnote information. The results of this study also indicate that nonarticulation exists for the Saudi companies. However, when using the footnotes to supplement the published numbers, most of the nonarticulation can be explained and a significant amount of the nonarticulation eliminated. The ability to explain most of the nonarticulation using the footnotes is not consistent with prior research. This finding suggests that the Saudi companies' footnotes may either contain information more easily identifying missing items affecting operations or that the footnotes are more thorough than those of US companies.

INTRODUCTION

The issue of nonarticulation has been researched extensively in companies that follow United States (US) Financial Accounting Standards (FASB), otherwise known as Generally Accepted Accounting Principles (US GAAP). The purpose of this study is to determine if nonarticulation also exists in the financial statements of Saudi companies. Saudi companies use accounting standards accepted by the Saudi government. These standards are based on US FASB standards, UK accounting standards, and International Accounting Standards Board (IASB) standards and procedures (International GAAP).

Early cash flow literature (*e.g.*, Revsine, 1973; Lawson, 1978; 1985; Lee, 1972; 1978; 1981; 1985) suggested that cash flow information may be superior to accrual income information. The debate over cash flow reporting eventually produced a general consensus among financial statement users and researchers that published cash flow information is incrementally useful over accruals (e.g., Largay and Stickney, 1980; Lee, 1981; Sorter, 1982; Gombola and Ketz, 1983; Christie et al., 1984; Casey and Bartczak, 1984; 1985; Lawson, 1985; Bowen et al., 1986; 1987; Gombola et al., 1987). After much discussion and two exposure drafts (FASB 1981; 1986), the FASB subsequently addressed the issue of cash flow information and concluded that companies should publish a cash flow statement (FASB, 1987). Later, the IASB issued International

Accounting Standards 7 requiring companies adopting its standards to publish a Statement of Cash Flows (Whittington, 2005). Prior literature and research on the Statement of Cash Flows provided the motivation for subsequent studies on cash flow information that lead to the issue of nonarticulation.

Articulation, in the context of the financial statements, doesn't just suggest that the changes in one statement should be reflected in the others, but also means that these changes should flow through their proper classifications and be presented in the right places on the financial statements. In the context of cash flows, it is not sufficient to say that the net change in cash flows on the cash flows statement should equal the change in the cash balance on the balance sheet between the beginning and end of the period. Each of the three cash flows, cash flow from operating activities, cash flow from investing activities, and cash flow from financing activities, on the cash flow statement should represent the changes in the associated balances on the other statements. In the context of cash flow from operations, cash flow from operations should fully represent the change in cash that is associated with operating activities, nothing less or more. Thus, applying the indirect method of calculating operating cash flow using two balance sheets and the income statement should yield the exact same number as reported net cash flow from operating activities on the cash flow statement, at least in theory. Therefore, if the reported cash flow from operating activities differs from the estimated operation cash flow, then the financial statements do not fully articulate with each other, and what Bahnson et al. (1996) labelled as "nonarticulation" exists.

The remainder of the paper is organized as follows. We first discuss prior research. Next, we discuss the development of our hypotheses. Then, we discuss the sample and methodology of the study. Finally, we provide results from our analyses and offer our concluding remarks.

RELEVANT PRIOR LITERATURE

Bahnson et al. (1996) addressed this nonarticulation problem by collecting data from *Compustat* for 9,757 companies to determine whether the reported cash flow from operating activities (CFFO) materially differed from estimated operating cash flow (OCF). They defined major nonarticulation as differences that fall in the range of -3% to +3% from reported CFFO. Bahnson et al. found that 75% of the studied financial statements had material differences between the reported CFFO and the calculated OCF. Moreover, these differences in some cases exceeded 100% of the reported CFFO.

Bahnson et al. (1996) then identified a smaller sample of ten firms and conducted an in-depth analysis of the footnotes associated with the selected sets of financial statements to explore causes and find out explanations for the nonarticulation problems. Although they were able to find explanations for some of the differences between the reported CFFO and the estimated OCF, they concluded that it was not possible to identify all the factors that caused the nonarticulation problem. They also concluded that the Financial Accounting Standards Board (FASB) should require the direct method of reporting CFFO.

Ward et al. (2006) also found that large and significant differences existed between the reported CFFO and the calculated OCF in US companies. The interesting finding of Ward et al. (2006) is that the reported CFFO produces more useful information than the calculated OCF in predicting future financial distress, which implies that the reported CFFO is more reliable than the

calculated OCF. Thus, their results suggest that the causes of the nonarticulation are issues in the balance sheet and income statement, not issues with the cash flow statement. These findings explained why early cash flow studies did not find operating cash flow to be useful in predicting financial distress. The estimated cash flow variable has bias in the measure leads to overstating the health of distressed companies, thus weakening predictive regression modeling.

Krishnan and Largay (2000) subsequently investigated whether the gross cash flows reported using the direct method led to more accurate predictions of future operating cash flow. As part of their study, they also attempted to determine the amount of measurement error in (OCF) when compared to CFFO of the direct firms. Krishnan and Largay (2000) found that most direct-method companies reported relatively small differences between the two measures. However, some companies reported very large differences.

Ward et al. (2009) investigated whether companies using the direct method to present the Statement of Cash Flows showed the same amount of nonarticulation as companies that used the indirect method. The authors found that companies using the direct method produced articulated statements, while companies using the indirect method had significant amounts of nonarticulation in their financial statements.

Miller (2002) was the only published study the authors found that investigated the existence of nonarticulation in non-US companies using standards difference from FASB standards. Miller sampled Hong Kong companies. Hong Kong companies follow standards based on IFRS (Hong Kong Accounting Standards, 2016). Miller (2002) used a database of Hong Kong companies to determine if nonarticulation existed among these companies' statements. Then, Miller analyzed the financial reports of thirty-five companies to see if he could explain the differences causing the nonarticulation. Similar to Bahnson et al. (2006), Miller (2002) concluded that he could not explain many of the major differences causing the nonarticulation.

HYPOTHESES DEVELOPMENT

Most prior nonarticulation studies (Bahnson et al., 1996; Krishnan and Largay, 2000; Miller, 2002; Ward et al., 2006; 2009) used Standards and Poor's database, *Compustat*, to collect their data to create their models. These studies first took net income and then threw out all allocations and changes in current assets and current liabilities that affected earnings to estimate OCF of firms. The authors then compared OCF to CFFO. The difference between OCF and CFFO represents the amount of nonarticulation between the statements.

Except for Bahnson et al., (2006) and Miller (2002), prior studies ignored the footnotes and only used the information in the published numbers of the financial statements. Miller (2002) basically replicated Bahnson et al. using companies from Hong Kong. Similar to Bahnson et al. (2006), Miller (2002) found that many of the major differences between OCF and CFFO could not be explained. This finding suggests that nonarticulation may be a universal occurrence, and not restricted to US GAAP.

For the purpose of this paper, the authors attempt to replicate for Saudi firms the detailed analysis of statements and footnotes incorporated by the Bahnson et al. (2006) and Miller (2002) studies. We first investigate whether the published cash flow number can be derived from taking net income (before non-controlling interest) and adjusting it for allocations and operating timing

differences (does nonarticulation exist). Then, for all companies with nonarticulation the authors completed a full in-depth analysis of each company's balance sheets, income statement, and the associated notes to identify any items needed to adjust the estimated operating cash flow of each company. Each statement and each page of the associated notes were carefully studied in this process. The possible effect of the footnote information on OCF was analyzed. After studying and analyzing the information, OCF for each company was estimated again after considering the footnote information.

Typical to this type of study, the major limitation of the study involves the subjectivity of reading and interpreting financial footnotes. Personal interpretation and professional judgment are rarely error free, which is a limitation of this study. However, personal interpretation and professional judgment is also used in the coding of major databases and prior studies found any bias to be minimal. In addition, Saudi companies do not report their financial information in *Compustat*. Thus, the authors had to pull the information off the financial statements manually to calculate the relevant variables.

The rule making body in Saudi Arabia, the Saudi Organization of Certified Public Accountants (SOCPA), is a governmental organization. Thus, less flexibility exists for Saudi companies for changing allocation methods (SOCPA, 2016). Thus, Saudi companies do not follow International or US GAAP completely, but instead, follow Saudi government principles. SOCPA has more power and is less influenced by outside parties than the FASB. The head of SOCPA's board is the Minister of Trade and Industry who reports directly to the King of the country. Having more power allows SOCPA to impose more scrutinized laws and standards for reporting purposes. For example, SOCPA's inventory standard indicates that companies should use the weighted average method to evaluate inventory and continue using this method. Although exceptions to this requirement are allowed, they are rare. The use of IFRS is allowed in Saudi Arabia; however, it is seldom used as the only basis for GAAP. None of the companies included in this study use IRFS alone (It is worth mentioning that SOCPA is working on a project to converge to IFRS.)

The findings of prior studies (Bahnson et al., 1996; Krishnan and Largay, 2000; Miller, 2002; Ward et al., 2006; 2009) constitute the motivation for this study, especially the severity of the nonarticulation problem in US companies. Because there are more resemblances than differences between US and the Saudi rules of reporting and disclosure, it is appropriate to assume that the level of nonarticulation found in Saudi companies would be similar to the nonarticulation level in US companies. Thus, this study tests the following hypotheses stated in null form:

H_1: significant nonarticulation exists between the financial statements of the Saudi companies.

H_2: adjusting the reported numbers on the statements using the footnotes does not significantly improve articulation for the Saudi firms' financial statements.

SAMPLE AND RESEARCH DESIGN

The original population of firms consisted of the 2014 financial statements of all publicly traded Saudi companies. Currently, there are 171 registered companies in the Saudi stock

exchange market (Tadawul, 2016). These publicly traded companies are divided into 15 different industries. Tadawul flags companies that experience substantial losses or are suspended from the market. Currently, there are nine flagged companies as shown in Table 1.

Table 1
Saudi Companies that Experienced Substantial Losses or were Suspended from the Market

Industry	No. of companies	No. of flagged companies
Banks & Financial Services	12	0
Petrochemical Industries	14	0
Cement	14	0
Retail	15	0
Energy & Utilities	2	0
Agriculture & Food Industries	16	2
Telecommunication & Information Technology	4	1
Insurance	35	4
Multi-Investment	7	1
Industrial Investment	15	0
Building & Construction	17	1
Real Estate Development	8	0
Transport	5	0
Media and Publishing	3	0
Hotel & Tourism	4	0
TOTAL	**171**	**9**

All flagged companies were excluded. Similar to previous studies using US companies, the authors excluded Banks & Financial Serveries and Insurance companies. Then, the authors randomly selected thirty companies from the Tadawul website. The 2014 financial statements along with associated notes of these thirty companies comprised the data used to calculate the variables for this study. All thirty companies used the indirect method of preparing the Statement of Cash Flows. Table 2 contains the final sample of Saudi firms.

For the purpose of this study, a sample of thirty companies was deemed appropriate. All numbers in this study had to be calculated by hand using the published financial statements. In addition, the authors had to analyze all the footnotes in the financial statements, determine information that would impact operations, and recalculate OCF for each relevant item.

In their analyses of companies' footnotes to reconstruct OCF both Bahnson et al. (1996) and Miller (2002) used similar sample sizes. Bahnson et al. (1996) used ten firms, while Miller (2002) used thirty-five firms. Although a small sample size is inherently a limitation of studies such as these, the authors felt that thirty firms were sufficient and appropriate for this study.

Table 2
Sample of Saudi Firms Selected.

Industry	Company's name
National Gypsum Co.	Building & Construction
Saudi Vitrified Clay Pipes Co.	Building & Construction
Anaam International Holding Group	Agriculture & Food Industries
Saudi Industrial Export Co.	Industrial Investment
United Electronics Co.	Building & Construction
Saudi Arabia Refineries Co.	Multi-Investment
United Wire Factories Co.	Building & Construction
Saudi Automotive Services Co.	Retail
Knowledge Economic City.	Real Estate Development
Herfy Food Services Co.	Agriculture & Food Industries
The Savola Group	Agriculture & Food Industries
Othaim Markets	Retail
Zoujaj Glass	Industrial Investment
Al Hokair Group	Hotel & Tourism
Astra Industrial Group	Industrial Investment
Yanbu Cement Co.	Cement
Al Ahsa Development Co.	Multi-Investment
Saudi Arabian Fertilizer Co.	Petrochemical Industries
Red Sea HousingCo.	Building & Construction
Al Sorayai Group	Industrial Investment
Saudi Pharmaceutical & Medical App. Co.	Industrial Investment
Electrical Industries Co.	Building & Construction
National Gas & Industerialization Co.	Energy & Utilities
Al Marai Co.	Agriculture & Food Industries
Tourism Enterprises Co.	Hotel & Tourism
Bawan Co.	Building & Construction
Dallah Healthcare Holding Co.	Retail
Saudi Paper Manufacturing Co.	Industrial Investment
Al Abdullatif Industrial Investment Co.	Industrial Investment
Fitaihi Holding Group	Retail

The two cash flow variables of interest are estimated operating cash flow (OCF) and cash flow from operating activities (CFFO) as reported on the Statement of Cash Flows.

To estimate operating cash flow (OCF), similar to previous studies, the following formula was applied to the information found in the financial statements:

OCF = NI + (CAb-CASHb) - (CAe - CASHe) - (CLb - DEBTb) + (CLe – DEBTe) + DEP + AMORT – OTHERGAIN + OTHERLOSS,

where NI = net income (before non-controlling interest), CA = current assets, CASH = cash, CL = current liabilities, DEBT = all loans, DEP = depreciation, AMORT = amortization, OTHERGAIN = all other gains, OTHERLOSS = all other losses, b = beginning of the period, and e = end of the period (one company in the sample reported an extraordinary item).

The primary variable of interest is DIFF, the difference between OCF and CFFO calculated as OCF - CFFO.

RESULTS AND DISCUSSIONS

Using only the published information on the financial statements, the authors calculated the estimated operating cash flow, OCF, and identified the reported operating cash flow, CFFO. Then, the difference between the two numbers was calculated (DIFF). DIFF represents the amount of nonarticulation in the financial statements. We scaled DIFF by both total assets (Ward et al., 2006; 2009) and CFFO (Bahnson et al., 1996). Because CFFO can be positive or negative, Ward et al. (2006) cautioned against scaling the difference by CFFO, as the results could be misleading. For comparison purposes, we use both total assets and CFFO as scaling measures. Table 3 contains the percentage differences for each firm.

The results for DIFF were similar to those reported in prior studies. The raw numbers suggest substantial nonarticulation among the companies for both scaling measures. A few of the differences were extreme with Knowledge Economic City having a difference exceeding 19% when scaled by total assets and over 2,000% when scaled by reported operating cash flow (CFFO). Using the same 3% level of significance as Bahnson et al. (1996), 23 of the 30 companies (76.6%) had differences exceeding three percent of CFFO, when scaled by CFFO as Bahnson et al. (1996) did. When using total assets as the scaling measure, seven of the 30 companies had differences exceeding three percent of total assets.

Table 3
The Difference between OCF and CFFO Scaled by Total Assets and CFFO: Unadjusted Using Only Financial Statement Information.

Name of Company	DIFF Scaled by Total Assets	DIFF Scaled by CFFO
National Gypsum Co.	4.00%	68.07%
Saudi Vitrified Clay Pipes Co.	-0.37%	-1.57%
Anaam International Holding Group.	21.77%	140.00%
Saudi Industrial Export Co.	-1.32%	-15.84%
United Electronics Co.	-4.28%	-22.55%
Saudi Arabia Refineries Co.	0.12%	4.34%
United Wire Factories Co.	0.23%	1.05%
Saudi Automotive Services Co.	-1.22%	-66.64%
Knowledge Economic City.	-19.49%	-2089.00%
Herfy Food Services Co.	-1.26%	-5.43%
The Savola Group	-1.49%	-18.58%
Othaim Markets	-0.23%	-1.43%
Zoujaj Glass	-2.22%	-33.19%
Al Hokair Group	-0.28%	-1.23%
Astra Industrial Group	0.55%	9.82%
Yanbu Cement Company	-0.30%	-1.37%
Al Ahsa Development	29.57%	-1061
Saudi Arabian Fertilizer Company	-0.25%	-0.71%
Red Sea Housing	-0.90%	-8.16%
Al Sorayai Group	-1.11%	-17.24%
Saudi Pharm & Medical Corporation	1.92%	185%
Electrical Industries Company	-8.35%	-29.14%
National Gas & Industerialization Co.	-1.23%	-6.97%
Al Marai	-0.92%	-6.88%
Tourism Enterprises Co.	-0.71%	-14.15%
Bawan Co.	-1.12%	-12.48%
Dallah Healthcare Holding Company	4.55%	50.92%
Saudi Paper Manufacturing Company	2.85%	38.16%
Al Abdullatif Industrial Investment Company	0.25%	2.07%
Fitaihi Holding Group	1.47%	20.60%
Number of companies with differences > +-3%	**7**	**23**

To supplement the reported numbers, the authors next recalculated OCF after reviewing the footnotes, to look for supplemental information that would help identify items that should, or should not, go in the operating section of the Statement of Cash Flows. The recalculated amounts for DIFF after relevant adjustments are shown in Table 4. These results show substantial

improvement in articulation after adjusting the numbers for the footnoted information. For example, the articulation for Knowledge Economic City improved tremendously; the difference is now only .12% of total assets and 3.08% of CFFO. After adjusting for footnoted information nine companies (30%) have differences greater than three percent when scaled by CFFO, while only one of the companies have differences greater than three percent when scaled by total assets.

Table 4
The Difference between OCF and CFFO Scaled by Total Assets and CFFO: Adjusted for Footnote Information

Name of Company	DIFF Scaled by Total Assets	DIFF Scaled by CFFO
National Gypsum Co.	0.12%	1.97%
Saudi Vitrified Clay Pipes Co.	-0.16%	-0.68%
Anaam International Holding Group.	4.52%	28.95%
Saudi Industrial Export Co.	-0.75%	-3.06%
United Electronics Co.	-0.54%	-2.71%
Saudi Arabia Refineries Co.	0.09%	3.23%
United Wire Factories Co.	0.51%	2.34%
Saudi Automotive Services Co.	-0.02%	-1.03%
Knowledge Economic City.	-0.12%	-3.08%
Herfy Food Services Co.	0.02%	0.09%
The Savola Group	-0.05%	-0.63%
Othaim Markets	0.03%	0.22%
Zoujaj Glass	0.00%	0.00%
Al Hokair Group	0.00%	-0.02%
Astra Industrial Group	0.49%	8.65%
Yanbu Cement Company	0.22%	1.01%
Al Ahsa Development	1.73%	62.08%
Saudi Arabian Fertilizer Company	0.08%	0.23%
Red Sea Housing	-0.31%	-2.83%
Al Sorayai Group	0.05%	0.83%
Saudi Pharm & Medical Corporation	1.69%	163%
Electrical Industries Company	-0.81%	-2.84%
National Gas & Industerialization Co.	0.23%	1.30%
Al Marai	-0.14%	-1.07%
Tourism Enterprises Co.	0.00%	0.00%
Bawan Co.	-0.62%	-6.86%
Dallah Healthcare Holding Company	0.08%	0.94%
Saudi Paper Manufacturing Company	0.83%	11.07%
Al Abdullatif Industrial Investment Company	-0.02%	-0.17%
Fitaihi Holding Group	0.00%	0.04%
Number of companies with differences > +-3%	**1**	**9**

Generally, there are more similarities than differences between US accounting standards and Saudi accounting standards. However, the authors identified over twenty differences between US GAAP and Saudi GAAP for the firms in our sample.

Some of the major differences in the calculations that explain why the footnotes help in adjusting the numbers to more appropriate amounts centered on pension reporting, interest reporting, and the use of aggregation. One major difference relates to pension accounting. Saudi companies do not have a pension standard and call it 'end of service' instead of pension expense. All of the companies recorded the unpaid part of the end of service (pension) expense as a long-term liability. Thus, the pension expense would not show up in OCF, estimating the number.

Saudi companies are inconsistent in the treatment of interest expense. Some companies call interest expense financial burdens, others call them financing costs, while some companies call them financial expenses. Thus, some companies treat interest expense as an operating item, while others do not.

Another important reason for the differences between CFFO and OCF is the aggregation level on the balance sheet. There are so many accounts aggregated under one category that distinguishing between operating and non-operating activities is difficult. Although these aggregations might be immaterial when considered separately, the accumulated effect of all of the aggregations can greatly impact the calculation of OCF, leading to high levels of nonarticulation.

Another interesting finding is that companies investing heavily in other activities than their main operations have significantly more nonarticulation. Companies focusing mostly on their operations that do not have other income, and expenses tend to have a very high level of articulation regardless of the size of the company or the method used to calculate operating cash flow. Finally, combinations, acquisitions, and disposals of businesses also appear to have an impact on the level of nonarticulation.

The results of the unadjusted numbers in this study do appear consistent with the findings of Bahnson et al. (1996) and Miller (2002). However, to test our hypothesis we need to determine if the nonarticulation is significantly material. The absolute value of DIFF for each company was summed and a t-test for significance from zero was calculated in both situations. The authors used the absolute value because, in this study, we are only interested in the amount of nonarticulation, not the direction of the difference. In addition, Ward et al. (2006; 2009) cautioned against using CFFO as the scaling measure because it can be negative or positive; dividing by a negative number can produce inconsistent scaling results. By using the absolute value, we are able to eliminate this scaling problem. The test results are reported in table 5.

Table 5 contains the means for DIFF, t-test statistics, and p-values for testing DIFF calculated before and after considering the impact of footnote information. Because H_1 is a two-tailed test of differences with no direction assumed, one must use a Tukey two-way adjusted when interpreting levels of significance. Thus, the results reported in Table 5 have been adjusted for the two-way assumption.

The t – test results show that significant nonarticulation exists when the difference (DIFF) is scaled by total assets (t statistic = 2.83, p-value <.016). The nonarticulation is still significant,

even after adjusting for the additional footnoted information (t statistic = 2.63, p-value < .026). However, the results differ when difference is scaled by CFFO; the results are never significant, not for the published information only or for the footnote-adjusted information (t statistics of 1.03 and 1.82, p-values < .624 and < .158, respectively). This result may appear counterintuitive based on the results reported in Table 4 showing that the differences were greater when scaled by CFFO. However, the variances in the results when scaling by CFFO were much greater than when scaling by total assets, thus resulting in much smaller test statistics. And, as explained earlier, scaling DIFF by CFFO adds additional noise to the nonarticulation measure.

Thus, H1 is partially, but not completely, accepted. Significant nonarticulation exists for the Saudi companies if the difference is scaled by total assets. However, the difference is not significant when scaled by CFFO.

Table 5
Tests of Differences (DIFF): Published Unadjusted Information and Footnote Adjusted Information

Scaled by total assets:

Sample	Means for DIFF	Standard Deviations	t Statistic	Prob > t
Published Information (n = 30)	0.0370	0.0715	2.83	0.016
Footnote Adjusted (n = 30)	0.0050	0.0104	2.63	0.026

Scaled by CFFO:

Sample	Means for DIFF	Standard Deviations	t Statistic	Prob > t
Published Information (n = 30)	36.3200	193.3240	1.03	0.624
Footnote Adjusted (n = 30)	0.1037	0.3126	1.82	0.158

To test H_2, whether adjusting the reported numbers using the footnotes significantly improved articulation, the two DIFF measures (DIFF calculated using the published information only and DIFF calculated adjusting the published information for footnote information) were calculated for each measure. Because of the small sample sizes, we calculated the Folded F test of equal variances for the two groups compared to see if a t – test of difference between the two measures would be appropriate. In all comparisons, the Folded F - test Statistic was significant at p – values less than .001, thus indicating that the variances from the two groups were not equal. Significant Folded F – test Statistics suggest that parametric tests such as the t – test would not be appropriate for this comparison, and could produce biased results. Thus, for our sample, a non-parametric statistic is a more reliable test of significance. As a result, we used the non-parametric Wilcoxon Test of Z approximation for each comparison test (Bhattacharyya and Johnson, 1977). The results for the comparison tests are reported in Table 6.

The results for the comparison tests show that adjusting the reported numbers for footnoted information significantly improved articulation in all cases, even when the difference is scaled by

CFFO (p – values < .0001 in all cases). Thus, using the footnotes significantly improves articulation, even when using the weaker scaling measure of CFFO. So, H_2 is rejected. Using the footnotes for the Saudi companies does result in significantly improved articulated numbers. This result is contrary to the findings of Bahnson et al. (1996) and Miller (2002).

The results of this study suggest that nonarticulation issues also affect Saudi firms. However, the Saudi companies may provide more detailed footnote information than US companies. By adjusting the numbers on the financial statements using footnote information, one is able to significantly improve articulation. Failure to adjust the published numbers in the statements for the footnote information would result in similar nonarticulation issues as found in US companies.

Table 6
Non-parametric Wilcoxon Test of Amount of Difference in Nonarticulation between Statement Information and Footnote Supplemented Information

Non-parametric Wilcoxon Test:		
Variable	**z approximation**	**Prob > z**
DIFF Scaled by TA (n = 30)	3.41	0.0003
DIFF Scaled by CFFO (n = 30)	4.00	0.0001

Thus, our results using footnote information contradict Bahnson et al. (1996) and Miller (2002) somewhat. Bahnson et (2002) were not able to explain the nonarticulation issues using footnoted information. For the Saudi companies in this study, the footnote information was sufficient to explain a significant amount of the nonarticulation.

CONCLUSION

The results of this study suggest that the occurrence of nonarticulation in Saudi companies does exist, especially if one scales the difference by total assets. When taking into consideration only the published financial numbers from the financial statements the Saudi companies produced nonarticulation levels similar to those reported for US companies in prior research. Trying to estimate the operating cash flow without carefully studying the financial statements and the associated notes is still not sufficient for Saudi companies.

However, if one is careful to incorporate footnote information into the financial numbers from the financial statements, then the differences decrease significantly, resulting in significantly better articulation. Thus, the results of our analyses for the Saudi companies suggest differences from Bahnson et al. (1996) and Miller (2002) for the footnoted information. Unlike Bahnson et al. (1996) and Miller (2002), adjusting operating results for relevant footnoted information significantly improved articulation (significantly decreased the difference between reported operating cash flow and estimated operating cash flow).

The different findings of this study are interesting and add to the previous literature on nonarticulation. Our findings would seem to suggest that the footnote requirement differences

between the different country's standards of reporting result in less nonarticulation among the Saudi companies. Thus, investors in the Saudi Arabia market are making decisions with more articulated statements than investors in the US and Hong Kong markets.

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FEDERALLY FUNDED R&D FUELS REGIONAL ECONOMIES: A PANEL DATA ANALYSIS

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ABSTRACT

Sustained economic growth and innovation are only possible with adequate research and development (R&D). The Federal Government is the largest source of funds for academic R&D, although the amount contributed has declined in recent years. This article looks at the short-term and long-term impact of federally funded academic R&D on state economies using panel data that cover the period between 2005 and 2015. Spillover effects at the national level are incorporated in a total factor productivity model as suggested in the literature. The analysis shows that federal investment in academic R&D significantly increases state GDP in the long term, although the short-term economic impact is also not negligible. Most important, R&D activity from universities, businesses, states, and other entities collectively improves productivity and promotes job creation and innovation.

INTRODUCTION

Academic R&D in the United States is largely funded by the federal government through various agencies. The literature suggests that academic R&D leads to higher returns than private R&D from industry (Broström & Karlsson, 2017; Youtie & Shapira, 2008). Some suggest this is due to the public nature of government-funded academic R&D, while others argue academic R&D lacks a commercial focus and consequently contributes little to economic growth (for an earlier discussion of R&D–economic growth relations, see Anselin, 1997; Mansfield, 1991; Jaffe, 1989). There is also a disproportionate amount of academic R&D in basic research, whereas businesses tend to focus on applied research and development. This academic focus is perceived as a drain in funding by some, especially if desired results are not achieved, while others see it as a necessary step to create innovation (Baumann & Kritikos, 2016; Youtie & Shapira, 2008; Jaffe, 1989).

Federally funded university R&D is a source of knowledge that can benefit both the institution conducting the research and the region in which the institution is located. Since the Bayh-Dole Act of 1980, universities and others conducting federally funded research have been able to retain the patents or licenses from their findings. The data show that university R&D mostly occurs in large, public, Midwestern U.S. universities with combined funding across the U.S. in 2014 of $7 billion, of which 56 percent came from the federal government (Weinberg et al., 2014). This funding is an incentive for further innovation for most universities, but it also allows the commercialization of their findings. Although the U.S. Patents and Trademark Office (USPTO) indicates that the number of patents granted to universities is small relative to the number granted to firms, there is still a positive trend of increased of academic patenting.

The process by which universities and firms can patent R&D findings is assumed to promote economic growth, though the extent of that growth has not been fully determined. Following growth accounting methods, the value of innovation is assumed to come from R&D investment from academia, industry, state government, and federally funded research development centers. The importance of R&D in regional economic development is presented in a way that underscores the need for future investments. For example, a study in the 1990s finds university R&D is an important stimulus for economic development leading to increases in GDP of $15.5 billion CAD and an employment spike of up to 200,000 in Canada (Martin & Trudeau, 1998).

There is a dependency between basic and applied research, as well as between basic research and development, which highlights the importance of academic R&D in an economic growth framework. Moreover, universities rely heavily on federal government assistance to be able to conduct research. Given the ongoing debate in the literature about the impact of academic R&D on economic growth, this paper seeks to investigate empirically the extent of the contribution of federally funded university R&D to economic growth. Furthermore, since any impact of R&D has significant public policy implications, this paper runs several scenarios for a group of U.S. states to find both the long- and short-term impact of federally funded university R&D on the states' economies.

This paper particularly aims to answer the following four broad questions:

- *What is the trend in federally funded academic R&D in the United States?*
- *What role does federally funded academic R&D play in short-term economic growth?*
- *What role does federally funded academic R&D play in long-term economic growth?*
- *What are the implications of the impact of federally funded academic R&D for the selected regional economies?*

In the sections that follow, this paper first reviews the literature on the relationship between R&D and economic growth. The third section introduces data issues, concepts, and research questions. The fourth section deals with study methodology. The fifth section presents the trends in academic R&D. The sixth section presents the study's findings. The seventh section discusses the implications and limitations of this study. The conclusion follows.

LITERATURE REVIEW

R&D as a Concept

Research and Development (R&D) refers to the investigative activities undertaken by firms, universities, and other entities to create or improve products and processes (Hall, Contribution to the International Encyclopedia of the Social Sciences, Second Edition, 2006). The U.S. Federal Government Office of Management and Budget defines R&D as "activities that comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications" in its Circular A-11, section 84 (OMB, 2017). Generally, R&D is divided into basic research, applied research, and development. The federal government

defines basic research as the experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts. Applied research is the original investigation undertaken to acquire new knowledge and is directed primarily toward a specific practical aim or objective. Finally, development or experimental development is the creative and systematic work that draws on knowledge gained from research and practical experience, directed at producing new products or processes or improving existing ones (OMB, 2017). Generally, universities and research facilities expand their R&D resources on basic and applied research, whereas firms focus on the development of products and processes.

R&D aims to gain additional knowledge that allows for technological progress and innovation. The potential increase in the stock of knowledge is a result of a collaborative effort among firms, universities, research facilities, and individuals. Successful creation of knowledge results in technological advancement that facilitates production and increases consumption within an economy. Innovation and progress spur economic growth alongside capital and labor. The eminent economist Joseph Schumpeter advanced this "innovation economics" model in identifying innovation as the critical dimension of economic change. His theory emphasized the role of innovation, entrepreneurial activities, and market power in promoting economic growth (Schumpeter, 1942).

The investments that government and businesses make in basic and applied R&D are critical for growth and development of subsequent technologies, products, firms, and industries. Estimates of the contribution of R&D to economic growth were initially developed by Solow (1956) in a production function framework commonly referred to as “total factor productivity” (Solow, A Contribution to the Theory of Economic Growth, 1956). Recent estimates show that technological and scientific innovation are responsible for about half of America’s economic growth (Ezell & Andes, 2016). Therefore, innovation is key to increasing economic growth and wages in the long run, as it is an indicator of productivity. According to the Information Technology and Innovation Foundation, U.S. productivity from the mid-2000s to the present has been at its lowest level since the 1940s, due in part to the lack of innovation (Baily & Montalbano, 2016). The U.S. trails behind technology-intensive countries such as Germany or Japan, which translates into significant losses in potential economic growth. An increase in productivity by a mere percentage point is found to boost the economy by $2.3 trillion in a single year while simultaneously shrinking the federal budget deficit by more than $400 billion (Foundation, 2016).

Investment in R&D and innovation are tightly linked in promoting economic growth. Often, the direct impact of R&D is complemented by spillover effects which contribute to greater economic growth. For instance, the real effects of academic research, spillover effects using corporate patents and R&D, university research show a significant effect of academic R&D on corporate patents for drug, medical tech, electronics, optics, and nuclear technology areas (Jaffe, 1989). Moreover, industrial innovations heavily rely on academic R&D, and such spillovers are facilitated by the geographic coincidence of universities and research laboratories within and across states (Zoltan, Audretsch, & Feldman, 1992; Mansfield, 1995).

The more recent literature emphasizes the importance of R&D for innovation. A slump in economic growth was partly attributed to the lack of investments in R&D which prompted increased spending in research from 1980. Industrial investments in R&D was heavily used as a

strategic policy aimed at addressing the U.S. productivity slowdown during that period to present (Broström & Karlsson, 2017). Furthermore, continued promotion of R&D is necessary to increase the private economic value of research by-products such as patents. The literature finds that patents, licenses, and startups derived from R&D are significantly and positively related to their scientific value and the potential for economic gain (Kogan, Papanikolaou, Seru, & Stoffman, 2017).

This paper seeks to quantify the effect of R&D on economic growth at the state level. Particularly, it focuses on the effect that federal subsidies to universities have on local and regional economic growth. Universities receive R&D funding from various sources including businesses, federal and state governments, nonprofit organizations, and donations. The federal government provides a sizable portion of universities' R&D funding through its various agencies. The federal government spent $131.4 billion in 2015 and an estimated $145.4 billion in 2016 on university R&D funding. Its largest grant-awarding branches are the National Science Foundation, the U.S. Department of Defense and Technology, the U.S. Department of Agriculture, the U.S. Department of Commerce, and the U.S. Department of Homeland Security (National Science Foundation, 2017).

R&D and Spillover Effect

The measurement of R&D effects is a difficult concept, rife with endogeneity issues. R&D itself creates a pool of knowledge that sometimes is non-rival and non-excludable to others, effectively making R&D outcomes a public good. The subsequent creation of a large stock of knowledge capital fosters cooperation, innovation, and investment within an economy. This makes the direct link between federally funded R&D and the corresponding economic benefits difficult to establish.

Solow developed an econometric framework for the effect of technological progress on aggregate output (gross national product) between 1909 and 1949. Assuming constant returns to scale and that factors are paid their marginal products, he found technical change to be neutral on average. His main contribution lies in his Solow residuals, whereby changes in aggregate output not caused by labor and capital were assumed to be from technical changes (Solow, 1957). Griliches later expanded this framework in a "knowledge production framework" (Griliches, 1979). Issues relating to the adequate measurement of output in R&D-intensive industries and the measurement of the so-called stock of R&D "capital" were raised. The capital stock was modeled following a spillover effects model. Further, Jaffe expanded on Solow's model, and particularly on Griliches' knowledge production framework, to analyze R&D spillovers using the number of patented innovations (Jaffe, Technological Opportunity and Spillovers of R & D: Evidence from Firms' Patents, Profits, and Market Value, 1986). He later enriched the model by including additional indicators for R&D spillovers such as corporate patents, corporate R&D, university research, geographical characteristics, and state R&D expenditures (Jaffe, 1989). Jaffe found significant effects of academic R&D on corporate patents, especially in the life sciences field.

More recent research on the effect of R&D on economic growth focuses on the dissemination of sciences using Solow's total factor productivity model (Mansfield, 1995). This paper will take advantage of a Cobb Douglas production function, as widely used in the literature,

to analyze the effect of R&D on economic growth while accounting for spillovers. Most of the research focuses on the by-product of R&D in the form of academic articles. Another important consideration in evaluating the impact of R&D is the capacity of a university or a firm to absorb from the already-present knowledge stock. Similarly to Knott, with her research quotient and organizational IQ framework, this paper will aim to isolate the effect of federal R&D funding to a state's universities on its gross domestic product (Knott, 2008).

R&D in the U.S.: An Overview

The Bayh-Dole Act of 1980 (the Act) made it possible for universities, small businesses, and nonprofit institutions to retain the patent and licensing rights from their federally funded research. It is perhaps one of the most influential pieces of legislation about intellectual property in recent times. The Act removed the restrictions that had previously allowed only the government itself to retain ownership of what was created with government funds (Matthew, 2008).

R&D plays a significant role in the technological advancement and the process of innovation. The share of patents granted to research universities dramatically increased due to the Act. R&D is widely recognized as a contributor to economic growth alongside capital and labor. The economic impact of R&D can be measured in its commercial transfer, scientific dissemination, and export of resources. The subsequent movement of knowledge through publications, conference and working papers, and collaboration among different entities increase the value of R&D (R&D: National Trends and International Comparisons, 2014).

Table 1: R&D Output (2005-2015) for the Selected States

State	Real GDP*	Total R&D*	Patents	Licenses	Startups
Alabama	174,404,272,727	2,274,357,916	386	36	8
Florida	757,819,454,545	6,828,132,610	3,046	164	31
Georgia	423,930,090,909	4,949,276,909	1,853	181	17
Kentucky	164,461,272,727	1,604,144,675	491	18	9
Mississippi	93,855,909,091	618,913,434	135	10	4
North Carolina	417,602,909,091	9,114,900,936	2,483	236	25
South Carolina	167,174,545,455	1,813,267,409	642	22	9
Tennessee	260,212,818,182	2,293,332,002	818	88	7
Virginia	414,648,818,182	5,479,662,643	1,459	91	14

***Notes**: *In chained 2009 dollars. All values averaged between 2005 and 2015.*
***Sources**: AUTM, BEA, USPTO*

Since our regional scenarios focus on Tennessee and its neighbors, this R&D overview will use a select number of southern and southeastern states in comparing R&D behaviors. These states are Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. Among the selected states, North Carolina leads by investing 2.18 percent of its potential GDP in R&D (Table 1). Virginia, Alabama, Georgia, and South Carolina spend from 1.30 percent to 1.08 percent on average on R&D outlay. In descending order, Kentucky, Florida, Tennessee, and Mississippi spend between a high of 0.98 percent and a low of 0.66 percent in R&D. It is to be noted that Tennessee spends 0.66 percent of its corresponding GDP on R&D.

Between 2005 and 2015, Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia were granted a total of 124,427 utility patents, accounting for about 10.73 percent of all patents granted by the U.S. Patents and Trademark Office (USPTO). Moreover, these states held about a fifth of all licenses (18.37 percent) and startups (18.16 percent) in the nation. Overall, North Carolina, Florida, and Georgia seem to invest more in R&D and have a higher number of patents granted, licenses, and startups than their counterparts in Table 1.

Academic R&D and Output

Some researchers note that universities have assumed an expanded role in science and technology-based economic development (Youtie & Shapira, 2008). Investments in R&D in general, and specifically in academic research, should respond to the economic needs of an area. This highlights the importance of regional and local contexts when responding to R&D needs. Transformation hubs such as Silicon Valley (Northern California) and Route 128 (the Boston metropolitan region in Massachusetts) are examples of university networks that have had a powerful influence on innovation and local economic development. Other researchers discount the importance of regional proximity when looking at the impact of university R&D, arguing that knowledge spillovers are widely available (Beise & Stahl, 1999).

As seen in Tables 2 and 3, academic R&D expenditures make up a significant portion of total state R&D expenditures. The share of academic R&D for the selected states in many cases amounts to a third of total R&D expenditures, except Mississippi, where it accounts for two-thirds of the total amount. These shares of spending range from a low of 21 percent for Virginia to a high of 39 percent for Tennessee. The federal government is the largest contributor to academic R&D, in most cases funding at least half of the total. This observation demonstrates the importance of federal funding in academic institution R&D. The states with the highest levels of R&D and GDP, which were North Carolina, Florida, and Georgia, received respectively 60 percent, 53 percent, and 59 percent of their academic R&D funding from federal sources.

Table 2: Academic R&D (2005-2015) for the Selected States

State	Total R&D*	Total Academic R&D*	Business R&D*	State Government R&D*
Alabama	2,274,357,916	751,006,265	1,509,624,439	13,727,211
Florida	6,828,132,610	1,866,305,481	4,861,857,052	99,970,078
Georgia	4,949,276,909	1,622,196,129	3,317,884,167	9,196,612
Kentucky	1,604,144,675	524,491,103	1,063,121,657	16,531,914
Mississippi	618,913,434	407,092,165	207,161,811	4,659,458
North Carolina	9,114,900,936	2,261,850,986	6,823,132,878	29,917,072
South Carolina	1,813,267,409	598,229,845	1,173,352,534	41,685,029
Tennessee	2,293,332,002	900,880,654	1,388,532,676	3,918,671
Virginia	5,479,662,643	1,166,674,434	4,287,305,967	25,682,242

***Notes**: *In chained 2009 dollars. All values averaged between 2005 and 2015.*

Table 3: Share of R&D by Origin (Average 2005-2015) for the Selected States

State	Total R&D	Total Academic R&D	Business R&D	State Government R&D	*Federal Academic R&D**
Alabama	100%	33%	66%	1%	*65%*
Florida	100%	27%	71%	1%	*53%*
Georgia	100%	33%	67%	0%	*59%*
Kentucky	100%	33%	66%	1%	*46%*
Mississippi	100%	66%	33%	1%	*58%*
North Carolina	100%	25%	75%	0%	*60%*
South Carolina	100%	33%	65%	2%	*48%*
Tennessee	100%	39%	61%	0%	*66%*
Virginia	100%	21%	78%	0%	*58%*

Note: *******Federal Academic R&D as a share of Total Academic R&D*
Sources*: AUTM, BEA, USPTO*

Business R&D was the single largest source of total R&D in the selected states, excluding Mississippi, ranging from 61 percent for Tennessee to 78 percent in North Carolina. These significant amounts of business spending on R&D resulted in increased productivity. The growth fostered through industry innovation could be increased through added investment in academia while simultaneously promoting cooperation between academia and industry. In short, the data present a skewed distribution of R&D spending, with businesses being significantly on the right tail while academia is of somewhat reduced weight. Given the importance of R&D spending to economic growth, state governments are underinvesting, as Table 3 shows.

Academic R&D creates an impact far beyond economic growth. For example, Mansfield (1991) estimates the social rate of return of academic R&D on industrial innovation and finds that such innovation would not have been possible in the absence of academic R&D. From 1975 to 1985, about one-tenth of new products and processes commercialized in the information processing, electrical equipment, chemical, instrument, drug, metal, and oil industries could have been developed only with substantial delays without recent academic research (Mansfield, Academic research and industrial innovation, 1991). Furthermore, the transfer of technology from research to industry can vastly expand the resource base in such a way that companies with no internal R&D efforts achieve additional capabilities and that companies with some level of internal R&D in place find their research and development capabilities augmented and enhanced (Rahm & Hansen, 1999). Moreover, Rahm & Hansen assert that using the available knowledge and technologies developed in universities to enhance the competitiveness of U.S. industry can be a super-optimum technology policy solution (Rahm & Hansen, 1999).

Table 4 below shows non-standardized academic R&D output for the selected states. Florida, North Carolina, Georgia, and Virginia have the highest numbers of total patents granted, whether business or academic. Moreover, these states seem to emphasize science and engineering program graduate enrollment, postdoctoral fellows, and researchers.

Table 4: Academic R&D Output (2005-2015) for selected states

State	APat	UPat	BPat	Ph.D.	M.A.	S&E* GS	S&E* Post	S&E* RS	UFaculty
Alabama	386	37	348	2,056	10,937	8,720	373	309	9,433
Florida	3,046	227	2,819	8,377	29,275	28,092	1,495	508	22,971
Georgia	1,853	119	1,734	3,930	15,087	14,305	1,368	173	16,903
Kentucky	491	37	454	1,788	8,167	5,998	391	249	9,032
Mississippi	135	11	124	1,138	4,376	3,963	171	42	6,664
North Carolina	2,483	132	2,350	4,081	15,099	17,831	2,075	661	21,793
South Carolina	642	35	607	1,579	5,534	4,716	372	59	8,619
Tennessee	818	51	767	2,849	10,495	8,157	893	182	11,723
Virginia	1,459	69	1,390	4,686	17,893	16,721	1,000	309	16,167

***Notes**: *S&E: Science and Engineering; APat = All Patents; UPat = University Patents; BPat = Business Patents; Ph.D. = Doctorate Degrees; M.A. = Master's Degrees; S&EGS = Science and Engineering Grad Students; S&EPost = Science and Engineering Postdocs; S&ERS = Science and Engineering Research Staff; UFaculty = University Faculty*

***Sources**: AUTM, NSF-NCES, USPTO, IPEDS*

Patents, licenses, and startups for each state are among the most widely used indicators for R&D outcomes. According to the USPTO, a patent is the grant of a property right to the inventor, with a term of 20 years for a new application. There are three types of patents: utility, design, and plant. Utility patents are the most widely sought-after types of patents from R&D. They are granted to anyone who "invents or discovers any new and useful process, the machine, article of manufacture, or composition of matter, or any new and useful improvement thereof" (Patents Getting Started, 2015). Businesses hold the bulk of patents compared to universities and other entities. Increases in licensing and startups are alternative measures of innovation and the effect of R&D.

DATA, CONCEPTUAL ISSUES, AND RESEARCH QUESTIONS

Data

The National Science Foundation (NSF) reports R&D expenditure data through its National Center for Science and Engineering Statistics (NCSES). The NCSES conducts extensive surveys regarding R&D Funding and Expenditures, Science and Engineering Research Facilities, and other areas related to education, research, and funding. The data used in this study comes from a collection of R&D surveys including the Business R&D and Innovation Survey (BRDIS), the Higher Education Research and Development Survey (HERD), the Survey of Earned Doctorates (SED), the Survey of Graduate Students and Postdoctorates in Science and Engineering, the Integrated Postsecondary Education Data System (IPEDS), and the Survey of State and Government Research and Development. Patents data for businesses and universities were collected from the United States Patent and Trademark Office (USPTO). Additional data on patents, licenses, and startups were collected through the Association of University Technology Managers' (AUTM) Statistics Access for Tech Transfer (STATT).

Table 5: Summary Statistics: 50 States +District of Columbia 2005-2015

Variables	Obs.	Mean	Std. Dev.	Min	Max
GDP*	561	293,000	357,000	25,500	2,240,000
Wages*	561	128,000	152,000	10,100	958,000
Employment	561	3,511,440	3,818,826	302,630	22,700,000
University R&D*	561	1,120	1,360	44.1	7,930
Business R&D*	561	5,230	10,400	20.7	95,900
State R&D*	561	31.7	61.5	0.16	449
FFRDC R&D*	136	944	1,250	4.64	4,670
Federal U. R&D*	561	673	826	24.6	4,970
Research Equipment*	561	39,.1	51.5	1.47	368
Associate	561	16,946	21,003	447	132,442
Certificate	561	11,558	15,614	287	104,359
Bachelor	561	32,755	32,823	1,427	189,975
Master	561	13,377	14,826	388	71,529
Doctorate	561	3,153	3,547	21	18,697
S&E Graduate***	561	12,279	14,403	54	83,680
S&E Postdoc***	559	1,142	1,827	3	10,601
Research Staff	530	371	561	1	5,367
Faculty	560	11,432	11,299	974	57,819
University Patents	516	85	120	0	981
Business Patents	560	2,499	5,556	18	40,661
Licenses	528	96	108	0	493
Startups	521	14	20	0	222

***Notes**: *In millions chained 2009 dollars. All values averaged between 2005 and 2015.*
*****S&E: Science and Engineering*

University R&D spending accounts for an average of $1.1 billion with a maximum observation of $8 billion (Table 5). Business R&D is on average five times as high with a mean of $5.2 billion. Comparatively, state government R&D expenditures average only $32 million with a low of $160,000, suggesting a large variation from state to state and from year to year.

Balanced Panel Data

Strongly balanced panel data are constructed with 50 states and the District of Columbia (N = 51) over a period spanning from 2005 to 2015 (T = 11) for a total of 561 observations. All dollar values are adjusted for inflation (real) using 2009 chained dollars. Selected indicators are summarized in Table 6. The longitudinal setup permits a greater capacity for capturing interstate differences and intrastate dynamics (Hsiao, 2014). More degrees of freedom can be used in the analysis of R&D expenditures for each state individually over the years as well as for all states at a certain point in time.

A simple cross-sectional structure would miss the delayed effects of R&D expenditures. The very nature of R&D implies lagged results that can be approximated using panel data, as is the case, for example, with an application for and granting or refusal of patents, which can take years and occur over multiple time periods. In contrast, time-series data would capture little of the

difference in R&D spending between states, part of which is to be captured by spillover effects. Overall, the nature of panel data allows for an evaluation of individual state differences in spending over time, states' dynamic changes in R&D spending over time, and the combined differences of all the states in spending behaviors. This dynamic analysis could also provide insight into economies of scale from which states with higher R&D might benefit.

Selection Bias and Omitted Variable Bias

A state's decision to invest in R&D is subject to its criteria, such as the availability of funds, research activities of businesses and universities, or even a focus on R&D itself. Therefore, the very decision to invest in R&D is endogenous to the state, representing a type of selection bias. Depending on its characteristics, each state decides to invest in a specific level of R&D. This causes another selection bias due to the differences in observable characteristics between the states in R&D investment.

The panel data alleviate these issues of selection biases by observing the R&D spending behaviors of each state over the entire period of interest, thus giving insight into variations in their characteristics. Moreover, the effects of R&D spending can be disentangled from other factors, such as other capital and labor spending, within total spending to achieve a level of GDP.

The impact of potential omitted variables that might be the real causes for a level of GDP is minimized by the panel data structure. The framework used here is similar to that used when employing panel data to solve selection bias issues. The longitudinal aspect of the data could not capture some of the effects of variables that might be correlated with R&D expenditures but are excluded from the model. This is possible due to both the intertemporal dynamics (T = 11) of the states and the individuality of the states (T = 51).

Research Questions and Geographical Scope

This paper uses three layers of geographies to assess (a) the short-term economic impact of academic R&D expenditures (Tennessee), (b) the long-term economic impact of academic R&D on GDP growth (across the states), and (c) scenarios for the selected states (the southeastern states). This paper addresses the following major research questions using these layers of geographies:

- *What is the trend in federally funded academic R&D in the United States?*
- *What role does federally funded academic R&D play in short-term economic growth?*
- *What role does federally funded academic R&D play in long-term economic growth?*
- *What are the implications of the impact of federally funded academic R&D for the selected regional economies?*

METHODOLOGY

Short-Term Economic Contributions of Academic R&D

To estimate the short-term economic impact of academic R&D, this study employs a widely used input-output model, IMPLANpro© (www.implan.com). The following input variables are used to estimate the short-term economic impact:

- *Payments to researchers: technician/staff scientist, faculty, research analyst/coordinator; postgraduate researcher, graduate student, clinician, and research support;*
- *Goods and services purchased locally, statewide, and nationally;*
- *The vendor, contractor, and subcontractor opportunities.*

In estimating the economic impact of innovation, new start-ups formed as a result of federal university R&D are calculated using the AUTM survey and Census Bureau Surveys. According to our estimates, in 2014, about 10 percent of all establishments are new start-ups, employing on average eight (8) people. Using the data from AUTM and Census Bureau Surveys, on average, every $100 million in university R&D spending generates 1.52 new start-ups in the U.S.

Economic Impact Method Assumptions

Geography. A clearly defined study area allows us to identify out-of-area monetary flows. If the source of revenue for a company, institution, or industry is from outside a clearly defined area, we then argue that the monetary activity is a net addition to the area's economy. This treatment is an important component of economic impact estimates. In this study, Tennessee is defined as the geographical unit to estimate the short-term economic impact of federally funded academic R&D.

Economic Impact. What is the meaning of economic impact? Economic impact refers to an economic activity's net new contribution to the region in which the activity takes place. Some examples include a visitor from out of town spending money on a hotel/motel, a new manufacturing plant operating in the region, federal or out-of-region money flowing to an area to support a new program, or an activity that is unique in the region. Economic impact analysis is different from economic contribution analysis or economic significance analysis, in which we often counterfactually remove an institution, program, or event from an economy without determining whether that given institution, event, or program may be considered net new to the region.

In reporting economic impact estimates, we follow the procedure outlined below:

1. Business revenue (output) effect—direct, indirect (the effect of business-to-business interactions), and induced (the effect of employee spending of wages and salaries) by major industries. These measures combined (indirect and induced) are also called the ripple effect. The business revenue effect represents all economic activities (i.e., trades, value

added, income, taxes, proprietary income, etc.) associated with the activity. Therefore, this figure should not be aggregated with any other measures reported here.
2. Employment effect—direct, indirect, and induced by major industries.
3. Labor income effect—direct, indirect, and induced by major industries.
4. Local and state taxes—total taxes by major industries.

These categories of impact, except local and state taxes, are reported at the direct, indirect, and induced impact level.

1. Direct effect: Changes in economic activity during the first round of spending.
2. Indirect effect: Changes in sales, income, or employment within the region in backward-linked industries supplying goods and services.
3. Induced effect: Increases in sales within the region from employees spending earned income (for example, doctors in a hospital spend their earnings on goods and services in the regional economy; this spending generates business revenues, employment, and wages and salaries throughout the study area economy).

Long-Term Economic Impact of Academic R&D

The analysis of R&D impact is based on Solow's residuals or Total Factor Productivity approaches, focusing on accounting growth (Solow, 1957). A Cobb-Douglas production function will be used to evaluate the effect of R&D, and particularly academic R&D, in promoting economic growth. The difficulty lies in disentangling the effect of R&D—referred to as technical progress in Solow's works—from capital and labor investments. An alternative way to measure the link between research and economic impact by accounting for spillover effects of R&D is modeled by Griliches (1979), Jaffe (1986), and Knott (2008), among others.

Theoretical Framework

Spillover Effect. Spillover effects (positive externalities) are assumed in the presence of any and all R&D activity at the state and national level. Therefore, spillover is constructed from aggregate U.S. R&D activity for the period of interest. Conceptually, a lower knowledge stock leads both to imitation by the less-informed agent and to the invention of new knowledge for both states (Jovanovic & Rob, 1989). A significant portion of the literature uses geographical proximity for increased knowledge spillover, although there is some evidence in the literature that spillovers are facilitated by geographical coincidence (Mansfield, 1995; Jaffe, 1986 and 1989; Zoltan, Audretsch, & Feldman, 1992). Another measure widely used for spillovers is the technological proximity between entities, often firms (Colino, 2016). Clusters of similar industries are formed using the North American Industry Classification System (NAICS) with the assumption that spillovers are more likely within an industry than across industries. The parametrization of spillover effects follows the literature by using an instrumental variable approach. The total impact of contemporaneous national R&D expenditures in the U.S. is assumed to impact GDP *and* investment in R&D. Therefore, the first stage model is:

$$\ln(GDP_{i,t}) = \alpha_{i,t} + \beta\ln(GDP_{i,t-1}) + \boldsymbol{\gamma}\mathbf{ln}(\boldsymbol{R\&D_t}) + \delta\ln(R\&D_{i,t}) + \delta_1\ln(R\&D_{i,t-1}) + \mu X_{i,t} + \varepsilon_{i,t} \quad (1)$$

Total U.S. R&D includes combined academic, business, state, and research center R&D expenditures. State level R&D is analyzed for up to one lagged period. The vector *X* represents all other controls, such as employment and educational outcomes for each state. The estimates from ***Equation 1*** will be used in the second-stage model of income impact. This is in part to mitigate simultaneity bias involving the bidirectional relationship between R&D and its outcomes (Orlando, 2002). Lagged values of patents, licenses, startups, science and engineering graduates, and faculty members are included in the analysis.

It is important to note that others have used a slightly different approach, whereby spillover is computed as the sum of the differences in knowledge between a focal firm and the overall firms' average for a given year, measured using R&D expenditures (Knott, 2008). The difficulty in spillover measurement is often about quantifying the actual flow of knowledge that crosses from one entity to another. The spillover is, then, a type of indirect return. Proxies for spillovers as knowledge transfers include citations, patents, and past and present R&D expenditures for an entity and its competition. This study focuses on states and the impact of their R&D spending on GDP growth.

Cobb-Douglas Production. The economic impact of R&D is estimated using a Cobb-Douglas production function using capital, labor, and the knowledge function as determinants of state GDP growth. The model closely follows the literature's specification to predict the effect of a state's R&D investments on its productivity growth (Hall & Mairesse, 1995).

$$GDP_{i,t} = \alpha_i Capital_{i,t}^{\beta}\, Labor_{i,t}^{\rho}\, R\&D_{i,t}^{\delta}\, Spillover_{i,t}^{\gamma} \varepsilon_{i,t} \qquad (2)$$

In equation (2), the vectors $R\&D_{i,t}$ and $Labor_{i,t}$ are R&D expenditures and labor, respectively, for state i in year t. The real R&D expenditures are broken down by academic, business, and state to differentiate their respective marginal effects. The labor vector, $Labor_{i,t}$ refers to the manpower needed to carry out R&D. Individuals with bachelor, associate, master, and doctoral degrees are accounted for. Science and engineering postdoctoral fellows, non-faculty research staff, and faculty are all factors of R&D production, which in turn increases economic impact, or GDP. Overall state employment information was excluded to determine the effect of those who specialize in R&D. Finally, time-invariant effects due to the unobserved heterogeneity for each state will be analyzed with various tools including fixed and random effects models for panel data. The vector $Capital_{i,t}$ is defined as the stock of available knowledge for research. The cumulative pool of knowledge available for research at the present time is conditional on internal and external R&D. To measure this pool of available R&D, a knowledge production function is estimated, as is consistent with the literature prominently advanced by Jaffe (Jaffe, 1986). The knowledge function relies on previous investments in R&D and the subsequent outputs derived therefrom, including patents, licensing, and startups.

Econometric Issues

Unobserved Heterogeneity. This bias comes from unobservable individual state characteristics that might affect that state's R&D spending, college graduation rates, and differences in labor and capital investment. For instance, states such as California or Texas will disproportionately invest in R&D because of a focus on technological innovation in Silicon Valley or on the exploitation of the oil industry. These differences among the states lead to an endogenous issue whereby the predictors are correlated among themselves. In other words, the covariance between the predictors and the error terms is not equal to 0: $cov(X_{i,t}, \varepsilon_{i,t}) \neq 0$.

The unobserved heterogeneity is due to time-invariant state characteristics that can be eliminated by taking the first differences of the variables. This is the same as using a fixed effects model but only for two time periods. Since there are 11 time periods, the fixed effects model can be used to reduce the effects of the time-invariant state component. In other words, the fixed-effects model can help reduce the omitted variable bias, which is linked to the unobserved heterogeneity issue. Nonetheless, a random effects model might instead be more consistent if the issue of $cov(X_{i,t}, \varepsilon_{i,t}) \neq 0$ persists.

The choice between a fixed-effects and a random-effects model will be made via a Hausman test under the null hypothesis that random effects are preferred due to higher efficiency, while the alternative specifies a fixed effects model is at least as consistent and thus preferred. The test rejects the null hypothesis of the random effects model being the better specification. A fixed effects model is appropriate for the data. The fixed effects specification controls for unobserved heterogeneity to be constant over time. In this case, the state-specific characteristics are correlated with the other independent variables in R&D.

Multicollinearity. In the presence of strong correlations among the predictors, a simple way to improve the normality of the data is through transformation. The data is transformed into the natural logarithm. The Spearman's rho correlation coefficients still show a mostly positive pairwise relationship among variables. However, the coefficients' magnitudes are vastly lower than those of the raw data. It is tentatively concluded that the multicollinearity issue has been alleviated to some extent by this transformation, although additional checks need to be performed on the data. Aside from the reduction of the multicollinearity effect, the log transformation has the benefit of simplifying the model. The log-log Cobb-Douglas function model's coefficients are now simply elasticities about a unit percent change in the predictors, *ceteris paribus*.

Although the log-log transformation of the production function improves the model, the issue of multicollinearity persists, with the predictor variables being highly correlated. The most problematic issue is the main variable of interest, which is R&D expenditure, specifically academic R&D, and its relationships with the factors of production such as bachelor's, master's, and doctoral students and postdoctoral fellows, among others. It is reasonable to assume the availability of academic R&D funding allows a university program to expand and to attract more talented individuals. On the other hand, it is likely that an already well-established program will be considered more favorably by funding agencies.

Challenges Regarding Academic R&D and Its Outcomes. University R&D is correlated with many input factors, including education level, research staff, and production of intellectual

property such as patents and licenses. A two-stage analysis is used to model the relationship between these factors of R&D production and the university portion of total R&D expenditures. Then a structural model relating R&D expenditures to state GDP will be evaluated.

As mentioned previously, this model is insufficient, as it fails to disentangle the direction of the relationship between factors of input and output. For example, the availability of R&D funding might allow for increased enrollment and expansion of graduate programs, and not vice-versa, in a given year. Nonetheless, the R&D spending for a period is the function of past input factors. That is, the current availability of faculty members, postdoctoral fellows, and graduate students, for instance, is necessary for obtaining R&D funds in the future. This bidirectional relationship is the main issue with this particular assessment because the outcome variables can very well be the predictor variables and vice versa. Thus, lagged input factors can be used to explain R&D expenditures.

GDP and R&D Expenditures Instrumental Model. The final model looks at the relationship between R&D and GDP. The familiar capital and labor production Cobb-Douglas function are used. However, capital is replaced with R&D expenditures for two reasons. First, it is the only "observable" measure of capital expenditures available in the dataset. Moreover, it is the only capital that is relevant in the determination of the relationship between R&D and GDP. The instrumental variable approach is widely used in the economics literature to account for an exogenous source of variation to minimize endogeneity issues including multicollinearity or omitted variables (Hausman, 1975; Miguel, Satyanath, & Sergenti, 2004; Larcker & Rusticus, 2010).

To analyze the relationship between federally funded academic R&D and GDP, this paper used the following model with the lagged R&D inputs serving as instruments, such that:

$$\ln(GDP_{i,t}) = \alpha_{it} + \beta_1 \ln(Capital_{i,t-1}) + \rho_1 \ln(Labor_{i,t-1}) + \delta_1 \ln(R\&D_{i,t-1}) + \varepsilon_{i,t-1} \quad (3)$$

The fitted values from the estimates of ***Equation 3*** will be used in the final as seen below.

$$\ln(GDP_{i,t}) = \alpha_{it} + \beta \ln(Capital_{i,t}) + \beta_1 \ln(\widehat{Capital}_{i,t-1}) + \rho \ln(Labor_{i,t}) + \rho_1 \ln(\widehat{Labor}_{i,t-1}) + \delta \ln(R\&D_{i,t}) + \delta_1 \ln(\widehat{R\&D}_{i,t-1}) + \gamma \ln(Spillover_{i,t}) + \varepsilon_{i,t-1} \quad (4)$$

The lagged variables, in this case, one period, will be used to evaluate the relationship

STUDY RESULTS

Trends in R&D. Federal R&D spending in the U.S. represents about 0.75 percent of U.S. GDP in 2015. From a historical perspective, federal R&D as a percentage of U.S. GDP declined dramatically from 1.02 percent in 2005 and 1.01 percent in 2010 to 0.75 percent in 2015.

Table 6: Federal R&D

Federal R&D	2015	2016 (Preliminary)
Basic Research	$31.5 billion	$33.2 billion
Applied Research	$32.1 billion	$34.5 billion
R&D Plant	$2.9 billion	$2.5 billion
Development	$64.9 billion	$72.3 billion
Total R&D Spending	$131.4 billion	$142.6 billion

Source: BERC, BEA, and National Science Foundation

In 2015, federal university R&D spending in the U.S. was around $37.9 billion, representing about 0.21 percent of the nation's GDP. This was a decrease from 2010 when federal academic spending was 0.25 percent of the nation's GDP at $37.5 billion.

Table 7: Federal Academic R&D

Federal University R&D	2010	2015
Total University R&D	$61.2 billion	$68.7 billion
Total Federal University R&D	$37.5 billion	$37.9 billion
Federal University R&D as a percent of the U.S. GDP	0.25%	0.21%

Source: BERC, BEA, and National Science Foundation

Short-Term Economic Impact of Federally Funded Academic R&D

Scenario: $400 million Federal Academic Funding in Tennessee

To demonstrate the short-term impact of the federally-funded academic R&D spending, we ran a scenario for the state of Tennessee. This very same scenario may be replicated for any other state or the nation overall. In Tennessee, a federal university R&D funding of $400 million would translate in 581 new post-doctoral fellows across universities, 328 new STEM PhDs, 10,130 new masters and doctoral students, 6.08 new startups, and 49 new jobs through these startups. As seen in **Tables 8 and 9,** in economic terms, this would be:

Table 5: Short-Term Economic Impact

Scenario: $400 Million Federal University R&D Impact in Tennessee						
Impact Type	**Jobs**	**Personal Income**	**GDP**	**Business Revenue**	**State and Local Taxes**	**Federal Taxes**
Direct Effect	2,217	$151,504,821	$194,749,611	$399,999,991		
Indirect Effect	1,317	$70,087,603	$112,179,660	$192,171,964		
Induced Effect	1,359	$66,034,032	$108,671,18	$188,299,905		
Total Effect	**4,893**	**$287,626,456**	**$415,600,455**	**$780,471,860**	**$22,947,411**	**$61,024,382**

Source: BERC and IMPLAN

Table 6: Start-Up Impact

Scenario: $400 Million Federal University R&D Impact in Tennessee						
Impact Type	**Jobs**	**Personal Income**	**GDP**	**Business Revenue**	**State and Local Taxes**	**Federal Taxes**
Direct Effect	49	$4,015,389	$5,401,713	$11,989,183		
Indirect Effect	45	$2,482,623	$3,798,446	$6,380,737		
Induced Effect	40	$1,935,226	$3,184,827	$5,518,457		
Total Effect	**134**	**$8,433,238**	**$12,384,986**	**$23,888,377**	**$633,783**	**$1,791,556**

Source: BERC and IMPLAN

The total short-term economic impact of federal academic funding of $400 million results in 5,027 new jobs including post-doctoral fellows being created, $804.4 million increases in business revenues, $296.1 million in personal income, $23.58 million in local and state taxes and fees, and $62.82 million in federal taxes. These impact estimates do not include the impact of increased productivity in the economy through knowledge creation, human capital formation, and other technology-related channels. Notice also that the magnitude of indirect and induced effects are on par with that of direct effects, if not greater.

Long-Term Economic Impact of Federally Funded Academic R&D

Below is the instrumental variable estimation of the relationship between GDP and R&D. Robust standard errors were used to minimize heteroscedasticity, autocorrelation, and stationarity issues. These potential biases will be subsequently tested in the robustness-check section. Each type of R&D analyzed in all models was instrumentalized using human capital variables including educational levels and availability of faculty. All variables used as instruments were lagged one period. These estimates include the impact of increased productivity in the economy through knowledge creation, human capital formation, and other technology-related channels.

The results in Table 10 show a significant contribution of federal university R&D to state GDP. Academic R&D itself is highly significant in its relationship with state GDP, but federal R&D is of an even greater magnitude. The variable of interest, federal university R&D, is a significant predictor of GDP growth. A percentage increase in federal university R&D leads to a 0.127 percent boost in GDP, all else being equal. For instance, a 1 percent increase in federal academic R&D in Tennessee leads to a GDP gain of $330 million. The federal university R&D's impact on GDP is even greater than that of overall academic R&D coming from various sources, such as firms, not-for-profit institutions, and individuals. The results of this study suggest R&D marginal effects ranging from 0.10 percent to 0.35 percent. These results are consistent with the literature. For the U.S., all else being equal, an increase of $379 million in federal R&D may potentially increase GDP by $23 billion. Those results are consistent with the literature in both in the relationship between R&D and economic growth, but also in magnitude.

Table 10: GDP Fixed-Effects (within) IV Regression

GDP	1	2	3
Constant	14.209***	12.904 ***	10.480***
	(1.690)	(1.817)	(2.356)
Employment	0.599 ***	0.707***	0.858***
	(0.110)	(0.110)	(0.128)
Spillover	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Business R&D	-	0.013	0.009
		(0.008)	(0.009)
Total R&D	0.347***	-	-
	(0.100)		
University R&D		0.111***	-
		(0.034)	
Federal University R&D			0.127***
			(0.042)
Sigma u	0.196	0.144	0.169
Sigma e	0.024	0.024	0.024
Rho	0.985	0.974	0.979

***Notes**: Robust Standard Errors are reported in parentheses*
, **, * indicates significance at the 90%, 95%, and 99% level, respectively*

Overall, R&D is a significant predictor of economic growth, no matter its source of funding. A 1 percent increase in a state's total R&D leads to a 0.347 percent increase in the state's GDP. For example, in Tennessee the gain from total R&D is substantial: a 1 percent increase in total R&D results in an increase of $902 million in GDP. Table 11 summarizes the gains from the most significant R&D for a few select states comparable to Tennessee.

Table 11: Gains from 1 Percent Growth in R&D

State	Total R&D	University R&D	Federal University R&D
Alabama	605,182,826	193,588,743	221,493,426
Florida	2,629,633,507	841,179,595	962,430,707
Georgia	1,471,037,415	470,562,401	538,391,215
Kentucky	570,680,616	182,552,013	208,865,816
Mississippi	325,680,005	104,180,059	119,197,005
North Carolina	1,449,082,095	463,539,229	530,355,695
South Carolina	580,095,673	185,563,745	212,311,673
Tennessee	902,938,479	288,836,228	330,470,279
Virginia	1,438,831,399	460,260,188	526,603,999

*Notes: *In chained 2009 dollars. All values averaged between 2005 and 2015.*

Business R&D is not significant for any of the specifications analyzed. The lower effect of business R&D compared to academic R&D might be due to competitive restrictions. Unlike academic R&D, business R&D often tends to be internal for the sake of competitiveness. This competitive secrecy hinders the measurement of potential gains in economic growth for business R&D. Lacking this characteristic, academic R&D can achieve a higher impact on GDP. The dissemination of academic R&D is also more straightforward through peer-reviewed materials and publication and therefore is less costly.

Spillover effects are all highly significant for the model. The specification used in this paper relies on spillovers coming from lagged two-year periods of R&D investments to be internalized as output. The results being highly significant, although of minimal magnitude, points to a state's R&D investment promoting its own and other states' economic growth.

This study's findings are consistent with the literature concerning the impact of R&D on economic growth. It extends the literature by analyzing states, which cannot be as easily categorized as firms with regard to technological proximity. Geographical proximity could be a potential dimension for measuring the effects of a state's R&D on neighboring states, which is a direction future research might take.

STUDY IMPLICATIONS, LIMITATIONS, AND FUTURE RESEARCH

Implications

This study provides a pathway to improve productivity and promote innovation through arguably straightforward means. Innovation is key to economic growth, and the funding required to support and promote innovation is minimal in comparison to the expected large and positive economic consequences. The federal government could and should invest in higher levels of academic R&D specifically, as it is demonstrated that academic R&D yields the highest returns. Policies such as the Bayh-Dole Act have been crucial in promoting innovation within academia. Policies should be promoted and enacted that facilitate cooperation between businesses and universities and that even provide funding to promote such activities.

Limitations and Future Research

Sample Size and Structural Change. The study may be affected by several limitations, with the small sample size being the primary concern. This could potentially undermine our conclusions regarding the magnitude of the long-term impact of R&D on GDP. However, we conclude that our results are robust and in line with the findings in the literature. Moreover, the period of analysis (2005-2015) could potentially influence the results due to the economic recession (2008-2012), when funding R&D may not have been among the federal government's foremost priorities.

Time Lag and Spillover. Concerning the estimation itself, agreement on the number of appropriate lags for R&D is mixed. However, a large portion of the literature agrees to the point that one to three time periods seem acceptable, especially when accounting for fast-paced technological change. Moreover, the construction of spillover effects tends to differ, with some

arguing for a knowledge production function methodology (Pakes & Griliches, *Patents, and R&D at the Firm Level: A First Look*, 1984), while others just look at the difference in "knowledge levels." This paper takes a broader approach whereby total national R&D conducted would benefit all states equally. We believe this construct may need to be visited further.

Estimation Biases. Several robustness checks were conducted to reduce biases in estimates: heteroscedasticity, autocorrelation, and a unit root/stationary test, which was undertaken to ensure the temporal invariability of statistical properties such as mean, variance, and autocorrelation, among others. Using a robust fixed effects model allowed for reducing this potential source of bias.

Future Directions. The phase of technological change dramatically affects the life cycle of technology and products in the market. Future research may revisit the literature and carefully identify the time lag and structural breaks in translating federally funded R&D into innovation and welfare. Furthermore, the spillover concept may require robust treatment given the fact that technology and knowledge in today's world do not have a geographic boundary.

CONCLUSION

R&D investment is critical to the economic welfare of a state. R&D spending brings technological progress and innovation. Most important, it is economically beneficial. According to the results of this analysis, a significant number of states with high GDP also happen to have high levels of R&D spending. An investment in more R&D spending is beneficial to a state, although each state also needs to take advantage of the knowledge capital already available.

Academic R&D seems to provide more value regarding GDP growth compared to business R&D. This finding might be due to two reasons: (1) geographical coincidence, whereby universities' R&D outcomes tend to stay local, while business activities tend to have a more national scope, and (2) it is difficult to measure private business R&D outcomes. Regarding federally funded R&D, neither short- nor long-term impacts are negligible.

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BUILDING OPTIMAL RISKY AND UTILITY MAXIMIZING TIAA/CREF PORTFOLIOS

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ABSTRACT

We present a step-by-step process that investors can use to build optimal risky portfolios with Excel Solver and illustrate the process using TIAA/CREF annuities and mutual funds. Because these funds and other tax deferred eligible investments cannot be sold short, investors would face additional challenges in applying the portfolio theory in practice on those products. The inability to short-sell results in an optimal portfolio with low returns and to garner higher returns, investors must select a higher return and find an optimal portfolio for that return.

After forming optimal risky portfolios, we compute the utility for investors with differing levels of risk aversion. We discuss the challenges of applying theory to practice and, the assumptions implicit in forming optimal portfolios, and the limitations of the process. The empirical results shown in this study also help gauge the additional costs in applying this method on investment vehicles that cannot be sold short.

INTRODUCTION

Federal tax law permits taxpayers to invest for retirement using 401(k), 403(b), and/or 457 accounts. These accounts are merely accounts that comply with certain federal requirements and are designed to permit taxpayers to invest for their retirement on a tax sheltered or tax deferred basis. In general, for 2018, eligible taxpayers under the age of 50 are permitted to invest up to $18,500 in a 401(k), 403(b), or 457 account. Taxpayers over the age of 50 are permitted a "catch up" which permits investing an additional $6,000 per year for a total of $24,500 per year in the account.

Typically, employers will select a provider for the retirement account or accounts and the provider will provide support for both the human resource department and employees. The provider and/or the Human Resource Office will provide employees with information regarding the account in general and the features of those accounts. In addition, the specific investment choices permitted under the employees plan are provided. Moreover, employees are provided with resources that provide information about the investment choices such as past returns during specified historical periods (such as year-to-date, one-year, three-year, five-year, ten-year, and since inception), expenses of the various investment options, the types of assets the fund invests in, background of the fund manager, and other fund related information. Representatives of the investment provider may even provide onsite presentations and one-on-one counseling. While, these can provide general investment information, and can highlight the need to diversify your investment portfolio, they fall short of providing a specific investor with a portfolio that will be most rewarding to that specific investor.

The purpose of this paper is to show investors and investment advisors how to create optimal risky and utility maximizing portfolios using Excel. To illustrate the process, we utilize TIAA/CREF investment options and then to use Markowitz (1952) optimization to form an

optimal risky portfolio. Once an optimal risky portfolio is formed, we discuss risk aversion and use three levels of risk aversion to form "utility-maximizing" portfolios for investors with each level of risk aversion. Our goal is to provide guidance to investors and/or investment advisors that will permit them to use a simple tool to allocate retirement assets to achieve the highest return with the lowest level of risk.

We selected TIAA/CREF for illustrative purposes because they began offering retirement services to teachers about 100 years ago. Now, TIAA/CREF is a full service financial services company that specializes in serving the needs of academics, researchers, and workers in the medical and cultural fields. As of the first quarter of 2018, TIAA/CREF had nearly $1 trillion in assets under management and was serving 5 million clients in institutional retirement plans. According to Pensions & Investments (2013), TIAA/CREF is one of the largest managers of equity and fixed-income assets (based on assets under management). TIAA/CREF has also received numerous awards for investment performance. For example, Lipper named TIAA/CREF the best overall large fund company based on risk-adjusted performance from 2013-2017 among up to 48 peer companies. Moreover, 67% of TIAA/CREFs funds received an overall Morningstar rating of 4 or 5 stars based on risk-adjusted returns at the end of the first quarter of 2018.

While the above discussion highlights the retirement accounts and mentions sources of information in general, and the importance of TIAA/CREF to some investors in particular, investors remain unaware precisely how assets should be allocated. We fill that void by illustrating how optimal risky portfolios can be formed using Excel Solver. We then form utility maximizing portfolios for investors with differing levels of risk aversion.

The next section discusses risk, return, and the benefit of diversification. It also lists investment options offered by TIAA/CREF. Section 3 discusses our data and the historical returns, variances, and return correlations of TIAA/CREF investment choices. Building optimal risky portfolios using Excel Solver and then forming utility maximizing portfolios is explained and illustrated in Section 4. The paper concludes with the recommended asset allocation based on our dataset and then provides the utility of portfolios for investors with risk aversion scores from one through three. The assumptions, challenges, and limitations of this approach are also discussed.

RISK, RETURN, CORRELATION, AND THE BENEFIT OF DIVERSIFICATION

Finance textbooks often stress that investors should only care about two variables, risk and return (Bodie et al. 2014; Brigham and Ehrhardt 2014; or Smart et al. 2014).

As Equation 1 shows, the return of an investment portfolio is the market value weighted average of the returns of the investments making up the portfolio:

$$E(R_p) = W_a R_a + W_b R_b \quad (1)$$

where R_p is the return on the portfolio; W_a and W_b are the market value weights of the portfolio invested in investments "a" and "b"; and R_a and R_b are the expected returns of investments "a" and "b."

The risk of a portfolio is its variability of returns and can be computed as shown in Equation 2:

$$\sigma_p^2 = W_a^2\sigma_a^2 + W_b^2\sigma_b^2 + 2W_aW_b\sigma_a\sigma_b\rho_{a,b} \quad (2)$$

where $\sigma_p^2$is the variance of the portfolio; W_a^2 and $W_b^2$are the squared market value weights for investments "a" and "b"; $\sigma_a^2$and $\sigma_b^2$are the variance of the returns of investments "a" and "b"; σ_a

and σ_b are the standard deviations of the returns of investments "a" and "b"; and $\rho_{a,b}$ is the correlation between investments "a" and "b".

Risk, return, and diversification require further discussion. As illustrated by Equation 2, if the correlation between assets is perfectly positive (+1), there is no benefit to diversification. Conversely, with perfect negative correlation (-1), all risk could be eliminated. In practice, neither of these cases is typically observed. However, if an investor diversifies into an asset class that is not perfectly correlated with the returns of the current portfolio, the risk of the portfolio may be reduced. Therefore, investors should hold a mix of assets that are not highly correlated. As Solnik (1974) shows, both diversifying within a country and between countries is important because of the potential diversification effects.

As portfolio size increases, the portfolio return formula does not change, it remains the market value weighted average of the returns of the investments in the portfolio. However, the formula for portfolio variance changes when portfolio size increases. Besides adding a squared market value weight for the additional investment times the investments variance, more covariance terms are needed for each possible combination of assets. For example, for a portfolio with four investments, Equation 3 shows the corresponding formula.

$$\sigma_p^2 = W_a^2\sigma_a^2 + W_b^2\sigma_b^2 + W_c^2\sigma_c^2 + W_d^2\sigma_d^2 + 2W_aW_b\sigma_a\sigma_b\rho_{a,b} + 2W_aW_c\sigma_a\sigma_c\rho_{a,c} + 2W_aW_d\sigma_a\sigma_d\rho_{a,d} + 2W_bW_c\sigma_b\sigma_c\rho_{b,c} + 2W_bW_d\sigma_b\sigma_d\rho_{b,d} + 2W_cW_d\sigma_c\sigma_d\rho_{c,d} \quad (3)$$

Deciding what asset classes to include in the portfolio and in what proportion is the heart of the portfolio management decision. According to Brinson, Hood, and Beebower (1986) and Brinson, Singer, and Beebower (1991), more than 90 percent of a portfolio's return is due to asset allocation decisions. More recent studies, such as Ibbotson and Kaplan (2000) and Xiong, Ibbotson, Idzorek, and Chen (2010), point out that asset allocation may not be as important in explaining variation in returns across various funds as previously believed. Yet, Ibbotson (2010) concludes asset allocation is still a very important aspect.

Table 1 lists selected TIAA/CREF investments and the name of the investment funds suggests that the assets that some of them hold are dissimilar. Thus, because investment portfolios should take on the risk and return attributes of the underlying asset class, we would expect to have some asset classes with low correlation to other classes. Therefore, it should be possible to build a diversified portfolio from TIAA/CREF annuities or mutual funds. Because investors are only permitted to invest in the investments selected by their employer, we examine two scenarios: annuities only and mutual funds only. The rationale for this choice is that some employers only permit investing in annuities during working years. However, after retirement, the investor may move money as they see fit.

DATA AND METHODOLOGY

Data

The TIAA/CREF investments that we considered are listed in Table 1. Money market investments, targeted retirement funds, and funds with insufficient history to make reliable comparisons were excluded. Daily net asset value (NAV) for the eight variable annuities was extracted directly from TIAA/CREF's website and begins on May 1, 1997. Daily returns for the annuities were computed as shown in Equation 4.

$$r_t = (NAV_t/NAV_{t-1}) - 1 \quad (4)$$

Table 1
TIAA/CREF INVESTMENT CHOICES

TIAA/CREF Variable Annuities	**Inception Date**
CREF Equity Index Account QCEQRX	4/29/1994
CREF Global Equities Account QCGLRX	5/1/1992
CREF Growth Account QCGRRX	4/29/1994
CREF Stock Account QCSTRX	7/31/1952
TIAA Real Estate Account QREARX	10/2/1995
CREF Bond Market Account QCBMRX	3/1/1990
CREF Inflation-Linked Bond Account QCILRX	5/1/1997
CREF Social Choice Account QCSCRX	3/1/1990
TIAA/CREF Mutual Funds	**Inception Date**
TIAA-CREF Equity Index Fund (Retirement) TIQRX	3/31/2006
TIAA-CREF Inflation-Linked Bond Fund (Retirement) TIKRX	3/31/2006
TIAA-CREF International Equity Fund (Retirement) TRERX	10/1/2002
TIAA-CREF International Equity Index Fund (Retirement) TRIEX	10/1/2002
TIAA-CREF Large-Cap Growth Index Fund (Retirement) TRIRX	10/1/2002
TIAA-CREF Large-Cap Value Fund (Retirement) TRLCX	10/1/2002
TIAA-CREF Large-Cap Value Index Fund (Retirement) TRCVX	10/1/2002
TIAA-CREF Mid-Cap Growth Fund (Retirement) TRGMX	10/1/2002
TIAA-CREF Mid-Cap Value Fund (Retirement) TRVRX	10/1/2002
TIAA-CREF S&P 500 Index Fund (Retirement) TRSPX	10/1/2002
TIAA-CREF Small-Cap Blend Index Fund (Retirement) TRBIX	10/1/2002
TIAA-CREF Small-Cap Equity Fund (Retirement) TRSEX	10/1/2002
TIAA-CREF Social Choice Equity Fund (Retirement) TRSCX	10/1/2002

Returns for the 13 mutual funds were extracted from the Center of Research in Securities Prices (CRSP) survivorship bias free mutual fund data base and begin on April 3, 2006. Data for all series end on December 31, 2014.

Correlations of TIAA/CREF investments

Creating a correlation matrix in Excel is a simple process once the analysis tool pack is installed. Simply click on the data tab, and then click on the analysis tab. This will cause a drop-down list box to appear. Select correlation and then select all the cells that contain return data for the selected investments.

Tables 2 and 3 summarize the historical correlations TIAA/CREF variable annuities and

Table 2
CORRELATION OF TIAA/CREF VARIABLE ANNUITIES
Correlations shown in this table are for daily return data from May 2, 1997 through December 31, 2014.

	QCEQRX	QCBMRX	QCGLRX	QCGRRX	QREARX	QCILRX	QCSCRX	QCSTRX
QCEQRX	1							
QCBMRX	-0.221	1						
QCGLRX	0.928	-0.210	1					
QCGRRX	0.963	-0.219	0.889	1				
QREARX	0.190	-0.030	0.191	0.175	1			
QCILRX	-0.201	0.739	-0.184	-0.189	-0.001	1		
QCSCRX	0.984	-0.087	0.919	0.941	0.190	-0.099	1	
QCSTRX	0.988	-0.218	0.970	0.947	0.195	-0.195	0.978	1

Table 3
CORRELATION OF TIAA/CREF MUTUAL FUNDS
Correlations are for daily return data from April 3, 2006 through December 31, 2014.

	TIKRX	TIQRX	TRBIX	TRCVX	TRERX	TRGMX	TRIEX	TRIRX	TRLCX	TRSCX	TRSEX	TRSPX	TRVRX
TIKRX	1												
TIQRX	-0.235	1											
TRBIX	-0.220	0.946	1										
TRCVX	-0.230	0.988	0.922	1									
TRERX	-0.156	0.868	0.803	0.856	1								
TRGMX	-0.222	0.959	0.937	0.921	0.851	1							
TRIEX	-0.149	0.887	0.809	0.877	0.972	0.859	1						
TRIRX	-0.236	0.986	0.926	0.954	0.864	0.970	0.883	1					
TRLCX	-0.225	0.987	0.928	0.994	0.863	0.930	0.881	0.957	1				
TRSCX	-0.235	0.997	0.944	0.986	0.865	0.958	0.884	0.985	0.985	1			
TRSEX	-0.222	0.947	0.994	0.921	0.805	0.941	0.811	0.929	0.927	0.944	1		
TRSPX	-0.238	0.997	0.927	0.990	0.868	0.947	0.890	0.985	0.987	0.995	0.927	1	
TRVRX	-0.213	0.985	0.950	0.979	0.863	0.955	0.876	0.964	0.983	0.986	0.950	0.978	1

mutual funds, respectively. Annuity correlations reveal that some asset combinations are highly correlated and would not offer much diversification benefit. Thus, an investor might hold only one of those assets because they can be viewed as compliments. For example, the CREF Equity Index Account (QCEQRX) and the CREF Stock Account (QCSTRX) have a correlation coefficient of 0.988. However, other asset combinations such as the CREF Equity Index Account (QCEQRX) and the TIAA Real Estate Account (QREARX) have a small positive correlation coefficient of 0.190 while the CREF Equity Index Account (QCEQRX) and the CREF Bond Market Account QCBMRX have a negative correlation (-0.221). Both of these combinations potentially offer tremendous diversification potential.

Results of mutual fund correlations are similar to those of annuities. Some asset combinations are highly correlated and would not offer much diversification benefit such as the TIAA-CREF Equity Index Fund (Retirement) TIQRX and the TIAA-CREF Social ChoiceEquity Fund (Retirement) TRSCX at 0.997. However, other asset combinations potentially offer tremendous diversification potential (the TIAA-CREF Inflation-Linked Bond Fund (Retirement) TIKRX and the S&P 500 Index Fund (Retirement) TRSPX at -0.238.

OPTIMAL RISKY PORTFOLIOS AND UTILITY MAXIMIZING PORTFOLIOS

Optimal risky variable annuity portfolios

Harry Markowitz's (1952) Nobel Prize winning research created Modern Portfolio Theory which asserts that investors should make investment decisions using the mean, variance, and covariance (or correlation) of securities, and this concept is widely accepted in the investment industry. The optimization of risky portfolios focuses on two aspects: maximizing returns while holding risk constant or minimizing risk while maintaining the same level of return. The goal of portfolio optimization is to maximize portfolio return per unit of risk. With a risk-free asset, this can be simplified to maximizing the Sharpe ratio of a portfolio, which is its excess return per unit of total portfolio risk. Equation 5 illustrates maximizing the Sharpe ratio.

Pure theory suggests that an optimal portfolio can be found by correctly combining assets and the optimal portfolio will dominate all other portfolios in terms of risk and return. Once this dominant portfolio is found, it can be combined with a risk-free asset to form the Capital Market Line (CML). Portfolios on the CML will dominate all others in risk-return space. All of these

portfolios will have the same excess return per unit of risk but their excess return per unit of risk will be higher than any other portfolio.

Maximizing the Sharpe ratio is tricky with a mutual fund or annuity investment because neither the investments nor the risk-free asset can be sold short. The following maximization problem shown in Equation 5 defines the optimization of a mutual fund or annuity portfolio:

$$Max\ \vartheta = \frac{E(r_w - C)}{\sigma_w}$$
$$max\vartheta = \frac{E(r_w) - c}{\sigma_w} \quad (5)$$

given the relationships in Equations 6 through Equation 11.

$$\sum_{i=0}^{n} w_i = 1 \quad \sum_{i=1}^{N} w_i = 1 \quad w_i \geq 0, i = 1,2,\ldots,N \quad (6)$$

where

$$E(r_w) = w^T \times R = \sum_{i=1}^{N} w_i E(r_i) \quad (7)$$

$$\sigma_w = \sqrt{\sum_{i=0}^{n}\sum_{j=0}^{n} w_i w_j \sigma_{ij}} \quad E(r_w) = W^T \times R = \sum_{i=1}^{N} w_i E(r_i) \quad (8)$$

$$W = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_N \end{bmatrix} \quad (9)$$

$$R = \begin{bmatrix} E(r_1) \\ E(r_2) \\ \vdots \\ E(r_N) \end{bmatrix} \quad (10)$$

and

$$S = \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{1N} \\ \vdots & \ddots & \vdots \\ \sigma_{N1} & \cdots & \sigma_{NN} \end{bmatrix} \quad (11)$$

where w_i is the market value weight invested in investment i; $E(r_i)$ is the expected rate of return of investment i; σ_{ij} is the covariance between investment i and investment j; and c is a constant. Changing c permits finding infinite combinations of w_i and therefore creating the efficient frontier with the selected mutual fund or annuity investments. These portfolios dominate all other choices in terms of return for a given level of risk. If the risk-free rate is used for c, a theoretical optimal risky portfolio may be found by solving the problem above. To better illustrate the application of portfolio optimization in practice, an example is provided using Microsoft Excel with TIAA/CREF annuities. Assume that an investor has selected eight annuities to consider based on their investment objectives. To construct an optimal portfolio, the investor must compute historical returns over some period such as May 1997 to December 2014 in this example. Table 4 shows the summary statistics for selected annuities.

Table 4
SUMMARY STATISTICS FOR TIAA/CREF VARIABLE ANNUITY RETURNS

Daily	QCEQRX	QCBMRX	QCGLRX	QCGRRX	QREARX	QCILRX	QCSCRX	QCSTRX
Mean	0.0004	0.0002	0.0003	0.0003	0.0002	0.0002	0.0003	0.0003
Std	0.0128	0.0023	0.0119	0.0140	0.0013	0.0035	0.0074	0.0122
Var	0.0002	0.0000	0.0001	0.0002	0.0000	0.0000	0.0001	0.0001
Annual	QCEQRX	QCBMRX	QCGLRX	QCGRRX	QREARX	QCILRX	QCSCRX	QCSTRX
Mean	0.0919	0.0532	0.0735	0.0811	0.0613	0.0556	0.0709	0.0839
Std	0.2027	0.0369	0.1885	0.2222	0.0207	0.0549	0.1174	0.1936
Var	0.0411	0.0014	0.0355	0.0494	0.0004	0.0030	0.0138	0.0375

Computing return metrics is straightforward. Daily average returns are computed by entering the following into the cell:
=AVERAGE(first cell in return column:last cell in return column) and then pressing enter. Standard deviation is computed by entering: =STDEV(first cell in return column:last cell in return column) and then pressing enter. Variance is computed by entering: =VAR(first cell in return column:last cell in return column) and then pressing enter.

Converting from daily to annual returns and variances can easily be accommodated by multiplying the daily return or daily variance cells by 252 (the approximate number of trading days in a year). Annual standard deviation can be computed by taking the square root of annual variance or multiplying daily standard deviation by the square root of 252.

At this point, the investor needs to set up to solve the constrained optimal problem using Equation 5. This task can be accomplished in Excel using the Solver tool. The process begins by first setting up Excel. In addition to needing the returns, standard deviations, and variances above, a covariance matrix must be created. We created a correlation matrix earlier by selecting the data tab in Excel, then data analysis, and then selecting the input range (the cells containing the daily returns of the investments of interest). The Excel output was a triangle (lower left) of the correlation of each combination of assets. The complete correlation matrix can be created by copying the lower row and then using the transpose function in paste special to paste those values into the last column. That process is repeated until all cells have a value (note that the diagonal will be one).

To create a covariance matrix, it is convenient to copy the average returns, standard deviations and variances, from the investments and pate them in column format, and also paste them using paste special and transpose to present them in row format. It is also convenient to paste the full correlation matrix nearby. Once that is completed, the complete covariance matrix can be constructed. Starting at the upper left-hand cell of the covariance matrix, enter the cell reference for the standard deviation for that investment (from the column data) times the cell reference for the standard deviation for that investment (from the row data) times the cell reference for the correlation of that asset with itself. The formula in that cell can be copied and pasted to the other cells in the covariance matrix. Some changes in the cells will need to be made, and some changes can be minimized by using the $ command to lock cell references.

The final step of setting up the Excel template is to make a column that lists each investment and then the words total, average, standard deviation, variance, and Sharpe ratio (as in

Table 5). The next column will be titled weights. This will serve as the template for the solver output (including the formulas for return and variance).

Once the spreadsheet is set up, the process begins by forming an arbitrary portfolio. For example, a portfolio equally split among the eight target funds. The portfolio mean and standard deviation (σ) may be computed using Equations 7 and 8, respectively.

This is accomplished in Excel by entering the following equations. To compute portfolio return in a way that solver can update it when it runs, enter the following equation in the portfolio return output cell:

=MMULT(TRANSPOSE(begining cell in portfolio weight range:ending cell in portfolio weight range), begining cell in asset return range:ending cell in asset return range)

but do not press Enter! To enter a formula that solver can iterate, press and hold Ctrl, Shift, and then Enter.

To compute portfolio variance in a way that solver can update it when it runs, enter the following equation in the portfolio return output cell:

=MMULT(MMULT(TRANSPOSE(begining cell in portfolio weight range:ending cell in portfolio weight range),begining cell covariance matrix:ending cell in covariance matrix), begining cell in portfolio weight range:ending cell in portfolio weight range)

and again do not press Enter at this point. To enter a formula that solver can iterate, press and hold Ctrl, Shift, and then Enter.

In the standard deviation output cell, enter:

=SQRT(varaice cell reference).

For the Sharpe ratio output cell enter:

=(portfolio return cell reference-risk-free rate cell reference / portfolio standard deviation cell reference).

The goal of the optimization is to maximize the Sharpe ratio of the portfolio as shown in Equation 5. Therefore, the ratio is computed so that the optimal solution can be derived in the next step. The risk-free rate in this case is assumed to be 3 percent; however, this can easily be changed and the scenario re-run to ascertain the impact of the choice of risk-free rate on the optimal portfolio.

The Solver function in Excel can find the maximum, minimum, or a specified number in a specific cell by changing parameters. The parameters are the cells containing the investment weights in each of the eight selected investments. Two constraints must be added to the Solver to further limit solutions. The first constraint is that the cells containing the weight in each investment must be ≥ 0 (no short sales). Secondly, the cell containing the sum of the weights must be 1 or 100 percent.

Table 5 reveals that there is a solution to the optimization problem. The optimal portfolio is 78.15% TIAA Real Estate Account (QREARX), 20.90% CREF Bond Market Account (QCBMRX), and 0.95% CREF Equity Index Account (QCEQRX). The optimal risky portfolio has an expected return of 5.99% and a Sharpe measure of 1.6616. In practice, as opposed to pure theory, an investor can't short sell the riskless asset to create a portfolio with a higher return. Thus, if an investor desires a higher rate of return, they must select a portfolio that is mean-variance

Table 5
OPTIMAL TIAA/CREF ANNUITY PORTFOLIOS

Portfolio	A	B	C	D	E	F
Target	Optimal	7%	7.50%	8%	8.50%	Max return
FUND	**Weight**	**Weight**	**Weight**	**Weight**	**Weight**	**Weight**
QCEQRX	0.0095	0.2844	0.4480	0.6116	0.7751	1
QCBMRX	0.2090	0	0	0	0	0
QCGLRX	0	0	0	0	0	0
QCGRRX	0	0	0	0	0	0
QREARX	0.7815	0.7156	0.5520	0.3884	0.2249	0
QCILRX	0	0	0	0	0	0
QCSCRX	0	0	0	0	0	0
QCSTRX	0	0	0	0	0	0
Total	1	1	1	1	1	1
Portfolio	A	B	C	D	E	F
Average	0.0599	0.0700	0.0750	0.0800	0.0850	0.0919
Var	0.0003	0.0039	0.0088	0.0158	0.0250	0.0411
Std	0.0180	0.0622	0.0937	0.1257	0.1581	0.2027
Sharpe Ratio	1.6616	0.6431	0.4805	0.3977	0.3480	0.3053

inefficient. To accommodate investors with differential return preferences, we used solver to solve for optimal risky portfolios with a range of different levels of return. This is accomplished in solver by adding a third constraint requiring that the portfolio return output cell equal a specified value and then re-running solver to obtain the optimal portfolio for that level of return. As an example, we repeated this process for desired return levels of 7%, 7.5%, 8%, 8.5%, 9%, and 9.18%. We will discuss these portfolios in greater detail once we select the utility maximizing portfolios.

Optimal risky mutual fund portfolios

To find optimal risky mutual fund portfolios, the process used for variable annuities can be repeated. Table 6 shows the summary statistics for selected annuities.

Table 6
SUMMARY STATISTICS FOR TIAA/CREF MUTUAL FUND RETURNS

Date	TIKRX	TIQRX	TRBIX	TRCVX	TRERX	TRGMX	TRIEX	TRIRX	TRLCX	TRSCX	TRSEX	TRSPX	TRVRX
4/3/2006	0.0000	0.0010	-0.0079	0.0033	0.0113	-0.0005	0.0080	0.0008	0.0013	0.0009	-0.0061	0.0020	0.0017
4/4/2006	-0.0010	0.0050	0.0043	0.0073	0.0090	0.0044	0.0095	0.0042	0.0066	0.0055	0.0043	0.0061	0.0039
4/5/2006	0.0030	0.0050	0.0049	0.0059	0.0022	0.0065	0.0016	0.0033	0.0046	0.0037	0.0049	0.0047	0.0061
4/6/2006	-0.0030	-0.0020	0.0000	-0.0033	0.0037	0.0027	0.0047	-0.0008	-0.0013	-0.0018	0.0000	-0.0020	-0.0011
12/26/2014	0.0009	0.0038	0.0069	0.0022	0.0027	0.0029	0.0028	0.0047	0.0028	0.0035	0.0065	0.0035	0.0029
12/29/2014	0.0000	0.0013	0.0037	0.0022	-0.0054	0.0010	-0.0022	0.0005	0.0017	0.0012	0.0029	0.0009	0.0049
12/30/2014	0.0009	-0.0050	-0.0047	-0.0033	-0.0099	-0.0057	-0.0105	-0.0056	-0.0039	-0.0052	-0.0047	-0.0047	-0.0045
12/31/2014	0.0018	-0.0094	-0.0069	-0.0110	-0.0036	-0.0053	-0.0050	-0.0090	-0.0089	-0.0093	-0.0076	-0.0104	-0.0095
Daily	TIKRX	TIQRX	TRBIX	TRCVX	TRERX	TRGMX	TRIEX	TRIRX	TRLCX	TRSCX	TRSEX	TRSPX	TRVRX
Average	0.0002	0.0004	0.0004	0.0004	0.0002	0.0004	0.0002	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
Std	0.0040	0.0138	0.0173	0.0145	0.0155	0.0153	0.0147	0.0130	0.0152	0.0138	0.0171	0.0135	0.0149
Var	0.0000	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002
Annual	TIKRX	TIQRX	TRBIX	TRCVX	TRERX	TRGMX	TRIEX	TRIRX	TRLCX	TRSCX	TRSEX	TRSPX	TRVRX
Average	0.0452	0.0961	0.1018	0.0899	0.0541	0.1031	0.0504	0.1018	0.0905	0.0944	0.0977	0.0942	0.1057
Std	0.0641	0.2191	0.2745	0.2308	0.2460	0.2428	0.2341	0.2058	0.2417	0.2185	0.2715	0.2141	0.2369
Var	0.0041	0.0480	0.0754	0.0533	0.0605	0.0589	0.0548	0.0423	0.0584	0.0477	0.0737	0.0459	0.0561

Table 7 reveals that there is a solution to the optimization. The optimal portfolio is 71.64% TIAA-CREF Inflation-Linked Bond Fund (Retirement) TIKRX and 28.36% TIAA-CREF Large-Cap Growth Index Fund (Retirement) TRIRX. The optimal risky portfolio has an expected return of 6.12% and a Sharpe measure of 0.4792. Because an investor can't short sell the riskless asset, if the investor desires a higher rate of return they must select a portfolio that is mean-variance inefficient. To accommodate investors with differential return preferences, we used solver to solve for optimal risky portfolios with desired levels of return of 7%, 7.5%, 8%, 8.5%, 9%, 9.5% , 10%, and 10.5%.

Assessing risk aversion and utility

Investors need to choose among competing combinations and should do so considering their own risk tolerance. While an investor could be risk-averse, risk-neutral, or risk-loving, a common assumption is that most investors are *risk-averse.* A *risk-averse investor* is simply one who dislikes uncertainties or assuming risk (i.e., prefers less risk to more risk for a given level of return). The optimal portfolios have the highest expected returns given the degree of risk or lowest degree of risk given the level of return. Choosing among competing optimal portfolios is a risk and return trade-off. Thus, the choice depends on the investors' risk tolerance.

Table 7
OPTIMAL TIAA/CREF MUTUAL FUND PORTFOLIOS

Portfolio	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Target	Optimal	7%	7.50%	8%	8.50%	9%	9.5%	10%	10.50%
FUND	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight	Weight
TIKRX	0.7164	0.5619	0.4737	0.3855	0.2972	0.2090	0.1208	0.0326	0
TIQRX	0	0	0	0	0	0	0	0	0
TRBIX	0	0	0	0	0	0	0	0	0
TRCVX	0	0	0	0	0	0	0	0	0
TRERX	0	0	0	0	0	0	0	0	0
TRGMX	0	0	0	0	0	0	0	0	0
TRIEX	0	0	0	0	0	0	0	0	0
TRIRX	0.2836	0.4381	0.5263	0.6145	0.7028	0.7910	0.8792	0.9674	0.1788
TRLCX	0	0	0	0	0	0	0	0	0
TRSCX	0	0	0	0	0	0	0	0	0
TRSEX	0	0	0	0	0	0	0	0	0
TRSPX	0	0	0	0	0	0	0	0	0
TRVRX	0	0	0	0	0	0	0	0	0.8212
Total	1	1	1	1	1	1	1	1	1
Portfolio	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Average	0.0612	0.0700	0.0750	0.0800	0.0850	0.0900	0.0950	0.1000	0.1050
Var	0.0043	0.0079	0.0111	0.0151	0.0200	0.0256	0.0321	0.0394	0.0530
Std	0.0652	0.0888	0.1054	0.1230	0.1413	0.1601	0.1792	0.1986	0.2302
Sharpe Ratio	0.4792	0.4503	0.4271	0.4065	0.3892	0.3747	0.3626	0.3525	0.3257

Risk and risk aversion are used to decide how to allocate wealth among competing investment opportunities. Investors hold different portfolios due to their differing attitudes toward risk.

Examining how to choose among competing alternatives is important while maximizing the investor's satisfaction. Thus, the goal is to maximize the investor's utility. Equation 12 is a commonly used utility function based on an investor's investment outcome:

$$U = E(r) - \frac{1}{2} A\sigma^2 \quad (12)$$

where *U* is the investor's utility; *E(r)* is the expected return of the portfolio; ½ is a constant scaling factor; "*A*" is the investor's risk tolerance or risk aversion score; and σ^2 is the portfolio variance. This formula reveals that utility changes are intuitive. An investor prefers to have a higher expected return, but feels penalized to bear a higher degree of risk, as measured by the portfolio variance. As the expected return of a portfolio increases, so does the investor's utility, ceteris paribus. An investor's utility also decreases as risk increases. However, the decrease depends on the investor's risk aversion score "*A*". Some investors place a large penalty on a portfolio for an increase in risk,

as represented by a higher "*A*", while other investors place much less of a penalty for a risk increase. More than one portfolio could be equally satisfying for an investor.

Creating utility maximizing portfolios

The optimal risky portfolios derived in the previous section do not account for the investor's risk preference. Although the portfolios are optimized based on Markowitz's mean-variance analysis, the ultimate choice still depends on the investor's risk attitude. The mutual fund separation theorem (Cass and Stiglitz 1970; Ross 1978; Chamberlain 1983) states that investors who are making optimal investment choices between a set of risky assets and a risk-free security should all hold the same portfolio of risky assets and their risk attitude does not influence the relative proportion of funds invested across different risky assets. Thus, the risk-preference-adjusted optimization does not need to re-create the optimal weights among risky assets. It simply needs to find the appropriate weights for the risk-free asset and the optimal risky portfolio. An optimal risky portfolio is created based on objective information including the expected risk and return, and a utility maximizing portfolio mixes the optimal risky portfolio with the risk-free asset and is based on the investor's subjective risk preference.

In Theory, the task is to quantify an investor's risk preference, which is typically done with a utility function. The previous section presented a common utility function. Therefore, Equation 13 shows an objective function:

$$\max U = E(r_p) - \frac{1}{2} A\sigma_p^2 \tag{13}$$

where r_p is the portfolio's expected rate of return and σ^2_p is the portfolio's expected variance. An investor allocates capital between the optimal risky portfolio and risk-free asset. Assume that the weight invested in the optimal risky portfolio is *x*. Thus, Equations 14 and 15 describe the expected rate of return $E(r_p)$ and expected variance σ^2_p for the portfolio, respectively:

$$E(r_p) = xE(r_w) + (1-x)r_f = r_f + x(E(r_w) - r_f) \tag{14}$$

$$\sigma_p^2 = x^2\sigma_w^2 \tag{15}$$

The target function of the maximization problem becomes Equation 16:

$$\max U = r_f + x(E(r_w) - r_f) - {}^1\!/_2\, Ax^2\sigma_w^2 \tag{16}$$

To find the optimal weight (x) that is needed to maximize an investor's utility, the first order derivative of the expression regarding x should be set at zero as shown in Equation 17. By doing so, an optimal weight (x) may be computed in Equation 18:

$$\frac{dU}{dx} = (E(r_w) - r_f) - Ax\sigma_w^2 = 0 \tag{17}$$

$$x^* = \frac{E(r_w) - r_f}{A\sigma_w^2} \tag{18}$$

However, the practice of building optimal mutual fund or variable annuity portfolios in practice differs from pure theory and portfolio choices may be mean variance inefficient, as we have shown in Table 5 and 7. This arises due to the inability to short-sell the risky assets (mutual funds or variable annuities) and the inability to short-sell the risk-free asset. Thus, investors seeking higher return must select higher risk but less efficient portfolios. Utility maximization is troublesome because portfolio excess return per unit of risk is not constant because of the inability

to short sell the risk-free asset. Despite this setback, we can approximate and investors utility by using Equation 12 and tabulating utility results for our optimal portfolios for each return level for investors with differing risk aversion levels. Table 8 and 9 provide the utility of selected variable annuity and mutual fund portfolios, respectively.

Table 8
UTILITY MAXIMIZING TIAA/CREF ANNUITY PORTFOLIOS

Risk Aversion Score	Portfolios					
	A	B	C	D	E	F
1	0.0597	0.0681	0.0706	0.0721	0.0725	0.0713
2	0.0596	0.0661	0.0662	0.0642	0.0600	0.0508
3	0.0594	0.0642	0.0618	0.0563	0.0475	0.0303

As shown, investors with different risk attitudes will desire different portfolios. While the optimal portfolio is 78.15% TIAA Real Estate Account (QREARX), 20.90% CREF Bond Market Account (QCBMRX), and 0.95% CREF Equity Index Account (QCEQRX), it was not the utility maximizing portfolio for any level of risk aversion that we used. Investors that are not sensitive to risk will prefer portfolio E. Table 5 shows that portfolio E would have 22.49% in the TIAA Real Estate Account (QREARX) and 77.51% in the CREF Equity Index Account (QCEQRX). It has an expected return of 8.5%, an expected standard deviation of 15.8%, and a Sharpe measure of 0.3479. The most risk averse investors in our example will prefer portfolio B that has 28.44% in the TIAA Real Estate Account (QREARX) and 71.56% in the CREF Equity Index Account (QCEQRX). The expected return is 7.5%, the expected standard deviation is 9.4%, and the Sharpe measure is 0.6431.

It is worthy to note that pure theory would create a CML with a linear risk-return tradeoff and all efficient portfolios would share the same Sharpe measure. However, pure theory and practice collide because of short sale constraints on investments and the risk-free asset. While investors can opt for higher returns than the optimal risky portfolio delivers, the cost of doing so is a decreasing Sharpe measure.

Table 9
UTILITY MAXIMIZING TIAA/CREF MUTUAL FUND PORTFOLIOS

Risk Aversion Score									
	A	B	C	D	E	F	G	H	I
2	0.0591	0.0661	0.0695	0.0724	0.0750	0.0772	0.0789	0.0803	0.0785
3	0.0570	0.0621	0.0639	0.0649	0.0650	0.0644	0.0629	0.0606	0.0520
1	0.0549	0.0582	0.0584	0.0573	0.0550	0.0515	0.0468	0.0408	0.0255

As with annuities, mutual fund investors with different risk attitudes will desire different portfolios. While the optimal portfolio is 71.64% TIAA-CREF Inflation-Linked Bond Fund (Retirement) TIKRX and 28.36% TIAA-CREF Large-Cap Growth Index Fund (Retirement) TRIRX, it is not the utility maximizing portfolio for any of our hypothetical investors. Investors that are not sensitive to risk will prefer portfolio H which is 3.26% TIAA-CREF Inflation-Linked Bond Fund (Retirement) TIKRX and 96.74% TIAA-CREF Large-Cap

Growth Index Fund (Retirement) TRIRX. This portfolio has an expected return of 10%, an expected standard deviation of 19.9%, and a Sharpe measure of .3525. The most risk averse investors in our example will prefer portfolio C which is 47.37% TIAA-CREF Inflation-Linked Bond Fund (Retirement) TIKRX and 52.63% TIAA-CREF Large-Cap Growth Index Fund (Retirement) TRIRX. This portfolio has an expected return of 7.5%, an expected standard deviation of 10.5%, and a Sharpe measure of 0.4271.

CONCLUSION

We review how to compute the risk and return of managed portfolios and illustrate the benefits of diversification. After presenting the theory, we apply the theory to TIAA/CREF data to illustrate how to use the Solver function in Excel. Using the Solver function in Excel provides investors with a step-by-step process to form optimal risky portfolios. After discussing how to form an optimal risky portfolio we address risk aversion and utility as a prelude to forming utility maximizing portfolios.

Using data for TIAA/CREF annuities and mutual funds, we illustrate the process and provide optimal risky and utility maximizing portfolios for select investments during a recent time period. Before an investor implements any of our solutions, one caveat must be clear. An assumption of pure theory is that the historical return data used is represents a good estimate of future returns, variances, and correlations. If this is true, the output should be a good guide to future asset allocation. Unfortunately, in practice, some investments have insufficient time histories to permit making this assumption. Moreover, short time periods can be distorted by major market disturbances as witnessed in the recent financial crisis. A possible solution to this problem is to use indexes as the underlying asset and infer from index allocation the allocation to specific investments that have the index as their benchmark.

A major take-away is that in practice, where short-selling is prohibited, the CML will not be linear. Thus, investors desiring a return greater than that delivered by the optimal portfolio must select an optimal portfolio for a higher return. However, the result will be a less efficient portfolio in terms of excess risk per unit of return.

A restriction to our study is the availability of the data set. Our sample period spans mostly the strong bull market after 1990's. For investors who wish to follow the procedure to optimize their retirement portfolios, we note that the optimization using data from shorter period should be utilized with caution. For most of investors, the expected investment horizon until retirement may be longer than what our sample period covers. It is worth considering how a major shift in the market regime would play a role in forming investment strategy for retirees.

Our study can be extended in a few ways. First, in response to the limitation specified above, a future study using indexes and their returns may be worth exploring. While a study using index would potentially overlook the effects from the fund providers, the longer available sample period with indexes would allow further research on other issues such as rebalancing. Another potential extension is to study the benefit of optimization within specific fund family. Many tax deferred eligible retirement plans are tied to a specific fund family. Whether or not it is worth to be restricted in investment selection in order to enjoy the tax benefit is one point of interest. Also, employers who sponsor retirement plans may also wish to take further consideration in this regard when choosing the providers.

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CAMELS-BASED PERFORMANCE OF INDIAN PUBLIC AND PRIVATE SECTOR COMMERCIAL BANKS DURING ECONOMIC DISTRESS

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ABSTRACT

In this study, we compare the performance of public and private sector commercial banks in India from 2005 to 2016 using CAMELS measures. We find that private sector banks have been better capitalized and have lower levels of non-performing loans compared to their public sector counterparts but the two sectors don't differ significantly in other respects. We also conduct further study into non-performing loans and find that while such loans occupied a similar position in the balance sheets of both sectors during the first half of our study period, public sector banks have seen a sharp increase in the weight of non-performing loans on their balance sheets in the post-financial crisis period.

INTRODUCTION

In the aftermath of the 2008 financial crisis, there has been a significant effort in many countries to improve financial regulation. Part of this involves ascertaining the capital adequacy of banks and deriving a proper valuation of financial assets on bank balance sheets. Indian banks, in particular, have come under increasing scrutiny with the emergence of news regarding the presence of large quantities of non-performing loans on their balance sheets that were previously unrecognized. Public sector banks have also been the subject of scandals and fraudulent schemes (see, for instance, Kazmin and Mundy (2018, February 21)). In this study, we provide a brief overview of the Indian banking system and then conduct a comparison of public and private sector banks in India over a 12-year period spanning the financial crisis. Introduction is followed by a review of the literature. We then explain our research methodology, conduct an analysis based on CAMELS measurements and a further analysis of non-performing assets. We then conclude with a recommendation for further study.

Overview of the Indian Banking Sector

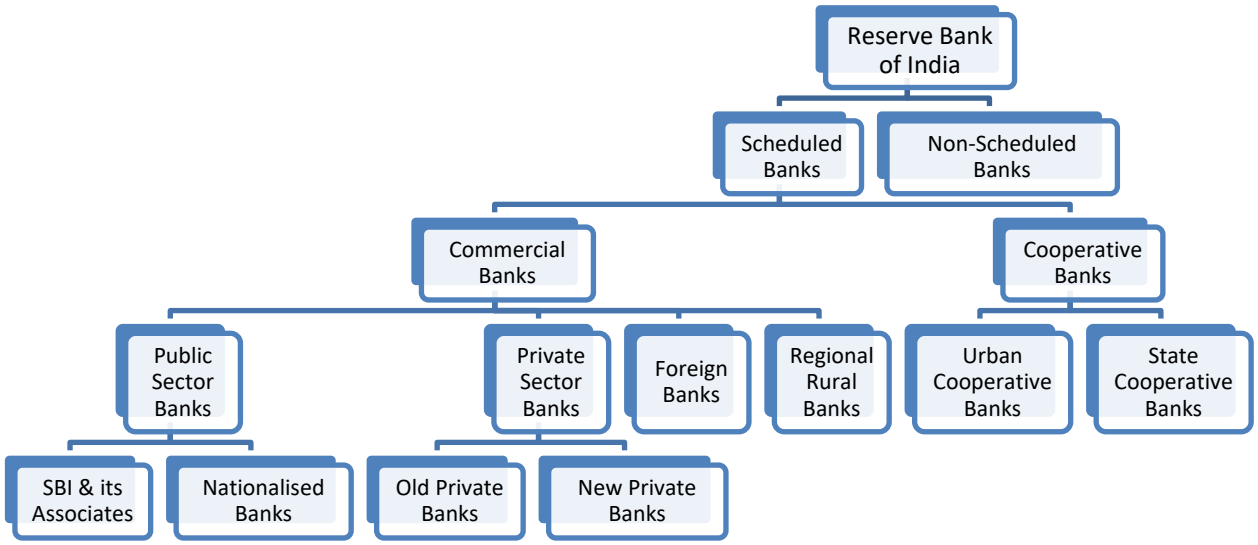
The fuel for the growth and development of an economy is finance. However, mere monetary funds would not suffice the purpose, unless it is regulated and channelized in the proper direction with proper management. This need of regulating and channelizing the flow of funds in

the economy is taken care by the banking system. A strong, resilient, and efficient banking system is essential for the economy to function smoothly and is without a doubt the backbone of any economy.

The Indian banking system has been the stimulus for the persistent growth of India's economy. The Indian financial system is dominated by the banking sector, which controls 63% of its assets, compared to Insurance companies controlling 19% and Non-banking financial institutions with 8% (see *Subbarao*). Thus, the onus of a smooth financial system operations lies with the banks. For the benefit of the economy, the banking system has been formed and different roles and responsibilities have been assigned to different types of banks to ensure the overall development of the nation.

The structure of the Indian Banking system is as follows:

Figure 1: Structure of Indian Banking System



Source - http://stockshastra.moneyworks4me.com/economic-outlook/indian-banking-industry-indian-banks-structure-business-model/

Reserve Bank of India - The Indian Banking system is controlled, monitored and regulated by the regulatory authority of the Banks, namely the Reserve Bank of India (RBI). RBI is the apex bank; it is the central bank of India.

Scheduled Banks - All banks which are included in the Second Schedule to the Reserve Bank of India Act, 1934, are Scheduled Banks. These banks comprise Scheduled Commercial Banks and Scheduled Co-operative Banks. Scheduled Commercial Banks in India are categorized into five different groups according to their ownership and/or nature of operation. These groups are (i) State Bank of India and its Associates, (ii) Nationalized Banks, (iii) Regional Rural Banks, (iv) Foreign Banks and (v) Other Indian Scheduled Commercial Banks (in the private sector). Scheduled Co-operative Banks consist of Scheduled State Co-operative Banks and Scheduled Urban Co-operative Banks. Scheduled banks come under the direct purview of the credit control

measures of the Reserve Bank of India. They are entitled to borrowings and rediscounting facilities from Reserve Bank of India (see also, *Evolution of Banking in India*).

Commercial Banks - The major banking segment that caters to the needs of trade, commerce, industries, agriculture, small business, transport, etc. in the Indian economy are the commercial banks. These banks carry out the basic banking business of accepting deposits and making loans and advances. Along with these, many other functions have also been vested upon by the commercial banks.

Based on the ownership pattern, the commercial banks can be classified as public sector banks (major holdings of the government), private sector banks (major non-government holdings), and foreign banks (having head offices located outside India). The primary difference between public and private sector banks, which are the focus of our study, is in terms of the composition of their capital. For public sector banks, the majority of their ownership (at least 51%) is under government control with the rest distributed through issuance of securities in the capital markets. Private sector banks, on the other hand, have shareholders in the form of individuals and/or institutions. These are regulated such that a public sector undertaking, including the Government of India, is not allowed to hold more than 40% of their shares (for more details of ownership limitations, see also *Reserve Bank of India. (2016, May 12)*). Because of the government control, public sector bank operations are influenced by government strategies such as welfare schemes and subsidies for the public, which are routed through these banks. Despite being commercial banks, these banks have to be thoughtful about the social benefits generated by their operations. On the other hand, private sector banks do act under the purview of regulatory authorities but are otherwise free to decide on their strategies akin to a conventional profit-seeking institution.

Research Problem

Constantly changing economic scenarios pose many challenges to the growing banking system. In the quest to fulfill its many functions, the banking system has been liberalized and additional reforms are taking place. These reforms lead to increasing opportunities as well as challenges for the banks. The entry of new private sector as well as foreign banks has led to increased competition while the role of regulatory authorities has widened and will have to contend with multiple facets of supervision.

The public sector banks' approach of social benefit is now in a drifting phase from mere social welfare to business-oriented social welfare. The major difference between public sector banks and private sector banks is narrowing and they are now competing directly with each other. Both sectors, however, have their advantages and disadvantages. The challenge lies in how both sectors cope with the dynamic circumstances of the economy. So, it is of interest to the researcher to compare the public and private sectors of the banking system. Our focus in this paper is on the performance differences between the two sectors, particularly in terms of their responses to the global financial crisis in the late 2000's.

LITERATURE REVIEW

A number of studies have conducted CAMEL-based analyses of Indian banks in various contexts. Mishra et. al. (2012) set up a ranking of twelve public and private sector banks using CAMEL ratios and found higher ranking banks to belong to the private sector. A similar study, using ten public and ten private sector banks, was conducted by Nandi (2013), who found that their selection of public sector banks scored higher. There are many more such studies that construct a CAMEL-based ranking of selected public and private sector banks, including but not limited to Prasad et. al. (2011), Devanadhen (2013), Rastogi & Saxena (2013), Sharma (2014), Palamalai & Saminathan (2016), and Rawlin et. al. (2017).

Acharya & Subramanian (2016) conducted a thorough analysis of the health of public sector banks vis-à-vis private sector banks by examining capitalization, exposure to systemic risk, and profitability. They find that while public sector banks, as of March 2014, had adequate Tier I capital, this was the result of overstated capital ratios due to regulatory forbearance provided by the Reserve Bank of India. These ratios might be subject to changes as the Basel 3 standards get adopted. The authors simulate three possible scenarios moving forward and find that, absent regulatory forbearance, all public sector banks would have Tier I capital ratios significantly lower than the mandated levels. On the other hand, all private sector banks would have Tier I capital ratios significantly higher than the mandated levels.

The Reserve Bank of India, in Financial Stability Report December 2017, found a strong negative correlation between capital adequacy and non-performing loans of -74% for all commercial banks. They also found that public sector banks recorded negative profitability ratios since March 2016 and that their gross non-performing loans were projected to increase to over 15% of total loans by September 2018. Private sector banks, on the other hand, had consistently positive profitability ratios and their gross non-performing loan ratio was projected to be at about 4%. The report also indicates a tightening of regulatory standards for public sector banks as evidenced by the following quote: "… any extension of forbearance to banks with a view to facilitating them to nurture their stressed assets should be viewed as a larger responsibility of the regulator to dovetail the interests of both the lenders and borrowers." (For further discussion of regulatory policy towards public sector banks, see also Nair (2015, March 03).)

Rather than focus on specific banks as has been done in the studies cited above and numerous other studies as well, the present study looks at the performance evolution of the entire sector of public and private sector banks with regards to how they emerged out of the 2008 global financial crisis. This particular aspect is crucial since there has been an increased emphasis on tightening financial regulation in the aftermath of that crisis. We also examine how public and private sector banks differ in terms of non-performing assets and how the difference has changed since the financial crisis.

RESEARCH METHODOLOGY

Type of Research - The research performed is analytical in nature. A detailed analysis of the Indian commercial banks has been carried out in the form of a time series analysis and in terms of performance comparison between the public and private sectors.

Research Objective - To compare the performance of Indian public sector and private sector commercial banks for the period of 2005 to 2016.

Data - The number of Scheduled Commercial Banks utilized in the study is summarized in Table 1. We note that the number of public sector banks has remained almost constant over the time horizon of our research. The number of private sector banks decreased by 25% over 2005-2011 before holding steady over the next five years. This drastic reduction is arguably due to the direct or indirect effects of the global financial crisis. We also see a 40% increase in the number of foreign banks operating in the country from 2005 to 2016. This denotes increased competition for the existing Indian banks.

Table 1: Composition of Scheduled Commercial Banks

Year	Foreign Banks	Private Sector Banks	Public Sector Banks		All Scheduled Commercial Banks
			Nationalized Banks	SBI & Its Associates	
2005	30	28	20	8	86
2006	29	28	20	8	85
2007	29	24	20	8	81
2008	27	23	20	8	78
2009	29	22	20	7	78
2010	31	22	20	7	80
2011	32	21	20	6	79
2012	36	20	20	6	82
2013	40	20	20	6	86
2014	42	20	20	6	88
2015	41	20	21	6	88
2016	42	21	21	6	90

Method for Data Analysis - The performance of Indian commercial banks was measured based on the CAMELS model. The CAMELS model was developed in 1970s by three banking supervisory agencies in the United States (US), namely the Federal Reserve, the Federal Deposit Insurance Corporation (FDIC), and the Office of the Comptroller of the Currency (OCC), as a part of the supervisory system for measuring the safety, soundness, and performance of a bank. Following existing literature (eg. *Poghosyan and Cihák, 2011* and *Betz et al., 2013*), we adopted the following proxies for measuring each variable in the CAMELS system:

- Capital Adequacy – We used two proxies:
    i. Capital Adequacy Ratio: This was obtained from the table titled *Selected Ratios of Scheduled Commercial Banks* published by the Reserve Bank of India (RBI).
    ii. Equity to Total Assets Ratio: Equity was calculated as the sum of Capital and Reserves & Surplus. Values were obtained from the table titled *Liabilities and Assets of Scheduled Commercial Banks* published by the RBI.
- Asset Quality – This was estimated using the ratio of Gross Non-Performing Assets (obtained from the table titled *Movement of Non-Performing Assets of Scheduled Commercial Banks*) to Total Assets.
- Management Quality – This was estimated using the ratio of Costs to Income with values obtained from the table titled *Earnings and Expenses of Scheduled Commercial Banks*. Cost denotes the sum of all operating expenses. Earnings refers to the sum of Net Interest Income and income from other sources.
- Earnings – We used two proxies obtained from *Selected Ratios of Scheduled Commercial Banks*:
    i. Return on Average Assets: defined as the ratio of net profit for the year divided by the average of total assets for the current and previous year.
    ii. Return on Average Equity: defined as the ratio of net profit for the year divided by the average value of equity for the current and previous year.
- Liquidity – This was estimated using the ratio of liquid assets to total deposits. For liquid assets, we used the sum of Cash in hand, Balances with RBI, Balances with banks in India, Money at call and short notice, Balances with banks outside India, and Indian Government securities. The conventional denominator in this ratio is the sum of total deposits and short-term funding but we weren't able to distinguish short-term from long-term funding on the banks' balance sheets and were therefore constrained to use only the former.
- Sensitivity to Market Risk – This was estimated using the ratio of income derived from market movements (sum of Net profit on sale of investments, Net profit on revaluation of investments, and Net profit on exchange transactions) to total income (sum of Net Interest Income and income from other sources).

Note: To clean up the data, we eliminated all observations with missing values of Capital Adequacy Ratio, Total Assets, Return on Average Assets, and Return on Average Equity, and observations with zero deposits. This resulted in an insignificant loss of less than 3% of observations.

Hypothesis – We test the following hypothesis for each aspect of the CAMELS measure:

- H_0 - There is no significant difference between the performance of selected public sector and private sector banks.
- H_1 - There is a significant difference between the performance of selected public sector and private sector banks.

As reported earlier, a number of studies have ranked various public and private sector banks on the basis of CAMEL ratings. The results in these studies over time have been mixed with

regards to which banks come out on top. As a result, while some aspects of public sector banks have been reported to be weakened in recent years, we chose to be agnostic in designing our overall alternate hypothesis and look for significant differences between public and private sector banks without being partial to a specific direction. However, given the predominant attention given to capital adequacy and non-performing assets in recent years, we are in a position to predict, based on extant evidence, that public sector banks have lower capital adequacy ratios and higher proportion of non-performing loans compared to their private sector counterparts.

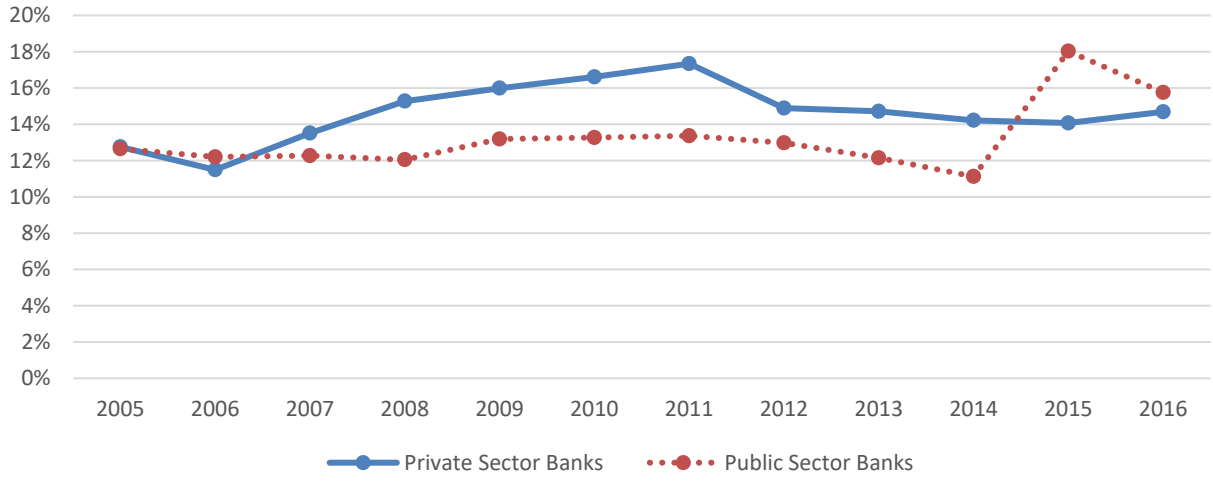
ANALYSIS

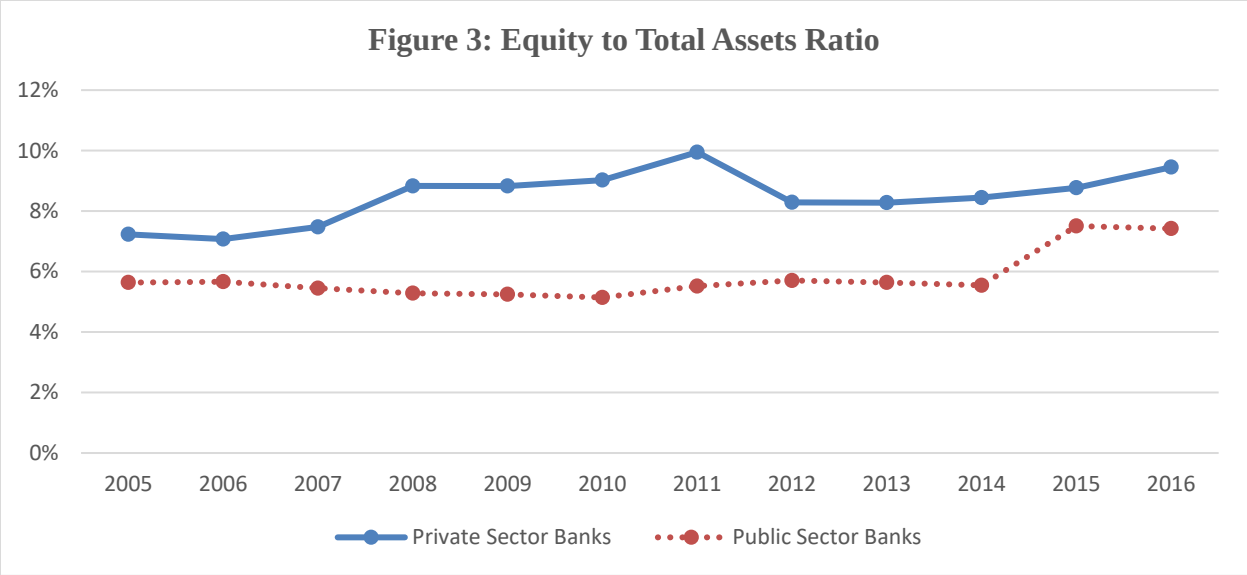
Table 2: Capital Adequacy

	Private Sector Banks	Public Sector Banks	t-statistic (p-value) for difference in means
Capital Adequacy Ratio	14.51%	13.25%	1.68 (0.094)
Equity to Total Assets Ratio	8.40%	5.81%	8.30 (< 0.001)

Table 2 shows that private sector banks were better capitalized than public sector banks. The difference in terms of the Capital Adequacy Ratio may appear small. However, this ratio is based on risk-weighted assets whose definition might appear arbitrary. Furthermore, in the timeframe of our analysis, the commonly accepted criteria for this ratio moved from the Basel II to the Basel III standard. Thus, we use the Equity to Total Assets Ratio as an alternative proxy to measure capital adequacy. In this case, the difference between private and public sector banks is much larger and highly statistically significant. We reject the null hypothesis for capital adequacy and confirm that our finding matches our expectation.

Figure 2: Capital Adequacy Ratio





Figures 2 & 3 clearly show that private sector banks were consistently better capitalized than their public sector counterparts over time.

Table 3: Asset Quality			
	Private Sector Banks	Public Sector Banks	t-statistic (p-value) for difference in means
Non-Performing Loans to Total Assets Ratio	0.73%	1.13%	-5.66 (< 0.001)

Table 3 indicates that private sector banks had a lower fraction of their assets tied up in non-performing loans, indicating that the former has been more judicious in their lending practices. We reject the null hypothesis for asset quality.

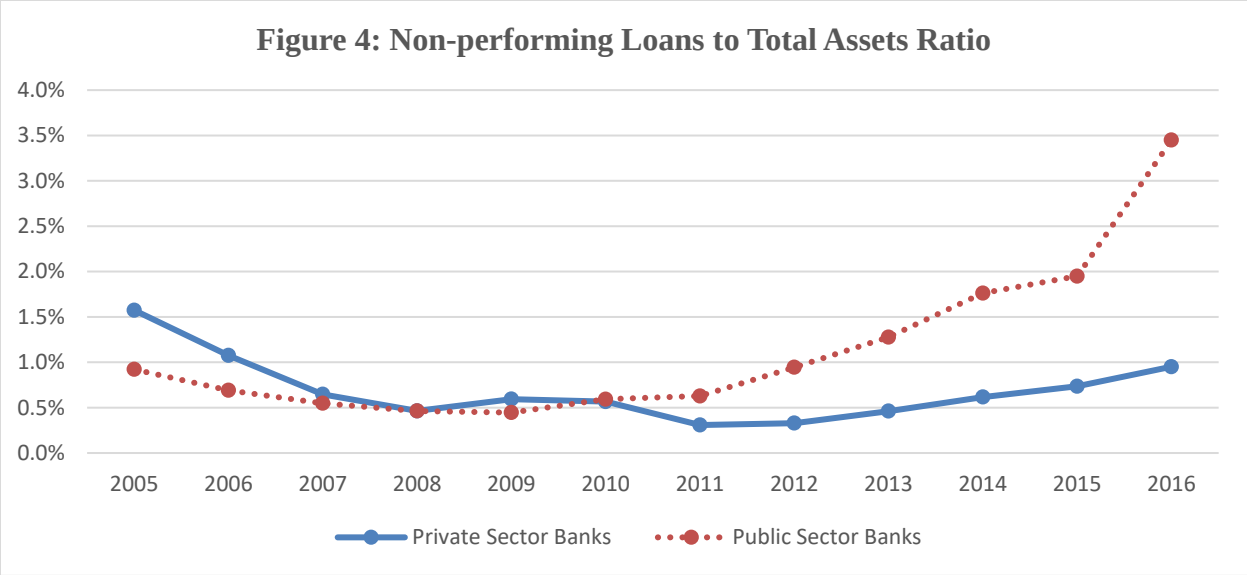


Figure 4 portrays a very interesting difference between the two sectors during the chosen time period. Early in the study private banks have a larger percentage of non-performing loans. For both sectors the steady decrease in the ratio during the global recession and the increase in the aftermath conforms with the pro-cyclical nature of risk-taking by banks. However, public sector banks appear to have been much more aggressive in their lending practices. This factor has also been widely reported elsewhere (for instance in the Financial Stability Report December 2017 published by the Reserve Bank of India) and thus confirms with our expectation. We explore this further in the next section.

Table 4: Management Quality

	Private Sector Banks	Public Sector Banks	t-statistic (p-value) for difference in means
Cost to Income Ratio	56.46%	48.72%	5.86 (< 0.001)

Table 4 shows that public sector banks were more cost efficient than the private sector banks, providing a useful indicator of management quality in terms of cost efficiency. We thus reject the null hypothesis for management quality. However, we also see from Figure 5 that most of this difference arises from the early years of our analysis and that in recent years the two sectors have been slowly converging in this regard.

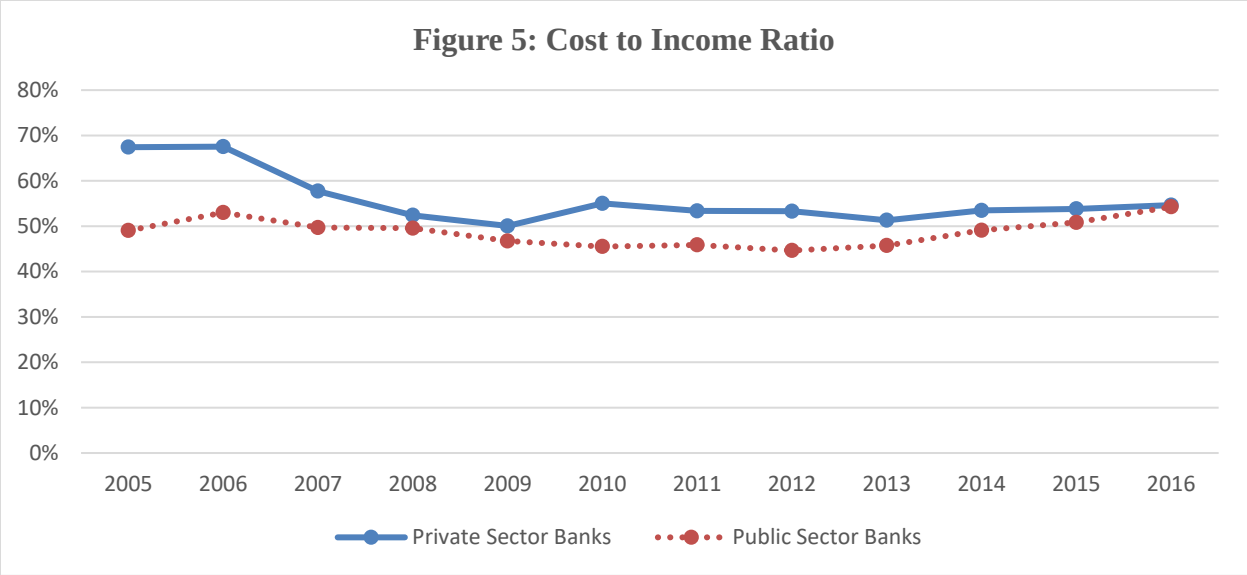
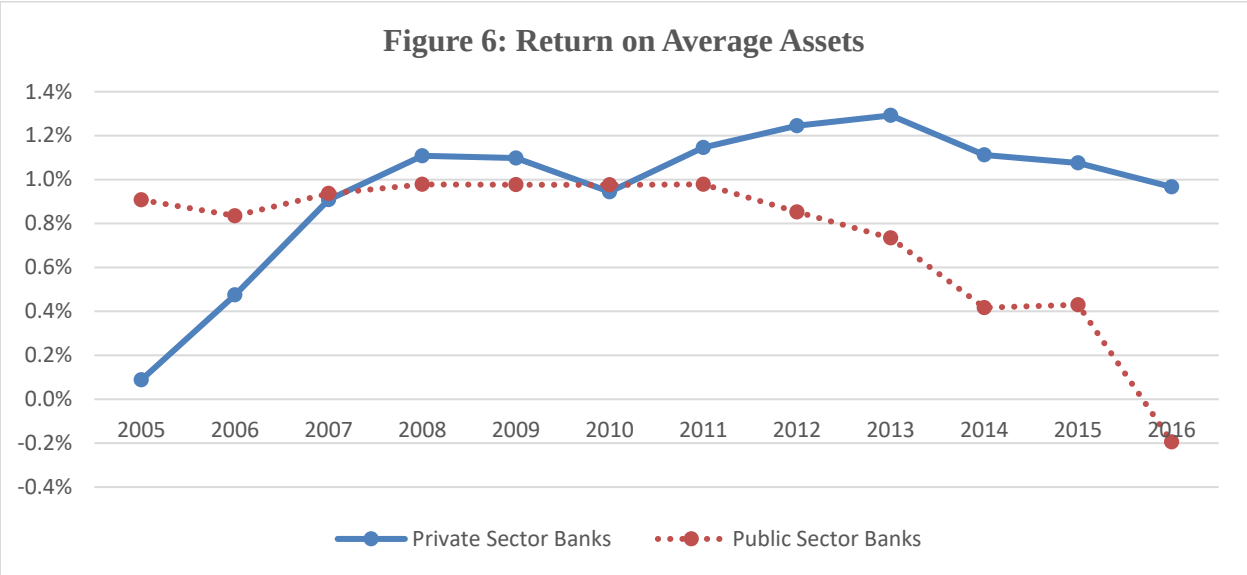
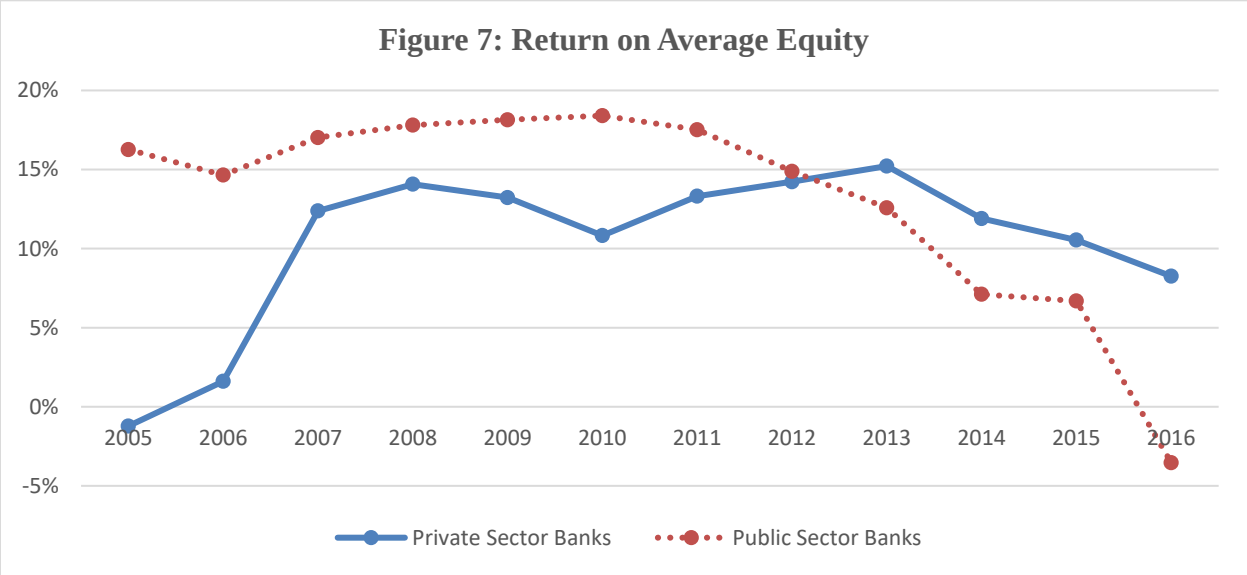


Table 5: Earnings			
	Private Sector Banks	Public Sector Banks	t-statistic (p-value) for difference in means
Return on Average Assets	0.92%	0.74%	2.93 (0.0036)
Return on Average Equity	9.86%	13.17%	-3.28 (0.0011)

Table 5 shows a significant difference in earnings between private and public sector banks but the direction of the difference depends on the proxy we use to measure earnings. In terms of ROA, private sector banks outperform banks in the public sector but the opposite is true if we use ROE as the measure. We are thus unable to reject the null hypothesis for earnings. The time-series analysis in this case turns out to be very revealing.





We can make a couple of significant observations from figures 6 & 7. In terms of both ROA and ROE, each ratio shows private sector banks were consistent in the years 2007-2016. On the other hand, public sector banks had steadily diminishing returns in terms of both measures from 2011 onward. This trend matches the increase in non-performing loans for public sector banks in the same time period. Our findings here are in line with those reported in Financial Stability Report December 2017, and Acharya & Subramanian (2016).

We also notice that the ROA values for both classes of banks were similar during the first half while the ROE for public sector banks was higher. This apparent discrepancy can be understood in light of the lower equity levels of public sector banks as seen in Figure 3, since all else equal, lower equity values result in higher values of ROE. We test this assertion by estimating the correlation between Equity to Total Assets ratio and ROE for each of the two classes. For public sector banks, we found a correlation of -12.4% with a p-value 0.025, confirming our conjecture. On the other hand, for private sector banks, we found a positive correlation of 12.3% with a p-value of 0.044, showing that the negative correlation between the equity ratio and ROE only exists for public sector banks.

Table 6: Liquidity

	Private Sector Banks	Public Sector Banks	t-statistic (p-value) for difference in means
Liquid Assets to Deposits Ratio	40.26%	38.46%	1.82 (0.069)

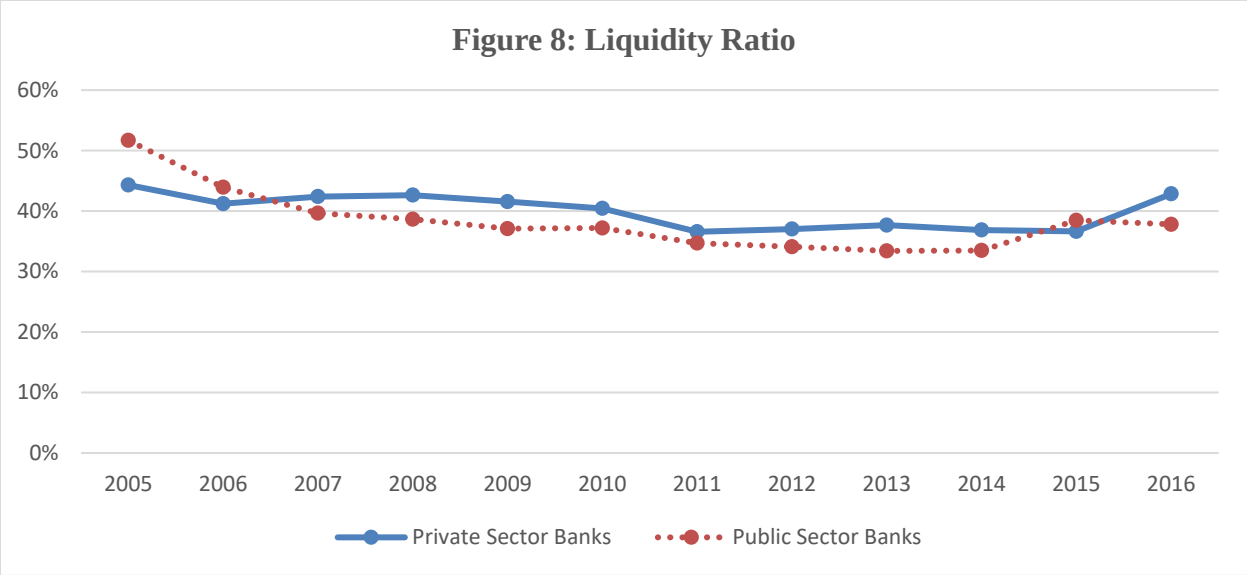
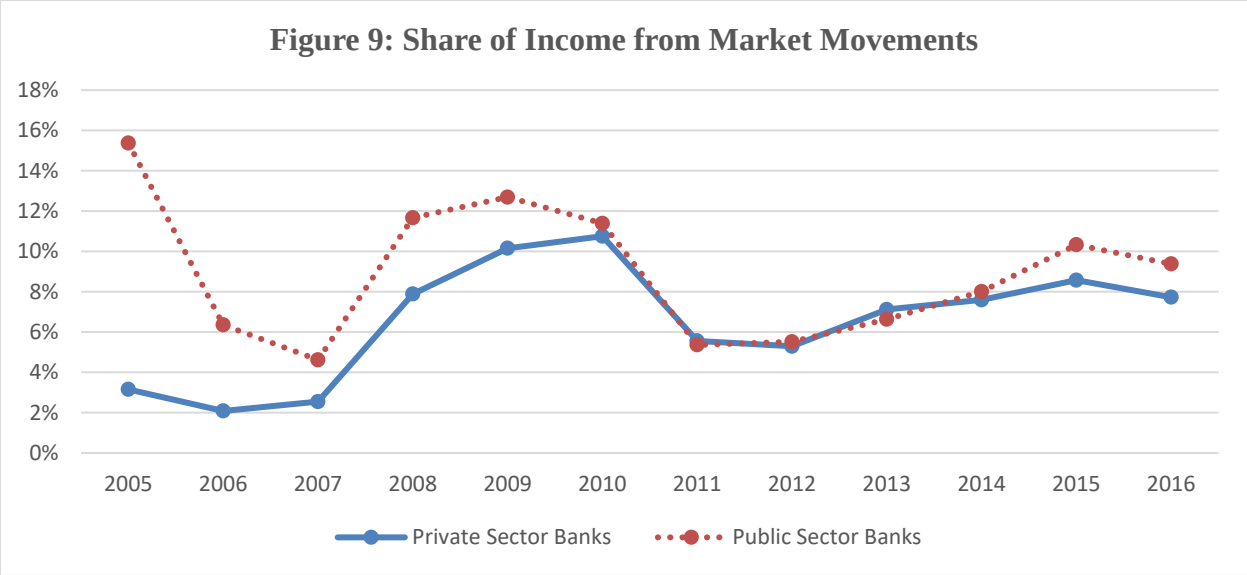


Table 6 shows that private sector banks were slightly more liquid than public sector banks. However, neither the magnitude nor the statistical significance of the difference is very high. We are unable to reject the null hypothesis for liquidity. This is confirmed in Figure 8, where we see both types of banks follow a similar trend while staying close to each other.

Table 7: Sensitivity to Market Risk

	Private Sector Banks	Public Sector Banks	t-statistic (p-value) for difference in means
Share of income from investments & exchange transactions	6.32%	8.98%	-4.58 (< 0.001)

Table 7 shows that private sector banks had a lower share of their income from sale and revaluation of investments and exchange transactions, implying a lower sensitivity to market movements. We thus reject the null hypotheses for sensitivity to market risk. Once again, the time-series analysis provides a clearer picture.



We see from Figure 9 that most of the difference between the two sectors occurs in the earlier years of our study, from 2005-2009. Subsequent to that, the two sectors are identical in terms of sensitivity to market risk, which is a possible indication of improving risk-management practices at public sector banks.

FURTHER ANALYSIS OF NON-PERFORMING ASSETS

Our analysis in the previous section indicates that a further investigation of non-performing assets is warranted. Specifically, we check whether the high non-performing assets ratio for public sector banks is caused by the existence of a few outliers or whether this was a sector-wide trend. To accomplish this, we compare the distributions of the relevant ratio between public and private sectors banks for each year and see if the distributions are statistically different.

Figure 10 shows the histograms for the years 2005 – 2010. We see that with the exception of a few outliers, the distributions of the private and public sector banks' NPL ratios lie in the same range. For instance, in 2006, almost all the banks in the public sector had less than 1.5% of their assets tied up in non-performing loans. This was also true of most private sector banks. While the precise limits vary from one year to the next, both types of banks had similar spreads.

Figure 10: Histograms for Non-Performing Loans to Total Assets (2005 – 2010)

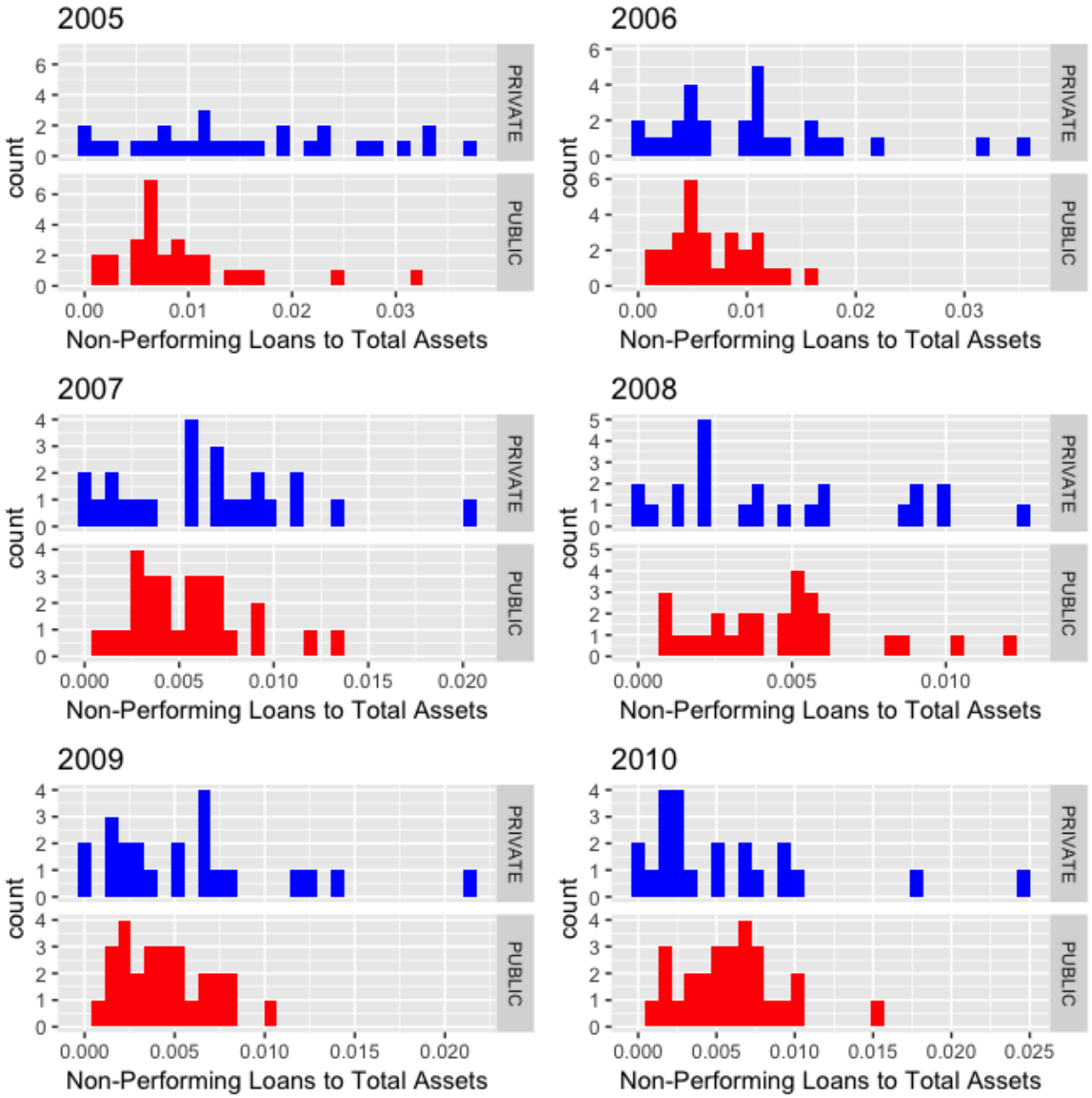
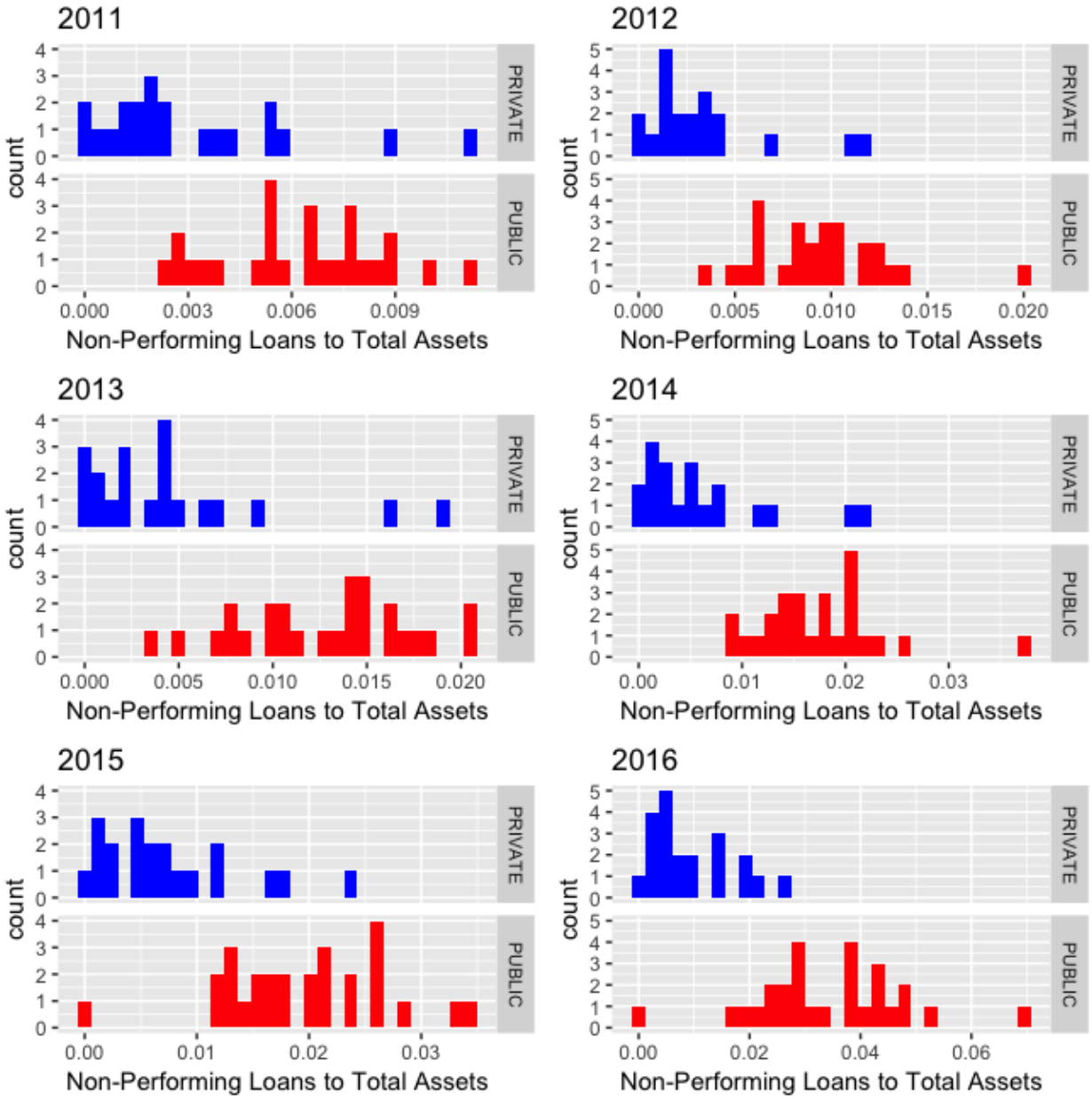


Figure 11 shows the histograms for the years 2011 – 2016. In contrast to Figure 10, we clearly see a shift to the right for the distributions of public sector banks compared to private sector banks. It is therefore not just a few outliers that cause the average ratio of non-performing loans to total assets for public sector banks to trend sharply upwards. Instead, the entire sector experienced this trend.

Figure 11: Histograms for Non-Performing Loans to Total Assets (2011 – 2016)



CONCLUSION

Based on our analysis, we find that the largest source of difference between public and private sector banks occur in the form of non-performing loans. The problem of bad loans issued by public sector banks have been well documented (see for example, *Mundy & Kazmin, 2017*). This problem has only worsened since the end of the financial crisis, likely fueled by an urge to expand lending in a booming economy. This in turn appears to have contributed to a significant drop in returns for public sector banks over the last five years. In contrast, non-performing loans for private sector banks have increased to a significantly lower extent in the same time-period and

their returns have been relatively steady. The other significant difference between the two sectors lies in their level of capitalization. Private sector banks have been better capitalized compared to public sector banks, which allows them to absorb unanticipated losses in the event of another national or international economic downturn. In terms of other factors, we do not find significant differences, especially over the later part of our analysis, strongly indicating that the increase in competition has led to a convergence in several operating characteristics of public and private sector banks.

This study provides interesting insight into the CAMELS-related performance of public and private banks in India…especially pre and post financial crisis. The authors contemplate a further comparison between the performance of banks in the Indian economy with banks located in a more established yet sluggish economy…such as the United States. This may provide insights as to how Indian banks can benefit from the experience of US banks as the Indian economy matures and slows. However, this is left to another study at a later date.

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IMPACT OF CORPORATE TRANSPARENCY ON TARGET FIRMS' ACQUISITION OPPORTUNITIES AND PREMIUMS: A SHORT-TERM STUDY

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ABSTRACT

I examine how the different corporate transparency levels affect target firms' market-timing opportunities and profits in the mergers and acquisitions market. My results show that acquirers have tendency to avoid low transparency (LT) targets, since it is high transparency (HT) targets that are more likely to receive takeover offers. While the univariate results show that LT targets always received higher acquisition premiums, after controlling for undervaluation and for various firm characteristics, I find that it is actually HT targets that are more likely to earn higher acquisition premiums in general. Only when competition level in the mergers and acquisitions market is strong or when the target has strong negotiating power, can LT targets successfully demand higher acquisition premiums. Therefore, target firms in general should increase their corporate transparency if they want to earn higher acquisition premiums.

INTRODUCTION

Information asymmetry creates noise, while such noise can inflict cost on market participants when market participants look at the wrong information or draw the wrong inferences from the information. As a result, information asymmetry pushes stock price away from its fair market value (De Long et al. (1990)). In this study, I classify targets based on their transparency levels: Low transparency (LT) and higher transparency (HT) based on Lang and Lundholm (1996). While studies have found various advantages and disadvantages for higher transparency, I examine specifically how corporate transparency impacts target firms' market-timing opportunities and profits in the mergers and acquisitions market by looking at the takeover offers and premiums of the target firms. Regarding the target firms, LT level can be advantageous for the targets if the targets are able to use the information asymmetry price discount to attract acquirers' bids and to negotiate higher acquisition premiums. On the other hand, information asymmetry problems of the target firms may also discourage acquirers from making offers, while rational acquirers may also discount the price of the LT target firms when negotiating for the acquisition premiums. As a results LT targets may receive lower acquisition premiums.

In this study, I assume that the investors are risk averse and are aware of the information asymmetry problems of the LT firms. As a result, investors will discount the price of LT targets as a form of information compensation discount. Less-than-rational acquirers which mistake price discounts as bargains are more likely to bid on LT targets and pay higher acquisition premiums to LT targets, while rational acquirers that are aware of the information asymmetry are more likely to bid on and pay higher premiums to HT targets.

A common question may be raised here: Why would acquirers overpay during acquisitions? Based on existing literature, acquirer managers may overpay during acquisitions when they are affected by hubris (Roll (1986)), empire-building mentality (Jensen (1986)), or free cash flow problems. If LT targets are able to use the information asymmetry and larger scaled mispricing to

take advantage of such acquirer managers (by accepting offers that are higher than the true value and rejecting offers below the true value as in optimal option exercise), they should be able to receive higher final acquisition premiums than HT targets. In addition, such findings will indicate that the information asymmetry problems can facilitate wealth transfer from the acquirer shareholders to the target shareholders.

This study provides several contributions. First, I use more direct measure (analyst forecast dispersion obtained from the IBES[1] Summary Tapes) to measure corporate transparency while some use private firms or firms that have recently had IPOs to identify firms with higher information asymmetry (Reuter et al. (2012)). By using a more direct measure of corporate transparency, I can draw more affirmative conclusions in this study. In addition, while LT can be beneficial in certain situations as mentioned in the next section of the literature review, using direct measures of acquisition offers and premiums, my results show that HT is more beneficial for target firms in the mergers and acquisitions market. Specifically, it is HT targets that are more likely to receive takeover offers and to earn higher acquisition premiums. Therefore, target firms that want to increase their market-timing opportunities and profits in the mergers and acquisitions market should choose to increase their transparency. Next, while the existing literature shows that managers do not always make optimal decisions, the results of this study show that acquirer managers are not totally oblivious of the information asymmetry problems. Like most investors in the market, acquirers also tend to discount the value of LT targets when they observe information asymmetry problems. As a result, LT targets receive lower acquisition premiums in general. However, when competition level is strong in the mergers and acquisitions market and when equipped with enough negotiating power, LT targets are capable of taking advantage of the timing option and demand higher premiums.

LITERATURE REVIEW AND MOTIVATION

In this section, I will present a brief literature review of the pros and cons of higher corporation transparency before discussing the motivation of this paper. Through the discussion, it should become clear that whether higher corporate transparency is beneficial to the corporation is a complex question, while this mergers and acquisitions study helps to narrow the gap of our understanding of corporate transparency.

Several researchers have identified the advantages of high transparency. For example, corporate transparency is found to have a positive relationship with profitability in the US market (Singhvi and Desai (1971)); with firm size and firm performance (Lang and Lundholm (1993)); with responsiveness to earning (Price (1998)); and with stock performance, institutional ownership, analyst following, and stock liquidity (Healy, Hutton, and Palepu (1999)). In addition, Welker (1995) and Leuz and Verrecchia (2000) also find the increased disclosure can reduce bid-ask spreads and increase share turnover. Amihud and Mendelsohn (1980), Callahan, Lee, and Yohn (1997) suggest that increased liquidity can lower a firm's cost of capital. Heflin, Shaw, and Wild (2005) find that higher quality accounting disclosures, measured by total disclosure rating, can increase market liquidity. Sengupta (1998) finds that a higher quality of disclosure is related to lower effective interest costs in debt issuances. Botosan (1997) finds a negative (no) relation between the cost of equity and disclosure when the firm has low (high) analyst following. Furthermore, Verrecchia (2001) suggests that increasing disclosure can reduce investment inefficiency by reducing information asymmetry and agency problems. Beatty and Ritter (1986)

[1] Institutional Brokers Estimate System.

believe that disclosure can reduce the ex-ante uncertainty and ex-ante underpricing. Durnev and Kim (2005) find that firms with more profitable investment opportunities (proxied by higher Q), more concentrated ownership, and rely more on external financing tend to disclose more and have better governance. Last but not least, Mensah et al. (2004) find that increase in disclosure can reduce analyst forecast dispersion.

However, high transparency is not always more advantageous than low transparency. Botosan and Plumlee (2002) find that while cost of equity is negatively related to annual transparency rating, it is also positively related to timeliness of disclosure, such as quarterly report disclosure rating. Hence, timely disclosure can increase the cost of equity capital. Bushee and Noe (1999) argue that increasing total disclosure can potentially reduce future stock volatility when attracting long-term investors. However, when transient institutions trade on short-term earnings news, the increase in volatility induced by transient investors will completely offset the reduction in volatility brought by long-term investors. Therefore, timely disclosure attracts transient investors and increases stock volatility. In addition, Verrecchia (1983), Healy, Hutton, and Palepu (1999), Darrough and Stoughton (1990), and Wagenhofer (1990) argue that disclosure can also be costly to a firm when it reveals information to competitors, which may cause the firm to lose its competitive advantage or bargaining power. Based on the existing literature in corporate transparency, the verdict on the pros and cons of greater corporate transparency is not yet settled or definitive. Some firms to choose high transparency, while other firms to choose low transparency for different reasons and motivations.

We can see that the existing literature has shown us that whether higher corporate transparency is beneficial to the firm is a complex question. I will use the next two market-timing studies as a more specific example. Lo (2011) uses various methodologies to examine the long-term performance of SEO firms to determine whether HT helps managers to time the SEO issuance more successfully. Contrary to the common believe that HT firms are better performers, Lo (2011) finds that HT firms tend to underperform their LT counterparts in the long run post SEOs. The results indicate that HT firms are more successful at issuing overvalued stocks. Therefore, when price correction occurs in the long run, HT firms in general experience more negative long-term performance post their stock issuance.

To examine whether HT also provides higher market-timing profit in the stock repurchase market, Lo (2017) uses fixed-price tender offer sample in the study and finds that it is LT firms that are more successful at timing fixed-price tender offer stock repurchases. Specifically, Lo (2017) finds that LT firms are more successful at buying back their own stocks at discounts. As a result, when price correction occurs in the long run, LT firms outperform their HT counterparts post their own stock buybacks.

Based on the above discussion, corporate transparency is a complex issue that requires further examination. Whether it is SEOs, stock repurchases, or mergers and acquisitions, each corporate event is unique. Hence, corporate events like mergers and acquisitions also demand our attention to help us further complete the understanding of corporate transparency. In fact, mergers and acquisitions is a more complex area to study than SEOs and fixed-price tender offers, since in the SEO and the fixed-price tender offer markets, the managers are dealing with less sophisticated external investors. Such information asymmetry problems may more easily provide LT firms with more information advantage over external investors. On the other hand, in the mergers and acquisitions market, target firms are dealing with much more sophisticated and experienced acquirers. Needless to say, information asymmetry and noise affect how acquirer managers make investment decisions, since their jobs are now more complicated than before. While acquirers often

make suboptimal decisions and overpay during acquisitions (Roll (1986)), it is interesting to see whether acquirers are able to overcome such information barrier when acquiring LT targets.

To find straightforward answers to this more complex question, rather than examining the long-term performance, I examine the actual acquisition offers and premiums received by target firms to provide more direct and conclusive results. Specifically, since information asymmetry of LT firms leads to heterogeneous expectations in accurate firm valuation, such heterogeneous expectations can cause higher price dispersion. In addition, risk-averse investors who perceive higher information risk will discount the stock price of LT firms, causing LT firms to be traded at discounts on average. Therefore, I examine whether the combination of higher price dispersion, price discount, and strong negotiating power can create valuable timing options by providing LT firms with more market-timing opportunities and higher acquisition premiums.

Several theories and studies are consistent with the hypothesis and find acquirers to make value-reducing or suboptimal decisions when they are affected by hubris (Roll (1986)), empire-building mentality (Jensen (1986)), or free cash flow problems. Roll (1986) argues that managers are often overconfident and over-optimistic. Acquirers tend to overestimate the potential synergistic gains and are likely to overpay while making acquisitions. Numerous studies have found consistent evidence indicating that acquirers often overpay during acquisitions. Asquith, Bruner, and Mullins (1983) find that bidders on average lose. Varaiya (1985) finds that when there are rival bidders, the successful bidders' loss is significantly greater. In addition, Loughran and Vijh (1997) find that acquirers in stock mergers underperform in the long run. The purpose of this study is to merge the corporate transparency literature with the mergers and acquisitions literature to determine the impact of corporate transparency in the mergers and acquisitions market.

HYPOTHESES

In this study, I classify targets based on their transparency levels. Low transparency (LT) targets have lower disclosure and more information asymmetry problems (Diamond and Verrechia (1991)); high transparency (HT) targets have higher disclosure, and therefore less information asymmetry problems. Since LT firms have more information asymmetry problems, risk-averse investors will discount the stock price of LT firms as a form of information compensation discount. On the other hand, since HT firms have little or no information asymmetry problem, the stock of HT firms is more likely to be traded at or close to the equilibrium.

In the null hypothesis, acquirers that bargain hunt will be more likely to bid on LT firms because of the information price discount. Furthermore, those who mistake information price discounts as bargains are more likely to overpay. Therefore, LT targets are not only more likely to receive takeover offers, but they are also more likely to earn higher acquisition premiums. This is especially true for targets with enough negotiating power to reject offers below their reservation prices, and only accept higher offers.

In the alternative hypothesis, acquirers are not totally irrational. Acquirers who are aware of the negative impact of information asymmetry problems will not treat the price discount of the LT targets as bargains. Therefore, they are more likely to bid on HT targets to avoid such uncertainty created by information asymmetry problems. In addition, when making offers, acquirers are also likely to apply information price discount when acquiring LT targets. As the result, HT targets receive higher acquisition premiums than LT targets. In this case, it is the HT targets that will have more market-timing opportunities and earn higher market-timing profits in the mergers and acquisitions market.

DATA AND METHODOLOGY

Mergers and acquisitions data are obtained from Securities Data Company, SDC, while financial data are obtained from Compustat and returns data are obtained from CRSP. Corporate transparency data is measured by analyst forecast dispersion obtained from IBES. In this study, I include both successful and unsuccessful merger and acquisition offers in order to provide a more complete study. The final sample consists of 5,422 of firms and 6,209 events.

A takeover is defined as successful when it results in a completed transaction. Since IBES only cover public firms, only public targets are included in the study. All observations with deal value of less than $1 million[2] or deal value that is less than 1% of the market value of the acquirer are eliminated from the sample (Moeller, Schlingemann, and Stulz (2002)). Deal value is defined by SDC as the total value of consideration paid by the acquirer, excluding fees and expenses yet including amount paid for all common stock, common stock equivalents, preferred stock, debt, options, assets, warrants, and stake purchases made within six months of the announcement date of the transaction. Financial and utility firms are excluded from the study. Targets with stock price of less than $2 per share are eliminated from the study since Ball et al. (1995) find that lower-priced stocks are more likely to be affected by market microstructure effects, such as large proportional bid-ask spreads.

While some may conclude the potential effects of the information asymmetry problems on mergers and acquisitions by comparing the empirical results of public targets with those of private targets[3], assuming that public targets are always more transparent and therefore have less information asymmetry than private targets are may not be valid[4]. Therefore, studies using direct transparency measures may provide more reliable conclusions than studies using the target's public status to proxy for the information asymmetry problems. In this study, I use the analyst forecast dispersion from IBES Summary Tapes to proxy for corporate transparency since firms with more information asymmetry problems should have higher analyst forecast dispersion. The analyst forecast dispersion has been commonly used to measure transparency or information asymmetry[5]. To measure analyst forecast dispersion, the standard deviation of forecast is scaled

[2] Other studies, like Schwert (1996), choose $10 million as the cut off when they examine public targets.

[3] Officer (2007), Chang (1998), and Officer et al. (2009) use private target samples to proxy for targets with more information asymmetry problems in their study.

[4] Private (public) targets and low (high) transparency targets may have very different firm characteristics. For example, ownership of private firms cannot be bought or sold as easily as that of public low transparency firms. Public firms have publicly-traded stocks, which allow investors to transfer their ownership easily, while private firms do not have publicly-traded stocks to provide investors with similar benefits. As a result, while the lack of liquidity in private firms may allow the acquirers to purchase private targets at discounts, such liquidity discounts may not be equally applicable to publicly-traded low transparency targets. In addition, private firms in general have more concentrated ownership when the stock of the firm is owned by a smaller number of shareholders. Such concentrated ownership in private firms often brings about better monitoring and fewer agency problems. On the other hand, concentrated ownership and fewer agency problems are not the typical characteristics of low transparency firms. Furthermore, regulations often affect public targets and private targets differently. For example, the William Act of 1968 only makes tender offers more costly and more time-consuming for the acquirer of public targets, while private targets and subsidiaries are not covered or protected by this regulation. Moreover, private firms are likely to have more limited sources of funds than low transparency firms, since funds of private firms are limited to the personal wealth of the small number of shareholders, in addition to debt financing and IPOs. Besides, assuming that all public firms are transparent is also unrealistic since managers often can choose the level, type, and timing of information disclosure to the outside investors, for as long as they still meet the basic disclosure requirements.

[5] Lang and Lundholm (1996), Healy, Hutton, and Palepu (1999), and Finnerty and Yan (2012).

by the stock price to facilitate comparisons across firms[6]. Industry median is subtracted from the scaled dispersion measure to adjust for the cross-industry variation (Lang and Lundholm (1996)).

Number of Bids

To determine if LT targets are more likely to receive takeover offers from acquirers, I perform both univariate and multivariate analyses. To examine the number of offers of a target, I use only the first announced offer from the same acquirer for each acquisition event. Therefore, when competing bids from a different acquirer occur, I include the first offer of the competing acquirer in the sample as well. In addition, I identify industry dummy based on all SIC codes of the acquirer and the target. If any of the acquirer's SIC codes matches with any of those of the target, the industry dummy is equal to one; otherwise, it is equal to zero. I also examine each of the event years separately to see if the result is consistent throughout the sample period.

After the above univariate analysis, I also perform multivariate analysis to determine if LT targets are more likely to receive offers. I use Probit model for the multivariate analysis. In the multivariate analysis, all firm year observations are included in the sample. The dependent variable is equal to one if the firm receives an offer and zero otherwise.

$$\begin{aligned} OFFER_T = {} & \alpha + \beta_1 DISPERSION + \beta_2 SIZE + \beta_3 BTM + \beta_4 QUICK\ ASSETS \\ & + \beta_5 CASH\ FLOW + \beta_6 LEVERAGE + \beta_7 COMPETITION \\ & + \beta_8 COMPETITION{*}LT\ DUMMY + \beta_9 Q{*}QUICK\ ASSETS + \beta_{10} Q{*}LEVERAGE \\ & + \beta_{11} Q{*}CASH\ FLOW + \beta_{12} TIME\ DUMMIES \end{aligned} \quad (1)$$

where DISPERSION is the industry-median-adjusted analyst forecast dispersion of the target firms, while higher dispersion means lower transparency. SIZE is the size of the transparency firm, which is the natural log of the market value of common stock, measured at the end of the fiscal year before the first bid. It is included in the analysis since smaller firms are less likely to be covered by financial analysts and have more information asymmetry problems. BTM is the book-to-market ratio of the transparency firm. It is calculated as book value of equity divided by the market value of equity, while book value of equity is calculated as the book value of common equity plus deferred taxes and investment tax credits in fiscal year t-1. QUICK ASSETS of the firm are calculated as the target's quick assets[7] divided by the market value of the common stock[8]. LEVERAGE of the firm is the debt-to equity of the target, and it is calculated as book value of long-term debt divided by the market value of the target's common stock outstanding as of the last balance sheet date before the acquisition. Quick assets, cash flow, and leverage of the targets are included in the model because Jensen's (1986) free cash flow theory suggests that targets with excess free cash flow and lower leverage are more likely to have agency problems. As a result, acquirers may prefer to acquire such targets in anticipation of more gains. Book-to-market, quick assets, cash flow, and leverage will all be adjusted by the industry median. To measure competition in the mergers and acquisitions market, I follow Schlingemann, Stulz, and Walkling (2002) by

[6] I also scale the forecast dispersion by the absolute value of mean earnings forecast as a robustness check.
[7] Quick assets are calculated as (cash + receivables + marketable securities). Cash flow measure (Lehn and Poulsen (1989)) is also used to proxy for agency problems.
[8] I also scale the quick assets by the total assets to determine if different scaling may affect the results.

calculating competition as the liquidity index[9] in specific industry as the value of all corporate control transactions of $1 million or more reported by SDC for each year and two-digit SIC code divided by the total book value of assets of all Compustat firms in the same two-digit SIC code and year. Interactions terms are also used. 1980s and 1990s DUMMIES are added to the regression to allow change in time series data[10].

Acquisition Premiums

I use several different measures to estimate acquisition premium in this analysis. The first premium measure is the percentage premium provided by SDC, which is calculated as the premium offered with respect to the target's trading price four week prior to the first announcement date. However, since Officer (2007) finds that the premium information provided by SDC is only available for about half of the observations, I also follow Moeller et al. (2002) to use the value of cash, stock, and other securities of the offer as the premium measure, since this variable provides the highest number of observations and is often available at announcement. The premium is then scaled by the market value of equity of the target 50 days prior to the announcement day (Moeller et al. (2002) and Officer (2007)). In addition, I follow Schwert (2000) to calculate the premium measure as the sum of price run-up prior to the first announcement and the price markup from the announcement. More specifically, the abnormal performance is estimated by the market model residual for the target firm cumulated over the period (-63, 126) from the first announcement day[11].

$$Premium_{\,i} = \sum_{t=-63}^{126} R_{it} - \alpha_i - \beta_i R_{mt} \tag{2}$$

where R_{it} is the return to target firm i on trading t, R_{mt} is the return to the CRSP NYSE/AMEX/Nasdaq value-weighted portfolio return on day t, while the α and β are estimated by using market model and return data during the (-316 and -64) event window from the first announcement date.

$$R_{it} = \alpha_{\,i} + \beta_i R_{mt} + \varepsilon_{it} \quad \text{where t = -316 to -64} \tag{3}$$

I first use univariate analysis to examine if LT targets are more likely to receive higher acquisition premiums based on the above premium measures, both industry-adjusted and

[9] The liquidity index is used because Boone and Mulherin (2002) find that private auction can occur and increase competition in the acquisition market when SDC does not report such events. Therefore, they find the number of bidders provided by SDC can underestimate the actual competition in the acquisition market.

[10] Bradley, Desai, and Kim (1988) find that average abnormal return of acquirers in acquisition falls from roughly 4 percent in the 1960s to 1.3 percent in the 1970s and -3 percent in the 1980s, all statistically significant. William Act, adopted in 1968, made the tender offer process more costly and more time consuming for the acquirers. Defense mechanisms adopted by target firms and state anti-takeover regulations in the 1980s also affected the returns of the acquirers.

[11] Price runup is included as a part of premium calculation because of potential insider trading activities prior to announcement (Meulbroek (1992)) and information leakage prior to the first announcement (Jarrell and Poulsen (1989)). Announcement of 13D filings with the Securities and Exchange Commission (SEC) when an investor acquires more than 5% of the target's stock can often provide a clue to the market of potential takeover offer. In addition, they find that price runup prior to the first announcement does not substitute for post announcement markup in their sample. Therefore, price runup should be considered as a part of acquisition premium.

unadjusted measures. After the univariate analysis, I also apply multivariate analysis to control for other variables. I perform a regression for each of the premium measures mentioned above, both adjusted and unadjusted.

$$\begin{aligned} Premium_T = {} & \alpha + \beta_1 DISPERSION_T + \beta_2 SIZE_T + \beta_3 SIZE_A + \beta_4 BTM_T + \beta_5 BTM_A \\ & + \beta_6 COMPETITION_T + \beta_7 INDUSTRY\ DUMMY + \beta_8\ \%\ of\ STOCK \\ & + \beta_9 POISON\ PILL + \beta_{10} QUICK\ ASSETS_T + \beta_{11} LEVERAGE_T \\ & + \beta_{12} POOLING\ INTERESTS + \beta_{13} COMPETITION_T * LT\ DUMMY_T \\ & + \beta_{14} ADVISING\ FEES\ PAID_T * LT\ DUMMY_T \\ & + \beta_{15} INDUSTRY\ DUMMY * LT\ DUMMY_T + \beta_{16} TIME\ DUMMIES \end{aligned} \quad (4)$$

where $DISPERSION_T$ is the transparency measure of the target, while higher dispersion indicates lower transparency. $SIZE_T$ and $SIZE_A$ are the size of the target and acquirer respectively, while BTM_T and BTM_A are the book-to-market ratio of the target and acquirer firms, respectively. In addition to the previously mentioned control variables, the *% of STOCK* is the percentage of acquisition payment made in stock. Based on the definition of SDC, *POISON PILL* [12] is equal to one if the target invokes the poison pill or if the existence of the poison pill discourages the potential acquirer, and zero otherwise[13]. *POOLING INTERESTS* is equal to one if the accounting method of the corporate combination is pooling of interests method, or zero otherwise[14]. Competition is used to proxy for negotiating power of the target firm. Two interaction terms, $COMPETITION_T$ * *LT Dummy* and $ADVISING\ FEES\ PAID_T$ * *LT Dummy*, are used to examine if competition in the target firm's industry and advising fees paid by the LT target will increase the negotiating power of the LT firm. $ADVISING\ FEES\ PAID_T$ is the investment banking fees or advisor fees[15] that the target pays upon completion of the merger. *INDUSTRY DUMMY * LT DUMMY* is included to examine if related merger can reduce the information asymmetry problems and market-timing premium of LT targets. *INDUSTRY DUMMY* is equal to one if any of the acquirer's SIC codes matches with any of the target's SIC codes; otherwise, the industry dummy is equal to 0. Time dummies are used to allow variables to change in time.

RESULTS

In Table I, I examine the characteristics of the targets based on the industry-adjusted, price-scaled analyst forecast dispersion and earnings-scaled analyst forecast dispersion. Since results based on the different measures provide very similar results, only those based on price-scaled dispersion are provided. In Table 1, I find that LT targets are in general smaller and have higher *BTM* ratio, lower *Q*, lower *CASH FLOW*, and higher *LEVERAGE*. Consistent with previous empirical results, Lang and Lundholm (1993) also find that LT firms are in general smaller, while Healy, Hutton, and Palepu (1999) find that LT firms are more likely to be traded at discount. The lower *Q* indicates that LT targets in general have lower growth rate and therefore fewer needs for external capital and disclosure. The higher *LEVERAGE* is consistent with the lower growth rate

[12] Schwert (1996), Ryngaert (1988), Malatesta and Walkings (1988), Bradley, Desai, and Kim (1988), Comment and Schwert (1995) all find higher acquisition premium when the target has poison pill in place.
[13] Note that while Gompers index may also be used to proxy for negotiating power, it is only available from 1990.
[14] Robinson and Shane (1990) find higher acquisition premium when pooling of interests method is used as the accounting method for mergers. This variable is obtained from SDC.
[15] This variable is obtained from SDC.

since low growth firms are more likely to have higher leverage. The lower *CASH FLOW* measured based operating income before depreciation minus all taxes, interests, and dividends indicates that LT targets are poorer performers than HT targets. The higher *QUICK ASSETS* are consistent with the agency theory that LT firms are more likely to have agency problems.

In Table II, I use Probit analysis to determine whether LT firms are more likely to receive offers, after controlling for the firm characteristics[16]. After controlling for the various firm characteristics, the results show that it is HT targets that are more likely to receive takeover offers. The interaction term of *COMPETITION*LT DUMMY* also indicates that when competition in the mergers and acquisitions market is strong, LT targets are less likely to receive offers. Potentially, when competition is strong, acquirers are less likely to act as bargain hunters. The positive *COMPETITION* coefficient indicates that when competition is strong in the mergers and acquisitions market, targets are more likely to receive offers. Surprisingly, *BTM* is insignificant, while it is smaller firms with higher *CASH FLOW* and lower *LEVERAGE* are more likely to receive takeover offers.

In Table III, I examine the various acquisition premium measures of successful mergers and acquisitions. Three premium measures are used based on the previous empirical studies, while *Schwert Premium* is further decomposed into *Price Markup* and *Price Runup*. In addition, two more premium measures are included to examine the price movement and premium up until the merger complete date. Both unadjusted raw premiums and industry-adjusted premiums are examined in Panels A and B, respectively. I find that whether raw premiums or industry-adjusted premiums are used, all of the univariate results show that LT targets are in fact able to demand higher acquisition premiums than HT targets. However, since stocks of LT targets are more likely to be traded at discounts to start with, to make sure that the higher premiums of LT targets are not inflated as a result of the price correction for the information price discount, various firm characteristics are used as control variables in the multivariate analysis in the next table.

In Table IV, control variables are chosen based on the existing available empirical studies and based on the hypotheses in this study. Results based on raw (industry-adjusted) premiums are provided in the first (last) two regressions. Note that only *4-week Premium* and *Moeller Premium* are used here, while *Schwert Premium* is excluded from this table. *Schwert Premium* is excluded from the regressions because it measures price runup during [-63, 126] of the announcement instead of the actual premium offers. Since the purpose of this table is to examine the premium offer than the price runup, it is appropriate to exclude *Schwert Premium* from this section of the analysis. The results show that smaller targets tend to receive higher acquisition premiums, while larger acquirers are more likely to pay higher premiums. The positive coefficient of acquirer's size is consistent with the finding of Moeller et al. (2002) that larger acquirers are more likely to be affected by hubris (Roll (1986)); therefore, larger acquirers are more likely to overpay than smaller acquirers do. More importantly, dispersion coefficient is negative in all cases, indicating that it is HT targets that are more likely to receive higher premiums, after controlling for various variables. However, the interaction terms of *COMPETITION* LT DUMMY* and *FEES PAID*LT DUMMY* indicate that when competition in the mergers and acquisitions market is strong or when negotiating power of the target (proxied by the advising fees paid by the target) is strong, LT targets can still demand higher acquisition premiums.

[16] Logit analysis is also used, while results remain similar (not reported).

CONCLUSIONS

In this study, I use multiple premium measures to examine how corporate transparency affects target firms' acquisition opportunities and premiums. While the univariate results show LT targets to receive higher acquisition premiums at the very surface, after controlling for various firm characteristics and undervaluation in the multivariate analysis, it is actually HT targets that are more likely to receive takeover offers and earn higher acquisition premiums. My results are robust across the multiple premium measures and are consistent with the alternative hypothesis: While acquirers do not always make optimal decisions, they are not totally irrational. Acquirers are well aware of LT targets' information asymmetry problems. Consequently, acquirers are more likely to bid on HT targets and pay higher premiums to HT targets, while LT targets earn lower acquisition premiums as a form of information price discount. However, when competition in the industry is strong or when equipped with enough negotiating power (proxied by advising fees paid by the target), LT targets can successfully negotiate higher acquisition premiums than their HT counterparts. Therefore, without negotiating power and strong competition level in the mergers and acquisitions market, target firms should increase their transparency level if they want to earn higher acquisition premiums.

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Table 1:
CHARACTERISTICS OF THE TARGETS BASED ON TOTAL TRANSPARENCY

Target firms are classified into low transparency (LT) and high transparency (HT) target portfolios based on the industry-adjusted, price-scaled analyst forecast dispersion. Targets with positive (negative) industry-adjusted dispersion are classified as LT (HT) targets. *SIZE* of the firm is market value of common stock at the end of fiscal year before the first bid. *Size* is quote in millions of dollars. *BTM*, book-to-market, is calculated as book value of equity divided by market value of equity in fiscal year t-1, while book value of equity is calculated as book value of common stock equity plus deferred taxes, plus investment tax credit. *Q* is calculated as market value of assets divided by book value of assets. *CASH FLOW* is calculated as operating income before depreciation - total tax income + change in deferred taxes from the previous year to the current year -gross interest expense on short- and long-term debt, total preferred dividend requirement on cumulative preferred stock and dividend paid on noncumulative preferred stock, and total dollar dividends declared on common stock before scaled by total assets. *QUICK ASSETS* are calculated as (cash + receivables + marketable securities) / market value of common stock. *LEVERAGE* is calculated as long-term debt / market value of common stock. All variables are adjusted by industry median. *INDUSTRY DUMMY* is equal to one if any of the acquirer's SIC codes matches with any of the target's SIC codes; otherwise, the industry dummy is equal to 0. All variables are winsorized at 1% and 99%. When the target receives more than one bid in a calendar year, only the first observation is included. Mean, (median), and [p-value] are reported below.

	Low Transparency (N = 3375)	**High Transparency (N = 2047)**	**LT - HT**	**p-value of t test and (Wilcoxon Test)**
SIZE	660.90 (161.73) [< .0001]***	1477.47 (308.82) [< .0001]***	-816.57	0.0001*** (0.0001)***
BTM	0.17 (0.06) [< .0001]***	-0.03 (-0.10) [0.0330]***	0.20	0.0001*** (0.0001)***
Q	0.24 (-0.02) [< .0001]***	0.35 (0.04) [< .0001]***	-0.11	0.0021*** (0.0001)***
QUICK ASSETS	0.59 (0.02) [< .0001]***	0.31 (-0.03) [< .0001]***	0.28	0.0010*** (0.0001)***
CASH FLOW	-0.02 (0.01) [< .0001]***	0.06 (0.06) [< .0001]***	-0.08	<.0001*** (0.0001)***
LEVERAGE	0.39 (0.06) [< .0001]***	0.17 (0) [< .0001]***	0.22	0.0001*** (0.0001)***

Table 2 **Probit Analysis of Bidding**			
All IBES firms are included in the analysis to determine if LT firms are more likely to receive offers. The dependent variable, offer, is equal to one if the firm receives at least an offer in a given year. Time dummies are used to allow change in time series data.			
Intercept	**-0.5644** **(<.0001)***	**-0.5741** **(<.0001)***	**-0.5779** **(<.0001)***
Dispersion	**-3.7770** **(0.0001)***	**-3.4780** **(0.0006)***	**-2.9336** **(0.0046)***
LOG(SIZE)	**-0.0246** **(0.0392)**	**-.0270** **(0.0245)**	**-0.0281** **(0.0219)**
BTM	**-0.0321** **(0.3517)**	**-0.0293** **(0.3958)**	**-0.0238** **(0.5002)**
Quick Assets/ MV Equity	**-0.0024** **(0.8785)**	**-0.0024** **(0.8777)**	**0.0026** **(0.8755)**
LP CashFlow/ Asset	**0.5323** **(<.0001)***	**0.5192** **(<.0001)***	**0.6546** **(<.0001)***
Leverage	**-0.0909** **(<.0001)***	**-0.0890** **(<.0001)***	**-0.0809** **(0.0007)***
Competition	**0.1466** **(<.0001)***	**1.5605** **(<.0001)***	**1.7684** **(<.0001)***
Competition* LT Dummy		**-0.6174** **(0.0449)**	**-0.8908** **(0.0049)***
Q*Quick Assets			**0.0416** **(0.4197)**
Q*Leverage			**0.0700** **(0.1845)**
1980 Dummy	**-0.4071** **(<.0001)***	**-0.4068** **(<.0001)***	**-0.4091** **(<.0001)***
1990 Dummy	**-0.5499** **(<.0001)***	**-.5524** **(<.0001)***	**-0.5489** **(<.0001)***

Table 3
UNIVARIATE ANALYSIS OF ACQUISITION PREMIUM

The *4-week Premium* is calculated as the offer price minus the price four weeks prior to the first announcement scaled by the price four weeks prior to the first announcement. *Moeller Premium* is calculated as the sum of cash payment, stock payment, and other security payment divided by the market value of equity of the target 50 days prior to the announcement day (Moeller et al. (2002) and Officer (2007). *Schwert Premium* is calculated as the CAR from day -63 to day 126 after the first announcement, while price marketup and price runup are also calculated (Moeller et al. (2002). Value weighting results are reported, while equal weighting provides similar results. Mean and (median) are both examined below.

Panel A: Raw Premiums

	4-Week Premium	*Moeller Premium*	*Schwert Premium* [-63, 126]	*Price Markup* [-63, 0]	*Price Runup* [0, 126]	*Schwert Premium* [-63, completion]	*Price Markup* [0, completion]
LT	47.89% (40.74%)	61.07% (52.21%)	41.51% (36.98%)	27.66% (23.55%)	13.56% (10.10%)	42.26% (37.70%)	28.41% (24.28%)
HT	41.79% (35.92%)	51.44% (45.42%)	28.76% (28.27%)	21.18% (18.81%)	7.65% (7.34%)	29.11% (28.77%)	21.52% (19.33%)
Difference	6.10%	9.63%	12.75%	6.48%	5.91%	13.15%	6.89%
P value	<.0001***	<.0001***	<.0001***	0.0001***	0.0001***	<.0001***	0.0001***

Panel B: Industry-Adjusted Premiums

	4-Week Premium	*Moeller Premium*	*Schwert Premium* [-63, 126]	*Price Markup* [-63, 0]	*Price Runup* [0, 126]	*Schwert Premium* [-63, completion]	*Price Markup* [0, completion]
LT	22.09% (12.12%)	128.46% (128.55%)	21.26% (16.97%)	14.28% (8.37%)	6.70% (4.00%)	25.02% (19.21%)	18.05% (12.58%)
HT	17.19% (12.79%)	120.06% (125.57%)	9.02% (9.74%)	9.28% (6.05%)	-0.17% (0.93%)	11.49% (13.37%)	11.74% (8.84%)
Difference	4.90%	8.40%	12.24%	5.00%	6.87%	13.53%	6.31%
P value	0.0003***	0.0003***	<.0001***	<.0001***	<.0001***	<.0001***	<.0001***

Table 4
MULTIVARIATE ANALYSIS OF ACQUISITION PREMIUM

Premium measures are calculated as in Table 3. Reported results are based on value weighted returns, while equal weighting provides similar results. Only successful mergers are included.

	Raw 4-Week Premium	***Raw Moeller Premium***	***Industry-Adjusted 4-Week Premium***	***Industry-Adjusted Moeller Premium***
DISPERSION$_T$	-402.57** (0.0228)	-4.36* (0.0769)	-402.23** (0.0176)	-6.59** (0.0124)
SIZE$_T$	-9.40*** (<.0001)	-0.12*** (<.0001)	-7.96*** (<.0001)	-0.16*** (<.0001)
SIZE$_A$	5.03*** (0.0007)	0.06*** (0.0006)	3.90*** (0.0057)	0.06*** (0.0008)
BTM$_T$	-5.04 (0.3594)	0.10 (0.1622)	-4.21 (0.4242)	0.13* (0.0861)
BTM$_A$	-0.94 (0.8876)	-0.02 (0.8174)	4.53 (0.4789)	0.11 (0.2024)
COMPETITION$_T$	5.29 (0.8668)	-0.05 (0.9095)	-5.49 (0.8560)	-1.48*** (0.0007)
INDUSTRY DUMMY	4.92 (0.3543)	0.14** (0.0406)	3.54 (0.4859)	0.07 (0.33230)
% of STOCK	0.03 (0.7370)	0.00 (0.1032)	0.01 (0.9349)	0.01** (0.0465)
POISON PILL	31.42 (0.3581)	0.12 (0.7734)	31.64 (0.3342)	-0.15 (0.7344)
QUICK ASSETS/ MVE$_T$	0.20 (0.7749)	-0.01 (0.8771)	-0.06 (0.9291)	0.01 (0.7990)
LEVERAGE$_T$	-0.39 (0.8754)	0.02 (0.5616)	0.76 (0.7488)	0.01 (0.8024)
POOLING INTEREST	-0.28 (0.9518)	0.08 (0.1349)	0.95 (0.8282)	0.09 (0.1189)
COMPETITION LT DUMMY $_T$*	67.08* (0.0922)	0.51 (0.3189)	71.08* (0.0628)	1.09** (0.0492)
*FEES PAID * LT DUMMY $_T$*	0.75* (0.0706)	0.01** (0.0243)	0.82** (0.0395)	0.01** (0.0217)
INDUSTRY D LT DUMMY$_T$*	-0.70 (0.8955)	0.07 (0.3107)	-1.54 (0.7641)	-0.08 (0.2702)
1980 DUMMY	5.82 (0.6093)	-0.01 (0.9137)	12.00 (0.2716)	-0.46*** (0.0006)
1990 DUMMY	10.92** (0.0323)	-0.05 (0.4694)	30.04*** (<.0001)	0.23*** (0.0011)

REVISITING RESPONSIBILITY ACCOUNTING: WHAT ARE THE RELATIONSHIPS AMONG RESPONSIBILITY CENTERS?

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ABSTRACT

The importance of better analysis and decentralization of decision-making is increasing in today's fast-paced, complex, and large-scale business operations. Responsibility accounting was introduced to accommodate the need for decentralization, accurate information, and analysis. In this paper, we review the evolution of the concept of responsibility accounting (RA) and responsibility centers since the 1920s. Based on the concept of responsibility accounting, managers responsible for their centers' costs should have authority over those centers' activities and expenditures. This study of RA's historical development reveals interrelationships of cost, profit, revenue, and investment centers.

Organizations' daily activities—such as manufacturing, sales, and supply chain coordination—require capital investments, resulting in the investment centers' covering all other centers. Traditionally, operations or manufacturing has been considered a cost center, while marketing and sales have been considered a revenue center. The intersection of cost and revenue centers is the profit center, which needs information from both the cost and the revenue centers and is related to transfer pricing. In this paper, we suggest a new center, namely research and development (R&D), to accommodate the ever-changing needs of development activities.

Understanding the relationship among responsibility centers provides an organized information flow, which can enhance decision-making and cost control. This study focuses on the historical background and the position of responsibility accounting in an organizational accounting system. Future research avenues are also discussed.

INTRODUCTION

Decentralization can be traced back to 256 B.C. and the ancient Egyptians (Chatfield, 1974). The concept of delegating authority has always been effective for both business and non-profit purposes. When organizations grow, they not only expand in terms of size, profit and structure, but also face an increased number of tasks. As organizations and corporations progress, their managers' work increases, and it gradually becomes more difficult to keep track of all the organization's information and to make appropriate decisions based on that timely information (Mojgan, 2012). With decentralization, it is impossible for one person to carry out all the necessary, numerous, and various tasks and to make the best decisions for the organization (Madison, 1979). Accountants, industrial engineers, and others prudently developed a concept of decentralizing authority with a certain level of controllability and made all people responsible for their level of authority by having them report to top-level management or the authority above them according to the chain of command.

The responsibility accounting (RA) concept was introduced during the 1920s to handle varying levels of control and authority in management (Diemer, 1924 and Weger, 1926). According to Sawabe (2015), "Examining the practice of responsibility accounting system and its relationships with core values allow us to understand better the interactions and learning at the bottom layers of an organization" (pg.10). RA is designed to control expenditures by the individuals who are actually responsible for these expenditures (Higgins, 1952). It refers to the authority given to managers in charge of cost control, holding them responsible for the costs related to their operations. Holding one manager responsible for all the controllable cost is burdensome; thus, responsibility centers are needed. An entire organization can be viewed from four responsibility centers: cost, revenue, profit, and investment.

Large businesses usually have numerous departments and centers; thus, daily operations are complex, and job boundaries are difficult to identify. In contrast, the work is easily manageable in small-scale organizations. Thus, responsibility accounting may not be as helpful in small organizations as it is in large ones (Ritika and Rani, 2015). Establishing responsibility centers is necessary to implement RA. For each responsibility center, a manager is assigned to handle that center with a limited level of authority for decision-making related to the center's activities. Every dollar should be under the control of at least one manager (Neal, 2004). Improvement in responsibility accounting may help large organizations create a more organized internal structure.

The purpose of this paper is to trace the historical development of responsibility accounting (RA) concept and implementation of RA centers, help understand the relationships among centers, and determine responsibility accounting's position in a modern organizational accounting system. Successfully identifying RA's position results in better implementation. Proper positioning also increases understanding of where to begin the implementation process. Based on recent studies, the application of RA and the satisfaction level it produces in different sectors and countries indicate better management and control. The relationships among centers provide appropriate information flow, thus accelerating the reporting process as well as organizational activities.

HISTORICAL BACKGROUND OF RESPONSIBILITY ACCOUNTING

This study has tried to trace RA's origin and evolution. During the 1950s and 1960s, companies' economic activities were significantly diversified (Zimnicki, 2016). Gradually, the need for decentralization and responsibility accounting increased. Although RA was initiated in the 1920s, it gained much popularity during the 1950s. The history of responsibility accounting is closely related to the development of cost-reporting activities. Cost accounting's effectiveness depends on the flow of reporting and the quality of cost information among an organization's multiple departments. During the 1920s, the cost communications among accountants, engineers, production foremen, sales executives, and others started to question both cost information's quality and who would receive that information. They began to question the policies, procedures, cost classifications, forms of report, and persons to whom to report. In an industry cost-report study, Diemer (1924) found that only a small number of cost reports were brought to the foreman's attention, while the rest of the reports were directed to managers because they did not want the foreman to have profit information. Higgen Botham (1924), as mentioned in Black and Edwards (1979), emphasized the importance of holding a manager responsible for costs. He also discussed giving the manager authority in terms of cost controllability before putting the manager in charge of the center.

Later in 1926, based on uncontrollable costs as well as the need for both budgeting estimates and responsibility budgeting, RA was identified as a solution. As mentioned earlier, one manager alone cannot handle all the work and make profitable decisions in a timely manner. As a result, the authority and responsibility are divided into centers with their respective managers. Higgins (1952) was apparently the first to identify responsibility centers by explaining the organization chart and determining to whom the cost report is directed. In his chart, he showed how vice presidents of sales, production, and finance managed revenue, investment, and cost centers; and he illustrated the flow of cost reports from the bottom to the vice presidents.

There are four types of responsibility centers: cost, profit, investment, and revenue. Initially, the only center we could trace throughout the literature was the cost center. A cost center can contain 2 to 24 smaller cost centers (White,1959). In support of this argument, Most (1972) identified within the oil industry several cost centers, such as the process cost center and the market cost center. In developing a transportation model, Smith (1975) identified six cost centers: administration, shipping, line haul, documentation, pickup, and delivery. For this paper's purpose, a cost center is one center with one manager to whom the sub-cost center managers report to (Mojgan, 2012).

Later literature added three more types of centers to the list for better handling and higher quality of cost control. In the 1950s, the terms *investment center* and *profit center* became popular (Terborgh, 1969); but not until the 1960s was this concept investigated. Terborgh (1969) explained controllable assets, such as cash and inventory, and found that residual income was better for evaluating an investment center's performance than return on investment (ROI), which focuses on ratio rather than an absolute value. This change in measuring performance discouraged managers in making new investments with ROIs lower than the initial investment.

Schoute (2008) discussed designating responsibility centers, especially choosing between profit and investment centers. Determinants include investment opportunity, size, diversification, and capital intensity. Schoute discovered a positive correlation between capital intensity and the investment center's size; this concept was relatively newer than profit centers. For this study, an organization is considered to have both centers rather than having only one although an organization is free to have either. Discussions about investment centers were found in 1980s textbooks in the 1980s. The profit center concept, however, became a popular topic in studies during the 1950s. Dean (1955) discussed the profit center as one of the elements in stimulating and measuring a manager's performance. According to Francesco (1966), giving a manager authority and autonomy is a company's most profitable approach. Watson (1975) proposed that a research and development (R&D) department should be a profit center with the R&D manager having all the authority and responsibility for cost and profit. Some of the most recent studies have shown that organizations have started viewing R&D as a separate autonomous unit rather than a sub-cost center. For example, Sawabe (2015) noted, "Typically there are four types of functionally differentiated amoeba [centers] namely manufacturing, sales, R&D and general administration" (pg. 24).

In 1980s textbooks, only three responsibility centers were identified— profit, cost, and investment —leaving room for developing the revenue center concept in the late 1980s. Budd, Blaufuss and Haranda (1988) described a revenue center from a nursing department's perspective, stating that variable billing made the nursing department a revenue center rather than a cost center.

Recently, there were some sporadic evidence about international diffusion of RA implementation. Fowzia (2011) studied service organizations' use and satisfaction level in Bangladesh. Using the RA model, she found that three factors—assignment of responsibility,

performance measurement technique, and reward system—determine the satisfaction level resulting from RA. In Ugandan public universities, the application of RA was found to increase efficiency and to create more satisfaction in terms of decision-making (Owino et al., 2016). Another recent research results about RA implementation came from Vietnam. Tuan (2017) investigated textile-manufacturing organizations in terms of level of application of RA. The author used seven criteria to define medium and high usage levels. Medium level of RA application included activities such as forming centers, allocating authority, regular reporting and providing incentives, whereas high level included distribution of costs and revenues, preparation and regular use of budgets. Tuan (2017) concluded that RA was not properly applied among Vietnam textile manufacturing organizations. Another researcher who investigated Vietnamese construction companies also concluded that RA had not been used in that industry. Phu et al., (2017) mentioned, "Accounting work at the units mainly focuses on financial accounting. Management accounting in general and RA in particular in general construction companies have not been implemented yet" (pg.11).

Until 2000, the focus was on deep fundamental studies of RA and responsibility centers. Since the last decade of the 20th century, RA research has focused on implementation, application, uses, and improvements of RA systems. However, before implementing and applying RA, we must know RA's relationship with cost accounting (CA), managerial accounting (MA) and with the centers' internal relationships. Knowledge of this study's findings will make implementing RA as an accounting system much easier.

RESPONSIBILITY CENTERS

A responsibility center is a unit or subunit of an organization. According to the literature, there are four types of responsibility centers: (1) *cost*, (2) *revenue*, (3) *profit*, and (4) *investment*.

A *cost center* is one of the most important responsibility centers. A cost center manager is usually responsible for achieving operational efficiency, minimizing product cost, and maximizing effectiveness. A revenue center manager is responsible for marketing and sales activities and for generating and maximizing revenue. In a *revenue center*, the performance measurement tool is the comparison of actual returns with estimated or budged returns. In modern organizations, accurately measuring core profit is impossible. In addition, large organizations' transfer-pricing problem triggered the need for a profit center. Although it does not need to be a separate legal company, a subsidiary or a part of an organization could be a profit center (Francesco, 1966). Closely related to transfer pricing, a profit center exists to better understand and assist transfer pricing among different product lines' exchange of goods and services and to maximize profit (Wells, 1968). An *investment center* is responsible for the supply of funding, and the manager is responsible for controllable assets. An investment center and its performance measurement process are different from the cost center. ROI, residual income, and net present value (NPV) are some of the many commonly used tools for measuring investment centers' performance. Because of weaknesses in ROI's ratio focus, residual income could be better for measuring an investment center's performance (Terborgh, 1969). As Francesco (1966) noted, ROI could be a better measure when the divisional manager or investment center manager cannot control the asset base or when the asset base is fixed (Terborgh, 1969). Based on the above descriptions, all these centers are interrelated and require communication of decisions to operate seamlessly.

INTERNAL RELATIONSHIP OF RESPONSIBILITY ACCOUNTING WITH COST ACCOUNTING, MANAGERIAL ACCOUNTING AND RESPONSIBILITY CENTERS

Responsibility accounting is a mix of cost accounting and managerial accounting. In an organizational structure, the core of the organizational activity is cost accounting, from the basic recording of financial transactions to generating complex cost reports. Managers make decisions after examining cost reports. Decision factors include some portion of responsibility and authority. Some costs are controllable, changeable, or reducible. Practical decision-making requires appropriate cost reports. These decisions affect the internal as well as the external users. The results of managerial decisions are reflected in financial statements prepared in accordance with Generally Accepted Accounting Principles (GAAP) and International Accounting Standards (IAS) and are known as financial accounting and reporting. Based on the above discussion, RA works with some of the cost accounting elements such as cost reports and with some of the managerial accounting elements such as decision-making based on information and cost reports. Figure 1 illustrates the organizational position of responsibility accounting to clarify the relationship of RA with cost and managerial accounting. Figure 2 illustrates the relationship among responsibility centers. Figure 3 adds another responsibility center to the relationship—the R&D center. The discussion below explains these relationships.

The Relationship Among Responsibility Accounting, Cost Accounting, And Managerial Accounting

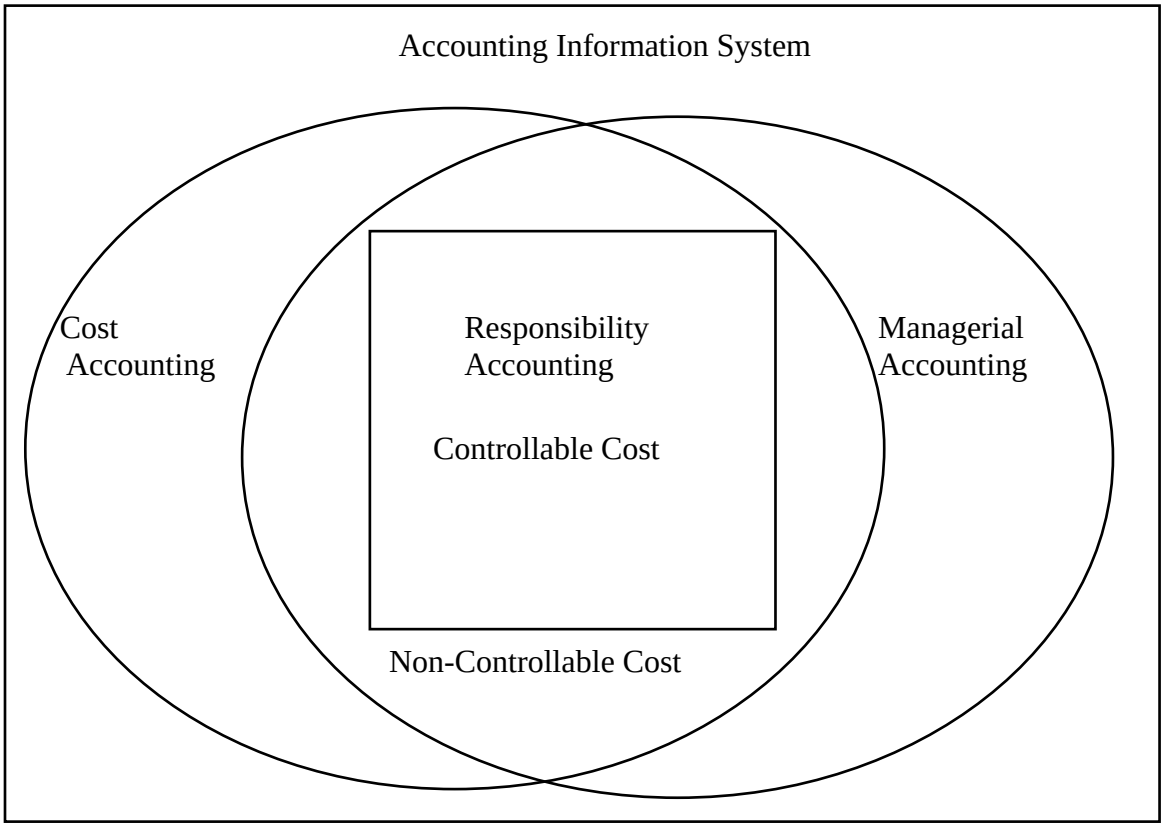
Kellogg (1962) stated that RA is closely related to cost accounting because cost accounting needs to assign responsibility for expenses. Figure 1 presents an accounting and information system as a rectangle including cost and managerial accounting as two separate circles, with responsibility accounting in their intersection as another rectangle. According to Nawaiseh et al. (2014), "The system of responsibility accounting depends on the interrelationship between accounting and information system and organizational structure of the company" (pg. 125). The concept of an accounting information system is very broad. It can include internal audit, tax accounting, financial accounting, cost accounting, and much more.

Within the scope of this paper, only cost accounting and managerial accounting are considered for determining RA's position and for obtaining accurate and beneficial accounting information to make better decisions.

Managerial accounting uses cost-accounting information for decision-making. Cost accounting is considered as either a subset of managerial and financial accounting or a separate accounting system. If cost accounting is a subset of managerial accounting, the cost accounting circle would be inside managerial accounting, and responsibility accounting would be inside the common portion of managerial accounting and cost accounting. For this paper, cost accounting is treated as a separate system because in many cases management cannot control or is not supposed to influence cost-accounting decisions such as the reporting process that depends on industry requirements; standards such as IAS and GAAP; and regulations provided by SEC and others. For example, a company with a core business of manufacturing and selling microwaves cannot show a sale of a used truck as sales revenue in its books because it is part of the company's capital assets. Cost accounting standards would not allow management to cover or change the reporting of such as sale. It is illogical for managers to think only in terms of simple journal entries related to sales and purchases.

Considering responsibility accounting a separate system provides some portion of cost for managerial control. Note that except for the two circles in Figure 1, many other circles could represent different accounting systems such as tax, financial, public, government accounting, among many others; but we are working solely with cost accounting and managerial accounting. Also, note that the outer section of managerial accounting and cost accounting involves other decisions unrelated to cost controllability.

FIGURE 1 - The Relationship among Responsibility Accounting, Cost Accounting, and Managerial Accounting



Managerial accounting identifies, analyzes, interprets, and communicates decisions regarding organizational goals—whether they are controllable or not. Cost accounting's major objectives are cost control, product costing, and inventory pricing (Higgins, 1952). The common element for both accounting systems is cost controllability. Based on the controllability principle, costs are of two types: controllable and non-controllable. If we consider cost and managerial accounting as two circles, their intersection also has controllable and non-controllable costa. In Figure 1, one circle is cost accounting, and the other circle represents managerial accounting. At their intersection are the two types of costs. The controllable portion is separated by a rectangle. The rest of the common portion is the non-controllable cost for managers. The cost that managers can control with a certain level of authority is in the area of responsibility accounting, illustrated

by the rectangle in the overlapping area of cost and managerial accounting. The outside area of the square is the non-controllable cost (i.e., managerial decisions cannot affect them). By properly positioning responsibility accounting, managers can better determine what they need to address for better performance outcomes in terms of organizational and personal purposes.

Relationship Among the Centers

Once controllable costs are identified, organizations must focus on sections producing and reducing those costs. By controlling these sections, managers can increase their organizations' efficiency and effectiveness. If responsibility accounting is considered, many costs are controllable. Figure 2 illustrates the relationship among these centers, which are the responsibility of multiple managers. The investment center manager determines which project should be approached; the capital amount; budgeting techniques; and measurement of results with ROI, IRR, and many other methods (Terborgh, 1969). Noteworthy here is that investment centers fund all the costs and expenses (Madison, 1979 and Most, 1972). According to Freeman (2004), investment center managers may have some control over cost and revenue centers. Mojgan (2012) noted that investment center managers have some responsibility for profit, revenue, and cost centers. The investment center controls assets such as cash, inventories, and others (Terborgh, 1969). Investment of idle cash, use of inventories, and even some accounts receivable decisions are handled by the divisional manager or the investment center manager. The investment center is also responsible for funding and generating some portion of cost as well as revenue. Mojgan (2012) noted that profit is a measure to calculate the investment center's performance. The above discussions place the investment center in the outer circle; inside this circle, the other circles evolve.

Usually, the revenue center manager oversees marketing, advertising, sales, and promotion. Cost center managers are mainly responsible for controlling production costs so that production efficiency and superior quality are ensured. Profit center managers need information from both the cost and the revenue centers to understand their area of controllability, to determine the product contribution, and ultimately to identify ways to increase different product lines' profits (Freeman, 2004). These managers are also responsible for generating statements to guide revenue and cost centers' activities. An organization could have several profit centers (Francesco, 1966), depending on the product lines and the number of different products produced.

Depending on the area of responsibility and profit structure, the profit center could be even bigger than the cost center. The equations below provide a basic idea about the size of the centers; however, size should not be limited to these equations:

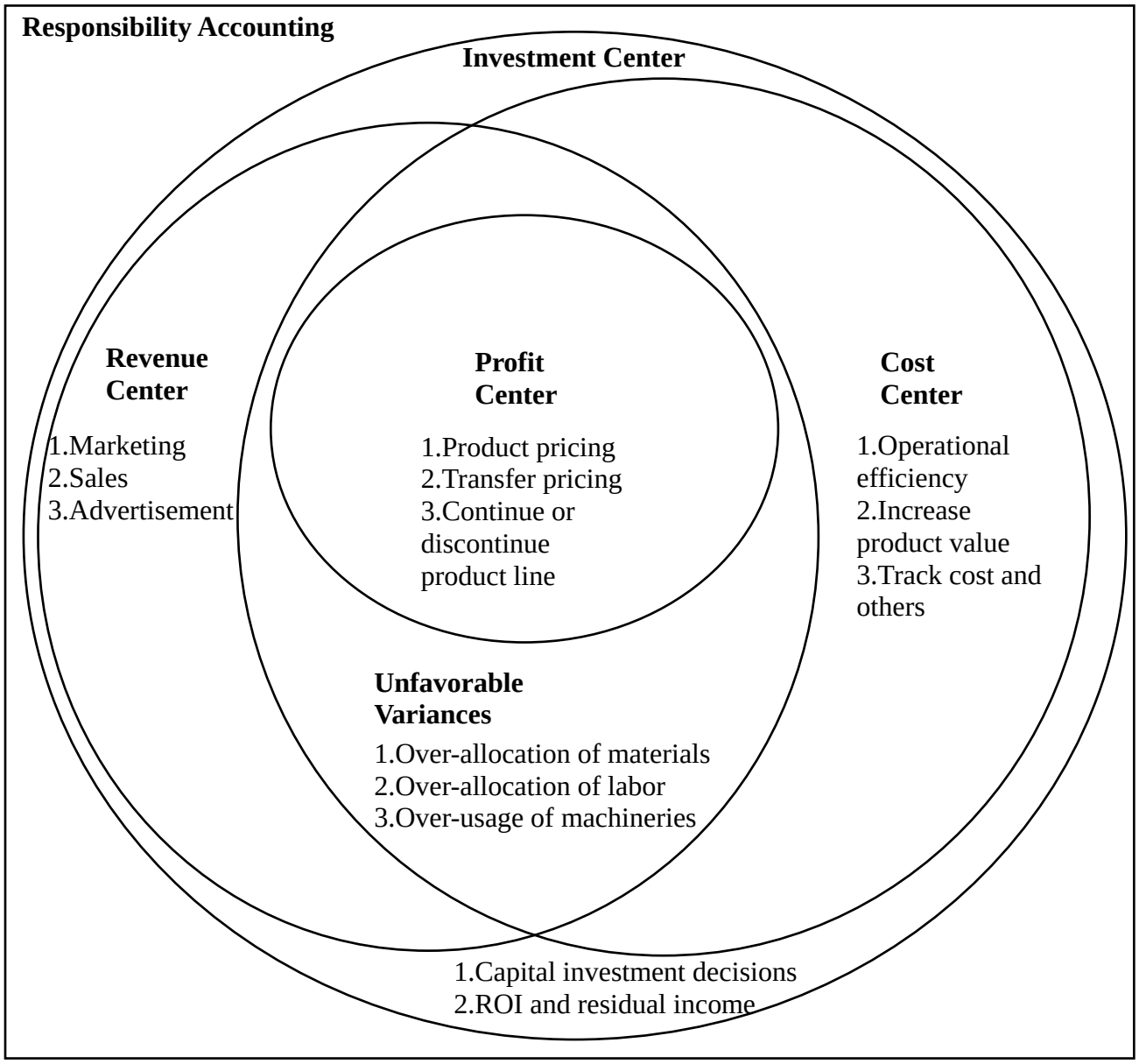
$$\pi = TR - TC \qquad \textit{(Equation 1)}$$
$$\pi = (P * Q) - (UC * Q) \qquad \textit{(Equation 2)}$$
$$\pi = Q\,(P - UC) \qquad \textit{(Equation 3)}$$

These equations represent a profit perspective where, π = Profit, TR = Total Revenue, TC = Total Cost, Q = Quantity, P = Price, UC = Unit cost.

Based on the equations above, we can establish the following scenarios to determine a profit center's size:

$\pi < TR$ *Scenario 1*
$\pi = TR$ *Scenario 2*
$\pi > TR$ *Scenario 3*

FIGURE 2 - Relationship among the Centers



If a firm has a profit, total revenue will always be larger than that profit; thus, Scenario 1 is true, and the revenue center will be larger than the profit center. The cost of sales, advertisement, and promotion for normal operations are always deducted from total revenues. Therefore, total profit cannot be equal to total revenue, and Scenario 2 is false. A profit center's size cannot be equal to that of a revenue center. Scenario 3, indicating that profit is greater than total revenue, is impossible because no matter what happens, profit can never be bigger than sales revenue. Therefore, a profit center cannot be larger than a revenue center, and Scenario 3 is false. The next three scenarios reflect the relationship between total revenue and total cost:

$TC < TR$	*Scenario 4*
$TC = TR$	*Scenario 5*
$TC > TR$	*Scenario 6*

In Scenario 4, total cost is less than total revenue, resulting in some profit. Thus, Scenario 4 is true; and a cost center must be smaller than a revenue center. The same applies for Scenario 5. If total cost and revenue are equal, there is no profit. The size of the revenue center and of the cost center is equal. However, an organization in such a scenario cannot sustain this equilibrium for long. Equation 5 is true but does not apply long term. If total cost is greater than total revenue, then there is no profit. The theory does not apply because it is a profit scenario and a revenue center cannot be smaller than a cost center. Scenario 6 is true but does not apply here. Nevertheless, the relationship of profit with total cost is slightly different from the relationship with total revenue. The relationship with total cost and profit would be the following:

$\pi < TC$	*Scenario 5*
$\pi = TC$	*Scenario 6*
$\pi > TC$	*Scenario 7*

This section needs further explanation. In checking organizations' financial statements, the most common scenario is Scenario 5: net profit less than total cost. If all the costs such as cost of goods sold, depreciation, sales and marketing, tax, and others are summed, the amount is usually greater than the net profit after EBTDA, EBIT and EBT. Therefore, net profit and gross profit are usually less than their respective costs. Scenario 5 is true, and the profit center is smaller than the cost center. Scenarios 6 and 7 are also possible but only when gross profit is so large that it covers not only the total cost but also the entire related cost nearly twice. As a result, we have considered the most common possible scenario.

All center managers must understand the boundary or limit of their control. Freeman (2004) discussed what each center manager should and should not control. A cost center manager can control costs such as purchasing but should not interfere with revenue investment. A revenue center manager can control revenues such as contracting but should not control cost-investment decisions. A profit center manager can control both cost and revenue, but not investments. Finally, an investment center manager can have some control over cost, revenue, and profits. The profit center is at the intersection of the revenue and cost centers (Schoute, 2008); and it is responsible for balancing revenue, cost, and unfavorable variances for the unit it controls (Mojgan, 2012). When the actual cost is higher than the budgeted cost, unfavorable variances usually occur because of over-allocated resources such as direct material, direct labor, and over-used machinery. Managers can control this type of variance (Mojgan, 2012; Madison, 1979). The reason the profit

center is at the intersection of the cost and revenue centers, but not in the separate portion of the cost center's circle, is that unfavorable variance is the production cost, which reduces profit. When the unfavorable variance is low, the amount of profit increases. Therefore, cost center managers must determine the point representing the tradeoff between these elements that is their responsibility and authority to ensure maximum profit with the least variances. The reason for choosing to locate the profit center in the intersection is that some costs, such as administrative, are necessary for operation that revenue and the cost center cannot be held responsible for.

Another important factor is the number of centers varying from large to small, depending on the organization. Some organizations have only one cost center, but others have up to 24; however, maintaining that many cost centers may be neither profitable nor easily manageable. The ideal number of cost centers is often very small (White, 1959). However, Mojgan (2012) noted that the size and number of centers would not affect the model because all the sub-cost centers report to one main cost center manager.

Placing R&D Center into the Relationship

Research and development (R&D) activities do not completely fit the descriptions of a revenue, a cost, or a profit center. Thus, we suggest that R&D must have a separate place in the conceptual map (Figure 3). We also explore the internal relationships among the centers, including R&D as a newly added center. Furthermore, we suggest that R&D stands in the intersection of the profit center and the cost center and takes some portion of unfavorable variances.

R&D activities are essential for organizations to stay current and competitive. Organizations try to engage their customers and the public at large in their R&D activities. Multinationals invest a huge portion of their funds in newer and better products. As an organization grows, it becomes more R&D intensive than small businesses (Schoute, 2008). New product and service development, introduction of new cost-efficient machinery, or energy-efficient methods are all R&D based. The success rate of R&D projects is very low; usually 9 out of 10 projects die, and the successful ones may take up to 15 years to develop (Watson, 1975).

Keeping track of these R&D activities may be even more difficult because according to the matching principle, cost is matched in the year's revenue, which could be recognized 5 to 20 or even more years later. Managing R&D expenses well has become this century's prime focus. Appropriate management of R&D expenses can provide corporations a competitive advantage. Moreover, determining which projects are more efficient and logical to develop within a reasonable period, more profitable, or more in demand is onerous task Market research, decision-making and other related activities are difficult for one manager to handle. Furthermore, managers may be unable to regularly control the success of research projects. However, they can effectively manage costs. Based on information collected from the market about the need for new product or improving existing product line, managers try to determine the product or concept in which the company should be investing. Ritika and Rani (2015) identified the R&D cost center as a sub-classification of the cost center; but what is proposed here is a separate center for R&D activities with autonomy and the ability to transfer inventions to the cost and profit centers at a price. In this way, an R&D center can finance some of its own costs by selling its invention to other departments in the company.

Watson (1975) was the first researcher to suggest that R&D as a separate center is related to the concept of transfer pricing. Moreover, a cost center itself has many centers to oversee regarding the daily operations of existing business. Burdening the manager with this colossal

responsibility of R&D with its uncertain outcomes works in opposition to the objectives of the development activities and growth. A cost center manager may focus only on costs, not on the research activities' revenue or profit improvements. However, an R&D center will be looking for both the cost and profit related to R&D (Watson, 1975) that will make it easy to track the long-term R&D projects, R&D costs, and profits.

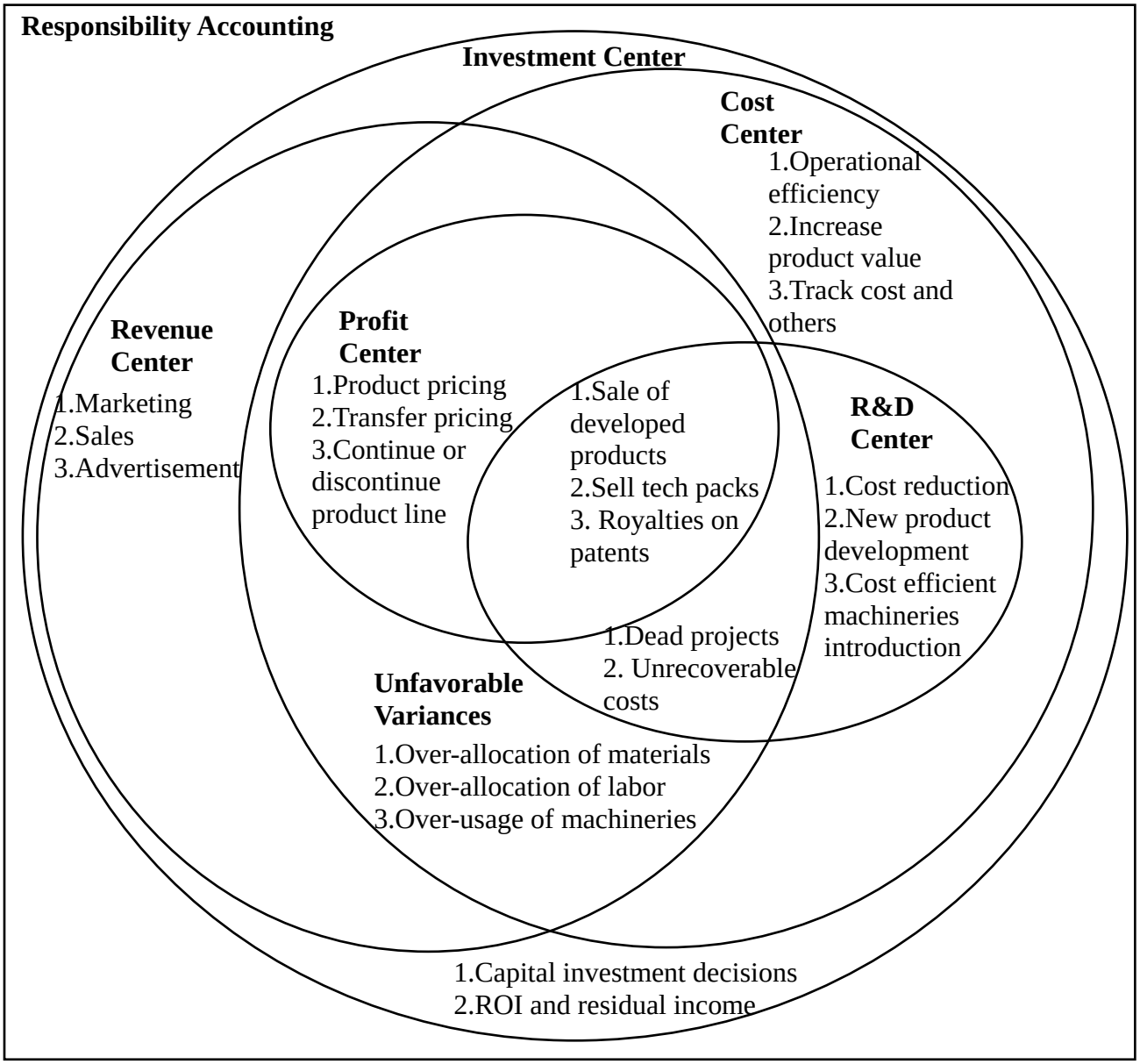
Watson (1975) was the first researcher to suggest that R&D as a separate center is related to the concept of transfer pricing. Moreover, a cost center itself has many centers to oversee regarding the daily operations of existing business. Burdening the manager with this colossal responsibility of R&D with its uncertain outcomes works in opposition to the objectives of the development activities and growth. A cost center manager may focus only on costs, not on the research activities' revenue or profit improvements. However, an R&D center will be looking for both the cost and profit related to R&D (Watson, 1975) that will make it easy to track the long-term R&D projects, R&D costs, and profits.

Any R&D center's invention generated and transferred to a cost center may help it to reduce cost. After developing new products, an R&D center transfers them to the profit center at a cost. Because the profit center makes product-line decisions, such as which products to continue, which to discontinue, and which to add, the profit center buys the invention from the R&D center so that the cost center can produce the product and the revenue center can sell it at a profit.

A new R&D center must have a separate manager to identify development opportunities new inventions, and cost-effective measures as well as to determine profits. One might wonder why an R&D center and a cost center overlap. As previously noted, investment centers sponsor everything; in contrast, most of an R&D center's work is related to developing new products, focusing on cost- reduction projects, or designing energy-efficient machinery. Another question is why the entire R&D center does not fall into the cost center. Many other activities in an organization do not relate to the cost center such as doing market research or searching for technological availability. Figure 3 reveals that under the same RA concept, the new R&D center is proposed to have a better command over R&D cost and profits and to encourage R&D activities. A separate manager will be given the authority and responsibility for the R&D costs, keep track of the years needed for developing, record revenues, and look for new R&D opportunities.

An R&D center generates cost through research and development, so it is in some portion of the cost center. An R&D center also works with profit and sells its invention, so it takes a portion of profit of the revenue center. Furthermore, an R&D center also has the burden of dealing with dead projects and of absorbing some of the unrecoverable costs, a portion of unfavorable variances. A profit center manager is not responsible for the cost of experimenting because it is not under his control. The cost center manager cannot be held responsible for the R&D center's fluctuating profit or even R&D's huge cost, which he cannot control. Thus, a separate R&D center manager who has authority and responsibility that is controllable is necessary

FIGURE 3- Placing R&D Center into the Relationship



DISCUSSION

Different authors have viewed responsibility accounting from different perspectives, but everyone has agreed on one common concept: controllability with authority and responsibility. Some authors mentioned it as a tool; others mentioned it as a technique. Properly implementing RA can provide more controllability benefits than a mere tool or technique can. Nawaiseh et al. (2014) focused on the extent of RA implementation in Jordanian companies and the obstacles those companies face by testing hypothesis and determining whether the companies realize the importance of RA. This paper discusses the initial steps of the implementation process and shows how these steps can further clarify the internal relationship.

Based on the literature review, most of the studies focused on cost controllability, responsibility centers, budgets, and responsibility accounting's relationship with transfer pricing. The RA literature has overlooked not only the relationship among centers but also R&D's unique position. This study examines responsibility accounting's relationship with cost accounting and managerial accounting. While focusing on the relationships among centers, this study also determines the R&D center's position and overlapping areas associated with all the centers discussed.

To be adopted quickly, every invention must provide a relatively high advantage compared to available alternatives. A better cost-benefit analysis helps managers realize a project's true value. Many benefits are associated with implementing responsibility accounting and with the interrelationship of investment, profit, revenue, cost, and R&D centers. The information flow will be stable and relevant. It will aid better communication and decision-making. Each center's manager will understand which information and decisions are important to which center. The managers will communicate their decisions with other center managers so that those managers can make informed decisions related to their center to better achieve the budgeted goals as well as to see their centers' performances relative to that of all other centers. If we can establish this communication flow among centers, create internal co-operation, and avoid mere one-way reports to upper-level management, organizations can benefit.

IMPLICATIONS

Based on the historical overview, the fundamental facts about RA did not change from 1920 to 2017. However, RA's application and use did evolve. Early studies focused on developing the concept of RA and responsibility centers; but recent ones have dedicated on the implementation. Some of the recent research has shown that RA is not being properly applied or that the RA system is not working properly.

Recent studies have found that most of the companies applying RA system have considered neither RA's relationship with cost and managerial accounting nor the internal relations among the centers. These gaps in the literature could be a reason for the lack of proper implementation or for the RA system's improperly working.

Besides assigning responsibility and measuring it with benchmarks, organizations could try explaining cost and managerial perspectives. Such an addition could help organizations understand not only their boundaries of responsibility and authority but also cost perspectives. Organizations should also consider responsibility centers' relationships to better define responsibilities and provide a better understanding of RA.

Many organizations have already started to consider R&D as a separate center, but they may need to provide it full authority and responsibility. Taking these steps before implementing or applying RA could help organizations achieve their desired level of satisfaction. Freeman (2004) observed, "Effective financial control helps the organization to detect problem at the earliest level possible. And responsibility center is one of the most effective control systems" (pg. 1,). This study shows RA's basic organizational structures, which if considered can solve problems at any level. Therefore, these structures and relationships are very important to consider before applying RA.

FUTURE RESEARCH AVENUES

No matter how much research has been done, there is always room for improvement. This study's scope has been limited to the profit scenario of responsibility accounting from the profit center's perspective. The loss scenario is left for future research. Another limitation of this study is that it was impossible to include other accounting systems and to examine RA's results besides those related to cost accounting and managerial accounting. This study has considered the most generic accounting equation (Profit < Total Cost); however, the other two equations (Profit = Total Cost and Profit > Total Cost) may occur in rare cases in which the profit center's size determination should be further investigated. Center sizes might also be determined based on the complexity of, need for, or volume of work.

Future studies could also address favorable versus unfavorable variance. The lower the unfavorable variance, the higher the profit. Another topic for investigation could be how the ratio of favorable to unfavorable variance influences cost and profit center sizes or relationships among centers. Thus, additional studies are needed to understand the implementation of R&D profit centers, activities, and boundaries.

We believe responsibility accounting is ripe with multiple research opportunities in today's business world of complex organizations, which need to better understand cost, revenue, profit, and R&D center activities. The history of responsibility accounting reveals a growing need for responsibility accounting and more research about this topic, especially relating to the accounting systems, the interrelationships among the centers, the role and requirements of R&D centers, and the overlapping areas of responsibility and authority.

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THE DEMISE OF THE U.S. TREASURY'S myRA RETIREMENT PROGRAM: WHY IT FAILED

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ABSTRACT

In 2017 the U.S. Treasury announced the termination of its myRA program. This program, enacted during the Obama era in 2015, was designed to get more Americans to save for retirement. The program operated as a starter for a Roth IRA account for those individuals who did not have retirement plans at work. The program had automatic payroll deductions, no fees, no minimum balance, and virtually no risk with the funds being invested in Treasury debt. When a balance reached $15,000, then the savings rolled over into a private sector Roth IRA.

This paper explains why the program failed. To begin with, the program had few participants. A problem for participants was the low rate of return on Treasury debt. This type of retirement fund needs better returns over a long investment horizon. Unfortunately for the myRA program, potential participants can find private sector alternatives with better expected returns. In addition, the program had high management costs for the government. Taxpayers paid nearly $70 million in management costs since the date of launch and the government expected future costs to run $10 million per year. Unfortunately, the participants contributed only $34 million to their accounts. The result was a failed government program.

The main purpose of the program was to improve retirement income for seniors. But the government efforts on the myRA program were misguided. A basic analysis of the program's characteristics, with a comparison to the characteristics of market alternatives, reveals the inadequate design of the program. Unfortunately, the government wasted substantial funds administering this doomed program. Those government funds could have better gone to shoring up Social Security, an important program that provides retirement income for seniors. Social Security has solvency problems and needed the funds wasted on the myRA program.

INTRODUCTION

In 2017, the U.S. Treasury announced the termination of its myRA program. [1] This program, enacted during the Obama era in 2015, was designed to get more Americans to save for retirement. The program operated as a starter for a Roth IRA account for those individuals who did not have retirement plans at work. The program had automatic payroll deductions, no fees, no minimum balance, and virtually no risk with the funds being invested in Treasury debt. When a balance reached $15,000, then the savings rolled over into a private sector Roth IRA. [2]

This paper explains why the program failed. A basic analysis of the program's characteristics, with a comparison to the characteristics of market alternatives, reveals the inadequate design of the program.

LITERATURE REVIEW

Prior research has examined how investors can optimize their retirement planning. Investors need to select investments that are suitable for long term retirement planning. There can be a shortfall risk if investors choose highly conservative portfolios with low expected return. The investor then is at risk for having inadequate savings for retirement. This shortfall risk is often a neglected, or even omitted, part of the risk assessment of retirement investing. Leibowitz and Kogelman (1991) formally model asset allocation decisions subject to shortfall risk by considering investment horizon, minimum returns thresholds, and allowable probabilities that returns will fall below the minimum threshold. Their model indicates that even for short-term investment horizons as small as five years, optimal portfolio allocations should include equity components of at least 30%. For investors who are more risk tolerant, equity components may be as high as 85%. This suggests that portfolio allocations that exclude material equity components are likely to suffer from shortfall risk, especially for investors with longer investment time horizons. Smith and Gould (working paper) also model the shortfall risk problem and conclude that "for a variety of plausible assumptions about asset returns, investment strategies, and what constitutes shortfall, the minimum risk portfolio generally has between 50 and 70 percent stocks."

Several empirical studies suggest myopic risk management techniques expose investors to a high probability of shortfall risk because of the exaggerated focus on short-term portfolio volatility. For example, Spitzer and Singh (2008) examine shortfall risk by testing the effectiveness of target-date funds. They find that a simple 50/50 stock/bond portfolio unambiguously outperforms target-date funds that systematically move investors to funds that are more heavily weighted in bonds as those investors approach retirement. Haensly (2016) observes that even though TIPS are virtually risk free, a strategy relying heavily or solely on investing in TIPS for retirement typically fails to provide adequate retirement resources. He concludes that "significant shortfall risk exists for TIPS-only portfolios across a range of savings plans and securities selection rules." Therefore, strategies that rely solely, or heavily on interest-bearing securities with little or no capital gains potential are likely to subject an investor to retirement shortfall and should be avoided because they produce suboptimal outcomes.

THE CREATION OF THE myRA PROGRAM

The program was created to help citizens prepare for retirement. Financial planners have long urged citizens to start saving early for their retirements. With looming shortfalls in Social Security and Medicare, along with towering federal deficits, planners have encouraged citizens to exercise self-reliance in planning for their futures without undue reliance on shaky federal programs. Despite the presence of the traditional IRA, the Roth IRA, the 401 (k), the 403 (b), and traditional pensions, planners have found many citizens with insufficient savings for their old age. Some citizens have failed to take individual initiative. Other citizens have lacked employer-sponsored retirement plans.

There is history behind the creation of the myRA program. Powell (2013) notes that policy experts have long favored automatic IRAs to help solve the problem of inadequate retirement savings. But their proposed laws have failed. The proposals would require employers to automatically enroll employees in IRAs unless the employees opted out. In 2009 the Treasury Department developed an alternative idea of R-bonds, or retirement bonds, to encourage savings. The R-bonds would have the characteristics of an IRA and be aimed at workers at firms that do not sponsor retirement plans, part-time employees who are not eligible for plans that their firms sponsor, and the self-employed or non-

employed. With the recent gridlock in Washington, an advantage of R-bonds was that they would not require congressional authorization. With R-bonds, the employee could arrange an automatic payroll deduction with no government fees for an investment in government bonds. The R-bond proposal was not adopted.

With the President's State of the Union address in 2014, the President seized on some of the fundamentals of the proposed R-bond program and named his new program the myRA program. Its purpose was to help millions of Americans build a nest egg.

The White House (2014) summarized the myRA as a simple, safe, and affordable starter savings account. The President directed the Department of the Treasury to create the program which would be offered through employers and would help millions of Americans begin to save for retirement. The program targeted Americans who did not have workplace retirement plans. The product functioned like a Roth IRA with no tax deduction but with tax free growth. The savers benefitted from principal protection since the account would never go down in value. Like all savings bonds, the account was backed by the U.S. government. Contributions could be withdrawn tax free at any time. Initial investments could be as low as $25 and contributions could be as low as $5 through easy payroll deductions. Savers could keep the same account when they changed jobs and could roll the balance into a private sector retirement account at any time. Savers earned the same variable interest rate as the federal employees' Thrift Savings Plan (TSP) Government Securities Investment Fund. The plan was available to millions of American who could earn up to $191,000 per year. Participants could save up to $15,000 in their accounts before transferring the balance to a Roth IRA.

OPERATION OF THE myRA PROGRAM

The designers of the program hoped for many participants. Unfortunately, these hopes were not realized. As of 2017, contributions to the program totaled only $34 million. [3] A problem for participants was the low rate of return on Treasury debt. This type of retirement fund needs better returns over a long investment horizon. Unfortunately for the myRA program, potential participants can find private sector alternatives with better expected returns. In addition, the program had high management costs for the government. Taxpayers paid nearly $70 million in management costs since the date of launch and the government expected future costs to run $10 million per year. [4] The result was a failed government program. In 2017 the U.S. Treasury announced the termination of the program.

ANALYSIS OF THE myRA PROGRAM

The program had some positive characteristics: low fees, guaranteed return, low minimum investment, and wide availability to millions of Americans. On the other hand, the program's return on investment was low. Inflation can eliminate much, if not all, of the growth potential. Over a long time horizon for accumulating savings for retirement, the worker who instead invests in a low-fee private Roth IRA with automatic monthly transfers can utilize investment funds that can deliver better expected rates of return.

Some competitive models can show why the program's low rate of return is an important drawback for the retirement saver even if there is high volatility in the market. The following models pit the program against a private sector Roth IRA. The competitive models utilize reasonable assumptions based on recent financial performance for the myRA investment and recent financial performance for possible Roth investments.

Under all models, the saver deposits $1,000 at the start of each year and the saver has a 40 year time horizon with 40 years serving as the time horizon for the saver's working years. In addition, under all models, the normal return for the myRA model with investment in its government fund is 1.5% per year with no fees while the normal return for a Roth IRA with a mix of stocks and bonds is 8% per year after Vanguard fees of .2%.

In the first model, assume a myRA account with annual deposits of $1,000 and a 1.5% growth rate per year for 40 years. The account would grow to a total of $55,082 at the end of 40 years. This first choice assumes the worker stays with the same investment choice with 1.5% growth even after graduating to a regular Roth IRA in year 14 when the account exceeds $15,000.

In a second model, assume this worker observes that when the myRA account exceeds $15,000 after 14 years, the worker then wants to invest in other choices and begins earning 8% in a regular Roth IRA for the next 26 years. The total comes to $202,341.

In the third model, assume a worker, from the start, uses a regular Roth IRA with an 8% return per year. The Roth IRA continues through year 40 and totals $279,781.

In the fourth model, assume that market volatility for stocks and bonds is important. Assume the Roth IRA, in a state of volatility, has no growth for the first 5 years and then has 8% growth for 35 years. The total comes to $260,029. For comparison, note that the myRA government account used in Model 1 has the advantage of eliminating the effects of market volatility due to its investment in stable government bonds. It again totals $55,082 at the end of 40 years, the same amount as shown in the first model even if the account operates in a market for stocks and bonds that is volatile in the fourth model.

In the fifth model, assume that volatility is even more pronounced. Now assume a Roth IRA has no growth for the first 5 years and then experiences a sudden 50% drop in the market that comes just after the deposit early in year 6 with no growth for the rest of the year. From there, the account has 8% growth. The total for the Roth comes to $212,387. For comparison, note that the myRA government account used in Model 1 has the advantage of eliminating the effects of market volatility. It again totals $55,082 at the end of 40 years, the same amount as shown in the first model.

In the sixth model, assume high volatility operates to the advantage of the saver. Now assume a Roth IRA has 20% growth for the first three years. From there, the account has 8% growth for 37 years. The total for the Roth comes to $294,645. For comparison, note that the myRA government account used in Model 1, despite a volatile market in this sixth model, would again total $55,082 at the end of 40 years, the same amount as shown in the first model.

In the seventh model, assume high volatility both helps and hurts the saver. Now assume a Roth IRA has 20% growth for the first three years and a sudden 50% drop in the market at the start of year 10 that occurs just after the early deposit for that year with no growth for the rest of the year. From there, the account has 8% growth. The total for the Roth comes to $202,114. For comparison, note that the myRA government account used in Model 1, despite a volatile market in this seventh model, would again total $55,082 at the end of 40 years, the same amount as shown in the first model. Table 1 summarizes the results for the seven models.

Table 1: Comparison of Seven Models

Model Number	Comments	Future Value of Account
1	myRA type of account with no equities for 40 years	$55,082
2	myRA account for 14 years followed by Roth IRA with mix of stocks and bonds for 26 years	$202,341
3	Roth IRA with steady returns	$279,781
4	Roth IRA with unfavorable volatility	$260,029
5	Roth IRA with unfavorable, intense volatility	$212,387
6	Roth IRA with favorable volatility	$294,645
7	Roth IRA with mixed, intense volatility	$202,114

DISCUSSION

Among all the models, Model1has the lowest total at $55,082 after 40 years despite its advantages of low fees and low volatility. Its low average return dooms this model to the lowest performance.

Model 2 matches Model 1 for 14 years until the point at which the account graduates to a regular Roth IRA. At that point, the saver earns regular Roth IRA returns for 26 more years. The total becomes $202,341 which exceeds Model 1 by $147,259, or 367%.

Model 3 uses a regular Roth IRA return for the entire 40 years. It totals $279,781 which exceeds Model 2 by $77,440 or 38%. These results show the first 14 years are important to the size of the accounts despite similar types of investments over the final 26 years.

Model 4 addresses investor fear of volatility. The “myRA” type of investment eliminates volatility by using government bonds. But even with the first 5 years in Model 4 producing no overall return due to volatility in a Roth IRA, the remaining 35 years of normal Roth IRA growth is enough to produce a total of $260,029. The penalty for volatility is not enough for the Roth IRA to lose this competition. The Roth IRA in model 4 exceeds Model 1 by $204,947 or 472%. The Roth IRA in model 4 also defeats Model 2.

Model 5 makes the volatility even more severe with 5 years of no growth for the Roth IRA followed by a sudden 50% drop in the market. Nevertheless, the Roth IRA in model 5 still defeats Model 1. Model 6 shows high volatility that operates to the advantage of the saver. The Roth IRA in model 6 then defeats Model 1 by a wide margin. Model 7 shows high volatility that both helps and hurts the saver. The Roth IRA in model 7 again defeats Model 1.

In summary, the myRA type of investment seems to be a weak savings vehicle. Under numerous plausible scenarios, the saver would be better off arranging for a regular Roth IRA despite the myRA having the advantages of lower fees and less volatility. The better growth rate for the Roth IRA overwhelms the myRA in the long run even with penalties against the Roth IRA for volatility and fees. The myRA program seems to be an ineffective tool for solving the problem of inadequate retirement savings for lower income individuals.

CONCLUSION

When the myRA program was introduced, it was hailed as a way to help lower income individuals fund their retirements. But an analysis of the program's characteristics shows that the program was a weak savings vehicle. Private sector alternatives appear to be superior savings vehicles even after adjusting for volatility and fees. Nevertheless, Social Security is an important program for this type of lower income saver. Social Security was created to provide an essential level of retirement income for those without adequate retirement savings. Social Security is highly progressive in the sense that it provides a higher return to the lower income worker than the high income worker. It seems government funds lost on the myRA program might have been better spent on shoring up Social Security.

FOOTNOTES

[1] Brandon (2017)
[2] White House (2014)
[3] Ebeling (2017)
[4] Ebeling (2017)

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LONG-RANGE DEPENDENCE IN SECTORAL INDICES

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ABSTRACT

This study tests for market efficiency in the Indian financial market by analyzing long-range dependence in sectoral equity index returns. It applies three fractal analysis techniques— the Classical Rescaled Range, Wavelets, and Roughness-Length relationship methods— to the complete range of equity price information available for each of the sectoral indices on the Bombay Stock Exchange and the National Stock Exchange. As many as 15 of the 30 indices studied in total exhibit persistence in returns, a finding consistent with recent studies of broader Indian market indices. The results point to the existence of pricing inefficiencies that may well offer exploitable opportunities for excess returns in significant sections of the Indian capital market.

INTRODUCTION

Over the last three decades, India has emerged as an important player in the global economy. Concomitantly, the country has attracted increasing capital inflows, and the question of informational efficiency in the pricing of assets in this emerging economy has assumed greater significance (Dicle et al, 2010). Not surprisingly, recent studies have sought to assess the informational efficiency of the country's capital markets. The results of these studies are not in perfect agreement, but on balance the evidence appears to suggest some degree of dependence in market returns (see, for example, Poshakwale, 2002; Sarkar & Mukhopadhyay 2005; and Mishra et al, 2011).

The present work extends the literature on market efficiency within the Indian context by analyzing the behavior of a total of thirty returns series for sectoral equity indices on the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE). This contrasts with existing studies, which concern themselves primarily with broader market indices. A recent study by Palamalai & Kalaivani (2015) does conduct tests of weak-form efficiency for Indian sectoral indices, but in contrast to the aforementioned study, which tests for serial correlation and any departures from a random walk using autocorrelation, unit root, variance ratio, and the runs tests, the present work employs fractional integration models to check for the presence of long-range dependence or memory in the series. Further, in contrast to the prior study's focus on a 5 ½-year period beginning in 2009, we analyze returns behavior over the full window for which data are available, which amounts to between 11 to 18 years for the BSE indices and roughly 3 to 20 years for the NSE indices; the vast majority of the indices span a period of 11 to 20 years, or roughly two to three times that of the previous work cited. Further, we seek to ascertain whether each of the returns series studies can be classified as "persistent" or "antipersistent", based on its estimated Hurst exponent. The study by Hiremath & Kumari (2015) represents another recent assessment of pricing efficiency in the Indian context, and it tests for long memory in both sectoral and broader indices. However, that study also constrains itself to a relatively narrow window, focusing on the 9 years between 2003 and 2012. Further, it considers only about half of the sectoral indices (16 out of a total of 30 available indices) on the BSE and the NSE. In the absence of any compelling a priori reason to either exclude any available sectoral indices or any available price information on those indices, the present study applies three fractal analysis techniques, viz., the Classical

Rescaled Range (R/S), Wavelets, and Roughness-Length relationship methods, to the complete range of price information available for all sectoral indices on the BSE and NSE, ending on August 31, 2017. A later section details the contrasting results of this approach. In summary, our results show that returns for 15 of the 30 series studied behave in a manner that is inconsistent with efficient pricing, a finding that agrees with some recent studies of broader market indices (e.g. Mishra et al, 2011). Our results have significant practical implications. The existence of temporal dependencies suggests that traders who can exploit inefficiencies to generate excess returns through technical trading rules. These rules can be more effective if the precise nature of returns behavior (such as "persistence" or "antipersistence") can be identified.

The remainder of this study is organized as follows. The section below provides a brief review of the literature on market efficiency within the Indian context, with a focus on long memory. This is followed by a description of the data, a discussion of the methodology employed to study long-range dependence in returns, and a presentation of the empirical results. The concluding section discusses the results and implications of the study.

INFORMATIONAL EFFICIENCY OF INDIAN CAPITAL MARKETS

The evidence on market efficiency within the Indian context is mixed, though the balance of it appears to lie in favor of some predictability of returns. In an early study of Indian stock market efficiency, Poshakwale (2002) tests for linear and nonlinear dependence using an equally weighted portfolio of 100 stocks, and 38 of the most actively traded individual securities listed on the BSE for the period 1990-1998. The results reject the random walk hypothesis and are consistent with the presence of non-linear dependence and volatility persistence.

While Poshakwale (2002) tests for structural breaks in volatility due to regulatory changes in the sample period 1990-1997, a later study of the BRIC countries (for the period 1990-2007) by Kasman (2009) suggests that incorporating sudden variance shifts due to domestic and global economic and political events into the model reduces the estimated volatility persistence by as much as 34% for the Indian stock market. Using a similar sample period of 1990-2007, Badhani (2008) studies the CNX Nifty Index for the presence of long memory in returns and returns volatility. The study suggests that the volatility of returns (but not the returns themselves), are characterized by persistence. Such volatility persistence was not observed for the 2001-2007 sub-period, however, and the author concludes that the results are more consistent with structural breaks in the volatility process.

Sarkar & Mukhopadhyay (2006) analyze four broader market indices for a period between six and fifteen years (depending upon the index) ending in the year 2000. Using daily returns, they find nonlinear dependencies in the returns series and dynamics beyond the second moment that contribute to inefficiency in these markets. Mishra et al (2011) study two sectoral (Banking and IT, both from the NSE), and four non-sectoral indices roughly over the period 1991-2010. Their findings are similar to those of Sarkar & Mukhopadhyay (2006). Variance Ratio tests lead them to reject the random walk hypothesis in the case of all the six indices they consider. They also find evidence of nonlinear dependence in returns, and the results of a rescaled range (R/S) analysis suggest some persistence (long memory) in returns.

A recent work by Bhat & Nain (2014) also tests for persistence, though its focus is on the volatility of returns on four sectoral indices—the BSE Bankex, Information Technology (IT), Metal, and Public Sector Undertakings (PSU) indices. That study finds evidence of volatility persistence in the BSE Bankex and IT indices. Similarly, Mukherjee et al (2011) find evidence of

persistence in return volatility (but not returns) for the BSE Sensex index over the period 1997-2009.

Mishra & Mishra (2011) test the random walk hypothesis in the presence of nonlinearities for two market indices belonging to the National Stock Exchange (NSE) and ten individual stocks. Their findings suggest that the series of returns for both indices and most of the individual stocks studied follow a random walk, a finding that stands in contrast to those from some of the studies mentioned above (e.g., Poshakwale, 2002; Sarkar & Mukhopadhyay, 2006; and Mishra et al, 2011).

The question of persistence has also been addressed for returns on individual securities, as against equity indices. For example, Rajagopal (2011) employs classical R/S analysis to study returns on 25 infrastructure stocks. He finds evidence of antipersistence in most of the series; in these returns series, the dependency between two sets of returns is such that an up-trend in one set is more likely to be followed by a down- trend in the next set of the same length. Another study of weak-form efficiency in the Indian markets is that by Hiremath & Kamaiah (2012). They use a non-parametric variance ratio test and analyze the behavior of several non-sectoral BSE indices, among others, for a period roughly covering 1998—2009 (the data for some of the indices originate later than 1998). They find evidence consistent with weak-from inefficiency, especially in the case of mid-and small-cap equities. In an earlier study, Hiremath & Kamaiah (2010), the authors document a mean-reverting tendency among India stock returns.

Studies have addressed the issue of long memory in returns and volatility in the context of markets other than equities as well. For example, Kumar (2014) is a recent study that documents the existence of long-range dependence in returns and volatility in the market for foreign exchange, specifically the Indian Rupee-USD market. The results are inconsistent with weak-form efficiency in this market, and suggest that models incorporating long-range dependencies will likely possess greater forecast accuracy than would short-memory models.

Palamalai & Kalaivani (2015) and Hiremath & Kumari (2015) are the two studies of which we are aware that assess informational efficiency in Indian sectoral indices. The first of these studies uses a sample of daily returns for about 5 ½ years beginning in 2009 and 2010, and tests for efficiency based on autocorrelation, unit roots, the variance ratio, and runs in return signs. The results suggest significant autocorrelation in returns (reported for lags of up to 12 days), and the existence of unit root, pointing to weak-form inefficiency. Taking a different approach to the question of market efficiency, the present work assesses whether there is long memory/long-range dependence in the returns series. The Hiremath & Kumari (2015) study focuses on a window of nine years ending in March 2012, and tests for long memory in 16 sectoral and 13 broader indices traded on the BSE and the NSE. In contrast, the present study uses self-affine fractal analysis methods to estimate the Hurst exponent, seeking to identify each series as exhibiting persistent/trend-reinforcing behavior, antipersistent/mean-reverting behavior, or Brownian motion. The existence of such patterns would contradict efficient pricing and suggest the possibility of establishing profitable trading strategies based on historical market information.

DATA, METHODOLOGY, & EMPIRICAL RESULTS

We consider the returns on a total of 30 sectoral equity indices on the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE), employing the entire price series available for each index on the BSE and NSE sites (bseindia.com; nse.com), ending on August 31, 2017. Some additional information (that for the NIFTY Pharma index) has been collected from

Investing.com. Table 1 below shows the time period over which each of the 19 BSE sectoral index price series is available. The data for the BSE indices span a period of roughly 11 to 18 years.

Table 1
BSE Sectoral Index Date Range ending August 31, 2017

Index	Data Start Date	N
Auto	01/02/1999	4628
Bankex	01/01/2002	3901
Basic Materials	16/09/ 2005	2962
Capital Goods	01/02/1999	4628
Consumer Discretionary	16/09/ 2005	2962
Consumer Durables	01/02/1999	4628
Energy	16/09/2005	2962
FMCG	01/02/1999	4628
Finance	16/09/2005	2962
Healthcare	01/02/1999	4628
Industrials	16/09/2005	2962
IT	01/02/1999	4628
Metal	01/02/1999	4628
Oil and Gas	01/02/1999	4628
Power	03/01/2005	3142
Realty	02/01/2006	2891
Teck	31/01/2000	4380
Telecom	16/09/2005	2962
Utilities	16/09/2005	2962

Table 2 below provides some descriptive statistics for the daily returns on the BSE indices. The returns data are non-normal, and, except for the Auto index, Metal index and, to some extent, the Telecom index, return distributions are quite significantly leptokurtic. Also, virtually all return series are negatively skewed to some degree.

Table 2
BSE Sectoral Index Returns Descriptive Statistics

Index	N	Mean %	St Dev	Skewness	Kurtosis
Auto	4628	0.068	0.016	-0.299	3.36
Bankex	3901	0.085	0.019	-0.066	6.25
Basic Materials	2962	0.039	0.018	-0.397	5.17
Capital Goods	4628	0.062	0.018	-0.029	6.42
Consumer Discretionary	2962	0.045	0.014	-0.671	7.20
Consumer Durables	4628	0.062	0.019	-0.294	4.06
Energy	2962	0.045	0.017	-0.264	9.67
FMCG	4628	0.050	0.014	-0.045	5.03
Finance	2962	0.058	0.018	0.017	6.35
Healthcare	4628	0.056	0.014	-0.100	7.43
Industrials	2962	0.041	0.017	-0.083	6.16
IT	4628	0.050	0.023	-0.398	8.11
Metal	4628	0.056	0.022	-0.255	4.03
Oil & Gas	4628	0.059	0.018	-0.304	7.70
Power	3142	0.026	0.017	-0.095	8.00
Realty	2891	0.017	0.028	-0.464	7.08
Teck	4380	0.014	0.020	-0.544	7.60
Telecom	2962	0.012	0.020	-0.077	4.28
Utilities	2962	0.024	0.017	-0.438	10.90

Tables 3 and 4 below list the corresponding information for the sectoral indices on the NSE. Some price series, such as those for the Realty, PSU Banks, Metal, and Pharma indices are relatively short, especially in relation to what is available for BSE indices. A total of 11 sectoral indices are available on the NSE, and the data for these span a period of roughly 3 to 21 years. In general, the returns are characterized by varying degrees of negative skewness and are leptokurtic (with the exception of Pharma and PSU Banks).

Table 3 NSE Sectoral Index Date Range, ending August 31, 2017		
Index	**Data Start Date**	**N**
Auto	01/01/2004	3396
Bank	04/01/2000	4399
Energy	01/01/2001	4149
Financial Services	01/01/2004	3396
FMCG	01/01/1996	5397
IT	01/01/1996	5397
Media	30/12/2005	2892
Metal	13/07/2011	1518
Pharma	01/02/2011	1630
PSU Banks	02/08/2012	1255
Realty	23/07/2014	764

Table 4 NSE Sectoral Index Returns Descriptive Statistics					
Index	**N**	**Mean %**	**St Dev**	**Skewness**	**Kurtosis**
Auto	3396	0.070	0.015	-0.247	5.25
Bank	4399	0.071	0.019	-0.156	5.62
Energy	4149	0.062	0.017	-0.451	8.85
Financial Services	3396	0.068	0.019	-0.092	7.06
FMCG	5397	0.060	0.015	-0.142	4.59
IT	5397	0.087	0.023	-0.331	6.65
Media	2892	0.038	0.017	-0.198	4.80
Metal	1518	-0.065	0.017	0.052	1.58
Pharma	1630	0.040	0.011	-0.491	2.96
PSU Banks	1255	0.076	0.020	0.193	2.14
Realty	764	0.014	0.020	-0.650	4.80

To test for persistence, we estimate the self-affinity index (or Hurst exponent, H) for the index returns series using Mandelbrot's (1972) rescaled-range (R/S) analysis methodology, which has its origins in Hurst's (1951) study of the Nile river. We begin by defining a time series **Y** with n consecutive values **Y** = $Y_1, Y_2,\ldots,Y_n$. The mean and standard deviation, Y_m and S_n , are defined as usual:

$$Y_m = \frac{\sum_{i=1}^{n} Y_i}{n} \quad (1)$$

$$S_n = \sqrt{\frac{\sum_{i=1}^{n}(Y_i - Y_m)^2}{n}} \quad (2)$$

The range, R, is defined here as the difference between the highest and lowest cumulative deviation values of Y over the n observations:

$$R = \text{Max}[\sum_{i=1}^{n}(Y_i - Y_m)] - \text{Min}[\sum_{i=1}^{n}(Y_i - Y_m)] \quad (3)$$

That is, successive deviations from the mean are cumulated through the series of Y values, the minimum and maximum cumulated values are identified, and the difference is taken between those two values. As Y has been redefined to a mean of 0, the maximum cumulated deviation would be at least 0, and the minimum at most zero. Hence, R will be non-negative. Now, the range can be viewed as the distance traveled by the series in time n. For systems following Brownian motion, distance covered is proportional to the square root of time, so that for $R = T^{0.5}$ for such systems. A general form of this rule for systems with dependence rather than Brownian motion would be (Hurst, 1951):

$$\frac{R}{S_n} = k \cdot n^H \quad (4)$$

In the equation above, k is a constant, and H is the "Hurst exponent". The left hand side of the equation shows the rescaled range, R/S ("range scaled by standard deviation"), and the relationship captures how the range of cumulated deviations scales over the time increment, n. For random series, we would expect the exponent (H) to be 0.5. Taking the log of each side, we get:

$$\log\left(\frac{R}{S_n}\right) = \log k + H \cdot \log n \quad (5)$$

As such, we can estimate the Hurst exponent, H, as the slope of the plot of log (R/S_n) against log (n). In practice, the Y series is divided into contiguous sub-periods and H is estimated by OLS (see Peters, 1994, pages 61-63). Consider, for example, a series consisting of 680 logarithmic returns. This series is divided successively into periods of length n, with n assuming values of whole integer factors of 680 (i.e. 2, 4, 5, 8, 10, 17, etc.). In the case of each n, an average range and standard deviation can be calculated. For instance, for n of 2, there will 340 windows, for n of 4 there will be 170 windows, and so on). The logarithm of the average R/S value obtained for the window length is regressed on the logarithm of the window length, n. The coefficient of log n is the estimated Hurst exponent, or scaling exponent, H. The value of H is 0.50 for a random series, or independent process; if $0.50 < H \leq 1$, the elements in the series influence other elements in the series, and the series is "persistent". The series is "anti-persistent" if $0 \leq H < 0.50$; in this case, the process reverses itself more frequently than a random process would.

A second method we use to estimate the Hurst exponent is that of the Roughness-Length relationship (R/L), which is similar to the R/S method described above, except that the vertical range is replaced with the root-mean-square roughness of the data. Thus, where the average range and standard deviation were calculated in the R/S approach, the root-mean-square roughness is calculated (after adjusting for local linear trend) under the R/L approach. This yields the average root-mean-square roughness for each interval length, denoted say, by *s (w)*. If the trace is self-affine, the roughness measure, *s(w)* is related to the Hurst exponent, *H*, as $s(w) = w^H$, and the Hurst exponent is estimated as in the case of the R/S approach through a regression.

Third, we employ the Wavelets method to estimate the Hurst exponents. This approach exploits the fact that transforms of self-affine traces are themselves self-affine. We decompose the

series to be analyzed in time frequency space and assess variations in power. Should the wavelet power spectrum be related to frequency by a power law function, we would infer the existence of fractal properties. As noted by Mulligan (2004), the method is applicable in the case of non-stationary series. The application of this method is briefly described below[1].

T wavelet transforms are taken, each with a distinct scaling coefficient, K_i. Let S_i denote the standard deviations from 0 of those scaling coefficients. Now, let R_i be the T-1 ratios of the standard deviations. So, $R_1 = S_1/S_2$, $R_2 = S_2/S_3$, etc. Next, estimate the average of the R_i as:

$$R_{AVG} = \frac{\sum_{i=1}^{T-1} R_i}{T-1} \quad (6)$$

Finally, estimate the Hurst exponent as $H = \Phi (R_{AVG})$; where Φ is a heuristic function that approximates H by R_{AVG} for stochastic self-affine series. In the present estimation process, T is varied up to a value of 4, and i takes the values of 0, 1, 2, and 3 for the scaling coefficients. As such, we estimate H using the first three dominant wavelet functions, a process also followed in Mulligan (2004). The wavelet method does not yield a standard error for hypothesis testing.

Table 5 below presents the results of the R/S analysis, the Wavelets method, and the R/L method for all thirty sectoral indices included in the study. The results for the **BSE indices** may be summarized as follows (summary results for both sets of indices under all three methods are tabulated in Table 6 below).

- There is agreement between all three methods that **persistence** appears to characterize the returns in **11 sectoral indices**: Auto, Basic Materials, Capital Goods, Consumer Discretionary, Consumer Durables, Healthcare, Industrials, IT, Metal, Realty, and Utilities.
- There are **3 sectors** in which the R/L method suggests the presence of **anti-persistence**, and for which the R/S approach does not return an exponent significantly different from 0.50. These sectors are Energy, Fast Moving Consumer Goods (FMCG), and Telecom.
- There are **2 sectors**, Oil & Gas, and Power, for which the R/S method does not lead to the rejection of the null, but for which the R/L and Wavelets methods suggests the existence of returns **persistence**. There is **1 sector**, Finance, for which the R/S method suggests **persistence**, but the R/L method fails to reject the null.
- For **1 sector**, TECK, the R/S and Wavelets methods on the one hand, and the R/L method on the other, suggest opposite returns behavior; the first two indicate returns **persistence**, while the third suggests the **antipersistent** behavior.
- Finally, under neither the R/S method nor the R/L approach is the null rejected for **1 sector**, Bankex.

For the eleven **sectoral indices on the NSE**, the results are as follows:

- The **4 sectors**, IT, Media, Metal, and PSU Banks are shown to have **persistence** in returns based on all three methods.
- For the **3 sectors**, Bank, Energy, and FMCG, **persistence** is indicated by the Wavelets and R/L methods, but the null is not rejected under the R/S method.

[1] The Wavelets method derives from the work of Beylkin (1992), Coifman et al (1992), and Daubechies (1990).

- Under neither the R/S method nor the R/L approach is the null rejected for **1 sector**, Financial Services.
- For **2 sectors**, Pharma and Realty, the R/L method suggests **antipersistent** behavior, but the null is not rejected under the R/S method.
- Finally for **1 sector**, Auto, the R/S and Wavelets methods suggest **persistence** in returns, but the null is not rejected under the R/L method.

Table 5
Estimated H for BSE & NSE Sectoral Indices

		R/S Analysis		Wavelets	R/L Analysis	
BSE Sectoral Indices	**# In Trace**	**Est. H**	**p-value**	**Est. H**	**Est. H**	**p-value**
Auto	4620	0.582	0.0000	0.589	0.566	0.0060
Bankex	3780	0.528	0.4987	0.571	0.507	0.1966
Basic Materials	2520	0.568	0.0009	0.613	0.559	0.0000
Capital Goods	4620	0.571	0.0069	0.608	0.580	0.0000
Consumer Discretionary	2520	0.572	0.0008	0.632	0.548	0.0000
Consumer Durables	4620	0.583	0.0000	0.610	0.574	0.0000
Energy	2520	0.503	0.9118	0.575	0.484	0.0254
FMCG	4620	0.503	0.9602	0.583	0.473	0.0000
Finance	2520	0.548	0.0044	0.581	0.503	0.4700
Healthcare	4620	0.555	0.0469	0.597	0.546	0.0000
Industrials	2520	0.571	0.0000	0.629	0.556	0.0000
IT	4620	0.558	0.0001	0.588	0.530	0.0394
Metal	4620	0.564	0.1018	0.596	0.581	0.0000
Oil & Gas	4620	0.521	0.5295	0.582	0.523	0.0014
Power	2520	0.547	0.1603	0.578	0.542	0.0000
Realty	2520	0.569	0.0248	0.614	0.559	0.0000
Teck	4320	0.529	0.0024	0.585	0.479	0.0613
Telecom	2520	0.496	0.9003	0.581	0.464	0.0019
Utilities	2520	0.548	0.0926	0.604	0.533	0.0000
NSE Sectoral Indices	**# In Trace**	**Est. H**	**p-value**	**Est. H**	**Est. H**	**p-value**
Auto	3360	0.531	0.0744	0.576	0.508	0.2274
Bank	4320	0.53	0.4825	0.572	0.513	0.0000
Energy	3960	0.526	0.4452	0.545	0.519	0.0000
Financial Services	3360	0.526	0.2775	0.569	0.505	0.5782
FMCG	5040	0.497	0.952	0.563	0.461	0.0000
IT	5040	0.579	0.0000	0.588	0.558	0.0000
Media	2520	0.575	0.0000	0.576	0.531	0.0000
Metal	1440	0.531	0.0257	0.556	0.480	0.0036
Pharma	1440	0.462	0.4895	0.625	0.460	0.0000
PSU Banks	1080	0.549	0.0013	0.568	0.518	0.0054
Realty	720	0.503	0.5552	0.621	0.431	0.0000

Table 6
Summary of Results

BSE Sectoral Indices	R/S		Wavelets		R/L	
	Persist.	Anti-Pers.	Persist.	Anti-Pers.	Persist.	Anti-Pers.
Auto	✓		✓		✓	
Bankex			✓			
Basic Materials	✓		✓		✓	
Capital Goods	✓		✓		✓	
Cons. Discretionary	✓		✓		✓	
Consumer Durables	✓		✓		✓	
Energy			✓			✓
FMCG			✓			✓
Finance	✓		✓			
Healthcare	✓		✓		✓	
Industrials	✓		✓		✓	
IT	✓		✓		✓	
Metal	✓		✓		✓	
Oil & Gas			✓		✓	
Power			✓		✓	
Realty	✓		✓		✓	
Teck			✓			✓
Telecom			✓			✓
Utilities	✓		✓		✓	
NSE Sectoral Indices						
Auto	✓		✓			
Bank			✓		✓	
Energy			✓		✓	
Financial Services			✓			
FMCG			✓		✓	
IT	✓		✓		✓	
Media	✓		✓		✓	
Metal	✓		✓		✓	
Pharma			✓			✓
PSU Banks	✓		✓		✓	
Realty			✓			✓

DISCUSSION OF RESULTS & IMPLICATIONS OF STUDY

Our analysis of long memory in Indian sectoral equity indices includes estimating the Hurst exponent for the 30 returns series associated with the BSE and NSE sectoral indices using the rescaled range (R/S), Wavelets, and Roughness-Length relationship (R/L) methods. As the results in Table 5 and Table 6 above indicate, as many as 15 of the 30 series are characterized by persistence, or long-range dependence. For every sector, the Wavelets method yields estimates that are greater than 0.50, in many cases quite close to 0.60, and in roughly a third of the cases even higher than 0.60. The R/S analysis confirms significant persistence in the case of 17 of these returns series. Among the indices for which significant persistence is observed, the estimated Hurst exponents range between a low of 0.529 and a high of 0.583 (based on R/S), between a low of 0.556 and a high of 0.632 (based on Wavelets), and between a low of 0.513 and a high of 0.581 (based on the R/L method). Only for the BSE Bankex and NSE Financial Services sectoral indices is there no evidence of pricing inefficiency based on the R/S and R/L methods.

These results are qualitatively similar to those reported by Mishra et al (2011) for broader market indices in India. They find persistence in the case of the BSE 100, BSE 200, BSE Sensex, and CNX Nifty indices, with estimated Hurst exponents (for raw returns) ranging between 0.575 and 0.619. The estimated exponents are significantly different from the benchmark of 0.50 for a series consistent with a random walk. For the banking sector, however, our results are mixed; we find only mixed evidence of persistence in the BSE Bankex series as persistence is suggested by the Wavelets method but not the R/S and R/L approaches. Our finding in the case of Bankex is confirmed by Hiremath & Kumari (2015). Mishra et al (2011) find strong persistence (relative to the broader indices that they study) for the Nifty Bank index, and the Wavelets and R/L methods in our study confirm this finding. As noted above, we do find evidence of persistence in the NSE PSU Bank index as well, which is in contrast to Hiremath & Kumari (2015). Further, the existence of long memory in the IT and Realty sectors had been documented previously by Rajagopal & Hays (2012a; 2012b), *inter alia*; updated data in our study confirm their findings. Hiremath & Kumari (2015) find evidence of long memory in the BSE Realty index, but not in the case of the IT sector. Our results confirm, at least qualitatively, the findings of Palamalai & Kalaivani (2015), who document weak form inefficiency in the sectoral indices that they examine. While they find evidence that all the 23 sectoral indices in their study exhibit behavior inconsistent with weak form efficiency, our analysis of long-range dependence suggests that the behavior of half of the sectoral indices diverges from what would be expected of series that follow a Brownian motion, but that that divergence in not true for all the sectors.

The consistent evidence that Hiremath & Kumari (2015) find of long memory in the BSE Auto, Capital Goods, Consumer Durables, Health Care, Metal, and Realty sectors is confirmed here using a significantly wider time frame. Their finding of long memory in the NSE Auto and FMCG indices, however, does not receive the same degree of confirmation in our study, in that not all three of our methods support that conclusion.

Interestingly, there are 6 returns series—those for BSE Energy, FMCG, TECK, and Telecom; and NSE Pharma and Realty—that appear to be antipersistent. This is the only evidence of antipersistence observed in the study, and is suggested by the R/L method; the finding is not supported by either the Wavelets or the R/S methods. Chamoli et al (2007), who test for the relative effectiveness of the Wavelets, R/S, and R/L techniques (in addition to the Power Spectrum and Variogram methods) in estimating the Hurst exponent, demonstrate that the Wavelets and R/S

methods provide superior estimates of H across varying lengths of synthetically generated fractional Brownian motion data with a given Hurst exponent[2]. In relation to other methods, including the R/L approach, the Wavelets and R/S methods are found to be more robust in the estimation of the Hurst exponent for time series of both long as well as short length. In light of this, and as there is a large variation in the data length across the 30 series considered here (from 764 to 5397), we are inclined to discount the finding of antipersistence which is suggested solely by the R/L method.

Further, there is some inconsistency in the results for the BSE and NSE Realty indices; R/S analysis suggests that the NSE Realty index does not exhibit long-range dependence, but that the BSE Realty index does. This discrepancy is likely due to the fact that the BSE Realty series covers a period of time that is roughly three times the period covered by the corresponding NSE series. It includes the period of the real estate crash of 2008, while the NSE series begins only in 2014, rendering the two series quite different qualitatively.

In summary, the conclusion of long-memory is consistently supported by all three methods for as many as 15 of the 30 sectoral indices on the BSE and NSE. In addition, some evidence of antipersistence is found for 6 returns series, though this finding is not supported by the Wavelets and R/S methods. The results of this study point to the existence of significant pockets of pricing inefficiency in the Indian market; there is evidence of exploitable opportunities in several sectors in addition to the IT and Realty sectors considered by previous studies of long memory in the Indian context. Trading strategies aimed at extracting excess returns may be effective in as many as half of the sectors studied.

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THE SHORT-TERM EFFECT OF PRE IPO EARNINGS MANAGEMENT ON POST IPO OWNERSHIP STRUCTURE

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ABSTRACT

The purpose of this study is to investigate whether IPO firms engage in earnings management before IPO to increase institutional ownerships after IPO. Using a sample of 302 IPO's, we find that IPO firms with high discretionary accruals, a measure of aggressive earnings managements, have greater institutional ownerships one quarter after IPO than IPO firms with low discretionary accruals. This result holds after controlling for other influencing factors such as initial offer price, underwriter reputation, and offer fraction. This result is robust across different testing methods.

1. INTRODUCTION

Benefits from institutional ownerships to public firms have been well documented in previous studies on institutional ownerships. The benefits range from positive operational/market performance (Nofsinger & Sias (1999), and Dennis & Strickland (2002)) to higher R & D spending (Baysinger et. al. (1991)). Thus, ownership structure may be one of the most important considerations in firms' IPO decisions as suggested by Booth et. al. (1996), and Mello et. al. (1998).

One possible way to attract institutional investors at IPO is to offer high asking prices because institutional investors avoid investing in low-price stocks, which is evidenced in Falkenstein (1996) and Gompers and Metrick (2001). On the other hand, many studies on earnings managements by IPO firms find that IPO firms engage in aggressive earnings managements (i.e., income-increasing activities) before IPO in order to increase the offer price (e.g. Schipper (1989); Chaney and Lewis (1995); Teoh et al. (1998a & 1998b); Ducharme et al. (2001)). Therefore, there may be a linkage between earnings managements before IPO and presence of institutional investors after IPO, which may not last long due to the market efficiency.

The purpose of this study is to investigate the above-addressed linkage between pre IPO earnings managements and post IPO institutional ownerships over short term. It is hypothesized that IPO firms with aggressive earnings managements have greater institutional ownerships over a short time period after IPO's than IPO firms without aggressive earnings managements do.

The remainder of this paper is organized as follows. First, a hypothesis is developed through a review of previous literatures and logical reasoning. Then, sample selection and measurement of variables are described. The empirical tests and their results are followed. In the final section, conclusions are addressed

2. HYPOTHESIS DEVELOPMENT

Benefits of institutional ownerships to public firms are diverse. For example, the institutional ownership is positively related to the benefits of policing firms (Clyde 1997). Stoughton & Zechner (1998) and Sun et. al. (2008) suggest that institutional investors may provide the monitoring function to improve IPO firms' performance after IPO's. Field and Lowry (2009) find that IPO's with greater institutional ownerships outperform those with smaller institutional ownerships. But institutional ownerships vary across firm and offer characteristics such as underwriter reputation, offer size, earnings, firm age, and involvement of venture capitalists. Baysinger et al. (1991) find that the institutional ownership has positive impact on corporate R&D spending. Moreover, higher institutional ownership can avoid higher transaction cost imposed by individual investors (McInish and Wood (1992)). IPO firms with more institutional investors experience lower mortality rates than the others (Fernando et al. (2004)). Ke and Ramalingegowda (2005) provide evidence that transient institutional investors (i.e., those actively trading to maximize short term profits) trade to exploit the post-earnings announcement drift and hence improve the market efficiency.

Because of these benefits associated with institutional ownership, IPO firms may have strong incentives to attract institutional investors at IPO's. And hence a strong presence of institutional investors after IPO would be an important consideration in the firm's decision on selection of offer prices at IPO. To attract more institutional investors, IPO firms would select the highest offer price amongst available because institutional investors tend to avoid lower-priced stocks and invest more in higher-priced stocks (Falkenstein (1996) and Gompers and Metrick (2001)). Fernando et al. (2004) find empirical results supporting this argument: i.e., they find that post-IPO institutional ownership increases monotonically with the chosen IPO price level.

Two possible ways to increase offer prices at IPO are readily available to IPO firms. The first is to reduce the number of shares outstanding through acquisitions of treasury stocks and/or reverse stock splits. The other way is to adopt aggressive earning managements that increase earnings, which, in turn, increase the offer price. But the aggressive earnings management can be an effective means of increasing offer prices only if there is a significant information asymmetry between stock issuing firms and investors. It is because intelligent and sophisticate investors like institutional investors would not be fooled by inflated earnings by IPO firms if and when they have a full access to information about IPO firms as IPO firms do. In fact, there is significant information asymmetry between IPO firms and investors at IPO's because IPO firms are private before IPO and hence there is not sufficient information about the firms available to general investment public until after IPO's. Quite a few studies on IPO find that IPO firms do engage in earnings managements before IPO's to take advantage of this information asymmetry. Chaney & Lewis (1995) show that earnings management affects firm value when value-maximizing managers and investors are asymmetrically informed. Teoh et. al. (1998) also suggest that IPO firms opportunistically inflate earnings to influence the offer price. Friedlan (1994) show that IPO firms make income-increasing discretionary accruals in financial statements released before IPO to affect offer prices because financial statement information is useful in valuing IPO shares without existence of market-determined prices for IPO shares until after IPO. Even established public firms do manage earnings aggressively to push up their offer prices, thereby leading to decease in the degree of under-pricing (Kim and Park (2005)).

Thus, IPO firms may engage in aggressive earnings management to increase offer prices and hence increase institutional ownerships because it is doable and beneficial to IPO firms. But it is open question whether the increased institutional ownerships by aggressive earnings managements will sustain over long term. Since the information asymmetry between IPO firms and investors/shareholders will eventually disappear over long term period after IPO's, market prices of IPO shares and hence the institutional ownership may decrease over long term as results of market corrections for inflated earnings by aggressive earnings managements. On the other hand, the institutional ownerships could increase if the IPO firms' performance improves by quality monitoring services rendered by institutional investors after IPO's, which usually takes a long time period to happen. Therefore, a testable hypothesis would be

Hypothesis*: IPO firms with more aggressive earnings managements before IPO's have greater institutional ownerships over a short time period after IPO's than IPO firms with less aggressive earnings managements do.*

3. SAMPLE SELECTION AND DATA

Our initial sample of IPO issuers are obtained from the IPO database of Hoovers Incorporated. The sample period extends from April 1997 to December 2002. Several selection criteria are applied sequentially. First, financial institutions and utility firms are excluded because they are in regulated industries and hence usually have different behaviors than unregulated firms do. Also, the sample excludes ADRs because ADRs are subject not only to US regulations but also to regulations of foreign country where their base stocks are listed and traded. Firms with offer price less than one dollar (penny stocks) and firms with offer size less than one million dollars are excluded. It is because institutional investors, in general, do not invest in penny stocks and small offers. Finally, relevant data availability in COMPUSTAT data files over the period of six years surrounding each IPO (i.e., t= [-2, 0, 3]) is required. These selection criteria yield the initial sample of 302 IPO issuers.

4. MEASUREMENTS OF VARIABLES

The earnings management is measured by discretionary accruals which are differences between total accruals and the expected benchmark accruals (nondiscretionary accruals). The nondiscretionary accruals are industry wide accruals, varying across firm and industry characteristics, while discretionary accruals are firm specific accruals. Cross-sectional modified Jones model was used to estimate discretionary accruals of each IPO firm (Jones, 1991; Dechow et al., 1995; Teoh et al., 1998a).[1]

[1] Cross-sectional method is used because a time series approach is not possible for IPO's. The cross-sectional approach has an additional advantage in that it incorporates changes in accruals resulting from changes in economic conditions for the industry as a whole. Since the cross-sectional regression is re-estimated each year, any changes in economic conditions affecting expected accruals in a particular year are filtered out. Moreover, the common practice by underwriters of comparing market prices and financial information of similar firms for pricing IPO shares also evidence the importance of controlling for the effect of industry-wide economic conditions on accruals to get discretionary accruals of individual firms.

For each IPO firm, we use at least ten industry-matched firms with the same three-digit SIC code. If we are unable to find ten industry-matched firms with the same three-digit SIC code, we use industry-matched firms with the same two-digit SIC code. For each IPO firm j, we run the following cross-sectional regression model:

$$TAC_{iy}/TA_{iy-1} = \alpha_{0j}[1/ TA_{iy-1}]+ \alpha_{1j}[(\Delta REV_{iy} - \Delta REC_{iy})/ TA_{iy-1}]+ \alpha_{2j}[PPE_{iy}/ TA_{iy-1}]+\varepsilon_{iy} \quad (1)$$

Where,

TAC_{iy} = total accruals (net income before extraordinary items minus cash flow from operations) in year y for the i^{th} firm in the industry group matched with offering firm j.

TA_{iy} = total assets in year y for the i^{th} firm in the industry group matched with offering firm j.

ΔREV_{iy} = change in revenues in year y for the i^{th} firm in the industry group matched with offering firm j.

ΔREC_{iy} = change in accounts receivable in year y for the i^{th} firm in the industry group matched with offering firm j.

PPE_{iy} = property, plant, and equipment in year y for the i^{th} firm in the industry group matched with offering firm j.

Using estimated coefficients from regression model (1), discretionary accruals (DAC) for the issuing firm j in year y are then estimated by subtracting nondiscretionary accruals (NAC) from total accruals (TAC) as follows:

$$DAC_{jy} = TAC_{jy} - NAC_{jy}$$

$$= [TAC_{jy}/TA_{jy-1}] - \alpha_{0j}[1/ TA_{jy-1}] - \alpha_{1j}[(\Delta REV_{jy} - \Delta REC_{jy})/ TA_{jy-1}]$$

$$- \alpha_{2j}[PPE_{jy}/ TA_{jy-1}]$$

The institutional ownership data are obtained from the 13F filings reported in the database of Thomson One Banker. We measure institutional ownership by 'the percentage of shares owned by all institutional investors' at the end of first quarter after IPO.[2]

Other variables that are proven to affect institutional ownerships are offer price, offer fraction, and underwriter reputation (see Fernando et. al. (2004) and Field & Lowry (2009)). These variables are used in sample description and regression analyses as control variables. Theses variables are measured as follows:

Offer price (OPRC): initial price at which shares were offered at IPO.

Offer fraction (OFRC): the number of shares offered as a fraction of total number of shares outstanding.

Underwriter Reputation (UWRP): underwriter reputation based on the rankings of Carter and Manaster (1990), and updated according to the information in Jay Ritter's website.

[2] We also used 'the number of institutional owners' as an additional measure of institutional ownership. The results are basically the same.

Table 1 presents descriptive statistics for the above-addressed variables. On average, the IPO firms have about $879 million in market value after IPO's. Mean (median) value of offer price is $14.77 ($14.00), while mean (median) value of institutional ownerships after IPO's is 25.60% (21.00%). Mean (median) of offer fraction is 29.82% (median of 24.35%). The sample firms appear to choose highly reputed underwriters with mean (median) rank of 8.15 (9.10) out of 10 point scale. Discretionary accruals (DAC), the measure of earnings management, has mean value of -0.128 and median of -0.057.

<Table 1> Descriptive Statistics for Selected Variables

Variables	Mean	Standard Deviation	Percentiles				
			5%	25%	50%	75%	95%
Offer price ($)	14.77	7.37	7.00	11.00	14.00	17.50	24.00
Offer fraction (%)	29.82	20.49	10.51	17.62	24.35	33.33	100.00
Underwriter Reputation	8.15	1.51	5.10	8.10	9.10	9.10	9.10
Institutional Ownership (%)	25.60	18.50	5.00	13.00	21.00	32.00	69.00
Discretionary Accruals	-0.128	0.321	-0.545	-0.251	-0.057	0.056	0.223

Offer price (OPRC): initial price at which shares were offered at IPO.
Offer fraction (OFRC): the number of shares offered as a fraction of total number of shares outstanding.
Underwriter Reputation (UWRP): underwriter reputation based on the rankings of Carter and Manaster (1990), and updated according to the information in Jay Ritter's website.
Institutional ownership (INOS): percentage of shares owned by all institutional investors after IPO.
Discretionary accruals (DAC): difference between total accruals and nondiscretionary accruals

5. EMPIRICAL TESTS AND RESULTS

5.1 Univariate Test

If the discretionary accrual of an IPO firm is in top, middle, or bottom one-third of the distribution of the sample firms' discretionary accruals, the IPO firm is assigned to high-, medium-, or low-earnings management group, respectively. The potential effect of earnings management on post-IPO institutional ownership is, then, examined by comparing institutional ownerships across these three groups.

Comparisons of institutional ownerships across three levels of earnings managements (high, medium and low) at the end of the first quarter after IPO's along with the corresponding test statistics and p-values are presented in Table 2. Mean (median) institutional ownerships are 28.6% (24%), 25.8% (23%) and 22.3% (18%) for the high-, medium-, and low-earnings management

group, respectively. This indicates that more aggressive earnings management is related to higher post-IPO institutional ownership. For overall comparison, Kruskal-Wallis χ^2 statistic of 6.335 indicates that there are statistically significant differences in institutional ownerships across earnings management levels ($\alpha<0.05$).

Pair-wise comparisons along with the corresponding Wilcoxon z-statistics for pair-wise comparisons along with the corresponding p-values shown in Table 2 suggest that IPO firms in the high-earnings management group have greater institutional ownerships than those in the low-earnings managements (24% vs. 18%). And the difference is statistically significant ($\alpha<0.05$). Also, a statistically significant difference in institutional ownerships also exists between medium- and low- earnings management groups ($\alpha<0.05$). However, there is no statistically significant difference in institutional ownerships between high- and medium-earnings management groups. In short, post-IPO institutional ownerships of IPO firms in the high- and medium-earnings management groups are significantly greater than those of IPO firms in the low earnings management. Since discretionary accruals are measures of aggressive earnings managements, these results support our hypothesis that IPO firms with more aggressive earnings managements before IPO's have greater institutional ownerships after IPO's than the firms with less aggressive earnings managements do.

.

<Table 2> Comparisons of Post-IPO Institutional Ownership Across Earnings Management Levels

Pre-IPO Earnings Management (DAC)	Mean	Std Dev	Min	25%	50%	75%	Max
High	0.286	0.205	0.030	0.130	0.240	0.340	0.900
Medium	0.258	0.171	0.010	0.130	0.230	0.320	1.000
Low	0.223	0.173	0.000	0.140	0.180	0.260	0.980
Overall Comparison: Kruskal-Wallis χ^2 statistic (p-value)	6.335 (0.042)**						
Pairwise Comparison: Wilcoxon z-statistic (p-value)	High vs. Medium		Medium vs. Low		High vs. Low		
	0.595 (0.276)		1.999(0.046)**		2.285 (0.022)**		

1. Sample firms were classified into three groups (High, Medium and Low), based on the magnitude of discretionary accruals (DAC).
2. Institutional ownership is defined as the percentage of shares owned by all institutions at the end of first quarter after IPO.
3. ***: Significant at $\alpha<0.01$; **: Significant at $\alpha<0.05$; *: Significant at $\alpha<0.10$; Two-tail tests;

5.2 Regression Analyses

Results from the univariate tests ignore potential effects of other variables on institutional ownerships. Fernando et. al. (2004) and Field & Lowry (2009) argue and provide empirical evidence that institutional investments in IPO's are influenced by characteristics of the offer and IPO firms. These factors include offer price, underwriter reputation, and offer fraction. Positive relations between post-IPO institutional ownerships and each of these variables are expected because of the following reasons. Since institutional investors, in general, have stronger working

relationships with high reputation underwriters than with low reputation underwriters for investments in and monitoring of their investee firms, it is more likely that institutional investors invest in IPO firms through high reputation underwriters than through low reputation underwriters, which leads to a positive relationship between institutional ownerships and underwriter reputations. Because institutional investors tend to avoid investments in low price stocks (Falkenstein (1996) and Gompers and Metrick (2001)), it is highly likely that institutional investors invest more in IPO firms with high offer prices than they do in IPO firms with low offer prices, which again leads to a positive relationship between institutional ownerships and offer prices. Institutional investors may invest more in IPO firms with high offer fractions than in IPO firms with low offer fractions, because institutional investors may prefer investments in IPO firms where they can exercise significant influence over the IPO firms' decisions. And they have capacity to do so, while most individual investors may not. Thus, it is reasonable to expect a positive relationship between institutional ownerships and offer fractions, a measure of ownership percentage offered at IPO's.

Table 3 shows Pearson correlation (Panel A) and Spearman rank correlation (Panel B) among these variables. As expected, post-IPO institutional ownerships have significantly positive correlations with offer price, underwriter reputation, and offer fraction. More importantly, correlation coefficient between post-IPO institutional ownerships (INOS) and the degree of pre-IPO earnings management (EMGT) are 0.147 from Pearson correlation and 0.106 from Spearman correlation, which are statistically significant at $\alpha<0.05$ and $\alpha<0.10$, respectively. The correlation coefficients among some independent variables presented in Table 3 are statistically significant but their values are less than 0.4. According to Judge et. al. (1980), any correlation coefficient between independent variables below 0.8 is not likely to present a serious multi-collinearity problem in interpreting regression coefficients. Since the highest correlation coefficient among determining variables of institutional ownership is 0.375, it may not be necessary to exercise extra efforts to control for the potential multi-collinearity problems among independent variables in this study.[3]

[3] We also conducted the procedures suggested by Belsley, Kuh and Welsch (1980) to detect any severe collinearity among variables. The diagnostics result indicates that there is no significant multi-collinearity problem.

<Table 3> Correlation among Variables

Panel A: Pearson Correlation

	INOS	EMGT	OPRC	UWRP	OFRC
INOS	1.000	0.147**	0.186***	0.167***	0.153***
EMGT		1.000	0.082	-0.085	-0.000
OPRC			1.000	0.317***	-0.109*
UWRP				1.000	-0.172***
OFRC					1.000

Panel B: Spearman Correlation

	INOS	EMGT	OPRC	UWRP	OFRC
INOS	1.000	0.106*	0.212***	0.107*	0.333***
EMGT		1.000	0.117**	-0.022	0.033
OPRC			1.000	0.375***	-0.178***
UWRP				1.000	-0.331***
OFRC					1.000

OPRC (Offer Price): initial price at which shares were offered at IPO.
OFRC (Offer Fraction): the number of shares offered as a fraction of total number of shares outstanding after IPO.
UWRP (Underwriter Reputation): underwriter reputation based on the rankings of Carter and Manaster (1990), and updated according to the information in Jay Ritter's website.
INOS (Institutional ownership): percentage of shares owned by all institutional investors after IPO.
EMGT (Earnings Management): Degree of aggressive earnings management measured by discretionary accruals.
***: Significant at $\alpha<0.01$; **: significant at $\alpha<0.05$; *: significant at $\alpha<0.10$;

Effects of offer price, underwriter reputation, and offer fraction on institutional ownerships are examined, again, using the following single regressions.

$$INOS_i = \beta_0 + \beta_1 OPRC_i + \varepsilon \quad (1)$$

$$INOS_i = \beta_0 + \beta_1 UWRP_i + \varepsilon \quad (2)$$

$$INOS_i = \beta_0 + \beta_1 OFRC_i + \varepsilon \quad (3)$$

Where
$INOS_i$ = institutional ownership, defined as the percentage of shares owned by all institutions at the end of first quarter after IPO,
$OPRC_i$ = initial offer price,
$UWRP_i$ = underwriter reputation for i^{th} firm, measured by the rankings of Carter and Manaster (1990), and updated according to the information in Jay Ritter's website,
$OFRC_i$ = offer fraction, defined as the number of shares offered divided by total number of shares outstanding after IPO.

Results from regression models (1), (2), and (3) are presented in Table 4. The regression coefficients (t-values) of OPRC, UWRP, and OFRC are 0.002 (1.68), 0.205 (2.94), and 0.138 (2.69), respectively, all of which are statistically significant. These results also indicate that offer

price, underwriter reputation, and offer fraction may affect institutional ownerships. And hence these variables need to be controlled for to measure the net effect of earnings managements on institutional ownerships.

The effect of earnings managements on institutional ownerships without controlling for the other influencing variables is investigated using the following single regression model (Model 1).

$$INOS_i = \beta_0 + \beta_1 EMGT_i + \varepsilon \quad (4)$$

Where
$INOS_i$ = institutional ownership, defined as the percentage of shares owned by all institutions at the end of first quarter after IPO,
$EMGT_i$ = discretionary accruals in year t-1 (one year before IPO).

Results from the regression model (4) are presented in Table 4. The regression coefficient (t-value) of EMGT is 0.085 (2.57), which is statistically significant at α=0.05. This indicates that degree of aggressive earnings management is significantly positively related to post-IPO institutional ownership, which is consistent with our hypothesis.

As an attempt to investigate if this result holds after controlling for the other influencing variables mentioned above, the following multiple regression model (Model 2) is estimated:

$$INOS_i = \beta_0 + \beta_1 EMGT_i + \beta_2 OPRC_i + \beta_3 UWRP_i + \beta_4 OFRC_i + \varepsilon \quad (5)$$

Where
$EMGT_i$ = discretionary accruals in year t-1 (one year before IPO),
$OPRC_i$ = initial offer price,
$UWRP_i$ = underwriter reputation for i^{th} firm, measured by the rankings of Carter and Manaster (1990), and updated according to the information in Jay Ritter's website,
$OFRC_i$ = offer fraction, defined as the number of shares offered divided by total number of shares outstanding after IPO.

Our hypothesis predicts that β_1 is positive because the IPO firms with more aggressive earnings managements are likely to attract more institutional investors over short term. Results from the regression model (5) are also presented in Table 4. The regression coefficients (the corresponding t-values) of OPRC, UWRP, and OFRC are 0.056 (1.91), 0.019 (2.49), and 0.173 (3.44), respectively. All of these coefficients are statistically significant at α=0.10, α=0.05, α=0.01, respectively, indicating that institutional ownerships are statistically positively related to offer price, underwriter reputation and offer fraction, as expected. These results are consistent with that of Fernando et al. (2004). More importantly, the regression coefficient (its corresponding t-value) of EMGT (β_1) is 0.087 (2.70), which is statistically significant α =0.01 as predicted. This result suggests that the aggressiveness of earnings managements before IPO's is positively related to post-IPO institutional ownerships over the short term period, even after controlling for the other influencing variables such as offer price, underwriter reputation, and offer fraction. This is strong evidence supporting the hypothesis.

<Table 4> Effect of Pre-IPO Earnings Management on Post-IPO Institutional Ownership: Regression Analysis

$$INOS_i = \beta_0 + \beta_1 EMGT_i + \varepsilon \quad \text{(Model 1)}$$

$$INOS_i = \beta_0 + \beta_1 OPRC_i + \varepsilon \quad \text{(Model 1)}$$

$$INOS_i = \beta_0 + \beta_1 UWRP_i + \varepsilon \quad \text{(Model 1)}$$

$$INOS_i = \beta_0 + \beta_1 OFRC_i + \varepsilon \quad \text{(Model 1)}$$

$$INOS_i = \beta_0 + \beta_1 EMGT_i + \beta_2 OPRC_i + \beta_3 UWRP_i + \beta_4 OFRC_i + \varepsilon \quad \text{(Model 2)}$$

Independent Variables	Expected Signs	Simple Regression				Multiple Regression
		Model 1				Model 2
		Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)
Intercepts		0.267 (23.50)***	0.220 (9.25)***	0.089 (1.54)	0.215 (11.53)***	-0.089 (1.14)
EMGT	+	0.085 (2.57)**				0.087 (2.70)***
OPRC	+		0.002 (1.68)*			0.056 (1.91)*
UWRP	+			0.205 (2.94)***		0.019 (2.49)**
OFRC	+				0.138 (2.69)***	0.173 (3.44)***
Adj. R^2 (%)		1.84	0.60	2.48	2.02	8.82
F-value (p-value)		6.63 (0.011)**	2.83 (0.094)*	8.65 (0.004)***	7.21 (0.008)***	8.28 (0.000)***

OPRC (Offer Price): initial price at which shares were offered at IPO.
OFRC (Offer Fraction): the number of shares offered as a fraction of total number of shares outstanding.
UWRP (Underwriter Reputation): underwriter reputation based on the rankings of Carter and Manaster (1990), and updated according to the information in Jay Ritter's website.
INOS (Institutional ownership): percentage of shares owned by all institutional investors after IPO.
EMGT (Earnings Management): Degree of aggressive earnings management measured by discretionary accruals.
***: Significant at $\alpha<0.01$; **: significant at $\alpha<0.05$; *: significant at $\alpha<0.10$.

6. CONCLUSIONS

The purpose of this study is to investigate the effect of pre-IPO earnings management on IPO issuers' post-IPO institutional ownership structure. Due to potential benefits from institutional ownerships to IPO firms, it is expected that IPO firms may adopt aggressive earnings managements to increase IPO offer prices and hence attract more institutional investors. We hypothesize that IPO firms with more aggressive earnings managements before IPO's have greater institutional ownerships over a short time period after IPO's than IPO firms with less aggressive earnings managements do.

Using a sample of 302 IPO firms, we find empirical results supporting our hypothesis. The results show that IPO firms with high level of pre-IPO discretionary accruals (i.e., a measure of aggressive earnings management) have higher institutional ownership, as measured by the percentage of shares owned by all institutional investors at the end of the first quarter after IPO. These results hold even after controlling for the other influencing variables on post-IPO institutional ownerships such as initial offer price, underwriter reputation, and offer fraction. These results are robust across different testing methods.

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