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The Effect of Supplemental Instruction on Student Performance in Principles of Economics Classes

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Abstract

We randomly assigned supplemental instructors to two out of four sections of principles of economics in the fall of 2012. We examine the effect of supplemental instruction (SI) on student exam scores controlling for instructor, major, credit hours earned, previous GPA, math SAT scores and demographic variables. We find that being in a section with SI leads to an increase in a student's exam average of approximately 2.7 percentage points ($p < .058$). Our results suggest that the positive impact of SI would be greater if more students attended SI sessions offered to them.

Introduction

Supplemental instruction (SI) is a type of peer-assisted learning which began in the United States in the late 1970s. It was originally developed in the Division of Student Affairs at the University of Missouri-Kansas City. The use of SI grew so that by the mid-90s over 500 institutions had adopted an SI program (Blanc & Martin, 1994). The basic design of most SI programs is to designate and assign undergraduate students as supplemental instructors to high-risk courses—i.e. those with a higher than average percentage of students earning a D, F or W. These courses are usually freshman or sophomore level, and the supplemental instructors are usually juniors and senior who have previously taken and mastered the course. The supplemental instructor will hold two to five weekly study sessions outside of regular class times. According to the original design of SI, attendance at SI sessions is voluntary, and the sessions are meant to focus on learning strategies to master the material (Congos & Schoeps, 1993). In other words, SI sessions are for the purpose of clarifying concepts, and teaching problem-solving skills and learning strategies. They are not meant to serve as simply a recitation or a mini-lecture. Rather, as a type of collaborative and peer-led learning, SI sessions should involve group discussion and cooperative interaction (Blach, DeBuhr and Martin, 1983). Each supplemental instructor receives training at the beginning of the semester from the institution's SI supervisor, attends class, takes notes and completes all the assignments (Hurley, Jacobs and Gilbert, 2006). There may also be additional training sessions during the course of the semester.

A variety of studies have claimed to show a number of benefits from SI. The most obvious and direct benefit is a higher course grade (Blanc et al., 1983; Burmeister et al., 1994; Congos & Schoeps, 1993; Kenney & Kallison, 1994; Lockie & Van Lanen, 1994; Lundeberg, 1990; Martin & Blanc, 1981; Wolfe, 1987). Some claim additional benefits as well, such as higher overall semester grade point averages (Blanc et al., 1983) and learning skills that can be transferred to other classes (University of Missouri-Kansas City, 2005). However, much of the evidence in support of SI is anecdotal and fails to control for other variables which affect student performance (Kochenour et al., 1997). Many studies also fail to address the sample selection bias that arises from a voluntary program. Since attendance at SI sessions is voluntary, students may be self-selecting into groups based on characteristics which are closely related to academic performance.

There are also studies which fail to find evidence that SI is effective (Schwartz, 1992; Visor, Johnson and Cole, 1992). Those studies which attempt to control for other factors use ANOVA or ANCOVA analysis (e.g. Kochenour et al., 1997). Drake (2013) conducts a simple regression without controlling for other relevant independent variables. Burnmeister et al. (1994) contrasted final course grades between SI and non-SI participants in algebra, calculus and statistics classes, using data from 45 separate institutions over 16 semesters. A simple comparison of means finds statistically significant higher course grades for SI participants in algebra and calculus, but not statistics.

Kenney and Kallison (1994) employ a methodology that is most similar to ours. Their data comes from two lecture classes in calculus taught by the same instructor at the University of Texas in the fall of 1989. Each class was divided into two discussion sections, with one section from each class receiving the SI treatment. The other two sections were standard discussion sections and formed the control group. Using multiple regression analysis, they find three statistically significant variables: high school class rank, discussion section attendance and control/treatment group membership. Thus, SI had a significant effect beyond the effect of discussion section attendance.

We also use multiple regression analysis to investigate the effectiveness of SI on student performance. We also avoid sample selection bias issues by randomly assigning which sections would have SI. However, like many other studies, they use final course letter grades. In contrast, we use exam averages which contain more granular information.

Data and Statistics

The data come from four sections of principles of economics classes taught during the fall semester of 2012 at a public, liberal arts university with an enrollment of approximately 6,000 undergraduates. Roughly eighty percent of the students are business majors taking a required class. The rest are non-business majors taking the course to fulfill a social science requirement in the core curriculum. Two separate instructors each taught two sections: each instructor taught one section with a supplemental instructor and one section with no SI. Students were unaware of the possibility of SI when they were registering for classes. Two SI sections were randomly selected after students registered and the classes were full. In fact, even the instructors were unaware of which sections would have SI at the time of registration. All of the data for the independent variables was obtained from the office of institutional research which is responsible for university records. IRB approval was obtained to collect and use student data for the study. All students signed a consent form for the use of their anonymous data.

We test the following relationship:

$$SCORE_i = \beta_0 + \beta_1 SI_i + \beta_2 SEX_i + \beta_3 INSTR_i + \beta_4 RACE_i + \beta_5 BUS_i + \beta_6 HRS_i + \beta_7 GPA_i + \beta_8 SATM_i + \mu \qquad (1)$$

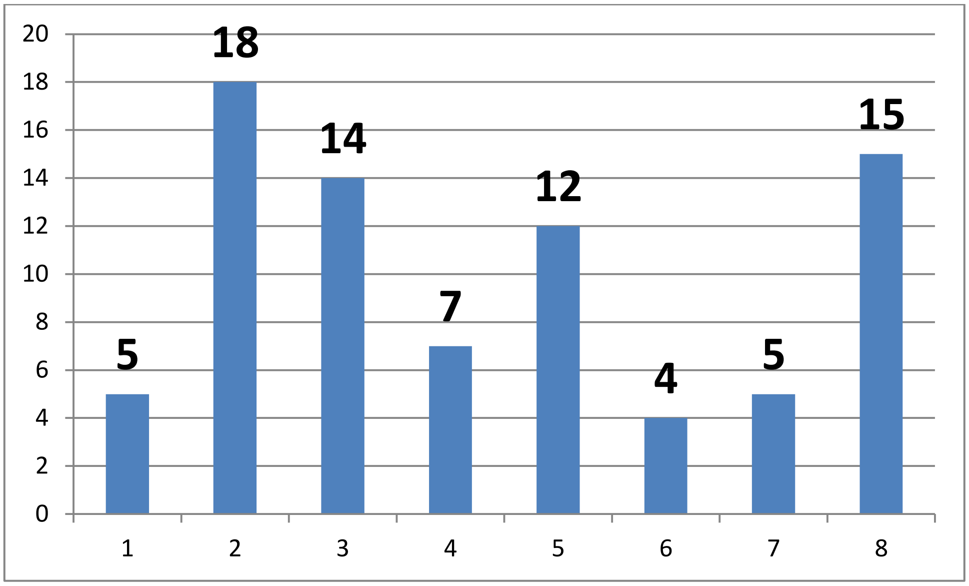
SCORE is the semester exam average for each student expressed in decimal form. SI, SEX, RACE and BUS are indicator variables with a value of one if the student is in an SI section, is female, is non-white and is a business or economics major, respectively; and zero otherwise. INSTR is another dummy variable to control for the individual instructor. This variable is picking up any characteristics specific to the instructor or the two sections taught by that instructor such as teaching style, difficulty of exams, et cetera. HRS is the earned credit hours at the beginning of the fall 2012 semester, GPA is the overall grade point average at the beginning of the fall 2012 semester and SATM is the student's SAT math score. Some students had ACT scores instead which were converted using the concordance developed by ACT's Research Division. The original sample size was 198 students. However, 16 students had no SAT or ACT score and they were dropped from the initial regression.

Table 1: Summary Statistics

Variable	***Mean***	***Median***	***Maximum***	***Minimum***	***Std. Dev.***
BUS	0.81319	1	1	0	0.39084
INSTR	0.40659	0	1	0	0.49255
GPA	2.94835	3.02	4	1.5	0.53718
HRS	46.15599	45.5	113	3	25.23824
SCORE	0.71761	0.7188	0.9563	0.2125	0.1216
SI	0.5	0.5	1	0	0.50138
SEX	0.43956	0	1	0	0.4977
RACE	0.14286	0	1	0	0.35089
SATM	566.5934	560	720	60	63.11823

Attendance at SI sessions varied across the semester, peaking before exams. Attendance was also relatively low. The table below shows SI attendance for both sections every two weeks during the semester. Thus "1" indicates the first two-week period of the semester, while "8" indicates the eighth and last two-week period of the semester.

Figure 1: SI Session Attendance



Results

As expected GPA and SATM are both highly significant ($p < .01$), but most interestingly, SI is also significant ($p < .058$) with a coefficient of approximately 0.0267. This means enrollment in an SI section will increase the average student's total exam score by approximately 2.67 percentage points. For example, they would earn an exam average of 77.67% instead of a 75%. Recall that attendance at SI sessions is voluntary; so many students who are enrolled in an SI section may rarely or never attend an SI session. Controlling for attendance could potentially introduce an endogeneity bias since those who are more likely to attend may possess characteristics which influence performance on exams. Another potential problem could be students in the non-SI sections attending SI sessions. We are confident that this was a rare occurrence. Both instructors were careful to discuss SI sessions with only the sections that were assigned a supplemental instructor. Students in the non-SI sections who asked about SI were told that the sessions were not available to them. The supplemental instructors themselves reported that only two or three students from non-SI sections attended the sessions during the semester. To the extent that this did occur, it would understate the positive effect of SI since this would potentially improve the student outcomes of the non-SI sections.

Table 2: Regression 1

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
SI	0.026652	0.013947	1.910942	0.0577
INSTR	-0.001583	0.014739	-0.107390	0.9146
SEX	-0.010413	0.015181	-0.685953	0.4937
RACE	-0.004426	0.020556	-0.215325	0.8298
HRS	0.000364	0.000292	1.246027	0.2144
GPA	0.128023	0.013572	9.433137	0.0000
BUS	0.017921	0.018789	0.953821	0.3415
SATM	0.000412	0.000123	3.344307	0.0010
C	0.067760	0.081901	0.827341	0.4092
R-squared	0.441027			
Adjusted R-squared	0.415179			
F-statistic	17.06205			
Prob(F-statistic)	0.000000			

We now consider another regression model. To test the robustness of these results and to increase the sample size, we include those students who had no SAT or ACT math scores. We enter a zero for their score and include a dummy variable for the absence of such a score. MISSING has a value of one if there is no SAT or ACT score. This model has one more variable but 16 more observations.

$$SCORE = \beta_0 + \beta_1 SI + \beta_2 SEX + \beta_3 INSTR + \beta_4 RACE + \beta_5 BUS + \beta_6 HRS + \beta_7 GPA + \beta_8 SATM + \beta_8 MISSING + \mu \quad (2)$$

We get similar results: GPA, SATM and SI are still significant, but the SI coefficient is now approximately 0.0249 ($p < .062$). Overall, these results are very close to the prior estimate.

Table 3: Regression 2

Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
SI	0.024930	0.013263	1.879653	0.0617
INSTR	-0.005385	0.013985	-0.385037	0.7006
SEX	-0.003190	0.014591	-0.218611	0.8272
RACE	-0.001020	0.019107	-0.053381	0.9575
HRS	0.000306	0.000272	1.123184	0.2628
GPA	0.124586	0.013112	9.501515	0.0000
BUS	0.015420	0.018474	0.834724	0.4049
SATM	0.000426	0.000121	3.515076	0.0006
MISSING	0.151016	0.071231	2.120106	0.0353
C	0.073813	0.079919	0.923598	0.3569
R-squared	0.461656			
Adjusted R-squared	0.435884			
F-statistic	17.91323			
Prob(F-statistic)	0.000000			

Conclusion

We find that enrolling in a section of principles of economics that has supplemental instruction has a significantly positive impact on student performance as measured by course exam average. We control for demographic variables and relevant predictors of course performance such as grade point average and SAT math score. We avoid potential sample selection bias by randomly assigning SI to two out of four sections. Another possible variable to include would be attendance at SI sessions. However, this would potentially introduce sample selection bias.

It should also be noted that there was a lower proportion of students earning a D, F or W in the SI sections than the non-SI sections. The percentage of students with a D, F or W in the SI sections was 24.76%, while the corresponding percentage in the non-SI sections was 35.85%.

Although we do find that the SI program does have a benefit on student performance, we must also consider the cost of such a program. Supplemental instructors are paid, and the SI supervisor is usually a paid staff position. For example, at one university the supplemental instructors are paid $8 an hour for a maximum of eighteen hours per two-weeks. The SI supervisor may also have other administrative duties such as supervising the student learning center, so only part of this salary should be counted as a cost of SI. However, the SI supervisor may also have staff or graduate assistant support which should be counted toward program costs. These labor costs, as well as other resource costs might be used for other programs that could yield a larger benefit. For example, how do the benefits of SI compare to those of using small discussion or recitation sections in conjunction with a large lecture class? This is an important policy question that has been largely ignored. On the other hand, the benefits of SI could increase if more students participated. The marginal improvement in exam score is impressive when considering the relatively low attendance at SI sessions. Perhaps universities with SI programs could focus on finding effective ways to encourage more student participation—perhaps by publicizing the tangible increase in student performance.

Acknowledgment

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Keynes and Friedman Prescriptions and Performance: A Look at Fiscal & Monetary Policy Effects Since 1976

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Abstract

The last decade has seen the renewal of the arguments between Keynesians and Monetarists regarding money, interest rates, and government intervention in the economy. Examination of the nominal data suggests that the theoretical relationships behave as expected. However, first differencing of the data frequently results in contradictory relationships. These observations suggest that the current problems of the US economy reflect a failure of fiscal and monetary policy to correct the imbalances that created the financial market meltdowns. The effects of policy changes and expected outcomes reflect to some extent the personalities at the Federal Reserve and in the Executive branch of the government.

Introduction

My motive for selecting this particular topic is the recent intense coverage in the media given to fiscal and monetary (Fed) policy. Given that so many theories are being questioned, my sense was that this was a good a time to me to see what the data has to say. The best thing you can say about "data" is that it has no duty to follow one theory or the other. The data is simply casting the shadows for us to interpret using statistical tools. The consequences of selecting this particular research topic required me to revisit much of what I thought I learned in my various classes in economics from undergraduate to graduate level courses. As an undergraduate, I was fairly convinced by Keynes' arguments regarding the role of government in righting an economy in trouble. By the time I finished my MBA, I was leaning to the monetarist point of view. I did not believe that money was the root of all evil, but I definitely believed that it was not neutral. From an individual point of view, money mattered. My experiences and observations in the post-doctoral years continued to suggest that the arguments for the best prescriptions for an ailing economy seem to rest partly on myth and legend. Finally, in the last few years, there appeared what has been termed the new economic consensus (NEC). The NEC reflects the increasing recognition that the Keynesian prescriptions for stimulating economic activity and reducing unemployment no longer seem to work. There is an increasing sense that lower tax rates and decreased government spending are seen to produce more robust results.

The observations to be discussed later in this paper suggest strongly that forces are at play that cannot be *dominated* or *controlled* by fiscal or monetary policy. There are some relatively short periods when the ongoing applications of fiscal or monetary "fixes" result in outcomes counter to what the "theory" suggests. With these preliminary admissions in mind, the remainder of this paper is as follows. The literature review will be relatively cursory. A whole encyclopedia could be filled with the millions of words and thousands of articles, tracts, and treatises that have been written on these topics. Moreover, there is no shortage of economics-related web sites with short treatises on the topics of Keynesianism, Neo Keynesianism, and Monetarism.

The data and method of analysis section is relatively simple. All of the data was obtained from the FRED data bases maintained by the St. Louis Federal Reserve Bank. Accordingly, my results should be replicable by other researchers. I do not engage in data mining to find intricate patterns although that is not to say that they do not exist. The question at hand is whether or not they *persist* over time. And while consistency may be the hobgoblin of small minds, it is ever the objective of the policy makers and their advisors. Everyone is familiar with the quaint rostrum that "*insanity is doing the same thing over and over again and expecting different results*." It would seem at the very least a description of the popular rostrums that continue to be put forward to solve one of the most difficult economic periods since the Great Depression.

The results section is really the heart of this paper. There are a number of findings or observations regarding theory and reality. I use a number of graphs to illustrate what tables of statistical results cannot even begin to describe. Some look like the random scrawling's of someone under the influence. That economic data meanders so nonlinearly was a startling observation. With some reasonable exceptions we mostly accept that things operate in linear fashion. An x% increase in the supply of money should give us a y% change in output and income within plus or minus some reasonable level of variation. By implication, we live in a world of *cause* and *effect*. We have become too inured in expecting outcomes within plus or minus two standard deviations of a computed mean.

Literature Review

The literature on Fiscal and Monetary theory and policy is very extensive. However, some themes remain fairly consistent. On the Fiscal side, there is the New Economic Consensus (NEC) which is the Post-Keynesian face of the argument for restoring a role for Fiscal policy. Tcherneva (2008) observes that the Post-Keynesians have renewed their call for reinstating fiscal policy as the main tool for macroeconomic coordination. In particular they see the principal objective of fiscal policy initiatives as achieving full employment. They also advocate Abba Lerner's *functional finance* that uses tax policy to control consumption, government borrowing and lending to control interest rates, investment and inflation. In addition, they believe "the government should print, hoard or destroy money" (Lerner, 1943, pp. 41) as necessary to achieve its goals. The NEC also recognizes that fiscal policy is inherently inflationary. Fontana (2007) suggests that money matters and describes that an important objective for central banks is to bring the loan rate to its natural level.

On the Monetary side, Jefferson (1997) suggests that monetary affects must recognize the distinction between *inside* and *outside* money. Outside money consists of the various components of the M2 money measures that are assets of the private sector. Inside money consists of portions of the money stock that are simultaneously and asset and a liability of the private sector. Motolese (2003) suggests that money is generically non-neutral. He supports this view by observing that "… nominal process and real output change in response to changes in the exogenous growth rate of money." (Motolese, 2003, p317) Leeper and Roush (2003) also call for a reemphasis of the role of money. They observe that the way money is modelled significantly affects measures of changes in output and inflation following changes in the money supply. Leeper and Roush identify two puzzles: Liquidity and Price. The liquidity puzzle arises when monetary disturbances fail to achieve the negative short-term correlations effects that should prevail between changes in the money supply and interest rates. The price puzzle arises when higher interest rates are interpreted as tighter monetary policy but are followed by higher prices for some period of time after the disturbance. Friedman (1959) observes that velocity changes are as important as changes in the stock of money. Moreover, he expects that monetary policy operates most directly on investment and income through changes in the money stock rather than changes in the rate of interest.

Three central issues are explored in this paper. First, how does the money supply relate to Gross Domestic Product (GDP)? Second, how do unemployment rates (UnRate) relate to Gross Federal Government Debt (GFD)? Third, how does the price level, as implicit in the Consumer Price Index for All Urban Consumers (CPIU), relate to the money supply? These are all issues central to the arguments between Monetarists and Keynesians.[1]

The fundamental disagreement between Keynesians and Monetarists devolves from one issue: How does a [national] economy recover from periods of economic weakness ostensibly brought about by a lack of [private] demand. Keynesians believe that a higher level of government spending (public demand) is required in order to speed up economic recoveries. Monetarists believe that controlling the money supply (and interest rates) are the keys to promoting economic growth and containing inflation. In particular, Monetarists call for an increase in the money supply to lower interest rates and spur capital investment. The objective of both policies is to increase economic output, employment, and national income; Keynesians through government intervention and Monetarists through [steady or policy-fixed] increases in the money supply. Keynes also believed in a monetary stimulus; an initial injection into the money supply to lead to an increase in real GDP.

Keynesians emphasize the role fiscal policy can play in stabilizing the economy. In particular Keynesian policy prescriptions suggest that higher government spending in a recession can help the economy recover quicker. Government intervention can stimulate aggregate demand and real output through government borrowing and increased [deficit] spending. Keynesians say it is a mistake to wait for markets to clear like classical economic theory suggests. Monetarists emphasize the importance of controlling the money supply to control inflation. Friedman, a dominant proponent of Monetary Policy, suggests that the aim of a central bank (like the Fed) is to keep the supply of and demand for money in equilibrium as measured by growth in productivity and consumer demand for goods.

Keynes observed, among other things, that the rate of interest determined the *speculative* demand for money. We ought to remind ourselves that Keynes was a speculator in currencies, commodities and later in equities. It is probable that at least some of his insights on the role of interest rates and liquidity preferences were based on personal experience. The speculative demand has as its underpinning the desire for profit. If interest rates rise, bond prices will fall leading to capital losses; a situation to be avoided. If the expectation is that rates will continue to rise for some length of time, the demand for cash balances (liquidity) should rise. If, on the other hand, interest rates are expected to fall, the prices of long-term bonds will increase leading to a capital gains. This should, in the short run, result in a decrease in demand for cash (reduction in liquid assets) as cash balances are converted in bond investments.

Monetarists look at the liquidity issue from a different perspective. It is the supply of money (rather than Keynesian demand for liquidity) that is the primary determinant of nominal GDP and price levels. Unlike Keynes, Friedman believes the economy to be inherently stable and works best when left alone (Laissez faire). Moreover, government intervention will more often destabilize things more than they help.

One final comment on deficit spending is in order. In one of the several periods of surfing the web in search of contemporary comments on Keynes and Friedman, a little mentioned theory came to light, namely *Chartalism*. Chartalism is a theory that emphasizes the relationship between government policy activities and the value of [paper] money. A German economist, Georg Friedrich Knapp, develop this theory near the end of the 19th century. There are two important notions implicit in Knapp's theory. The first notion is that it is impossible for a sovereign government to go bankrupt. The reason is that the government can print money to settle its debts. The second is that fiat money receives it value from the fact that the government accepts the [printed] paper in payment of tax obligations. Knapp's view of fiat currency is in sharp contrast to the then popular view of metallism; money as a commodity (gold or silver) with intrinsic value that makes it widely accepted as a medium of exchange. It is of interest to note that a number of economists, most notably Nobel laureate Paul Krugman, have suggested that debt does not matter. Could it be that Chartalism is seeing a de facto rebirth? Knapp died in 1926, just short of his 78th birthday. It is likely that he witnessed the Weimar Republic's hyperinflation between June 1921 and January 1924. Much if not all of the hyperinflation caused by printing of money to settle portions of the reparations forced upon Germany by the allies after World War I.

Data and Methodology

The data sets utilized in this study were largely obtained from the FRED database maintained by the Federal Reserve Bank of St Louis, Missouri. Two issues immediately arise concerning some of the data. Gross Domestic Product (GDP) is reported quarterly and in seasonally adjusted form. Most of the other FRED data is available in monthly values and in seasonally and non-seasonally adjusted forms. It seemed a much better idea to have 12 data points per year rather than 4. Accordingly, a monthly series of GDP was generated. The simple assumption used to create the monthly is that the percentage rate of quarterly change can be recalculated to a monthly rate ($Rate_m$). See Equation (1):

$$Rate_m = \left(\frac{GDP_t}{GDP_{t-1}}\right)^{\frac{1}{3}} - 1 \tag{1}$$

This process was repeated for each pair of adjacent quarterly returns. The next issue concerned the seasonal adjustments (SA) made to the series. Seasonal adjustments are made primarily to smooth out the [normal] variations in the quarter-to-quarter data; or month-to-month for data reported on a monthly basis. M1 and M2 are available in SA and NSA forms as well as the Unemployment Rate (UnRate). The differences between SA and NSA yield the seasonal adjustment factors (SAF) peculiar to each data series. A plot of the various SAFs revealed that SAF factors for M1 and M2 were quite different and varied over time. Seasonal adjustments for M1 are significantly greater in magnitude than M2: M1 SAFs run from -2% to +3% in the period from January 1976 until January 1980. After 1980 the range was steadily decreasing to -1% and +2% with peaks and values appearing almost sinusoidal. M2 SAFs by contrast ran initially between -0.6% and +0.6% and declined slightly in range until 1994. After 1994, the ranges run from -0.8% to +0.6% with peaks and valleys exhibiting the same sinusoidal wave patterns. The UnRate SAFs exhibit a similar sinusoidal wave pattern but with a significantly greater range than M1 or M2: -10% to +5% with SAFs rising on occasion to +7 or +8 percent. A consistent theme in articles reviewed suggested strong correlations between the money supply, output, and employment. A conservative (and unorthodox) approach suggests that the M2 SAFs be utilized to "deseasonalize" the monthly GDP values. A final observation on most economic data sets maintained by the Federal Reserve is that they are based on sampling and quite possibly some old fashion "Kentucky windage" estimates. Accordingly, conclusions drawn from data analysis are always subject to demurs based on the magnitude of potential errors in data points. On the other hand, it is the *trend* of the data sets that is the key to answering the questions posed in this paper.

Two forms of the data are examined: Nominal and First Difference (FD). By nominal is meant the data in its recorded form. Unhappily [time series] nominal data is subject to unit root problems. All data series were subjected to an Augmented Dickey-Fuller (ADF) unit root test and all failed. First differences, on the other hand, all passed unit root tests. All statistical analysis performed using Micro TSP 5.1.

When we move from nominal to first differenced (FD) data sets, we lose much of the strong correlations which are the principal characteristic on times series data. Table 1 contains the Nominal and First Differenced correlation coefficients for the variables of interest. Changes in sign and/or magnitude are evident. For example, nominal M2 and CPIU exhibit a strong positive correlation (0.957). The FD correlations are significantly weaker and negative (-0.158). Two of the variables (Gross Federal Debt [GFD] and Unemployment Rate [UnRate]) exhibit significantly weaker correlations as well as a change in sign for UnRate. The correlation between FD GDP and M2 remains strongly positive (0.653) although not quite as strong as the nominal data (0.981). A number of these relationships will change when lagged terms are introduced.

Table 1: Correlation Coefficients for Nominal Data (Lower Left) And First Differenced Data (Upper Right)

	CPIU	GDP	GFD	UNRATE	M2
CPIU	1	-0.009	-0.162	-0.010	-0.158
GDP	0.986	1	-0.079	-0.242	0.653
GFD	0.929	0.952	1	0.075	0.249
UNRATE	-0.122	-0.105	0.102	1	-0.114
M2	0.957	0.981	0.985	0.037	1

The FD data relationships are examined in from two perspectives. First, we seek to determine the relationship over the entire 37 years 7 months of the sample period (Long Term). Second, we examine individual presidential terms to determine if there is any significant difference between the long-term (37 plus years) and the Short Term (4 to 8 years) regression coefficients.

Money Supply (M2) and Real Gross Domestic Product (GDP)

Both Keynes and Friedman recognize the long-term relationship between the money supply and economic output as measured by [Real] GDP. The first hurdle to surmount is the question regarding the *neutrality of money*. The monetarist view is that expansion of the money supply is necessary in order to accommodate economic [GDP] growth. The Neo-Keynesian view is that the central bank in concert with Fiscal policy initiatives (the Fed in this case) must inject some liquidity to lower interest rates and spur production of [capital] goods. Accordingly, we assume, in concert with Monetarist concepts, that M2 is the "causal" variable and GDP the "effect" variable. As a check on this simplifying assumption, a Pairwise Granger Causality test is conducted. The results suggest that GDP "Granger" causes M2 and M2 "Granger" causes GDP. Both test statistics are significant at the 0.001 level.

The long run relationship between M2 and Real GDP is positive for the 37+-year period (1976:02 to 2013:07). See Equation (2). The $M2_{t-1}$ regression coefficient suggests that for each \$1 Billion increase in M2, Real GDP increases by \$478.3 million.

$$\text{Real GDP}_t = 3113.779 + 0.4783 * M2_{t-1} \tag{2}$$

If we sub-divide the M2 and Real GDP data by presidential terms (the short-run), we observe that over time, expansion of the M2 yields increasing smaller increases in Real GDP. The sample period encompasses five presidential terms; Carter (1977-1980), Reagan (1981-1988), Bush I (1989-1992), Clinton (1993-2000), Bush II (2001-2008) and the first 4.6 years of Obama (2009-2013). Table 2A displays the M2 regression coefficients by presidential term. The Carter, Reagan (at least the first 2 years), and Bush I sub-periods are most likely affect by a number of events (inflation, increased taxes and the First Gulf War). However, from Clinton to Obama we observe a steady decline in the increases in Real GDP per unit of additional M2.

Table 2A: M2 and Real GDP by Presidential Terms

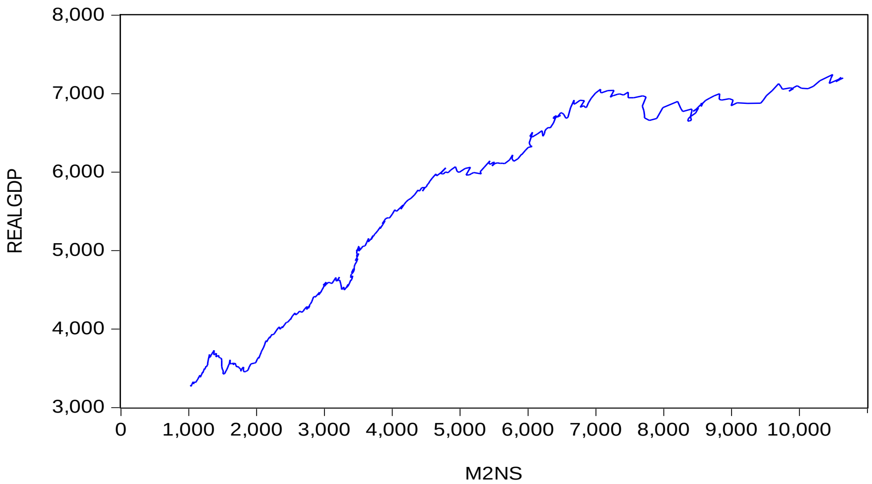
President	Intercept $^{\text{t-stat}}$	Slope $^{\text{t-stat}}$	Adj R^2
Carter	3387.596 $^{0.000}$	0.13512 $^{0.241}$	0.0086
Reagan	2123.424 $^{0.000}$	0.79796 $^{0.000}$	0.9653
Bush I	4089.804 $^{0.000}$	0.15789 $^{0.018}$	0.0982
Clinton	1907.240 $^{0.000}$	0.87599 $^{0.000}$	0.9684
Bush II	4029.558 $^{0.000}$	0.39571 $^{0.000}$	0.8127
Obama	5202.726 $^{0.000}$	0.18940 $^{0.000}$	0.8422

Table 2B is based on the observed (and verified by Chow tests) breaks in the [Exhibit 1] X-Y plot of [nominal] M2 and Real GDP (not seasonally adjusted). The M2 coefficients contained in Table 2B suggest strongly that the relationship between M2 and Real GDP appears to be breaking down. The slope coefficient declines from 1.37409 to 0.07406 for the period from 1976:02 through 1978:12 and 2006:12 through 2013:07, respectively. Careful examination of Exhibit 1 supports this view; the X-Y relation between M2 and Real GDP is almost flat after 2006:12 and is supported by the precipitous drop in the adjusted R-square to 0.2589. These results suggest that Monetary Policy, for reasons as yet not fully understood, have lost a significant amount of their effectiveness in accommodating [real] economic expansion.

Table 2B: M2 and Real GDP by Break Point Analysis (Chow Test)

Break Points	Intercept $^{t\text{-stat}}$	Slope $^{t\text{-stat}}$	Adj R^2
1976:02 to 1978:12	1831.668 $^{0.000}$	1.37409 $^{0.000}$	0.9554
1978:12 to 1982:06	4208.231 $^{0.000}$	-0.41255 $^{0.000}$	0.4733
1982:06 to 2000:04	1908.796 $^{0.000}$	0.86804 $^{0.000}$	0.9737
2000:04 to 2006:12	3555.266 $^{0.000}$	0.48166 $^{0.000}$	0.9111
2006:12 to 2013:07	6296.301 $^{0.000}$	0.07406 $^{0.000}$	0.2589

Exhibit 1**: Plot of M2 (nsa) and Real GDP (nsa)**



Unemployment Rate and Gross Federal Debt

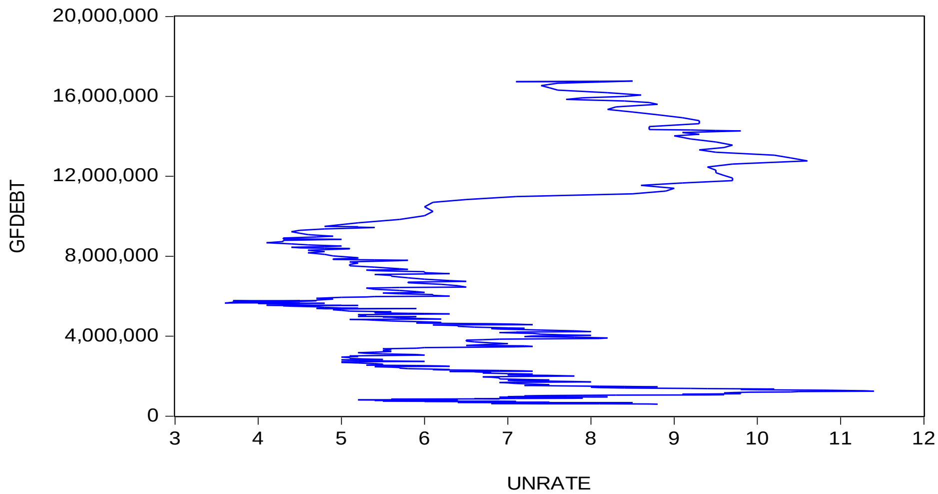
The debate between economists of all persuasions regarding the usefulness of Fiscal Policy (deficit spending) in order to lower the unemployment rate rages on unabated. The Keynesian prescription is quite simple: Increased government spending, even if it requires borrowing, in order to create demand for capital goods. That should over time increase employment and with it the increases in demand as incomes grow. Causality is readily fixed: Increased government spending follows in the wake of increases in the unemployment rate. This is verified statistically with a Granger causality test: The null hypothesis that the Unemployment Rate (UnRate) does not Granger Cause Gross Federal Debt (GFD) is rejected at the 0.0001 level. All that remains is ascertain the lag between increases in UnRate and increased spending and its effectiveness.[3]

The X-Y plot (Exhibit 2) of the Unemployment Rate (UnRate) and Gross Federal Debt (GFDEBT) reveals a series of back and forth moves against a slowly increasing GFDEBT at first (1967 to 2003) and then increasing at an increasing rate. Table 3 reveals the details of changes in GFD and changes in UnRate. Two time-periods are especially noteworthy for comparison. Between Jan 1976 and May 1979, the UnRate declined 3.6% at an inflation-adjusted cost of $82.216 Billion for each 1 percent decline. In the most recent period from Jan 2010 up to July 2013, the UnRate declined 2.9% at an inflation adjusted cost of $585.372 Billion for each 1% decline in the UnRate. The average annual rate of increase is approximately 6.54% or slightly greater than the average rate of inflation over the same period (4.74%). In between the five periods of declining UnRate are four periods of increasing UnRate accompanied by an increase in GFD. These four periods pose an interesting conundrum to the question of how effective deficit spending is in reducing unemployment. Consider the fact that unemployment rose 6.5% between October 2006 and January 2010 during which the GFD increased by $4.092 Trillion (or $629.676 Billion for each 1 increase in UnRate or $290.592 Billion in inflation-adjusted dollars.) What we cannot know with any certainty is how much of the deficits where actually reducing unemployment. The counter argument is how much does deficit spending contribute to a rise in unemployment. This Keynesian connection appears problematic.

Table 3: Gross Federal Debt (Millions) and Unemployment Rate

Period End	GFDEBT	UnRate	ΔGFDEBT	ΔUnRate	Cost / Δ 1%	Cost in 1982-1984 Dollars
Jan-76	600,490	8.8				
May-79	812,115	5.2	211,625	-3.60	-58,785	-82,216
Jan-83	1,244,493	11.4	432,378	6.20	69,738	71,307
Oct-89	2,952,994	5.0	1,708,501	-6.40	-266,953	-212,542
Feb-92	3,915,744	8.2	962,750	3.20	300,859	217,070
Oct-00	5,662,216	3.6	1,746,472	-4.60	-379,668	-218,200
Jan-03	6,460,776	6.5	798,560	2.90	275,366	151,550
Oct-06	8,680,224	4.1	2,149,666	-2.30	-934,637	-463,150
Jan-10	12,773,120	10.6	4,092,896	6.50	629,676	290,592
Jul-13	16,738,599	7.7	3,965,479	-2.90	-1,367,407	-585,372

Exhibit 2: Unemployment Rate and Gross Federal Debt



The Money Supply and Price Level over Time

The final question for this inquiry addresses the ability of the monetary authority to control increases in the money supply without fanning inflationary pressures. It is now widely accepted that some [low] level of inflation is necessary for the economy to grow. The most often heard number from statements by the Federal Reserve is around 2% per annum. We already stated that the level of inflation for the time period of this study averaged 4.74%. The data shows three periods of accelerated M2 growth and is confirmed by regression analysis: The first between 1982m08 and 1987m01 is shown in Equation (3). The all regression coefficients are significant at the 0.0000 level.

$$M2 = -3{,}539.245 + 55.887 * CPIU \tag{3}$$

The second period of accelerated M2 growth begins after 1995m05 and runs until 2008m04. See Equation (4). All regression estimates are significant at the 0.0000 level.

$$M2 = -7{,}354.029 + 71.1655 * CPIU \tag{4}$$

The third period runs from 2008m04 until 2013m07. See Equation (5). All regression estimates are significant at the 0.0000 level.

$$M2 = -18{,}108.82 + 122.379 * CPIU \tag{5}$$

The observation of interest is that each successive period has seen acceleration in M2 growth even as CPIU appears to increase at an even pace. These effects are not nearly as evident when first difference data is used for the same sample time frames. One explanation may be discerned from the trace of Real GDP after 2006m12 shown in Exhibit 1. Real GDP has been expanding at a much lower pace when compared to the more robust growth rates prior to 2006m12.

Conclusions

The data examined in this study covers a relatively brief period of economic activity. However, since the second oil shock in the late 1970's a number of significant changes have taken place in the makeup of the US economy. How events like the advent of the internet, artificial intelligence and advances in robotics, more fuel efficient automobiles, and the emergence of China as a major supplier of inexpensive goods have impacted the variables of interest cannot be readily determined. We can at best only surmise how the various factors acting together or separately motivate the monetary and fiscal authorities to make the decisions that they do. A few things are clear.

Real GDP expansion has slowed markedly in the last 8 to 10 years. The response of the US Government and the Federal Reserve has been to accelerate money growth in an effort to reduce interest rates and thereby motivate capital investment. The data suggests, however, that they more they pile on, the less we see of desired results. It is difficult to make an argument for deficit spending as a primary [Keynesian] policy tool for lowering unemployment and expanding output. It is also apparent that the Federal Reserve as the central banker of the US seems to have lost a significant amount of its monetary *mojo*.

More analysis is needed. Key among the unexplored variables is Total Capacity Utilization (TCU) and the shrinking US manufacturing base, real personal savings, the balance of trade, and the flow of investment capital into and out of the US.

Notes

[1] The use of M2 as an aggregate measure of the money stock was suggested Dr. Tom Simpson. As a former Federal Reserve economist, he related that most work at the Fed looked at M2 rather than M1. After redoing all the regressions, etc., I find no real significant differences. All the results contained herein are based on M2 (not seasonally adjusted).

[2] ADF tests are performed three ways: without a constant, with a constant, and with a constant and a trend term. FD data rejected the null hypothesis at test values better than the 0.01 level.

[3] Granger causality is a statistical process for determining if X causes Y or Y causes X. Granger's test for causality is based on the ability of one time series to be useful in predicting changes in a second time series. The Lucas Critique suggests that it is naïve to expect that the effects of changes in economic policy can be based entirely on the basis of relationships observed in historical data. Thus we are faced with a conundrum. The body of monetary theory is built upon the notion that changes in the money stock precede or cause changes in other economic variables. Two-way Granger causality suggests concomitant variation, which as every book on statistics reminds us; concomitant variation does not necessarily imply causation.

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CEO Social Networks and Bank Performance

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Abstract

We investigate the impact of CEO social networks on bank performance, proxied by return on assets (ROA), return on equity (ROE), and net interest margin (NIM), during the recent financial crisis. First we construct a unique dataset of CEO networks based on 97 bank CEOs' social ties, which allows us to assign a Social Network (SN) score to each CEO. Although our performance proxies have varying degrees of statistical significance, our results do provide evidence that CEO networks in 2006, the year prior to the financial crisis, are related to bank performance during the crisis period. Our results suggest that well-connected CEOs experience better bank performance. Our results support the notion that social networks provide CEOs with an enhanced information flow to predict market trends, establish business strategy, exchange physical resources, and thus enhance firm value.

Introduction

In recent years, bank CEOs have increasingly come under increased scrutiny by stockholders, analysts, rating agencies, and regulatory agencies. A renowned example is that in July 2007, when Vernon W. Hill II, founder of Commerce Bank, was forced to step aside when faced with a federal threat prohibiting the bank from opening new bank branches unless he is removed as CEO and Chairman. Consistent with that, an emerging body of literature attempts to link CEO characteristics to banking performance (e.g., Cornett et al, 2009; Fahlenbrach and Stulz, 2011).

One key assumption that underlies these models is that bank CEOs make decisions on financing, investing, and other strategic decisions in individual terms. However, intuitively, bank CEOs are not isolated entities but rather a component of social networks. In other words, social peers are important drivers of managerial decisions of bank CEOs. Therefore, it seems reasonable to conjecture that social networks have an impact on bank performance. Against this background we examine the effect of CEO networks on bank performance during the recent financial crisis.

There are two distinct aspects to CEO social networks. On the one hand, through these connections, a CEO has more access to valuable information about product characteristics, regulatory change, as well as industry and market trends (Granovetter, 1974). This information advantage will lead to better strategic decisions, and hence better financial performance. Second, social networks may have an influence on governance legislation to secure a more favorable policy to firms (Faccio et al, 2006), which is particularly important in a period of financial crisis. Finally, social networks facilitate firm collaboration and value improving practices spread (Chevalier, 1995; Phillips, 1995). When firms face uncertainty related to an industry distress or market crisis, the social network benefits can be intensified (Schoorman et al, 1981; Byrd and Hickman, 1992). On the other hand, CEOs with centralized social connections are more likely to fall victim to herding or group thinking, resulting in lower performance outcomes during a crisis.

To facilitate our study, we construct a CEO's social centrality score (SN) based on three measures: (1) degree, which indicates how active a CEO is in social networks, (2) closeness, which measures the capability of a CEO to quickly interact with other peer CEOs in the network, and (3) betweenness, which measures a CEO's ability to act as a network intermediary. Since it is not theoretically clear which of the measures is more important, we form an aggregate social network measure (*SN*) based on the equal-weighted average of the above three measures. Then a ranking of low-medium-high SN was performed to reduce the influence of extreme values and ease the interpretation of results. In the end, the highest centrality is assigned a value of two; the lowest centrality is assigned a value of zero.

Following Fahlenbrach and Stulz (2011), we utilize three alternative measures of bank performance. The first measure of bank performance is the banks' buy-and-hold returns over the time period July 1, 2007, to December 31, 2008. We also use two measures that emphasize bank profitability during the crisis, i.e., return on assets (*ROA*), defined as the banks' cumulative net income over the years 2007 and 2008, divided by total assets as of year-end of 2006, as well as return on equity (*ROE*), defined as the banks' cumulative net income over the same period, divided by the book value of equity as of year-end of 2006. We also use net interest margin (*NIM*) as an indicator of the bank performance. Following Demirgüc-Kunt and Levine (2001), *NIM* is defined as the bank's net interest income divided by total assets.

The results reveal that there is a positive association between *SN* and bank performance after controlling for bank characteristics and other CEO characteristics. Second, such an association between *SN* and bank performance is stronger when *ROE* is used as the measure of financial performance rather than buy-and-hold return, indicating that bank CEO networks are more relevant to bank profitability is market valuation. Overall, the results reveal that CEO social network increase bank performance during the financial crisis.

Our findings are closely related to two recent studies by Beltratti and Stulz (2012) and Fahlenbrach and Stulz (2011). Consistent to their findings, we also report that CEO ownership has no significant impact on bank performance during the financial crisis, contrasting with the notion that CEO-alignment is one of the main determinants of bank performance. We add to this debate by revealing that CEO networks instead have a positive impact on bank performance during the financial crisis. The results indicate that bank CEOs' social network characteristics matter during the financial crisis.

The remainder of the paper is organized as follows. Section 2 discusses related literature and hypotheses and Section 3 describes the data and explains the methodology used. Section 4 provides the empirical results and Section 5 concludes.

Literature Review and Hypotheses Development

Our research is related to two distinct lines of literature: the first is the literature regarding the role of social networks on value creation, and the second is the literature on the impact of executive social network on corporate performance.

There are several arguments in favor of social network, suggesting that the nexus of bank social ties contributes to more efficient managerial decision making and market power, and thus leads to better bank performance. First, social networks foster an enhanced flow of information (Granovetter, 1974). In the bank CEO context, a CEO can have better access to information on industry trends, as well as related market and economic prediction, thereby leading to better managerial decisions.

Second, a better position in social networks facilitates knowledge sharing including development, diffusion, and adoption of value-improving innovation (Coleman et al, 1966). It may further incentivize CEOs to create new financial products and better business practices, which eventually benefit banks. Similarly, Uzzi (1996) argues that social networks improve feedback among members, improve the capacity of R&D, facilitate the recognition of common interests, and hence alleviate the free-rider problems that are embedded in innovation processes. This free-rider problem is particularly severe in the banking sector due to the difficulty of obtaining a patent for a financial innovation.

Third, Cohen and Fields (1999) acknowledge that social networks are a critical part of Silicon Valley collaborations. Firms with CEOs that are closely connected may obtain better terms of contract between their firms (Schoorman et al., 1981), and they may even share resources. In the banking industry, it can have similar effects as a low cost of lending or shared customer base. On the other hand, social networks may make collusion formation possible. Smith (1976) states that "people of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public". Thus, banks with centrally connected CEOs may retain a competitive advantage over other isolated counterparts through social networks, leading to better performance of their banks.

The effect of social network on firm performance is largely unexplored until recently. For example, Horton et al, (2012) find that social connections among executive directors are positively related to the firms' future performance, supporting the notion that social capital brings either tangible or intangible resources to the firm and creates value. In contrast, Dey and Liu (2010) find that the presence of social connections between conventionally independent directors and the firm's CEO lead to lower operating performance and poorer financial reporting quality, implying that such a social connection weakens director's monitoring effectiveness.

There are also arguments implying that CEOs' social networks may have adverse effects on bank performance. First, social networks can be a mechanism through which misleading and inaccurate information is spread and therefore results in negative economic outcomes. Second, bad practices and value-destroying innovation may proliferate among social networks, and eventually lead to diminished performance during a crisis. Finally, collusion such as price-fixing is illegal in the U.S. and firms may ultimately suffer due to bad publicity resulting from the resulting litigation and reputation costs. Given these contrasting findings, we test the following hypothesis:

> *CEOs' social networks at the onset of the financial crisis are positively related to bank performance during the crisis.*

Data and Research Design

Data

We follow Beltratti and Stulz (2012) and Fahlenbrach and Stulz (2011) in the selection of banks. This study requires data on CEOs in 2006, the last complete year prior to the financial crisis, and financial data for 2007 and 2008. To this end, we first researched firms with Industry Classification (SIC) codes between 6000 and 6300 in the fiscal year 2006 and obtained a list of 132 firms from this effort. We then excluded firms with SIC code 6282, investment advice, since they are not in the lending business. Following the practice in Fahlenbrach and Stulz (2011), I excluded pure brokerage houses and also American Express, which is not a traditional bank. This step results in an original sample of 98 banks, which is consistent with the sample selection results in Fahlenbrach and Stulz (2011).

In the next step, we hand-collect all social network data for the 98 bank CEOs from the Boardex database. Boardex does not contain information on one CEO, resulting in the final 97 CEO sample size. Specifically, using biographical information of bank CEOs collected from the Boardex database, we defined five social networks that represent the ties among the individuals in this paper.

First, current employment network (*CE*): Two bank CEOs are defined as connected to each other through *CE* if one of them sits on another firm's board or both of them sit on the board of a third firm at the same time, which is called "interlocking board members" in finance literature.

Second, previous employment network (*PE*): Two bank CEOs are defined as tied to each other through PE if they have had overlapping working experience in the past. This paper only considers CEOs during their tenure as executives or board members, and does not take into account employment overlap as junior executives or employees. This approach seeks to maximize the likelihood of two CEOs' mutual acquaintance through *PE*.

Third, education network (*ED*): We defined two CEOs as connected to each other through *ED* if they graduated from the same school within one year of each other with the same professional or doctoral degree. This method does not include bachelor degrees and master degrees, and therefore maximizes the probability that two bank CEO know each other through shared education in the past.

Fourth, other activities network (*OA*): We defined two bank CEOs as connected to each other through other activities if they attend the same charities, sports clubs, or other organizations. To ensure that two bank CEOs have actually met, we do not include occurrences when the CEO's position in an organization is just as a member, e.g., a member of the American Financial Association.

Table 1: Descriptive Statistics

Variable	***Number***	***Mean***	***Std.***	***Minimum***	***Maximum***
buy-and-hold return	66	0.62	0.38	0.045	1.57
ROA	64	1.12%	0.46%	0.03%	2.55%
NIM	66	3.40	0.88	1.09	5.78
ROE	64	13.42%	5.67%	0.32%	29.19%
Cash/total assets	64	2.33%	1.21%	0.34%	6.47%
Bank size (LNTA) (bill.)	83	9.8	1.51	7.54	14.19
Charter value (CV)	83	1.22	0.08	1.05	1.45
book to market ratio (B/M))	97	0.53	0.15	0.27	0.87
Tier1 capital ratio (Tier 1)	66	9.71%	1.99%	5.73%	19.02%
Too-big-to-fail (TBTF)	97	0.18	0.39	0	1
CEO shareholding (%CEO_OWN)	66	0.02	0.03	0	0.15
Social network (SN)	97	0.68	0.83	0	2

The table shows summary statistics for key variables for a sample of 97 banks for fiscal year 2006. All accounting variables are measured in millions of dollars and are retrieved from the Compustat annual and Compustat Bank annual databases. The first measure of bank performance is the banks' buy-and-hold returns over the time period July 1, 2007, to December 31, 2008. Return on assets (*ROA*) is defined as the banks' cumulative net income over the years 2007 and 2008, divided by total assets as of year-end 2006. Return on equity (*ROE*) is defined as the banks' cumulative net income over the years 2007 and 2008, divided by the book value of equity as of year-end 2006. Net interest margin (*NIM*) is defined as banks' net interest income divided by total assets. Bank size (*LogM*) is the natural log of total assets at the end of the 2006 fiscal year. Charter value (*CV*) is calculated as the sum of the market value of equity plus the book value of liabilities divided by the book value of total assets. Book to market ratio (*B/M*) is computed as the book value of bank equity as a percentage of market value. CEO shareholding (*%CEO_OWN*) is the percentage of shares outstanding held by a CEO. Too-big-to-fail (*TBTF*) is a dummy variable that takes a value of one if a bank either has to submit to April 2009 stress test conducted by the Federal Reserve Board or belongs to other national financial institutions in the largest market capitalization decile as of 2006. Tier 1 is the ratio of a bank's core equity capital to its total risk-weighted assets and is retrieved from the Compustat Bank database.

Fifth, social network (*SN*): We defined two bank CEOs as connected to each other if they share at least one of the above networks. We concede that there are other social networks. For example, bank CEOs could get acquainted through mutual business providers, suppliers, and customers. There are also additional personal relationships such as family links and neighbors. However, the above four networks are arguably the most related social networks in terms of a CEO's business decisions. The final sample includes 97 CEOs during 2007-2008. We retrieve stock return data from the Center for Research in Security Prices (CRSP), accounting data for banks from Compustat, and executive compensation information from ExecuComp. Table 1 provides descriptive statistics on the sample and detailed variable description.

Table 1 indicates that average ROA is 1.12%, the mean ROE is 13.42, and the mean net interest margin is 3.40. In addition, the Tier1 capital ratio is roughly 9.71% and the book to market ratio is about 6.69%. Altogether, Table 1 indicates that the sample banks are in general well capitalized. It is not surprising that this study covers large-size and well capitalized banks since ExecuComp is biased toward large firms. Table 1 also indicates that a CEO, on average, holds 2% of the entire equity of the bank, ranging from almost zero to about 15%.

Measures of Bank Performance

Following Fahlenbrach and Stulz (2011) and Beltratti and Stulz (2012), we use three measures of bank performance. We calculate return for each bank using buy-and-hold returns from July 1, 2007, to December 31, 2008. If a bank is delisted or merged prior to December 2008, we put the proceeds into the cash account in terms of buy-and-hold returns.

Alternatively, we use two accounting-based bank performance measures during the crisis: return on equity (ROE), and return on assets (ROA). ROA is defined as the banks' cumulative net income over the years 2007 and 2008, divided by total assets as of year-end 2006. ROE is defined as the banks' cumulative net income over the years 2007 and 2008, divided by the book value of equity as of year-end 2006. Following Demirgüc-Kunt and Levine (2001), we also use net interest margin (NIM) as an indicator of bank performance. NIM is defined as a bank's net interest income divided by its total assets.

Control Variables

To ensure that our results are robust, we employ the following control variables in the regression model: lagged stock returns/ROA, lagged stock returns/ROE in 2006, book-to-market ratio, bank size, and Tier 1 capital ratio as in Fahlenbrach and Stulz (2011).

Lagged stock returns/ROA and lagged stock returns/ROE in 2006 is used to control for bank performance at the onset of the financial crisis. The book to market ratio (B/M) is computed as the book value of bank equity as a percentage of market value, and is a proxy for a bank's growth expectation and is expected to be positively associated with bank performance. Bank size, measured as the natural log of market value of a bank, is expected to be positively associated with bank performance. Tier 1 capital ratio is the ratio of a bank's core equity capital to its total risk-weighted assets and is retrieved from the Compustat Bank database. Tier 1 capital ratio measures the financial strength of a bank. It is expected that a bank with a higher Tier1 capital ratio would have better financial performance during the financial crisis because a bank with more capital is less likely to face the debt overhang problem (Myers and Majluf, 1984) and have more flexibility to respond to adverse shocks.

We also include charter value (CV), a too-big-to-fail (TBTF) dummy, and *%CEO_OWN* in the models. CV is calculated as the sum of the market value of equity plus the book value of liabilities divided by the book value of total assets. Furlong and Kwan (2005) find that, on average, consumer lending is positively associated with CV, while commercial lending and real estate mortgage are negatively associated to CV. Overall, CV is negatively related to bank performance. Palia and Porter (2004) also provide evidence that the effect of CV is sensitive to the financial market and fluctuate over time. The TBTF is a dummy variable that takes a value of one if a bank either has to submit to the April 2009 stress test conducted by the Federal Reserve Board or belongs to other national financial institutions in the largest market capitalization decile as of 2006. This variable is used to control the effect of the too-big-to-fail perception on bank performance during the financial turmoil. CEO shareholding (%CEO_OWN), the percentage of shares outstanding held by a CEO, is a proxy for CEO-shareholder alignment.

Model Specifications

We regress buy-and-hold returns (BH_i) on the bank CEOs social network dummy and control variables listed above. The main regression specification is as follows:

$$BH_i = \alpha_0 + \beta_1 SN + \beta_2 TBTF + \beta_3 \%\_CEO\_OWN + \beta_4 CV + \beta_5 laggedR + \beta_6 B/M + \beta_7 LogM + \beta_8 I2Tier1 + \varepsilon \quad (1)$$

Where:
BH_i is the buy-and-hold return for bank *i*;
SN is a variable representing a CEOs' social network, ranging from a value of 0 to 2;
TBTF is a dummy variable that takes a value of one if a bank either has to submit to the April 2009 stress test conducted by the Federal Reserve Board or belongs to other national financial institutions in the largest market capitalization decile as of 2006;
%CEO_OWN is the percentage of shares outstanding held by a CEO;
CV is calculated as the sum of the market value of equity plus the book value of liabilities divided by the book value of total assets;
LaggedR is the stock return in 2006;
B/M is the book to market ratio;
LogM is the natural logarithm of the bank's market capitalization;
Tier1, is the ratio of a bank's core equity capital to its total risk-weighted assets and is retrieved from the Compustat Bank database.

Alternatively, we regress *ROA*, *ROE*, and *NIM* respectively, on the bank CEOs social network dummy and control variables listed above. The main regression specifications are as follows:

$$ROA_i = \alpha_0 + \beta_1 SN + \beta_2 TBTF + \beta_3 \%\_CEO\_OWN + \beta_4 CV + \beta_5 laggedROA + \beta_6 B/M + \beta_7 LogM + \beta_8 I2Tier1 + \varepsilon \quad (2)$$

Where:
ROA_i is the return on assets for bank *i*;
LaggedROA is the lagged return on assets over the five previous quarters;
All other variables are defined as in equation (1) above.

$$ROE_i = \alpha_0 + \beta_1 SN + \beta_2 TBTF + \beta_3 \%\_CEO\_OWN + \beta_4 CV + \beta_5 laggedROE + \beta_6 B/M + \beta_7 LogM + \beta_8 I2Tier1 + \varepsilon \quad (3)$$

Where:
ROE_i is the return on equity for bank *i*;
LaggedROE is the lagged return on equity over the five previous quarters;
All other variables are defined as in equation (1) above.

$$NIM = \alpha_0 + \beta_1 SN + \beta_2 TBTF + \beta_3 \%\_CEO\_OWN + \beta_4 CV + \beta_5 laggedROE + \beta_6 B/M + \beta_7 LogM + \beta_8 I2Tier1 + \varepsilon \quad (4)$$

Where:
NIM is the net interest margin for bank;
LaggedROE is the lagged return on equity over the five previous quarters;
All other variables are defined as in equation (1) above.

Endogeneity

There are no valid instruments to control for potential endogeneity in the study of social network. Therefore, we follow other social network studies that only use an empirical setup to account for endogeneity (e.g., Fracassi and Tate, 2012; Chikh and Filbien, 2011; Renneboog and Zhao, 2011; Berger, et al, 2013). Indeed, reverse causality is not a major concern in this empirical research setting, for two reasons. First, we use CEOs' social networks as of year 2006 to explain bank performance during the crisis (2007-2008 or 2007-2009). Hence there is at least a one-year lag between the dependent variable and independent variables. This approach eliminates a direct contemporaneous endogenous effect. Second, most of the social links among bank CEOs were initiated long before the financial crisis. As such, it is hard to argue that the causality runs from bank performance to CEO social networks. To further eliminate this potential endogeneity, we use pre-crisis (year 2006) bank characteristics and CEO characteristics to predict bank performance.

Results

CEO Networks and Buy-and-hold Return

Model (1) of Table 2 documents results of the buy-and-hold returns with control variables including *LaggedR*, *B/M*, and *logM*. Those three control variables are widely used in prior research on buy-and-hold returns (e.g., Beltratti and Stulz, 2012). The results show that *B/M* is statistically significant and positively associated with buy-and-hold returns, consistent with the findings in Beltratti and Stulz (2012). In contrast to Beltratti and Stulz (2012), we find that lagged stock return is not statistically significantly related to buy-and-hold returns during the crisis. The results suggest that the bank financial performance in the crisis is not associated with the pre-crisis stock performance.

Model (2) of Table 2 reports that Tier1 capital ratio is statistically significant and positively related to the financial crisis, consistent with the results in Beltratti and Stulz (2012). In model (3) of Table 2, we include *%CEO_OWN* and *CV* to the model. However, the coefficients on both variables are not statistically significant. The results on *%CEO_OWN* are comparable to Beltratti and Stulz (2012). Finally, we include *SN* and *TBTF* to model 4 of Table 2, and find that neither variable result in significant results.

Table 2: Buy-and-hold Returns and CEO Social Network

	(1)	*(2)*	*(3)*	*(4)*
SN				0.032
				(1.52)
TBTF				−0.006
				(-1.03)
%CEO_OWN			−0.023	−0.041
			(-0.43)	(-0.03)
CV			0.043	0.029
			(0.00)	(0.03)
LaggedR	0.146	0.349	0.132***	0.323
	(1.27)	(1.34)	(3.34)	(0.33)
B/M	0.606***	0.609***	0.565**	0.511***
	(3.34)	(4.34)	(2.23)	(0.44)
LogM	0.034	0.056	0.067**	0.033
	(0.05)	(1.03)	(2.03)	(0.03)
Tier 1		0.043***	0.038***	0.035**
		(3.04)	(3.02)	(2.01)
Intercept	4.21***	4.34***	5.12**	3.87***
	(4.23)	(3.67)	(2.77)	(3.66)
Adj R-Sq	0.08	0.10	0.09	0.09
F-value	4.12***	4.23***	3.21***	5.23***
Obs.	83	83	66	66

All variables are defined as in Table 1. *t* statistics are reported in parenthesis and statistical significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively.

CEO Networks and ROA/ ROE/NIM

Table 3 reports similar results for *ROA* as for buy-and-hold returns in Table 2. The results show that *B/M* is statistically significant and positively associated with *ROA*. The results for *ROE* presented in Table 4 are very similar to previous tables with one important exception. Table 4 also indicate that *SN* is statistically significant and positively associated with *ROE*, suggesting that banks with well-connected CEOs have better financial performance in terms of *ROE*. The results imply that well-connected bank CEOs tend to perform better during financial crisis. The potential explanation is that CEOs could utilize social networks to collect information and exchange resources, and thus make optimal financial decisions. Both the tangible and intangible capital from social networks will help a bank outperform its peers. Table 5 reports the results when using *NIM* as the dependent variable. The results indicate that Lagged *NIM* is a good predictor of the current *NIM*, suggesting that a bank with higher *NIM* during the pre-crisis period tends to have higher *NIM* during the crisis.

Table 3: Return on Assets (ROA) and CEO Social Network

	(1)	*(2)*	*(3)*	*(4)*
SN				0.032
				(1.07)
TBTF				−0.007
				(-1.40)
%CEO_OWN			−0.004	−0.004
			(-1.00)	(-1.80)
CV			0.005	0.003
			(1.43)	(0.34)
Lagged ROA	−0.113	−0.134	−0.131	−0.382
	(-1.13)	(-1.31)	(-1.23)	(-0.23)
B/M	0.053***	0.062***	0.052***	0.066***
	(2.82)	(4.43)	(3.02)	(4.02)
LogM	0.001	0.005	−0.003	0.003**
	(1.10)	(1.30)	(-1.33)	(2.01)
Tier 1		0.003	0.005	0.003
		(1.10)	(0.20)	(0.30)
Intercept	3.23***	2.65***	2.21**	1.65***
	(2.97)	(3.23)	(2.12)	(4.32)
Adj R-Sq	0.07	0.07	0.08	0.11
F-value	3.43***	3.54***	3.78***	3.78***
Obs.	83	83	66	66

All variables are defined as in Table 1. *t* statistics are reported in parenthesis and statistical significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively.

Table 4: Return on Equity (ROE) and CEO Social Network

	(1)	*(2)*	*(3)*	*(4)*
SN				0.06**
				(2.02)
TBTF				-0.08
				(-0.02)
%CEO_OWN			0.027	-0.003
			(0.81)	(-1.08)
CV			0.014	0.019
			(0.52)	(0.01)
Lagged ROE	−0.523	0.522	−0.345	−0.426
	(-1.84)	(1.01)	(-0.77)	(-0.47)
B/M	0.752**	0.633	0.826***	0.820**
	(2.43)	(1.84)	(4.23)	(2.23)
LogM	0.715	−0.751**	0.042	−0.008
	(1.32)	(-2.41)	(0.83)	(-0.02)
Tier 1		2.028	0.016	0.020
		(0.52)	(0.81)	(0.01)
Intercept	1.23**	0.87***	0.93***	1.68***
	(2.10)	(3.12)	(4.21)	(4.33)
Adj R-Sq	0.09	0.09	0.10	0.10
F-value	1.63	1.99**	2.13**	1.32***
Obs.	83	83	66	66

All variables are defined as in Table 1. *t* statistics are reported in parenthesis and statistical significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively.

Table 5: NIM and CEO Social Network

	(1)	*(2)*	*(3)*	*(4)*
SN				0.32
				(1.00)
TBTF				-0.232
				(-0.82)
%CEO_OWN			0.132	-0.032**
			(0.33)	(-2.13)
CV			0.309	0.043
			(0.59)	
				(0.00)
Lagged NIM	0.321**	1.243***	0.783***	0.343**
	(2.84)	(3.09)	(3.19)	(2.20)
B/M	0.032	-0.431	0.654**	0.123*
	(0.36)	(-1.32)	(2.54)	(1.89)
LogM	1.021	−0.932**	0.134	0.002
	(1.78)	(-3.89)	(0.56)	(1.02)
Tier 1		1.032**	0.082	0.032
		(2.52)	(0.34)	(0.05)
Intercept	-1.21**	-2.32***	0.43***	0.91***
	(-2.00)	(-1.99)	(2.44)	(2.01)
Adj R-Sq	0.09	0.11	0.11	0.12
F-value	2.63**	3.99***	3.13***	2.92***
Obs.	83	83	66	66

All variables are defined as in Table 1. *t* statistics are reported in parenthesis and statistical significance at the 10%, 5% and 1% levels is indicated by *, ** and ***, respectively.

Conclusions

This study examines the bank performance for 97 banks over 2007-2008 focusing on buy-and-hold returns, *ROA*, *ROE*, and *NIM*. The results suggest that well-connected bank CEOs experience better bank performance. The social network effect on bank performance is more statistically significant using *ROE* as an indicator of bank performance. The results support the notion that social networks provide CEOs with an enhanced information flow to predict market trends, establish business strategy, exchange physical resources, and thus enhance firm value.

Our findings are also comparable with that of Beltratti and Stulz (2012), as the results also show that *B/M* is statistically significant and positively associated with bank performance, that lagged bank performance is not a good predictor of bank performance during the financial crisis, and that *%CEO_OWN* is not a main determinant for financial performance during the financial crisis.

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The Financial Crisis and the Wealth-Impact of Liquidity Infusions for Publicly-Traded Banks

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Abstract

Data were gathered to examine the relative importance of liquidity infusions for commercial banks during the financial crisis. Many banks received such infusions from the FED in the fall of 2008, and many others received private debt and equity infusions of cash before and after the financial crisis. Our initial and continuing examinations of the data, and of the market responses to announcements of liquidity infusions, have not generated significant results for the announcement period, though longer term market responses are negative and significant. As many of the smaller and not systemically-risky banks were allowed to fail, or were "absorbed' (purchased) by larger banks, we sense that much of the liquidity "story" was lost as a result of those "exits." Within the sample examined, our ability to support our beliefs (*that the cash was far more important for the distressed than the non-distressed banks that were "forced" to accept the infusions*) was compromised. Future work includes an expanded data set, for the period farther removed from the financial crisis.

Introduction

The real estate bubble and financial crisis rose to a head in the fall of 2008, with real estate prices beginning their three or four year slide, and many of the largest banks in the world at the brink of insolvency. Regulators in the US, and across the world, come to the banks' "rescue" with unprecedented infusions of liquidity to stave off the collapse of the largest banks, and the potential failure of the banking system writ large.

In the wake of those actions, academics and practitioners were left wondering about investor beliefs concerning those infusions. Did they help, or hurt? And to what degree does the relative size of the cash infusion to a bank or other financial services firm characterize the market response? How do the firm's own characteristics help to describe the market's response to announcements of substantial liquidity infusions? Third, how might those responses anticipate specific firms' justifiable needs for liquidity in later crises? Answers to these and related questions hold meaning for investors, policymakers and management. From the value of liquidity to the firm, to the importance of policymakers in framing appropriate regulatory responses to business conditions, what lesson might the wealth-impacts of those financial-crisis-era infusions have for later investors and policymakers?

With our initial examinations, we had hoped to find that the announcements of infusions were significantly positively received by the stock market for cash-strapped firms, and negatively or neutrally received for firms not in such dire need of cash. Such findings elude us. We continue to examine the data, seeking publishable results, and look forward to expanding our research with a conference presentation in a few months.

Background

Past research into the value of liquidity to the firm builds on varied principles and theoretical foundations. Seminal studies by Miller and Orr (1966, 1968), Myers and Majluf (1984), Jensen (1986) and Stulz (1990) theoretically establish the condition that firm value (stock price) is first enhanced and later reduced as the firm acquires liquidity. Extant research (see, for example, Lehn and Poulsen (1989), Mann and Sicherman (1991), Perfect, Peterson and Peterson (1995) and Harford (1999)) provides substantial evidence of the costliness to stockholders of the over-accumulation of liquidity. A narrower literature supports the enhancement of value with additional liquidity.

Dasgupta and Sengupta (2007) remark on the importance of liquid assets not only to forgo economic malaise, but to pursue profitable investment – the prospects of a firm with available liquidity are far brighter than the converse; Ferreira and Brooks (2007) similarly find a separating signal for privately placing firms, based upon firm and placement characteristics, but make no precise allowance for the firms' liquid assets. More recently, Bernstein (2008) and Strahan (2008) note the greater returns demanded of the cash-poor firm and the unprecedented growth in liquid assets prior to Great Recession, respectively. Barclay and Holderness (2007) comment on the power of new liquid assets to signal either greater management entrenchment or upcoming management change with new investments in growth; is the financial services firm providing the first, or the second, signal to the stock-buying public with its announcement?

Research holds that firm value is first enhanced as it acquires liquidity to fund profitable growth and later reduced as cash-like assets are over-accumulated. The primary contribution of this study comes from examining factors associated with liquidity infusions and the consistency of any discoveries with existing theory and prior empirics. To accomplish this, a sample of financial services firms funding announcements is examined, where liquidity arrivals are signaled by the bank, lender, broker or other financial services firm with the announcement.

The announcements represent liquidity-enhancing events with observable empirical features. The private buyer clearly signals a belief in any "hidden" firm value with the size and price of the purchase. The power of a signal from a public buyer is a cornerstone of this study. An adjusted measure employed by Wruck (1989), and used by Hertzel and Smith (1993), Graham (2001) and Brooks and Graham (2005) allows for the examination of the portion of the announcement period (the several days around the announcement) return that is due to factors other than simple information asymmetry resolutions.

Put simply, at the optimum, the expected marginal return on the last dollar of slack equals the expected marginal cost of free cash flow for that same dollar. For the financial services firm to be examined in this study, that announce material infusions of liquidity or cash, there is an assumption that existing firm liquidity levels fall well below this theoretical "optimum." An ancillary goal of this study is to consider this optimal level of liquidity, and the manner with which the optimum might be better specified in the current operating environment.

Methodology

The idea underlying this research is that market responses to announcements of liquidity infusions by financial firms, up to and during the financial crisis, will be characterized both by market expectations about the firm itself, and by existing levels of liquidity within the firm. We control for both the features of the liquidity-infusion-announcing firms, and for those firms' levels of available cash or liquidity. To test this main premise, data on the announcements of such infusions (the assumption being that the firm-specific wealth-effect will occur with the announcement) were gathered.

The data sources used included the Wall Street Journal, the Dow Jones News Wire and the Business News Wire. Sundry internet sources were also employed, but experience suggested that announcements on those more "public" platforms typically followed the wire services by an hour or more. The initial sample period ran from January 1, 2007 through June 30, 2009. Data collection concluded in the fall of 2011.

Data Analysis. Augmenting the returns and announcement data gathered using the sources listed above, firm-specific financial and ownership data, and returns data, were gathered using Compustat and Bloomberg, respectively. A dependent variable was constructed with abnormal returns measured in two ways. The first measure is the traditional abnormal return over the period from three days before the announcement to the day of the announcement, if there is time to trade the stock on the announcement date. For firms announcing after the close of trading, the next trading day is treated as day 0. This initial measure is calculated as:

$$AR_{i,t} = R_{i,t} - [\,\hat{\alpha}_i + \hat{\beta}_i\,(R_{m,t})] \qquad (1)$$

where ARi,t is the abnormal return for firm i in period t, Ri,t is the total return for firm i in period t, and $[\hat{\alpha}\text{ i} + \hat{\beta}\text{ i (Rm,t)}]$ is the market-model predicted return for firm i in period t; $\hat{\alpha}$ i is the intercept for security i predicted from the pre-event estimation period from day -200 to day -60; $\hat{\beta}$ i is the slope coefficient of security i over this same pre-event estimation period and Rm,t is the value-weighted return of the market during period t. The second measure is an adjusted abnormal return employed as the dependent variable in this study:

$$\text{ARitADJ} = [1/(1 - \gamma)][\text{ARit}] + [\gamma/(1 - \gamma)][(\text{Pb} - \text{P0})/\text{Pb}] \qquad (2)$$

where ARi,tADJ is the adjusted abnormal stock return for firm i in period t, γ is the ratio of shares placed to shares outstanding after the placement for firm i, and ARi,t is the traditional measure of the abnormal return for firm i in period t described in Equation (1) above. Pb is the market price two days prior to the event window; P0 is the placement price. Stock prices will be taken from the Bloomberg or Center for Research in Security Prices (CRSP) files. The element (Pb - P0)/Pb is the discount received by the placement purchaser.

The reason for the adjustment is straightforward; if a new provider of liquidity, as with a sovereign wealth fund making the Citigroup purchase, buys equity at a 10% discount, and the market responds with a modest 1% or 2% declination in Citi's stock price, a signal of an increase in firm value is implied, and this adjustment measures the size of that effective increase in value.

Many of the liquidity infusions were of forms other than common stock privately placed. For those issues, the traditional abnormal return in equation 1 above were measured, and adjustments to the effective number of shares outstanding, depending upon details in the liquidity-infusion announcement, were made.

Of greater consequence were the relative size of the liquidity infusion and the market's response to the announcement, as a function of the relative size and nature of the infusion, and fundamental factors specific to the firm. Market responses derive from many factors, such as stated uses for the funds, ownership of the firm receiving the cash, identity of the liquidity provider (differing responses to government and private sector infusions are expected, for example) prior stock price performance and the firm's dividend policies.

Data were gathered on 111 cash infusions for US firms, and for around two dozen firms outside the US. General features of those announcing firms are provided in Table 1 below.

Table 1: Sample Descriptive Statistics

Summary Statistics Data	
Number of observations	137 (133*)
Regional distribution	Austria (1), Belgium (2), Belgium/Netherlands (2), Canada (2), France (3), Germany (2), Great Britain (5), Israel (1), Japan (1), Netherlands (2), Singapore (1), Switzerland (4), USA (111)
Governmental	90
Private	47
Infusion amount ($)	
Average	n/a**
Min	17,000,000
Max	85,000,000,000
Infusion amount (%MV)	
Average	49.05
Min	0.04
Max	685.49
* Three transactions (Dexia, Citigroup, IKB) split up due to different liquidity sources (private/governmental)	
** Capital injections were denominated in different currencies	

Data in Table 1 reveal that the significant majority of the infusions occurred for firms in the US, and the average infusion was close to half the market value of the firms receiving the liquidity infusions. As well, a majority of the infusions were from the respective governments (90 out of 137 or just under 66%), with the remaining third from private sources. A few of the infusions, as noted at the bottom of Table 1, were from both private and public sources.

An initial set of examinations of the data was conducted to begin to discern the separable impact of the cash infusions on firm value, as proxied by abnormal returns, and characterized by Equation (3) below.

$$AR\ t = \alpha + \beta * CashInfusion\ (\%MV) + \varepsilon \qquad \textbf{\textit{(3)}}$$

Tables 2, 3 and 4 describe overall market responses in the time after the liquidity-infusion announcements, for the sample as a whole, and for the separate private and governmental infusions. Table 2 portrays the entire sample responses; Table 3 illustrates the returns of the firms receiving government infusions, and Table 4 reveals market responses for the firms receiving private liquidity infusions.

Results

A cursory review of the data in Tables 2-4 suggests some significant market response to the liquidity announcements, but a deeper review of the results is more meaningful. While the longer-term abnormal returns are uniformly negative and significant, that finding is simply an artifact of the period reviewed; returns across most markets, and for financial firms in particular, were negative and significant in the period examined. As well, the very low R-square measures suggest a "great deal more is going on" in the period being studied than simply the cash infusions for financial firms.

Concluding Remarks

An expanded data set, including the period years removed from the financial crisis, is required to attach any real meaning to this study. While the results here are attractive, the lack of any significant announcement-period abnormal return (the time one day after the announcement) is noteworthy. Additional study, beyond the sample period, is planned.

Table 2: Stock Market Reaction to Liquidity Infusions

Variable	Coefficient *Standardized Coefficient*	Probability (p-value)		R^2
Market reaction (total, n=135)				
1. Cash infusion as % of MV; Abnormal return one day before announcement				
Cash (beta)	0.003044	0.8136		
	0.020481			
C (alpha)	0.775674	0.5564		0.000419
2. Cash infusion as % of MV; Abnormal return one day after announcement				
Cash	-0.004714	0.5837		
	-0.047576			
C	-0.335682	0.7022		0.002264
3. Cash infusion as % of MV; Abnormal return one week after announcement				
Cash	0.024261	0.0353		
	0.181319			
C	-2.01846	0.0855		0.032876
4. Cash infusion as % of MV; Abnormal return one month after announcement				
Cash	-0.003774	0.8237		
	-0.019354			
C	-9.64414	0.0000		0.000375

Table 3: Stock Market Reaction to Governmental Liquidity Infusions Only

Variable	Coefficient *Standardized Coefficient*	Probability (p-value)		R^2
Market reaction (governmental only; n=91)				
5. Cash infusion as % of MV; Abnormal return one day before announcement (governmental infusions only)				
GovCash	-0.014135	0.2928		
	-0.111472			
C	2.178032	0.1558		0.012426
6. Cash infusion as % of MV; Abnormal return one day after announcement (governmental infusions only)				
GovCash	-0.003939	0,713		
	-0.039092			
C	-0.132172	0.9137		0.001528
7. Cash infusion as % of MV; Abnormal return one week after announcement (governmental infusions only)				
GovCash	0.029836	0.0273		
	0.23149			
C	-1.266549	0.4043		0.053587
8. Cash infusion as % of MV; Abnormal return one month after announcement (governmental infusions only)				
GovCash	-0.001405	0.9414		
	-0.007812			
C	-10.45635	0.0000		0.000061

Table 4: Stock Market Reaction to Private Liquidity Infusions Only

Variable	Coefficient *Standardized Coefficient*	Probability (p-value)		R^2
Market reaction (private only; n=44)				
9. Cash infusion as % of MV; Abnormal return one day before announcement (private infusions only)				
PrivCash	0.088598	0.0113		
	0.378388			
C	-3.192458	0.1908		0.143177
10. Cash infusion as % of MV; Abnormal return one day after announcement (private infusions only)				
PrivCash	-0.011407	0.4272		
	-0.122767			
C	-0.607538	0.5552		0.015072
11. Cash infusion as % of MV; Abnormal return one week after announcement (private infusions only)				
PrivCash	-0.016325	0.4916		
	-0.106454			
C	-2.76693	0.1089		0.011332
12. Cash infusion as % of MV; Abnormal return one month after announcement (private infusions only)				
PrivCash	-0.008987	0.8264		
	-0.034026			
C	-8.051236	0.0087		0.001158

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Short-Selling Constraints: The Asymmetric Role of Institutional Ownership, Relative Short Interest, Options and Dividends

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Abstract

We assess the effect of four short-sale constraints on stock returns in generally falling versus generally rising markets, and considering relative effects for large/mid-cap versus small/micro-cap firms. We find that the constraint behavior is asymmetric when testing during generally falling versus generally rising markets, and that small- and micro-cap firms provide important effects when viewed separately. Our results provide substantive pricing differences between least versus most short-sale constrained stocks.

Introduction

It is widely documented in the finance literature that the degree to which short sellers are constrained in their activities can be measured by several key proxies for these constraints. The mainstream measures include institutional ownership, relative short interest, and the presence of options. Some evidence of a role for dividend- versus non-dividend-paying firms also exists. The literature is rich with assessments of the roles of each individual measure, and even with some combined roles. However, questions remain unaddressed whether these measures capture asymmetric effects in falling versus rising markets, whether these measures exhibit different behavior for different size firms, while simultaneously controlling for other issues including option introduction effects and effects of the recent short sale ban in 2008.

These questions provide the motivation for this study, undertaken in the context of Miller's (1977) contention that when investors differ in their beliefs as to the value of an asset, the presence of short-sale constraints can generate deviations from fundamental value. He argues that investors with bullish opinions about a stock will rationally take long positions, while bearish investors would like to short the stock. If unable to short the stock because of a constraint, bearish investors instead sit on the sidelines and do not trade. In this case, the price of the stock represents the opinions of only the most optimistic investors, translating into artificially inflated prices, and thus lower subsequent returns. Lecce, Lepone, McKenzie, and Segara (2012) further demonstrate that for any given degree of divergence in investor expectations, the greater the short-sale constraint and the greater the price and return bias. We assess price and return bias in context of Miller’s bull and bear arguments, observing differences in our estimation results over generally rising and generally falling markets during our time horizon.

We examine the effects of four constraint variables on excess returns, where positive pricing (negative return) bias is expected to be related to the presence of short-selling constraints. Using a random effects panel regression on a balanced panel dataset of 1,582 S&P Total Market Index firms, we examine the roles of institutional ownership, relative short interest, presence of options, and dividend payments in rising versus falling securities markets and the degree to which they may represent constraints to short-selling activities. Our results confirm a variety of prior studies.

After identifying the "most" and "least" short-sale constrained firms, the results reveal an overall pattern where the stocks that are defined as being the most short-sale constrained do in fact have higher price (lower return) bias than their least short-sale constrained counterpart. However, this higher price (lower return) bias is more pronounced in generally rising markets than in generally falling markets for both large/mid-cap and small/micro-cap firms.

Motivation

It is unclear from prior studies whether the constraint proxies exhibit different behavior in falling versus rising markets. Practitioners have claimed that market activity shows that securities lending firms are faced with more demand to short-sell during rising markets than during falling markets, because of divergence of investor expectations. The risk-to-reward ratio is also unfavorable in a falling market versus a rising market. Additionally, a depressed stock price introduces motivation for takeovers/acquisitions, motivation which may not have been present before the fall in stock price. Short positions, therefore, are likely to get trimmed or closed out the lower the stock price goes. Short-selling constraints may be more prevalent in a falling market, but not as relevant as in the rising market.

A remaining question involves whether these measures exhibit different behavior for different size firms. Smaller firms are generally less liquid than larger firms. Smaller firms may not have established option structures, and may not capture the attention of institutional investors. This is a compelling argument that a comparison of constraint effects between larger and smaller firms is in order.

Short-Selling Constraints and Price/Return Bias

Using a rational expectations framework, Diamond and Verrechia (1987) argue that short sellers are sophisticated investors. This notion is supported in that short selling occurs despite greater transaction costs and larger downside risks associated with short selling relative to holding long positions.

The proceeds from a short sale are not immediately available to the short seller, but instead are frozen as collateral for the owner of the borrowed shares. While the short seller can earn interest on these proceeds, the earned rate is normally below the market rate. The difference between the market rate for lending the shares and the below-market rate earned for the short seller represents compensation to the lender during the delay of availability of short sale proceeds. Another item related to the cost of short selling is the tax treatment. Short sale profits are taxed at the short-term capital gains rate, regardless of the length of time the short position is open.

There are risks associated with short-selling as well. The maximum gain for a short seller is the price of the stock if the stock price falls to zero, but the potential loss is unlimited (if the stock price rises without end). Another risk to the short seller is that the loan can be recalled at the lender's option. This can happen if the lender decides to sell those shares. If the short seller is unable to locate a new lender, then the short seller must purchase shares in the open market, return them to the original lender, and close the position. Short sellers have the ability to avoid this risk by choosing to borrow on a term basis, but additional fees may be involved.

Based on these points, Diamond and Verrechia (1987) suggest that short sellers will not trade unless they expect the price of the asset to fall by an amount large enough to compensate them for the additional costs and risks associated with short selling. The authors then propose that short sellers are more informed than holders of long positions.

When investors are unable to short sell an asset or unwilling to incur the higher costs of doing so, that asset is said to be short-sale constrained. We define a constraint as anything that makes short selling less attractive or more difficult relative to a long position.

It is traditionally held that one of the proxies for a short selling constraint is the proportion of a firm’s shares owned by institutional investors (IO). D'Avolio (2002) shows that institutional investors are the main suppliers of stock loans. Therefore, IO could be a proxy of the loan supply as well as a proxy for the cost of short selling. Short sellers must borrow shares from an investor willing to lend. Low levels of IO may thus be consistent with low loan supply. Furthermore, if loan supply is thin, the short seller may have to pay a sizable fee, making it more expensive to short sell. Chen, Hong, and Stein (2002), Nagel (2004), and Asquith, Pathak, and Ritter (2005) use IO as a proxy for short-sale constraints and demonstrate that the cross-sectional underperformance in returns is stronger when IO is low than when it is moderate or high.

A second common metric for the degree of constraint to short selling is relative short interest (RSI), the ratio of the number of shares which have been sold short to the number of shares outstanding. This proxy was first proposed by Figlewski (1981) as representative of the demand to short sell a given stock. It is traditionally held that as the level of RSI for a given firm increases, it becomes more difficult to short that firm at the margin. Asquith and Meulbroek (1995) and Desai, Ramesh, Thiagarajan, and Blachandran (2002) find negative and significant abnormal returns for stocks with high short interest levels. Chen et al. (2002), however, point out that using short interest to proxy for short-sale constraints is problematic for at least two reasons. First, most stocks have little or no short interest outstanding at any given time, and, second, low short interest may reflect the high transaction costs of shorting. Boehme, Danielsen, and Sorescu (2006), however, question the use of RSI alone as representative of a short selling constraint, and Jones and Lamont (2002) argue that stocks that are very costly to short will have low short interest. Thus, it is arguable that low levels of short interest, as opposed to high levels, could be more representative of a short-selling constraint.

The lack of exchange-traded options for a given stock may represent another form of a short-sale constraint. With options, investors can take a short position in a stock without having to short sell the stock directly. For instance, by either buying put options or writing call options, an investor can bet on the expected downward movement in the value of a particular asset. However, when stocks do not have exchange-traded options, pessimists are limited to short selling the stock directly. Figlewski and Webb (1993), Danielsen and Sorescu (2001), and Phillips (2011) find evidence that firms with exchange-traded options are less short-sale constrained.

A lack of exchange-traded options is not a common feature among either large-cap or mid-cap stocks. At the end of 2011, all of the S&P 500 firms had exchange-traded options, and at least 99% of S&P 400 mid-cap firms had exchange-traded options. There are considerably more firms in the S&P small-cap and S&P microcap indices without exchange-traded options. Starting with the S&P Total Market Index, which has 3,773 constituent firms, and dropping the S&P 500 large-cap and the S&P 400 mid-cap firms, only about 62% of the remaining S&P small cap and S&P microcap firms have exchange-traded options.

The decision to introduce a stock option is not made by a firm's board of directors, but instead is made at the discretion of the option exchange. Mayhew and Mihov (2004) point out that if the primary motivation of the exchange is the long-term profitability of the exchange, then the board of the option exchange will select stocks which are likely to generate the largest long-term trading volume. Danielsen, Van Ness, and Warr (2007) examine stock characteristics which are predictive of option introduction and find that stocks with high market capitalization, improving liquidity and high abnormal volatility are favored for option listing. Phillips (2011) argues that while it is unlikely that option exchanges are attempting to select stocks exhibiting improving efficiency, it is possible that they may indirectly do so based on their selection criteria. He supports this conclusion by citing an increase in IO, suggesting that stocks undergo an increase in investor recognition and/or popularity prior to option introduction.

If option introduction reduces short-sale constraints, it would be expected to be predictive of negative abnormal returns as historical negative information withheld from the market is impounded in stock prices. Conrad (1989) and Detemple and Jorion (1990), however, investigate whether option introductions change the price levels of underlying stocks and find positive effects. Sorescu (2000) and Danielsen and Sorescu (2001), on the other hand, find that for options listed from 1980 to 1995, the underlying stock realizes negative abnormal returns following option introduction. Using a control sample of non-optioned stocks having similar characteristics to those selected for option introduction, Mayhew and Mihov (2005) find that the control portfolio exhibits similar negative abnormal returns, suggesting that the relationship between option introduction and negative abnormal return may be spurious and more a result of stock characteristics common at the time of option listing. Ni, Pearson, and Poteshman (2005) further show that stocks with exchange-listed options tend to cluster at option strike prices on expiration dates. They also show that there is no corresponding change in the distribution of the closing prices of non-optionable stocks. Phillips (2011) finds that option introduction alleviates 79% of the price adjustment efficiency disparity between short-sale constrained and unconstrained stocks in relation to negative news. No significant improvement in adjustment efficiency is found in response to positive news.

Finally, dividend paying firms may be more short-sale constrained than non-dividend paying firms (Dechow, Huton, Meulbroek, and Sloan 2001). Consider a short seller shorting a dividend paying firm. The paid dividends belong to the lender of the shares, not to the short seller. Thus, the short seller must transfer any paid dividends back to the lender once the position is closed. In frictionless capital markets, the share price should fall by the amount of the dividend. However, Frank and Jagannathan (1998) demonstrate that the ex-dividend stock price is normally higher than the pre-dividend stock price less the amount of the dividend. For example, if a firm pays a $0.10 dividend, but the share price only falls by $0.09, then the short seller will have to make up the difference, which represents a material cost to the short-seller. For short sellers, an impending dividend may deter opening a short position, or may encourage closing of an open short position, prior to the dividend payment. Asquith, Pathak, and Ritter (2005) provide evidence that the median number of consecutive months that a firm is highly shorted is 2–3 months. This is consistent with the notion of investors shorting a dividend paying stock between dividend payments, but not during. Other research by Michaely and Vila (1995 & 1996), and Koski and Scruggs (1998) show that trading volume increases after dividend announcements and before the ex-dividend date, suggesting that some traders engage in a dividend-capturing strategy. They also document abnormal trading activity prior to the ex-dividend date. They conjecture that securities dealers may short a stock cum-dividend and buy it back ex-dividend if they believe the price decrease on the ex-dividend date will be greater than the amount of the dividend plus any additional transaction costs.

In this paper, all of the four above-referenced constraints are investigated in order to augment findings from prior research, but for our time frame. examined with several previously established controls, as well as our additional controls for option introduction for the short sale ban that was temporarily in force in 2008.

Data Source and Selection Procedure

The data for this study are compiled from four different sources and span September 2007 through December 2011. Data on stock returns are from the Center for Research in Security Prices (CRSP) Daily Stocks File for NYSE, AMEX, and NASDAQ stocks. Our semi-monthly IO and RSI data are compiled by ShortSqueeze.com, which provides data on a universe of approximately 7,000 firms. Exchange-traded options data are compiled by DeltaNeutral.com, which provides end-of-day quotes for options on all optioned stocks for the U.S. Equities markets, including every stock, index, and ETF for all strike prices and expiration dates. Finally, the Fama-French factor returns are obtained from Kenneth French's website. September 2007 marks the beginning of the analysis because it is the first month where stock exchanges were required to provide standardized semi-monthly, as opposed to monthly, data regarding IO and RSI on a stock-by-stock basis.

The starting universe of stocks is defined as all S&P Total Market Index[1] (S&P TMI) firms which were part of the S&P TMI from September 2007 through December 2011. The S&P TMI is used because it allows for some degree of homogeneity with regard to firm quality, especially necessary for small or micro-cap firms. As of December 2011, there were 3,773 constituent firms forming the S&P TMI. 998 firms were dropped that were not part of the index starting from September 2007. An additional 986 firms were lost based on not having an observation in each of the firm-specific datasets (CRSP, ShortSqueeze.com), at each of the possible 104 semi-monthly data points. This screening process leaves us with a panel dataset consisting of semi-monthly observations for 1,582 S&P TMI firms spanning September 2007 through December 2011.

Methodology

In this investigation, a cross section of stock returns of 1,582 companies over 52 months from September 14, 2007 through December 30, 2011 is examined. A random effects panel regression is used to control for both firm-specific and time-specific random effects and the Arellano (1987) version of the White (1980) heteroscedasticity-consistent covariance matrix corrected standard errors to control for heteroscedasticity and auto correlation. Based on previous research into factor models, specifically, Fama and French (1993 & 1996), and Carhart (1997), the model controls for the market, size, value, and momentum factors.

The following regressions are estimated using a semi-monthly time horizon. The time subscript is suppressed.

$$(R_i - R_f) = \alpha + \sum_{j=1}^{8} \Omega_j \phi_j + \beta_1 \lambda_1 + \beta_2 \lambda_2 + \mu_i + \eta + \varepsilon_i \tag{1}$$

$$(R_i - R_f) = \alpha + \sum_{j=1}^{8} \Omega_j \phi_j + \beta_3 \lambda_3 + \beta_4 \lambda_4 + \mu_i + \eta + \varepsilon_i \tag{2}$$

$$(R_i - R_f) = \alpha + \sum_{j=1}^{8} \Omega_j \phi_j + \beta_5 \lambda_5 + \mu_i + \eta + \varepsilon_i \tag{3}$$

$$(R_i - R_f) = \alpha + \sum_{j=1}^{8} \Omega_j \phi_j + \beta_6 \lambda_6 + \mu_i + \eta + \varepsilon_i \tag{4}$$

$$(R_i - R_f) = \sum_{j=1}^{8} \Omega_j \phi_j + \sum_{k=1}^{K} \beta_k \Lambda_k + \mu_i + \eta + \varepsilon_i \tag{5}$$

where:
$(R_i - R_f)$ = the excess return on stock i

β_1 through β_6 = regression coefficients for λ_1 through λ_6, respectively
λ_1 = 1 if top tercile of short interest, 0 otherwise
λ_2 = 1 if middle tercile of short interest, 0 otherwise
λ_3 = 1 if middle tercile of institutional ownership, 0 otherwise
λ_4 = 1 if lower tercile of institutional ownership, 0 otherwise
λ_5 = 1 if the stock is optioned, 0 otherwise
λ_6 = 1 if the stock pays a cash dividend in the current two-week period, 0 otherwise
Ω = a vector of coefficients for the control variables
ϕ = the values of the control variables
λ = the values of the constraint variables
Λ = the values of the constraint variables including cross terms
μ = the firm specific random effect, normally distributed with mean = 0
η = the time specific random effect, normally distributed with mean = 0
ε = the error term
α = the intercept term
K = number of constraint variables including cross terms

R_i represents the semi-monthly return on the i^{th} firm (at time t), and R^f is one-half the return of the one-month Treasury bill.[2] The first four control variables are the excess return on the market portfolio *(R_m-R_f)*, the difference between the returns of value-weighted portfolios of small and big firm stocks *(SMB)*, the difference in returns of value-weighted portfolios of high and low book-to-market stocks *(HML)*, and the difference in returns of value-weighted portfolios of firms with high and low prior momentum *(UMD)*, or up minus down. The last four control variables are specific to this study: a control variable representing the point at which exchange-traded options for a given firm were introduced, a control variable indicating a short-sell banned firm at the beginning of the ban which took effect September 19, 2008 (impacting the return calculated from September 15th through September 30th), a control variable indicating a short-sell banned firm at the end of the ban which ceased on October 8, 2008 (impacting the return calculated from September 30th through October 15th), and a control variable indicating a short-sell banned firm a week after the removal of the ban (impacting the return calculated from October 15th through October 31st).

The 2008 short-sell ban was set in place in an attempt to protect selected financial firms from short sellers, who were being blamed for the rapid stock price declines that some firms were experiencing. Research by Autore, Billingsley, and Kovacs (2011) found that, at the onset of the ban, the typical banned stock exhibited a positive abnormal return. They also find that when the ban was removed, the same stocks experienced a price reversal. Our first two short-sell ban controls are set in place to account for these two effects. Research by Harris, Namvar, and Phillips (2009) indicates that for stocks experiencing negative performance prior to the ban, the price reversal occurred approximately two weeks following the ban. Additionally, they find that for stocks with positive pre-ban performance, the estimated price inflation is similar in magnitude to their negative performance counterparts, but without a post-ban reversal. Our third short-sell ban control is set in place for this reason.

Based on prior research, we hypothesize that low IO, lack of options, and presence of dividends should behave as priced constraints. A hypothesis for RSI is less apparent, given the divergent results from prior studies, but our results should provide marginal evidence to the arguments. We expect substantive differences in significance and parameter estimates depending on market environment (generally falling versus generally rising) and between large/mid and small/micro-cap stocks. Since no prior study addressed these estimations, our intent is to establish baseline knowledge using our additional controls and specifications across falling and rising markets and across our two firm size groupings.

An additional hypothesis results from the relationship between our short sale constraint proxies and an exogenous government imposed short sale ban on selected financial firms in 2008. We expect that the short-sale banned stocks, although representing relatively few data points, should be a strongly significant, priced factor in any specifications that include it as a control, since even our most constrained endogenous combinations could not bring about the extremity of a ban.

Summary Statistics

Sample

Panel A of Table 1 provides a breakdown of the 1,582 S&P TMI firms used in the study. To be included in the sample, a firm had to be included in the S&P TMI index from September 2007 through December 2011. Beyond this, we remove any firm that could not be matched up with CRSP and ShortSqueeze.com, datasets at every one of the 104 semi-monthly data points between September 2007 and December 2011. 1,582 S&P TMI firms remain after screening.329 of the 1,529 firms are S&P 500 large-cap firms, 161 are S&P 400 mid-cap firms, and the remaining 1,092 are S&P small and micro-cap firms. Panel B of Table 1 provides summary statistics for IO and RSI for all 1,582 firms. Panels C and D provide the same summary statistics across large and mid-cap firms and small and micro-cap firms, respectively. Both variables are calculated for each firm separately before the cross-sectional sample statistics are computed.

D'Avolio (2002) shows that institutional investors are the main suppliers of stock loans. Thus, as the level of IO falls, the supply of shortable shares falls with it, thereby constraining the short sale of a given stock. Panel B of Table 1 shows that the average outstanding shares owned by institutions is approximately 60.67% of a firm's outstanding shares. However, as evidenced by Panels C and D, institutional investors hold smaller portions of small and micro-cap firms (53.55%) versus large or mid-cap firms (76.54%). This finding, combined with the findings of D'Avolio (2002) is consistent with the notion of small and micro-cap firms being more short-sale constrained than large or mid-cap firms.

The role of RSI was proposed by Figlewski (1981), and approximates the demand to short sell a given stock. It is traditionally held that as the level of RSI for a given firm increases, it is more difficult to short that firm at the margin. Consistent with the findings of Chen et al. (2002), however, we observe that on average, firms have little or no short interest outstanding, as evidenced by an average of only 4.88% of outstanding shares shorted at any given time.

Panel B of Table 1 also provides a breakdown of option, dividend, and short-sell ban status for the 1,582 firms in the study. The exchange-traded option section shows that, of the 1,582 investigated firms, 941 (59.5%) have traded options, 224 (14.2%) introduced options at some point during the study, and the remaining 417 (26.4%) do not have any exchange-traded options. The dividend-paying section provides a breakdown of dividend paying versus non-dividend paying firms. 661 firms (41.8%) did not pay any cash dividends during the term, while 921 firms (58.2%) paid at least one dividend from September 2007 to December 2011. The short-sell ban section shows that of the 1,582 firms in the study, 325 (20.5%) of them were part of the list of short-sell banned firms in the fall of 2008.

Table 1. Summary Statistics.

	N	Mean	Std Dev	Median	Min	Max
Panel A.						
S&P 500 Large-Cap	329					
S&P 400 Mid-Cap	161					
S&P TMI less Large and Mid-Cap	1,092					
	1,582					
Panel B. All Firms (1,582)						
	N	Mean	Std Dev	Median	Min	Max
Institutional Ownership (IO)	1,582	60.67	24.32	67.03	1.75	96.69
Relative Short Interest (RSI)	1,582	4.88	4.15	3.88	0.02	34.90
Exchange-Traded Options	941	59.5%				
No Exchange-Traded Options	417	26.4%				
Introduced Exchange-Traded Options	224	14.2%				
All Firms	1,582	100.0%				
Dividend Paying	921	58.2%				
Non-Dividend Paying	661	41.8%				
All Firms	1,582	100.0%				
Short-Sell Banned Firms	325	20.5%				
Non-Short-Sell Banned Firms	1,257	79.5%				
All Firms	1,582	100.0%				
Panel C. Large & Mid-Cap (490)						
	N	Mean	Std Dev	Median	Min	Max
Institutional Ownership (IO)	490	76.54	11.76	78.67	35.53	95.81
Relative Short Interest (RSI)	490	4.26	3.42	3.13	0.71	34.90
Exchange-Traded Options	477	97.3%				
No Exchange-Traded Options	0	0.0%				
Introduced Exchange-Traded Options	13	2.7%				
All Firms	490	100.0%				
Dividend Paying	395	80.6%				
Non-Dividend Paying	95	19.4%				
All Firms	490	100.0%				
Short-Sell Banned Firms	92	18.8%				
Non-Short-Sell Banned Firms	398	81.2%				
All Firms	490	100.0%				
Panel D. Small & Micro-Cap (1,092)						
	N	Mean	Std Dev	Median	Min	Max
Institutional Ownership (IO)	1,092	53.55	25.12	55.31	1.75	96.69
Relative Short Interest (RSI)	1,092	5.16	4.41	4.26	0.02	34.00
Exchange-Traded Options	464	42.5%				
No Exchange-Traded Options	417	38.2%				
Introduced Exchange-Traded Options	211	19.3%				
All Firms	1,092	100.0%				
Dividend Paying	526	48.2%				
Non-Dividend Paying	566	51.8%				
All Firms	1,092	100.0%				
Short-Sell Banned Firms	233	21.3%				
Non-Short-Sell Banned Firms	859	78.7%				
All Firms	1,092	100.0%				

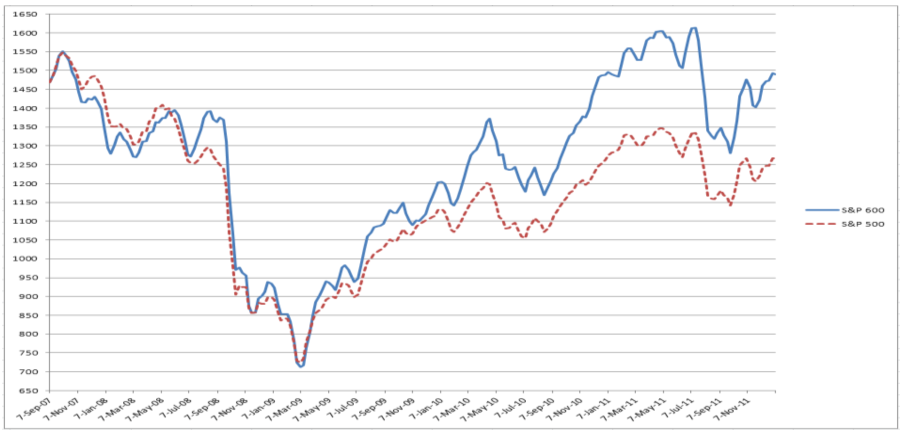
Panels C and D of Table 1 provide the same breakdown as Panel A, but for large and mid-cap firms versus small and micro-cap firms. It is interesting to note that all 490 large and mid-cap firms had exchange-traded options at the end of the study. 477 (97.3%) began the study with exchange-traded options, and the remaining 13 (2.7%) introduced options at some point during the study. 395 (80.6%) paid at least one cash dividend during the study, and 92 (18.8%) were part of the short-selling ban list. Note, however, that 464 of the 1,092 (42.5%) small and micro-cap firms began the study with exchange-traded options, 211 (19.3%) introduced options, and the remaining whereas 417 (38.2%) did not have any exchange-traded options at any point during the study. 462 (46.6%) small and micro-cap firms pay cash dividends, and 233 (21.3%) were part of the short-sell ban list.

In summary, if the lack of exchange-traded options does in fact represent a short-selling constraint, then that constraint mostly applies to small and micro-cap firms, and not as much to large or mid-cap firms. Second, if cash dividends represent a short-selling constraint, then that constraint applies to 80.6% of large and mid-cap firms, but only to about 48.2% of the small and micro-cap firms. Therefore, it may be useful to examine firms separately based on size. Otherwise, the presence of options and the payment of cash dividends may be proxies for size rather than specific short selling constraint measures.

Test Windows: Full-Term, Generally Rising, and Generally Falling Securities Market

Figure 1 presents the weekly performance of the S&P 500 index from September 2007 through December 2011. Our analysis is conducted across the full term, as well as a "generally falling" term and a "generally rising" term. The generally falling term is from September 14, 2007 through February 27, 2009, and spans 36 semi-monthly data points for 1,241 firms. The generally rising term is from March 13, 2009 through December 30, 2011, and spans 68 semi-monthly data points for the same 1,529 firms.

Figure 1. Weekly Performance for the S&P 500 large-cap and S&P 600 small-cap indices.
(September 2007 through December 2011, smoothed +/-1).



We hypothesize that short-selling constraints may exhibit an asymmetric pattern depending on the general character of the surrounding market context. Practitioners have claimed that market activity shows that securities lending firms are faced with more demand to short-sell during rising markets than during falling markets. It is argued that this occurs due to the notion that a rising securities market is more likely to exhibit differing investor expectations (CNBC 2008).

Short-selling constraints may also behave asymmetrically because the risk-to-reward ratio is unfavorable in a falling market versus a rising market. For example, a stock shorted at $35.00 has a maximum profit of $35.00 less shorting costs. If that same stock drops to $7.00, then the maximum profit is $7.00 less shorting costs. The potential loss, though, is unlimited in both cases. In addition, a depressed stock price introduces motivation for takeovers/acquisitions, motivation which may not have been present before the fall in stock price. Events like these can easily turn the short initiated at $7.00 into a substantial loss overnight. Hence, short positions generally get trimmed or closed out the lower the stock price goes. As a consequence, while short-selling constraints may be present in a falling market, they may not be as relevant as their rising market counterpart.

Test of Differences

Table 2 presents a difference of mean test for IO and RSI for each of the three groups of firms (all firms, large & mid-cap, and small & micro-cap). The test is conducted three times, once across option status, once across dividend status, and once across falling versus rising securities markets. Panel A contains results for all 1,582 firms, Panel B contains results for large and mid-cap firms only, and Panel C contains results for small and micro-cap firms only.

Panel A of Table 2 shows that the means of both IO and RSI are statistically higher in the case where the firm has exchange-traded options. With regard to IO, the results show that, on average, for firms with exchange-traded options, 70.10% of outstanding shares are institutionally owned, versus 40.98% for firms without exchange-traded options. This finding is consistent with Fehrs and Mendenhall (1994), who examined the average number of institutional investors of optioned stocks relative to a non-optioned control sample, and found that optioned stocks attract a greater number of institutional investors. Boehmer and Kelley (2009) found that stocks with greater IO are priced more efficiently to the extent that their prices more closely follow a random walk. The authors argued that if options attract institutional investors, and if institutional investors are more informed and sophisticated than the average investor, then greater institutional investor holdings will contribute to improved informational efficiency.

Panel A of Table 2 also presents results for tests of differences in IO and RSI based on the dividend-paying status of firms. In the case of IO, there is no difference in institutional holdings for dividend versus non-dividend paying firms. In the case of RSI, however, there appears to be reduced values for dividend paying firms. Consistent with Frank and Jagannathan (1998), dividend paying firms, on average, have lower levels of short interest than do non-dividend paying firms.

Finally, Panel A of Table 2 shows results for tests of differences in IO and RSI depending on whether the overall securities market (represented by the S&P 500 index) was "generally falling" or "generally rising". From September 2007 through February 2009, when the S&P 500 index was generally falling, stocks had statistically lower levels of IO and statistically higher levels of RSI, compared to the period March 2009 through December 2011, when the S&P 500 index was generally rising. Lower levels of institutional ownership during falling markets is consistent with the notion of "flight to quality", whereas higher levels of RSI during this same time frame is consistent with the idea of traders taking advantage of a generally falling market by increasing their short position across securities. Similar results were apparent regardless of firm size, as reported in Panels B and C of Table 2.

Individually Specified Constraint Variables

Past studies demonstrated that (individually or in some combinations) low levels of IO, high levels of RSI, the absence of exchange-traded options, and the presence of dividends are all consistent with the notion of a short-sale constraint. In this section of the study, individual firm returns are regressed on each of the aforementioned constraints individually to determine if the presence of any of the constraints translates to a reduction in the returns associated with the corresponding stock. The vector of control variables is included in each regression.

Table 3 provides semi-monthly return analysis for all 1,582 firms, from September 2007 through December 2011. The four columns of results coincide with IO, RSI, option status, and dividend status, respectively. Both IO and RSI are divided into terciles (low, mid, & high).[3] A random effects panel regression is used to control for both firm-specific and time-specific random effects and the Arellano (1987) version of the White (1980) heteroscedasticity-consistent covariance matrix corrected standard errors to control for heteroscedasticity and auto correlation. The model is used to test semi-monthly returns for 1,582 firms are shown as a function of the individual short-sale constraint proxies (IO, RSI, OPT, and DIV), controlling for the market, size, value, momentum, as well as option introduction and effects of the 2008 short-selling ban. Returns are expressed in percentages per half-month. *, ** denote statistical significance at the 0.05, and 0.01 levels, respectively.

The tercile representing the lowest short-sale constraint (high IO and low RSI) is used as the "base case." A test is then run to determine whether the two other terciles of that variable are statistically different from the corresponding base case with regard to their impact on firm returns.

A value of 1 is assigned if a firm has exchange-traded options, 0 otherwise. Similar to both IO and RSI, the least constrained condition (the presence of options) is used as the base case. A test is then run to determine whether the lack of tradable options has a statistically different impact on firm returns relative to that base case. The presence of exchange-traded options is considered to be the least constrained condition because options allow investors to bet on the downward movement in a stock without having to short the stock directly. Pessimistic investors can either buy puts or write calls.

Finally, a value of 1 is assigned if a firm pays a cash dividend in the current two-week period, 0 otherwise. Based on the results of Frank and Jagannathan (1998), a test is run to determine if cash dividends represent a material cost to short sellers when the stock price does not fall by the amount of the dividend. Based on their result, the absence of cash dividends is used as the least constrained case. It should be noted that a dividend-paying firm is categorized as "dividend-paying" only during the two-week period of an actual dividend payment. So although a firm may pay a consistent quarterly dividend throughout the study, it is categorized as "no dividend payment" during all months where no actual dividend is paid since we are interested only in the effect of an actual dividend payment. This variable definition is motivated by Asquith, Pathak, and Ritter (2005), who provide evidence that the median short position lasts 2-3 months. This is consistent with short sellers shorting stocks between quarterly dividend payment dates.

In Table 3, we observe all four individually specified constraints behaving in a manner universally consistent with theoretical expectations. The first two columns of Panel A present the results for IO and RSI. The results indicate that low levels of IO and high levels of RSI translate into lower firm returns at a statistically significant level, relative to high levels of IO and low levels of RSI, respectively. This is consistent with Miller's (1977) theory that short-sale constrained stocks will have artificially high prices and yield lower subsequent returns.

The third column tests the impact of exchange-traded options on firm returns. Again, consistent with individual specification expectations, the results indicate that the lack of a tradable option is associated with lower returns/inflated prices, a potential mechanism being the inability to take a synthetic short position via options. Finally, the fourth column of Panel A tests the impact that the presence of cash dividends has on firm returns. Like the previous three constraint proxies, presence of cash dividends also may imply a short-selling constraint and artificially higher prices and lower subsequent returns.

Table 2. Institutional Ownership and Relative Short Interest Across Option Status, Dividend Status, and Falling Versus Rising Securities Markets.

Panel A. All Firms (1,582)

SUMMARY STATISTICS							t-STATISTICS: DIFFERENCE OF MEANS					
		Mean	StdDev	Median	Min	Max		No Opt	Opt	Diff	t	
IO	No Opt	40.98	22.21	38.51	1.36	91.88	IO	40.98	70.10	-29.12	-28.30	**
	Opt	70.10	18.32	74.14	4.32	96.69						
RSI	No Opt	3.19	3.45	2.26	0.02	30.96	RSI	3.19	5.99	-2.80	-15.06	**
	Opt	5.99	4.30	4.97	0.12	34.90						
		Mean	StdDev	Median	Min	Max		No Div	Div	Diff	t	
IO	No Div	59.72	25.23	63.40	1.75	96.69	IO	59.72	61.35	-1.62	-1.29	
	Div	61.35	23.64	68.45	3.31	95.81						
RSI	No Div	5.42	4.50	4.62	0.02	34.00	RSI	5.42	4.49	0.93	4.30	**
	Div	4.49	3.82	3.41	0.03	34.90						
		Mean	StdDev	Median	Min	Max		Falling	Rising	Diff	t	
IO	Falling	56.86	23.81	62.47	1.19	93.37	IO	56.86	61.50	-4.64	-5.36	**
	Rising	61.50	24.91	67.61	1.73	98.53						
RSI	Falling	6.00	5.98	4.75	0.01	96.00	RSI	6.00	4.29	1.71	9.60	**
	Rising	4.29	3.83	3.23	0.02	26.58						

Panel B. Large & Mid-Cap (490)

		Mean	StdDev	Median	Min	Max		No Opt	Opt	Diff	t	
IO	No Opt	60.83	15.91	60.20	35.92	88.26	IO	60.83	76.54	-15.70	-3.53	**
	Opt	76.54	11.77	78.67	34.59	95.81						
RSI	No Opt	7.89	5.49	7.33	0.99	20.27	RSI	7.89	4.24	3.65	2.38	*
	Opt	4.24	3.40	3.11	0.71	34.90						
		Mean	StdDev	Median	Min	Max		No Div	Div	Diff	t	
IO	No Div	82.94	8.41	84.70	56.78	94.65	IO	82.94	75.00	7.94	7.55	**
	Div	75.00	11.94	76.89	35.53	95.81						
RSI	No Div	5.15	3.40	4.33	1.29	18.61	RSI	5.15	4.04	1.10	2.84	**
	Div	4.04	3.40	2.82	0.71	34.90						
		Mean	StdDev	Median	Min	Max		Falling	Rising	Diff	t	
IO	Falling	73.48	12.09	75.15	10.05	93.37	IO	73.48	77.78	-4.30	-5.54	**
	Rising	77.78	12.20	80.00	35.27	98.53						
RSI	Falling	4.89	5.71	3.19	0.58	96.00	RSI	4.89	3.93	0.96	3.31	**
	Rising	3.93	2.99	2.96	0.64	20.59						

Panel C. Small & Micro-Cap (1,092)

		Mean	StdDev	Median	Min	Max		No Opt	Opt	Diff	t	
IO	No Opt	40.57	22.15	37.38	1.36	91.88	IO	40.57	65.43	-24.86	-20.90	**
	Opt	65.43	20.67	69.16	4.32	96.69						
RSI	No Opt	3.10	3.33	2.24	0.02	30.96	RSI	3.10	7.27	-4.17	-19.24	**
	Opt	7.27	4.44	6.26	0.12	34.00						
		Mean	StdDev	Median	Min	Max		No Div	Div	Diff	t	
IO	No Div	55.83	25.02	58.64	1.75	96.69	IO	55.83	51.09	4.74	3.13	**
	Div	51.09	25.03	49.61	3.31	94.75						
RSI	No Div	5.46	4.66	4.63	0.02	34.00	RSI	5.46	4.83	0.64	2.41	*
	Div	4.83	4.09	3.92	0.03	23.34						
		Mean	StdDev	Median	Min	Max		Falling	Rising	Diff	t	
IO	Falling	49.40	24.01	51.05	1.19	92.52	IO	49.40	54.20	-4.80	-4.51	**
	Rising	54.20	25.69	55.71	1.73	98.25						
RSI	Falling	6.50	6.03	5.72	0.01	56.58	RSI	6.50	4.45	2.05	9.26	**
	Rising	4.45	4.15	3.38	0.02	26.58						

Table 3. Individual short-sale constraint proxies.

	All Firms (1,582) Sep 2007 through Dec 2011			
Intercept	-0.499 **	-0.611 **	-0.631 **	-0.645 **
	(-7.70)	(-8.23)	(-9.27)	(-9.34)
Rm - Rf	1.025 **	1.025 **	1.026 **	1.026 **
	(24.86)	(24.83)	(24.46)	(24.80)
SMB	0.759 **	0.759 **	0.758 **	0.758 **
	(11.22)	(11.20)	(11.03)	(11.18)
HML	0.073	0.071	0.070	0.070
	(1.165)	(1.13)	(1.08)	(1.10)
UMD	-0.110 **	-0.109 **	-0.109 **	-0.109 **
	(-4.18)	(-4.12)	(-4.08)	(-4.12)
Option Intro	1.145	1.130	1.195	1.128
	(1.63)	(1.60)	(1.70)	(1.60)
Short-Sell Ban	6.674 **	6.621 **	6.665 **	6.649 **
	(8.039)	(7.96)	(8.01)	(8.00)
Short-Sell Ban Removal	9.519 **	9.466 **	9.518 **	9.493 **
	(8.89)	(8.85)	(8.88)	(8.88)
Short-Sell Ban Residual	-2.328 *	-2.387 *	-2.340 *	-2.351 *
	(-2.44)	(-2.50)	(-2.45)	(-2.46)
Mid IO	-0.060			
	(-1.14)			
Low IO	-0.381 **			
	(-7.16)			
High RSI		-0.164 **		
		(-2.91)		
Mid RSI		-0.014		
		(-0.27)		
No Options			-0.117 *	
			(-2.56)	
Dividends				-0.309 **
				(-4.39)

Tests of Asymmetry for Individually Specified Constraint Variables

If the short-selling constraint variables behave symmetrically, then we should expect to find the same pattern on both the "generally falling" and "generally rising" markets as for the entire full-term analysis. Additionally, if the short-selling constraint variables apply equally to large/mid-cap firms as they do to small/micro-cap firms, then we should see no difference on the impact on returns based solely on market capitalization.

Institutional Ownership (IO)

We again break IO into terciles (high, mid, and low). We then assign a value of 1 if a firm is an S&P TMI large or mid-cap firm, 0 otherwise. We then assign a value of 1 if an observation rests in the generally falling market, which runs from September 2007 through February 2009, 0 otherwise. Table 4 then presents the results for the panel regression run on the 12 different possible combinations (3 * 2 * 2 = 12) of IO, market capitalization, and market direction. Eight different tests of differences are then run to determine if specific levels of IO behave as constraints if only paired with large or small-cap firms, and whether the constraints behave differently based on the prevailing market environment. A random effects panel regression is used to control for both firm-specific and time-specific random effects and the Arellano (1987) version of the White (1980) heteroscedasticity-consistent covariance matrix corrected standard errors to control for heteroscedasticity and auto correlation. The model is used to test semi-monthly returns for 1,582 firms as a function of the individual short-sale constraint proxy institutional ownership (IO), controlling for the market, size, value, momentum, option introduction, and the effects of the 2008 short-selling ban. Analysis is conducted across the 12 possible combinations of high, mid, or low IO, large/mid-cap firms versus small/micro-cap firms, and a generally falling versus generally rising market (3 * 2 * 2 = 12). The generally falling term is from September 14, 2007 through February 27, 2009, and spans 36 semi-monthly data points. The generally rising term is from March 13, 2009 through December 30, 2011, and spans 68 semi-monthly data points. Returns are expressed in percentages per half-month. *, ** denote statistical significance at the 0.05, and 0.01 levels, respectively. Tests of differences are conducted to determine if specific combinations differ from one another at a statistically significant level.

Table 4 (Institutional Ownership). Combinations of institutional ownership, market capitalization, and market direction.

Sep 2007 through Dec 2011	
Institutional Ownership (IO)	
Rm - Rf	1.007 **
	(25.36)
SMB	0.771 **
	(12.01)
HML	0.076
	(1.27)
UMD	-0.106 **
	(-4.35)
Option Intro	1.188
	(1.69)
Short-Sell Ban	6.690 **
	(8.04)
Short-Sell Ban Removal	9.460 **
	(8.84)
Short-Sell Ban Residual	-2.294 *
	(-2.40)
Low IO, LG-Cap, Falling	-1.091 **
	(-4.10)
Low IO, LG-Cap, Rising	-0.433 **
	(-3.41)
Low IO, SM-Cap, Falling	-1.363 **
	(-8.26)
Low IO, SM-Cap, Rising	-0.640 **
	(-6.05)
Mid IO, LG-Cap, Falling	-0.613 **
	(-3.34)
Mid IO, LG-Cap, Rising	-0.362 **
	(-4.47)
Mid IO, SM-Cap, Falling	-1.157 **
	(-6.14)
Mid IO, SM-Cap, Rising	-0.369 **
	(-3.37)
High IO, LG-Cap, Falling	-0.535 **
	(-3.54)
High IO, LG-Cap, Rising	-0.332 **
	(-4.18)
High IO, SM-Cap, Falling	-1.277 **
	(-6.24)
High IO, SM-Cap, Rising	-0.309 **
	(-2.99)

Test of Differences			
	Variable	Param	Stat
Test 4.1	Low IO, LG-Cap, Falling	-1.091	
	Low IO, LG-Cap, Rising	-0.433	(4.20) *
Test 4.2	Low IO, SM-Cap, Falling	-1.363	
	Low IO, SM-Cap, Rising	-0.640	(10.89) **
Test 4.3	High IO, LG-Cap, Falling	-0.535	
	High IO, LG-Cap, Rising	-0.332	(1.09)
Test 4.4	High IO, SM-Cap, Falling	-1.277	
	High IO, SM-Cap, Rising	-0.309	(14.54) **
Test 4.5	Low IO, LG-Cap, Falling	-1.091	
	Low IO, SM-Cap, Falling	-1.363	(1.20)
Test 4.6	Low IO, LG-Cap, Rising	-0.433	
	Low IO, SM-Cap, Rising	-0.640	(2.93)
Test 4.7	High IO, LG-Cap, Falling	-0.535	
	High IO, SM-Cap, Falling	-1.277	(15.56) **
Test 4.8	High IO, LG-Cap, Rising	-0.332	
	High IO, SM-Cap, Rising	-0.309	(0.09)

Four of the eight tests yield differences in IO. Test 4.1 shows that low levels of IO, when paired with large/mid-cap firms, has a statistically different impact on returns based on the prevailing market environment. Specifically, the constraint is more binding in a falling market than in a rising market. Test 4.2 shows that this previous result applies to small/micro-cap firms as well. At the other end of the spectrum, Test 4.4 reveals that high levels of IO, when paired with small/micro-cap firms, also behaves differently depending on the direction of the market. Finally, Test 4.7 shows that high levels of IO, combined with a falling market, have different impacts on returns based on firm size.

Relative Short Interest (RSI)

Like IO, we also break RSI into terciles (high, mid, and low). We again assign a value of 1 if a firm is and S&P TMI large or mid-cap firm, 0 otherwise, and a value of 1 if an observation rests in the generally falling market, 0 otherwise. Table 5 then presents the results for the panel regression run on the 12 different possible combinations (3 * 2 * 2 = 12) of RSI, market capitalization, and market direction. Again, eight different tests of differences are then run to determine if specific levels of RSI behave as constraints if only paired with large or small-cap firms, and whether the constraints behave differently based on the prevailing market environment.

Test 5.2 shows that low levels of RSI, when combined with small/micro-cap firms, impacts returns more strongly in a falling market then in a rising market; Tests 5.3 and 5.4 indicate that high levels of RSI, when examined for either large/mid-cap or small/micro-cap firms, acts similarly. Tests 5.5 and 5.8 reveal that both low RSI combined with a falling securities market, and high RSI combined with a rising market, have a more significant impact on returns for small/micro-cap firms than for their large/mid-cap counterparts.

Option Status (OPT)

A value of 1 is assigned to any stock that has exchange-traded options, 0 otherwise. We again assign a value of 1 if a firm is an S&P TMI large or mid-cap firm, 0 otherwise, and a value of 1 if an observation rests in the generally falling market, 0 otherwise. Table 6 then presents the results for the panel regression run on the 8 different possible combinations (2 * 2 * 2 = 8) of OPT, market capitalization, and market direction. Once again, eight different tests of differences are then run to determine if the lack of exchange-traded options acts as a constraint if only paired with either large/mid-cap or small/micro-cap firms, and whether the constraint is only binding in either falling or rising markets.

Tests 6.1 and 6.2 are interesting in that they show that the impact on returns for a lack of options for either large/mid-cap or small/micro-cap firms differs depending on the direction of the market. More interesting still is that, for large/mid-cap firms, the effect of option status is more binding in a rising market, whereas for small/micro-cap firms, the effects of option status is more binding in a falling market. An economic justification for this result is elusive, given that, at this point, we are looking at options in isolation. Test 6.4 indicates that the return for optioned small/micro-cap firms is statistically different between rising and falling securities markets. Tests 6.5 and 6.6 show a size differential for non-optioned stocks in both a falling (Test 6.5) and rising (Test 6.6) securities market. Finally, Test 6.7 shows that the return differential across firm size is also statistically different for optioned stocks in a falling market.

Dividend Status (DIV)

A value of 1 is assigned to a stock that pays a cash dividend in the upcoming two-week period, 0 otherwise. In this case, a dividend-paying firm will be assigned a value of 0 between dividend payments, and a value of 1 only during the two-week period of an actual cash dividend. The purpose for this is to solely test the effect of an actual dividend payment on the decision of a short seller. We then assign a value of 1 if a firm is an S&P TMI large or mid-cap firm, 0 otherwise, and a value of 1 if an observation rests in the generally falling market, 0 otherwise. Table 7 then presents the results for the panel regression run on the 8 different possible combinations (2 * 2 * 2 = 8) of DIV, market capitalization, and market direction. Eight different tests of differences are then run to determine if the presence of cash dividends act as a constraint if only paired with either large/mid-cap or small/micro-cap firms, and whether the constraint is only binding in either falling or rising markets.

Concluding Remarks

Using S&P Total Market Index firm data from September 2007 through December 2011, we assessed the pricing of a variety of short sale constraints. Lower subsequent returns (artificially higher prices) are associated with low IO, high RSI, lack of exchange-traded options, and presence of cash dividends. Parsing the full term into generally falling and generally rising markets, we find substantial support for asymmetry in the pricing of constraints. We ultimately find that, controlling for market capitalization, short-sale constraints are more binding in a generally rising market than in a generally falling one.

Our study suggests practical guidance for short sellers, since many of our results imply substantive pricing outcomes. Public policy changes may also be implied; since investors may be able to apply these outcomes to more closely identify over- or under-valued stocks, it may be in the public interest to increase market liquidity by increasing the frequency and quality of information used by short-sellers and to improve the collection and archiving of short-sale activity information. Promoting the possibility of synthetic short positions through greater availability of option structures for small and micro-cap stocks may also have the potential of curbing over-valuation of stocks by enabling pessimistic influences.

Different constraint effects in generally falling and generally rising markets suggest that asymmetry could be a significant effect in other studies. Finally, the significant results from our extension to small- and micro-cap stocks suggest that the lack of options, which is predominantly a small firm issue, may significantly deter synthetic short positions, and that firm size and related liquidity or information availability effects should be considered when drawing conclusions regarding short-sale constraints.

Table 5 (Relative Short Interest). Combinations of relative short interest, market capitalization, and market direction.

Sep 2007 through Dec 2011	
Relative Short Interest (RSI)	
Rm - Rf	1.007 **
	(25.24)
SMB	0.772 **
	(11.96)
HML	0.074
	(1.24)
UMD	-0.104 **
	(-4.25)
Option Intro	1.198
	(1.70)
Short-Sell Ban	6.694 **
	(8.05)
Short-Sell Ban Removal	9.449 **
	(8.81)
Short-Sell Ban Residual	-2.309 *
	(-2.41)
Low RSI, LG-Cap, Falling	-0.257
	(-1.76)
Low RSI, LG-Cap, Rising	-0.464 **
	(-5.99)
Low RSI, SM-Cap, Falling	-1.333 **
	(-7.51)
Low RSI, SM-Cap, Rising	-0.393 **
	(-3.53)
Mid RSI, LG-Cap, Falling	-0.683 **
	(-4.09)
Mid RSI, LG-Cap, Rising	-0.343 **
	(-4.06)
Mid RSI, SM-Cap, Falling	-1.163 **
	(-5.63)
Mid RSI, SM-Cap, Rising	-0.500 **
	(-5.34)
High RSI, LG-Cap, Falling	-1.045 **
	(-5.57)
High RSI, LG-Cap, Rising	-0.168
	(-1.61)
High RSI, SM-Cap, Falling	-1.341 **
	(-7.89)
High RSI, SM-Cap, Rising	-0.583 **
	(-4.79)

Test of Differences			
	Variable	Param	Stat
Test 5.1	Low RSI, LG-Cap, Falling	-0.257	
	Low RSI, LG-Cap, Rising	-0.464	(1.35)
Test 5.2	Low RSI, SM-Cap, Falling	-1.333	
	Low RSI, SM-Cap, Rising	-0.393	(15.98) **
Test 5.3	High RSI, LG-Cap, Falling	-1.045	
	High RSI, LG-Cap, Rising	-0.168	(12.20) **
Test 5.4	High RSI, SM-Cap, Falling	-1.341	
	High RSI, SM-Cap, Rising	-0.583	(10.29) **
Test 5.5	Low RSI, LG-Cap, Falling	-0.257	
	Low RSI, SM-Cap, Falling	-1.333	(53.65) **
Test 5.6	Low RSI, LG-Cap, Rising	-0.464	
	Low RSI, SM-Cap, Rising	-0.393	(0.82)
Test 5.7	High RSI, LG-Cap, Falling	-1.045	
	High RSI, SM-Cap, Falling	-1.341	(3.03)
Test 5.8	High RSI, LG-Cap, Rising	-0.168	
	High RSI, SM-Cap, Rising	-0.583	(13.30) **

Table 6 (Option Status). Combinations of option status, market capitalization, and market direction.

Sep 2007 through Dec 2011	
Options (Opt)	
Rm - Rf	1.007 **
	(25.75)
SMB	0.711 **
	(12.19)
HML	0.072
	(1.23)
UMD	-0.105 **
	(-4.38)
Option Intro	1.133
	(1.61)
Short-Sell Ban	6.606 **
	(7.93)
Short-Sell Ban Removal	9.368 **
	(8.76)
Short-Sell Ban Residual	-2.374 *
	(-2.48)
No Opt, LG-Cap, Falling	0.508
	(1.94)
No Opt, LG-Cap, Rising	-1.280 **
	(-3.71)
No Opt, SM-Cap, Falling	-1.151 **
	(-7.32)
No Opt, SM-Cap, Rising	-0.545 **
	(-5.28)
Opt, LG-Cap, Falling	-0.670 **
	(-4.85)
Opt, LG-Cap, Rising	-0.348 **
	(-4.81)
Opt, SM-Cap, Falling	-1.483 **
	(-8.39)
Opt, SM-Cap, Rising	-0.439 **
	(-4.43)

Test of Differences			
	Variable	Param	Stat
Test 6.1	No Opt, LG-Cap, Falling	0.508	
	No Opt, LG-Cap, Rising	-1.280	(20.47) **
Test 6.2	No Opt, SM-Cap, Falling	-1.151	
	No Opt, SM-Cap, Rising	-0.545	(8.10) **
Test 6.3	Opt, LG-Cap, Falling	-0.670	
	Opt, LG-Cap, Rising	-0.348	(3.36)
Test 6.4	Opt, SM-Cap, Falling	-1.483	
	Opt, SM-Cap, Rising	-0.439	(20.33) **
Test 6.5	No Opt, LG-Cap, Falling	0.508	
	No Opt, SM-Cap, Falling	-1.151	(43.27) **
Test 6.6	No Opt, LG-Cap, Rising	-1.280	
	No Opt, SM-Cap, Rising	-0.545	(4.55) *
Test 6.7	Opt, LG-Cap, Falling	-0.670	
	Opt, SM-Cap, Falling	-1.483	(38.17) **
Test 6.8	Opt, LG-Cap, Rising	-0.348	
	Opt, SM-Cap, Rising	-0.439	(2.27)

Table 7 (Dividend Status)
Combinations of dividend status, market capitalization, and market direction.

Sep 2007 through Dec 2011	
Dividends (Div)	
Rm - Rf	1.007 **
	(25.42)
SMB	0.771 **
	(12.04)
HML	0.073
	(1.23)
UMD	-0.104 **
	(-4.29)
Option Intro	1.201
	(1.70)
Short-Sell Ban	6.684 **
	(8.04)
Short-Sell Ban Removal	9.453 **
	(8.83)
Short-Sell Ban Residual	-2.305 *
	(-2.41)
No Div, LG-Cap, Falling	-0.613 **
	(-4.49)
No Div, LG-Cap, Rising	-0.284 **
	(-3.80)
No Div, SM-Cap, Falling	-1.314 **
	(-8.53)
No Div, SM-Cap, Rising	-0.456 **
	(-4.79)
Div, LG-Cap, Falling	-0.943 **
	(-4.18)
Div, LG-Cap, Rising	-0.814 **
	(-7.74)
Div, SM-Cap, Falling	-1.170 **
	(-4.41)
Div, SM-Cap, Rising	-1.007 **
	(-7.20)

Test of Differences			
	Variable	Param	Stat
Test 7.1	No Div, LG-Cap, Falling	-0.613	
	No Div, LG-Cap, Rising	-0.284	(0.23)
Test 7.2	No Div, SM-Cap, Falling	-1.314	
	No Div, SM-Cap, Rising	-0.456	(0.27)
Test 7.3	Div, LG-Cap, Falling	-0.943	
	Div, LG-Cap, Rising	-0.814	(3.56)
Test 7.4	Div, SM-Cap, Falling	-1.170	
	Div, SM-Cap, Rising	-1.007	(17.53) **
Test 7.5	No Div, LG-Cap, Falling	-0.613	
	No Div, SM-Cap, Falling	-1.314	(0.58)
Test 7.6	No Div, LG-Cap, Rising	-0.284	
	No Div, SM-Cap, Rising	-0.456	(1.77)
Test 7.7	Div, LG-Cap, Falling	-0.943	
	Div, SM-Cap, Falling	-1.170	(48.52) **
Test 7.8	Div, LG-Cap, Rising	-0.814	
	Div, SM-Cap, Rising	-1.007	(11.23) **

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Notes

1. Criteria for S&P TMI inclusion can be found at: https://www.sp-indexdata.com/idpfiles/indexalert/prc/active/factsheets/fs-sp-total-market-index-ltr.pdf
2. Monthly risk-free rates of return are multiplied by 0.50 and applied to both mid and end-of-month regressions.
3. The distribution of RSI is non-linear with approximately 97% of its values falling below 23%. However, the range of RSI values extends beyond 100%. Terciles were therefore still employed since extreme values of RSI, while few in number, represent valid data points.

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Valuation of Flex Bonus Certificates - Theory and Evidence

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Abstract

In this paper we introduce a new financial product named Flex Bonus Certificates (FBC) and provide detailed descriptions of the product specifications. We show that the payoff of a FBC can be duplicated by the combination of five positions. A pricing formula is developed and a certificate is presented as an example to examine how well the model fits empirical data. The results show that issuing FBCs is a profitable business and the results are in line with previous studies pricing other structured products. Finally, we simulate and present the sensitivities of FBCs to changes in different pricing input variables.

Introduction

Structured financial products – i.e. newly created securities that combine fixed income securities, equities, and derivative securities – have been growing explosively in volume and complexity during the last two decades (Das, 2001; Hernandez et al., 2010). Earlier structured financial products were mainly engineered from fixed income securities, equities, and *plain vanilla* derivatives (e.g. Equity Linked Certificates of Deposit, Outperformance Certificates, Discount Certificates and Reverse Convertible Bonds). Later, issuers of structured financial products begin to incorporate exotic derivatives into these newly created securities in order to provide extra capital protection if the underlying asset price does not breach a lower barrier (e.g. Bonus Certificates and Knock-In Reverse Convertible). Several studies in the literature emphasize this new trend of more complex securities. For example in Hernandez et al. (2008), the authors analyze the Bonus Certificates €123 billion market by examining a sample of 5,560 issues outstanding in August 2005 issued by banks in Europe. Bonus Certificates could be considered a second generation of Outperformance Certificates *"upgraded"* with barrier options to provide extra capital protection as long as the underlying asset price does not breach a lower barrier.

More recently, issuers of structured financial products began to incorporate multiple layers of capital protection. One of the particularly interesting structured products recently created by investment banks with multiple layers of capital protection is known as the Flex Bonus Certificates (to be referred to as FBC henceforth). The rate of return on the investment in one FBC certificate is contingent upon the performance of a pre-determined underlying asset over a pre-specified period (known as observation period). As long as the underlying asset price has never reached a predetermined level (which is usually set below the initial price of the underlying asset and referred to as the knock-out level 1) during the observation period, the investors of the certificates will receive a return equal to the maximum of the return based on a minimum redemption level (i.e. minimum redemption level 2) and the return based on the final value of the underlying asset price (Scenario 1). If the underlying asset price ever reaches the knock-out level 1 but never reaches a lower knock-out level (i.e. knock-out level 2) during the observation period, the investors of the certificates will receive a return equal to the maximum of the return based on a lower minimum redemption level (i.e. minimum redemption level 1) and the return based on the final value of the underlying asset price (Scenario 2). Finally, if the underlying asset price ever reaches the knock-out level 2 during the observation period, the investors of the certificates will receive a return equal to the return of the underlying asset price (Scenario 3). In calculating the return on the underlying asset, the certificate issuers use only the change in the asset price; the cash dividends paid during the period are not included. In other words, investors in the FBC do not receive cash dividends even though the underlying assets pay dividends during the term to maturity. The appendix is an example of a Flex Bonus Certificate.

The purpose of the paper is to extend Hernandez et al. (2008) to Flex Bonus Certificates and provide an in-depth economic analysis for the certificates to explore how the principles of financial engineering are applied to the creation of new structured products. A pricing model for the certificates is developed by using option pricing formulas. In addition, an example of a FBC issued on January 5, 2006 by UniCredit Bank Aktiengesellschaft (formerly Bayerische Hypo- und Vereinsbank AG, commonly referred to as HypoVereinsbank or HVB to be referred to as HVB henceforth), a well-recognized large bank in Europe, is presented. In this example, the certificate is priced by calculating the cost of a portfolio with a payoff similar to the payoff of the certificate. Whether issuers of Flex Bonus Certificates earn a profit in the primary market is a question answered in the paper.

The rest of the paper is organized as follows: The description of the certificates is introduced in the second section. The pricing model is developed in the third section. In the following section, an example of a FBC is presented and the profit for issuing the certificate is calculated using the model developed in the previous section. In the following section, the Greeks of the Certificates are presented. In the final section the conclusions are presented.

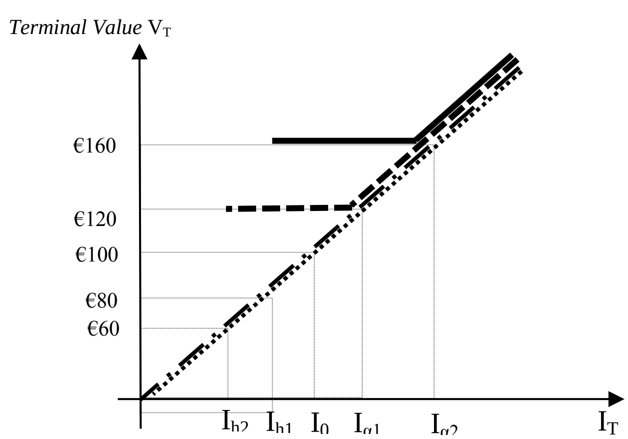
Description of the product

The rate of return of a certificate is contingent upon the price performance of its underlying asset during the observation period. The beginning date of the observation period is known as the initial fixing date and the ending date of the period is known as the final fixing date. The price of the underlying asset on the initial fixing date is referred to as the initial fixing level, and the price of the underlying asset on the expiration date is referred to as the final fixing level. If we define I_0 as the initial fixing level, I_{h1} as the knock-out level 1, I_{h2} as the knock-out level 2, $I_{\alpha 1}$ ($\equiv I_0\,(1+\alpha_1)$) as the minimum redemption level 1, $I_{\alpha 2}$ ($\equiv I_0\,(1+\alpha_2)$) as the minimum redemption level 2, and I_T as the final fixing level, then for an initial investment of €1 in a FBC, the total value that an investor will receive on the expiration date (known as the *redemption value* or settlement amount), V_T, is equal to:

$$V_T = €1\ x \begin{cases} (1+\alpha_2) & \text{if all } I_t > I_{h_1},\ t \in [0;T] \text{ and } I_T \le I_{\alpha_2} \\ (1+\alpha_1) & \text{if all } I_t > I_{h_2},\ t \in [0;T] \text{ and } I_{h_2} \le I_T \le I_{\alpha_1} \\ \dfrac{I_T}{I_0} & \text{Otherwise} \end{cases}$$

Alternatively, the relationship between the terminal value of a certificate and the terminal value of the underlying asset based on the change in the underlying asset price (without taking into account dividends) with a knock-out level 1 at 80% of the initial fixing level, a knock-out level 2 at 60% of the initial fixing level, a minimum redemption level 1 at 120% of the initial fixing level, and a minimum redemption level 2 at 160% of the initial fixing level can be represented in Figure 1. The solid line in Figure 1 represents the terminal value of the certificate on maturity day T as a function of the terminal value of the underlying index when the knock-out level 1 is never broken over the term of maturity (Scenario 1). The dashed line represents the terminal value of the certificate on maturity day T, as a function of the terminal value of the underlying index when the knock-out level 1 is broken over the term of maturity but the knock-out level 2 is not (Scenario 2). The long dash dotted line represents the terminal value of the certificate on maturity day T as a function of the terminal value of the underlying index when the knock-out level 2 is broken over the term of maturity (Scenario 3). The dotted line represents the terminal value of the underlying asset. The slope for the value of the underlying asset (dotted line) is, of course, one. The slope for the value of the certificate when participating in the performance of the underlying asset (solid line, dashed line, and long dash dotted line) is also one.

Figure 1: The terminal value of an investment in a Flex Bonus Certificate



The pricing of Flex Bonus Certificates

Repayment Scenario 1

The terminal value from Equation (1), V_T, for an initial investment in one FBC with knock-out level 1, I_{h1}, minimum redemption level 2, $I_{\alpha 2}$, and term to maturity T, when the underlying asset price has never reached the knock-out level 1 during the observation period, can be expressed mathematically as:

$$V_T = \frac{€1}{I_0}\begin{cases} I_T & \text{if } I_T > I_{\alpha_2} \\ I_0\left(1+\alpha_2\right) & \text{if } I_T \le I_{\alpha_2} \end{cases} \tag{1}$$

$$= €1\left(1+\alpha_2\right) + \frac{€1}{I_0}\max\left[0, I_T - I_0\left(1+\alpha_2\right)\right] \tag{2}$$

The €1(1+α_2) in Equation (2) is the payoff of a long position in one zero coupon bond with a face value equal to €1(1+α_2). The payoff max[0,I_T-I_0(1+α_2)] in Equation (2) is the payoff of a long position for a call option on the underlying asset with an exercise price I_0(1+α_2). So the payoff for investing in one FBC as presented in Equation (2) (i.e. as long as the underlying asset price has never reached the knock-out level 1 during the observation period) is the same as the combined payoffs of taking the following two positions:

1. A long position in one zero coupon bond with a face value equal to €1(1+α_2) and a maturity date the same as the maturity date of the certificate;
2. A long position in €1/I_0 shares of call options on the underlying asset. The exercise price of the option is I_0(1+α_2), and the term to expiration is T, the same as the term to maturity of the certificate.

Position 1, a long position in one zero coupon bond with a face value equal to €1(1+α_2) can be replicated by a long position in one zero coupon bond with a face value equal to €1(1+α_1) plus a long position in one zero coupon bond with face value equal to €1(α_2-α_1), both bonds with maturity date the same as the maturity date of the certificate. Thus, the payoff for investing in one FBC as presented in Equation (2) (i.e. as long as the underlying asset price has never reached the knock-out level 1 during the observation period) is the same as the combined payoffs of taking the following three positions:

1. A long position in one zero coupon bond with a face value equal to €1(1+α_1) and a maturity date the same as the maturity date of the certificate;
2. A long position in one zero coupon bond with a face value equal to €1(α_2-α_1) and a maturity date the same as the maturity date of the certificate;
3. A long position in €1/I_0 shares of call options on the underlying asset. The exercise price of the option is I_0(1+α_2), and the term to expiration is T, the same as the term to maturity of the certificate.

Repayment Scenario 2

The terminal value from Equation (1), V_T, for an initial investment in one FBC with knock-out level 1, I_{h1}, knock-out level 2, I_{h2}, minimum redemption level 1, $I_{\alpha 1}$, and term to maturity T, when the underlying asset price has reached the knock-out level 1 but has not reached the knock-out level 2 during the observation period, can be expressed mathematically as:

$$V_T = \frac{€1}{I_0}\begin{cases} I_T & \text{if } I_T > I_{\alpha_1} \\ I_0\left(1+\alpha_1\right) & \text{if } I_T \le I_{\alpha_1} \end{cases}$$
$$= €1\left(1+\alpha_1\right) + \frac{€1}{I_0}\max\left[0, I_T - I_0\left(1+\alpha_1\right)\right] \tag{3}$$

The €1(1+α_1) in Equation (3) is the payoff for a long position in one zero coupon bond with a face value equal to €1(1+α_1). The payoff max[0,I_T-I_0(1+α_1)] in Equation (3) is the payoff of a long position for a call option on the underlying asset with an exercise price I_0(1+α_1). So the payoff for investing in one FBC as presented in Equation (3) (i.e. as long as the underlying asset price has reached the knock-out level 1 but never reached the knock-out level 2 during the observation period) is the same as the combined payoffs of taking the following two positions:

1. A long position in one zero coupon bond with a face value equal to €1(1+α_1) and a maturity date the same as the maturity date of the certificate;
2. A long position in €1/I_0 shares of call options on the underlying asset. The exercise price of the option is I_0(1+α_1), and the term to expiration is T, the same as the term to maturity of the certificate.

Repayment Scenario 3

The terminal value from Equation (1), V_T, when the underlying asset price has reached the knock-out level 2, I_{h2}, during the observation period can be expressed mathematically as:

$$V_T = (€1/I_0) \text{ x } I_T \tag{4}$$

The I_T in Equation (4) is the payoff for a long position in the underlying asset. So the payoff for investing in one FBC as presented in Equation (4) (i.e. when the underlying asset price has reached the knock-out level 2 during the observation period) is the same as the payoff of a long position in the underlying asset. A long position in the underlying asset, from the put-call parity, can be synthetically replicated by the combination of a long position in a zero coupon bond, a short position in put options and a long position in call options.

Replicating Portfolio One

The combination of the replicating portfolios for the payoffs presented in Equation (2) (i.e. when the underlying asset price has never reached the knock-out level 1during the observation period), Equation (3) (i.e. when the underlying asset price has reached the knock-out level 1 but never reached the knock-out level 2 during the observation period), and Equation (4) (i.e. when the underlying asset price has reached the knock-out level 2 during the observation period) results in the replicating portfolio for the payoff for investing in one FBC and such payoff is the same as the combined payoff of taking the following six positions:

1. A long position in €1(1+α_1) down-and-out cash-or-nothing options. The barrier of the option is I_{h1} and the term to expiration of the option is T, the same as the term to maturity of the certificate.
2. A long position in €1(α_2-α_1) down-and-out cash-or-nothing options. The barrier of the option is I_{h1} and the term to expiration of the option is T, the same as the term to maturity of the certificate.
3. A long €1/I_0 shares of down-and-out call options on the underlying asset. The exercise price of the option is I_0(1+α_2), the barrier of the option is I_{h1}, and the term to expiration is T, the same as the term to maturity of the certificate.
4. A long position in €1(1+α_1) down-and-in cash-or-nothing options. The barrier of the option is I_{h1} and the term to expiration of the option is T, the same as the term to maturity of the certificate.
5. A short position in €1/I_0 shares of down-and-in put options on the underlying asset. The exercise price of the option is I_0(1+α_1), the barrier of the option is I_{h2}, and the term to expiration is T, the same as the term to maturity of the certificate.
6. A long position in €1/I_0 shares of down-and-in call options on the underlying asset. The exercise price of the option is I_0(1+α_1), the barrier of the option is I_{h1}, and the term to expiration is T, the same as the term to maturity of the certificate.

Based on the In-Out Parity (Hull; 2003), the value of a regular call equals the value of a down-and-out call, C_{do}, plus the value of a down-and-in call, C_{di}.

$$C = C_{do} + C_{di} \tag{5}$$

Solving for C_{do},

$$C_{do} = C - C_{di} \tag{6}$$

Thus, Position 3 is equivalent to:

1. A long position in €1/I_0 shares of call options on the underlying asset. The exercise price of the option is I_0(1+α_2)and the term to expiration is T, the same as the term to maturity of the certificate.
2. A short position in €1/I_0 shares of down-and-in call options on the underlying asset. The exercise price of the option is I_0(1+α_2), the barrier of the option is I_{h1}, and the term to expiration is T, the same as the term to maturity of the certificate.

Moreover, based on the in-out parity, the value of a zero coupon bond with a face value equal to€1(1+α_1) and a term to expiration T equals the value of €1(1+α_1) down-and-out cash-or-nothing options with term to expiration T and barrier I_{h1}, plus the value of €1(1+α_1) down-and-in cash-or-nothing options with term to expiration T and barrier I_{h1}. Thus, Position 1 and Position 4 combined is equivalent to:

1. A long position in one zero coupon bond with a face value equal to €1(1+α_1) and a maturity date the same as the maturity date of the certificate;

So, the portfolio of securities with the same payoff as the payoff of a FBC can be simplified to six positions:

1. A long position in one zero coupon bond with a face value equal to €1(1+α_1) and a maturity date the same as the maturity date of the certificate;
2. A short position in €1/I_0 shares of down-and-in put options on the underlying asset. The exercise price of the option is I_0(1+α_1), the barrier of the option is I_{h2}, and the term to expiration is T, the same as the term to maturity of the certificate.
3. A long position in €1(α_2-α_1) down-and-out cash-or-nothing call options. The barrier of the option is I_{h1} and the term to expiration of the option is T, the same as the term to maturity of the certificate.
4. A long position in €1/I_0 shares of down-and-in call options on the underlying asset. The exercise price of the option is I_0(1+α_1), the barrier of the option is I_{h1}, and the term to expiration is T, the same as the term to maturity of the certificate.
5. A short position in €1/I_0 shares of down-and-in call options on the underlying asset. The exercise price of the option is I_0(1+α_2), the barrier of the option is I_{h1}, and the term to expiration is T, the same as the term to maturity of the certificate.
6. A long position in €1/I_0 shares of call options on the underlying asset. The exercise price of the option is I_0(1+α_2)and the term to expiration is T, the same as the term to maturity of the certificate.

Since the payoff of FBC is the same as the combined payoffs of the above six positions, the fair value of the certificate can be calculated based on the value of the six positions. Any selling price of the certificate above the value of the above six positions is the gain to the certificate issuer. The value of Position 1 is the price of a zero coupon bond with a face value €1$(1+\alpha_1)$ and maturity date T. So it has a value of €1$(1+\alpha_1)$ e^{-rT}. The value of Position 2 is the value of €1/I_0 shares of down-and-in put options on the underlying asset with term to expiration T, the same as the term to maturity of the certificate, and each option having the value P^{di}:

$$P^{di} = -I_0 e^{-qT} N(-x_1) + Xe^{-rT} N\left(-x_1 + \sigma\sqrt{T}\right) + I_0 e^{-qT}\left(\frac{H}{I_0}\right)^{2\lambda}\left[N(y) - N(y_1)\right]$$
$$- Xe^{-rT}\left(\frac{H}{I_0}\right)^{2\lambda-2}\left[N\left(y-\sigma\sqrt{T}\right) - N\left(y_1 - \sigma\sqrt{T}\right)\right] \qquad (7)$$

$$x_1 = \frac{\ln\left(\frac{I_0}{H}\right)}{\sigma\sqrt{T}} + \lambda\sigma\sqrt{T} \qquad y_1 = \frac{\ln\left(\frac{H}{I_0}\right)}{\sigma\sqrt{T}} + \lambda\sigma\sqrt{T}$$

$$y = \frac{\ln\left(\frac{H^2}{I_0 X}\right)}{\sigma\sqrt{T}} + \lambda\sigma\sqrt{T} \qquad \lambda = \frac{(r-q) + \frac{\sigma^2}{2}}{\sigma^2}$$

Where r is the risk-free rate of interest, q is the dividend yield of the underlying assets, X ($\equiv I_0(1+\alpha_1)$) is the exercise price, H is the knock-out level ($\equiv I_{h2}$), and σ is the standard deviation of the underlying asset return.

The value of Position 3 is the value of €1$(\alpha_2-\alpha_1)$ down-and-out cash-or-nothing call options with each option having the value CN_c^{do}:

$$CN_c^{do} = e^{-rT} N\left(d_1 - \sigma\sqrt{T}\right) - e^{-rT}\left(\frac{H}{I_0}\right)^{2\mu} N\left(d_2 - \sigma\sqrt{T}\right) \qquad (8)$$

where H is the knock-out level ($\equiv I_{h1}$), and

$$d_1 = \frac{\ln\left(\frac{I_0}{H}\right) + \left(r - q + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \qquad d_2 = \frac{\ln\left(\frac{H}{I_0}\right) + \left(r - q + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \qquad \mu = \frac{r - q - \frac{\sigma^2}{2}}{\sigma^2}$$

Denoting

$$A = I_0 e^{-qT} N(d_3) - Xe^{-rT} N(d_3 - \sigma\sqrt{T}) \qquad (9)$$

$$B = I_0 e^{-qT}\left(\frac{H}{I_0}\right)^{2(\mu+1)} N(d_4) - Xe^{-rT}\left(\frac{H}{I_0}\right)^{2\mu} N\left(d_4 - \sigma\sqrt{T}\right) \qquad (10)$$

$$C = \left[e^{-rT} N\left(d_1 - \sigma\sqrt{T}\right) - \left(\frac{H}{I_0}\right)^{2\mu} N\left(d_2 - \sigma\sqrt{T}\right)\right] \qquad (11)$$

$$D = \left[\left(\frac{H}{I_0}\right)^{\mu+\lambda} N(z) + \left(\frac{H}{I_0}\right)^{\mu-\lambda} N\left(z - 2\lambda\sigma\sqrt{T}\right)\right] \qquad (12)$$

where

$$d_3 = \frac{\ln\left(\frac{I_0}{X}\right) + \left(r - q + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \qquad d_4 = \frac{\ln\left(\frac{H^2}{I_0 X}\right) + \left(r - q + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}$$

$$z = \frac{\ln\left(\frac{H}{I_0}\right) + \lambda\sigma^2 T}{\sigma\sqrt{T}} \qquad \lambda = \sqrt{\mu^2 + \frac{2r}{\sigma^2}}$$

The value of Position 4 is the value of €1/I_0 down-and-in call options with exercise price X ($\equiv I_0(1+\alpha_1)$), knock-out level H($\equiv I_{h1}$), term to expiration T, and each option having the value C_1^{di}:

$$C_1^{di} = B + C \qquad (13)$$

The value of Position 5 is the value of €1/I_0 down-and-in call options with exercise price X ($\equiv I_0(1+\alpha_1)$), knock-out level H($\equiv I_{h1}$), term to expiration T, and each option having the value C_2^{di}:

$$C_2^{di} = B + C \qquad (14)$$

The value of Position 6 is the value of €1/I_0 call options with an exercise price X(≡ $I_0(1+\alpha_2)$), term to expiration T, and each option having the value C_3:

$$C_3 = \mathrm{I}_0\ \mathrm{e}^{-qT}\ \mathrm{N}(\mathrm{d}_5) - \mathrm{X}\ \mathrm{e}^{-rT}\ \mathrm{N}(\mathrm{d}_6) \tag{15}$$

$$d_5 = \frac{\ln\left(\frac{I_0}{X}\right) + \left(r - q + \frac{1}{2}\sigma^2\right)T}{\sigma\sqrt{T}} \qquad d_6 = d_5 - \sigma\sqrt{T}$$

Therefore, the total cost, TC, for each certificate is

$$\mathrm{TC} = €1\left[(1+\alpha_1)e^{-rT} + (\alpha_2\text{-}\alpha_1)CN_c^{do} + \frac{1}{\mathrm{I}_0}\left[-P^{di} + C_1^{di} - C_2^{di} + C_3\right]\right] \tag{16}$$

Replicating Portfolio Two

Alternatively, by the put-call parity and the in-out parity the payoff of one FBC is also exactly the same as the payoff for holding the following five positions:

1. A long position in the underlying asset;

2. A short position in zero coupon bonds. The face values of the bonds are the cash dividends to be paid by the underlying asset and the maturity dates are the ex-dividend dates of cash dividends;

2. A long position in €1/I_0 shares of down-and-out put options on the underlying asset. The exercise price of the option is $I_0(1+\alpha_1)$, the barrier of the option is I_{h2}, and the term to expiration is T, the same as the term to maturity of the certificate.

3. A long position in €1/I_0 shares of down-and-out put options on the underlying asset. The exercise price of the option is $I_0(1+\alpha_2)$, the barrier of the option is I_{h1}, and the term to expiration is T, the same as the term to maturity of the certificate.

4. A long position in €1/I_0 shares of down-and-out put options on the underlying asset. The exercise price of the option is $I_0(1+\alpha_1)$, the barrier of the option is I_{h2}, and the term to expiration is T, the same as the term to maturity of the certificate.

5. A short position in €1(α_2-α_1) down-and-out cash-or-nothing put options. The barrier of the option is I_{h1} and the term to expiration of the option is T, the same as the term to maturity of the certificate.

The value of Position 1 is the price of underlying asset on fixing date I_0. The value of Position 2 is the present value of cash dividends to be paid by the underlying asset, to be denoted as PV_D. The value of Position 3 is the value of €1/I_0 shares of down-and-out put options with exercise X(≡ $I_0(1+\alpha_2)$), knock-out level H(≡ I_{h1}), term to expiration T, and each option having the value P_{do} (Hull; 2003):

$$P_1^{do} = P - P_1^{di} \tag{17}$$

The value of Position 4 is the value of €1/I_0 shares of down-and-out put options with exercise X (≡ $I_0(1+\alpha_1)$), knock-out level H(≡I_{h2}), term to expiration T, and each option having the value P_{do} (Hull; 2003):

$$P_2^{do} = P - P_2^{di} \tag{18}$$

The value of Position 5 is the value of €1(α_2-α_1) down-and-out cash-or-nothing Put options with knock-out level H(≡ I_{h1}), term to expiration T, and each option having the value CN_p^{do}:

$$CN_p^{do} = e^{-rT}\left(N\left(-d_3 + \sigma\sqrt{T}\right) - N\left(-x_1 + \sigma\sqrt{T}\right) + \left(\frac{H}{I_0}\right)^{2\mu}\left(N\left(y - \sigma\sqrt{T}\right) - N\left(y_1 - \sigma\sqrt{T}\right)\right)\right) + \tag{19}$$

Therefore, the total cost, TC, for each certificate is

$$TC = \frac{€1}{I_0}\left[I_0 - PV_D + P_1^{do} + P_2^{do}\right] - €1(\alpha_2\text{-}\alpha_1)CN_p^{do} \tag{20}$$

Since the payoff of FBC is the same as the combined payoffs of the above five positions, the fair value of the certificate can be calculated based on the value of the five positions. Any selling price of the certificate above the value of the above five positions is the gain to the certificate issuer. If B_0 is the issue price of the certificate, any selling price above the fair value is the gain to the certificate issuer. And the profit function for the issuer of certificates is

$$\Pi = B_0 - TC \tag{21}$$

Empirical Results

In this section, a FBC issued by by UniCredit Bank Aktiengesellschaft (formerly Bayerische Hypo- und Vereinsbank AG, commonly referred to as HypoVereinsbank or HVB) on January 5, 2006 using the Dow Jones EURO STOXX 50[SM] (Price) Index as the underlying asset is empirically examined. The FBC is the "HVB Flex Bonus Zertifikat – auf den DJ EURO STOXX 50[SM]" (ISIN DE000HV095D1), and the major characteristics of the certificate are listed in the appendix of the paper.

Based on the information in the appendix, the certificate was sold at EUR 102.00 per EUR 100.00 par value. The final fixing date or expiration date (i.e. the date on which the closing price of the underlying asset will be used as final fixing level) was set on January 4, 2012, six years later than the initial fixing date. In order to calculate the issuer's profit, the following data is needed for the certificate: 1) the price of the underlying asset, I_0, 2) the cash dividends to be paid by the underlying asset and the ex-dividend dates so the dividend yield, q, can be calculated, 3) the risk-free rate of interest, r, and 4) the volatility of the underlying asset, σ. All option pricing equations are based on continuous dividend yield. Since the dividends from the underlying asset are discrete, the following approach to calculate the equivalent continuous dividend yield for underlying asset that pays discrete dividends is used. For an underlying asset with a price I_0 at t=0 (the issue date) and which pays n dividends during a time period T with cash dividend D_i being paid at time t_i, the equivalent dividend yield q will be such that

$$q = -\frac{\ln\left[1 - \frac{\sum_{i=1}^{n} D_i e^{-r t_i}}{I_0}\right]}{T} \tag{22}$$

The prices and dividends of the underlying asset are obtained from Bloomberg; the risk-free rate of interest is the yield on swap rates which the term to maturity match those of the certificate. The volatility (σ) of the underlying asset is the implied volatility obtained from Bloomberg based on the options of the underlying asset. If the implied volatility is not available, the historical volatility calculated from the underlying asset prices in the previous 260 days is used. The one-year rate of interest, r, on January 9, 2006, the initial fixing date of the certificate, based on the Euro swap rates is 3.206%. The dividend yield, q, of the Dow Jones EURO STOXX 50^{SM} (Price) Index is 3.25%. The Dow Jones EURO STOXX 50^{SM} (Price) Index value on the initial fixing date of the certificate, I_0, is 3,671.78. The implied volatility of the Dow Jones EURO STOXX 50^{SM} (Price) Index is 12.842% on the issue date. Therefore, the total cost of issuing one FBC, TC, based on Equation (35) is

$$TC = \frac{€100}{3,671.78}\left[3,671.78 - 716.11 + 561.72 + 546.09\right] - €100 \text{ x } €0.4 \text{ x } 0.21159 = 102.204 \tag{23}$$

The profit for issuing the FBC, π, is

$$\Pi = €\,102 - €\,102.204 \approx €\,0 \tag{24}$$

The profit calculated at issuance is a gross profit before any design, administrative or marketing costs. Some issuers disclosed their marketing costs such as commissions to brokers or dealers in the prospectuses. The marketing costs are usually between 1% and 4%. So when these commissions are considered the issuance of the FBC is a profitable business. The consistency between the empirical result calculated from the pricing model developed in the paper and the reported mispricing in the literature for structured products suggests the model developed in the paper is sound. The result provides additional evidence that inventors of newly structured products are rewarded for their creativity and innovative ability. Several studies have reported, based on large surveys, that structured products have been overpriced, 2%-7% on average, in the primary market based on theoretical pricing models (Abken, 1989; Baubonis et al., 1993; Burth et al., 2001; Wilkens et al., 2003; Grünbichler and Wohlwend, 2005; Stoimenov and Wilkens, 2005; Benet et al., 2006; Hernandez et al., 2008; Hernandez et al., 2010; Hernandez et al., 2013) for various types of structured products.

The Flex Bonus Certificate Sensitivities

The characteristics of FBCs can be expressed in terms of sensitivities, sometimes referred to as "Greeks", such as Delta, Gamma, Vega, Theta, Rho, Psi, and so on. These sensitivities are the mathematical first and second derivatives of the pricing formula with respect to the pricing input variables. *Delta (Δ)*: measures the change in the option price per $1 increase in the underlying asset price. Figure 2 presents the behavior of delta for three FBCs with different term to maturities. For FBCs, delta is positive: as the underlying asset increases, the FBC price increases. As time to expiration increases, delta is less volatile. *Gamma (Γ)*: measures the change in Delta per $1 increase in the underlying asset price. Figure 3 presents the behavior of gamma for three FBCs with different term to maturities. As time to expiration increases, gamma is less volatile. *Vega*: measures the change in the option price per 1% increase in the volatility of the underlying asset's returns. Figure 4 presents the behavior of vegas for three FBCs with different term to maturities. The vega for the FBCs is almost negative and as time to expiration increases, vega is less volatile. *Theta (θ)*: measures the change in the option price per 1 day decrease in the term to maturity of the option. The FBCs become more valuable as time to expiration decreases assuming a 1-day change in time to expiration. Figure 5 presents the behavior of thetas for three FBCs with different term to maturities. Rho (ρ) measures the change in the option price per 1% increase in the interest rate. Figure 6 presents the behavior of rho for three FBCs with different term to maturities. Figure 6 assumes 1 basis point change in the interest rate (i.e. 1/100 of one percent). Psi (ψ) measures the change in the option price per 1% increase in the dividend yield of the underlying asset. Figure 7 assumes 1 basis point change in the dividend yield (i.e. 1/100 of one percent) and presents the behavior of psi for three FBCs with different term to maturities. Figure 7 shows that the psi for the FBCs is always negative and larger the longer the term to maturity.

Figures 2 through 7 assume initial index level at 3,671.78, knock-out level 1 at 80% of the initial fixing, knock-out level 2 at 60% of the initial fixing, minimum redemption level 1 at 120% of the initial fixing, minimum redemption level 2 at 160% of the initial fixing, $\sigma = 12.84\%$, $r = 3.21\%$, and $\delta = 3.26\%$.

Conclusion

In this paper we introduce a new financial product named Flex Bonus Certificates and provide detailed descriptions of the product specifications. In the paper we show that the payoff of a Flex Bonus Certificate can be duplicated by the combination of a long position in a zero coupon bond, a long position in call options on an equity or an equity index (the underlying asset), a short position in down-and-in put options on the underlying asset, a long position in down-and-in call options on the underlying asset, a short position in down-and-in call options on the underlying asset, and a long position in cash-or-nothing down-and-out options. A pricing formula is developed to price the certificates. A certificate issued by UniCredit Bank Aktiengesellschaft (formerly Bayerische Hypo- und Vereinsbank AG, commonly referred to as HypoVereinsbank or HVB) is presented as an example to examine how well the model fits empirical data. The results show that issuing Flex Bonus Certificates is a profitable business and the results are in line with previous studies pricing other structured products. Finally, we simulate the sensitivities of Flex Bonus Certificates to changes in different pricing input variables and parameters used in the design of Flex Bonus Certificates. Our study provides insight into the design, payoff, pricing, Greeks and profitability of Flex Bonus Certificates. The methodology and approach used in this paper can be easily extended to the analysis of other types of structured products.

Acknowledgement

We are thankful for the suggestions from the participants in the 2013 Academy of Financial Services Conference and 2014 Academy of Economics and Finance Conference. Funding for the research was provided by Harold A. Dulan Professorship for Capital Formation and Robert E. Kennedy Chair for Investment.

Notes

1. For more details on Outperformance Certificates see Hernandez et al. (2013).

Figure 2: The Flex Bonus Certificate Deltas

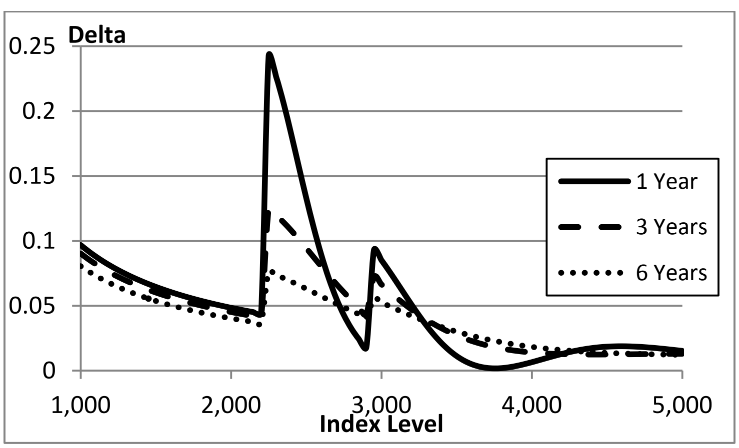


Figure 3: The Flex Bonus Certificate Gammas

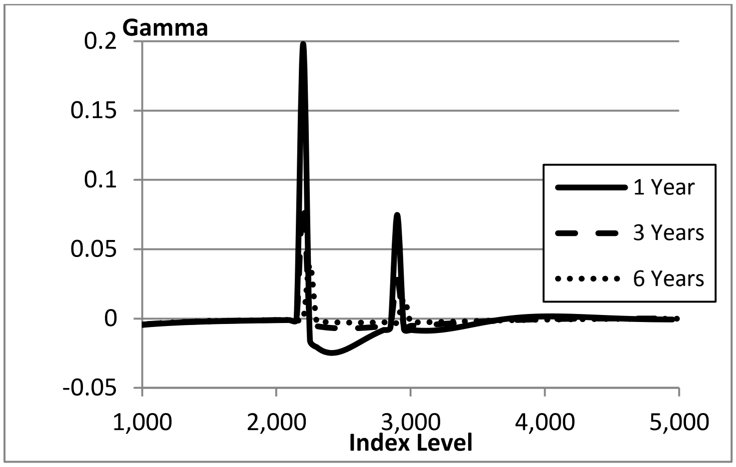


Figure 4: The Flex Bonus Certificate Vegas

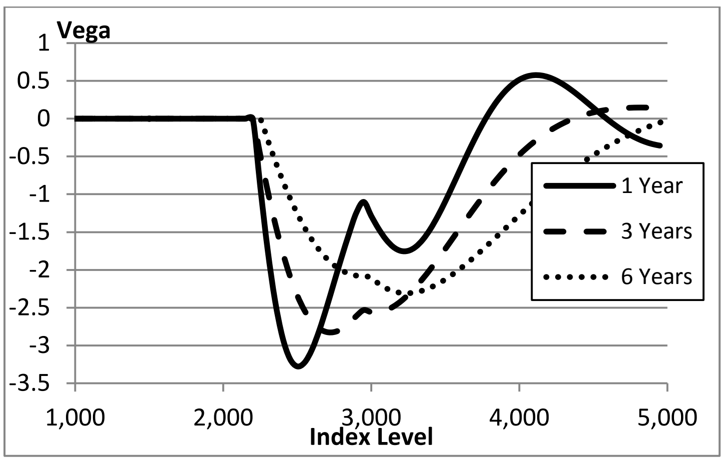


Figure 5: The Flex Bonus Certificate Thetas

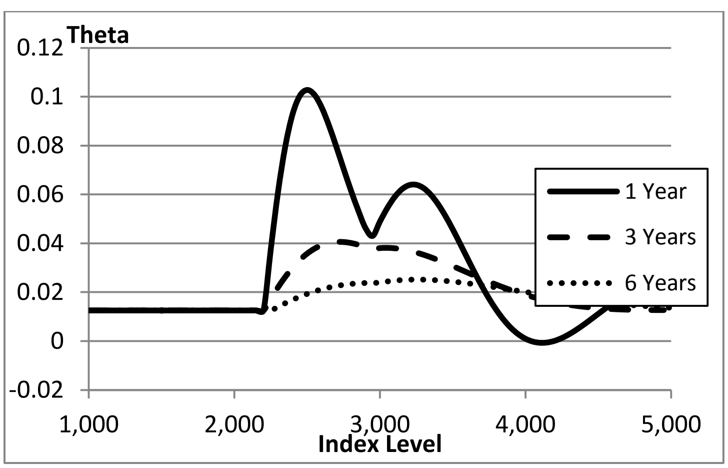


Figure 6: The Flex Bonus Certificate Rhos

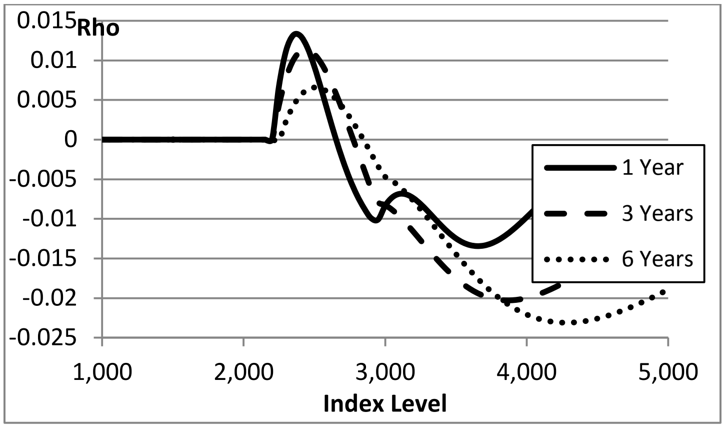
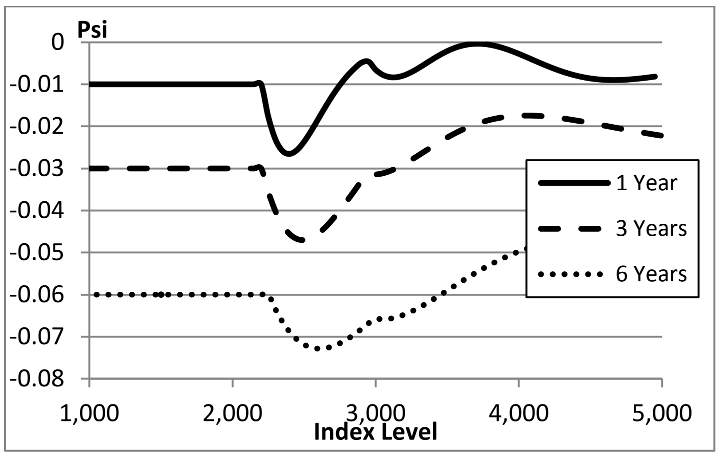


Figure 7: The Flex Bonus Certificate Psis



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Appendix - Example of a Flex Bonus Certificate

HVB Flex Bonus Certificate

On the Dow Jones EURO STOXX 50^{SM}

Issuer	Bayerische Hypo- und Vereinsbank AG
Index	Dow Jones EURO STOXX 50^{SM} (Price) Index (ISIN EU0009658145)
Issue Size	600,000 Certificates
WKN/ ISIN Code	HV095D / DE000HV095D1
Offering Period	5 December 2005 – 5 January 2006
Initial Sale Price	EUR 102.00
Denomination	EUR 100.00
Minimum Trading	1 Certificate
Payment Date	January 11, 2006
Maturity Date	January 11, 2012
Redemption	The repayment amount per certificate is calculated as follows:

- If $I_{min} > 0.8 \text{ x } I_0$

$$\text{EUR } 100.00 \text{ x } \left(1+\max\left(\frac{I_{final}-I_{initial}}{I_{initial}};0.60\right)\right)$$

- If $0.6 \text{ x } I_0 < I_{min} \leq 0.8 \text{ x } I_0$

$$\text{EUR } 100.00 \text{ x } \left(1+\max\left(\frac{I_{final}-I_{initial}}{I_{initial}};0.20\right)\right)$$

- If $I_{min} \leq 0.6 \text{ x } I_0$

$$\text{EUR } 100.00 \text{ x } \left(\frac{I_{final}}{I_{initial}}\right)$$

$I_{initial}$ is the initial fixing level

I_{final} is the final fixing level

I_{min} is the lowest level of the index during the observation period

Initial Fixing Date	January 9, 2006
Initial Fixing Level	official closing level of the Index on the Initial Fixing Date
Final Fixing Date	January 4, 2012
Final Fixing Level	official closing level of the Index on the Final Fixing Date
Observation Period	January 10, 2006 - January 4, 2012 (respectively inclusive)
Exchange Listing	from January 11, 2006 in Frankfurt (Smart Trading) and Stuttgart (EUWAX®)

The U.S. State Personal Income Tax Simplifications with the LG Tax System

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Abstract

The existing non-uniformed state personal tax systems have simple flat tax rate(s) or complex systems with 6-12 tax brackets. Citizens and government offices would like to have an efficient, equity-based, and simpler tax system. In this paper, a fair and simple linear and gradual (LG) tax system has been developed. The implied LG tax system would not only simplify our current state tax systems, but also reduce processing time and managing costs for individuals and state governments. The findings include the estimations and projections of the selective four states' tax revenues for individual state income taxes.

Introduction and Literature Review

Majority of the U.S. states currently are levying a broad-based personal income tax. Typically, progressive taxes are imposed as effective tax rates, which rise with income levels. With the exception of Florida, South Dakota, Texas, and Washington, which do not require personal income tax, there are ten states that intensively impose a regressive tax rate on sales and excise taxes. These taxes account more than fifty percent of their tax revenues. Half of these states are taxing with flat rates for their personal incomes. However, the states that have applied the graduated income tax rates have almost the same as or even lower flat tax rates. These graduated income tax rates vary widely among the states. (Davis 2013). The existing state personal tax systems are not uniformed in tax brackets. Some states have a simple flat tax rate, which are not fair and impractical for different income levels. Other states have complex tax systems that possess up to 9 or 12 tax brackets, which are too complex. These complex personal tax systems have long been recognized as an imminent topic for many state legislators and policymakers. Many recommendations and proposals of taxation have been focused on the possible impacts on revenue, equity, and efficiency of state economy. An increasing numbers of citizens and state government offices would like to reduce tax processing time and operating costs by a simplified tax system. In this paper, a new simpler, more efficient, and fairer linear and gradual (LG) tax system with a suggested 2-4 tax bracket has been developed regarding their tax rates and calculations, analysis, and projection with a purpose of reducing tax processing time and cost to achieve the increased state tax revenues.

Several linear income tax proposals have been discussed and analyzed in the last couple of decades. Slemrod, Yitzhaki, and Mayshar (1994) have investigated two-bracket piecewise linear income tax structures. For promoting the Pareto-efficient tax schedules, they used a two-class economy with at least one marginal tax rate equal to zero and let the marginal tax rate change in either direction. They analyzed the optimal structure of taxation for the social welfare function, utility function, and distribution with the standard optimal linear income tax system. They concluded that a linear income tax offers considerable administrative advantages over more complex graduated income tax systems. They stated "yet historically countries have accepted the higher administrative costs in order to achieve a more progressive distribution of the tax burden than that offered by a linear income tax system." This paper challenged the pervasive policy and showed the benefits of allowing two brackets rather than one is very sensitive to the parameterization of the problem.

Bruce, et al. (2010) estimated panel regressions of state data for 1989 through 2006 to assess the effects of tax rates, tax structure characteristics and other controls on state personal income tax (PIT) bases. They compared results across three broad measures of state PIT bases, actual state AGI as reported to us directly by revenue officials in several states, a measure calculated as total PIT collections divided by the top PIT rate, and total aggregate gross income (AGI) on federal returns filed from each state (federal AGI). Results indicated that higher marginal tax rates have no impact on actual bases reported by the states, small negative effects on federal AGI, and larger negative effects on calculated bases.

Another paper published by Diamond and Saez (2011) considered the optimal progressivity of earnings taxation and considered if capital income should be taxed. They argued "a result from basic research is relevant for policy only if it is based on economic mechanisms that are empirically relevant and first order to the problem." Hence, they placed high implicit marginal tax rates on low earners in the models with only an intensive margin for low earners. Also, the zero optimal tax rates at a known top of the earnings distribution and the low and decreasing marginal tax rate on very high earners that comes from simulations using the lognormal distribution of skills for the Pareto efficiency. They argued that a zero taxation of capital income from the aggregate efficiency result, capital income asymptotically, and capital income from the Atkinson-Stiglitz theorem because savings rates are not uniform in the civilian.

More currently, Freebairn (2012) suggested several personal income taxation reform options. He proposed the removal of tax expenditures for some forms of labor remuneration and the increase of more neutral system of taxation for different forms of capital income. He then evaluated the choice of an expenditure base or a concessional income tax base, and then the rate concession for taxing personal capital income. The removal of offsets and the Medicare Levy for a transparent and simpler tax rate schedule, and automatic indexation of the thresholds were analyzed and recommended in this study.

Davis, et al. (2013) indicated that the use of low income tax credits like the Earned Income Tax Credit (EITC) is an important indicator of tax progressivity. There were only two of the ten most regressive state income taxes to have a permanent EITC, while seven most progressive state income taxes currently provide a permanent EITC. Because EITC is targeted to low-income working families with children, it typically offers little or no benefits to older adults and adults without children. Thus, refundable low income credits are a good complementary policy to state EITCs. Eleven States offer income tax credits of their own design to ensure that families below a certain income level are not subject to the personal income tax. These credits also improve the progressivity of a state's personal income tax. Two of the most regressive state income tax loopholes are capital gains tax breaks and deductions for federal income taxes paid. In combination with a flat or only nominally graduated rate structure, they pointed out these tax breaks can sometimes create the odd and unfair as a result of the highest income taxpayers paying less of their income taxes than middle-income taxpayers.

In addition, Kao and Lee (2013) developed a linear and gradual tax system to simplify the existing US progressive personal income taxation. The intent of this study is to eliminate the current complex Tax Tables and Tax Rate Schedules, by simply replacing tax rates with tax calculations. The advantages of this system include simplifications on tax calculation, analysis, modification, reform, and projection with reductions of tax processing time and management cost for individuals, businesses, and government entities.

Models

The existing state tax rates are presented as below either at a flat tax rate or multi tax rates. Some states have simple tax systems with less than 3 tax brackets (such as from 1 to 3) and some have complex tax systems with such as up to 12 tax brackets and different filing statuses. *TI* is taxable income and *Yi* represent different levels of taxable income. The flat tax rate is a_1. The multi tax brackets are c_1, c_2, c_3, c_4, and so on. The tax rate (*TR*), marginal tax rate (*m*) and tax (*T*) are expressed in the formula below.

1. Current state tax rate models

If $TI \leq Y_1$ *or all range, then* $TR = a_1$ — *A current tax rate is* a_1 *(a flat tax rate)*
If $Y_1 < TI \leq Y_2$*, then* $T = c_1\, TI - d_1$ — *A current tax or tax rate formula is* $c_1 - d_1 / TI$
… …
If $Y_{n-1} < TI \leq Y_n$ *then* $T = c_n\, TI - d_n$ — *A current tax or tax rate formula is* $c_n - d_n / TI$

2. Proposed state tax rate models

If $Y_1' < TI \leq Y_2'$*, then* $TR = a_2 + TI / b_2$ — *A proposed tax rate formula or tax is TR x TI*
If $Y_2' < TI \leq Y_3$*, then* $TR = a_3 + TI / b_3$ *or* $TR = c_2 - d_2 / TI$ *(It is an option)*
$TI > Y_3$*, then* $TR = m - d_3 / TI$

There will be 2, 3 or 4 taxable income ranges only, which simplify existing flat tax rate (too simple and not fair to both low and high taxable incomes) or multi tax rates (too complex), to have more reasonable tax rates to different taxable incomes. Their taxable income ranges will be easier and simpler than existing taxable income ranges. Tax rates change linearly or gradually. The marginal tax rate (m) may be adjusted up or down according to actual situations. The total levied tax amount can then be summed up the above equations and shown as a simple function of TI. The formula can be expressed as below.

$$\text{Total levied tax amount} = a_2 \sum TI + \sum TI^2/b_2 + a_3 \sum TI + \sum TI^2/b_3 + m \sum TI - D_3 \quad \ldots\ldots\ldots\ldots\ldots (1)$$

In the linear equation of $TR = a + TI/b$, tax rates increase linearly corresponding with taxable incomes with a constant slope 1/b, which are more reasonable. Marginal tax rate (*m*) is usually expressed by $TR = m - d / TI$, in which tax rates increase fast at first and then slow. The slope is not a constant, which is d/TI^2. For the different economic condition or tax revenue adjustment, the base rates in the LG Tax System can be easily adjusted and modified to desirable levels.

Implications

1. Existing state personal tax systems

Some state personal tax systems are too simple (such as flat tax rates) and some are complex (such as from 6 to 12 tax brackets), which are usually not very complex compared with the existing personal federal tax system. State tax systems for individuals have tax rate ranges (0-12.3%). Each state has different situations. Flat tax rates are easy but too simple, which cannot cover all taxable incomes reasonably. More tax rate brackets increase complexity of a tax system, which have more smooth tax rate changes. Table 1 shows state tax systems for individuals (2013). Their basic information is from www.taxadmin.org/fta/rate/ind_inc.pdf. California personal tax system has its tax rates 1%-12.3% with 9 brackets. Iowa personal tax system has 9 tax brackets with 0.36%-8.98%. Missouri tax system has tax rates 1.5%-6% with 10 tax brackets. Hawaii has tax rates 1.4%-11% with 12 tax brackets.

Table 1 Tax Rate Ranges and Tax Brackets in State Tax Systems

State	Tax Rate Range	Tax Bracket No.	State	Tax Rate Range	Tax Bracket No.
Alabama	2-5%	3	Alaska	No State Income Tax	
Arizona	2.59-4.54%	5	Arkansas	1-7%	6
California	1-12.3%	9	Colorado	4.63%	1
Connecticut	3-6.7%	6	Delaware	2.2-6.75%	6
Florida	No State Income Tax		Georgia	1-6%	6
Hawaii	1.4-11%	12	Idaho	1.6-7.4%	7
…………………………			………………………………………		
South Carolina	0-7%	6	South Dakota	No State Income Tax	
Tennessee	6% On Dividends And Interest Income		………………………………………		
West Virginia	3-6.5%	5	………………………………………		
Dist. Of Columbia	4-8.95%	4			

2. Existing California and LG tax systems for individuals (9 tax brackets is reduced to 4)

California's personal income tax rate is relatively progressive with a range from 1% to 12.3% and 9 tax brackets, which is shown in Table 2 (Schedule X and Y). The California tax system is more complex than other states. In Table 2, there is no difference when TI is not over \$7,455 with a flat tax rate of 1%, then their tax rates increase from 1% to 12.3%.

When the LG tax system is used, the 9 tax brackets are simplified into the 4 brackets with easy taxable income ranges and tax rate range check is provided for a self-checking tool as shown in Table 3.

The LG tax rate formulas are applied to match the tax rates in Table 2 with simplicity and meaning. For Single or Married/RDP filing separately at TI from 0 to \$100,000, a linear relationship of $y = a + x/b$ is imposed:

Tax Rate = 0.01+ TI / 1,694,915 (tax rate range: 0.01-0.069) ……………………………….. (2)

The slope b = 1/100,000/(0.069-0.01) = 1/1,694,915 and 0.069 is calculated from (2,154.83 + 0.093 (100,000 – 48,942)) / 100,000). For Single or married/RDP filing separately at TI from \$100,000 to \$300,000, another linear relationship $y = a + bx$ is found:

Tax rate = 0.06 + TI / 11,111,111 (tax rate range: 0.069-0.087) ………………………. (3)

At TI=300,000, tax rate = [20,853.22 + 0.103 (300,000 - 250,000)] / 300,000 = 0.0867. For Single or married/RDP filing separately at TI from \$300,000 to \$500,000:

Tax rate = 0.07169 + TI / 19,595,471 (tax rate range: 0.087-0.0972) ……………….... (4)

Table 2 Existing California Personal Tax Rate Schedules

Schedule X — Single or married/RDP filing separately
If the taxable income is

Over	But not over	Tax			the amount over
$0	$7,455	$0.00	plus	1.00%	$0
$7,455	$17,676	$74.55	plus	2.00%	$7,455
$17,676	$27,897	$278.97	plus	4.00%	$17,676
$27,897	$38,726	$687.81	plus	6.00%	$27,897
$38,726	$48,942	$1,337.55	plus	8.00%	$38,726
$48,942	$250,000	$2,154.83	plus	9.30%	$48,942
$250,000	$300,000	$20,853.22	plus	10.30%	$250,000
$300,000	$500,000	$26,003.22	plus	11.30%	$300,000
$500,000 and over		$48,603.22	plus	12.30%	$500,000

Schedule Y — Married/RDP filing jointly, or qualifying widow(er) with dependent child
If the taxable income is

Over	But not over	Tax			the amount over
$0	$14,910	$0.00	plus	1.00%	$0
$14,910	$35,352	$149.10	plus	2.00%	$14,910
$35,352	$55,794	$557.94	plus	4.00%	$35,352
$55,794	$77,452	$1,375.62	plus	6.00%	$55,794
$77,452	$97,884	$2,675.10	plus	8.00%	$77,452
$97,884	$500,000	$4,309.66	plus	9.30%	$97,884
$500,000	$600,000	$41,706.45	plus	10.30%	$500,000
$600,000	$1,000,000	$52,006.45	plus	11.30%	$600,000
$1,000,000 and over		$97,206.45	plus	12.30%	$1,000,000

Table 3 LG Tax System for California Individual Tax Rate

Taxable income (TI)	LG Tax Rate Formula	(Range check)
Schedule X – Single or married/RDP filing separately		
$0 - $100,000	0.01+ TI / 1,694,915	(0.01-0.069)
$100,000 - $300,000	0.06 + TI / 11,111,111	(0.069-0.087)
$300,000 - $500,000	0.07169 + TI / 19,595,471	(0.087-0.0972)
Over $500,000	0.123 – 12,897 / TI	(0.0972-0.123)
Schedule Y — Married/RDP filing jointly, or qualifying widow(er) with dependent child		
$0 - $200,000	0.01+ TI / 3,388,108	(0.01-0.069)
$200,000 - $600,000	0.06 + TI / 22,222,222	(0.069-0.087)
$600,000 - $1,000,000	0.07169 + TI / 39,190,942	(0.087-0.0972)
Over $1,000,000	0.123 – 25,794 / TI	(0.0972-0.123)

At *TI*=500,000, tax rate = [26,003.22 + 0.113 (500,000 – 300,000)] / 500000 = 0.0972. For TI from $500,000 and over, the original tax computation is converted into its tax rate format:

Tax=48,603.22+0.123(TI-500,000)=0.123 TI–12,897 or Tax rate=0.12 –12,897/TI …………. (5)

For Married/RDP filing jointly, qualifying widow(er) or Head of household, similar calculations are used to find their LG formulas. For Married/RDP filing jointly, the constants b and d are the double comparing with Married/RDP filing jointly, which is very easy.

For Single or married/RDP filing separately, total tax can be calculated from the equation (6). Here *w, x, y,* and *z* are individual numbers during the four taxable income ranges. Other similar equation(s) may be used for tax analysis and projection.

$$Total\ Tax = 0.01\sum TIw + \sum TIw^2/1{,}694{,}915 + 0.06\sum TIx + \sum TIx^2/11{,}111{,}111 + 0.07169\sum TIy + \sum TIy^2/19{,}595{,}471 + 0.123\sum TIz - 12{,}897z \ \ldots\ldots (6)$$

The LG tax rate formulas in Table 3 are much simpler than the existing tax computations in Table 2. The LG Tax System has easy taxable income ranges and tax rate range check. Also the simple equation (6) can be used to calculate total tax for all tax returns of Single or married/RDP filing separately. Figure 1 shows the tax rate differences from the existing CA and LG tax systems with the differences 0-0.8%. The relationships between tax rates and taxable incomes (TI from 0 to $100,000) in the existing tax system are curves down and up from the linear relationship in the LG Tax System. The linear relationship is much easy. The existing 9 tax brackets are reduced to 4 taxable incomes only with minor tax rate differences.

3. Existing Iowa and LG tax systems for individuals (9 tax brackets is reduced to 3)

Iowa individual income tax system adopts a graduated rate structure. It offers a refundable earned income tax credit (EITC) and sales tax base except groceries. Iowa completely excludes certain types of capital gains income. Iowa personal tax system has 9 tax brackets with tax rates 0.36%-8.98% and Tax Tables for IA individuals with 5 pages.

From these tax data from Tax Tables and tax computation (over $95,450), the two LG formulas are found and matched, which are shown in Table 4. The two formulas are much easier than the 5-page Tax Tables. Table 5 shows the tax rate differences from the LG tax system and existing Tax Tables plus tax computation (over $95,450) as Tax = 0.898×(TI - 95,425) + 6,846 with minor differences.

The graphs of tax rates (tax/TI) over TI show the increase from 0 to 4.20% in almost linearly when TI increase from 0 to $20,000. Then tax rates increase from 4.20% to 7.256835%, which is from [0.0898×(100,000-95,425)+6,846]/100,000=0.07256835 with linearity, when TI increase from $20,000 to $100,000. Two linear formulas are found to match the tax rates reasonably and simply.

Tax rate = TI/476,190 (tax rate range check: 0-0.042) …………………………………. (IA/1)

Tax rate = 0.03436 + TI/2,617,086 (tax rate range check: 0.042-0.07257) ……………. (IA/2)

The slope for $y = x/b$ is from 1/20,000/0.042=1/476,190. Also 1/2,617,086, which is the slope for $y = a + x/b$, is from 1/(100,000-20,000)/(0.07256835-0.042) = 1/2,617,086 and 0.042 – (20,000/2,617,086) = 0.03436. When taxable incomes are over $100,000, a gradual tax rate formula of $y = c - d/x$ is converted from [0.0898*(TI-95,425) + 6,846] / TI:

Tax rate = 0.0898 – 1,723 / TI (tax rate range check: 0. 07257-0.0898) ……………... (IA/3)

Table 4 LG Iowa Individual Formulas for All Filing Statuses

Filing Status	Taxable income (TI) Over	Not over	Your TI	Tax rate formula	Tax rate	(Range check)	Tax (Rate x TI)
(IA/1)	0	20,000		TI / 476,190		(0 - 0.042)	
(IA/2)	20,000	100,000		0.03436+TI/2,617,086		(0.042-0.07257)	
(IA/3)	100,000			0.0898-1723/TI		(0.07257-0.0898)	

Tax rate differences between for the existing Iowa Individual Tax System and the LG tax system from Table 4 are shown in Table 5, which are compatible with 0-0.7%. From Table 4, tax data such as total tax may be calculated from taxable income data. It is not necessary to use the IA Tax Tables and tax computations. Taxable income data may be used for tax projection.

$$Total\ Tax = \sum TI^2/476{,}190 + 0.03436\sum TIj + \sum TIj^2/2{,}617{,}086 + 0.0898\sum TIk - 1{,}723\,k \ \ldots (7)$$

Here *i, j* and *k* are individual numbers during the three taxable income ranges. The total tax equation (7) or similar equations may be used to do total tax calculation, projection and analysis. Tax rate or tax is a function of TI. Also TI is a function of tax rate (or tax).

During a recession, booming economy or special situations, LG tax rates may be reduced for more opportunities to promote economic growth or increased for collecting more tax. One easy way is such as -0.5% or +1% from LG tax rate formulas directly. Such as the equation (IA/2) is modified into 0.02436+TI/2,617,086 with tax rate range check (0.032-0.06257) by simple subtraction -1%.

Table 5 Comparison of Tax Rates between the Existing Iowa and LG Tax Systems

Taxable Income ($)	Iowa Tax System Tax Table	Tax Rate	LG Formulas (Table 6)	Difference (Absolute Value)
100	0	0.0%	0.02%	0.0%
500	2	0.4%	0.11%	0.3%
1000	4	0.4%	0.21%	0.2%
5000	68	1.36%	1.05%	0.3%
10,000	278	2.78%	2.10%	0.7%
15,000	536	3.57%	3.15 %	0.4%
20,000	842	4.21%	4.20%	0.0%
30,000	1489	4.96%	4.58%	0.3%
40,000	2169	5.42%	5.00%	0.4%
50,000	2925	5.85%	5.35%	0.5%
60,000	3717	6.20%	5.73%	0.5%
70,000	4565	6.52%	6.11%	0.4%
80,000	5463	6.83%	6.49%	0.3%
90,000	6361	7.07%	6.87%	0.2%
95,450	6846	7.17%	7.08%	0.1%
100,000		7.26%	7.26%	0.0%
200,000		8.12%	8.12%	0.0%
500,000		8.64%	8.64%	0.0%
1 million		8.81%	8.81%	0.0%
10 million		8.96%	8.96%	0.0%

4. Existing Missouri and LG tax systems for individuals (10 tax brackets is reduced to 2)

Missouri personal income tax also uses a graduated rate system and state sales tax base excludes groceries. The income tax deduction for federal income taxes paid fails to offer refundable income tax credits to non-elderly taxpayers. Missouri has 10 tax brackets with marginal tax rates at 1.5%, 2%, 2.5%, 3%, 3.5%, 4%, 4.5%, 5%, 5.5% and 6% and Tax Table for individuals. All individual taxes are searched and calculated at first and added them together to have their total tax. The Tax Table provides non-continuous tax numbers, which is complex. The tax $312 at $8,950 is jumped to $315 at $9,000. When the LG tax system is used, the two tax rate formulas are found and matched (Table 6), which are simple and reasonable and also easy for tax analysis and projection. Tax rates change smoothly and continuously. The Figure 2 shows their tax rate differences, which are very compatible from 0 to 0.002.

Table 6 LG Tax System for Missouri Individuals with Tax Rate Range Check

Filing Status	Taxable income (TI) Over	Not over	Your TI	Tax rate formula	Tax Rate	(Range check)	Tax (Rate × TI)
(MO/1)	0	10,000		0.01313+TI/410,256.4		(0.013 - 0.0375)	
(MO/2)	10,000			0.06 - 225/TI		(0.0375-0.06)	

For tax calculation, analysis, modification and projection, they can be done easily. Here m and n are individual numbers during the two TI ranges. The LG formulas can be modified by changing tax rate slopes or base tax rates such as +0.2% or -0.3% easily and reasonably according to actual situations in 2013 or future, which may be used for tax projection.

$$\text{Total Tax} = 0.01313\sum Tim + \sum(TI)^2 m/410{,}256.4 + 0.06\sum Tin - 225\,n \quad \ldots\ldots (8)$$

Tax calculation and analysis may be done practically and easily. The total tax is calculated by the equation (8), in which m and n are individual numbers during the two TI ranges. The LG formulas can be modified by changing tax rate slopes or base tax rates such as +0.2% or -0.3% easily and reasonably according to actual situations in 2013 or future, which may be used for tax projection.

5. Hawaii tax system simplification with the LG tax system (12 tax brackets is reduced to 4)

The existing HI personal tax system has the most tax brackets (12) in all U.S. states. Its tax rates are from 1.4% to 11% with Tax Table (12 pages) and the three filling statuses in Tables 7 and 8, which are complex (www6.hawaii.gov /tax/2012/n11ins.pdf). When LG Tax System is used, the existing system can be simplified significantly with 4 tax brackets and without Tax Table, which is shown in Table 9. The LG tax rate formulas with tax rate range check are used to replace the above Tax Table and Tax Rate Schedules. The Figure 3 shows their tax rate differences from the two tax systems compatibly.

Table 7 The Existing HI Tax Table for Married Filing Jointly (12 pages)

Taxable Income (TI) At least But less than	Tax is	Taxable Income TI range	Tax is	Taxable Income TI range	Tax is
0 - 50	0	50 - 100	1	……..…..	
6,000 - 6,050	106	6,050 - 6,100	108	…………	
…..…………		99,900 - 99,950	6,751	99,950 - 100,000	6,755

Table 8 The Existing HI Tax Rate Schedules (12 tax brackets)

I. Single and Married Filing Separately		II. Married Filing Jointly		III. Unmarried Head of Household	
0 - $2,400	1.4% of TI	0 - 4,800	1.4% of TI	0 - $3,600	1.4% of TI
$2,400 - $4,800	34+3.2% (TI-2400)	4,800-9,600	67+3.2%(TI-4800)	3,600-7,200	50+3.2% (TI-3600)
$4,800 - $9,600	110+5.5% (TI-4800)	9,600-19,200	221+5.5%(TI-9600)	7,200-14,400	166+5.5% (TI-7200)
…..……………		……………………..		…………………	
175,000-200,000	13,879+10%(TI-175000)	……………..		363,500-300,000	20,818+10%(TI-262,500)
Over 200,000	16379+11%(TI-200,000)	Over 400,000	………	Over 300,000	24568+11%(TI-300,000)

Table 9 The LG Tax System for HI Individuals with Tax Rate Range Check (4 tax brackets)

Filing status	Taxable Income (TI) Range / Tax Rate Formula / (Rate Range Check)			
I.	0-20,000	20,000-50,000	50,000-200,000	over 200,000
Tax rate formula	0.014+TI/509,165	0.04375+TI/2,097,902	0.06281+TI/10,478,519	0.11-5,621/TI
II.	0-40,000	40,000-100,000	100,000-400,000	over 400,000
Tax rate formula	0.014+TI/1,009,081.7	0.04435+TI/4,307,250.5	0.06280+TI/20,942,408.4	0.11-11,242/TI
III.	0-30,000	30,000-75,000	75,000-300,000	over 300,000
Tax rate formula	0.014+TI/763,747.5	0.04376+TI/3,149,790	0.06279+TI/15,704,979	0.11-8,432/TI
Rate range check	(0.014-0.054)	(0.053-0.068)	(0.067-0.082)	(0.081-0.11)

For the tax analysis, projection and modification of the filing status I, total tax equation is as below:

$$\text{Total Tax} = 0.014\sum TI + \sum TI^2/509165 + 0.04375\sum TI + \sum TI^2/2097902 + 0.06281\sum TI + \sum TI^2/10478519 + 0.11\sum TI - 5621\,n \quad \ldots\ldots (9)$$

The above equation (9) is used to calculate the total tax for the whole two groups of Single and Married taxpayers filing separately. The total tax equation or similar equations may be used to do total tax, tax difference, average tax or tax rate and tax data analysis and tax projection simply and practically, which do not need to have individual tax data at first and then to add them together. Tax rate or tax is a simple function of TI. During a recession, booming economy or special situation, LG tax rates and slopes may be modified simply and reasonably by such as -0.5% or +0.3% from the LG tax rate formulas directly according to actual situations.

Conclusion

The benefits of this proposed tax simplification process could combine all filing statuses, taxable incomes, incomes, tax rate formulas, tax rate range checks, taxpayer information, tax rate, and tax calculations into short tax simplification phases. Tax rate formulas could then connect to the related filing statuses, taxable income, and income brackets. Subsequently, the total tax amounts will be calculated automatically or manually with simple procedures.

Numerous benefits can be illustrated by applying this LG tax system. The taxable income ranges would reduce to simple levels instead of complex tax brackets. It would simplify the tax payers' reporting process and reduce the preparation time. The proposed LG formulas would serve the similar purpose of taxation with more fine-tuned tax rates. The tax rates could be easily tested with tax office and payers. The complexity of tax rates and amount calculations could be simplified from the existing system. The long-listing tax tables could be eliminated or replaced by modest formulas. The proposed tax rates represent the minor tax rate differences with the current systems only within 0.8% of margin. For the ease of tax rate modification, tax office could change the rates and estimated the revised revenue rapidly. The streamline of tax analysis and revenue projection would enhance the efficiency of the revenue offices. In conclusion, we could anticipate an increase of total tax revenue from this proposed tax reform with the easier, more efficient, and fairer LG system for the reduction of tax preparation time, the complexity of tax rates analysis, as well as the complications of tax rate systems.

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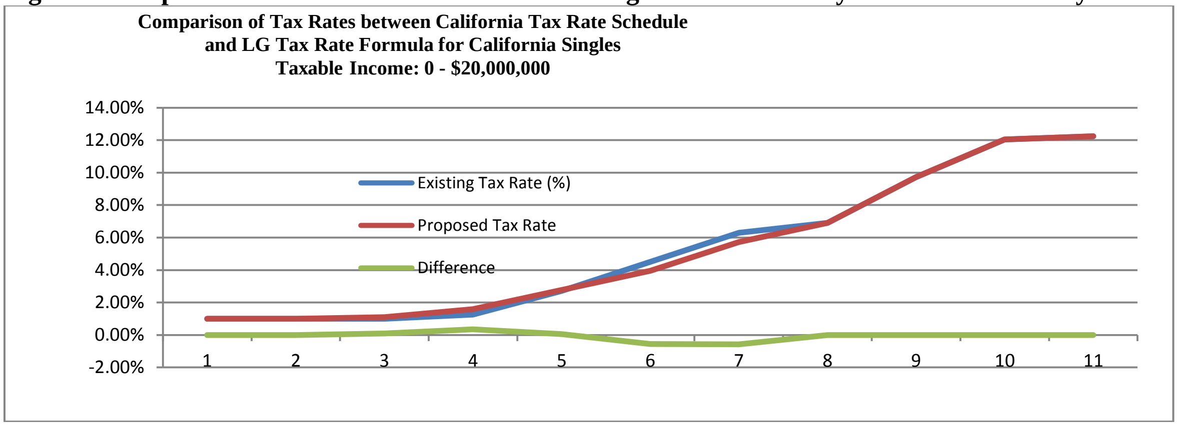
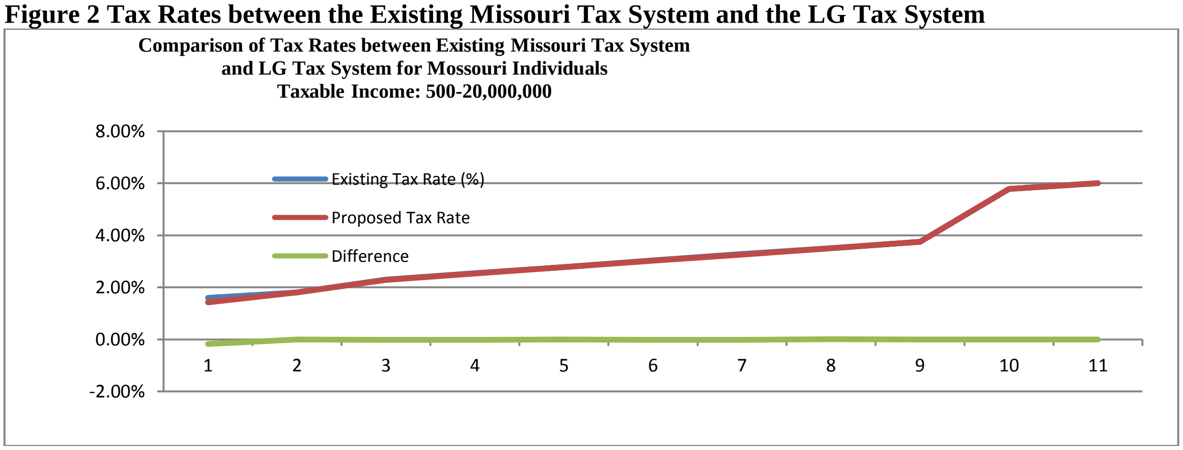
Appendix

Figure 1 Comparison of Tax Rates between the Existing California Tax System And LG Tax System



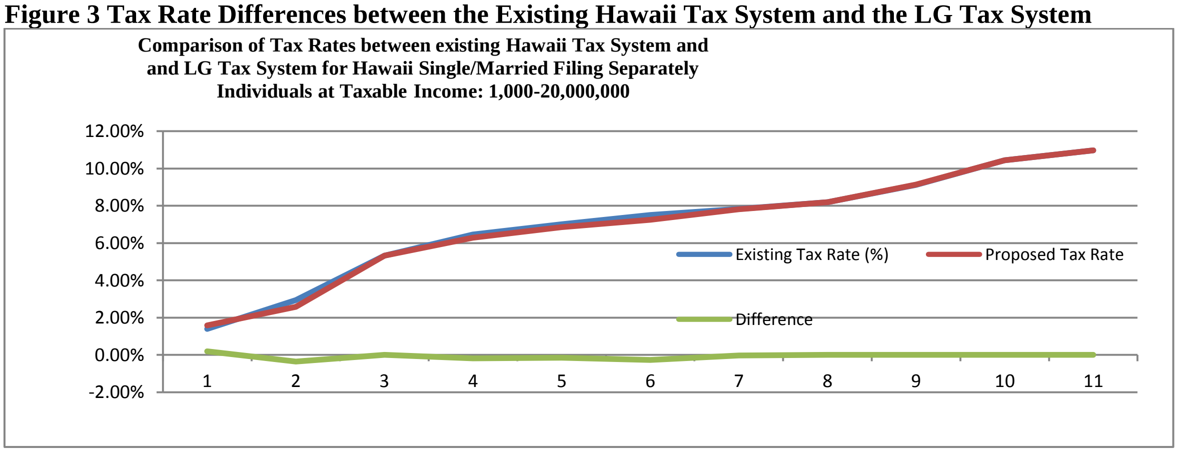
(Taxable income: 1=$100, 2=$500, 3=$1,000, 4=$10,000, 5=$30,000, 6=$50,000, 7=$80,000, 8=$100,000, 9=$500,000, 10=$5,000,000, 11=$20,000,000)

Figure 2 Tax Rates between the Existing Missouri Tax System and the LG Tax System



(Taxable income: 1=$500, 2=$2,000, 3=$4,000, 4=$5,000, 5=$6,000, 6=$7,000, 7=$8,000, 8=$9,000, 9=$10,000, 10=$100,000, and 11=$20,000,000)

Figure 3 Tax Rate Differences between the Existing Hawaii Tax System and the LG Tax System



(Taxable income: 1=$1,000, 2=$6,000, 3=$20,000, 4=$40,000, 5=$60,000, 6=$100,000, 7=$160,000, 8=$200,000, 9=$300,000, 10=$1,000,000, 11=$20,000,000)

Home Bias and Risk Differentials

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Abstract

This paper explores a risk differential model of home bias theoretically to examine how well market risks could explain degree of home bias across countries. The optimal portfolio choice model is revised to take into account of market risks within a framework of a portfolio rebalancing model. Key issue is asymmetric return differential, which is decomposed into two parts; traditional differential of return and risk differential. Using annual panel data of Asian emerging markets and the developed markets in 2002-2012, the risk differential model of home bias is estimated across countries and the evidence generally supports our model.

Introduction

Financial globalization has been progressed with introduction of low-cost electronic trade of assets across borders and the openness of emerging markets since 1990s (World Bank dataset, 2013). In particular, the international portfolio net inflows to Asian emerging countries are fast growing. For example the amount of transactions has increased from $765 million to $30 billion in China, from $3.9 billion to $16.9 billion in South Korea between 1998 and 2012 (World Bank dataset, 2013). Despite the rapid increase in financial globalization, investors in general are still reluctant to reap a full benefit of international diversifications and hold disproportionate share of local equities (Portes and Rey 2005, and Forbes 2010).

The lack of cross-border diversifications may be attributed to transaction costs in the international capital flows, information frictions, investors' hedging incentives in the frictionless markets, and behavioral bias (Heathcote and Perri 2007, Artis and Hoffman 2007, Wincoop and Warnock 2006, Cooper and Kaplanis 1994, and Coeurdacier 2009). That is, domestic equities with low return are preferred to foreign equities with high returns because the domestic equities are perceived to incur less transaction costs and are also perceived to hold lower risk than foreign equities. This phenomenon is commonly called "equity home bias puzzle" and is simply referred to as "home bias", hereafter (French and Poterba, 1991).

The home bias has been explained in three branches of modeling frameworks. One group uses the transaction cost model where the transaction cost is explained by barrier of international capital flow (e.g., Coeurdacier and Rey 2011, Forbes 2010, Hau and Rey 2008, and Ramos and Thadden 2003). Another group uses the gravity model based on relative market size and distance between trading countries to measure information asymmetry and transaction costs as barriers to bilateral portfolio flows (e.g., Portes and Rey 2005, Tesar and Werner 1995, Razin 2010, Martin and Rey 1999, and Faruqee, *et al* 2004). The other group recently deals with risk-hedging incentives based on the model of international portfolio investment flows in which home bias is structured to hedge the non-tradable income and exchange risks (e.g., Coeurdacier 2009, Coeurdacier and Rey 2011, Heathcote and Perri 2007, Artis and Hoffman 2007, Wincoop and Warnock 2006, and Cooper and Kaplanis 1994).

Despite the contribution of the literature, a premise exists that the reason for the home bias may be rooted deeper than the above mentioned motivations (i.e., transaction costs, risk-hedging incentives, and gravity) portrayed in the three branches of modeling frameworks. The differentials of market risks across countries may be the unexplained portion of home bias by the three branches of modeling framework. For example, countries with low market risks would have stronger home bias than countries with high risks because investors of the countries take into account of market risks in international portfolio flows that cannot be observed in transaction costs, risk-hedging incentives, and gravity. There have been no such attempts focusing on the direct effect of market risks on home bias.

This paper purposes to theoretically explore a risk differential model of home bias, and test it to investigate a degree of home bias across countries. Our model of home bias is developed to take into account of risk differential between the two trading countries within a framework of a portfolio rebalancing model. Key theoretical issue is asymmetric return differential, which is a risk adjusted return differential, depending on a degree of development of financial markets. It can be decomposed into two parts, traditional return differential and risk differential, in order to distinguish the impact of risk differential from the effect of traditional differential of return on home bias.[1] Asymmetric return in international capital flows has been used in Kim (2011) in order to test how well both return and risk influence exchange rates in international portfolio rebalancing process in the short-run. Risk differentials in our model actually capture asymmetric returns from Kim (2011) in a framework of international portfolio flows model.

In our model, the market risk is built to be theoretically captured by the correlation between returns divided by market volatilities, reflecting friction of asset trades between two countries. The higher correlated the markets, the closer each market is to each other, and the better information is revealed. The asset trades are less frictionless and less costly. The correlation of market returns may have two opposite effects on the international portfolio flows. It causes the negative effect on capital flows by reducing hedging demand against bilateral capital flows when the two markets move very similarly. Meanwhile, it has a positive effect due to the less information asymmetry and less transaction costs when the two capital markets move together. In a case where the second positive effect dominates the first negative one, a rise in the correlation between market returns tends to increase international capital flows, and thus, leading to the erosion of home bias. In addition to correlation between market returns, the volatilities of market returns can also affect market risks. The more volatile the foreign financial market, the higher market risk for foreign investment, and the more home bias occurs.

Using annual data from 2002-2012 of nine countries (i.e., three developed financial markets: United States, United Kingdom, and Japan and six emerging financial markets: China, Korea, Malaysia, Singapore, Australia and Thailand), we investigate to test the risk differential model of home bias across countries. The study focuses on estimating the degree of home bias of Asian emerging countries and comparing it with that of the developed counties. The cases of Asian emerging countries would be suitable with application of our model since Asian countries are assumed to be more risky than the developed markets.

The section II of our study explores the portfolio flow model with risk differential to explain home bias puzzle in theory. The section III provides data and evidence for the risk differential model of home bias, and conclusion and summary are in the last section.

Model of Home Bias

This study develops a risk differential model of home bias from the perspective of a portfolio model, which considers market risk in the portfolio rebalancing process. To do so, a portfolio model framework developed by Kim (2011) was revised to derive risk differential by utilizing market risk explicitly for international capital flows. In the proposed model, it was assumed that hedging costs were too high to cover all of the risks. That is, the market trading risk is imperfect. Perfect hedging is impossible as well. Let A and A^* denote the domestic and overseas assets, respectively. These assets are mainly equity and bond. Domestic investors (*h)* hold domestic (A^h) and overseas (A^{*h}) assets, while foreign investors (*f)* hold their own home asset (A^{*f}) and overseas asset (A^f). The investors choose their optimal portfolio balance to maximize their expected utility due to uncertain returns. The expected utility functions for domestic and foreign investors are the mean-variance function of the expected profit.

$$Max_{A^h\ A^{*h}} \sum\nolimits_{t=0}^{\infty} \beta^t E_0[\Pi_t - \frac{1}{2}\rho\sigma_{\Pi}^2] \tag{1}$$

$$Max_{A^f\ A^{*f}} \sum\nolimits_{t=0}^{\infty} \beta^{*t} E_0[\Pi_t^* - \frac{1}{2}\rho^*\sigma_{\Pi^*}^2] \tag{2}$$

where β and β^* is constant discount factors for the home and the foreign country. ρ and ρ^* are the degrees of absolute risk aversion for domestic and foreign investors. E_0 is the expectation operator with the current information. Π_t and Π_t^* are the profits of the domestic and foreign investors in terms of each country's currency, and σ_{Π}^2 and $\sigma_{\Pi^*}^2$ are the variances of the profits.

$$\Pi_t = A_t^h dR_t + S_t A_t^{*h} dR_t^* \tag{3}$$

$$\Pi_t^* = \frac{1}{S_t} A_t^f dR_t + A_t^{*f} dR_t^* \tag{4}$$

In (3) and (4), dR_t and dR_t^* are returns on domestic and overseas assets. S_t is the exchange rate of the domestic currency per unit of the foreign currency, and a rise in S_t depreciates the value of the domestic currency. The domestic and foreign returns are assumed to be subject to shocks of prices and dividends, abstracting from deriving the returns endogenously in the model. The foreign assets and their returns are expressed in terms of their foreign currency, and the domestic investors are exposed to the exchange risk when they hold overseas assets. Using the profits (3) and (4), the first order conditions are derived to maximize the expected utility for domestic and foreign investors. Then, the optimal demand for the assets can be obtained by recursively substituting the optimal choice of each asset into the first order conditions.

$$A^h = (\frac{1}{\sigma_R^2 - Cov(dR, dR^*)\delta^*})\ (\frac{1}{\rho})[E(dR) - \delta^* E(dR^*)] \quad (5)$$

$$A^{*h} = \frac{1}{S}(\frac{1}{\sigma_{R^*}^2 - Cov(dR, dR^*)\delta})\ (\frac{1}{\rho})[E(dR^*) - \delta E(dR)] \quad (6)$$

$$A^f = S(\frac{1}{\sigma_R^2 - Cov(dR, dR^*)\delta^*})\ (\frac{1}{\rho^*})[E(dR) - \delta^* E(dR^*)] \quad (7)$$

$$A^{*f} = (\frac{1}{\sigma_{R^*}^2 - Cov(dR, dR^*)\delta})\ (\frac{1}{\rho^*})[E(dR^*) - \delta E(dR)] \quad (8)$$

where σ_R^2 and $\sigma_{R^*}^2$ are the variances of the returns. δ^* and δ are the co-relation between the domestic and foreign returns, representing an inverse of market risk in the international portfolio equity flows. i.e., $\delta^* = \frac{Cov(R, R^*)}{\sigma_{R^*}^2}$, $\delta = \frac{Cov(R, R^*)}{\sigma_R^2}$.

δ^* and δ are an increasing function with covariance terms between the two returns, and decreasing with variances of return. If the capital markets between two countries are well integrated with each other, then the two countries' returns move together in the same direction. δ and δ^* are positive in this case. The volatilities (variances) of market returns also affect market risks. The more volatile the foreign market, the higher market risk for foreign investment, and the more home bias will be strengthened. The greater δ and δ^* indicates a higher degree of capital market integration between the two countries and a low volatilities. Thus, δ and δ^* reflect an inverse of market risk. The market risk may be all kinds of barriers or resistances to international portfolio flows in a broader concept: transaction costs, information asymmetry, default or country risks as well as cultural and social barriers to cross-border portfolio flows such as language, culture, religion, weak economic freedom as well.[2]

A risk adjusted differential of returns is defined as a difference between domestic and foreign rates of returns adjusted by an inverse of the market risk, δ and δ^*, in the portfolio investment flows. It equals $[E(dR) - \delta^* E(dR^*)]$ for foreign investors to purchase domestic assets, and equals $[E(dR^*) - \delta E(dR)]$ for domestic investors to buy foreign assets. These return differentials are asymmetric as long as market risk are different between markets ($\delta^* \neq \delta$). The optimal portfolio demands (A^{*h}, A^h, A^{*f}, A^f) from (5)~(8) depend on the risk adjusted differential of return, its variance and covariance terms as well as the degree of risk aversion for investors given the exchange rate. A relative increase in domestic return to the foreign return and a lower degree of risk aversion induces more demand for domestic assets.

The effects of δ^* and δ on asset demands depend on their relative impacts on the asymmetric differential of return and its volatilities. With a greater increase of δ^* and δ, the risk-adjusted differential of return is reduced between home and abroad and there is less risk-hedging incentive for both domestic and foreign assets. This diversification motives reduce international portfolio investment and, thus, increase more home bias. However, The greater δ^* and δ, the less volatility in returns and, the greater demands for foreign assets as shown in the denominator of the optimal asset demands in (5)~(8). The more correlated with each market, the less transaction costs and the less asymmetry of information. The home bias will shrink as a result.

Market clearing conditions for home and foreign equity markets are $A_t^h + A_t^f$ =1, and $A_t^{*h} + A_t^{*f}$ =1. Here, the equity supplies are normalized at home and abroad. From the market equilibrium conditions of the domestic and overseas assets, the equilibrium asset returns are derived, $E(dR_t) = \frac{\rho\rho^*}{(\rho + \rho^*)}[\sigma_R^2 + \delta^* \sigma_{R^*}^2]$ and $E(dR_t^*) = \frac{\rho\rho^*}{(\rho + \rho^*)}[\sigma_{R^*}^2 + \delta\sigma_R^2]$ when an initial level of the exchange rate equals to one (S_0 =1). Higher returns are expected as compensation for higher variance of returns and higher degree of the risk aversion.

To focus on the role of the risk-adjusted, asymmetric return in the international capital flows, asset prices and exchange rate are assumed to be exogenously determined. For simplicity, dividend flows from the net holdings of foreign (domestic) assets by domestic (foreign) investors are also assumed to be exogenously given.

Home Bias

Home bias is defined as excessive holding shares of domestic assets among total assets by domestic investors, $A^h - SA^{*h}$. The risk adjusted, asymmetric returns play an important role in explaining home bias in our model. Substituting the optimal portfolio demands (A^{*h}, A^h, A^{*f}, A^f) in (5)~ (8) into the definition of home bias, home bias by domestic investors can be expressed in terms of a risk adjusted differential of return, variance and covariance terms of returns and degree of risk aversion.

$$A^h - SA^{*h} = \Delta[E(dR) - \delta^* E(dR^*)] - \Delta^*[E(dR^*) - \delta E(dR)] \qquad (9)$$

where $\Delta^* = (\frac{1}{\sigma^2_{R^*} - Cov(dR, dR^*)\delta})\ (\frac{1}{\rho})$, $\Delta = (\frac{1}{\sigma^2_R - Cov(dR, dR^*)\delta^*})\ (\frac{1}{\rho})$. The terms of Δ^* and Δ, which are functions of the variance and covariance of returns, become important channels for the transmission of different shock effects to the risk adjusted differential of return and, thus, to home bias. Home bias would be strengthened under the positive Δ^* and Δ, when the risk adjusted return differential is greater for domestic assets than for foreign assets. i.e. $[E(dR) - \delta^* E(dR^*)] > [E(dR^*) - \delta E(dR)]$. Δ^* and Δ tends to be positive when variance of market returns get much greater than covariance terms, and when covariance term between market returns get smaller. This is a case where the markets are very volatile, and where the home and foreign financial markets are not closely correlated to each other. Thus, home bias phenomenon may pertain to the case in which the two financial markets are not well integrated or where the markets become very volatile. Home bias by the foreign investors can be easily derived by using symmetry to the bias (9) by the domestic investors. The asymmetric returns can be decomposed into two parts to explain home bias; the traditional differentials of returns and risk differential. This decomposition makes a role of risk differential distinguished from the effect of traditional differential of return in determining home bias.

$$A^h - SA^{*h} = (\Delta + \Delta^*)[E(dR) - E(dR^*)] + \Delta(1-\delta^*)E(R^*) - \Delta^*(1-\delta)E(dR) \qquad (10)$$

The first term in (10) represents the effect of the traditional differential of return to explain capital flows for the arbitrage purpose $(E(dR) - E(dR^*))$, while the second term of (10) is risk associated with foreign investments by domestic investors. The third term is risk related to domestic investment itself.

The last two terms in (10), $\Delta(1-\delta^*)E(R^*) - \Delta^*(1-\delta)E(dR)$, turn out to be market risk differentials between abroad and home investments by domestic investors, reflecting the diversification motives of market risks. Without loss of generality, it is assumed that $\Delta^* = \Delta$ at an initial market conditions for home and abroad. Risk differential can be separated from the asymmetric returns in the right hand side of (11) to clarify the effect of market risk on home bias. The second term of the right hand side of equation (11) is the effect of "*so called*" risk differential on home bias.

$$A^h - SA^{*h} = \Delta[E(dR) - E(dR^*)] + \Delta^*[\delta E(dR) - \delta^* E(R^*)] \qquad (11)$$

Under the positive Δ^* and Δ, home bias will get stronger when the domestic rate of return is greater than the foreign return ($E(dR) > E(dR^*)$) in the first term of (11), and when $\delta^* < \delta$ in the second and third terms.

δ will get greater than δ^* when the two markets are less correlated to each other and when domestic return is less volatile than abroad. Volatilities of returns was utilized as risk estimates or investment cost to international portfolio flows by De Moor and Van Pee (2010). Their risk estimates are different form our measure of risks, where involve both correlation and volatilities between returns. Market risks in our model reflect degree of incomplete risk sharing, which is an inverse of

δ^* and δ, $(1-\delta^*)$ and $(1-\delta)$. The more correlated capital markets, the less volatile the markets, the greater δ^* and δ, the less degree of market risk. The importance of correlation between market returns was studied to explain home bias by Forbes (2010), showing that foreign investors from countries where asset markets are more correlated with the U.S. tend to invest more in the U.S. even if their return on the U.S. are less than abroad. The return differential persists, and shows the portfolio model do a poor job.

The recent studies began to focus on the risk-hedging incentive in determining international portfolio flows. Home bias is structured to hedge the risk arising from the exchange risk or non-tradable income risk. See Coeurdacier (2009), Coeurdacier and Rey (2011), Heathcote and Perri (2007), Artis and Hoffman (2007), Wincoop and Warnock (2006) and Cooper and Kaplanis (1994). These risks are expressed in the covariance terms between equity return and income risk or exchange risk, which are totally different in the economic meanings from those of δ^* and δ in our model. Hau and Rey (2008) shows that home bias is a tendency of the investors' portfolio rebalancing toward holding more home equities to avoid the exchange risk, and can be expressed as a function of the share of the exchange risk among the total portfolio payoff risks of domestic and foreign assets.

It is notable in our model to see that the exchange risk does not appear to play any role in deciding international portfolio flows. The only important channels are differential of return and risk differential associated with international portfolio flows, which is in sharp contrast to the recent empirical studies.

Estimation

Risk differential model of home bias

Using a simple *GLS* estimation technique, we test a risk differential model of home bias to estimate the degree of home bias across countries. ($A^h - SA^{*h}$) detonates n-vector of relative home bias by domestic investors in each market, and depends on the differentials of return and risk differentials across countries.

$$A^h - SA^{*h} = c_0 + c_1[E(dR) - E(dR^*)] + c_2[\delta E(dR) - \delta^* E(dR^*)] + e \qquad (12)$$

According to theory, the effects of return differential (c_1) should be positive under the positive Δ^* and Δ when the markets are very volatile, and where the home and foreign financial markets are not closely correlated to each other. The effect of risk differential (c_2) will be negative when the home and foreign financial markets are not closely correlated to each other, and when the domestic market is less risky than abroad.

Equity returns are used as proxy for market returns, which are the change rates of stock index for each country. Only equity investment is considered to get consistent data series for international portfolio flows and home bias originally including both equity and bond. The inverse of market risk (δ^* and δ) are directly calculated from the covariance and variance terms of equity returns. Bilateral home bias for domestic equity is calculated from the definition of market clearing conditions for home and foreign equity markets and that of home bias; $A_t^h + A_t^f = 1$, $A_t^{*h} + A_t^{*f} = 1$. Using these definitions, we get the normalized home bias by market capitalization; $A^h - SA^{*h} = (1 - A^f) - SA^{*h} = 1 - (A^f + SA^{*h})$. Bilateral home bias for domestic equity is defined as one minus a (normalized) sum of liabilities and assets of international portfolio investment for each country.

Data

Using annual panel data from 2002-2012 of nine countries including the developed and Asian emerging markets both, we investigate to test the risk differential model of home bias. Among these nine countries, the U.S., and the U.K., and Japan have the developed financial markets, while China, Korea, Malaysia, Singapore, Australia and Thailand are the Asian emerging markets. The change rates of stock index for each country are obtained from the data base of the central bank of each country, and IMF, *International Financial Statistics*. Bilateral portfolio flows and home bias portfolio investment are obtained from the International Monetary Fund, *International Financial Statistics*, the *Coordinated Portfolio Investment Survey*. The covariance and variance terms of equity returns are obtained from the World Bank and IMF, *International Financial Statistics.* All data series of liabilities and assets of international portfolio investment and market capitalization of each country are obtained from the World Bank and IMF data base.

Empirical results

The Generalized Least Squares (*GLS*) statistical technique was used to estimate the risk differential model of home bias because the traditional *OLS* estimation results may be biased when the residuals are auto-correlated and when their variances are heterogeneous. Stock returns had stable *AR(1)* processes, and thus, the estimation results should not be spurious. The unit root test results are eliminated since all series of variables (returns and risks) were stable over time. The estimation results of the risk differential model in (12) are provided in Table 1. The numbers in the parenthesis are *p*-values. R^2 is relatively high, indicating that the returns and market risk could explain the exchange rate fluctuations well.

Table 1 shows the estimation results for the effects of differentials of return and risk differential on home bias. The effects of return differential (c_1) are negative in sign for all cases of countries and statistically significant at 5% level for Australia, China, Japan, Singapore and Malaysia. The negative effect of differential of return on home bias implies that these markets are relatively stable, and are closely correlated to each other. That is, during the sample periods, Australia, China, Japan, Singapore and Malaysia are relatively stable, and well integrated with each other. Meanwhile, the effects of risk differential (c_2) are positive for all countries and statistically significant for Japan, Korea, Singapore and Malaysia. The effect of risk will be positive when the home and foreign financial markets are closely correlated to each other, and when the domestic investors think that the domestic market is more risky than abroad.

In sum, the effects of both return differential and risk differential on home bias seem to be statistically significant at 5% level for Asian financial markets. This result shows that differential of return becomes to be important role in home bias at the well integrated markets among Asian cross-border countries, where are relatively stable. Meanwhile, risk differentials play to work at the risky domestic markets such as Asian emerging markets where investors from Asian countries feel that domestic market is more risky than abroad. The first differential plays important role at the well integrated markets, while the second risk differential become to play important role at the risky domestic markets. These evidences support our model of risk differential for home bias puzzle in international portfolio flows.

The effects of risk differentials on home bias do seem to be different between the developed and developing markets. In particular, this effect does not appear in the U.K. and the U.S., indicating that investors from the U.K. and the U.S. do not feel that their domestic markets are more risky than abroad.

Conclusion and Policy Implications

This paper explores a risk differential model of model theoretically to examine how well market risks could explain degree of home bias across countries. The optimal portfolio choice model is revised to take into account of market risks within a framework of a portfolio rebalancing model. Key issue is asymmetric return differential, which is decomposed into two parts; traditional differential of return and risk differential. Using annual panel data of Asian emerging markets and the developed markets in 2002-2012, the risk differential model of home bias is estimated across countries and the evidence generally supports our model.

In the *FGLS* estimation results, the effects of return differential are negative in sign for all cases of countries and statistically significant for Australia, China, Japan, Singapore and Malaysia. This implies that these markets are relatively stable, and are closely correlated to each other. Meanwhile, the effects of risk differential are positive for all countries and statistically significant for Japan, Korea, Singapore and Malaysia. The effect of risk will be positive when the home and foreign financial markets are closely correlated to each other, and when the investors think that the domestic market is more risky than abroad. These results show that differential of return becomes to be important role in home bias at the well integrated markets among cross-border countries, where are relatively stable. Meanwhile, risk differentials play to work at the risky domestic markets where investors from Asian countries feel that domestic market is more risky than abroad. These evidences generally support our model of risk differential for home bias puzzle. The effects of risk differentials on home bias seem to be different between the developed and developing markets. In particular, this effect does not appear in the U.K. and the U.S., indicating that investors from the U.K. and the U.S. do not feel that their domestic markets are more risky than abroad.

Table 1. The *FGLS* estimation results of the risk differential model for home bias

	FGLS estimation			
	c_0	c_1	c_2	remarks
Japan	0.003 (1.19)	-0.052 (0.044)*	0.178 (0.037) *	R^2=0.3292 Rt MSE=0.0343 *F*=147.43(0.0001)*
U.K.	0.001 (1.761)	-0.080 (0.754)	0.601 (0.513)	R^2=0.4029 Root MSE=0.0071 *F*=3.320(0.0700)
U.S.	0.012 (0.892)	-0.006 (0.692)	0.019 (0.674)	R^2=0.2334 Rt MSE=0.0456 *F*=17.43(0.0001)*
Australia	0.000 (0.113)	-0.019 (0.022)*	0.018 (0.576)	R^2=0.5253 Root MSE=0.0124 *F*=12.12(0.0001)
China	-0.002 (0.690)	-0.020 (0.012) *	0.009 (0.829)	R^2=0.4423 Rt MSE=0.0711 *F=24*.43(0.0001)*
Korea	0.003 (0.474)	-0.040 (0.200)	0.218 (0.018) *	R^2=0.6150 Root MSE=0.0615 *F*=14.97(0.0002)*
Malaysia	0.002 (1.860)	-1.802 (0.024)*	4.594 (0.009) *	R^2=0.3205 Root MSE=0.0137 *F*=10.98(0.0117)
Singapore	0.012 (1.22)	-2.358 (0.013) *	4.235 (0.019) *	R^2=0.4566 Rt MSE=0.0013 *F*=78.43(0.0001)*
Thailand	0.0022 (1.67)	-0.045 (0.752)	1.006 (0.272)	R^2=0.9886 Root MSE=0.0177 *F*=48.80(0.0001)*

*) significant at a traditional level of significance (5% and 10%). The numbers in the parenthesis are *p*-values.

Notes

[1] Asymmetric return was studied in a very short term paper by Ang and Chen (2002), but they did not provide any specific academic intuitions, modeling and testable implications..

[1] Akitoby and Stratmann (2010) show that changes in political institutions, such as improvements in democratic rights and increased government accountability, have a direct effect on emerging financial markets.

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The Impact of Exchange Rate Variation on The Return Disparity for Dual-Listed Securities

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Abstract

Dual-listed companies share cash flow at a given proportion but maintain listing on separate stock exchanges. Given this agreement, returns to these shares ought to be identical, but an extensive literature finds disparity in these returns attributed to differences in investor sentiment in the separate markets in which these securities trade. The literature has identified a significant relationship between exchange rate variation and this return disparity but has been silent on the cause of this relationship. We develop a rational market explanation and an investor sentiment explanation to explain this relationship. Our empirical tests support the investor sentiment hypothesis.

Introduction

Dual-Listed Companies (DLCs) result from a virtual merger of two companies where both individual firms are contractually bound by profit sharing and economies rights agreements but retain their separate, legal identities.[1] In keeping with their separate legal identities, the DLC twins[2] maintain distinct stock issues and stock listings on separate geographically dispersed exchanges. The most famous example of this arrangement is the Royal Dutch / Shell DLC which was formed in 1907 with the firms agreeing to split cash flow on a 60% / 40% basis. Thus, under the assumption of market efficiency, given the public nature of the agreement, the stock prices of these two twins ought to maintain a 60 / 40 ratio and their return distribution ought to be identical to maintain that ratio. From the time of the establishment of the Royal Dutch / Shell DLC until its eventual merger in 2005, the twins rarely and only transitorily traded at the expected 60 / 40 price ratio. This puzzle has given rise to a literature exploring the causes for the observed disparity and investigating the lack of successful arbitrage of the price disparity.

Rosenthal and Young (1990) provided that first analysis of the price behavior of DLC stocks in the academic literature when they investigated the pricing behavior of Royal Dutch / Shell and Unilever N.V. / Unilever PLC. Since this seminal study, a growing literature has established return discrepancies across a number of different twins. The evidence from these papers suggests that the return discrepancy results from investor sentiment and that noise from that sentiment prevents successful arbitrage. The literature also finds a relationship with the exchange rates between the two countries where the stock is listed without providing an explanation for the relationship. In this paper we develop and test two competing rationales for the influence of the exchange rate. In addition, we apply a new methodology to more directly test the investor sentiment hypothesis and to analyze the role of exchange rate variation in returns of DLC twins. The rest of the study is organized as follows. Section 2 provides background on previous literature. Section 3 provides a discussion of the alternative explanations of the relationship between exchange rate variation and DLC twin return deviations. We also describe the contributions of this paper in more detail. Section 4 discusses the empirical data that we use. Section 5 details our empirical results. Section 6 reports our conclusions.

Previous Literature

The literature on DLC twin securities universally finds large and variable mispricing between these securities. The initial paper documenting mispricing between DLC twins studied two sets of twins but later studies find mispricing across a large set of twin securities. Within the literature, a number of structural explanations for the price discrepancies are investigated but largely dismissed. As the literature evolved, growing evidence led to the conclusion that the mispricing is linked with market inefficiency, particularly to mispricing from investor sentiment. Throughout the studies, investigators have found that arbitrage designed to benefit from mispricing would fail. Later studies attribute this failure to the behavior of noise traders acting on sentiment.

The twin security literature begins with Rosenthal and Young[3] (1990) study of mispricing between the two Dutch/Anglo twins of Royal Dutch and Shell and Unilever NV and Unilever PLC. They report consistent mispricing between these two pairs and that the direction and magnitude of the mispricing is variable. Several arbitrage strategies were found to be insufficiently profitable to pay for the cost of financing and transactions. They examine several possible micro market explanations for the mispricing but conclude that these explanations are faulty or insufficient to explain the magnitude of the mispricing. They conclude (p. 141) that they " . . . document what appears to be persistent mispricing . . ."

Froot and Dabora (1999) were the first to test causation of the mispricing. Their data consisted of the two twins studied by Rosenthal and Young plus an Anglo / US twin, Smith Kline / Beecham. Their empirical work examined the difference in returns for the twins instead of examining price differentials on the basis that regardless of the appropriate price ratios the return to each twin ought to be identical. They find that return differentials are affected by the location of the trade and suggest possible explanations for the locational effect. A number of institutional factors are examined and generally dismissed. Froot and Debora find merit in two possible institutional explanations, tax-induced heterogeneity and agency problems associated with the classification of stocks as domestic or international. They find, however, that neither explanation is sufficient to explain the mispricing.

These findings lead Froot and Dabora (1999) to examine the role of market inefficiencies. Specifically, they posit that market-wide noise might infect the price of a twin trading in a certain market but not another. To test for this influence they regress the return differential between the two twins against the two market indexes on which the twins trade most heavily. For example, they regress the return of Royal Dutch minus the return of Shell against the return of the S&P 500 Index and the return of the FTSE. The S&P 500 Index measures the return to the U. S. market because Royal Dutch trades primarily on the NYSE. The FTSE Index measures the return to the U. K. market because Shell trades primarily on the London Stock Exchange. They find that the return differential is significantly related to both indexes. There is a significant positive relationship between the return differential and the S&P 500 Index and there is a significant negative relationship between the return differential and the FTSE. Froot and Dabora interpret this result as strong evidence that the price differential is influenced by local market returns. In other words, when the U. S. market shows a positive return the return for Royal Dutch tends to show a positive return and the return differential between Royal Dutch and Shell tends to be a positive. In contrast when the return for the FTSE is positive, the return for Shell tends to be positive and the return differential between Royal Dutch and Shell tends to be negative. Similar findings are reported for the other two DLC twins in their sample. These results are consistent with local investor sentiment influencing the return differential and the price discrepancy between DLC twins.

Froot and Dabora (1999) seem somewhat reluctant to attribute the market location influence to the role of investor sentiment. For example, they note that the investor sentiment argument suffers from an inability to identify the cause and the persistence of the noise. On the other hand, Froot and Dabora argue extensively that the DLC case provides a better test of the impact of market location than the closed-end fund discount mystery, which behavioralists widely attribute to investor sentiment. Further, they provide no alternative to the investor sentiment argument as an explanation of the influence of market location other than micro-market factors, which they found to be inadequate. Also, the results reported by Froot and Dabora were widely cited as evidence of the impact of investor sentiment by other researchers, most notably by Shleifer (2000) and Barberis and Thaler (2002).

Froot and Dabora also address the question as to why arbitrage discipline had not eliminated the price differentials. They note that the failure of arbitrage may result from a lack of sufficient financing for any particular investor. They further note, however, that the lack of arbitrage does not explain the cause of the initial discrepancy.

Extending previous studies, Bedi, Richards and Tennant (2003) investigate the price behavior of 14 twins, including two identified in previous studies and 12 twins created in the fifteen year period prior to their study. They find significant mispricing in all fourteen cases. In addition, they replicate Froot and Dabora's analysis over six twins, confirming the influence of market location and investor sentiment. In their regressions Bedi et. al. study new twins and extend the time periods for the previously studied twins. Bedi et. al. also study the impact of announcement of the unification of twins into a single company. They find that following cross listings of the single company, that company grows more sensitive to the market where the primary listing occurs which is interpreted as additional evidence of the important role of location and investor sentiment.

Bedi et. al. extend the discussion concerning arbitrage activity without conducting an arbitrage simulation by referencing examples of failed arbitrage activity. For example, they cite Lowenstien's (2000) report that the hedge fund, Long-Term Capital Management, had a $2.3 billion arbitrage position on the Royal Dutch / Shell twin at the time of its 1998 collapse.

Three later studies Scruggs (2007), De Jong, Rosenthal, and Van Dijk (2009) and Baker, Wurgler and Yuan (2012) begin with the premise that mispricing of the twins reflects investor sentiment in the market where each security is listed. Scruggs (2007) studies the limits of arbitrage given the influence of noise traders using the Royal Dutch / Shell and Unilever twins as a case study. Interestingly, he finds noise trading especially significant around the collapse of Long-Term Capital Management. De Jong et. al. (2009) confirm the existence of large mispricing across 12 twin pairs and apply arbitrage strategies to each pair. They find that their strategies on average profitable but subject to large idiosyncratic risk. Baker et. al. (2012) develop a sentiment index for six countries along with a global sentiment index. Their country sample includes both the U. K. and the U. S., and they utilize a sample of three U. K. / U. S. twins as part of their study. In a joint validation of their investment sentiment indexes and the hypothesis that the pricing gap of twins results from investor sentiment, they find that their investment sentiment indexes provide significant explanatory power for the extent of the pricing gap of the twins.

All of the empirical work cited above involves exchange rate data in an integral way. Rosenthal and Young (1990) compare price ratios against cash flow ratios. These price ratios must be determined in a single currency and thus require price conversion using exchange rate data. Changes in the exchange rate will change the observed price ratio. Following Froot and Dabora (1999) examination of price deviations are made based on stock returns differentials between the twins. The individual stock returns are calculated with the twin's domestic currency. Thus, changes in return differentials will be affected by changes in the exchange rate. The Froot and Dabora study and additional studies that followed regress the return differentials against the stock indexes of the respective markets for the twins and the exchange rate across the twins' currencies. In all cases the exchange rate was highly significant in explaining variation in the return differential. Little or no analysis is provided as to the cause of this association. In the next section we develop two alternative hypotheses to explain the relationship of change in the exchange rate and the return differential between the DLC twins. One argument depends on market rationality and the other depends on the role of investor sentiment. The former is consistent with inferences from the literature concerning the role of the exchange, but inconsistent with the main conclusion of the literature that investor sentiment is the cause of the return differentials between DLC twins. For the latter argument just the opposite is true. We also develop hypotheses to test between these alternatives. Thus, our contribution to the literature is to analyze the relationship between exchange rate variation and variation in DLC twin return, a relationship that has been part of previous empirical testing, but curiously without analytic discussion of the relationship.

Contributions of Current Paper

The Undefined Role of Exchange Rate Variation in Past Studies

Following Froot and Debora (1999), studies have examined the DLC twin pricing anomaly using return differences between the DLC twins. For ease of reference, we refer to the security whose return appears first in the return difference as the Security A. The other security is referred to as the Security B. As noted above, previous studies, as illustrated in equation (1), regress the security return differential separately against the two stock indexes on which Security A and Security B primarily trade and the exchange rate between the currencies for these two markets.

$$(r_a^S - r_b^S) = \alpha + \beta_1(r_a^M) + \beta_2(r_b^M) + \beta_3(r_{ab}^X) \tag{1}$$

Where: $(r_a^S - r_b^S)$ represents the return differential between Security A and Security B, r_a^M represents the return to a market index where Security A trades, r_b^M represents the return to a market index where Security B trades, and r_{ab}^Xrepresents the direct quote for the currency in which security A trades relative to the currency in which security B trades.

In these studies the coefficient for the index of the Security A is generally positive and the coefficient for the Security B is generally negative. These results are taken as support for the investor sentiment argument, as the return differentials tend to increase when the market for Security A increases and tends to decrease when the market for Security B decreases. The argument proceeds as follows: When investors are particularly bullish in Market A the influence of these investors increase the return to Security A, causing the DLC return differential to increase. Likewise, when investors are particularly bullish in Market B they cause an increase in the return to Security A, causing the DLC return differential to decrease.

In all cases, the exchange rate variable is negative and highly significant. Thus, as the currency for the Security A appreciates, the return differential decreases. As argued above, interpretation of this result is virtually missing in the previous literature. Instead, the exchange rate is treated as a control variable whose influence is presumed to flow from a rational market adjustment to currency fluctuations. As we have previously noted, this interpretation is inconsistent with the argument that investor sentiment is causing the DLC twin return disparity. Indeed, the presumption that the influence of the exchange rate variation on the DLC twin return disparity results from a rational market adjustment necessarily questions the interpretation that influence of the index returns provides evidence of the influence of investor sentiment. Our contribution is to analyze the possible role of exchange rate variation on the DLC twin pricing disparity and to test between rationale and investor sentiment explanations. We proceed in this section by first analyzing two conflicting explanations for the role of exchange rate variations. Then we discuss empirical tests to be used to distinguish between these explanations.

The Role of the Exchange Rate

In this section we develop two explanations for the significant relationship found in previous studies between exchange rate variation and differential in the returns between DLC twins. We begin our analysis under the assumption of market efficiency. This assumption implies that the DLC twin price ratios are consistent with the agreed cash flow ratio. For purposes of illustration we use the Royal Dutch and Shell twin agreement which has the familiar 60 / 40 cash flow split in favor of Royal Dutch. If the prices of the twins are stated in local currencies (the US$ for Royal Dutch and the British £ for Shell) the price ratios will reflect the exchange rate as well as the cash flow ratio. This relationship may be illustrated by equation (2):

$$\frac{Prd}{Ps} = \frac{CFrd}{CFs} * \frac{\$}{£} \qquad (2)$$

If, for example, the price of Royal Dutch is $60 and the exchange rate is $2 / £ then the price of Shell would be 20 £. Taking the first derivatives shows that the price ratio will change with the exchange rate at the rate of the cash flow ratio as shown in equation (3):

$$\frac{\delta PR}{\delta ER} = \frac{CFrd}{CFs} \qquad (3)$$

Thus, changes in the exchange rate would cause a change in the price ratio at a multiple of the cash flow ratio of 1.5. If, in our example, the US$ would appreciate to $1.95 / £, this change of -.05 in the exchange rate would lead to a drop of -.075 in the price ratio if price equilibrium were to continue. The US$ price of Royal Dutch must drop or the British £ price of Shell would have to increase, or both. If, for example, the $ price of Royal Dutch stayed at $60, the price of Shell would increase to 20.51 £.

Putting this relationship in terms of returns, when the US$ appreciates to maintain equilibrium the return to Royal Dutch must be less than the return to Shell. If the return to Royal Dutch is the first return in the return differential, the return differential would be negative. This result is consistent with previous empirical findings showing a negative relationship between the direct quote for the Security A and the return differential for the DLC twin.

The relationship between exchange rate variations and security returns may be broaden from this narrow perspective of DLC twins. If our assumption of market efficiency is extended to include purchasing power parity, changes in the exchange rate ought to correlate with changes in equity return differentials in general. As the US$ appreciates relative to the British £, for example, according to purchasing power parity, the relative price of U. S. goods ought to fall relative to the price of British goods. By extension the relative price of all US securities ought to fall relative to their British counterparts. Under this scenario, exchange rate variation and index return variation are inexorably tied. As we will argue more fully below, under the assumption of a rational market explanation for the tie between exchange rates and DLC twin returns the conclusion that the association between index return variation and DLC return differentials reflects investor sentiment is questioned.

Supporters of the argument that the DLC twin return disparity results from mispricing due to investor sentiment can argue for dismissal of the above argument based on the observation that the price ratios between Royal Dutch and Shell were never in equilibrium. Such a defense, however, would suggest the need for a different explanation for the observed association between exchange rate variation and DLC twin return differential. The investor sentiment argument needs to postulate a mechanism by which a change in the exchange rate would be transferred to the difference in security returns under conditions of mispricing. We develop such an argument below and in the next section we discuss empirical tests to differentiate between the rational market argument and the argument consistent with the role of investor sentiment.

If differences in investment sentiment across markets are responsible for the DLC return disparity, one may predict an association between exchange variation and DLC return disparity quite different from the explanation provided in the literature. Bullish sentiment concerning a particular local market is not isolated within the geographic boundaries of that market. A bullish trend within a particular national market encourages bullish sentiment in investors outside the market boundaries. This extra market bullish sentiment leads to international cash flows into that market. Examples are easy to find and would include recent price bubbles in the Brazilian market, the Chinese market, the Indian market and indeed, the US equity market during the dot-com bubble. Purchasing the local currency to participate in the market boom requires purchase of the local currency, leading to local currency appreciation.

For the sake of clarity we apply this argument to the specific example of the DLC twin return disparity. Previous empirical work has regressed the return disparity between Security A and Security B and the direct quote for the Security A relative to the Security B. The regression results show an inverse relationship between the exchange rate quote and the return disparity. In other words, if the currency of the Security A appreciates relative to the currency of Security B (the value of the direct quote decreases) the return disparity increases. This is consistent with bullish sentiment in the local market for Security A causing a relatively high return to Security A, increasing the return differential between the two twins, and causing currency appreciation for the home currency of the Security A resulting from international cash flows from bullish investors. In the next section we discuss our empirical methodology designed to distinguish between the two possible explanations for the association between exchange rate variation and DLC twin return disparity.

Testing the Role of the Exchange Rate Variable

As noted above, previous tests have regressed DLC twin return disparity separately against the home index for the two securities and the exchange rate between the home currency of the two securities. We take issue with this procedure for two reasons. For one, this procedure assumes independence between the index returns. This assumption is unrealistic and would tend to obscure the exact influence of a difference in the level of return sentiment. For example, if returns are falling in the market where Security B trades, one would not expect the return differential to increase if the return differential in the market where Security A trades was decreasing at a greater rate. The key is not the direction of the movement of either the market where Security A or Security B trade but the relative movement in the markets where Security A and Security B trade. To capture this influence and to provide a more precise measure of differences in sentiment across the markets, we estimate equation (4a). In this regression, the difference in investor sentiment between the markets where Security A and Security B trade is measured by the difference in the return index for the two markets.

$$(r_a^S - r_b^S) = \alpha + \beta(r_a^m - r_b^m) \tag{4a}$$

Where: the terms are as defined for equation (1)

The use of equation (4a) allows a more direct test of the investor sentiment argument. A positive relationship between the return disparity for the DLC twin securities and the difference in the home country index returns may be interpreted as support for the investor sentiment argument. If bullish investor sentiment in the country market where Security A trades is driving up the prices of local securities in general, including the DLC twin partner, both variables will be positive leading to a positive regression coefficient for the independent variable.

There is an alternative explanation for a positive regression coefficient for finding a positive regression coefficient from equation 4(a). If as discussed above exchange rate variations cause a rational change in security prices across home markets, differences in the DLC twin returns should occur as differences occur across all securities in keeping with purchasing power parity[4]. If this is the case, then the return disparity between DLC twin returns should closely mimic the return differential in the index. Thus, we test the hypothesis that the regression coefficient for the index return differential in equation 4(a) is equal to one.

If the exchange rate appreciation occurs when investor sentiment is bullish in a particular market we would expect an association between the DLC twin return disparity and both the index return differential and the exchange rate between the two country's currencies. In this case there is no reason to assume that the index return variable and the exchange rate will move in lock step. Thus, when the return differential in the DLC twins is regressed against both the index return differential and exchange rate variation, we would expect a positive regression coefficient for the former and a negative regression coefficient for the later. To test for this possibility we apply equation (4b).

$$(r_a^S - r_b^S) = \alpha + \beta_1(r_a^m - r_b^m) + \beta_2(r_{ab}^X) \tag{4b}$$

Where: the terms are as defined for equation (1)

Our empirical analysis proceeds in three steps. First, we estimate equation (1) to determine if results from our sample data are consistent with results from previous studies. Second, we estimate equation (4a) recognizing that a positive association between the two variables may be interpreted as supporting either the investor sentiment argument or rational impact from exchange rate variation. To distinguish between the two we test the hypothesis that beta = 0 and that beta = 1. Finally, we estimate equation (4b) to test for investor sentiment in the exchange rate variable.

Sample Data

We gather return data on six currently traded DLC twin pairs and for consistency with previous research the Royal Dutch / Shell pair. The six currently traded twins include five relatively new DLC twins and the Unilever NV / Unilever PLC twin. Price data for each DLC twin among the seven pairs and for the appropriate stock index is gathered from the markets on which they are listed and gathered from the Bloomberg Professional service. Returns are calculated as logarithmic monthly returns.

In addition we gather currency exchange rate data pertinent for each twin pair. One of the DLC twins for each of the seven pairs trades on the London market. There are four matching currencies: the U. S. dollar, the Australian dollar, the South African rand, and the euro. For consistency purposes, we always treat the twin trading on the London market as Security B, therefore our exchange rate is always the indirect quote for the British £. Exchange rate data is also collected from the Bloomberg Professional service.

The sample periods are different for each DLC twin. The sample period for the Royal Dutch / Shell twin begins with data availability on Bloomberg which is November 1989 and ends December 2004[5]. For the Unilever twin data begins November 1989 and ends September 2013. For the five relatively new DLC twins the sample period begins on the first day of the first full month following the formation of the DLC. Sample periods for all six currently traded DLC twin ends on August 2013.

Table 1 identifies the twins, the local index on which they predominately trade, and the currency in which the index is priced. Table 2 provides an indication of the return differential used to measure the return discrepancy for the twins and the appropriate index and identifies the exchange rate. Also, Table 2 indicates the data period for each of the twins in our sample.

Table 1: Twin Sample Firms, Corresponding Index and Currency

Company	**Index**	**Currency**
BHP Billiton Ldt. (BLT AU)	ASE All Ordinaries	AUD
BHP Billiton PLC. (BLT LN)	FSTE All-Share	GBP
Carnival Corp. (CCL US)	NYSE Composite	AUD
Carnival PLC. (CCL LN)	FSTE All-Share	GBP
Investec Securities LLC (INL SJ)	JALSH African All-Share	ZAR
Investec PLC. (INVP LN)	FSTE All-Share	GBP
Rio Tinto Ldt. (RIO AU)	ASE All Ordinaries	AUD
Rio Tinto PLC. (RIO LN)	FSTE All-Share	GBP
Reed Elsevier N.V. (REN AU)	AEX Euronext Amsterdam	EUR
Reed Elsevier PLC. (REN LN)	FSTE All-Share	GBP
Unilever N.V. (UNA AU)	AEX Euronext Amsterdam	EUR
Unilever PLC. (ULVR LN)	FSTE All-Share	GBP
Royal Dutch (RDSA NA)	AEX Euronext Amsterdam	EUR
Shell (RDSB LN)	FTSE All-Share	GBP

Note: The company name is followed by Bloomberg's ticker symbol.

Table 2: Return Definitions and Sample Periods

Equity Return Differences	**Index Return Differences**	**Foreign Exchange Rate**	**Time Period**
R(BLT AU – BLT LN)	R(ASX – FTSE)	(AUD / GBP)	Jul-01 : Aug-13
R(CCL US – CCL LN)	R(NYSE – FTSE)	(USD / GBP)	Apr-04 : Aug-13
R(INL SJ – INVP LN)	R(JALSH – FTSE)	(ZAR / GBP)	Jul-02 : Aug-13
R(RIO AU – RIO LN)	R(ASX – FTSE)	(AUD / GBP)	Feb-96 : Aug-13
R(REN NV – REN LN)	R(AEX – FTSE)	(EUR / GBP)	Feb-94 : Aug-13
R(UNA NA – ULVR LN)	R(AEX – FTSE)	(EUR / GBP)	Nov-89 : Aug-13
R(RDSA NA – RDSB LN)	R(NYX – FTSE)	(EUR / GBP)	Nov-89: Dec-04

Empirical Results

Replicatory Analysis

We begin our empirical analysis with a replication of previous studies to establish generality of our results. So, for the seven DLC twins we regress the return differential of the pair against the appropriate indexes and exchange rate as shown in equation (1). Our results are shown in Table 3.

Table 3: Results of Replicatory Analysis, Regressing DLC Differential Returns Against Index Returns and Exchange Rates

	BHP Billiton Group	Carnival Corp.	Investec Group	Rio Tinto	Reed Elsevier	Unilever	Royal Dutch Shell
Index A	0.289** (3.48)	0.990*** (6.45)	-0.069 (-0.74)	0.300 ** (3.29)	0.074 (1.43)	0.151** (3.76)	0.194* (3.13)
Index B	-0.327*** (-4.00)	-0.929*** (-5.82)	-0.036 (-0.32)	-0.421*** (-4.76)	-0.083 (-1.11)	-0.151* (-2.76)	-0.285** (-3.40)
Exchange Rate	-0.817*** (-11.23)	-0.350* (-2.77)	-0.887*** (-11.50)	-0.736*** (-8.75)	-0.636*** (-8.89)	-0.712*** (-12.11)	-0.640*** (-6.00)
R squared	0.638	0.547	0.604	0.461	0.338	0.446	0.279

T statistic in parentheses, below coefficients, *p<.01, **p<.001, ***p<.0001 (one-tailed test p-values)

Previous findings have shown that regressions explaining the differential between returns of the DLC twins show: 1) a significant positive relationship with the return for the home index for the Security A twin, 2) a significant negative relationship with the return for the home index for the Security B twin, and 3) a significant negative relationship for the exchange rate between the home currencies for the twins with the exchange rate stated as the direct quote for the Security A twin's currency. As reported in Table 3, our results are generally consistent with these findings.

In six of the seven cases, consistent with expectations, the regression coefficient for the Security A twin is positive and the regression coefficient for the Security B twin is negative. In these six cases, with one exception, the regression coefficient is significant. In most cases the regression coefficient is significantly different from zero at the 0.001 level. The DLC twin, Investec, which had an incorrect sign for the index return of the Security A twin, was the only twin trading on the South African market.[6] One might hypothesize that the small market size of the South African market might somehow contribute to this inconsistency. On the other hand, the twin with generally insignificant results, Reed, traded on the London market and Euronext. We have argued above that these regressions are in some sense misspecified which may lead to insignificant results. We will test these same securities below using an alternative regression procedure.

Results of regressing the difference in the twin returns against the appropriate exchange rates are highly significant and consistent with previous studies. In all seven cases there is an inverse relationship between the twin return differential and the direct quote for Security A's currency. In all but one case the strength of the association between the DLC return difference and the exchange rate is stronger than the association with the index return. In each of these six cases the regression coefficient is significantly less than zero at the 0.0001 level. When the home currency appreciates, the return differential for the DLC twin falls, which is consistent with both the rational market behavior hypothesis and investor sentiment hypothesis.

Test of Investor Sentiment and the Rational Market Response to Exchange Rate Hypothesis

We have argued above that previous tests of investor sentiment were misspecified in that the investor sentiment effect should be measured by differences in home country returns rather than the level of home country returns. To examine the role of investor sentiment as measure by home index return differences we utilize equation (4a) and regress the difference in DLC twin returns against the difference in returns of home country index. Results are reported in Table 4.

Table 4: Regressing DLC Return Differential on the Index Differential

	BHP Billiton Group	Carnival Corp.	Investec Group	Rio Tinto	Reed Elsevier	Unilever	Royal Dutch / Shell
Index A– Index B	0.597*** (5.34)	1.297*** (11.19)	0.501*** (4.16)	0.560*** (5.47)	0.239*** (4.60)	0.319*** (6.96)	0.308*** (4.76)
R Squared	0.167	0.507	0.117	0.125	0.083	0.146	0.112

T statistic in parentheses underneath the regression coefficient, *p<.01, **p<.001, ***p<.0001, P values are based upon one tailed test.

There is a dramatic strengthening of the results consistent with the investor sentiment argument when the difference in home-index returns is used as the explanatory variable. For all seven cases, as expected, there is a positive relationship between the difference in home index returns and the difference in twin returns. According to the investor sentiment argument, when bullish sentiment results in higher returns for the home market of one twin relative to the home market for the other twin, the return differential between the twins reflects that sentiment. For emphasis, we note that the results reported above were inconsistent with investor sentiment in the case of the Investec twin and insignificant in the case of the Reed twin. When the explanatory variable is correctly specified as the return difference in home country index both of these cases display test results that are both consistent with investor sentiment causing return differences and which are highly significant. In fact, in all seven cases the positive relationship between the difference in home index returns and the difference in DLC returns is significant at the 0.0001.

We have presented evidence that may be argued to show that investor sentiment contributes to return difference between DLC twins contrary to efficient market expectations. But this same evidence is consistent with variation in the exchange rates causing equal change across all securities including the securities involved in the DLC twin. If the DLC twin differential consistently and rationally reacts to exchange rate changes to the same degree as other securities in the market index then we would find a regression coefficient between the twins return differential and index differentials insignificantly different from one. If we fail to reject the null hypothesis that the regression coefficient equals one, we argue against the investment sentiment hypothesis. Results reported provide no support for the supposition that the observed correlation between DLC twin returns and index returns results merely from a joint rational response to exchange rate behaviors. As shown in Table 5, in all seven cases the hypothesis that the regression coefficient equals one is rejected at a high level of significance. Our results argue against previous explanations in the literature that view the association between exchange rate variation and disparity in DLC twin returns as merely a rational response to exchange rate variation. We are led then to the supposition that this association results from investor sentiment influencing both variables, although we do not argue that none of the correlation results from rational adjustment to exchange rate variation. In the next section we test the connection between investor sentiment and DLC pricing disparity directly.

Table 5: Test of Exchange Rate PPP

	BHP Billiton Group	**Carnival Corp.**	**Investec Group**	**Rio Tinto**	**Reed Elsevier**	**Unilever**	**Royal Dutch / Shell**
Beta	0.597	1.297	0.501	0.560	0.239	0.319	0.308
Beta -1	-0.403**	0.297**	-0.499***	-0.44***	-0.761***	-0.681***	-0.692***
Std. Error	0.12	0.12	0.12	0.10	0.05	0.05	0.06
T Statistic	-3.46	2.56	-4.15	-4.30	-14.65	-14.87	-10.71

T statistics were calculated as: (coefficient – 1) ÷ standard error, *p<.01, **p<.001, ***p<.0001; one tailed p-values

Including the Role of the Exchange Rate

If exchange rate differentials impact the return differentials in the DLC twins purely as a rational response to revaluation based on currency differentials then the impact of the exchange rate ought to be totally subsumed in return differences found in the indexes. Thus, when we estimate equation (4b) which includes the exchange rate as well as the index return differentials, we should find no additional association between exchange rate variation and twin return differentials. If bullish sentiment relative to a particular market encourages international cash flows then bullish investor sentiment is inexorably linked to currency appreciation and should associate with the return differential in DLC twins.

Table 6 reports the results from regressing DLC twin differentials against both home country index differentials and exchange rate movements. The results argue that exchange rate movements reflecting international investor sentiment provide additional explanatory power for the return differential of DLC twins. In all cases the regression coefficient for the exchange rate variable is highly significant. Indeed, in six of the seven cases the relationship between the DLC twin return disparity and the exchange rate is stronger than the association between DLC twin return disparity and the index return variation. In all cases, as shown in Table 6 in comparison to Table 5, a substantial increase in the percent of the variation in the DLC return differential that is explained occurs when adding the exchange rate variable to the equation. To test for the importance of the addition of the exchange rate variable we calculate the partial F-statistic. As reported in Table 6, for all seven of our DLC twins the addition of the exchange rate variable causes a significant increase in the percent of the variation in the DLC twin return differential that is explained by the model. Investor sentiment appears to affect the DLC twin differential, the differential in index returns and the exchange rate between the home currencies of the DLC twins.

Table 6: Regressing DLC Return Differential on Index Return differential and Exchange Rate

	BHP Billiton Group	**Carnival Corp.**	**Investec Group**	**Rio Tinto**	**Reed Elsevier**	**Unilever**	**Royal Dutch/ Shell**
Index A– Index B	0.309*** (4.01)	0.975*** (6.38)	-0.038 (-0.35)	0.366*** (4.41)	0.068 (1.44)	0.151*** (3.84)	0.109 (1.39)
Exchange Rate	-0.843*** (-13.54)	-0.380* (-3.10)	-0.925*** (-11.89)	-0.811*** (-11.17)	-0.641*** (-9.46)	-0.712*** (-12.40)	-0.663*** (-4.82)
R squared	0.636	0.543	0.588	0.453	0.338	0.446	0.227
Partial F	183.43***	9.64**	153.83***	124.72***	89.34***	153.81***	40.54***

T statistic in parentheses underneath the regression coefficient, *p<.01, **p<.001, ***p<.0001, P value based upon one tailed test

In all but one case the difference in index return differential remains significant. This case involves Investec where the home market for one of the twins is South Africa. It stands to reason that this small market would be especially susceptible to the impact of international cash flows which would cause the exchange rate variable to play a larger role in influencing the differential in the twin return.

Conclusions

Dual-Listed Companies (DLCs) result from a virtual merger of two companies where both individual firms are contractually bound by profit sharing agreements. Because the twins enjoy a proportional claim to the cash flow their returns ought to be identical. In fact there is a substantial disparity between the historical returns for DLC twins. Previous literature has argued that this differential is due to investor sentiment on the basis that DLC twin return differences are explained by returns for their home country index. Previous literature has also identified a relationship between variation in the exchange rate for the two country's home currency and the DLC twin return disparity. But the literature has not carefully examined the cause of this association and contrary to the conclusions concerning investor sentiment seems to view this association as a result of rational market behavior.

We contribute to the literature on DLC twin disparity by developing two hypotheses concerning the relationship between exchange rate variation and DLC twin return disparity. One argument suggests that the disparity is influenced by a rational response to exchange rate variation whereby all prices including asset prices move in accordance with purchasing power parity to reflect changes in the exchange rate. The second hypothesis argues that bullish investor sentiment relative to a particular market likely includes investors outside the market. Cash flows from these international investors cause currency appreciation for the market where bullish stock sentiment is high. Because the bullish sentiment also causes return disparity between the DLC twins, thus an association exists between exchange rate variation and DLC twin return disparity. Our empirical analysis supports the investor sentiment hypothesis. Although we do not argue that none of the association between the DLC twin return differential and exchange rate variation results from a rational market response.

Future research may wish to consider if the relationships found in this paper and previous research vary according to price change regimes. A researcher could explore whether the value of the return difference in DLC twin returns is dependent on market stock return regimes or exchange rate regimes? For example, will the return of Royal Dutch minus the return of Shell be positive if the return to the S & P 500 minus the return to the FTSE is positive regardless of changes in the exchange rate, or will the return of Royal Dutch minus the return of Shell be positive if a regime exist where the US$ is appreciating against the British £ regardless of the relative return of the S & P 500 and the FTSE. This analysis may shed additional light on the role of investor sentiment in the DLC twin return disparity.

Acknowledgments

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Notes

1. For rationales for the existence of dual-listed companies see Reserve Bank of Australia (2002) and Allens Arthur Robinson (2001).
2. We note that DLCs could be considered a subset of cross-listed securities whereby a single security is listed on more than one exchange. Also, we note that DLC stock pairs are often called Siamese twins due to the 'conjoined' nature of their cash flows. To avoid the use of a possible pejorative we simply use the term DLC twin.
3. Rosenthal and Young (1990) were the first to document the mispricing of DLC twins in the academic literature but, as evidenced by references to failed arbitrage attempts, the practitioner community was well of this mispricing. Indeed, Rosenthal and Young reference an analyst presentation in 1985 discussing the Royal Dutch / Shell mispricing.
4. We note that purchasing power parity ought to be more likely to hold for financial assets where frictions such as transportation costs would be minimal compared to real assets.
5. At the end of 2004 Royal Dutch and Shell announced their formal merger which is the basis for which we end the data December 2004. The merger was completed Summer of 2005.
6. We note in passing that Bedi et. al. dropped this security from their sample citing a technical difficulty. One might suppose that our regression results are similar to theirs for this security.

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Does Parenting Style Matter for Labor Market Outcomes? Evidence from the USA

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Abstract

This paper is an attempt to investigate whether parenting style has any causal impact on children's adult labor market outcomes. Most of the parenting style literature overlooks such investigation due to lack of suitable data that permit linking childhood events to outcomes in adult years. I take advantage of the National Longitudinal Survey of Youth 1997 (NLSY97) to fill that gap. Logit and OLS are used as empirical strategies. Findings suggest that parenting style is an important determinant of labor market outcomes. Among four categories of parenting style, authoritative parenting style (AVPS) is found to be the most beneficial.

Introduction

The impact of family background on children's outcomes appears to have gained increasing attention and interest. One of the most important family background variables is parenting style[1]. A key issue is the extent to which parenting style influences children's labor market outcomes in their adulthood. Most of the parenting style literature overlooks such investigation of the lasting impact of how parents rear their children perhaps due to lack of suitable data that permit linking childhood events to outcomes in adult years.

In this paper, I draw upon the National Longitudinal Survey of Youth 1997 (NLSY97), which contains information about both childhood and adulthood events, to investigate the implications of parenting style for adult labor market outcomes. Particularly, I look at whether parenting style children experience in their childhood has any significant effects on wages, number of weeks worked, number of weeks unemployed, and probability of having white collar job experienced by them in their adulthood. The nature and contents of the data allows me fairly well to identify these effects.

Motivation for this study lies in the concern about whether there should be public interventions in the area of child development in terms of promoting parent education and training programs. Justification for funding such programs needs information about associated costs and benefits. This study potentially will be of help in that regard.

The results of this study will have huge policy implications. If the relation under investigation is found to be statistically significant, that will mean parenting style has associated costs and benefits in terms of children's adult labor market outcomes. In that case, government should take those costs and benefits into account while designing policy interventions aimed at shaping parenting style.

Background

It is Baumrind (1966) who for the first time proposes three prototypes of parenting styles, namely, authoritative, authoritarian, and permissive. Subsequently, Maccoby and Martin (1983) extend Baumrind's typology to include an additional category- uninvolved. The extended typology is based on two global dimensions of parenting: demandingness and responsiveness. Maccoby and Martin cross these two parenting dimensions to identify four categories of parenting style. A parent is identified as authoritative if he/she is high in both demandingness and responsiveness. An authoritarian parent is one who is high in demandingness but low in responsiveness. If one is low in demandingness and high in responsiveness then he/she is identified as permissive. Finally, one is categorized as uninvolved if he/she is low in both demandingness and responsiveness. Figure 1 summarizes this classification scheme.

Development of the parenting style typology was mainly meant for research on family socialization practices during childhood (Glasgow et al., 1997). This is reflected in the fact that most of the previous research that uses parenting style as a variable belongs to the fields of psychology and family affairs. However, some works can be traced in the areas of adolescent functioning (Glasgow et al., 1997).

Survey of the literature suggests that parenting style affects a wide range of children's outcome. For example, compared to non-authoritative parenting style, authoritative parenting style foster psychological competence and educational attainment, and reduce internal distress and problem behavior (Baumrind, 1989, 1991; Bornstein and Bornstein, 2007; Dornbusch et al., 1987; Kim and Rohner, 2002; Lamborn et al., 1991; Steinberg et al., 1989; Steinberg et al., 1991; Steinberg et al., 1992; Steinberg et al., 1994). Uninvolved parenting style is found to have the worst impacts in terms of social competence, educational attainment, and psychological adjustment (Baumrind, 1991; Lamborn et al., 1991; Pittman and Chase-Lansdale, 2001; Weiss and Schwarz, 1996). Also, parenting style is found to matter for substance use and health risk behaviors (Jackson et al., 1994; Jackson et al., 1998; Coombs and Landsverk, 1988; Steinberg et al., 1994; Weiss and Schwarz, 1996). Even children's dietary behaviors are documented to be affected by parenting style. For example, Kremers et al. (2003) demonstrate that adolescents raised with an authoritative parenting style have better fruit consumption behavior and fruit-specific cognitions compared to those raised with other parenting styles. They find children of permissive parents to consume more fruits than children of uninvolved and authoritarian parents. Arredondo et al. (2006) shows children's eating behavior and physical activity to be associated with parenting style. The literature also suggests that parenting style is predictive of children's many other aspects such as their strategies for academic achievement (Aunola et al., 2000), psychological disorder and family connectedness (Dwairy et al., 2006), various psychiatric symptoms and personal discomfort of physical status (Xia and Qian, 2001), self-regulation (Grolnick and Ryan, 1989), self-esteem (Martinez and Garcia, 2007a, 2007b; Tafarodi et al., 2010), locus of control orientation and self-concept (Mcclun and Merrell, 1998), externalizing and internalizing behavior, work orientation, sexual experience, and pregnancy history (Pittman and Chase-Lansdale, 2001), self-reliance, anxiety and depression (Steinberg et al., 1991), and personality and adjustment (Weiss and Schwarz, 1996).

Figure 1: A two-dimensional classification of parenting styles

	High in responsiveness	Low in responsiveness
High in demandingness	Authoritative parenting style	Authoritarian parenting style
Low in demandingness	Permissive parenting style	Uninvolved parenting style

Apparently the literature is replete with studies focusing on the direct/immediate impact of parenting style. But whether the impact of parenting style persists in the long-run to determine adulthood events including labor market outcomes remains an unexplored issue to date. Particularly, the literature as a whole is suggestive of significant relation between parenting style and children's academic outcomes and mental health. Although the causal link between the former and children's adult labor market outcomes seems unclear, it is left empirically untested so far.

Parenting style may affect children's adult labor market outcomes through several pathways. The first and most important pathway is academic performance. Parenting style is almost unanimously reported in the literature to significantly affect children's academic attainment (see Spera, 2005). It is empirically evident that children with better academic success in turn achieve better adult labor market outcomes (see Card, 1999).

The second important pathway is mental health. As mentioned above, many studies suggest that different aspects of mental health are heavily influenced by parenting style. The status of mental health in turn inevitably conditions children's labor market outcomes in adulthood. Balsa (2008) rightly notes "Mental health problems are likely to persist in adulthood and affects productivity. Depression and other health conditions may decrease labor force participation, reduce attendance to work for those employed, and affect productivity and wages".

Finally, physical health condition can mediate the impact of parenting style on children's adult labor market outcomes. As Kremers et al. (2003), Arredondo et al. (2006) and studies (e.g. Coombs and Landsverk, 1988) focusing on the impact of parenting style on substance use suggest, how parents rear their children may be an important determinant of the children's physical health condition. Children with better physical health condition are likely to show better labor market performance in their adulthood. Findings of several studies (e.g. Smith, 2009; Contoyannis and Dooley, 2010; Hass et al. 2011) imply that poor childhood health leads to worst adult labor market outcomes.

The aim of the present study is to explore the effects that different parenting styles have on children's adult labor market outcomes. Our hypothesis is the following: parenting style has lasting impact on children in terms of labor market success, and children reared with authoritative parenting style will have better position in labor market than those reared with other types of parenting style.

Data

The NLSY97

The NLSY97 is an extensive survey conducted on a nationally representative sample of American youths who were 12 to 16 years old in 1997. The sample consists of 4,599 males and 4,385 females of different racial backgrounds. The cohort was first interviewed in 1997 and continued to be interviewed each year since then. The survey covers a considerable number of variables pertaining to different labor market characteristics as well as many other aspects of human life including education, family background, and wealth status.

Sample

I exclude the observations that have missing values for any variable under consideration. However, if parenting style variable is missing due to valid skip I replace it by 1 which means uninvolved parenting style. The reason for doing this is that valid skip in this case implies absence of corresponding parental figure. The absence of a parenting figure may be thought of as equivalent to uninvolved parenting. The above exclusion criteria yield samples of 3061 and 2891 observations when outcome variables are 'log real wage' and 'white collar job', respectively. On the other hand, the sample size is found to be of 3719 observations for both the remaining outcome variables, namely 'weeks unemployed' and 'weeks worked'.

Variables

Four measures of labor market outcomes, namely, hourly real wages, number of weeks unemployed, number of weeks worked, and probability of having white collar job are used in my analysis. For calculating hourly real wages, I first divide total annual income received as wages and salary from all jobs by corresponding year's total annual hours worked at all jobs. Then I top-code them to $1000 and bottom-code to $1 in order to reduce bias from outliers. The NLSY reports annual income in nominal terms. Hence, the computed hourly wages are in nominal terms. To make real, I convert the recoded hourly nominal wages into 2000 constant Dollar using urban consumer price index (UCPI). Number of weeks unemployed refers to the total number of weeks a respondent remained unemployed during a year. Number of weeks worked is defined as the total number of weeks a respondent worked at any job during a year. On the other hand, probability of having white collar job is represented by a dummy variable which corresponds to only employed respondents. The dummy assumes a value of 1 if an employed respondent works in a white collar job and 0 otherwise.

Following Balsa (2008), I take averages of the first three of the above measures of outcomes, namely hourly real wages, number of weeks unemployed, and number of weeks worked. Then following convention, I take natural logarithm of the average hourly real wages. So my first three dependent variables are natural logarithm of average hourly real wages (henceforth log real wage), average number of weeks unemployed (henceforth weeks unemployed), and average number of weeks worked (henceforth weeks worked). Averages are taken across the latest three rounds of interview[2]. Balsa states three advantages of using average measures of outcomes- minimizing measurement error and the incidents of exogenous temporary shocks on labor market outcomes, mitigating problems of missing observations, and avoiding the problem of not observing a reservation wage. My fourth dependent variable is the above mentioned dummy for white collar job (henceforth white collar job) corresponding to the year 2010.

My key explanatory variable is parenting style. The NLSY97 asked respondents about demandingness and responsiveness of their residential and nonresidential parents in rounds 1-4. Keeping consistency with the classification scheme mentioned in Figure 1, it created four categories of parenting style for each parent combining these two measures. These are authoritative parenting style (henceforth AVPS), authoritarian parenting style (henceforth ANPS), permissive parenting style (henceforth PPS), and uninvolved parenting style (henceforth UPS), which are coded 4, 3, 2, and 1, respectively (NLSY97 Codebook Supplement, Appendix 9). Because the influences of residential parents are understandably much more prominent than those of nonresidential parents, I consider only the parenting style of residential parents. Four rounds of observations on two residential parents give rise to eight values of parenting style for each respondent. It is important to note here that the necessity of distinguishing between residential and non-residential parents arises because in advanced societies like the USA it often happens that for different reasons children may get detached from biological parents and stay under the direct guardianship of persons other than biological parents. Given the nature of my study, what matters is residential relationship rather than biological one. In other words, it is residential parents who are in the best position to influence children no matter those parents are biological or not.

I construct parenting style variable for this analysis considering eight observations for each respondent. First, I determine the parenting environment under which a respondent grew up for each year combining both parents' parenting styles in the corresponding year. Then I define the parenting style by the parenting environment a respondent experienced in most years. That means the parenting style variable amounts to mode parenting style across the years in which parenting style is reported. Since the NLSY97 has data on parenting style for four rounds, there is a chance of bimodal situation (2 vs. 2). In that case, I take mode parenting style across the first three years as the best possible approximation. The reason is that the impacts of earlier years' parenting styles are likely to be more prominent than those of later years' parenting styles.

Understandably, respondents experiencing different types of parenting style are different in many observed and unobserved ways. These differences need to be controlled in order to obtain unbiased estimates. In an effort to control for observed heterogeneity, I use a number of demographic and family background variables. Demographic variables include age and dummies for race and gender[3]. Family background is characterized by family size, parents' education, and household net worth. Since ability of a respondent may simultaneously influence parenting style and outcome variables and there is no direct measure of ability, I use Peabody Individual Achievement Test (PIAT) percentile score in 1997 as a proxy of ability. To check whether the effects of parenting style, if there is any, are mediated by education and health, I use highest grade competed and health status as controls in some regressions.

Summary Statistics

Because samples used in this study are almost identical, presenting summary statistics for only one sample should be adequate. I decide to use the sample involved in my wage model for this purpose. However, summary statistics for the dependent variables of other three models are also included in order to have a greater picture. Table 1 displays the summary statistics. For brevity, only sample means are presented. Differences in sample means between different treatment groups are provided in Table 2.

Table 1: Sample means of variables for full sample and subsamples$^{\Psi}$

Variables	**Full sample**	**UP**	**PP**	**ANP**	**AVP**
Dependent variables					
Log real wage	2.266	2.214	2.247	2.209	2.294
Weeks unemployed	4.080	5.244	4.291	4.412	3.715
Weeks worked	35.359	32.152	35.339	34.262	37.066
White collar job	0.516	0.453	0.496	0.515	0.536
Demographic variables					
Dummy for white	0.549	0.537	0.589	0.472	0.549
Dummy for black	0.234	0.191	0.216	0.267	0.242
Dummy for Hispanic	0.208	0.256	0.189	0.250	0.201
Dummy for male	0.521	0.463	0.522	0.469	0.541
Age	15.117	15.224	15.284	15.037	15.037
Family background variables					
Household net-worth	89293.600	56512.810	86405.260	69583.610	99744.200
Household size	4.397	4.359	4.149	4.509	4.499
Residential parents' education	12.571	11.947	12.609	12.267	12.710
Innate ability					
PIAT	49.151	39.821	47.559	45.179	52.151
Other controls					
Highest grade completed	13.345	12.056	13.197	12.974	13.688
Health status	2.236	2.508	2.176	2.436	2.183
Number of observations	3061	246	805	352	1658

* Significant at the 10% level ** Significant at the 5% level *** Significant at the 1% level

$^{\Psi}$ Four subsamples correspond to UP (uninvolved parents), PP (permissive parents), ANP (authoritarian parents), and AVP (authoritative parents), respectively.

Table 2: Differences in sample means of variables between subsamples[Ψ]

Variables	UP vs. PP	UP vs. ANP	UP vs. AVP	PP vs. ANP	PP vs. AVP	ANP vs. AVP
Dependent variables						
Log real wage	0.033	-0.004	0.080*	-0.038	0.047	0.085**
Weeks unemployed	-0.953*	-0.832	-1.529***	0.121	-0.576**	-0.697*
Weeks worked	3.197**	2.120	4.924***	-1.077	1.727***	2.804***
White collar job	0.043	0.0618	0.083**	0.019	0.040*	0.021
Demographic variables						
Dummy for white	0.052	-0.065	0.012	-0.117***	-0.040*	0.077***
Dummy for black	0.025	0.076**	0.051*	0.051*	0.026	-0.025
Dummy for Hispanic	-0.067**	-0.006	-0.055**	0.061**	0.013	-0.049**
Dummy for male	0.058	0.005	0.078**	-0.053*	0.012	0.072**
Age	0.060	-0.187**	-0.186**	-0.247***	-0.246***	0.000
Family background variables						
Household net-worth	29892.450***	13070.800	43231.380***	-16821.650**	13338.930**	30160.580***
Household size	-0.210**	0.151	0.140	0.361***	0.350***	-0.010
Residential parents' education	0.662***	0.320	0.763***	-0.342*	0.101	0.443**
Innate ability						
PIAT	7.738***	5.358*	12.330***	-2.380	4.592***	6.972***
Other controls						
Highest grade completed	1.141***	0.918***	1.632***	-0.223	0.491***	0.713***
Health status	-0.332***	-0.073	-0.325***	0.260***	0.007	-0.253***

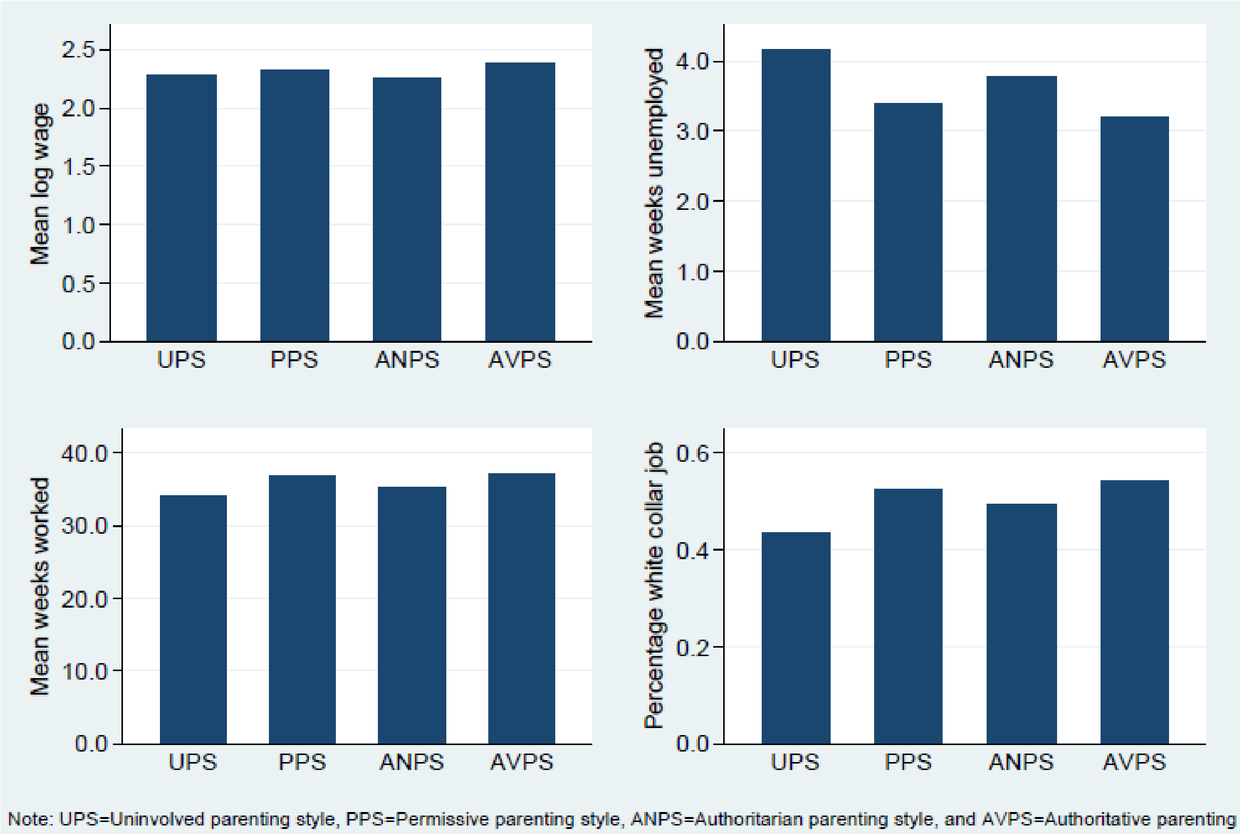
* Significant at the 10% level ** Significant at the 5% level *** Significant at the 1% level
[Ψ] Four subsamples correspond to UP (uninvolved parents), PP (permissive parents), ANP (authoritarian parents), and AVP (authoritative parents), respectively.

The unconditional means of dependent variables suggest significant benefits of PPS and AVPS in terms of children's adult labor market outcomes. Particularly, children reared with AVPS seem to earn 8 percent more, remain unemployed 1.53 weeks less, work 4.92 weeks more, and be 8.3 percentage points more likely to find white collar job compared to children reared with UPS. Although children reared with PPS and children reared with UPS are predicted be the same in terms of earnings and the likelihood of being in white collar job, the former remain unemployed 0.95 weeks less, and work 3.2 weeks more compared to the latter. Children reared with ANPS, on the other hand, are found no different than those reared with UPS in labor market performance. The superiority of AVPS over PPS and ANPS is also apparent. Children with the experience of AVPS are expected to remain unemployed 0.58 weeks less and work 1.73 weeks more than those with the experience of PPS. Relative to children with the experience of ANPS, they earn 8.5 percent more, stay unemployed 0.70 weeks less, and work 2.80 weeks more. For more visualization, sample means of outcome variables are presented through a bar chart in Figure 2.

It is evident from the remainder of the summary statistics is that in most of the cases the four treatment groups are significantly different from each other in control variables. Worth mentioning is the case of AVPS. Children reared with AVPS are significantly different from children reared with UPS in all controls except white dummy and household size. They are also significantly different from those who experienced ANPS in all controls except black dummy, age, and household size. However, the case is less so when this group is compared with children having experience of PPS.

The most important pattern that the summary statistics reveals is that as a whole, children having experience of AVPS have the best labor market performance among the treatment groups as I hypothesize. Children having experience of ANPS are found no different than children having experience of UPS and PPS. Children raised with PPS are found to be better than children raised with UPS in two labor market outcomes, namely weeks unemployed and weeks worked. However, since these predictions are drawn from unconditional means, they do not confirm any causal effects of parenting style on labor market performance. To see if these effects are causal, I estimate the relationship between parenting style and labor market outcomes in a regression framework, which will be discussed in the next section.

Figure 2: Parenting styles and labor market outcomes



Empirical Strategies

Each of my outcome variables is modeled as a function of parenting style and other covariates. There are four groups of respondents corresponding to UPS, PPS, ANPS, and AVPS, respectively. I construct three dummy variables for the last three groups and use them in my models as representative of parenting style. The first group is used as the reference group. Accordingly, the equation to be estimated is of the form:

$$y_i = \gamma_1 p_{1i} + \gamma_2 p_{2i} + \gamma_3 p_{3i} + \boldsymbol{\beta x_i} + \varepsilon_i \qquad (1)$$

where y_i is a labor market outcome; p_{1i}, p_{2i}, and p_{3i} are dummies for being reared with PPS, ANPS, and AVPS, respectively; $\boldsymbol{x_i}$ is a vector of other covariates; ε_{it} is the error term; and $\gamma_1, \gamma_2, \gamma_3$ and $\boldsymbol{\beta}$ are the parameters to be estimated. I focus on the estimation of γ_1, γ_2, and γ_3, because they are used to measure the effects of parenting style on labor market outcomes.

The equation is estimated using ordinary least squares (OLS) when the outcome variable is either log real wage, or weeks unemployed, or weeks worked. The estimation is done with logit regression when the outcome variable is a dummy for white collar job.

As the first attempt, I estimate the models letting the vector $\boldsymbol{x_i}$ contain only demographic and family background variables. This attempt addresses the problem of heterogeneity in observed variables. It is important to note that reverse causality, a significant source of endogeneity, is completely absent in my models because parenting style and labor market outcomes are measured in very different times. Nevertheless, endogeneity is likely to remain a threat due to unobserved ability. Children's ability is most likely to influence parents' decision about how they will rear their children and at the same time it has an effect on future labor market outcomes. That is why in the next attempt, I re-estimate the models controlling for PIAT percentile score, which is considered to be a proxy measure of unobserved ability.

As pointed out earlier, the apparent causal effects, if there is any, of parenting style on adult labor market outcomes may be mediated through three main channels, namely mental development, education, and health. To see if the premise is true, I further estimate the models cumulatively adding highest grade completed and health status as controls. Since there is no usable psychological data in the NLSY97, the claim about the mediation through mental development is left untested. If mediation by education and health is found, it will mean that intervention programs that facilitate education and health would be effective in mitigating the negative impact, if there is any, of parenting style on labor market outcomes.

Finally, children's intensive attachment to mothers may provoke someone to argue that mother's parenting style is much more relevant than father's. This point is substantiated by the fact that in her seminal research, Baumrind favors the mother's parenting style when it differs from the father's (see Weiss and Schwarz, 1996). Therefore, responding to the above claim, I redo all of the above estimations considering parenting style of residential mother only.

Empirical Results

Key Results

Main results are summarized in Table 3. For brevity, only the effects of key explanatory variables are reported. Columns 1, 3, 5, and 7 reports results from preliminary estimations in which only demographic and family background variables are controlled for. These results may be plagued by endogeneity arising from unobserved ability. To mitigate this problem, I modify the estimations to account for unobserved ability using PIAT percentile score as control. Results from these estimations are presented in columns 2, 4, 6, and 8.

Columns 1 and 2, which contain estimates from log real wage equations, suggest that irrespective of whether unobserved ability is controlled or not parenting style does not have any impact on wages whatsoever. However, although statistically insignificant, the estimates appear to reduce substantially once unobserved ability is controlled.

Table 3: Results from OLS and logit estimations[a]

	Log real wage		**Weeks unemployed**		**Weeks worked**		**White collar job**	
	1	2	3	4	5	6	7	8
Dummy for PPS	-0.0005 (0.050)	-0.019 (0.049)	-0.889* (0.521)	-0.816 (0.514)	2.560** (1.157)	2.398** (1.154)	0.038 (0.035)	0.029 (0.035)
Dummy for ANPS	0.004 (0.060)	-0.015 (0.060)	-0.871 (0.599)	-0.799 (0.594)	2.149 (1.322)	1.989 (1.318)	0.051 (0.040)	0.044 (0.040)
Dummy for AVPS	0.048 (0.047)	0.013 (0.046)	-1.457*** (0.491)	-1.295*** (0.485)	4.387*** (1.094)	4.025*** (1.095)	0.074** (0.033)	0.057* (0.033)
Control for PIAT?	×	✓	×	✓	×	✓	×	✓
N	3061	3061	3719	3719	3719	3719	2891	2891

[a] For log wage equations, reported are the percentage changes (when multiplied by 100) in wage due to change in treatment status from uninvolved parenting style to other categories. In the case of equations for white collar job, marginal effects are reported. For other equations, coefficients are reported. Figures in parentheses are robust standard errors. Logit estimations are performed for white collar job equations, while OLS estimations are performed for other equations.
*Significant at the 10% level ** Significant at the 5% level *** Significant at the 1% level

Estimates from equations for weeks unemployed are reported in columns 3 and 4. These estimates reveal that if unobserved ability is left unaccounted, children reared with PPS and AVPS are found to remain less unemployed than children reared with UPS by 0.89 and 1.46 weeks, respectively. ANPS is found to have no statistically significant effects. The estimates undergo considerable changes when unobserved ability is accounted for. For example, each of the three key coefficients reduces in absolute magnitude, and permissive parenting style becomes insignificant. AVPS, however, remains statistically significant at the 1% level of significance. In particular, children reared with AVPS are now found to be less unemployed than children reared with UPS by 1.3 weeks. The condition of ANPS in terms of statistical significance is also left unchanged.

Columns 5 and 6 provide estimates from equations for weeks worked. It is evident from these estimates that regardless of specifications (with and without having unobserved ability controlled for), relative to UPS, both PPS and AVPS have significant impact on weeks worked with the later having larger impact than the former, while ANPS seems to be immaterial.

Specifically, after controlling for unobserved ability, children having experiences of PPS and AVPS are predicted to work more than those having experience of UPS by 2.4 and 4.03 weeks, respectively. These effects are even larger when unobserved ability remains unaccounted for.

Finally, estimates from equations for white collar job are presented in columns 7 and 8. In terms of statistical significance, the estimates are qualitatively the same across models with and without having unobserved ability controlled- only AVPS affects the probability of getting a white collar job. However, the estimates undergo a quantitative reduction when unobserved ability is accounted for. Children with the experience of AVPS are expected to have a 7.4 percentage points higher probability of holding a white collar job compared to children with the experience of UPS when unobserved ability is not controlled for. This figure goes down to 5.7 percentage points after controlling for the unobserved ability.

A common pattern observed from the above estimations is that controlling for unobserved ability results in the reduction of estimates (absolute magnitude), implying the presence of endogeneity due to omitted ability variable. This justifies the statement that unobserved ability influences parents' decision about parenting style and labor market outcomes simultaneously, and hence justifies the use of PIAT as one of the controls to isolate the causal effects of parenting style.

Are the Effects Mediated by Education and Health?

Having examined key results, I go for testing whether the significant effects found above are mediated by educational attainment and health status as has been claimed earlier. I exclude the model for log real wage from this test because no effects of parenting style on wages are evident from the above estimations. For the remaining models, I sequentially add highest grade completed and health status to the models as controls. Due to lack of usable psychological variables in the NLSY97, I am unable to test the possibility that mental development can play role as a mediator.

Table 4 summarizes the results. Columns 2, 5, and 8 reports estimates from equations in which only highest grade completed is added, while estimates resulting from adding both highest grade completed and health status appear in columns 3, 6, and 9. On the other hand, respective estimates from Table 3 that result from controlling unobserved ability are put in columns 1, 4, and 7 for making comparison convenient.

Table 4: OLS and logit results after controlling for education and health[a]

	Weeks unemployed			Weeks worked			White collar job		
	1	2	3	4	5	6	7	8	9
Dummy for PPS	-0.816 (0.514)	-0.542 (0.512)	-0.399 (0.514)	2.398** (1.154)	1.204 (1.130)	0.928 (1.131)	0.029 (0.035)	-0.014 (0.033)	-0.014 (0.033)
Dummy for ANPS	-0.799 (0.594)	-0.536 (0.592)	-0.529 (0.593)	1.989 (1.318)	0.842 (1.289)	0.829 (1.288)	0.044 (0.040)	-0.004 (0.038)	-0.005 (0.038)
Dummy for AVPS	-1.295*** (0.485)	-0.901* (0.485)	-0.805* (0.487)	4.025*** (1.095)	2.312** (1.080)	2.125** (1.081)	0.057* (0.033)	-0.010 (0.032)	-0.010 (0.032)
Control for education?	×	✓	✓	×	✓	✓	×	✓	✓
Control for health?	×	×	✓	×	×	✓	×	×	✓
N	3719	3719	3719	3719	3719	3719	2891	2891	2891

[a] In the case of equations for white collar job, marginal effects are reported. For other equations, coefficients are reported. Figures in parentheses are robust standard errors. Logit estimations are performed for white collar job equations, while OLS estimations are performed for other equations.
*Significant at the 10% level ** Significant at the 5% level *** Significant at the 1% level

Estimates contained in columns 1, 2, and 3 provide evidence of gradual decline in the absolute values of the effects of parenting style on weeks unemployed due to the successive inclusion of highest grade completed and health status as controls. The effect of AVPS, the only significant effect in this case, goes down to -0.9 once highest grade completed is added. It further deteriorates to reach -0.81 following the inclusion of health status.

As for weeks worked, what follow the gradual inclusion of highest grade completed and health status are qualitatively the same as those happened in the case of weeks unemployed. Importantly, as evident from columns 4, 5, and 6, PPS turns out to be statistically insignificant when educational attainment is controlled for. It remains insignificant when health status is also controlled for. AVPS, however, remains significant in all specifications, although the magnitude of the effect decreases gradually. After controlling for highest grade completed and health status, children reared with AVPS are predicted to work more than those reared with UPS by 2.13 weeks. This figure is 4.03 when highest grade completed and health status are not controlled.

Finally, estimates from the model for white collar job undergo a little bit different consequences of controlling for highest grade completed and health status than the above in terms of magnitude. As demonstrated in columns 7, 8, and 9, although the absolute magnitudes of the three effects drastically decline following the inclusion of highest grade completed, they remain the same or have a little increase when both highest grade completed and health status are included. As for statistical significance, AVPS, the only significant variable in this model, turns insignificant when highest grade completed is controlled and remains insignificant when both highest grade completed and health status are controlled.

From the above analysis of Table 4, two points stand out. In the link between parenting style and adult labor market outcomes, the mediation of education and health factors are clearly evident, which is reflected in the gradual decline in absolute magnitude of the effects as well as in the fact that the effects which was previously significant become statistically insignificant or less significant as a result of controlling highest grade completed and health status. Secondly, that after controlling education and health, the effect of AVPS still remains significant in the cases of weeks unemployed and weeks worked suggest that these two outcomes are affected through channels other than education and health including mental development. Probability of holding a white collar job seems to be affected by AVPS solely through education and health.

Results when Only Mother's Parenting Style is Taken into Consideration

Results contained in Tables 3 and 4 are reproduced in Tables 5 and 6 taking only mother's parenting style into consideration. According to Table 5, the results remain qualitatively the same in terms of the directions of the effects. The statistical significance of the effects also remain the same except ANPS, which was found insignificant in the estimations of white collar job equations, now turns out to be predictive of having white collar job. The results, however, undergoes slight changes in magnitude. As for Table 6, a few changes take place. AVPS is no more significant in predicting weeks unemployed. Besides, the effect of AVPS on weeks worked slightly increases in magnitude. In sum, no matter both parents' parenting styles or only mother's parenting style are considered, results convey virtually the same message- AVPS is the best among parenting styles in terms of the effects on labor market outcomes, and education and health are proved to act as among channels through which those effects pass.

Table 5: Results from OLS and logit estimations (only mother's parenting style considered)[a]

	Log real wage		**Weeks unemployed**		**Weeks worked**		**White collar job**	
	1	2	3	4	5	6	7	8
Dummy for PPS	0.020 (0.042)	-0.002 (0.041)	-0.758* (0.422)	-0.646 (0.419)	3.052*** (0.966)	2.804*** (0.967)	0.060** (0.030)	0.046 (0.029)
Dummy for ANPS	0.024 (0.054)	-0.005 (0.053)	-0.879* (0.516)	-0.747 (0.514)	2.131* (1.176)	1.837 (1.177)	0.095*** (0.036)	0.077** (0.036)
Dummy for AVPS	0.045 (0.041)	0.011 (0.041)	-1.067*** (0.415)	-0.910** (0.412)	4.242*** (0.948)	3.894*** (0.952)	0.100*** (0.029)	0.080*** (0.029)
Control for PIAT?	×	✓	×	✓	×	✓	×	✓
N	2973	2973	3621	3621	3621	3621	2808	2808

[a] For log wage equations, reported are the percentage changes (when multiplied by 100) in wage due to change in treatment status from uninvolved parenting style to other categories. In the case of equations for white collar job, marginal effects are reported. For other equations, coefficients are reported. Figures in parentheses are robust standard errors. Logit estimations are performed for white collar job equations, while OLS estimations are performed for other equations.
*Significant at the 10% level ** Significant at the 5% level *** Significant at the 1% level

Table 6: OLS and logit results after controlling for education and health (only mother's parenting style considered)[a]

	Weeks unemployed			Weeks worked			White collar job		
	1	2	3	4	5	6	7	8	9
Dummy for PPS	-0.646 (0.419)	-0.389 (0.417)	-0.290 (0.419)	2.804*** (0.967)	1.668* (0.950)	1.481 (0.953)	0.046 (0.029)	0.005 (0.029)	0.004 (0.029)
Dummy for ANPS	-0.747 (0.514)	-0.531 (0.512)	-0.530 (0.511)	1.837 (1.177)	0.885 (1.158)	0.882 (1.157)	0.077** (0.036)	0.041 (0.035)	0.041 (0.035)
Dummy for AVPS	-0.910** (0.412)	-0.572 (0.413)	-0.494 (0.414)	3.894*** (0.952)	2.398** (0.942)	2.250** (0.944)	0.080*** (0.029)	0.025 (0.028)	0.024 (0.028)
Control for education?	×	✓	✓	×	✓	✓	×	✓	✓
Control for health?	×	×	✓	×	×	✓	×	×	✓
N	3621	3621	3621	3621	3621	3621	2808	2808	2808

[a] In the case of equations for white collar job, marginal effects are reported. For other equations, coefficients are reported. Figures in parentheses are robust standard errors. Logit estimations are performed for white collar job equations, while OLS estimations are performed for other equations.
*Significant at the 10% level ** Significant at the 5% level *** Significant at the 1% level

Discussion

As suggested by Table 3, ANPS is found to be as good as UPS across all labor market outcomes. PPS appears to be better than UPS only for weeks worked. For other outcomes, it is as good as UPS. Most impressive finding is about AVPS. As I hypothesized, this parenting style turns out to be the best among all parenting styles for all outcomes except log real wage. In fact, for log real wage, parenting style seems immaterial.

The fact that my hypothesis passes empirical test substantiates the point that neither parents' supportiveness without demandingness nor parents' demandingness without supportiveness yields better outcomes for children than parents' noninvolvement in children's matters. Supportiveness and demandingness complement each other to make synergistic effects on a range of children's outcomes. In the literature, numerous studies, as I discussed in literature review, show the importance of parenting style to a child's development in terms of education, health, and psychological strength. My findings are quite in line with those studies.

Summary and Conclusions

The available literature on parenting style utterly lacks studies focusing on the long-run effects of parenting style including the effects on children's adult labor market outcomes. In this study, using the NLSY97, a nationally representative dataset of the USA, I seek to mitigate this lack by empirically examine the existence and the strength of the causal link between how parents rear their children and children's labor market outcomes in their adulthood. I also investigate whether the link, if there is any, is mediated by educational and health. The mediation through mental development could not be tested due to unavailability of suitable data.

I use demographic and family background variables to control for observed heterogeneity. Considering the possibility that ability of a child, which is unobserved, may simultaneously determine parents' child rearing style and the child's adult labor market outcomes, I include PIAT percentile score, a surrogate for unobserved ability, in my control variables to reduce endogeneity. To see the role of education and health in mediating the influence of parenting style, I re-estimate my models cumulatively including highest grade completed and health status as controls.

My findings provide evidence of parenting style being a determinant of children's adult labor market outcomes. Importantly, AVPS is found to be the most beneficial to children. More specifically, on average, children with the experience of AVPS is predicted to remain less unemployed by 1.3 weeks, work more by 4.03 weeks, and be 5.7 percentage points more likely to have white collar job compared to children with the experience of UPS. PPS, however, is seen to be better than UPS only in terms of weeks worked. It raises the number of weeks worked by 2.4 in relation to UPS. In terms of other labor market outcomes, it is no different than UPS. ANPS, on the other hand, seems to remain as good as UPS across the series of estimations performed. Regarding the mediating factors, findings clearly suggest that education and health mediate the influences of parenting style.

The above findings have important policy implications in the context of decaying family values and problematic employment situation that the USA is experiencing nowadays. Relevant authorities must take the benefits of authoritative parenting and the costs of non-authoritative parenting into account during enactment of policies for family affairs especially those involving parents training. Intervention through education/health is a feasible option. Also, it should be kept in mind that difficulties in terms of labor market outcomes can be partially mitigated by implementing policies that promote authoritative approach to parenting.

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Notes

[1] Parenting style is a psychological strategy used by parents in rearing their children. Darling and Steinberg (1993, pp. 448) define parenting style as the emotional climate created by parents within which socialization of children occurs.
[1] Based on the availability of data, for log real wage, average was taken across 2007-2009 time period, and for weeks unemployed and weeks worked, averages were taken across 2008-2010 time period.
[1] Age variable is constructed by taking average of age across the period (1997-2000) in which parenting style is reported.

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Linkages among Gross State Product, Investment Outlays and Business Climate Variables: An Empirical Analysis

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Abstract

Unlike previous studies, this paper uses multivariate cointegration methodology and vector error-correction models to examine the dynamic linkages and causalities among gross state product, investment outlays, export, government expenditures, new business establishment, and educational attainment variables in South Carolina. Johansen and Juselius co-integration tests indicate cointegrating relationship among the series. VAR results indicate that new business establishment, capital investment, export, and educational attainment have long-run causal flow to gross state product. The results imply that a commitment to education, promotion of capital investment, export, and establishment of new business are important ingredients for successful development strategy for South Carolina.

Introduction

Economic development planners are always interested in the levels of employment and personal income as they develop strategies for their communities. Employment and personal income numbers are used for tracking local area economic conditions and trends. Per capita income is used as a yardstick to assess the economic well-being of residents, the quality of consumer markets, the economic performance, and changing fortunes of local economies. Shifting trends in local employment and per capita income growth have important social and political ramifications and significant implications in formulating local economic development strategies and initiatives. So it is important to study the factors that influence the level and growth of employment and per capita personal income. Persistent and large differences in the level of income both between counties and within counties have attracted the attention of economists and businesses.

Literature Review

Many explanations have been offered for differences in economic performance at the state, metropolitan and county level. Some researchers have focused on differences in tax policy (Carlino and Mills, 1996; Phillips and Goss, 1995; Mofidi and Stone, 1990; Easterly and Sergion, 1993), others on varying rates of capital investment in public infrastructure (Aschauer, 1989; Evans and Karras, 1994; Wylie, 1996; Hammond and Thompson, 2006). Many researchers also have focused on knowledge and technology. Their explanation is based on the empirical observation that higher levels of per capita personal incomes are associated with greater knowledge stocks (Rupasingha et al., 2002; Glaeser and Saiz, 2004).

Researchers have offered an array of explanations for the mechanism underlying the positive statistical association between knowledge stocks and per capita personal incomes at the state level: (1) workers with more knowledge are more productive; (2) education and technology allow more people to be employed in high productivity jobs (Rangazas, 2005); (3) education and technology allow people to adapt in response to negative economic shocks; (4) education and technology make people more creative (Glaeser and Saiz, 2004); and (5) education and technology allow people to adopt new technology from other places. South has experienced a considerable economic growth over the past thirty years, with southern states growing at phenomenal rates. These states had, on average, low state and local taxes, and it seems reasonable to infer that tax policies may have contributed to their relative success.

Some studies have examined the growth effects of taxation, mostly across countries. Evidence that taxes have long-term growth effects is sometimes thought to be evidence against convergence. However, less work has been devoted to determining whether state and local taxes affect relative state growth in the United States and, if so, how strong the effects are. As Mofidi and Stone (1990) noted, the empirical findings have been mixed with estimated effects ranging from positive to negative. Tax rates may be significant in simple regressions, as in the international literature, but multivariate regressions that add more explanatory variables can result in insignificant coefficients on tax rates. So far the evidence for negative and significant tax effects on growth across countries and across U.S. states has been mixed. Despite budget cuts, education funding is kept under high priority area. But the commitment to early childhood care and education is lacking. Ford and Stone (2007) focus on the economic development strategies of South Carolina as it entered the twenty-first century. According to the authors, there is a growing concern in the state with regard to the effectiveness of the state's long-standing economic development policy. The per capita income of South Carolina hovered at or near 80% of the national average since 1980. The state hit a plateau as of 2000, when it is ranked regularly among the ten poorest states in the nation.

A study by Schunk (2002) focuses on the development of the economy in South Carolina emphasizing the importance of recognizing high-technology employment, identification of strengths and weaknesses in attracting high-technology investments, and the lack of high quality education at all levels. Shannon (2007) examines the need for South Carolina to improve the quality of its workforce in order to compete in the global, knowledge-based economy. It provides an overview on the Workforce Innovation Network grant received by the South Carolina State Chamber of Commerce. Several factors that hinder the state to improve the quality of its workforce include the lack of broad effective leadership and communication or strong relationships with economic development organizations. Herriott and Torrey (2003) examine the problem of shrinking labor market in South Carolina and how the legislation can help change the situation.

Harrell (2006) examines information on the need to speed-up economic development in South Carolina. The state must redouble its economic development efforts to stimulate job growth. The article outlines three steps. First, there is a need to aggressively recruit companies to South Carolina. This will help in creating better jobs. The second step is to identify and implement ways to help large and small South Carolina companies thrive. The third step recommends that the state should transform research universities into economic engines. It is going to take the cooperation of government and business leaders to transform the state to a knowledge-based economy.

Hammond and Thompson (2006) found little role for public capital investment in either metropolitan or non-metropolitan regions, but that manufacturing investment tended to spur growth in non-metropolitan regions, in contrast to results for metropolitan regions. Further, they find some evidence which suggests that human capital investment (measured by college-level educational attainment) may not have a significant positive impact on growth in non-metropolitan labor market areas, in contrast to metropolitan areas. However, these results are only suggestive.

Rupasingha et al. (2002) examine economic growth for all U.S. counties, using per capita personal income data for the 1990-1997 periods. Their primary interest is the impact of social and institutional characteristics on growth. They find that the social and institutional characteristics matter for county income growth, as well as an important role for human capital (measured by college-level educational attainment) in raising county income growth.

Capital investment is essential for economic and employment growth. A decline in either domestic investment or net foreign investment will reduce future national income. As Elmendorf and Mankiw (1998) note: "Reduced domestic investment over a period of time will result in a smaller domestic capital stock, which in turn implies lower output and income. Reduced net foreign investment over a period of time means that domestic residents will own less capital abroad (or that foreign residents will own more domestic capital). In either case, the capital income of domestic residents will fall." Woodward and Guimarães (2009) present an analysis of the three key aspects of the impact of investment of BMW in South Carolina. The data gathered is noted to have collectively shown that local purchases and wages of the state are directly been affected by BMW's expenditures.

Barkley, Henry and Nair (2006) examine that public policy response to global competition is the creation of a geographic concentration of innovative activity (regional innovation systems [RIS]) that will enhance metropolitan economic development through knowledge spillovers, product development, and new firm spin-offs. High wages normally attract more labor force but inhibit employment growth. Education improves the skills, knowledge, and overall learning abilities of the individual. The increase in individual productivity can lead to growth in product output, thus causing economic growth. Hence, education should have positive influence on both employment and per capita income growth. Per capita income tax is expected to have negative affect on both dependent variables. Miley and Associates (2010) explain the impact of Boeing and BMW's investments on manufacturing employment and gross state product. The study indicates that these two investments have significant positive impact on South Carolina's manufacturing jobs, and incomes of the people.

The overall objective of this paper is to examine the dynamic linkages among gross state product, capital investment, export, educational attainment, and establishment of new business in South Carolina, which, in turn, can be useful for determining effective economic development strategy. The remainder of the paper is structured as follows: section 2 discusses methodology. Section 3 provides the data and empirical results. Section 4 presents conclusion and Implications.

Methodology

First, the standard statistical descriptors (mean, standard deviation, skewness and Kurtosis) are used to examine the likely distribution of data on each variable. Second, the modified DF (Dickey-Fuller) test, and the modified Ng-Perron test are applied for unit root (nonstationarity) following Elliot et al, (1996), and Ng and Perron (2001) respectively. Their counterpart (the KPSS) test for no unit root (stationarity) is also applied following Kwiatkowski, et al., (1992). Third, on the evidence of data nonstationarity, the order of integration of each variable is ascertained by the first or higher order differencing of the level data since all variables must be of the same order of integration to be cointegrated (Engle and Granger, 1987) revealing I(1) or I(d) behavior. Fourth, λ_{trace} and λ_{max} tests are implemented to search for cointegrating (long-run equilibrium) relationship among the variables, as outlined by [Johansen (1988, 1992, 1995) and Johansen and Juselius (1990)]. Finally, relevant vector error-correction models are estimated to capture the long-run and the short-run causal dynamics in terms of interactive feedbacks (lead-lag relationships) among the variables.

As the unit root tests have now become fairly standard, they do not require further elaborations. The cointegration procedure, as developed in Johansen (1988) and Johansen and Juselius (1990, 1992), allows interactions in the determination of the relevant economic variables and is independent of the choice of the endogenous variable. Most importantly, it allows explicit hypotheses tests of parameter estimates and rank restrictions using likelihood ratio tests. The empirical exposition of the Johansen and Juselius methodology is outlined as follows:

$$\Delta V_t = \tau + \Omega V_{t-1} + \sum_{i=1}^{k-1} \Omega_j \Delta V_{t-j} + m_t$$

where Vt denotes a vector of gross state product (GSP), capital investment (CI), export (EX), government expenditure (GE), new business establishment (NBE) and total degree award (TDA) while **Ω** = αβ'. Here, α is the speed of adjustment matrix and β is the cointegration matrix. The above equation is subject to the condition that **Ω** is less than full rank matrix, i.e., r < n. This procedure applies the maximum eigenvalue test (λmax) and the trace test (λtrace) for null hypotheses on r. Of these two tests, λmax test is expected to offer a more reliable inference as compared to λtrace test (Johansen and Juselius (1990)). However, the Johansen and Juselius test procedure suffers from its sensitivity to the selection of the lag structures. This study estimates the following equations to retrieve the error-terms for subsequent uses in the respective vector error-correction models:

$$Ln(GSP) = \alpha + \alpha_1 \ln(CI) + \alpha_2 \ln(EX) + \alpha_3 \ln(GE) + \alpha_4 \ln(NBE) + \alpha_5 \ln(TDA) \tag{1}$$

Next, on the evidence of data nonstationarity and I(1) behavior, the corresponding vector error-correction models are estimated. The relevant vector error-correction models are specified as follows:

$$\begin{aligned}\Delta \ln GSP(t) = \alpha_1 \varepsilon_{t-1} + \sum_{i=1}^{k} \beta_i \Delta \ln GSP(t-i) + \sum_{i=1}^{k} \psi_i \Delta \ln CI(t-i) + \sum_{i=1}^{k} \Pi_i \Delta \ln EX(t-i) + \\ \sum_{i=1}^{k} \eta \Delta \ln GE(t-i) + \sum_{i=1}^{k} \gamma \Delta \ln NBE(t-i) + \sum_{i=1}^{k} \kappa \Delta \ln TDA(t-i) + \varepsilon_t\end{aligned} \tag{2}$$

$$\begin{aligned}\Delta \ln CI(t) = \alpha'_1 \varepsilon'_{t-1} + \sum_{i=1}^{k} \beta'_i \Delta \ln CI(t-i) + \sum_{i=1}^{k} \psi'_i \Delta \ln GSP(t-i) + \sum_{i=1}^{k} \Pi'_i \Delta \ln EX(t-i) + \\ \sum_{i=1}^{k} \eta' \Delta \ln GE(t-i) + \sum_{i=1}^{k} \gamma' \ln NBE(t-i) + \sum_{i=1}^{k} \kappa' \Delta \ln TDA(t-i) + \varepsilon'_t\end{aligned} \tag{3}$$

$$\begin{aligned}\Delta \ln EX(t) = \alpha''_1 \varepsilon''_{t-1} + \sum_{i=1}^{k} \beta''_i \Delta \ln EX(t-i) + \sum_{i=1}^{k} \psi''_i \Delta \ln GSP(t-i) + \sum_{i=1}^{k} \Pi''_i \Delta \ln CI(t-i) + \\ \sum_{i=1}^{k} \eta'' \Delta \ln GE(t-i) + \sum_{i=1}^{k} \gamma'' \Delta \ln NBE(t-i) + \sum_{i=1}^{k} \kappa'' \Delta \ln TDA(t-i) + \varepsilon''\end{aligned} \tag{4}$$

The negative sign of the error-correction terms and their statistical significance indicate converging long-run equilibrium relationship and long-run causal flows from independent variables to the dependent variable of each equation. The remaining terms in first-differences (**Δ**) capture the short-run dynamics. Akaike Information Criterion (Akaike, 1969) is invoked to determine the optimum lag-structure to overcome the problems of overparameterization and underparameterization that are likely to induce bias and inefficiency into the estimated parameters.

Data and Empirical Results

The annual data for South Carolina for the period of 1990 to 2009 are used in this study. Total employment and per capita income data were collected from Federal Reserve Bank of Richmond (http://www.richmondfed.org). Capital Investment was obtained from SC Department of Commerce. Gross State Product was collected from Bureau of Economic Analysis. Personal Income was collected from Regional Economic Information System and Bureau of Economic Analysis. Government Expenditure was obtained from (http://www.usgovernmentspending.com). Business Establishments and Exports are from US Census Bureau. Unemployment rate was obtained from SC Virtual One Stop and finally, Total Degrees Awarded (TDA) was obtained from SC Commission on Higher Education.

Table 1 shows the descriptive statistics for the variables under investigation. Gross State Product (GSP), Capital Investment (CI), and Government Expenditure have mild negative skewers while export (EX) and total degree awarded (TDA) have mild positive skewers. The Kurtosis of each variable is below the benchmark of 3.0 for normal distribution. The Jarque-Bera Statistics also indicate near-normality in the data distribution of each variable. To have a cursory look at the extent of multicollinearity,

Table 1: Descriptive Statistics

	ln(GSP)	**ln(CI)**	**ln(EX)**	**ln(GE)**	**ln(NBE)**	**ln(TDA)**
Mean	11.2675	7.9859	8.6100	9.4289	11.3382	10.1806
Median	11.3327	7.9443	8.5620	9.7230	11.373	10.223
Maximum	11.9883	8.7604	9.8961	10.671	11.589	10.481
Minimum	10.2403	7.0286	7.3696	7.3264	10.902	9.9479
Std. Dev.	0.5227	0.4970	0.7386	0.9303	0.2022	0.1781
Skewness	-0.3957	-0.1471	0.0702	-0.5145	-0.6599	0.1182
Kurtoisis	2.0242	2.1840	1.8757	2.1183	2.3591	1.6601
Jarque-Bera	1.9729	0.9406	1.6047	2.2949	2.6907	2.3141
Probability	0.3728	0.6248	0.4483	0.3174	0.2604	0.3144

Table 2 reveals moderate multicollinearity between GSP and CI, EX and CI, NBE and CI, CI and TDA. But all other variables are highly positively correlated.

Table 2: Correlation Matrix

	ln(GSP)	**ln(CI)**	**ln(EX)**	**ln(GE)**	**ln(NBE)**	**ln(TDA)**
ln(GSP)	1.0000					
ln (CI)	0.5204	1.0000				
ln(EX)	0.9836	0.4417	1.0000			
ln(GE)	0.9887	0.5313	0.9681	1.0000		
ln(NBE)	0.9941	0.5505	0.9632	0.9844	1.0000	
ln(TDA)	0.9414	0.4136	0.9641	0.9417	0.9087	1.0000

Next, the time series property of each variable and its order of integration are examined by modified Dickey-Fuller (DF-GLS) test, modified Phillips-Perron (Ng-Perron) test and KPSS test. The results are reported in Table 3.

Table 3: Unit Root Test

	LEVEL			DIFFERENCES		
SERIES	DF-GLS	Ng-PERRON	KPSS	DF-GLS	Ng-PERRON	KPSS
ln (GSP)	-1.7494	-0.7241	0.1848	-5.7670	-2.5970	0.0750
ln (CI)	-2.5303	-2.1009	0.1368	-6.0387	-2.5616	0.0950
ln (GE)	-3.4724	-1.0818	0.1848	-5.5468	-3.7318	0.0786
ln (EX)	-3.1460	-1.4932	0.1221	-3.4355	-3.7318	0.0786
ln (NBE)	-2.9940	-0.2712	0.1833	-5.1975	-2.7351	0.0898
ln (TDA)	-4.1950	-2.3790	0.0851	-6.1686	-2.3603	0.0941

As observed in Table 3 above, modified Dickey-Fuller (DF), modified Phillips-Perron, KPSS tests fail to reject the null hypothesis of unit root (nonstationarity) for each variable. Thus all three tests confirm nonstationary in all variables included in the study. Stationarity is restored on first-differencing of all the variables.

Next, the λ_{trace} and λ_{max} tests for cointegration following the Johansen-Juselius procedure are applied. The results from cointegration test are reported in Table 4. The λ_{trace} finds five cointegrating relationship among GSP, CI, EX, GE, NBE and TDA at less than 5 percent significance level. The λ_{max} test finds evidence of four cointegrating relationship.

Table 4: Johansen and Juselius Multivariate Cointegration Test Result
Series: Ln (GSP), Ln(CI), Ln(EX), Ln(GE), Ln(NBE), Ln(TDA)

Hypothesized No. of CE(s)	**Eigenvalues**	**Trace Statistic (λ_{trace})**	**0.05 Critical Value**	**Prob.****
None *	0.9005	190.6551	107.3466	0.0000
At most 1 *	0.8654	126.0339	79.3415	0.0000
At most 2 *	0.6810	69.8884	55.2458	0.0015
At most 3 *	0.4955	37.8961	35.0109	0.0239
At most 4 *	0.3900	18.7409	18.3977	0.0448
At most 5 *	0.1606	4.9009	3.8415	0.0268
Hypothesized No. of CE(s)	**Eigenvalues**	**Max-Eigen (λ_{max}) Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.9005	64.6211	43.4198	0.0001
At most 1 *	0.8654	56.1455	37.1636	0.0001
At most 2 *	0.6810	31.9923	30.8151	0.0357
At most 3 *	0.4955	19.1552	24.252	0.2048
At most 4 *	0.3900	13.8400	17.1477	0.1423
At most 5 *	0.1606	4.9009	3.8415	0.0268

** McKinnon-Haug-Michelis (1999) p-values

Siding with the inference by the λ_{trace} test, the relevant vector error-correction models (2, 3 and 4) are estimated. The results are reported in Table 5. Table 5 reveals significant long-run causal flow from CI, EX, NBE and TDA to GSP. The coefficient of the error-correction term in GSP model, (ε_{t-1}) has the expected negative sign and statistically significant in terms of the associated t-value. This confirms convergence toward long-run equilibrium in the change of gross state product (GSP) at moderate speed since the numerical coefficient at -0.4645 is moderate.

Table 5: Error Correction Estimates[1]

Dependent Variable	Independent Variables						
	ε(t-1)	Δ ln(GSP(t-1))	Δ ln(CI(t-1))	Δ ln(EX)	Δ ln(GE)	Δ ln(NBE)	Δ ln(TDA)
Δ ln (GSP)	-0.4645	0.2765	-0.0176	-0.1547	-0.0517	0.4721	-0.0950
	(-3.7317)	(+1.6645)	(-1.8601)	(-2.2861)	(-1.6991)	(+11.8963)	(-0.5584)
Δ ln (CI)	-0.1571	0.7899	-0.0196	3.5583	-0.4795	11.7970	5.7151
	(-2.6890)	(+0.2536)	(-1.8601)	(+2.7859)	(-0.8396)	(+2.5240)	(+1.7900)
Δ ln (EX)	-0.5822	-0.8987	-0.0344	-0.1737	0.1309	1.8044	-0.9533
	(-3.0520)	(-1.3535)	(-0.9109)	(-0.6431)	(+1.0793)	(+1.8177)	(-0.6685)

[1] Values within parentheses are the t-statistics

There is evidence of short-run interactive feedback effect from CI, EX, NBE and TDA. Also, the coefficients of error-terms have expected negative signs and significant in CI (-0.1571) and EX (-0.5822) models. That means there is converging long-run relationship and long-run causal flows from independent variables. The coefficients of CI and EX are statistically significant with wrong signs in GSP model. The coefficients of CI and TDA are statistically insignificant with wrong signs in EX model.

Conclusions and Implications

This paper has applied Johansen and Juselius cointegration and VAR aproach to investigate the long-run dynamic causal relationship among gross state product (GSP), capital investment outlay (CI), export (EX), government expenditures

(GE), new business establishment (NBE), and total degree awarded (TDA). Specifically, this study employed DF-GLS, Ng-Perron, and KPSS unit root tests to determine the time series properties of GSP, CI, EX, GE, NBE, and TDA series. The results from DF-GLS, Ng-Perron, and KPSS unit root tests indicate that the series are stationary in their autoregressive representations. The Johansen and Juselius λ_{trace} test finds six cointegrating relationship among GSP, CI, EX, GE, NBE and TDA at less than 5 percent significance level. The λ_{max} test indicates evidence of four cointegrating relationships.

The vector error-correction model for GSP as dependent variable shows strong evidence of long-run equilibrium relationship from changes in CI, EX, GE, NBE, and TDA. Similar strong evidence of long-run equilibrium for CI and EX models exists. Significant short-run interactive feedback relationships are evident in cases of GSP, CI and EX as the dependent variables from EX, CI, and NBE.

Given the pivotal role that investment outlays, export, and new business establishment play in economic development, policy makers such as legislators, department of commerce and county development agencies should be energized to encourage capital investment, promote export, and facilitate the growth of new businesses like BMW and Boeing.

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The Landscape of Biofuels after the Ethanol Boom of 2006 and the Food Crisis of 2008: The Case of Biodiesel

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Abstract

In this paper, biofuels in the United States after the "ethanol boom" of 2006 and the food crisis of 2008 are analyzed. More precisely, long and short-term equilibrium between energy and agricultural commodities are investigated, also short term cross-market comovements are assessed through dynamic conditional correlation. In a subsequent step, tests for the presence of structural breaks in the pairwise correlations are conducted. Results suggest the presence of a weak cointegration relationship between energy and agricultural markets. Also, all pairwise correlations between markets were found to be significant. Tests of structural breaks detected the presence of two structural breaks. The first break was found in the pairwise correlation between Soybean and Biodiesel at the end of 2010, and the second one was found in the conditional correlation of Crude oil and Biodiesel at the end 2011 beginning 2012.

Introduction

After the oil crisis of 1973, and to some extent, the oil crisis of 1973 following the Iranian revolution, the focus has been placed on biofuels as an attractive alternative to fossil fuels to reduce the national reliance on foreign oil. Environmental concerns and rising oil prices, have given a new impetus to the use of biofuels to mitigate the global warming effects and reduce the US energy bill. The enthusiasm for biofuels has, therefore, led to an impressive expansion in the production of biofuels. Fueled by a generous package of federal and state incentives in the form of mandates, targets, and subsidies, the production of biofuels has attained historical records. The federal support started with the Energy Tax Act of 1978. The Tax Credit had been strengthened by other policy instruments, the most important of these instruments is the Renewable Fuel Standard (RFS) originated with the Energy Policy Act of 2005. The RFS was further expanded by the Energy Independence and Security Act (EISA) of 2007. Following the enactment of these incentives, the production of biofuels has grown substantially since 2005 and peaked in 2006. Furthermore the ban of oxygenate methyl tertiary butyl ether (MTBE) encouraged the switch to ethanol use. However, the global food crisis of 2007-2008 and the uncertainty surrounding the expected environmental benefits have led policymakers to reconsider their biofuels policies.

The topic of biofuels has been a field of active and intensive academic research. We aim through this work to gauge the general atmosphere after the "Ethanol Boom of 2006" and the food crisis of 2008. In particular, we assess the effects these two "booms" have had on biofuels from a policy and market perspectives. In conducting this work, our focus is on biodiesel as a representative of biofuels. To the best of our knowledge, this article is the first research in the literature to analyze "psychological", socio-economic, and financial market pulses after the two "booms" had passed. In addition, this work is probably among fewer articles that would have studied the biodiesel sector in the United States using time series econometric modeling with high frequency data. The rest of the article is as follows. The First section reviews some work on the economics of biofuels. The Second section is reserved to the Methodology. The third section is dedicated to results and discussion, and we conclude with some remarks and policy recommendations in the fourth section.

Literature Review

The issue of food prices has been an important topic of heated academic debate, especially after the food crisis of 2008. Various explanations have been given to the food price spike recorded in 2007-2008. Some researchers argue that the rise of food prices is due to structural factors based on the economic theory of partial equilibrium. Others think that the, recently emerged, excessive speculation in the agricultural futures markets is the main driver of food price transmission and high volatility across markets.

Zhang et al. (2009) analyze volatility of ethanol and commodity prices using a vector error correction model (VECM) and multivariate generalized autoregressive conditional heteroskedasticity (MGARCH) models. The authors use weekly wholesale price series of the US ethanol, corn, soybean, gasoline and oil from March 1989 to December 2007. They found no evidence of long-run relations among energy markets (ethanol, oil and gasoline) prices and agricultural commodities (corn and soybean) prices in recent years.

In another study, Zhang et al. (2010) use a vector error corrections model (VECM) and Granger causality tests .They investigate long and short-run relationships between agricultural markets as presented by corn, rice, soybeans, sugar, and wheat prices and energy markets as presented by ethanol, gasoline and oil from March 1989 through July 2008. They found no direct long-run price relations between fuel and agricultural commodity prices, but a modest and very limited short-run interaction.

Yu et al. (2006) analyze the cointegration and causality between crude oil prices and vegetable oils used in biodiesel production, including soybean, sunflower, rapeseed, and palm oil, using weekly data extending from the first week of January of 1999 to the fourth week of March 2006. They find only one cointegration relationship between crude oil prices and the vegetable oil prices. With respect to causality, they find that edible oil markets have strong linkages in contemporaneous time. Furthermore, they show, using variance-covariance decomposition and the Impulse Response Function, that edible oils were only affected by their own shocks in the short run. However, they find that shocks in the soybean oil prices to be a significant factor influencing the uncertainty of edible oil prices in the long-run, while shocks in petroleum prices do not have any significant influence on the variations in edible oil prices. The authors argue that the influence of crude oil price on edible oils will grow if high oil prices continue and edible oils become an increasing source of biodiesel.

Serra et al (2011b) investigate the relationships between ethanol, corn, oil, and gasoline monthly prices in US from 1990 to 2008. The authors fit an exponential smooth transition VECM to the data that allows for nonlinear adjustments toward long-run equilibrium. They found that an increase in energy prices causes an increase in corn prices through ethanol channel. The authors further argue that the fact corn is a direct input in the production of ethanol, increases in corn prices cause ethanol prices to increase. Given the land limitation to expand the production of corn, expansion of ethanol market will cause corn price increases that will results in turn, to high ethanol prices, a situation that may lead to a loss of the US ethanol competitiveness.

Du and McPhail (2012) motivated by strong comovement and increasing volatility of energy and agricultural prices, examine dynamic evolutions of ethanol, gasoline, and corn prices over the period of March 2005–March 2011. They find a structural change around March 2008 in the pairwise dynamic correlations between the prices in a DCC multivariate GARCH model. A structural VAR (SVAR) model is then estimated on two subsamples, In the more recent period, ethanol, gasoline, and corn prices are found to be more closely linked with a strengthened corn-ethanol relation, which can be largely explained by the new developments of the biofuel industry and related policy instruments.

Forbes and Rigobon (2002) point out that cross-market correlations estimated by the rolling window method, is positively related to the level of market volatility. When markets are more volatile, estimated correlation coefficients tend to increase and can be biased upward by the presence of heteroscedasticity. The reason is that traditional methods focus only on time-varying changes in the mean, without accounting for time-varying variance.

This rather large and growing body of work suggests a strong convergence in the assessment that the motor fuels markets and the corn and sugar markets are exhibiting ever stronger comovement, largely through the ethanol markets in the US and Brazil. That these results were analyzed through quite diverse and quite current econometric methods, the discovery of similar patterns across these analyses adds credibility to this emerging consensus that fuels market, ethanol markets and corn and sugar markets are more cointegrated following the onset of more aggressive bioenergy policies.

Comovement in global commodities tends to increase volatility. Volatility in a key cereal grain could endanger food insecure persons. Yet edible oils, for cooking or as curds, are also staples, serving as good sources of protein in many diets. Biodiesel, primarily from soybeans, could introduce an even more serious threat if edible oils were similarly impacted. There is reason to suspect this would not happen. Biodiesel is a much smaller industry. Moreover, the penetration of biodiesel into the soybean market as a share of total revenues (or of acreage) is far less a factor than it is for corn. To date, data on biodiesel has been too sparse for analysis given it is small and highly distributed market share. So the question here is whether there is a deepened integration in the agricultural markets for biodiesel which could increase volatility in the important edible oils markets generally.

Data and Methodology

We use daily future prices for biodiesel, canola, soybean, and the US benchmark West Texas Intermediate oil, from March 2009 to December 2012.[1] The data were collected from the Bloomberg Database at the Rawls College of Business at Texas Tech University.

Johansen Cointegration Procedure

The Granger representation theorem constitutes the backbone of the Johansen approach. The genuine of the Granger representation theorem is that it links cointegration to error correction. Johansen extends cointegration and error correction to vector autoregressive (VAR) framework. More formally, let's consider an unrestricted vector autoregressive model of order p in levels, $VAR(p)$ for a $(n\ x\ 1)$ vector $\boldsymbol{Y_t}$

$$Y_t = \Phi D_t + \Pi_1 Y_{t-1} + \cdots + \Pi_{t-p} Y_{t-p} + \epsilon_t \tag{1}$$

adding and subtracting terms from both sides of the $VAR(p)$ yields the $VECM(p)$ representation

$$\Delta Y_t = \Pi Y_{t-1} + \Gamma_1 \Delta Y_{t-1} \ldots + \Gamma_{p-1} Y_{t-p+1} + \Phi D_t + \epsilon_t \tag{2}$$

where $\Pi = -(I_1 - \Pi_1 - \cdots \Pi_p)$, $\Gamma_k = -\sum_{j=k+1}^{p} \Pi_j$, $k = 1, \ldots, p-1$, and the ϵ_t is a (n x 1) vector of error terms. The matrix Π is called *long-run impact* matrix and Γ_k are the *short-run impact* matrices.

Dynamic Conditional Correlations –Multivariate GARCH model (DCC-MGARCH)

The model used in this analysis is the Dynamic Conditional Correlation (DCC) of Engel (2002) which Bauwens *et al* (2006) categorized as a nonlinear combination of univariate GARCH models. It can be seen as a generalization of the Constant Conditional Correlation model (CCC) model proposed by Bollerslev (1990).
Let u_t be a (n x1) vector of residuals obtained from the estimation of the VECM with $E(u_t|\mathcal{F}_{t-1}) = 0$, where $\mathcal{F}_{t-1}$ is the sigma field generated by past information up to time t-1. The multivariate GARCH model describes the dynamics of the conditional covariance matrix of u_t in the following way

$$u_t = H_t^{1/2} z_t, \quad z_t \sim iid(0, I_n), \quad t = 1, \ldots, T \tag{1}$$

where H_t is an (n x n) positive matrix and $H_t = Var(u_t|\mathcal{F}_{t-1})$ is the covariance matrix of u_t conditional on $\mathcal{F}_{t-1}$. Several specifications for the matrix H_t have been proposed in the literature.

In the DCC framework, the matrix H_t is decomposed into a matrix of conditional variances and a matrix of conditional correlations

$$H_t = D_t R_t D_t \tag{2}$$

$$D_t = diag(h_{11t}^{\frac{1}{2}}, \ldots, h_{nnt}^{\frac{1}{2}}) \tag{3}$$

$$R_t = (I_n \odot Q_t)^{1/2} Q_t (I_n \odot Q_t)^{1/2} \tag{4}$$

$$Q_t = (1 - a - b)\bar{Q} + a\xi_{t-1}\xi_{t-1}^{\top} + bQ_{t-1} \tag{5}$$

where $\odot$ denotes the Hadamard product, $\xi_{it} = u_{it}/\sqrt{h_{iit}}$ $(i = 1, \ldots, n)$ are the residuals standardized by their conditional standard deviations, $\bar{Q}$ is the unconditional covariance matrix of ξ_t, *a* and *b* are non-negative scalar parameters satisfying *a* + *b* < 1, D_t is the diagonal matrix of time varying standard deviations from univariate GARCH processes, and R_t is the time varying conditional correlation matrix.
According to Engel specification, the estimation of DCC-MGARCH parameters is two-step procedure. In the first step, univariate GARCH model parameters are estimated. The second step uses parameter estimates from first step to estimate a multivariate DCC model.

Given The recent changes in the biofuel industry, we use the estimated matrix of the pairwise correlations R_t to test for potential structural breaks induced, in particular, by changes in governmental policies. In the following paragraph we consider the methodology of Bai and Perron (1998, 2003) to test for multiple structural breaks in the pairwise correlations.

Dating Multiple Structural breaks: Bai and Perron Methodology

In dating multiple structural breaks, Bai and perron consider the following linear equation:

$$y_t = x_t'\beta + z_t'\theta_t + e_t \qquad t = T_j - 1 + 1, \ldots, T_j \quad and\ j = 1, \ldots, m+1 \tag{1}$$

where y_t is the observed dependent variable at time t, x_t $(p\ x1)$ and z_t $(q\ x\ 1)$ are vectors of covariates, β and θ_j $(j = 1, \ldots, m+1)$ are the vectors of coefficients, and e_t are error terms at time t.
The proposed model is a partial structural change model since the parameter vector β is not time dependent and, thus, not subject to shifts and is estimated using the entire sample. When $\beta = 0$ the model is reduced to a pure structural change model where all coefficients θ_j are subject to changes. Letting $T_0 = 0$ and $T_{m+1} = T$, the break points $(T_1, \ldots, T_m)$ are explicitly

treated as unknown. And, therefore, estimated along with the regression coefficients β and θ_j for a given sample (x_t, y_t, z_t) of size T. The model does not assume that the error terms to have constant variance.
Bai and Perron use the principal of least squares to estimates equation (1). For each partition$(T_1, \dots, T_m)$, denoted$\{T_j\}$, the associated least squares coefficients β and θ_j are estimated by minimizing the sum of squared residuals $\sum_1^{m+1} \sum_{t=T_{j-1}+1}^{T_j} [y_t - x'_t\beta - z'_t\theta_j]^2$. Let $\hat{\beta}$ ($\{T_j\}$) and $\hat{\theta}$ ($\{T_j\}$) denote the estimates based on the given m partitions$(T_1, \dots, T_m)$. Substituting these in the objective function and denoting the resulting sum of squared residuals as $S_T(T_1, \dots, T_m)$, the estimated break points $(T_1, \dots, T_m)$ are such that $(\hat{T}_1, \dots, \hat{T}_1) = Argmin_{(T_1,\dots,T_m)} S_T(T_1, \dots, T_m)$, where the minimization is taken over all partitions $(T_1, \dots, T_m)$ such that $(T_1, \dots, T_m) \geq q$. Therefore the break points estimators are global minimizers of the objective function. The parameter estimates are the estimates associated with the m-partitions$\{\widehat{T_j}\}$, i.e. $\hat{\beta}$ ($\{T_j\}$) and $\hat{\theta}$ ($\{T_j\}$). The authors propose three tests to date multiple structural breaks.

SupF

The first test is a Chow-type test and defined for each partition as

$$F_T(\lambda_1, \dots, \lambda_n; q) = \frac{1}{T}\left(\frac{T-(n+1)q}{nq}\right) \hat{\delta}' R'(R \hat{V}(\hat{\delta})R')^{-1} R \hat{\delta} \tag{2}$$

where R is the matrix such that $(R\delta)' = (\delta1\text{-}\delta2, \dots, \delta n - \delta n{+}1)$, and $\hat{V}(\widehat{\delta})$ is an estimate of the variance covariance matrix of $\hat{\delta}$ that is robust to serial correlation and heteroskedasticity .
The ***SupF*** type statistic is then defined as the supermum of the F_T sequence in the following way

$$F_T(n; q) = \underset{(\lambda_1, \dots, \lambda_n)}{Sup} F_T(\lambda_1, \dots, \lambda_n; q) = F_T(\widehat{\lambda_1}, \dots, \widehat{\lambda_n}; q) \tag{3}$$

where the break fractions estimates $(\widehat{\lambda_1}, \dots, \widehat{\lambda_n})$ minimize the global sum of squared residuals.

Double maximum tests

Bai and Perron (1998) also consider tests of no structural change against an unknown number of breaks given some upper bound M for m. The following new class of tests is called double maximum tests and is defined for some fixed weights $\{a_1, \dots . a_M\}$ as

$$\boldsymbol{DmaxF_T}(M, q, a_1 \quad \dots, a_M) = \underset{1 \leq m \leq M}{max} a_m \underset{(\lambda_1, \dots, \lambda_n)}{sup} F_T(\lambda_1, \dots, \lambda_n; q) \tag{4}$$

$$= \underset{1 \leq m \leq M}{max} a_m \quad F_T(\widehat{\lambda_1}, \dots, \widehat{\lambda_n}; q) \tag{5}$$

The weights $\{a_1, \dots, a_M\}$ reflect the imposition of some priors on the likelihood of various numbers of structural breaks. Firstly, they set all weights equal to unity, i.e. $a_m = 1$ and label this version of the test as $\boldsymbol{UDmax\ F_T\ (M, q)}$. Then, they consider a set of weights such that the marginal p-values are equal across values of m. The weights are then defined as $a_1 = 1$ and $a_m = c(q, \alpha, 1)/c(q, \alpha, m)$, for $m > 1$, where α is the significance level of the test and c(q,α,m) is the asymptotic critical value of the test $\underset{(\lambda_1, \dots, \lambda_n)}{sup} F_T(\lambda_1, \dots, \lambda_n; q)$. This version of the test is denoted $\boldsymbol{WDmaxFT(M, q)}$.

Sequential test

The last test developed by Bai and Perron (1998) is a sequential test of ℓ versus ℓ +1 structural changes:

$$SupF_T(\ell + 1|\ell) = \left\{S_T(\hat{T}_1, \dots, \hat{T}_\ell) - \underset{1 \leq i \leq \ell}{min} \underset{\tau \in \Lambda_{i,\epsilon}}{inf} S_T(\hat{T}_1, \dots, \widehat{T_{\iota-1}}, \tau, \hat{T}_\iota, \dots, \hat{T}_\ell)\right\} / \widehat{\sigma^2} \tag{6}$$

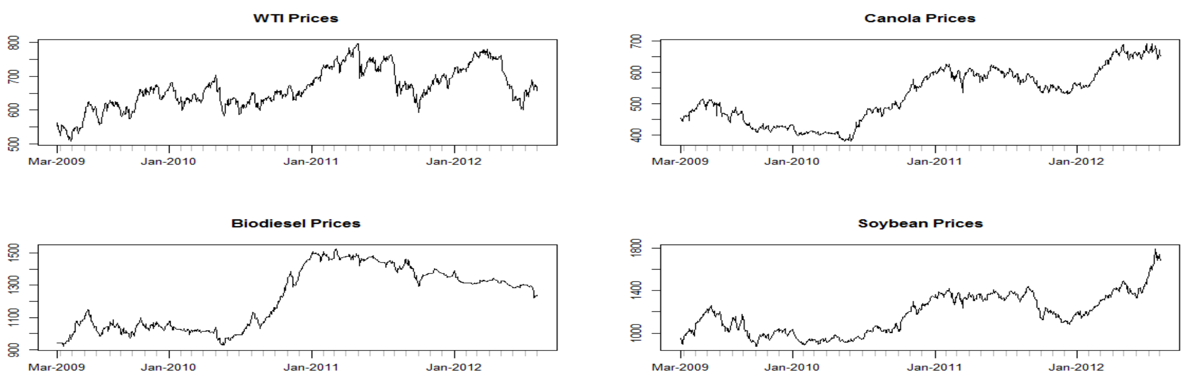
where $\Lambda_{i,\eta} = \{\tau;\ \widehat{T_{\iota-1}} + (\widehat{T_\iota}, \dots, \widehat{T_{\iota-1}})\eta \leq \tau \leq \hat{T}_\iota + (\widehat{T_\iota}, \dots, \widehat{T_{\iota-1}})\eta\}$.

The expression $S_T(\widehat{T}_1, \dots, \widehat{T_{\iota-1}}, \tau, \widehat{T}_\iota, \dots, \widehat{T}_\ell)$ is the sum of squared residuals resulting from the least squares estimation from each m-partition$(T_1, \dots, T_m)$, and $\widehat{\sigma^2}$ is a consistent estimator of σ^2 under the null hypothesis.
The asymptotic distributions of these three tests are derived in Bai and Perron (1998) and asymptotic critical values are tabulated in Bai and Perron (1998, 2003b).

Results and Discussion

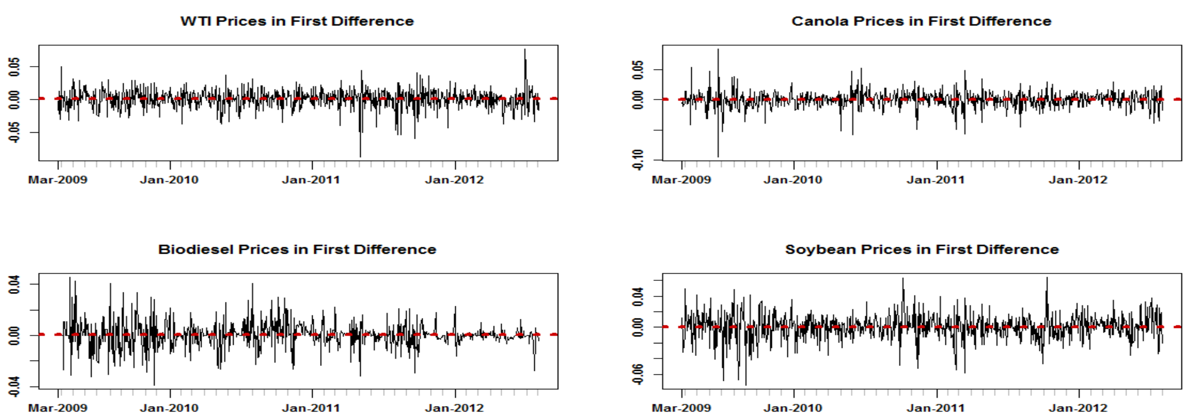
The massive use of food crops in the production of biofuels has been severely criticized and accused to have significantly participated in the advent of the food crisis of 2008 and another food crisis in 2011. The two spikes in food prices seem to be separated by a calm period immediately just after the crisis of 2008. According the graphs below (Figure.1), this period begins in early 2009 till the end of 2010, where another increase in prices, here for canola and soybean, start to be clearly visible. The graphs below of commodity prices[4], expressed in natural logarithm, illustrate clearly this tri-phase period.

Figure 1: Prices in Levels



Source: Own elaboration

Figure 2: Prices in First Differences



Source: Own elaboration

Figure.2 represents prices in first differences. The interpretation of these graphs needs some care. Variation in prices of WTI seems to be relatively stable and less volatile, except two spikes around mid-2011 and mid-2012 due probably to some brief tension in the international arena. Changes in soybean prices seem to be more volatile with clear periods of volatility clustering, right after the food crisis of 2008, at the end of 2010, and the end of 2012. For Canola, we observe some few spikes that seem to be more outliers than important volatility changes in the price. As far as the biodiesel is concerned, the price change of biodiesel tend to decay from 2009 to the end of 2012, which is in clear contrast with the high volatility periods observed in the case of soybean. This makes one to think that biodiesel and its principal feedstock: soybean start to be decoupled. The following sections, quantitatively check these assumptions and observations, and draw some conclusions about the effect of biofuels boom of 2006 (ethanol) and food crisis of 2008 on the post-crisis period starting early 2009.

Unit Root Tests

The first step in our empirical investigation is a series of unit root tests. We test univariate series using the Augmented Dickey Fuller test (ADF), Phillips Perron test (PP), and the Kwiatkowski–Phillips–Schmidt–Shin test (KPPS). Our results indicate that all series are non-stationary at the level and first difference stationary at the 5% level.

Johansen Procedure

In order to study the long-run relationships between the markets of crude oil (WTI), soybean, canola, and biodiesel, the Johansen approach is used to test for the rank of the long-run impact matrixΠ. Table. 2, shows results for, both, trace and maximum eigenvalue tests. Clearly, the trace statistic indicates only a weak cointegration relationship at the 10 % level, while the maximum eigenvalue test points to a one cointegration relationship at the 5% between the four markets.

The choice among the weak and the significant long-run equilibrium depends on many factors. First, the market of biodiesel in US is small compared to the ethanol market. Second, biodiesel received late (till 2004) and less subsidies compared to ethanol. Third, the sharp increase in the production of ethanol has altered the crop rotation corn-soybean, with a low soybean-to-corn acreage ratio ever recorded during the last decade (Goodwin et al, 2011) . Therefore, the expansion of the ethanol industry has have a depressive effect on, both, the acreage and production of soybean, which is the major feedstock used in the production of biodiesel in US.

Given all these factors, and to be very conservative, we opt for the weak cointegration relationship at the 10% level as displayed by the trace test instead of the highly significant one as obtained by the maximum eigenvalue test.

Table 2: Johansen Cointegration Tests

	Trace test				***Maximum Eigenvalue test***			
	test	10pct	5pct	1pct	test	10pct	5pct	1pct
$r \leq 3$	1.68	6.5	8.18	11.65	1.68	6.5	8.18	11.65
$r \leq 2$	3.8	15.66	17.95	23.52	2.13	12.91	14.9	19.19
$r \leq 1$	17.76	28.71	31.52	37.22	13.96	18.9	21.07	25.75
$r = 0$	45.86	45.23	48.28	55.43	28.1	24.78	27.14	32.14

The Vector Error Correction Model (VECM)

Given that the system is not of full rank, a Vector Error Correction Model (VECM) is estimated with three lags according to the AIC criterion. Results are displayed in table.3. All variables enter the error correction term ect_{t-1} with the correct sign, which means that there is a *correction mechanism* that correct past disequilibrium.. Moreover, all variables enter cointegrating system significantly.

The crude oil is endogenous as shown by its level of significance in the error correction term. Borenstein and Kellogg (2012) explain the endogeneity of crude oil by the fact that beginning 2011, crude oil production in the U.S. Midwest and Canada surpassed the pipeline capacity The authors conclude that the decrease in WTI prices did not “pass through” to refined products: gasoline and diesel, and thus to their “bio-substitutes”: ethanol and biodiesel.

The analysis of the short term dynamics reveals that crude oil does not adjust to any of the other variables except canola after two lags, this result is attributed to the presence of potential outliers.

Column two shows that canola adjusts both to its own price changes and changes in the soybean prices from the previous period. Canola and soybean are close substitutes in both the production of vegetable oils and biodiesel. It follows that an increase in the price of canola will stimulate the demand for soybean, this will moderately raise the price of soybean in the next period, which in turn will shift the demand for canola again upward and, thus, brings canola prices down to its market equilibrium.

Soybean reacts only to its own dynamics in the same order of magnitude, (0.113) and (-0.100), but with alternate signs. An increase in its price two periods back in time causes an onward shift in the demand for soybean. Again the market reacts with the *same* magnitude to bring back the price of soybean to its market equilibrium the following period.

The last column of table.3 shows that biodiesel reacts positively to an increase in the price of crude oil. This is because biodiesel is blended with the diesel. Therefore, an increase in the price of crude oil induces an increase in the price of diesel. Canola enters positively and significantly the equation of biodiesel with two lags. Biodiesel adjusts negatively and weakly to changes in soybean prices, this is because the volatility in the soybean market does not affect the volatility of biodiesel after the two "boom". A change in policy, as an attempt to reduce food prices, would have decoupled the market of biodiesel and that of soybean.

The diagnostic checking of the residuals of the estimated VECM(2) shows that the specification of our VECM(2) is quite satisfactory. Results of the diagnostic checking are available from the author upon request.

Table 3: Vector Error Correction Model Estimation Results

	Δ Crude Oil$_t$	Δ Canola$_t$	Δ Soybean	Δ Biodiesel$_t$
ect$_{t-1}$	-0.013**	-0.007*	-0.019***	-0.012***
	(0.004)	(0.004)	(0.005)	(0.003)
constant	0.095**	0.053*	0.135***	0.089***
	(0.030)	(0.028)	(0.033)	(0.020)
Δ Crude Oil$_{t-1}$	-0.027	-0.038	-0.057	0.068**
	(0.041)	(0.038)	(0.045)	(0.026)
Δ Canolat$_{-1}$	-0.025	-0.155***	-0.080	0.077**
	(0.046)	(0.042)	(0.050)	(0.030)
Δ Soybean$_{t-1}$	0.044	0.096*	0.113*	0.042
	(0.041)	(0.038)	(0.045)	(0.027)
Δ Biodiesel$_{t-1}$	-0.060	0.028	0.007	-0.127**
	(0.061)	(0.056)	(0.067)	(0.039)
Δ Crude Oil$_{t-1}$	-0.001	0.034	-0.003	0.042
	(0.041)	(0.038)	(0.045)	(0.026)
Δ Canola$_{t-1}$	0.091*	-0.050	0.077	0.145***
	(0.046)	(0.043)	(0.051)	(0.030)
Δ Soybean$_{t-1}$	-0.056	0.005	-0.100*	-0.063*
	(0.041)	(0.038)	(0.045)	(0.027)
Δ Biodiesel$_{t-1}$	0.062	0.066	0.097	-0.049
	(0.060)	(0.055)	(0.066)	(0.039)

***Significant at 1% level, **Significant at 5% level, *Significant at 10% level

The analysis of the short term dynamics reveals that crude oil does not adjust to any of the other variables except canola after two lags, this result is attributed to the presence of potential outliers.

Column two shows that canola adjusts both to its own price changes and changes in the soybean prices from the previous period. Canola and soybean are close substitutes in both the production of vegetable oils and biodiesel. It follows that an increase in the price of canola will stimulate the demand for soybean, this will moderately raise the price of soybean in the next period, which in turn will shift the demand for canola again upward and, thus, brings canola prices down to its market equilibrium.

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The last column of table.3 shows that biodiesel reacts positively to an increase in the price of crude oil. This is because biodiesel is blended with the diesel. Therefore, an increase in the price of crude oil induces an increase in the price of diesel. Canola enters positively and significantly the equation of biodiesel with two lags. Biodiesel adjusts negatively and weakly to changes in soybean prices, this is because the volatility in the soybean market does not affect the volatility of biodiesel after the two "boom". A change in policy, as an attempt to reduce food prices, would have decoupled the market of biodiesel and that of soybean.

The diagnostic checking of the residuals of the estimated VECM(2) shows that the specification of our VECM(2) is quite satisfactory. Results of the diagnostic checking are available from the author upon request.

Dynamic Conditional Correlation Multivariate GARCH

A parsimonious, GARCH(1,1)-DCC(1,1), following most of the literature, model is estimated. The test of Hafner and Herwartz (2004), with the null of no causality in variances, was note rejected at the 5% level (HH= 31.72 with a p-value = 0.134). Thus the model is diagonal.

Table.4. shows that all intercepts are null. The coefficients α and β are highly significant in all equations at 1% level. The conditions on α and β hold for all GARCH models .i.e. α, β >0 and α + β <1 , hence, all processes exhibit mean reversion. The sum of α and β for all processes is less than unity.

For crude oil, on the other hand, the sum of α and β (0.216) is roughly four times lower compared to the other markets. The value of α +β = 0.216 for crude oil implies a low volatility persistency. The low persistency in the volatility of WTI is in line with the cointegration results and the pipeline capacity constraint reported by Borenstein and Kellog (2012).

Table 4: GARCH Estimation Results**.**

	Crude Oil	***Canola***	***Soybean***	***Biodiesel***
ω	0.000 (0.000)	0.000 (0.061)	0.000 (0.506)	0.000 (0.000)
α	0.124*** (0.059)	0.187*** (0.133)	0.081*** (0.000)	0.125*** (0.023)
β	0.092*** (0.028)	0.567*** (0.000)	0.897*** (0.028)	0.841*** (0.037)
α +β	**0.216**	**0.754**	**0.978**	**0.966**

***Significant at 1% level, **Significant at 5% level, *Significant at 10% level

The coefficient of the DCC model estimates are highly significant at 1% level with α = 0.02 (0.018) and β = 0.957 (0.040). The high value of β coefficient indicates that the conditional correlation between the residuals is highly persistent.

Average correlations over the sample period are presented in table.5. All coefficients of correlations are highly significant. The pairs canola – soybean and biodiesel– crude oil have the highest average correlations as expected with coefficients of correlations (0.602) and (0.473) respectively. This again follows from the fact that soybean and canola are close substitutes and, thus, both markets contaminate each other. The same holds true for crude oil and biodiesel through the diesel market, as biodiesel is blended with diesel.

Structural breaks

The last decade had witnessed some major events. The global financial crisis and the implication of biofuels in the food crisis of 2008, have been questioned as major causes of the historical changes in the level of volatilities in the agricultural markets. It is therefore reasonable that such major events may have caused some structural changes in the dynamic correlation among the studied markets.

Consider the following equation

$$\rho_{tij} = \mu_{ij} + \epsilon_t \tag{7}$$

where ρ_{tij} is the dynamic conditional coefficient of correlation for the pair (i,j) at time t, and $\epsilon_t \sim N(0,1)$ is assumed to be a white noise process with mean 0 and variance of unity. Results suggest that only two pairwise correlations were subject to a structural shift in their meanμ_t. Namely the pair Soybean-Biodiesel and the pair Crude oil-Biodiesel, The first break occurred in November fourth 2010 (11/04/2020) . The Second break is detected at the end of 2012 for the pair Crude oil-Biodiesel.

The first break, most likely was du, to the elimination of the tax credit for biofuels, including the tax credit of $1 per gallon of biodiesel. The tax credit was extended to 2011 to support new investments the tax credit was again eliminated in 31 December 2011, a date that coincides with the date of the second structural break (01/312012). This second break also coincides with the elimination of the 54-cents- per-gallon import tariff the US used to impose on ethanol imports. The 45-cents-per-gallon tax credit to blenders has also been removed.

Table 5: Average Pairwise Correlations

	Crude Oil	***Canola***	***Soybean***	***Biodiesel***
Crude Oil				
Canola	0.246*** (0.094)			
Soybean	0.384*** (0.063)	0.602*** (0.111)		
Biodiesel	0.473*** (0.075)	0.226*** (0.114)	0.338*** (0.080)	

***Significant at 1% level, **Significant at 5% level, *Significant at 10% level

Conclusion

The increasing comovement of edible oils and biodiesel uncovers strong sensitivity for biofuels incentives to penetrate through the food and fiber markets. In the case of dedicated crops plated specifically to be used as biofuels, land competition makes food and fuel markets substitutes, a process that tends to increase demand and, in global commodities, elevate overall price volatility. Yet it was not obvious this would carry over, at least at this point in time, to biodiesel feedstocks. In the case of biodiesel, a wider number of alternative feedstocks can satisfy this demand and meet current industrial efficiency standards, including waste products of several kinds (e.g. wood waste). In the case of ethanol feedstocks, choices are more limited, attached to very high calorie (per weight) grains and sugar cane. In addition, the overall benefit to the producer of bioenergy subsidies seems to favor corn for ethanol over beans for biodiesel.

Corn and beans are grown in rotation. Since 2006, changes in rotations have favored corn in that farmers devote more years in a cycle to corn than to beans. So with a smaller share of the soybean product entering the biodiesel production stream than for corn or sugar, the larger volume of ethanol entering the fuel markets than biodiesel, and the potential for multiple substitutes for biodiesel feedstocks, the potentially adverse consequences (or at least higher volatility in addition to higher prices) of bioenergy policy for soybeans suggests a greater sensitivity of global markets from bioenergy policies. The careful step by step process outlined here, from unit root tests to DCC, shows a deepened integration between biodiesel, soybean and canola prices. That integration has induced volatility that, at least so far, appears in the form of punctuated price spikes (high and low) in all three markets at once, arguably the most dangerous form of food price volatility.

There may be advantages however to biodiesel over corn ethanol. Several useful biodiesel feedstocks, if extended to more marginal lands, are more environmentally friendly and heartier, or more sustainable (e.g. guar), as they require far less water and can be used to fix nitrogen in rotation to other crops. In addition, some substitute feedstocks can be drawn from residuals, not dedicated plantings, thus removing much of the direct food-fuel competition for land. Early indications here suggest a need for caution, for more local (distributed) operations, and policy pricing that is less distortionary. The early signals here on biodiesel, however, are worrying as the sensitivity in small price distortions quickly translates into a higher risk for both food consumers and bioenergy producers.

Notes

1. Our initial data contained Diesel, an important element in our projected analysis as it is blended with biodiesel. However, the Zivot and Andrews unit root test revealed that Diesel was trend-stationary with a broken trend. The break occurred in December fourth, 2010. A date we found while developing the analysis in this article using Bai and Perron methodology. We shall come to this break date in a later section. In any case, we unfortunately dropped Diesel from our analysis. Results of ZA unit root tests are available from the author upon request.
2. A VAR is stable if the determinant of the polynomial $I_n - \Pi_1 z - \cdots - \Pi_n z^n$ is zero, i.e. all its roots lie outside the complex unit circle.
3. Note the striking resemblance with the ADF test for unit root in the univariate case. In the ADF equation $y_t = \pi y_{t-1} + \sum_{j=1}^{k} \gamma_j \, \Delta y_{t-j} + \beta_0 + \beta_1 + u_t$, if the scalar $\pi = 0$ then the series is a unit root process. Johansen Procedure could be seen as a generalization of the unit root test to the multivariate case.
4. All prices are transformed to US Dollar per metric ton.

5. Due to space constraint, we do not report results of Box-Ljung results for residuals and squared residuals for different lags. These results, however, are available from the author upon request.

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