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EDITORIAL REVIEW BOARD

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CHANGING LEVELS OF DISCRIMINATION IN THE MARKET FOR BASEBALL CARDS

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ABSTRACT

Others have analyzed the pricing structure of baseball memorabilia for evidence of discrimination regarding player race with mixed results. The authors' 2004 paper included a fame component to the Fort and Gill (2000) censored Tobit model, which came up significant and swamped any racial differences in card pricing. In this paper, we examine how the effects of a player's race as well as fame on card price has changed across time. We use our original data set covering all single player cards (of hitters that played in a given year) across the entire decade of the 1960's, comprising some 2,770 cards. Analysis of these data suggest that there is a change in the way that player race affects card price, an effect we refer to as the 'novelty effect.' Further, we investigate cards from a more recent year (some 373 cards of players who played during1986) to determine if current era cards still have any trace of race impacts on price.

INTRODUCTION

Over the last 4 decades, baseball trading cards have moved from the shoebox under the bed to the showpiece of sport collectors. What had been a childhood hobby, collecting baseball cards that came with sticks of sugary sweet bubble gum, has become big business. Cards that once were used to make special noise effects on bikes tires are now investments in 'sports memorabilia.' Some of these cards can now sell for millions of dollars. For example, a 1910 Honus Wagner card recently sold for $2.35 Million ("$2.35M card, but how much is the bubblegum?" *USA Today*, 3/29/2007). Card collecting is clearly no longer just a hobby of pre-adolescent males, it is now a business, an investment for the buyer. The wide market for these trading cards has provided economists with a playground of data to examine how the value placed on player's cards is affected both by the player's skill and, possibly, by the player's race. For instance, if collectors display prejudice against non-white players, then cards of players with similar stats but of different races would presumably sell for different amounts. Alternatively, it may not be each individual buyer who is demonstrating prejudice so much as buyers jointly assuming that other buyers will display prejudice, thereby affecting price. This is something like England's famous "Page Two Girls" beauty contest where people are asked to pick what other people will think is the most attractive girl. At any rate, the result should be the same in this case: racial discrimination against non-white players should show up as reduced card price, all else equal.

What we bring to this discussion is two-fold. Initially, we examine how the impact of race may have changed across time as we have reason to believe that attitudes towards race may well have changed. Additionally, following our own work (Burnett and Van Scyoc, 2009), we bring the added dimension of a player's fame to the analysis. Indeed, we suspect that famous players' cards hold value distinct from racial impacts. If there is a racial bias on the part of card collectors it would most likely be seen in the cards of players not so famous and we feel we should include this idea into the academic literature.

Resale value of a particular player's card is paramount to today's buyer, which brings us to the issue of pricing these cards. Any number of player characteristics could affect the price of a given card, though chief among these elements would include demonstrated player skill (stats) as well as player race. Unobservable characteristics, such as off-field behavior (such as steroid use) may well influence the demand for cards, but since our primary data set is from the 1960's, one might expect that little of these types of influences are likely to remain in buyers minds. Though, by looking at pricing both in current markets (based on prices from 2008) and from previous markets (1981, a year that would have seen most of the players from the 1960's would have been inducted into the Hall of Fame, for instance but close enough to the time the players were on the field and well known among collectors), we may be able to ferret out changes in collector behavior. Apart from the off-field behavior, players' on-field behavior can be measured either directly by annual and lifetime player stats as well as by such awards as Most Valuable Player (MVP), election to the All Stars or Hall of Fame (HF). These observable characteristics are some measure of fame and how their careers were perceived at the time (All Stars, MVP) or since (Hall of Fame). We include all three of these measures of fame into our work, to determine if they appear to affect the value of cards. Supply conditions for these cards, according to the manufacturer, did not vary depending upon the popularity of the individual players. However, if card collectors did display any bias against non-white players, they may have been less likely to keep cards of those players, limiting the supply of those cards in later years. If that is the case, then our results, as well as the results of any work of this type may be bias downwards as a limited supply would suggest a higher price all else equal.

Exploring sports memorabilia for evidence on discrimination is hardly new, Kahn (1991) provides a nice literature survey in this field. Others, including Jewell (2002) and Fort and Gill (2000), continue this type of work. Research into the area of discrimination in sports has taken many forms; a myriad of papers have examined various aspects of discrimination from many different sports. For example, Rottenberg (1956), a forerunner in sports economics, was among the first to look at the baseball labor markets, work which was continued by Bellemore (2001) and others such as Bodvarsson and Banaian (1998). Other avenues of research have led to the examination of Hall of Fame voting, promotion to major leagues, and contract/salary issues; a nice look at Hall of Fame voting is provided by Jewell, Brown and Miles (2002), while Bellemore (2001), among others, looks at promotion issues. Many others look at contract, salary and arbitration results for evidence of discrimination (see, for instance Bodvarsson and Banaian, 1998, or Marburger, 1996). The application of economic principles and techniques to other sports in search of racial discrimination continues unabated with such articles as Szymanski (2000), who explores the English professional soccer leagues for evidence of discrimination, and Kahn and Sherer (1988), who look into racial discrimination in basketball player salaries. Fort and Gill (2000), McGarrity, Palmer and Poitras (1999), Gabriel, Johnson, and Stanton (1995), Andersen and LaCroix (1991), as well as Nardinelli and Simon (1990) all look at baseball cards for evidence of discrimination.

Some of the first work done on baseball cards used only very small samples using either single season or only selected cards (rookies, often). For example, Nardinelli and Simon (1990) explore a single season (1970) card set with only 334 hitter cards and 233 pitcher cards. Their primary contribution was to recognize that card prices are a left censored variable, so that a Tobit model would prove more appropriate (which has since become the standard for this sort of analysis). They discovered significant evidence of consumer discrimination even in their small data set. Using both hitter and pitcher cards can be problematical, as different variables are necessary to describe player skill.

Andersen and La Croix (1991) used two different time periods (1960 and 1977) and separated out non-white players into Latino and black groups. Again using a mixed sample of both hitters and pitchers, they found some discrimination though, their results were weaker than that of some previous studies. Presumably, they suspect that collectors have/had different levels of discriminatory feelings regarding Latinos versus blacks relative to white players. Tregarthen (1992), among others, shows that white player's card prices are about 10 to 20 percent higher than non-white players.

Gabriel, Johnson, and Stanton (1995) looked at only rookie cards, though they used a wider range of years, from 1984-1990. Still they had only 156 hitters and 134 pitchers. Rookie cards tend to be priced higher than cards from later on in the player's career, particularly for those players that play for several years in the major leagues (implying a high level of skill and, perhaps, fame). They employed a semi-log model, but did not find evidence of discrimination among these cards.

McGarrity, Palmer, and Poitras (1999) used cards of retiring players (again, both pitchers and hitters) from 1974. They compared results from differently constructed Tobit models and discovered that with less restrictive modeling the evidence of discrimination disappeared. Their particular choice of cards however may have pre-selected for those cards from players with a certain degree of fame and certainly for those players that played for several years, suggesting a high level of skill.

Fort and Gill (2000) suggested that previous explorations into the market for baseball cards for evidence of racial discrimination were flawed because the racial 'marker' used for the individual players is so often arbitrary (and, incidentally, the arbitrary choice of the researchers in questions, so that some level of bias may inadvertently be introduced). Our study employs a panel of both male and female raters, both undergraduates and non-students to determine the perception of race for individual players, with no input at all from the researchers except in the case of a tie.

Fort and Gill (2000) continued, however, to use both pitchers and hitters and they discover that there are different impacts of discrimination between these two groups. Because of this difference, we have restricted our study to just hitters, completely omitting pitchers from our data set, leaving analysis of this second group to future work.

The authors (2004) used 2,833 cards collected across the 1960's that showed distinct evidence of racial discrimination among collectors of about $2.66 higher prices on average for white rather than non-white players. However, once fame variables were added, the race of the player was less significant.

DATA AND METHODOLODGY

Data

We explore a much wider sample of baseball cards than previous researchers, using all Topps cards issued during the entire 1960-69 decade of only one hitter on each card. Cards with more than one man pictured on it were dropped, as were cards with manager's cards. For example, both the 1960 Topps #7 with both Willie Mays and Bill Rigney and the 1960 Tops #18 card of the entire Dodgers team were dropped. Even limiting our set to cards with only 1 hitter on them, and only to hitters, we still have a data set of 2,787 distinct cards. Additionally, we limited the data set further by removing all players who did not play more than 4 games. Still, this gives us a substantial sample of 2770 cards with which to work.

One benefit of using the decade of the 1960's is that off-field behavior is less likely to remain firmly in the memories of collectors than that of more recent players, and the matter of steroid use can be totally ignored. However, to the extent that card collectors are more likely to collect cards from the era of play they personally observed, there may be some residual effects. That being said, the 'star power' of these players is still more likely to be mostly due to their directly observable player characteristics. Also, if collectors of cards from the 1960's are likely to be of that era, they may be more likely to demonstrate discrimination as racial discrimination was far more ubiquitous and culturally accepted during the 1960's than it is today.

In order to have a comparison year, we have also collected a more recent sub-sample of cards from only a single year, 1986. This period of history is one where racial integration was commonplace but long enough ago that players from that era have already had the opportunity to be inducted into the Hall of Fame and be subject to the 'court of hindsight' so that fans will have had some time to make an historical judgment of talent. This subset of cards contains 374 unique cards.

Both annual and lifetime stats are recorded for each player in each of the samples. Annual stats include each players' age (Age), years of experience (Exp) in the major leagues, percentage at bats (PAB) and whether the year in question was the players' rookie year (Rookie). Lifetime stats include the number of lifetime home runs (LHR), lifetime batting average (LAVE) and lifetime slugging record (LSLG). A player's slugging percentage is the most popular measure of the power of a hitter. It is calculated as the total number of bases a player gets divided by hit at bats during a given season.

$$SLG = \frac{S + (2xD) + (3xT) + (4xHR)}{AB} \qquad (1)$$

where AB is the number of at bats, S, D, T, and HR are the number of singles, doubles, triples and home runs, respectively for a given player. The lifetime slugging percentage uses lifetime numbers rather than season numbers for these variables. Walks are excluded from this calculation.

Also, we collected the fame statistics, such as whether the player was on the year's All Star team, was voted most valuable player (MVP), played in the world series (WS) or was ever inducted into the Hall of Fame (HF). Statistics about players' performance are from *Total Baseball IV: The Official Encyclopedia of Major League Baseball* (1995) and Slocum's *Baseball Cards of the Sixties (*1994).

Card prices are from *The Sports Americana Baseball Card Price Guide and Alphabetical Checklist* (Beckett, various years). Beckett's pricing is the most frequently used price list for baseball cards. We have collected price data for each of the cards in our sample from more than one year. For the cards from the 1960's, we have prices from 2008 (Price08) to represent the most current prices available and from 1981 (Price81) to represent the earliest reliable prices we can obtain. Additionally, we have a listing of prices from a midpoint year (Price2000).

Perceived race of the players is determined by opinions gathered from at least 3 separate observers, as perceived race is the issue not genetic race. Our panel consisted of both males and females, from the age of 19 to 54, with at least one 'non-sports-fan' in each group to try to eliminate the possibility that panelists were familiar enough with the players' actual race rather than limiting their opinion to the apparent race of the player from the card picture. Each panelist viewed the cards independently so as not to be biased by other panelists' votes. Even though there was a different selection of panelists for each card, we had a surprising amount of agreement on apparent player race. In the very few cases where there was a tie, one of the authors cast the deciding vote.

We further refine the variables dealing with player skill by constructing two additional variables from the raw data we collected. Following Fort and Gill (2000), we construct a variable from the residual from a regression of lifetime slugging average on lifetime batting average (SLUGRES).

$$SLUGRES = LAVE - \alpha - \beta LSLG \qquad (2)$$

When this residual is positive, it indicates that the player outperforms expectations given his batting average. If it is negative, the player underperforms relative to expectations.

Another indicator of performance (or, technically, the recognition of player performance) is the residual from a regression of age on numbers of years of experience in the major leagues (AGERES).

$$AGERES = Exp - \alpha - \beta Age \tag{3}$$

Hence, a player with a positive AGERES is one that was brought up relatively early to the majors, presumably a mark of recognition of greater than average skill. Rather than truncate these residual variables into separate positive and negative variables as Fort and Gill (2000) do, we leave them as continuous variables and note that our variables have desirable properties such as being approximately normally distributed.

The tables below summarize the data from the 1960's cards. Table A shows the collected raw data with summary stats. Table B shows the summary statistics for the data broken down by race with the most current pricing. The following two tables summarize price differences for this card set, when the prices are collected from different years (the same cards, but prices from 2008 and 1981, respectively). In Table C we show the annual average price from 2008 for these cards broken down by race and year. Table D shows average price from 1981 also broken down by year and race. Figures 1 and 2 show a graphical representation of Tables C and D, respectively.

Table A: 1960's CARDS
(2770 Distinct Cards, Hitters Only)

Variable	Mean	Std. Dev.	Min.	Max
Price2000	11.49227	32.79809	1.5	550
Price81	1.021031	3.935799	.13	90
Price08	13.78587	39.69382	1.5	600
White	.7137707	.4520794	0	1
Exp (Experience)	4.288809	3.474041	0	17
Age	28.80894	3.841652	20	43
Rookie	.1517644	.358859	0	1
PAB (Percentage at Bat)	315.0458	198.0409	1	698
LHR (Lifetime Home Run)	114.8825	137.0335	0	755
LAVE (Lifetime Average)	.2543792	.02583014	.147	.386
LSLG (Lifetime Slugging)	.3828814	.0654361	.153	.559
AS (All Star)	.1405912	.347662	0	1
HF (Hall of Fame)	.0771449	.2668694	0	1
MVP (Most Valuable Player)	.0068493	.0824915	0	1
WS (World Series)	.0894016	.285374	0	1

Table B: All 1960's Data: Summary Stats by Race		
Variable	Whites	Non-Whites
Price 2008	12.82753	16.17569
Rookie	.1439	.171285
Lifetime Slugging	.3745	.40359
Percent at Bats	294.568	366.1108
Lifetime Home Runs	99.28182	153.7859
Lifetime Average	249.7833	265.84
LSLGRES	-2.3124	5.76648
AGERES	-.00125	.003103
World Series	.08989	.08816
MVP	.00505	.011335
Hall of Fame	.05252	.138539
All Star	.12424	.18136
Count	1980	790

Table C: Average Annual Prices from 2008 by Race		
Year	Whites	NonWhites
1960-1969	12.82753	16.17569
1960	13.8393	21.7377
1961	19.5913	24.5857
1962	18.0439	24.7826
1963	15.9171	23.7353
1964	12.3913	15.5385
1965	12.5300	16.5867
1966	9.7597	17.3842
1967	12.4143	11.2033
1968	6.9034	7.3635
1969	3.6148	8.9862

Table D: Average Annual Prices from 1981 by Race		
Year	Whites	NonWhites
1960-1969	.9896919	1.099181
1960	0.79286	2.16410
1961	1.77065	4.13757
1962	1.07105	0.83507
1963	1.59127	0.50868
1964	0.58522	0.97631
1965	0.67219	0.75267
1966	0.78083	0.85768
1967	1.60497	0.63055
1968	0.47347	0.44654
1969	0.35556	0.59486

Figure 1

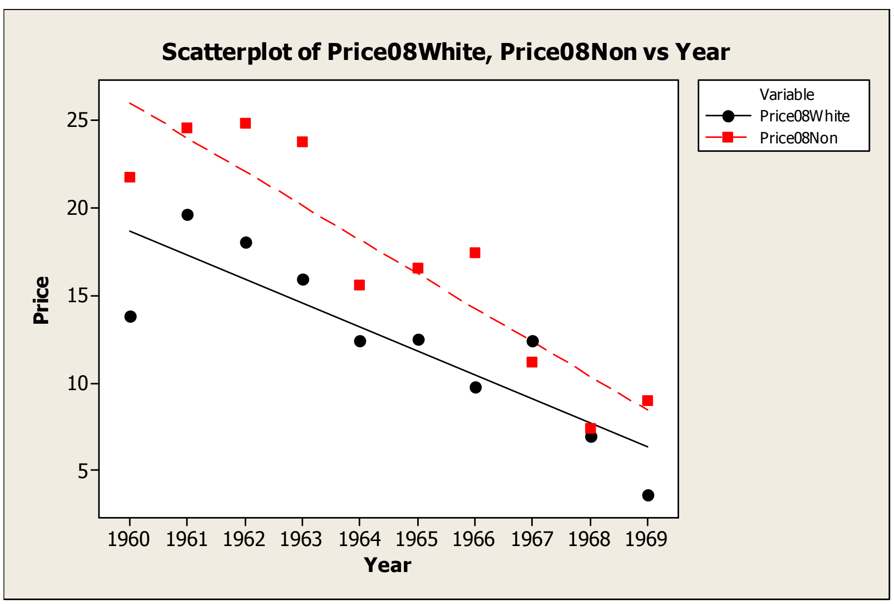
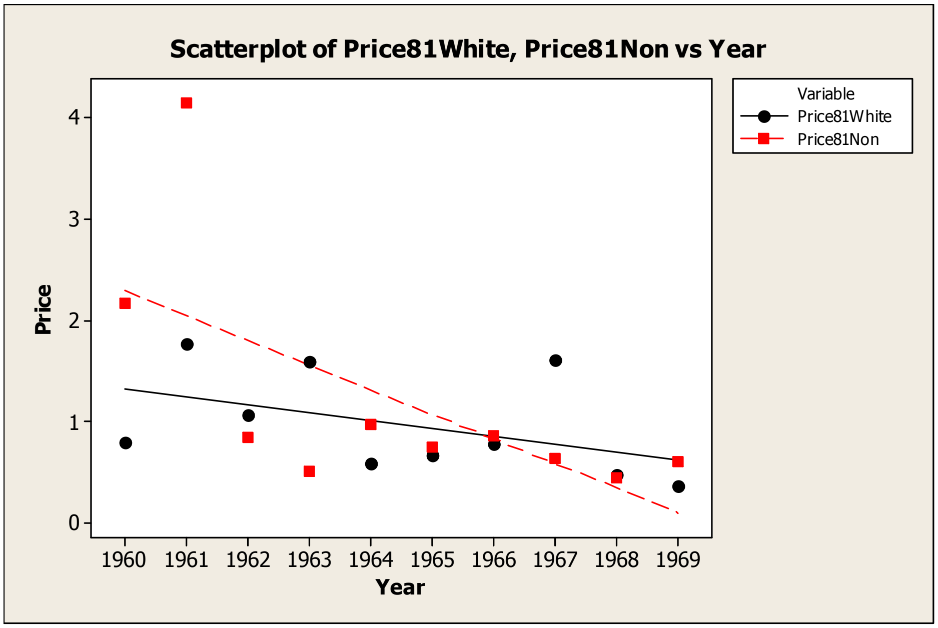


Figure 2



The preceding tables and figures demonstrate the expected effect of time on prices, as older cards would demand higher prices. However, additional information here is that there is a decided difference between the impacts of race on prices by year. It is fairly clear that these patterns are quite different in the 1981 price data and the 2008 price data. In the 2008 price data, prices for non-white players' cards are strictly *above* those of the white players' cards, while in the 1981 price data, after the first two years of the decade, the cards of both groups of players appear similar. Table B, however, shows that non-white players have the higher summary stats regarding performance, so we would expect to see them with higher card prices. Also in the early 1960's, non-white players were still very much novelties. Regardless of how one interprets these figures, however, what is clear is that there is a difference between the white and non-white players' card prices over time. It is that change that we are investigating here.

METHODOLOGY

Following previous studies, we note that prices for these cards are left-censored (with a lower limit of $1.50 in the 2008 data and a lower limit of $0.13 in the 1981 price data, we also note that the percentage of non-white player cards at this lower limit of $1.50 mirrored their representation in the overall sample (both were at 28%)). Since we have a left-censored sample, OLS estimates will be both biased and inconsistent, so we use a censored Tobit estimation method on our price variable (measured in dollars). Additionally, this data has elements that can be modeled as panel data. However, as the panels are quite limited (few players played over the entire decade and the vast majority played only a few seasons), the likelihood of getting significance using a panel approach is small, even though this approach may account for unobserved heterogeneity in our dataset.

In each of our regression pairs, we present one traditionally formatted model (much like Fort and Gill, 2000) that employs only the player stats and the *AGERES and SLUGRES* variables. The second regression in each pair also uses the fame variables that the authors have introduced elsewhere. While there is likely to be some collinearity among these variables, the measures of fame we have chosen to use (Hall of Fame, AllStar game, World Series, and MVP) are distinct enough honors so that they do not consistently overlap. By including these measures of fame, we are able to distinguish between those players that are ‘famous’ and those that are not.

We also introduce a *year* variable to account for changes by year, as suggested by Tables B and C (and related Figures 1 and 2) above. In order to pick up interactive effects from changes in racial impacts on the price of these cards, we also include an interactive effect with the year and *white* variables.

RESULTS

Table E shows the regression results from the player data from the 2770 cards collected over the decade of the 1960’s. It is run separately for two price years – 2008 and 1981. Further, regressions are shown that both include and exclude fame components. A startling result is the size, sign and strength of the estimated coefficient on the *white* variable in the 2008 price data. It is not only positive, it is large and quite significant both with and without fame components in the regression. In the 1981 price year data, the racial component also has a positive sign, but is much less significant. Also noteworthy is that the fame components of MVP and World Series play are only significant in the 2008 data and not for the 1981 data. Our conclusions are that when personal experience of the collectors is not a strong component of the demand for cards, that collectors fall back upon their inherent biases so that the discrimination result show up.

Table E: Regression Results: All 1960’s Cards, Comparison between Price2008 and Price 1981, Left-Censored Tobit, (t-stats in parentheses)

Dependent Variable:	Y=Price 1981		Y=Price 2008	
	Without Fame	With Fame	Without Fame	With Fame
Constant	.9246256 (1.23)	.6462078 (0.86)	-10.2511 (-1.58)	-17.67859 (-2.88)
White	.3443182 (1.81)	.3480181 (1.84)	5.229857 (3.21)	5.616802 (3.65)

Table E: Regression Results: All 1960's Cards, Comparison between Price2008 and Price 1981, Left-Censored Tobit, (t-stats in parentheses)				
Dependent Variable:	Y=Price 1981		Y=Price 2008	
	Without Fame	With Fame	Without Fame	With Fame
Rookie	.0986936 (0.40)	.0615439 (0.25)	5.275444 (2.49)	4.249804 (2.12)
PAB (Percent at Bat)	-.0004584 (-0.96)	-.0006186 (-1.24)	-.0118817 (-2.88)	-.0117184 (-2.89)
LSLG (Lifetime Slugging)	-3.112661 (-1.52)	-1.804709 (-0.88)	16.31179 (0.92)	45.42265 (2.7)
LHR (Lifetime Home Runs)	.0068812 (6.4)	.0031339 (2.46)	.1356906 (14.69)	.0467147 (4.52)
AgeRes+	-.0813663 (-1.92)	-.0893844 (-2.11)	.5317871 (1.49)	.2481217 (0.72)
LSLGRes+	.0070215 (1.48)	.0044222 (0.93)	.1773863 (4.34)	.1216967 (3.15)
AS (All Star)		.6369451 (2.23)		6.371516 (2.73)
HF (Hall of Fame)		1.905586 (4.5)		49.84484 (14.56)
MVP (Most Valuable Player)		.5777601 (0.51)		39.67296 (4.85)
WS (World Series)		.242256 (0.84)		15.3028 (6.75)
n	2770	2770	2770	2770
Log Likelihood	-7190.1731	-7174.5608	-13299.073	-13139.578
Pseudo R^2	.0047	.0069	.0236	.0353
Number of Left Censored Observations	335 ($0.13)	335 ($0.13)	137 ($1.5)	137 ($1.5)
+ See text for an explanation of these variables.				

Tables F and G continue to look at regression analysis of the 1960's data set, but with the additions of a year variable, so that Table F shows that older cards have higher prices, as one would expect. It also shows that the race components has completely receded with the introduction of the year variable in the 1981 price data regression, perhaps because the first non-white players admitted to the league were so superior to the existing white players by measured skill level that their value can entirely be explained by those superior stats (with the exception that no non-white players received All Star or MVP awards in those early years, and we note that those measures are insignificant in the 1981 price data). The 1981 price regression does not show high pseudo R^2's. In 2008, the pseudo R^2's double, perhaps showing that collectors operating some 40 years after the time of the players' careers may be reacting more to observable characteristics rather than was the case in 1981.

Table G, however, takes this concept one step further to show that there is an interactive effect between time (year) and race (white). We see that as time goes by, the 'novelty effect' that generated increased prices for non-white players' cards lessens, shown by the positive sign on the interactive variable. Indeed, we would expect this as baseball integration becomes more accepted and non-white players become more common place, the non-white players are less of a rarity making their cards relatively less valuable than previously for those collectors in 1981. Again, as in the previous table, we see stronger pseudo R^2's and more significant results from the more recent price data suggesting, perhaps, the further from personal memory the stronger the impact of observable characteristics such as player stats and race.

Table F: Regression Results: All 1960's Cards, Year Dummy, Comparison between Price2008 and Price 1981, Left-Censored Tobit, (t-stats in parentheses)

Dependent Variable:	Y=Price 1981		Y=Price 2008	
	Without Fame	With Fame	Without Fame	With Fame
Constant	661.895 (11.43)	638.3647 (11.03)	4032.074 (8.33)	3300.868 (7.2)
White	.006332 (.03)	.02783 (0.15)	3.100776 (1.89)	3.892862 (2.52)
Year	-.3357548 (-11.42)	-.323933 (-11.02)	-2.053159 (-8.35)	-1.685472 (-7.24)
Rookie	.1634711 (0.67)	.1265779 (0.52)	5.668123 (2.69)	4.587806 (2.3)
PAB (Percent at Bat)	-.0001763 (-0.37)	-.0002705 (-0.54)	-0.0100946 (-2.46)	-.0098707 (-2.44)
LSLG (Lifetime Slugging)	-6.635793 (-3.21)	-5.348239 (-2.58)	-5.861526 (-.33)	26.36419 (1.56)
LHR (Lifetime Home Runs)	.0072739 (6.81)	.004041 (3.18)	.1384474 (15.11)	.0519885 (5.04)
AgeRes+	-.0144593 (-0.34)	-.0245166 (-0.58)	.9552596 (2.62)	.5973602 (1.73)
LSLGRes+	.0034914 (0.74)	.0015115 (0.32)	.1571634 (3.87)	.0385124 (2.80)
AS (All Star)		.4480302 (1.57)		5.32833 (2.32)
HF (Hall of Fame)		1.703607 (4.03)		48.65659 (14.29)
MVP (Most Valuable Player)		.5481909 (0.55)		39.42838 (4.85)

Table F: Regression Results: All 1960's Cards, Year Dummy, Comparison between Price2008 and Price 1981, Left-Censored Tobit, (t-stats in parentheses)				
Dependent Variable:	Y=Price 1981		Y=Price 2008	
	Without Fame	With Fame	Without Fame	With Fame
WS (World Series)		.1072362 (0.37)		15.06421 (6.5)
n	2770	2770	2770	2770
Log Likelihood	-7123.9425	-7112.8374	-13264.299	-13113.444
Pseudo R^2	.0139	.0155	.0261	.0372
Number of Left Censored Observations	335 ($0.13)	335 ($0.13)	137 ($1.5)	137 ($1.5)
+ See text for an explanation of these variables.				

Table G: Regression Results: All 1960's Cards, Year Dummy, Comparison between Price2008 and Price 1981, Left-Censored Tobit, (t-stats in parentheses)				
Dependent Variable:	Y=Price 1981		Y=Price 2008	
	Without Fame	With Fame	Without Fame	With Fame
Constant	914.3291 (8.67)	893.0172 (8.49)	4378.578 (4.98)	3865.153 (4.65)
White	-357.8312 (-2.88)	-360.8399 (-2.91)	-488.6701 (-.47)	-796.7635 (-.81)
Year	-.4642689 (-8.66)	-.45635795 (-8.48)	-2.22955 (-4.98)	-1.972732 (-4.66)
Year*White	.1821478 (2.88)	.183691 (2.91)	.2503036 (.47)	.4075244 (.81)
Rookie	.1381393 (.56)	.1004959 (.41)	5.63265 (2.67)	4.528558 (2.27)
PAB (Percent at Bat)	-.000216 (-.45)	-.0002955 (-.60)	-.0101534 (-2.48)	-.0099313 (-2.46)
LSLG (Lifetime Slugging)	-6.400789 (-3.10)	-5.1505478 (-2.46)	-5.535842 (-.31)	26.89933 (1.59)
LHR (Lifetime Home Runs)	.0072055 (6.75)	.003963 (3.12)	.1383645 (15.10)	.0518484 (5.03)
AgeRes+	-.018602 (-.44)	-.0289855 (-.68)	.949195 (2.60)	.5868376 (1.70)
LSLGRes+	.0041692 (.88)	.0022254 (.47)	.1581578 (3.89)	.1093939 (2.84)
AS (All Star)		.4181267 (1.47)		5.2555 (2.28)
HF (Hall of Fame)		1.724339 (4.09)		48.6999 (14.31)
MVP (Most Valuable Player)		.6256705 (.63)		39.59401 (4.87)

Table G: Regression Results: All 1960's Cards, Year Dummy, Comparison between Price2008 and Price 1981, Left-Censored Tobit, (t-stats in parentheses)				
Dependent Variable:	Y=Price 1981		Y=Price 2008	
	Without Fame	With Fame	Without Fame	With Fame
WS (World Series)		.1179788 (.41)		15.08716 (6.51)
n	2770	2770	2770	2770
Log Likelihood	-7119.8	-7108.5928	-13264.188	-13113.113
Pseudo R^2	.0145	.0160	.0261	.0372
Number of Left Censored Observations	335 ($0.13)	335 ($0.13)	137 ($1.5)	137 ($1.5)
+ See text for an explanation of these variables.				

In order to see the true impact of race on card price, we need to find the full coefficient on *white*, which can be done by combining the direct coefficient with the interactive effect as follows:

$$\propto white + \beta white * year = [\alpha + \beta year] white \qquad (4)$$

where α, β are the coefficients on the two variables.

From Table G, using the Price81 regression we find a combined coefficient on *white* of [-357.8312+.1821478 year], which would suggest that partway through 1964 the break-even point would be reached.

$$\frac{-\alpha}{\beta} = year = \frac{357.8312}{.1821478} = 1964.51 \qquad (5)$$

We would expect to see then, that the coefficient on *white* would be negative before 1964 and then positive afterward, *a la* Figure 3. Given that this period was early in the racial integration of baseball, there well may be a 'novelty effect' on card collectors regarding these early players. So, it would not be unlikely that we would see collectors placing a premium on those early non-white player cards as they represented the racial pioneers in the game.

More evidence may be gleaned by exploring data taken from a more recent period, a period after the 'novelty effect' has worn off. Toward that end, Tables H and I show the summary statistics for single player, non-pitcher cards from players who played during 1986. That year was chosen to allow for the full impact of fame measurements, allowing enough time for inductions into the Hall of Fame to take place. Table I shows that white player cards garner higher prices, though a more thorough investigation is in order.

Figure 3

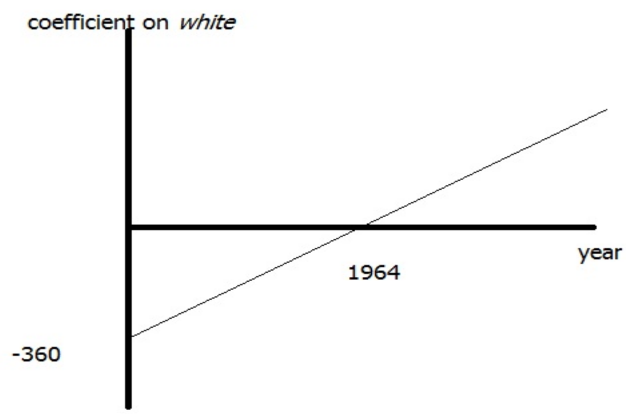


Table H: 1986 Card Data, Summary Stats (374 Distinct Cards, Hitters Only)				
Variable	Mean	Std. Dev.	Min.	Max
Price	.1600536	.1977005	.1	2
White	.6149733	.4872535	0	1
Exp (Experience)	5.818182	4.731288	0	22
Age	30.42513	4.505404	21	45
Rookie	.0882353	.2840167	0	1
PAB (Percentage at Bat)	334.7914	189.3278	2	687
LHR (Lifetime Home Run)	118.9439	115.2121	0	563
LAVE (Lifetime Average)	.2602701	.0236298	.132	.338
LSLG (Lifetime Slugging)	.3901711	.0547719	.171	.527
AS (All Star)	.1336898	.3407747	0	1
HF (Hall of Fame)	.0614973	.2405621	0	1
MVP (Most Valuable Player)	.0026738	.0517088	0	1
WS (World Series)	.0802139	.2719879	0	1

Table I: 1986 Card Data, Summary Stats By Race (374 Distinct Cards, Hitters Only)		
	Non-White	White
Price 2000	.1548611	.1633188
Exp	5.902778	5.765217
Age	30.22917	30.54783
Rookie	.083333	.0913043
PaB	369.3819	313.1348
LHR	133.6597	109.7304
LAVE	.2671319	.2559739
LSLG	.4016181	.3830043
AS	.1805556	.1043478
HF	.069444	.0565217
MVP	0	.0043478
WS	.0555555	.0956522
AGERES	.2711289	-.1697503
LSLGRES	.003839	-.0024035
Count	144	230

Table J shows the left-censored Tobit results for this data. One striking result is that the pseudo R^2 has increased substantially. It may be the case that collectors are basing purchasing decisions more on the player stats than on 'personality' or 'legend' status as compared to players from the 1960's, as those cards from the 1960's represent a much larger financial investment per card than do those cards in this more recent period. When it comes to race, the *white* variable is no quite longer significant at 20% significance, though it is positive as our earlier analysis would suggest it to be.

Table J: Regression Results: 1986 Comparison, Price = y, Left-Censored Tobit, (t-stats in parentheses)		
Price2000=y	1986 Cards	
	Without Fame	With Fame
Constant	-.61960692 (-1.9)	-.6598067 (-2.05)
White	.0591837 (1.17)	.0470278 (.95)
Rookie	.4290674 (4.54)	.4198453 (4.55)

Table J: Regression Results: 1986 Comparison, Price = y, Left-Censored Tobit, (t-stats in parentheses)		
Price2000=y	1986 Cards	
	Without Fame	With Fame
PAB (Percent at Bat)	.0001996 (1.28)	.0002515 (1.55)
LSLG (Lifetime Slugging)	.0375556 (.04)	.247862 (0.28)
LHR (Lifetime Home Runs)	.0020808 (5.15)	.0017481 (4.00)
AgeRes+	.044645 (2.84)	.0492516 (3.17)
LSLGRes+	10.26619 (6.01)	9.510943 (5.38)
AS (All Star)		-.0633627 (-.86)
HF (Hall of Fame)		.129962 (1.42)
MVP (Most Valuable Player)		.6021692 (1.76)
WS (World Series)		-.0027108 (-.03)
n	373	373
Log Likelihood	-101.62993	-98.758916
Pseudo R^2	.4542	.4697
Number of Left Censored Observations	258 ($0.1)	258 ($0.1)
+ See text for an explanation of these variables.		

BRIEF CONCLUSIONS

Our extensive analysis of discrimination on the part of baseball memorabilia collectors, via observation of baseball card pricing structure shifts across time, shows a shift in the premiums afforded to race. Looking at the data from the cards from the decade of the 1960's, a period very early in the integration of baseball, shows that initially there was a premium paid to non-white player cards due to what we refer to as the 'novelty effect'- though this effect wears off over the decade. A smaller data set, drawn from a single year (1986) shows another aspect of how race influences card price. In this second card set, chosen from a period of full racial integration in the sport but long enough ago for the players' stats to be complete (Hall of Fame entrance etc.), we see that race has ceased to become a significant factor regardless of any mitigating factor such as measures of fame. It appears that racism on the part of sports memorabilia collectors may have run its course.

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CUSTOMER INSIGHTS FOR COMMUNITY-ECONOMIC-DEVELOPMENT AGENCIES (EDAS): THE TIME SERIES BEHAVIOR OF PROGRAMS

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ABSTRACT

EDAs produce a variety of products and not all products need to generate profits; some of them may be produced for the good of society at large. However, in many cases EDAs do seek return on their investments. The market-selection method presented in this paper should be considered an investment in future profitability.

Keywords: Business Planning, Community Economic Development, Marketing, Market Selection, Sine Function.

INTRODUCTION

This paper is built on the premise that government units should adopt marketing approaches to meet mandates and satisfy client needs in the present day, diminishing-resources environment. In line with (Varadarajan, 2009), we define marketing approaches as customer-satisfaction focused behavior of firms. Examples of market-focused behavior include target market choices, creating product(s) which offer value to customers in exchanges, etc. Note that the marketing approach aims to achieve optimum relationships between the organization and its environment (Litten, 1980; White & Hammermesh, 1981).

Critiques of the marketing approach tend to argue that it is inappropriate to run government like business (Litten, 1980). We believe that this competes with the view that government needs to be more responsive to the needs of the public and that marketing may help governments accomplish this goal (Wilkie & Moore, 2007). Indeed, Osborne and Gaebler (1993) observe that

> Democratic governments exist to serve their citizens. Businesses exist to make profits. And yet it is business that searches obsessively for new ways to please the people. Most governments are customer-blind, while McDonald's and Frito-Lay are customer-driven. This may be the ultimate indictment of bureaucratic government.

And for the argument that governments should not be in competition with the private sector (Copulos, 1977), it is essential to note that government is definitely not a business, but is an institution charged primarily with serving the public interest and that, in many cases, it can do this more effectively by employing a marketing approach (Kotler & Drucker, 1993),

To demonstrate the usefulness of marketing approaches to community development organizations, this paper utilizes a case study approach. Specifically, it highlights how a government-funded EDA, which is the outgrowth of a need for an agency to monitor conditions in rural Illinois, can benefit from analyzing its past behavior to gain insights into target-market selection.

LITERATURE REVIEW

Many EDAs offer products that can be directed at different end-use markets. For example, the EDA at the University of Illinois, University of Illinois Extension, offers educational services to small businesses, local governments, and residents (health education, for example). Since opportunities differ in different markets and the future of the EDA is tied to its markets, market selection is a crucial consideration in business planning (Rossiter & Percy, 1996).

In marketing, market selection is often based on classifying purchasers as heavy and light users. Since heavy users generate the most revenue for the business, marketing efforts such as advertising are focused on heavy users, the primary target audience (East, Malcolm & Vanhuele, 2008).

Statistical approaches that are employed to categorize users and profile them include group comparison procedures, and cluster analysis (Lilien & Rangaswamy, 2004). The group comparison procedure utilizes median split of product-usage statistics to gain insights into the attitudinal / psychographic differences between heavy and light users (see for example, Lantz, 1995). For cluster analysis, the focus is on exploration. Specifically, respondents' scores on a number of profile variables such as personality measures are subjected to (dis)similarity analysis and the resulting pattern examined to understand differences between heavy and light users (Dillon & Goldstein, 1984). Note the *a priori* assumption in cluster analysis that heavy and light users would differ on profile variables; a questionable assumption given conflicting findings in the extant literature (Hackleman & Duker, 1980; Morgan, 1979).

To understand the methods of market selection used in EDAs, a search for relevant academic and practitioners' publications was conducted. As shown in Table 1, of the 120 hits in the *Community Development Journal*, only six articles contained "marketing" related discussions (Abucar, 1995; Cearbhaill & Cinnèide, 1986; Cossio & Winder, 1985; Hafner, 1995, Hodge, 1996; and Jones, 1967). However, none of these articles / reviews pertains to target-market selection. For example, Abucar (1995) highlights community development efforts in a Canadian region heavily dependent on producing and marketing natural resources. Similarly, Jones (1967) discusses marketing within the context of changing needs for agricultural products. As regards practitioner publications, a Google search for "regional economic consulting" produced 22, 400 results. The results page had one ad for the firm Quant Economics, Inc. (www.quanteconomics.com). Based on the belief that the advertising firm should have expertise in helping EDAs choose target markets, we explored their website for copies of white papers on the topic. While no publication could be found, the firm does claim expertise in market analytics such as pricing, and demographic analysis. Finally, a random pick of an economic-development consulting firm from the Google-search results lead us to ICF International's web page (www.icfi.com). Again, no publication on market selection was found (Table 1).

In summary, little or no publication on market selection strategies for EDAs could be found. However, as mentioned earlier, for survival in the marketplace, it is essential that EDAs optimize their programming. This paper utilizes empirical models to derive norms for programming decision making.

Table 1: Results of Literature Search

Source	Keywords	Search Period / date	# of Hits	Comments
Community Development Journal, Oxford University Press	Market selection (searched in text / abstract/ title)	Jan. 1996 – Jan 2011	120	The search resulted in articles that had little or no relevance for target market selection. http://cdj.oxfordjournals.org/
Community Development: Journal of the Community Development Society, Routledge	Market selection ("all words", and "all fields" search)	Issue 1, 1978 to Issue 1, 2011	0	The search was initiated through "informaworld" (http://www.informaworld.com)
Economic Development Quarterly, Sage Publications	Market selection ("all words", and "all fields" search)	Feb. 1987 to Feb. 2011	98	The search resulted in articles that had little or no relevance for target market selection. http://edq.sagepub.com/
Google.com	"regional economic consulting"	February 16, 2011	22, 400	When the search was restricted to the US, 17, 000 hits were obtained. The advertising on the results page was explored for market selection related publications (see text above).
ICF International (www.icfi.com)	Market selection	February 16, 2011	1	Claims to have expertise in researching markets for energy-efficient products; no publications on market selection was found.

THE SETTING

In 1986, a Task Force on the Future of Rural Illinois conducted a set of 25 public hearings and one of the outcomes was a need for a permanent agency to study rural issues and to identify potential remedies. In 1989, the focal EDA was created as a companion agency to the Governors Rural Affairs Council. Since then, the agency has obtained and utilized \$41.8MIL to improve the quality of life for rural residents.

Table 2 highlights some of the activity and capacity measures of the agency for the 2009 time period. It also shows the annual compound growth rate of the metrics during the past three years starting 2007. As shown in the table, the agency's financial capacity (budget) has declined during the 2007-2009 time period. The same is true for the institute's community-development activities. However, not all capacity measures pose a declining trend. The agency's human resources (number of full-time employees) registered a positive growth rate during the three-year time period.

Table 2: Capacity and Activity Metrics – Focal EDA, 2009

Category	Performance Metric	Value	Annual Compound Growth Rate (2007-2009)
Capacity Measures: Indicates the institute's ability to get things done	No. of full-time faculty & staff Budget	37 \$3.57 MIL	0.03 -0.07
Activity Measures: Measures progress toward the goals that drive the institute's behavior	Community-development programs Training programs	24 90	-0.28 -0.12

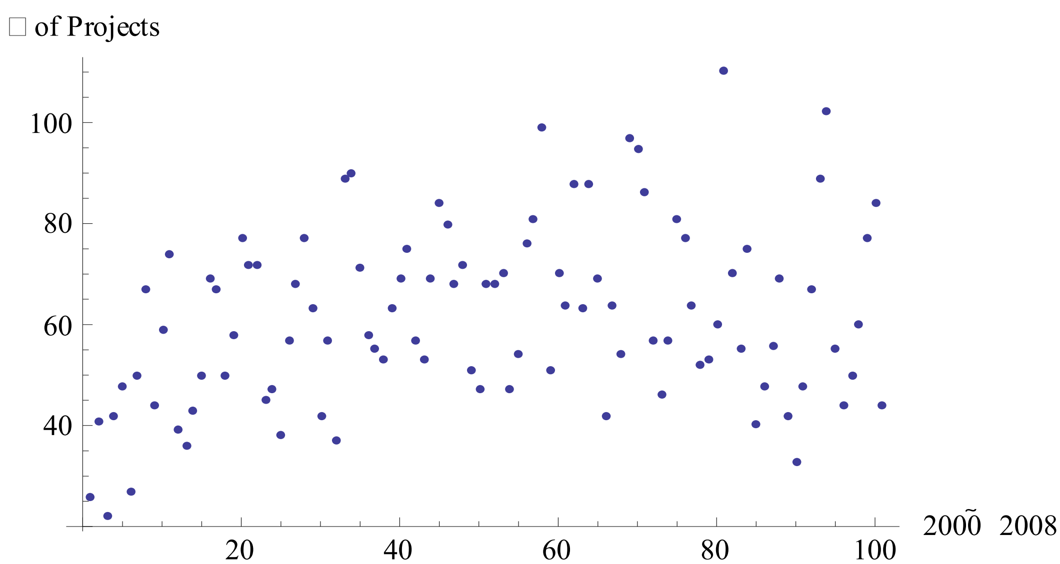
It is easy to dismiss the decline in financial capacity and programming activities as signs of uncertain economic times; and hope that marketplace would drive reversion to mean performance in the coming years. However, this "just play along" strategy can erode the agency's positional advantage; the incumbent advantage in the community-economic-development marketplace in Illinois.

The need to be robust and responsive to changes in the marketplace raises the question of where to compete. In fact, extant research suggests that 80% of (revenue) growth is explained by choices about where to compete, leaving only 20% explained by choices about how to compete (see for example, Bahadir, Bharadwaj & Parzen, 2005).

In the following pages, we address the "where to compete" question using a data driven approach. Because the evolution of markets is path dependent (Cohendet and Steinmueller, 2000) – that is, the current state in any one time is the sum product of all previous events, including random ones, we model the time series behavior of the focal EDA's programs to predict places (counties) to compete in the coming years.

Consider Figure 1. It is a list plot of the agency's programs implemented during the 2000-2008 time period. To better understand this wave-like pattern of demand for the programs, we utilize the sine function (Gartner & Halbherr, 2004).

Figure 1: Scatter Plot of the EDA's Programs: Monthly Data for 2000-2008



THE MODEL

As mentioned earlier, we hypothesize that the time pattern of EDA programming to be:

$$PD_t = f(\sin(t)) \tag{1}$$

where, PD_t = Demand for EDA programs during month *t*.

We operationalize equation 1 using the following formulation:

$$PD_t = a_1 + a_2 t + a_3 \sin\left[\frac{a_4 + t}{a_5}\right] + \epsilon_t \tag{2}$$

The parameters in equation 2 have the following interpretation:

a_1 = Constant term;
a_2 = Secular trend;

a_3 = Amplitude of the sine wave;
a_4 = Displacement of the sine curve relative to the time origin; $\sin(-a_4) = 0$.

The parameter a_4 is unique up to an additive factor of n. π. a_5. If *n* is odd, then a_3 changes signs.

a_5 = Period of the wave; a complete cycle of the sine wave requires $2.\pi.a_5$ years.

Note that statistically significant parameters a3 to a5 would enable us to not only assess the fit of the prediction equation 2 with observed data, but also predict the timing of the peaks and troughs in programming. The latter would help the EDA target its marketing efforts during peaks to outgrow competitors.

Data for model calibration were obtained from the agency's management information system. In all 6720 observations, pertaining to program implementations for the years 2000-2008, were assembled. The reduced data matrix had 9 (years) x 12 (monthly) data points.

MODEL CALIBRATION

The model (equation 2) was calibrated using nonlinear least squares. The presence of serially correlated errors, necessitated that ϵ_t be specified as follows:

$$\rho\epsilon_{t-1} + u_t$$

where, u_t are independent and identically distributed with $E(u_t) - 0, and\ V(u_{t)} - \sigma_u^2$ and

$$\beta = \frac{\sum_{t=z\,to\,n} e_t e_{t-1}}{\sum_{t=z\,to\,n} e_{t-1}^2}$$

The adjustment of equation 2 for correlated errors results in:

$$PD_t - \rho PD_{t-1} = a_1 + a_2 t + a_3 \sin\left[\frac{a_4 + t}{a_5}\right] + \epsilon_t - \beta\left[a_1 + a_2(t-1) + a_3 \sin\left[\frac{a_4 + (t-1)}{a_5}\right] + \epsilon_{t-1}\right]$$

This revised equation was calibrated using the 9x12 data matrix shown in Table 3, where rows = years and columns = months.

Table 3: Data Matrix

?	?	?	?	?	?	26	41	22	42	48	27
50	67	44	59	74	39	36	43	50	69	67	50
58	77	72	72	45	47	38	57	68	77	63	42
57	37	89	90	71	58	55	53	63	69	75	57
53	69	84	80	68	72	51	47	68	68	70	47
54	76	81	99	51	70	64	88	63	88	69	42
64	54	97	95	86	57	46	57	81	77	64	52
53	60	110	70	55	75	40	48	56	69	42	33
48	67	89	102	55	44	50	60	77	84	44	?

Note: "?" denotes unreliable data; we attribute these measurement errors to omissions by the agency's personnel in reporting or recording activities in the management information system.

RESULTS

During 2000-2008, the focal EDA implemented an average of 58 programs per month. Peaks were reached in March 2007 (110 programs) and April 2008 (102). A trough occurred in September 2000 (22 programs). How well does our model predict these peaks and troughs?

Table 4 shows the results of model calibration. The amplitude of the sine wave, parameter a_3, is statistically significant at the conventional $p \leq 0.05$ level. This supports our contention that the agency's program implementations follow a wave-like pattern. In addition, while coefficient a_5 implies a cycle length of about approximately 5 months, coefficient a_4 suggests that the start of the sine wave [sin(t) = 0] to be June 2000 (see Appendix 1 for more on the sine function).

Table 4: Model Parameters

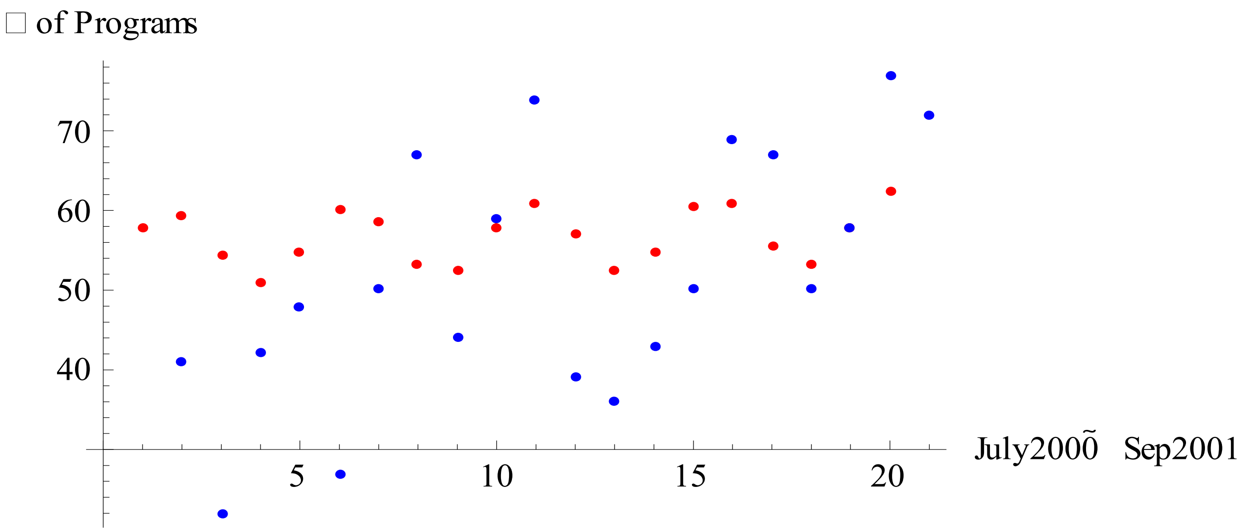
Parameter	Estimate	SE	t	p	Adj. R^2
a_1	55.0712	4.87394	11.2991	2.866×10^{-19}	0.88
a_2	0.136225	0.819583	1.66213	0.0997837	
a_3	-4.50814	2.27982	-1.97741	0.049893	
a_4	-12.0511	0.6274	-19.208	1.7587×10^{-34}	
a_5	0.732978	0.00943293	77.7042	8.76746×10^{-88}	

Figure 2 shows that the fitted model does a reasonable job of explaining the time varying pattern of demand for the programs (adjusted R^2 = 0.88); for simplicity, only the first 20 data points are used to demonstrate model fit. Appendix 2 provides additional information about model predictions.

Figure 2

Model Fit: Actual versus Prediction –July 2000-Sep. 2001

Model = $55.0712 + 0.136225 * x[[t]] - 4.50814 * \mathrm{Sin}\left[\frac{-12.0811 + x[[t]]}{[illegible]}\right] + 0.327167 * e[[t]]$



DISCUSSION

The data-driven approach to marketing decision making suggests that the focal EDA should target the high potential customers shown in Table 5 to increase and/or defend market share; these are the counties that value the agency's programs more than other competitive alternatives. A longitudinal study of business performance reveals that firms find it difficult to maintain higher performance levels than their competitors for more than five years at a time (Kauffman, 1995). Long term competitive advantage is often obtained by adapting new sources of temporary advantage. We believe that such an advantage can be gained by gathering and utilizing proprietary insights about the markets given in Table 5 and Appendix 3. For instance, the economic-development aspirations of these customers – county-level decision making units, can be gathered and disseminated to program managers. This would enable program managers to sell "solutions", that is, product bundles, to customers. For example, it could be beneficial to bundle community planning with other technical assistance such as economic-impact analysis and educational services. Note that most of the customers do not have the expertise in these areas and look elsewhere in the value chain for missing expertise.

Table 5: High Potential Customers (2008)		
Peak of the Sine Wave (Time)	Top 3 Customers (Counties)	# of Programs
January 2008	McDonough, Sangamon, and Shelby	21
June 2008	Champaign, McLean, and Sangamon	18
November 2008	Peoria, Schuyler, and Stark	17
Note: A list of high potential customers for each of the years (2000-2008) is given in Appendix 3.		

Within a broader context, the drivers of community-economic development are changing. For example, government funding for community spending in Illinois is expected to fall from $80 Mil in 2004 to $70 Mil in 2014 (http://www.illinoispolicy.org/news/article.asp?ArticleSource=2834). The consequence of reduced funding would be enhanced competition among EDAs for provision of business services such as site-selection assistance, professional development (for example, seminars and management training), and business "greening" consulting (Currid-Halkett & Stolarick, 2011).

EDAs produce a variety of products and not all products need to generate profits; some of them may be produced for the good of society at large. However, in many cases EDAs do seek return on their investments. The market-selection method presented in this paper is an investment in future profitability.

SUMMARY AND CONCLUSION

One of the essentials for competitive advantage is the ability to convert mere data into competitively useful insights about the marketplace. This paper spans counties, and EDA functions (for example, programs that help communities craft strategic plans), to translate programming data into marketing-planning insights.

Briefly, we suggest that the focal EDA's programs target the Illinois counties listed below: Adams, McDonough, McLean, Peoria, Sangamon, and Warren. The targeting should be based on proprietary market research about customer's incentive to implement the agency's programs. For example, do these counties value the technical, or the complementary services of the agency?

In conclusion, in these turbulent times, slow and steady doesn't win. Through analysis like this, EDAs can acquire market-insights to survive in this complex, post-financial-crisis world.

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APPENDIX 1
THE HARMONIC OSCILLATIONS: COMPUTING THE WAVE LENGTH

Express the sine component of equation 2 in the form:

$$a_3 Sin\left[\frac{a_4+t}{a5}\right] = -a_3 \cos\left[\frac{t}{a5}+\frac{a4}{a5}-\frac{\pi}{2}\right] \quad \text{(A1)}$$

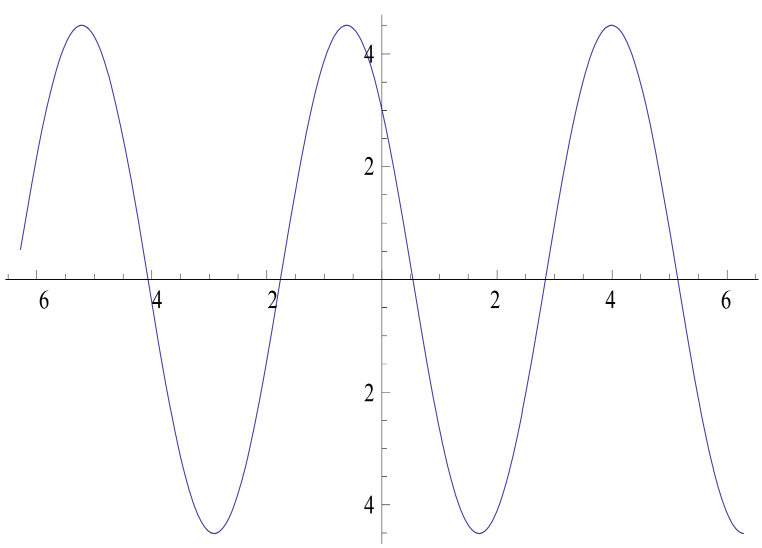
$$= a_3 \cos\left[\frac{t}{a5}+\frac{a4}{a5}-\frac{\pi}{2}+6\pi\right]$$

Simplifying using relevant parameters results in:

$$a_3 Sin\left[\frac{a4+t}{a5}\right] = 4.508 \cos\left[\frac{t}{.73298}+.8372\right] \quad \text{(A2)}$$

Now consider figure AF1. It is a plot of the function $4.508 \cos\left[\frac{t}{.73298}+.8372\right]$ where, *t* ranges from -2π to 2π.

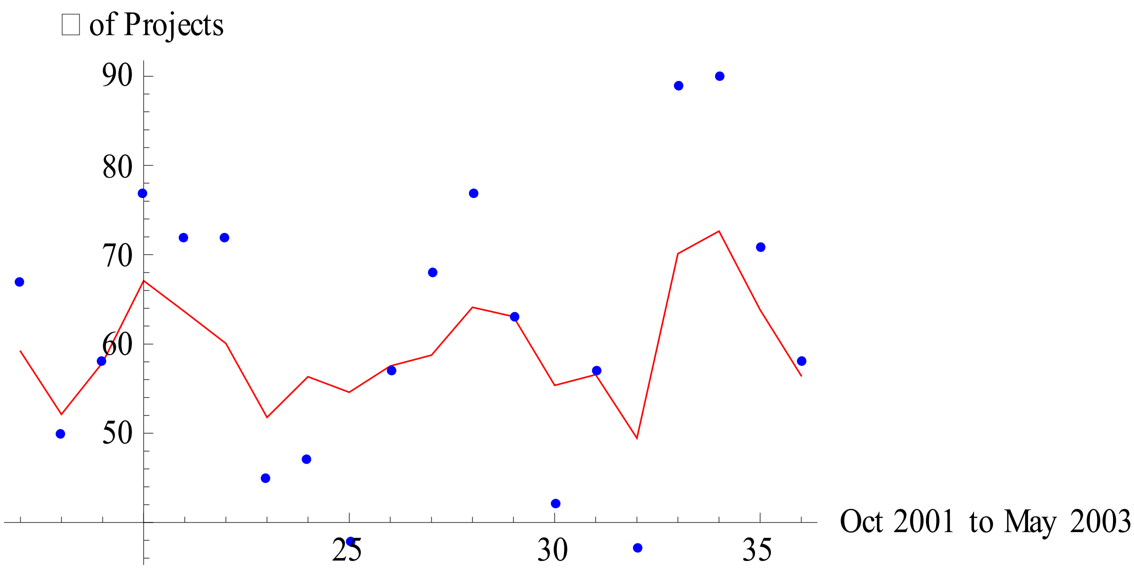
Figure AF1
Plot of the Function
$4.508 \cos\left[\frac{t}{.73298}+.8372\right]$



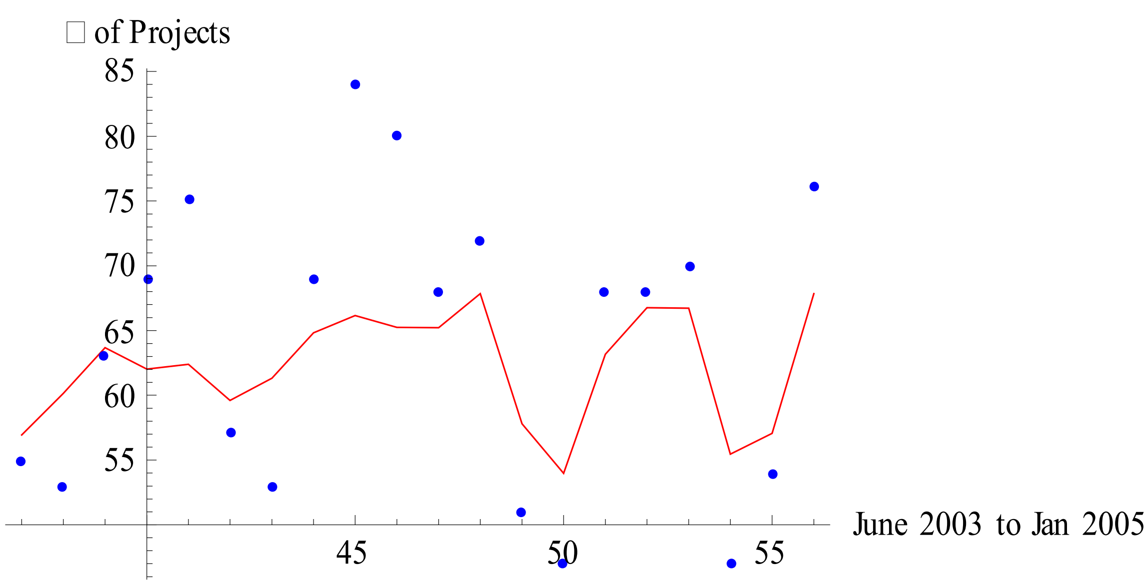
Note the wave length in Figure 1, around 5 *t* units. This suggests that the agency's programming peaks once in five months beginning June 2000.

APPENDIX 2
MODEL FIT

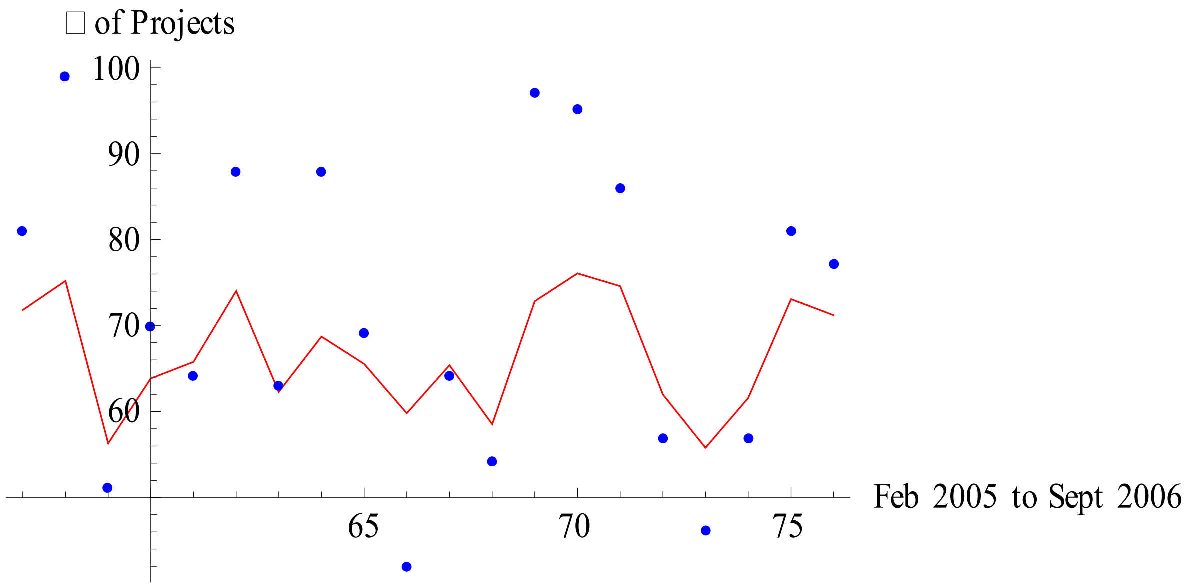
Data points: October 2001 – May 2003



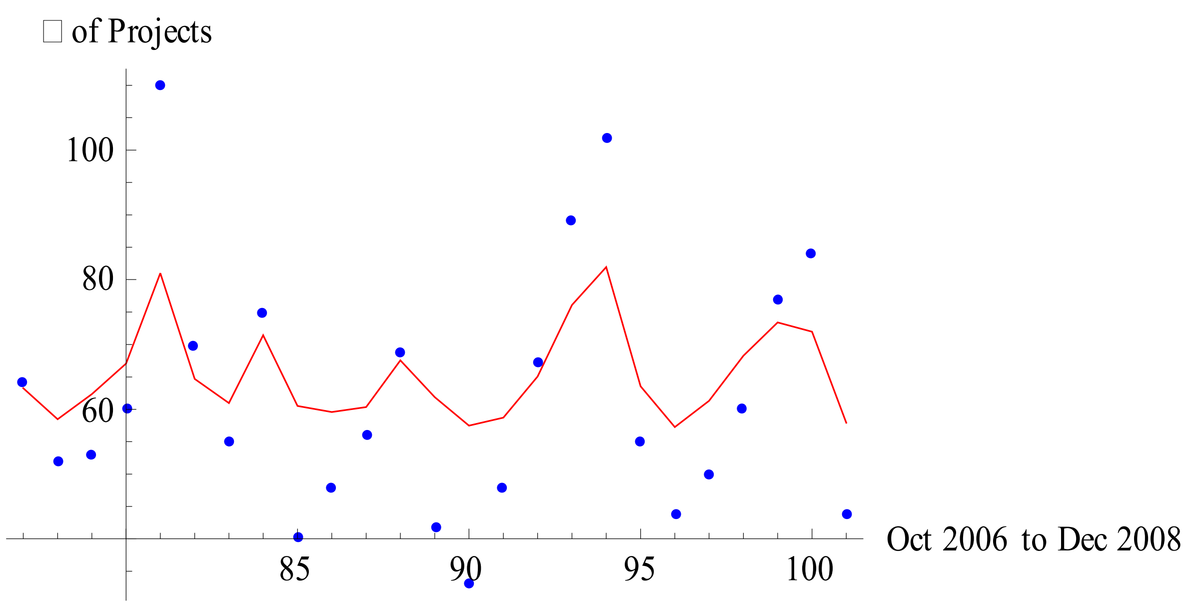
Data points: June 2003 – January 2005



Data points: February 2005 – September 2006



Data points: October 2006 – December 2008



APPENDIX 3
ATTRACTIVE COUNTIES FOR THE FOCAL EDA

We posit that a community-economic-development market offering has two orthogonal characteristics: value of the offering, and the cost of the program for the customer (price). The term orthogonal implies that changes in price do not affect the value of the offering. Rather, it changes the customer's incentive or intention to purchase the market offering (incentive to purchase = value – price). Customers at the peak of the sine curve believe that:

$$[\text{Value}_{\text{EDA PROGRAM}} - \text{Price}_{\text{EDA PROGRAM}}] > [\text{Value}_{\text{COMPETITOR'S}} - \text{Price}_{\text{COMPETITOR'S}}]$$

Simply put, customers at the peak of the sine curve possess a greater incentive to purchase the agency's products.

Table A3.1: Large Customers: IL Counties

Year	Counties
2008	McDonough, McLean, and Sangamon
2007	McDonough, McLean, Peoria, and Sangamon
2006	Fulton, McDonough, McLean, Peoria, and Sangamon
2005	Adams, McDonough, Sangamon, and Warren
2004	Adams, McDonough, and Sangamon
2003	Adams, Knox, Sangamon, and Warren
2002	Adams, LaSalle, McDonough, Sangamon, St. Clair, and Washington
2001	Adams, Hancock, Knox, McDonough, Rock Island, and Sangamon
2000	Fulton, McDonough, and Sangamon

MACROECONOMIC AND FINANCIAL EFFECTS OF HIGH AND VOLATILE OIL PRICES

Luis San Vicente Portes, Montclair State University

ABSTRACT

This study assesses the effect of higher and more volatile oil prices on the Central American and Caribbean economies. The focus of the study is on the macroeconomic implications of higher oil prices on economic performance (output and investment growth, inflation, balance of payments), policy instruments and response (interest rates, public debt, subsidies, government expenditure), and effect on financial markets (debt maturity, composition and payments arrears). Once such effects are established, the study provides country-specific policy prescriptions based on the countries' international energy balance, and composition of their power generation structure.

INTRODUCTION

At the heart of every form of economic activity lies the use of energy. While the form and intensity may vary, fluctuations in energy prices build up from the firm- and household-level decisions to the aggregate economy. From transportation, to industrial production, to small firms and self-employed entrepreneurs, high and volatile energy prices have a direct effect on the supply of goods and services in the economy. Moreover, such effects can have an immediate or inter-temporal impact on the government's budget as well as on the country's balance of payments.

As higher energy costs are passed on to consumers, inflation expectations may rise plausibly requiring unnecessary monetary tightening; or in the presence of energy subsidies, higher prices would deteriorate fiscal balance. Either way, the cost of borrowing may rise as a further burden on both the private and public sector, thus reducing the potential for future growth. Moreover, firms can delay investment decisions, thus reducing capital formation and long term growth.

While a country's energy trade balance would determine whether higher energy prices represent a positive or negative terms of trade shock, the inflationary concern remains. For energy rich countries, the fiscal effect becomes uncertain as higher royalty revenues could offset larger subsidy outlays. This way, the bleaker scenario would be for countries that are net importers of energy, thus facing inflationary, fiscal, and balance of payments risk.

A further aspect concerning fluctuations in energy prices is the magnitude of the changes: an economy may find it easier to adapt to a steady increase in fuel prices than to sharp swings. Thus, energy price volatility is likely to lead to less stable economic activity, which in turn can reduce investment and increase the perceived country risk in international capital markets because of a less certain fiscal outlook and exchange rate risk.

The connection between the micro- and macro-economics of higher and more volatile energy prices is to a large extent through the power sector, not withstanding the transportation industry. While electricity generation can be a diversified activity in terms of nature and sources of fuel, from renewable resources to exhaustible fossil fuels, the degree of dependence on hydrocarbon generation provides a direct mechanism to propagate oil price shocks to the rest of the economy through the channels outlined above. Hence, a thorough assessment of the macroeconomic effects of higher and more volatile oil prices on the real economy depends to a large extent on the power sector.

The purpose of this work is to assess the macroeconomic effects of higher and volatile oil prices for Central American and Caribbean countries, which most of them are characterized by a high energy dependence on foreign sources. The contribution of this study is to provide a broad view of all the macroeconomic, international, fiscal, and financing effects of such shocks in Central America and the Caribbean. Furthermore, the study identifies and ranks the countries in these regions according to different dimensions of vulnerability. The study takes as given the underlying trends in energy markets, as these countries' size is unlikely to make their purchases a determinant of international oil prices.

The World Bank (2006) provides an extensive overview of the recent developments in oil and commodity markets, and their effect in the Latin American and Caribbean economies. The primary difference between this study and the aforementioned is: 1) the range of variables analyzed in this study is larger, 2) this study assesses the effect of oil price volatility –beyond higher prices, and 3) this study also provides a preliminary vulnerability ranking for Central America and Caribbean countries in the event of continued rising and volatile oil prices. On the other hand this study is narrower as it only covers oil prices and Central America and the Caribbean economies; and also it does not provide output growth forecasts based on future oil price scenarios as the World Bank (2006) does.

The structure of the paper is as follows. Section II documents the trends in the oil market over the last 25 years; Section III explores the links between higher oil prices and macroeconomic, fiscal, and financial performance (such as growth, inflation, government budget balance, borrowing, and balance of payments) on the selected group of countries; Section IV studies the effect of the volatility in energy on the same dimensions; Section V focuses specifically on the countries' vulnerability to higher oil prices and impact on the power sector; and Section VI concludes and provides policy recommendations.

OIL PRICE TRENDS

The primary component of the study is an overview of oil prices over the last two and a half decades. While fluctuations in oil prices can be measured at very high (e.g. by the hour) or low frequencies (e.g. decades), the stance that the analysis takes is at annual frequency. That is, the focus is on annual changes in oil prices on government finances and on the economy as a whole.

Figure 1 presents the annual average daily price of a barrel of West Texas Intermediate (WTI) barrel of oil (FOB) between 1986 and 2009. While the highest average price in the chart is 99.67 USD in 2008, the highest daily price was 145.31 USD in July 3rd of the same year. As for the lows, the lowest average was 14.42 USD in 1998, while the lowest daily price was 10.25 in March 31st 1986.

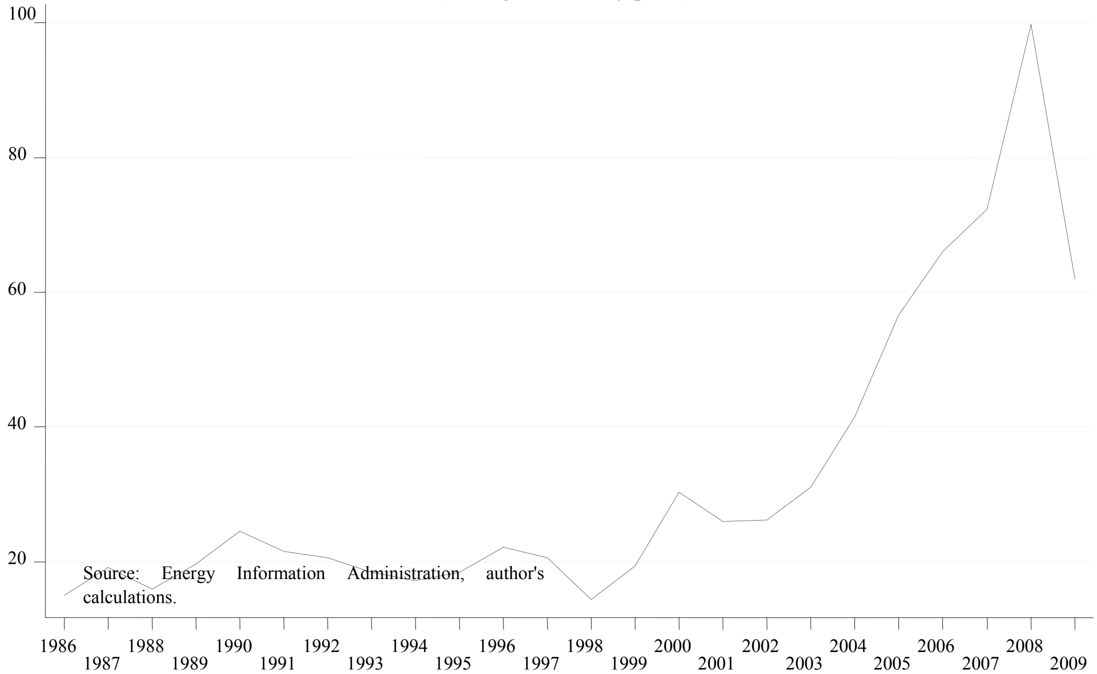
The range of oil prices during these years underscores the volatile nature of oil prices. From geo-political instability, to weather shocks, to global growth, oil markets are affected due to the tradeable and fungible nature of the commodity. Hence, not only higher oil prices, but also the associated volatility can have adverse effects on economic performance, as uncertainty may delay investment projects, as well as increase the risk profile of a country and its government's finances.

To measure the impact of oil price fluctuations over time, the study uses the annual standard deviation of daily oil prices within a year. (While a smoother measure of volatility, such as a one-year rolling-window could be calculated, the study uses within-year variation in order to facilitate the interpretation and matching to individual country annual time series.) Figure 2, presents the annual standard deviation of daily oil prices for the period 1986-2009. These numbers reflect daily deviations from the (annual) mean reported in Figure 1.

The highest annual variation occurred in 2008, in contrast, 1995 exhibited the lowest standard deviation. However, since average prices changed over the sample period, these indicators have to interpreted relative to the annual average price. That is, the highest variation occurred relative to a 99.67 USD average price, compared to the average price of 18.43 USD in 1995. In the subsequent analysis we the measure of volatility becomes the coefficient of variation, defined as the standard deviation divided by the average price. This way, the yearly volatility is normalized by the average price, which accounts for the fact that the higher the price of oil, the higher the dollar variation.

Figure 1. Oil Prices

(Average WTI daily price)



Based on the observations above, next, we turn to analyze the effect of these trends on key macroeconomic, public, and financial variables.

OIL PRICES AND THE ECONOMY

The goal of this section is to present the effect of higher energy prices on a set of key economic variables: output and investment growth, inflation, real interest rate, real exchange rate, current account, fuel imports, international reserves, debt, government balance, public debt, maturity of new debt issuance, and both interest and principal arrears.

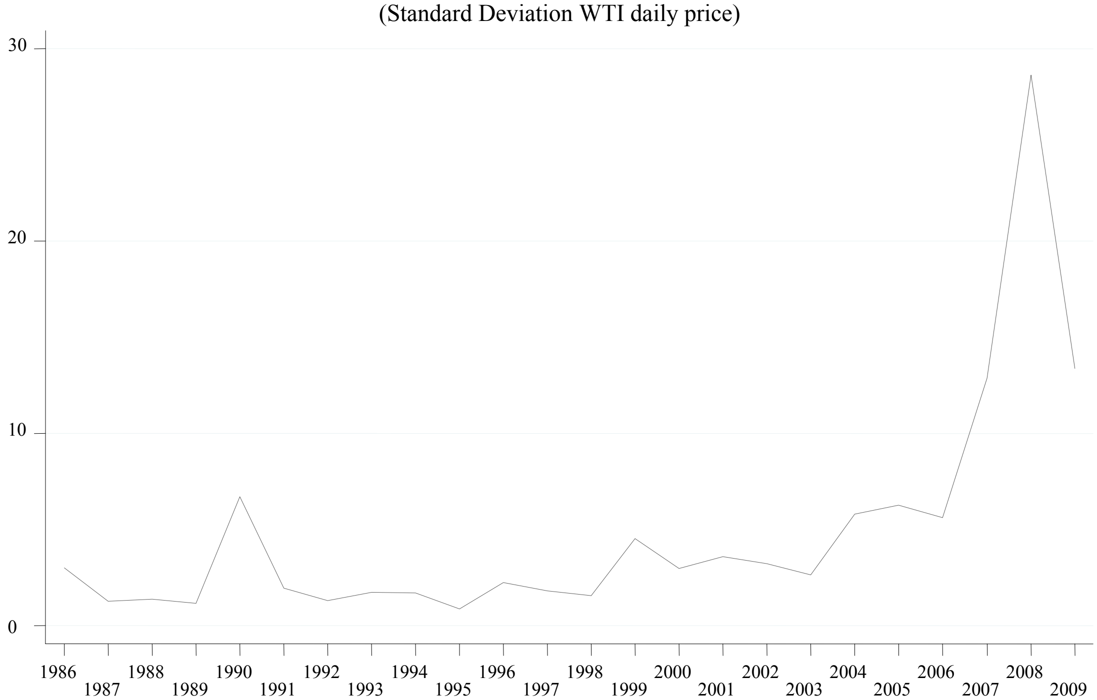
The source of non-oil price data is the World Bank's *World Development Indicators*, and *Global Development Finance*. These databases include the key economic indicators that the study seeks to assess. Oil prices correspond to the WTI Spot Price FOB quoted in US Dollars. Daily prices are available starting January 1986.

The countries under study are as follows. The seven Central America countries: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama. The Caribbean region includes 16 countries: Antigua and Barbuda, Barbados, Cayman Islands, Dominica, Dominican

Republic, Grenada, Guyana, Haiti, Jamaica, Netherlands Antilles, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, The Bahamas, and Trinidad and Tobago.

Figure 2. Oil Price Volatility

(Standard Deviation WTI daily price)



Source: Energy Information Administration, author's calculations.

The dataset consists of an unbalanced panel that spans the period between 1986 and 2008. Prior to 1986, the Energy Information Administration does not report daily prices, which are necessary to estimate the annual volatility. Although oil prices are available up to the year 2010, the macroeconomic and government time series are available up to the year 2008 for most countries.

The study first presents an aggregate view of the effect of higher oil price on the region, and then uses individual country observations to conduct a series of econometric tests. The regional analysis aggregates country variables weighted by the countries' share of the region's real GDP.

To refine the sample, the first distinction we make is between net oil importing countries versus net oil exporting countries. Since the focus of the study is on the adverse effect of higher oil prices, the final sample covers only net importing countries of oil. Thus we focus on rising oil prices as a negative shock on the country's terms of trade. The following countries reported positive fuel net exports in certain years: Netherlands Antilles, Barbados, and Trinidad and Tobago.

There is a vast literature on the effects of higher energy prices on oil exporting countries. This literature is closer to the 'resource curse' and 'Dutch disease', where the primary concern is the intertemporal management of natural resources, and the government's response to positive terms of trade windfalls. Both Spatafora and Warner (1995) and Villafuerte and Lopez-Murphy (2010) provide an overview of such channels and survey the literature.

Another key aspect of the study is that, because of the non-stationarity of oil prices, the empirical analysis focuses on identifying the effect of oil price *changes* on the chosen economic indicators.

The effect of oil price changes is split into four sets of variables: macroeconomic, international, government, and financial. All the results reported below control for time and include a regional dummy to account for differences between Central America and the Caribbean with the least informational expense.

The regional analysis starts by identifying the relation between rising oil prices and four core macroeconomic series: GDP growth, investment growth, inflation, and the real interest rate. Throughout the study we hypothesize about the expected sign of higher oil prices on the variables under study and then compare them to the econometric findings.

For this set of variables, in principle, the expectation is that rising oil prices negatively affect output and investment growth, and are (positively) associated to higher inflation and higher real interest rates.

In a related line of research, Blanchard and Gali (2007) set out to study why in industrialized economies the recent increases in oil prices have had milder effects than in the 1970s. They find that this is attributed to higher energy efficiency, better monetary policy, more flexible labor markets, and good luck (lack of concurrent adverse shocks). Though beyond the scope of this study, whether the same holds true for Central America and the Caribbean raises an interesting research question.

While higher oil prices initially appear as an increase in the relative price of energy, through different price and wage setting mechanisms, they can cause that a change in headline inflation results in higher core inflation as workers demand higher wages, and both energy and labor costs pass through to final goods and services prices. (Hunt et al. (2002) explore the mechanisms through which higher oil prices can pass through to core inflation in industrialized economies.) Furthermore, in an attempt to control inflation, a tightening of interest rates by the central bank can lead to a slowdown in output and investment. (The importance of this channel was first identified by Bernanke et al. (1997). The exact magnitude has been subject to debate and is extensively discussed in Hamilton and Herrera (2004)). A second mechanism, through which rising energy prices lead to slower growth, is as capital investment projects are postponed reducing investment and thus GDP in short- and long-run.

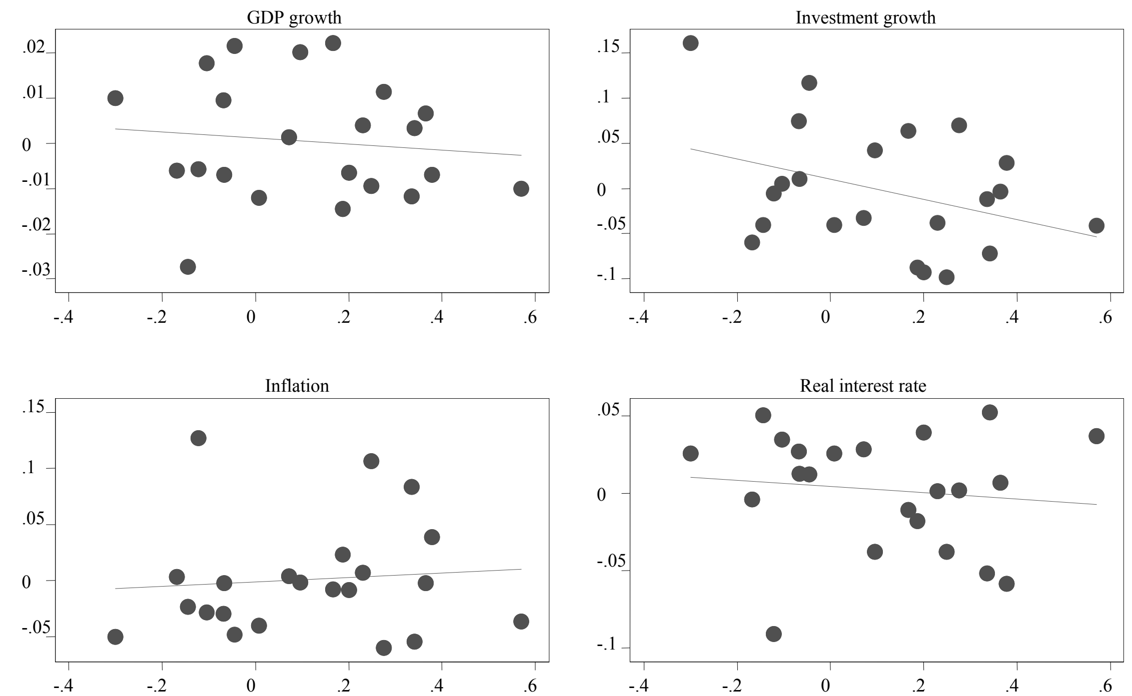
Lee and Ni (2002) and Fukunaga et al. (2010) conduct an industry-level analysis of the impact of higher oil prices. Their findings for the U.S. and Japan suggest that rising oil prices can have both negative supply and demand effects that reduce economic activity. In particular, oil shocks reduce the supply of oil-intensive industries like petroleum refining, industrial chemicals and paper; and reduce the demand of other industries, especially the automobile industry.

Figure 3 presents scatter plots (controlled for time and region) of the relation between changes in oil prices (horizontal axis) and output and investment growth, inflation and real interest rates. The top two panels illustrate the negative effect of oil prices on GDP growth and gross capital formation. Also, as expected, higher oil prices seem to feed into overall prices, leading to higher inflation.

Contrary to the expectation, higher oil prices appear to be negatively associated with real interest rates. This preliminary finding may suggest even though nominal rates might increase upon higher energy prices, the increase might not be enough to compensate the increase in inflation, thus leading to lower real interest rates. If this were to be the case, it might reflect the trade-off monetary authorities face between fighting inflation and balancing the economy around its potential growth rate. (While these results are indicative of the possible connections, no meaningful statistical inference can be done with the aggregate regional data because of the small sample size. In one of the models described below, higher oil prices appear to trigger an increase in real interest rates with a lag.)

Next, we turn to a series of selected international indicators such as the real exchange rate, fuel import dependency, international reserves (in months of imports), and short-term debt as a fraction of reserves. These variables taken together, point to the potential for heightened vulnerability due to higher oil prices. If higher oil prices are linked to weaker local currencies, this would result in an amplification mechanism of the initial shock. Also, the larger the share of fuel imports relative to other imports, higher oil prices weaken the countries' balance of payments sustainability, which can feedback through the further depletion of international reserves, which would put further pressure on the exchange rate and on the financing of imports. And finally, if the countries' response to rising oil prices includes additional international borrowing that may strain as well the countries' international debt position.

Figure 3. Oil prices and the Macroeconomy



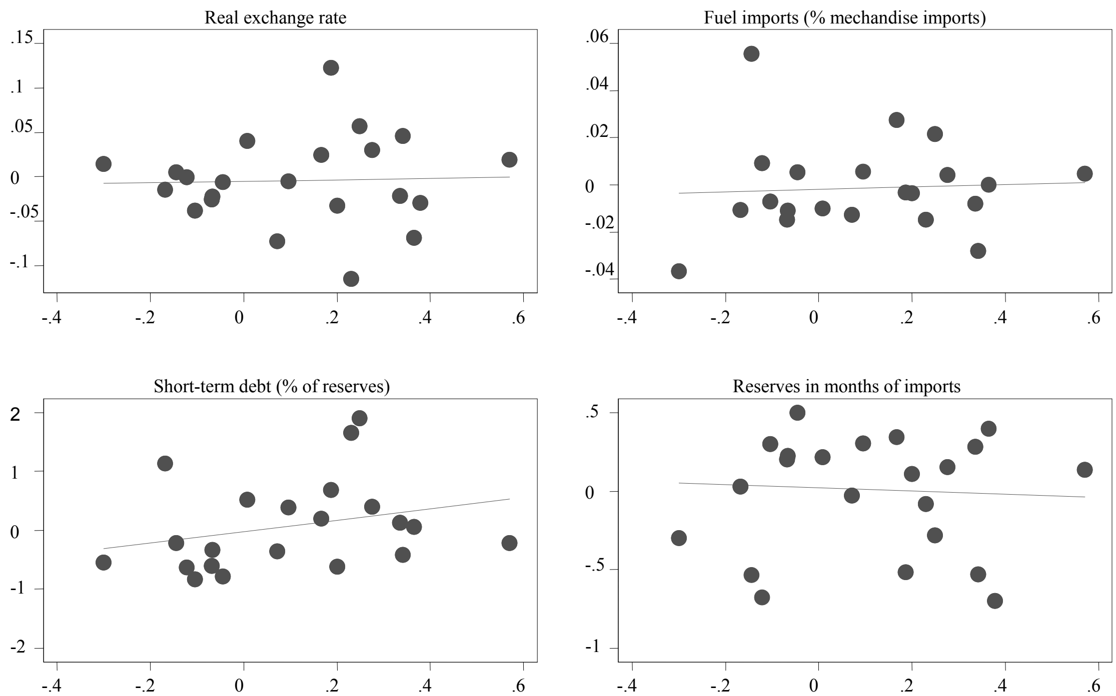
Source: WDI, author's calculations.

The relationship between higher oil prices and these variables for Central America and the Caribbean region is presented in Figure 4. In this case all variables exhibit the expected sign. Meaning that rising oil prices seem to be linked to weaker currencies (in real terms), to a larger share of fuel imports in total imports, to an increase in short-term debt relative to reserves, and to a decrease in reserves measured as months of imports.

Hence, these variables point to a weakened international position in the face of higher oil prices. In the analysis below, it is shown that based on country-level observations these relations are statistically significant in a variety of models.

Another set of important variables is the government's response and exposure to oil price shocks. For this, the study analyzes the effect of rising oil prices on the government's balance, debt, purchases, and subsidies. If smoothing mechanisms are in place, or political pressure rises demanding isolation from international market developments, then the government's finances (and country's as a whole) can be hampered.

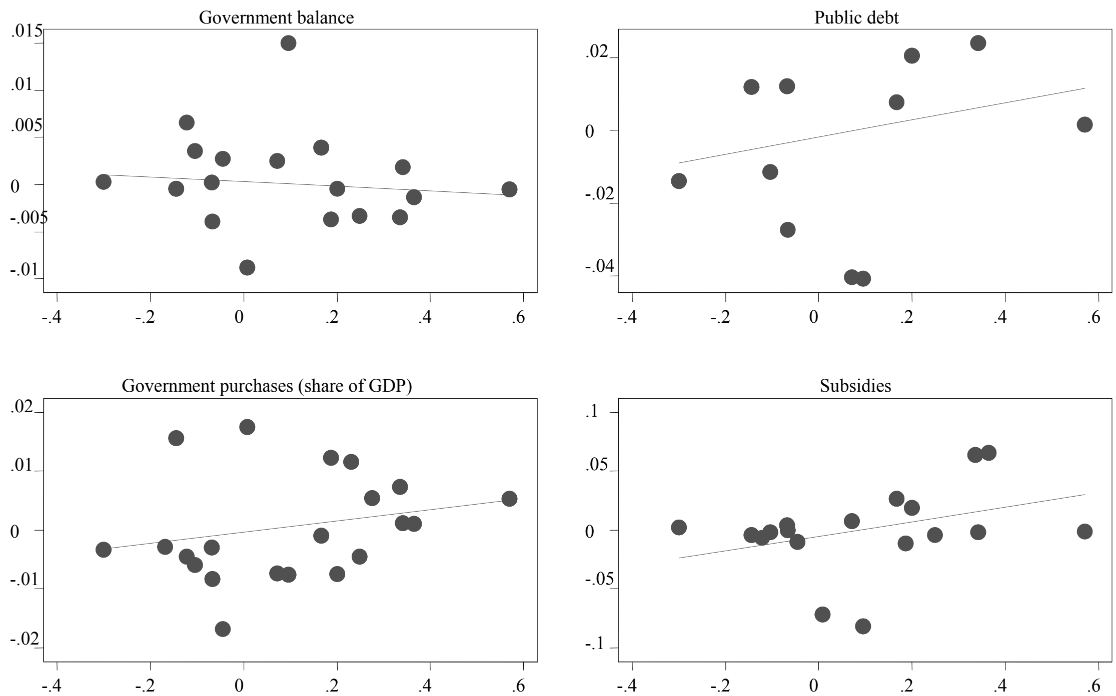
Figure 4. Oil prices and Key international variables



Source: WDI and GDF, author's calculations.

Kojima (2009) provides an in depth analysis of the policy response to rising oil prices in 49 developing countries. While most of them are microeconomic in nature, the fiscal repercussions are in line with those reported in this study, namely a weakening of the government's finances. The World Bank (2006) also presents detailed case studies on the policy responses for ten Latin American and Caribbean countries, including the Dominican Republic, El Salvador, Guyana, and Honduras.

Figure 5. Oil prices and Government sector



Source: WDI, author's calculations.

The overall view that Figure 5 presents, suggests a bleak horizon upon higher oil prices for Central American and Caribbean governments. The scatter plot shows a deterioration of the government's balance, an increase in government debt, an increase in government purchases, and higher subsidies.

While greater subsidies and a weakening of the government balance were expected, the larger share of government purchases as a fraction of GDP might suggest a form of counter-cyclical response to a weakening economy.

The last set of variables under study, correspond to a selection of international financing indicators. An inter-temporal smoothing mechanism suggested from the results above is temporary borrowing to face the oil price shock, and to counteract the plausible downturn in the economy. To understand further, Figure 6, presents the effect on the composition of short- and long-term debt, the change in new debt issuance maturity, and the performance of public debt given by principal and interest arrears. (Arezki and Bruckner (2010) analyze the effect of higher commodity prices on external debt in commodity exporting countries. Their main finding is that such windfalls are used to decrease the level of external debt in democracies. This study takes the opposite view, as the focus is on higher oil prices in oil importing countries.)

The top panel of Figure 6 suggests an increase in long term debt. While *a priori* one could expect an increase in maturity, the overall short- and long-term composition mix is harder to anticipate. However, the figure indicates that countries seem to increase long-term debt relative to short term borrowing. This may respond to allow a recovery period after which international commitments can be fulfilled.

As for the managing of the previous debt obligations, higher oil prices appear to delay both interest and principal payments. Public interest and principal arrears are positively related to rising oil prices. This provides another insight on how fiscal resources are allocated during such episodes: while subsidies and government spending increase, some international obligations are postponed.

Having established an initial characterization of the response of the selected variables to oil price changes within Central America and the Caribbean, next the study presents the disaggregated sample where each country represents an individual unit of observation. This allows us to have a larger sample on which to apply different econometric specifications, and infer the significance of the identified relations. The empirical strategy is to apply a battery of symmetric tests to assess the effect of higher oil prices on the chosen variables.

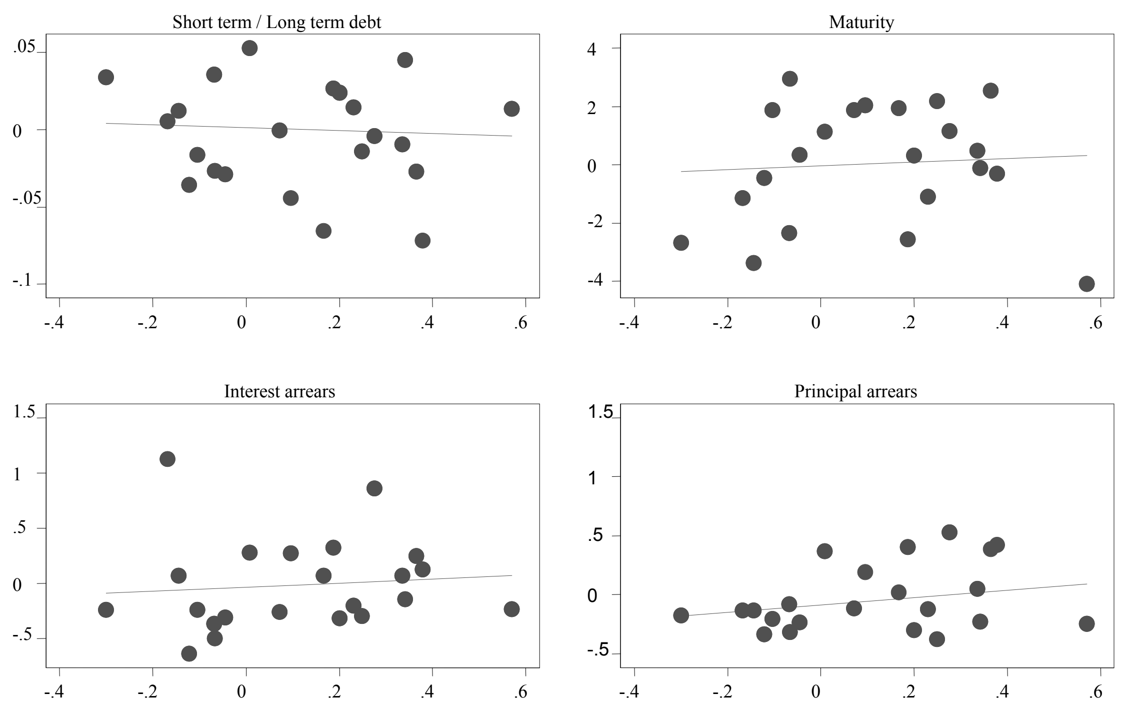
To allow for some time for oil price shocks to be reflected in the economies' aggregate indicators, we pursue four models that account for different adjustment periods. (For instance Lee and Ni (2002) report that at the industry-level, the decline in output occurs ten months after the oil price shock. For the U.S., Bernanke et al. (1997) report a seven-month lag on the VAR specification.) Model 1, includes a contemporaneous and a lagged effect of oil price changes as the independent variables. Model 2, accounts for a contemporaneous and two lagged effects of oil prices. Model 3, is based on a different strategy; it takes three-year averages of both regressors and dependent variables. Model 4, takes a similar approach using the five-year average of the variables to reduce the short-term noise that may independent of underlying trends in oil prices.

In all the diagnostic tests, the chosen variables are regressed on the same set of independent variables within each model specification. While this may come at the expense of richer variable-specific models, or of the quantitative interpretation of the coefficient magnitudes, it eases the comparison across variables and sheds light on the direction of potentially fruitful research.

Table 1. Oil Prices and the Economy								
Dependent Variable	Expected Sign	Model 1 oil price change		Model 2 oil price change			Model 3 oil price change	Model 4
		t	t-1	t	t-1	t-2	3y ave	5y ave
GDP growth	< 0	-	Yes	-	Yes*	-	-	Yes
Investment growth	< 0	Yes*	Yes	Yes*	Yes	Yes	Yes*	Yes
Inflation	> 0	Yes	Yes*	Yes	Yes*	Yes	Yes	Yes
Real interest rate	> 0	-	Yes	-	-	-	-	-
Real exchange rate	> 0	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Current Account/GDP	< 0	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fuel Imports (% Merchandise Imports)	> 0	Yes*	Yes*	Yes*	Yes*	Yes*	Yes*	Yes*
Reserves (months of imports)	< 0	Yes	Yes	Yes	Yes	-	Yes	-
Short-term debt (% of total reserves)	> 0	Yes	Yes	Yes*	-	Yes*	Yes*	Yes
Government balance (% GDP)	< 0	-	-	Yes	-	Yes	Yes	-
Government debt (% GDP)	> 0	-	Yes	-	Yes	-	-	Yes
Governement purchases (% GDP)	> 0	Yes	Yes	Yes	-	Yes	Yes	Yes
Subsidies (% of expense)	> 0	Yes	Yes	Yes	Yes	-	Yes	-
Maturity on new debt (years)	> 0	Yes	-	Yes	-	Yes	-	Yes
Public interest arrears (% change)	> 0	Yes	Yes	Yes	Yes	Yes	Yes*	Yes
Public principal arrears (% change)	> 0	Yes	-	Yes	-	Yes	Yes*	Yes
Short-term debt (% of total external debt)	> 0	-	-	-	-	-	-	-
Observation range		296-331		281-314			104-112	61-64

Notes: * denotes 10% statistical significance.
Source: WDI and GDF, author's calculations.

Figure 6. Oil prices and International financing



Source: GDF, author's calculations.

Table 1 presents the effect of oil prices on the selected variables grouped by their Macroeconomic, International, Public, and (International) Financing nature. In one or another version of the models we found the expected effect of higher oil prices on the economy. The only exception is short-term debt (as percentage of total debt), where long-term debt is the preferred instrument. This does not mean that short-term debt does not increase, but rather that long-term rate increases at a faster rate.

Among all variables, not surprisingly, the effect of rising oil prices on the share of fuel imports on merchandise imports is positive and significant across all models. Also, the negative effect on investment growth is consistent in all models and exhibits statistically significant contemporaneous effect in the lagged models and in the three-year average model. This effect is of particular importance since it has short- and long-term implications on growth. Similarly, all models identified the positive effect of higher oil prices on inflation and the negative effect on the current account; however, these effects are not statistically significant in all cases. For the rest of the variables the models did identify the expected effects though not in all models or with a high degree of statistical confidence.

From the above, the study can draw the following conclusions. Higher oil prices 1) slow down growth, through investment and overall output; 2) feedback into generalized price increases (inflation); 3) deteriorate external accounts (current account and fuel imports), and also are associated to a depletion of reserves and a depreciation of the local currency; 4) worsen the government's balance, increase public debt, purchases, and subsidies; and 5) increase the overall indebtedness of the countries and could lead to default on the debt obligations through higher interest and principal public arrears.

Beyond the partial effect of rising oil prices on these variables, in many cases they feed into each other. For instance the draining of reserves, along with higher arrears might trigger a speculative attack on the currency depreciating it further. Higher government purchases and public debt can crowd-out private investment decreasing further capital formation and overall growth.

OIL PRICE VOLATILITY AND THE ECONOMY

While higher oil prices imply an array of negative effects on the Central American and Caribbean economies, a second aspect worth analyzing is that of frequent changes in oil prices, beyond the underlying trend. In other words, oil price volatility. Taking daily prices as given, the question is what is the impact of large deviations around the yearly average price?

With this in mind, we estimate coefficient of variation of oil prices for every year. This statistic is defined as the standard deviation of oil prices within a year, divided by that year's average price. Then, we follow the same strategy as in the previous section: regress each of the selected variables through a series of model specifications with oil price volatility as the independent variable (along with time and regional controls).

A first step is to establish the expected effect of higher volatility on the chosen indicators. For most of the series, the predicted effect of greater oil price volatility is akin to that of higher oil prices, for instance on growth and inflation. For the latter, prices are more likely to be sticky downwards than upwards; thus frequent jumps in oil prices can result in higher inflation. In other cases it is harder to establish the likely effect such as on government purchases, for which the study uses the working hypothesis that higher prices and higher volatility have the same effect. Nonetheless, there are two cases on which the effect of volatility is likely to be opposite to that from higher prices: foreign exchange reserves and debt maturity.

Based on a precautionary savings argument, countries could in principle self-insure against volatile oil prices through higher international reserves. This in turn would decrease foreign borrowing and thus reduce longer term debt.

Table 2. Oil Price Volatility and the Economy

Dependent Variable	Expected Sign	Model 1 oil price change		Model 2 oil price change			Model 3 oil price change	Model 4 oil price change
		t	t-1	t	t-1	t-2	3y ave	5y ave
GDP growth	< 0	Yes	Yes*	Yes	Yes*	Yes	-	-
Investment growth	< 0	Yes*	-	Yes*	Yes	Yes	-	Yes
Inflation	> 0	Yes*	Yes	Yes*	Yes*	-	-	Yes
Real interest rate	> 0	-	-	-	-	Yes	-	-
Real exchange rate	> 0	Yes*	Yes	Yes*	Yes	Yes*	Yes	-
Current Account/GDP	< 0	Yes	Yes	Yes	Yes	-	Yes	Yes
Fuel Imports (% Merchandise Imports)	> 0	Yes	Yes	Yes	Yes	Yes*	Yes	Yes*
Reserves (months of imports)	> 0	-	-	-	-	Yes	-	-
Short-term debt (% of total reserves)	> 0	Yes	-	Yes	-	-	Yes*	Yes
Government balance (% GDP)	< 0	-	-	-	-	Yes	-	-
Government debt (% GDP)	> 0	-	-	-	-	Yes	-	Yes
Governement purchases (% GDP)	> 0	-	Yes	-	-	Yes	-	Yes
Subsidies (% of expense)	> 0	Yes	Yes	Yes	Yes	-	-	-
Maturity on new debt (years)	< 0	-	-	-	Yes	Yes	Yes	-
Public interest arrears (% change)	> 0	-	Yes	Yes	-	Yes*	-	Yes
Public principal arrears (% change)	> 0	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Short-term debt (% of total external debt)	> 0	-	-	-	-	-	Yes	-
Observation range		308-350		281-314			104-112	61-64

Notes: * denotes 10% statistical significance.
Source: WDI and GDF, author's calculations.

Table 2 presents the effect of higher oil price volatility on the selected series. As before most of the expected effects were found, however not as consistently as in Table 1. The most significant findings are the aggregate effects on output and investment growth, and investment. The more volatile oil prices are, the slower investment and output grow. On the other hand, the only fiscal effect seems to be on subsidies. One reason for this is that once aid measures are granted, they are (politically) harder to withdraw (see Kojima, 2009). Finally, the data does not seem to provide strong evidence of precautionary savings associated with the greater volatility.

However, such approach could provide an avenue to mitigate the increased strain on the exchange rate and external accounts; similar in spirit to a strategic oil reserve.

In sum, greater oil price volatility reinforces the effects from higher oil prices. This additional factor strengthens the argument for improving energy efficiency and designing mechanisms to hedge this type of risk.

VULNERABILITY

From aggregate performance, to public finances, to international borrowing, the findings from the two previous sections paint a bleak picture of the effects of higher and more volatile oil prices on countries that are net importers of oil in Central America and the Caribbean.

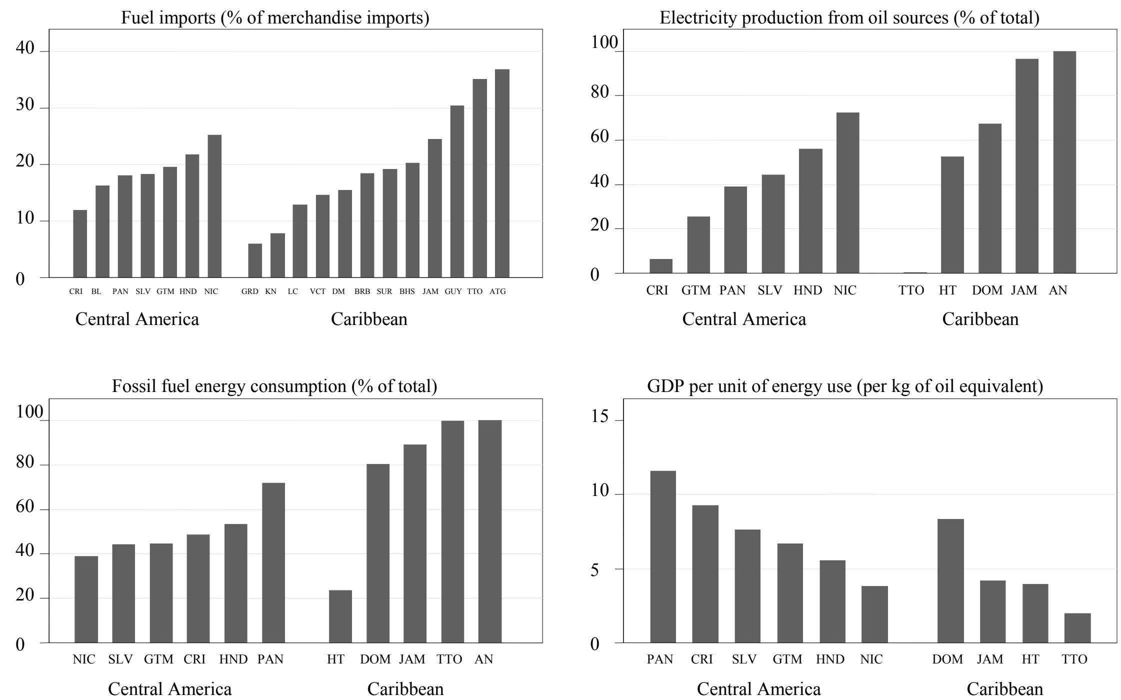
The objective of this section is to identify the countries in which these effects would be stronger because of their oil dependence, power generation mix, or inefficient use of energy. This as well, will provide insights to potential areas of improvement across countries. Bacon and Kojima (2008) follow a similar approach to assess the vulnerability associated with higher oil prices on a sample of countries from around the world. They find a large number of countries for which their vulnerability score increased between 1996 and 2006.

Figure 7, shows four variables that combined can proxy for the countries' vulnerability to higher and more volatile oil prices for the year 2006. The first concerns the share of oil sources on electricity production; the second, fossil fuel energy consumption as percentage of total; the third, the share of fuel imports in merchandise imports; and the fourth, the countries' economies energy intensity, that is, the amount of output per unit of energy used. (The statistics for fossil fuel energy consumption might include coal, and thus potentially overstate the countries' vulnerability to higher and more volatile oil prices.)

The interpretation of the first three panels of Figure 7, is that the further to the left a country is, the less vulnerable to higher oil prices is. And for the fourth panel is that the further to the left a country is, the more efficient the country is in its energy use. For instance, Costa Rica scores well on both vulnerability and efficiency measures as its fuel imports as a share of merchandise imports are low, the share of oil in electricity production is low, and has the second highest energy efficiency in Central America, and in the sample as a whole. On the other hand, Nicaragua amongst Central American countries, exhibits the highest fuel share of imports, the highest electricity production from oil sources, and the lowest energy efficiency. As for the Caribbean region, Trinidad and Tobago is a cause for concern because of its high dependence on fuel imports, high fossil fuel energy consumption, and low energy efficiency. Note that low energy efficiency can reflect high technical power losses, or as well a large underground economy, usually associated with high commercial losses.

Note that low energy efficiency can reflect high technical power losses, or as well a large underground economy associated with high commercial losses.

Figure 7. Country Vulnerability



Source: WDI, author's calculations.

CONCLUSIONS AND POLICY PRESCRIPTIONS

The purpose of this study was to determine the effect of higher and more volatile oil prices in the Central America and Caribbean region. After assessing such impact on aggregate, international, fiscal and financing time series, the following conclusions are derived.

At a macroeconomic level higher oil prices are associated with lower GDP and investment growth; with higher inflation and a weaker exchange rate. Moreover, oil price shocks also lead to a deterioration of the current account and to the depletion of foreign exchange reserves. On the fiscal side, the government balance worsens, public debt rises, and government purchases and subsidies increase. And finally, rising oil prices lead to a weakening of the countries' international debt position, as long-term debt increases, and arrears on public debt interest and principal increase. Taken together, these effects hurt the short- and long-term prospects of the economy, as growth decreases and higher instability and inflation build up.

Higher oil price volatility reinforce the effects above, though slightly less on the fiscal side. Nevertheless, such symmetry is a concern as well as it amplifies the effect of the initial oil price shock.

Based on the above, the study sought also to identify the degree of vulnerability of the different countries in the region, based on their fuel imports, oil share in power generation, and overall energy efficiency. The outcome is that countries like Nicaragua and Trinidad and Tobago, which exhibit the highest vulnerability ought to diversify their power generation mix, reduce the use of fossil fuels in their overall energy use, and to increase their energy efficiency (including the reduction in transmission and distribution power losses). This way, the effects of higher oil prices in international markets will be mitigated. Furthermore, since volatility seems to act as an amplification mechanism of the oil price dynamics, financial and hedging strategies seem key to a smoother functioning of the Central America and Caribbean economies in the presence of ever higher and volatile oil prices.

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ASSESSING THE EFFECTIVENESS OF MUSIC LYRICS IN CONVEYING ECONOMIC CONCEPTS

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ABSTRACT

Numerous economic concepts are present in popular music lyrics. We conduct a study to examine the effectiveness of using music to convey economic concepts. The empirical results suggest that there is an opportunity to improve student understanding by using music lyrics to introduce and reinforce economic concepts, but the selection of topic and music matter.

INTRODUCTION

An examination of the economics education literature raises questions regarding the instructional practices of economics instructors. Peer reviewed journals are filled with articles presenting innovative assignments and techniques for teaching economics. However, periodic survey results suggest that the vast majority of economics instructors remain firmly committed to the traditional chalk and talk approach to instruction (Watts & Becker, 2008; Becker & Watts, 2001; Becker & Watts, 1996). Watts and Becker (2008) argue that their survey provides evidence that economics instructors are slowly beginning to move away from the traditional approach in favor of more innovative instructional methods. We are puzzled by the fact that journals are filled with examples of educational innovation yet survey data show only a limited departure from the traditional chalk and talk. Perhaps chalk and talk remains popular because experience reveals that it is most effective.

Colander (2004) warns that economics instructors should not get consumed in the delivery of a course but rather should focus on the content of the course. The quality of a course is ultimately a function of the content; innovative delivery can, at most, build on the foundation established by substantive content. Regardless, the challenge facing economics education research is to assess the effectiveness of innovative approaches to teaching economics so as to validate innovative approaches to instruction. As economists, we are acutely aware that scarcity implies choice and that every choice of how to use class time comes at a cost. At issue is whether the marginal benefits of an innovation offset the associated marginal costs.

This study evaluates the efficacy of using songs (music and lyrics) to complement substantive content presented using a conventional lecture format. Our intent is to stimulate evaluation of innovations reported in pedagogical articles so as to elevate the innovations that improve instruction and to eliminate innovations that interfere with learning.

Section II reviews the salient literature. Section III states the guiding research question and associated hypotheses. It also describes the research design of the study. Section IV summarizes the data and presents the econometric model. In Section V we report our findings. Discussion and concluding remarks in Section VI complete the paper.

LITERATURE REVIEW

While traditional chalk and talk dominates economics instruction, alternative approaches to teaching economics are commonly employed by economics instructors (Becker & Watts, 1995; Becker & Watts, 2001; Watts & Becker, 2008). Watts and Becker (2008) survey economics instructors and report a litany of alternative approaches (e.g. classroom games, simulations, experiments, literature, the business press, case studies, and cooperative learning) as evidence that economics instruction is moving beyond the traditional chalk and talk approach. Alternatives to chalk and talk have been compiled in an edited volume by Becker, Watts, and Becker (2006).

Academic journals chronicle methodological approaches implemented by economics instructors. Watts and Smith (1989) identify an extensive list of references to economic concepts in literature for use in instruction. Watts (2003) compiles literary selections and organizes the excerpts by topic for easy access and comparison. Hartley (2001) presents an entire course reliant on reading material drawn from the Great Books of Western Civilization. McCannon (2007) presents a course designed to develop critical thinking skills that employs game theory to study biblical scripture. Perhaps most famously, although not pedagogical in purpose, Rockoff (1990) posited that Frank Baum intended his *Wizard of Oz* children's story as an allegorical commentary on monetary policy of the late 19^{th} century. Hansen (2002) has since offered a counter-argument challenging Rockoff's assertion but Dighe (2007) maintains that the *Wizard of Oz* remains a useful teaching tool to facilitate discussion of the competing interpretations.

Modern students and instructors may not relate to literature, drama, or game theoretic analysis of scripture. However, instructors have begun to use movies and television programs to illustrate economic concepts (Leet & Houser, 2003; Sexton, 2006; Mateer & Li, 2008). Indeed the animated series *The Simpsons* has inspired a cottage industry of innovative assignments (Hall, 2005; Considine, 2006; Gillis & Hall, 2010; Luccasen & Thomas, 2010). The focus of this paper, however, is the use of music to teach economics.

Empirical evidence suggests that music training contributes to cognitive development (Schlaug, Norton, Overy & Winner, 2005). A series of papers established what is popularly known as the Mozart Effect (Leng & Shaw, 1991; McGrann, Shaw, Shenoy, Leng & Mathews, 1994; Shaw, Silverman & Pearson, 1985; Shenoy, Kaufman, McGrann & Shaw, 1993). Efforts to duplicate the experimental results have varied (Rauscher & Shaw, 1998). Crncec, Wilson, and

Prior (2006) provide evidence of no Mozart Effect in children. Bangerter and Heath (2004) consider the persistence of the Mozart Effect despite the mixed empirical results as evidence of a broader social phenomenon regarding the role of the media promoting the initial findings. Regardless, Rubin (1977) finds that music prompts aid recall while Calvert (2001) and Calvert and Tart (1993) find that children and adults recall more educational material verbatim after exposure to ABC television's *Schoolhouse Rock*. To what extent can music convey college level economic concepts?

Tinari and Khandke (2000) assembled a collection of songs from which individuals and groups choose selections as the basis for further research regarding an economic event or concept. Harter (2003) offered students a choice to write short essays based on popular music or a longer essay based on an economics murder novel. Hall and Lawson (2008) suggest that music motivates students and advocate a structured writing assignment based on specific selections from a wide variety of music. Kane (1999) presents songs that illustrate principal-agent problems. Hall, Lawson, Mateer, and Rice (2008) author two websites featuring music and lyrics for use in economics instruction.

It should be noted that utilizing music in college courses is not the exclusive domain of economics faculty. Music has been used to teach biology, geography and social studies (Kandyba, 2003; Jurmu, 2005; White & McCormack, 2006). Walczak and Reuter (1994) employ popular music to teach sociology, and Albers and Bach (2003) play music prior to class to set-up the lecture in their sociology class. Weinrauch (2005) emphasizes the use of metaphors in music lyrics to teach courses in marketing strategy while Dettmar (1998) claims rock and roll music is essential in his introductory course to postmodernism. Despite the popularity of music as a teaching tool in a wide variety of disciplines, we have not found a single effort to assess its effectiveness.

Despite the apparent abundance of published papers pertaining to innovative instruction, papers reporting innovative teaching are rarely cited. We consider the lack of citations as evidence of the need to examine the effectiveness of using music as a teaching innovation. We limited our evaluation to the effectiveness of using music when teaching economics.

RESEARCH QUESTION, HYPOTHESES, AND RESEARCH DESIGN

Published papers report anecdotal evidence in the form of individual student comments regarding inclusion of music in class; however, no paper reports greater efficacy. It seems reasonable, therefore, to subject the use of music to teach economics to empirical examination. Given this void in the literature, we ask, does music contribute to the understanding and retention of economic concepts?

To answer this question, we pose two hypotheses for testing:

H1 Exposure to music relating to economic concepts improves understanding.
H2 Exposure to music relating to economic concepts improves retention.

To test these hypotheses, we conducted an experiment using two undergraduate classes of macroeconomic principles. In each class, music was used to complement a topic presented as part of the class lecture but not addressed in the textbook. In one class, we used two songs performed by Styx, “Too much time on my hands” (1981) and “Blue collar man” (1978), which address potential consequences of unemployment on individuals. In the second class, we used “I’d love to change the world” (1971) by Ten Years After, which illustrates the competing visions of human behavior and their relationship to the selection of an economic system.

Handouts with the printed lyrics for each song were distributed immediately preceding the playing of each song. Each class experienced music for one topic. Discussion of the lyrics and their relationship to the economic topic immediately followed the music. An unannounced quiz administered during the following class meeting assessed the impact of the music in comparison to the class that did not experience the music. Retention is examined by evaluating the student performance on a final exam question.

DATA AND ECONOMETRIC MODEL

Student performance data were collected in two macroeconomics principles classes that met at eight and ten in the morning four days per week. Both classes met in the same room with the same instructor. A conscious effort was made on days when music was used in a class to ensure that the classroom experience was otherwise identical for each class. The instructor slowed the pace of the lecture in one class to offset the time used to play the music in the other. Although attendance may be expected to vary based on the scheduled class time, student attendance did not adversely affect data collection. Descriptive statistics for the data are summarized in Table 1.

Table 1: Descriptive Statistics

Independent Variables	N	Minimum	Maximum	Mean	Std. Dev.
Gender (Base case: Male)	45	0	1	.33	.477
ACTMath	44	17	33	24.3182	4.43964
GPA	45	1.96	4	3.0171	.58166
Section (Base case: 8am class)	45	0	1	.69	.468
Engineering College (Base case: Business College)	45	0	1	.1778	.38665
Other College (Base case: Business College)	45	0	1	.0444	.20841
Micro A (Base case: D in microeconomics)	43	0	1	.2558	.44148

Table 1: Descriptive Statistics					
Independent Variables	N	Minimum	Maximum	Mean	Std. Dev.
Micro B (Base case: D in microeconomics)	43	0	1	.4186	.49917
Micro C (Base case: D in microeconomics)	43	0	1	.2558	.44148

Due to missing data, the dataset used in the statistical analysis included 43 observations. The class section scheduled at eight in the morning was less popular among students as evidenced by the discrepancy in enrollment. The early class consisted of fourteen students including two women whereas 31 students including 13 women enrolled in the later class. Previous research shows that women, on average, receive lower grades in economics courses (Anderson, Benjamin & Fuss, 1994). Therefore, we created a dummy variable, using male as the base case, to control for the gender of a student. Research also indicates that performance in economics courses is correlated with the score on the math component of the ACT (Ballard & Johnson, 2004). Prior studies show that performance in economics courses is positively correlated with the student's grade point average at the beginning of the academic term (Benedict & Hoag, 2004). All 45 students had existing grade point averages prior to enrolling in the course. Data collection was conducted during the spring quarter so the grade point average of each student reflected at least two quarters at the university.

Generally, freshman engineering students and sophomores from the business college enroll in the macroeconomic principles course. The course is required of students in both colleges. In addition, students from other colleges may enroll in the course. Dummy variables were created using the business college as the base case. These variables were intended to control for variation in curricular demands and student perceptions of the relevance of the economics courses. We constructed dummy variables for the class times using the earlier class as the base case. Research shows that previous performance in an economics course predicts performance in subsequent courses (Benedict & Hoag, 2004). We created dummy variables to represent student performance in the prerequisite microeconomics principles course using a D grade in microeconomic principles as the base case. To enroll in the principles of macroeconomics course, a student must pass microeconomic principles.

Econometric Model

We developed an econometric model using the student's score on an unannounced quiz or final exam question pertaining to the economic topic as the dependent variable. Quiz scores ranged from zero to three points. Final exam scores ranged from zero to two points. Grading reflects half point increments to accommodate partial credit for responses requiring multiple components. The variable of interest, Music, is a dummy variable indicating whether the student was exposed to music relating to the topic.

$$Score = B_0 + B_1*Music + B_2*Gender + B_3*GPA + B_4*ACTMATH + B_5*ENGINEERING\_COLLEGE + B_6*OTHER\_COLLEGE + B_7SECTION + B_8*MICRO\_A + B_9*MICRO\_B + B_{10}*MICRO\_C + \square$$

SECTION V – RESULTS

Table 2 reports the regression results using the student's score on an unannounced quiz question as the dependent variable. The regression examines the use of the two songs by Styx addressing the consequences of unemployment. The F-statistic is not statistically significant at any conventional level and the adjusted R-squared value (.151) reflects the goodness of fit after adjusting for the number of independent variables in the regression model.

The coefficient estimate for the variable of interest, Music, is positive (1.771) and statistically significant ($p = .024$) indicating that, on average, exposure to the music positively impacted performance on the unannounced quiz question. The sign of the coefficient estimates for the control variables Gender and GPA is as expected but not statistically significant. The coefficient estimate of the ACTMATH variable is negative and the magnitude of the estimate (-.014) is close to zero. Moreover, the estimate does not approach statistical significance at any conventional level. The coefficient estimates of the microeconomic principles grade and Engineering College dummy variables are positive but not statistically significant whereas the coefficient estimates for the Other College and Section dummy variables are negative and not statistically significant.

Table 2: Unemployment Quiz (STYX)

Model Utility & Independent Variables	Statistical Estimate	Standard Error	p-value
R^2	.394	n. a.	n. a.
Adjusted R^2	.151	n. a.	n. a.
F statistic	1.625	n. a.	.157
Constant	-2.315	1.697	.185
Gender	-.494	.542	.370
ACTMATH	-.014	.057	.813
GPA	.724	.553	.202
Micro A	.940	1.376	.501
Micro B	1.381	1.159	.245
Micro C	1.340	1.152	.255
Engineering College	.030	.528	.956
Other College	-.301	1.157	.797

Table 2: Unemployment Quiz (STYX)			
Model Utility & Independent Variables	Statistical Estimate	Standard Error	p-value
Section	-.452	.762	.557
Music	1.771	.736	.024*
* Statistically significant at the 5% level. n. a. Not applicable			

Table 3 reports the regression results using the student's score on an unannounced quiz question as the dependent variable. The regression examines the use of the song "I'd love to change the world" by Ten Years After. This song was selected due to its references to themes associated with competing visions of human behavior that influence the choice of economic systems. The F-statistic is nearly statistically significant at the 10% level. The adjusted R-squared value (.159) is consistent with the value reported in Table 2. The coefficient estimate for the variable of interest, Music, is negative (-.822) and statistically significant (p = .045) indicating that exposure to the song, on average, negatively impacted performance on the unannounced quiz question. This finding contradicts the previous result.

Table 3: Economic Systems Quiz (Ten Years After)			
Model Utility & Independent Variables	Statistical Estimate	Standard Error	p-value
R^2	.348	n. a.	n. a
Adjusted R^2	.159	n. a.	n. a.
F statistic	1.838	n. a.	.101
Constant	-.041	1.524	.979
Gender	-092	.423	.829
ACTMATH	-.011	.058	.852
GPA	.721	.520	.175
Micro A	-.522	.975	.597
Micro B	-1.005	.732	.180
Micro C	-.635	.744	.400
Engineering College	.887	.527	.103
Other College	-1.063	.844	.217
Music	-.822	.394	.045*
* Statistically significant at the 5% level. n. a. Not applicable			

Table 4 reports the regression results using performance on the final exam unemployment question as the dependent variable. The F-statistic indicates that the regression is statistically significant (p = .095) and the adjusted R-squared (.170) is consistent with the regression results presented in Tables 2 & 3. The coefficient estimate of Music is positive (.909) and statistically significant (p = .028). Similar to the unemployment quiz, this finding indicates that, on average, exposure to the music positively impacted performance on the final exam question.

Table 4: Unemployment Final Exam (STYX)

Model Utility & Independent Variables	Statistical Estimate	Standard Error	p-value
R^2	.372	n. a.	n. a.
Adjusted R^2	.170	n. a.	n. a.
F statistic	1.838	n. a.	.095**
Constant	-.958	.930	.311
Gender	.304	.265	.259
ACTMath	.046	.034	.191
GPA	.145	.326	.661
Micro A	.742	.617	.238
Micro B	.959	.463	.047*
Micro C	1.280	.471	.011*
Engineering College	.290	.330	.386
Other College	-.663	.536	.225
Section	-.870	.430	.052**
Music	.909	.394	.028*

* Statistically significant at the 5% level.
** Statistically significant at the 10% level.
n. a. Not applicable

DISCUSSION AND CONCLUDING REMARKS

In hindsight, it is clear that the music selected to illustrate consequences of unemployment related more directly to the topic than the music selected to accompany the topic of competing visions of human behavior and their relationship to selection of an economic system. However, the discrepancy of the results may be explained by the nature of the topics. The topic of consequences of unemployment is tangible and students can more easily recognize the topic in the music by Styx. In contrast, it is more difficult to recognize the subtle references to competing visions of human behavior and their nuanced connection to selection of an economic system reflected in the song by Ten Years After. The selection of the topic and music in this instance may have been overly ambitious.

Findings of this study contribute evidence that exposure to music may positively influence learning of economic concepts. More importantly to instructors, the results reveal that both the choice of topic and the selection of music to complement the topic matter. The disconcerting finding is that music may interfere with understanding of more complicated topics or in instances when the music does not relate as directly as it might otherwise.

In terms of duration, the findings show that music may have a positive and statistically significant effect on student performance on both an unannounced quiz question early in the quarter and a final exam question at the end of the quarter. The goodness of fit of the model improved over time. Nonetheless, this research program would benefit from future research that improves the goodness of fit of the regression model. Similarly, we would encourage future research that explores the effectiveness of music when presenting more complex topics.

This study examines the use of music to convey economics concepts in macroeconomics principles courses. We evaluate the efficacy of using music lyrics to illustrate content otherwise delivered using a lecture format. We acknowledge that there is no proverbial free lunch and that every choice incurs an opportunity cost. Using scarce class time to play and discuss music that illustrates an economic concept necessarily incurs an opportunity cost that varies by instructor and class, but there can be no argument that adding music to the course displaces something. This paper does not assess the cost side of the calculation, but rather we focus on assessing the potential benefits of adding music.

In conclusion, the findings of this study offer evidence that music may contribute positively to learning economic concepts. However, the findings also suggest that the choice of topic and music matter. Although encouraged by the findings, we take Colander (2004) very seriously and acknowledge that there is opportunity cost associated with using music.

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THE CASE FOR INTENSIVE SKILL-BIASED TECHNOLOGICAL CHANGE

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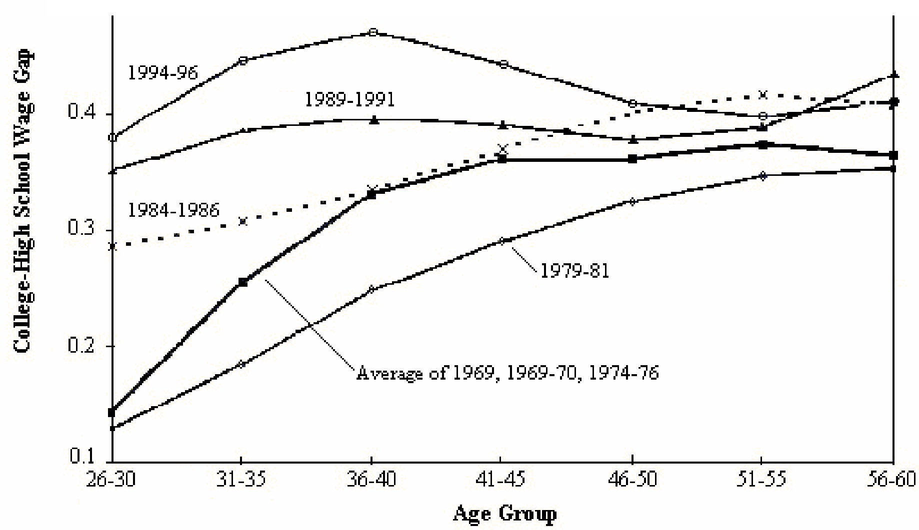
ABSTRACT

The skill-premium, defined as the relative wage of college to high-school graduates, has steadily increased over the past twenty years. Though skill biased technological change (SBTC) is generally considered to be the cause of the rise (Bound and Johnson 1992), little is known about the processes that have generated the improvements in technology. In this paper, we construct an intergenerational model of skill acquisition for the purpose of evaluating two theoretical alternative sources of SBTC. We find that intensive SBTC is necessary for the complete characterization of the observed changes in the wage premium profile. An example of intensive SBTC includes technological improvements in the actual acquisition of skills. In this case, an intertemporal substitution effect generates a reduction in the rate of skill acquisition by the old thereby replicating an important fact found in the data.

INTRODUCTION

The *skill-premium*, defined as the relative wage of college to high-school graduates, has steadily and remarkably increased over the past thirty years. Roughly, the premium has risen about 2% per year implying that the relative wage rate is three times as high as it was in 1980, the year the premium began to increase. *Skill biased technological change* (SBTC) is generally considered to be the cause (*e.g.*, Bound and Johnson, 1992; Autor, Katz, and Krueger, 1998; Guvenen and Kuruscu, 2010). In this case, technological advancements in the production of goods cause the relative marginal products of skilled to unskilled labor to rise. This form of SBTC has been examined in a dynamic general equilibrium framework by Heckman, Lochner, and Taber (1998) and has been found to explain the rising *average* skill premium reasonably well.

Figure 1: Changing Age Structure of the College-High School Wage Gap



Source: Card and DiNardo (2002), page 756.

Recently, however, the causality of SBTC has been called into question by Card and DiNardo (2002). Their argument can be found in Figure 1. They ask, why hasn't the *wage gap profile*, that represents the logged skill-premium by age, increased for every age group? Presumably, because SBTC necessarily predicts an equal change in the demand for all levels of skilled labor, Card and DiNardo (2002) label the behavior of the skill premium at cohort levels a puzzle. Though their empirics raise questions, a potential explanation can be theorized when SBTC is combined with life-cycle motives. For example, it could be the case that an increase in the return to skilled labor causes those with relatively more skills (middle to older aged workers) to economize on their skill acquisition activities thereby receiving a small wage premium. The younger workers, and therefore the less skilled, intertemporally substitute into the acquisition of skills and therefore receive a larger wage premium. The total effects of the combined lower skill acquisition rates by the old and higher skill acquisition rates by the young are a steeper skill acquisition profile and a flatter wage gap profile.

The purpose of this paper is twofold. First, we construct an intergenerational model of skill acquisition for the responses of life-cycle educational expenditures from a SBTC. The theoretical analysis employs a dynamic general equilibrium overlapping generations (OLG) model of skill acquisition drawing from Heckman (1976), Auerbach and Kotlikoff (1987), Heckman et al. (1998), Fowler and Young (2004), and Guvenen and Kuruscu (2010). The model represents an extension in one important way: the unskilled do not participate in risky capital markets. This feature replicates the well-known fact that equity ownership and education attainment are highly correlated (Haliassos and Bertaut, 1995; Bertaut and Starr-McCluer, 2002) and a large percentage of the population, roughly 43.1%, never hold risky equity assets (Mankiw and Zeldes, 1991; Guiso, Haliassos, and Jappelli, 2002).

An interesting feature that results from the model's skill acquisition sector and limited participation assumption is that biased technological improvements (in favor of skilled labor) can enter in two important ways: the final goods sector and the skill acquisition sector. If the relative productivity of skilled labor increases in the final goods sector, then the demand for skills is indirectly affected. Alternatively, if the labor's productivity in the acquisition of skills increases, then the demand for skills is directly affected. Technological change occurring through the demand for labor via the production of goods is labeled *extensive SBTC* and through the supply of labor via skill acquisition is denoted *intensive SBTC*.

Until now, extensive SBTC has been the focus of study within the literature. We find that the extensive margin alone cannot account for a flatter wage gap profile. Instead, a combination of extensive and intensive SBTC is required to replicate this puzzling empirical fact. In this case, the older aged workers economize on their skill acquisition activities while the younger workers substitute into the acquisition of skills. As predicted, the skill acquisition profile is steeper and the wage gap profile is flatter. Therefore, we make the case that intensive SBTC, and the effects it has on the acquisition of skills, is also a key for our understanding of the total effects of skill biased technological change.

The derivation of the theoretical higher education consumption profile also serves for a comparison to our second main purpose; to empirically examine the intertemporal substitution effect theory. More specifically, this paper uses the Consumer Expenditure Survey (CEX) data set to estimate the life-cycle profiles of the consumption of higher education. Changes in the education consumption profile that are consistent with an intertemporal substitution effect would necessarily imply a steepening of the skill acquisition profile; the young and old respectively increase and decrease spending on the acquisition of skills. The estimation technique employs the Heckman (1979) model of self-selection. By estimating education life-cycle profiles, and their subsequent changes over time, we document a significant steepening of the skill acquisition profile over the years 1982-2002.

The organization of the paper is as follows. Section 2 develops the OLG model of skill acquisition and of the skill premium. Section 3 quantifies the dynamics of the theoretical model. Section 4 documents the empirical methodology and data sources. Section 5 quantifies the dynamics of the empirical model. Finally, Section 6 concludes.

THE THEORETICAL MODEL OF HUMAN CAPITAL

The theoretical analysis employs an overlapping generations (OLG) model of production and skill acquisition by drawing from Ben-Porath (1967), Heckman (1976), Auerbach and Kotlikoff (1987), Heckman et al. (1998), Fowler and Young (2004), and Guvenen and Kuruscu

(2010). The OLG model allows for the replication of heterogeneity in households with respect to their age and higher education type.

Within the model, there are two types of agents that make economic decisions: households and firms. In contrast to the previous literature, access to the production and skill acquisition sector is assumed to be limited: this further distinguishes two subgroups of skilled and unskilled households. The unskilled do not to have access to capital, either human or physical, because of credit constraints; the credit constraints do not permit the acquisition of skills and thus allow us to label the credit constrained as the unskilled. As a result, skill-biased technological change may enter the model in both the skill acquisition sector and the production sector. Technological change in the production sector alters the relative productivity of good production. Technological change in the skill sector alters the relative productivity of skill attainment. Skilled biased technological change occurring through the demand for labor via the production of goods is labeled extensive SBTC and through the supply of labor via skill acquisition is denoted intensive SBTC.

At any given time the household sector comprises several generations that are overlapping. For analysis purposes, adults are defined as those individuals of college age - 18 years of age and older. Each period, one generation dies and another takes its place. Agents from generation t live for I periods, retire after $I_R \leq I$ periods, and then die. Therefore, at any point in time there is a set of agents indexed by $i \in \mathbf{I} = \{0,1,2,\ldots,I-1\}$. For simplicity, no bequests or inheritances are considered in this model. Within each age cohort, individual tastes and initial capital stocks are assumed to be identical. Thus, the use of a representative agent for each generation enables one to describe the aggregate behavior of a generation by the behavior of a single member

Skilled Households

Skilled agents in the model make lifetime decisions about consumption, saving, and leisure over their lives. Let $u(c_{t+i}^t, \ell_{t+i}^t)$ be the flow of utility from consumption, c, and leisure, ℓ, at time $t+i$ of an agent born at time t. Let lifetime expected utility of an agent born at time t be represented by

$$E_t\left\{\sum_{i=0}^{I-1} \beta^i \Psi_i u(c_{t+i}^t, \ell_{t+i}^t)\right\}, \tag{1}$$

where β is a time preference discount factor such that $0<\beta<1$ and $\Psi_i = \prod_{j=0}^{i} \psi_j$ denotes the unconditional probability of surviving up to age i with each ψ_j representing the conditional probability of surviving from age $j-1$ to j. Assume that $u(\cdot)$ is real valued, **differentiable,** strictly increasing, and strictly concave. The time endowment is normalized such that

$$1 = n^t_{1,t+i} + n^t_{2,t+i} + \ell^t_{t+i}, \tag{2}$$

where n_1 is time devoted to labor, n_2 is time devoted to human capital accumulation or skill acquisition (time spent studying). Each individual is born with an initial level of human capital or innate ability and chooses whether or not to add to the endowment, $h^t_{t+i} > 0$.

The budget constraints of a typical consumer born at time t at any time $t+i$, satisfying $I \geq i \geq 0$, are given in equation (3):

$$c^t_{t+i} + k^t_{t+i+1} \leq (1 + r_{t+i} - \delta_k) k^t_{t+i} + (1-\tau) w_{t+i} h^t_{t+i} n^t_{1,t+i} + ss^t_{t+i}, \tag{3}$$

where k represents physical capital accumulation, r is the return to physical capital, δ_K denotes the depreciation rate associated with physical capital, τ is a labor tax to fund social security benefits ss to the old, and wh is the real effective wage rate of skilled workers. Since there are no bequests and inheritances, agents invest in physical capital by consuming less in their working years than they earn in wages. Accordingly, the initial level of physical capital, k^t_t, is set equal to zero. Additionally, the old consume all goods and saving in their final period of life implying that $k^t_{t+I} = 0$.

Human capital accumulation is constrained by the following:

$$h^t_{t+i+1} \leq q^t_{h,t+i} h^t_{t+i} + q^t_{n,t+i} n^t_{2,t+i} + (1-\delta_h) h^t_{t+i}, \tag{4}$$

where δ_h denotes the depreciation rate associated with human capital. The q functions represent the marginal products for the factor inputs to human capital production. They are taken as given by each agent and defined as:

$$q^t_{h,t+i} \equiv \theta_1 \exp(a_{t+i})(h^t_{t+i})^{\theta_1 - 1}(n^t_{2,t+i})^{\theta_2}$$
$$q^t_{n,t+i} \equiv \theta_2 \exp(a_{t+i})(h^t_{t+i})^{\theta_1}(n^t_{2,t+i})^{\theta_2 - 1},$$

where θ_1 represents the *private return on the existing stock* of human capital, θ_2 measures the *private return to study hours*, h denotes existing human capital used in the production of future human capital, or the *ability to earn*, and a is an *ability to learn* parameter and represents an exogenous shift in total efficiency of human capital formation for all $i \in \mathbf{I}$ (For simplicity, the input of physical capital into the production of human capital is ignored. Although this assumption seems restrictive, one can argue that it may not be a serious problem since human capital production is likely to be relatively labor-intensive (Heckman et al., 1998; and Fowler and Young, 2004)). Because the marginal products with respect to existing human capital and skill acquisition hours of the right-hand side of equation (4) will define the returns to human capital production, we note that θ_1, θ_2, a, and h all affect the returns to human capital production. The total product is defined as the sum of the marginal products and is given by the function:

$$q(a_{t+i}, h_{t+i}^t, n_{2,t+i}^t) = (\theta_1 + \theta_2)\exp(a_{t+i})(h_{t+i}^t)^{\theta_1}(n_{2,t+i}^t)^{\theta_2}.$$

Unskilled Households

For the agent who is unskilled, all earned wages are consumed and no saving takes place; the agent is assumed credit constrained and thus cannot invest in human or physical capital. The general model of equations (1) – (4) is modified by:

$$\max_{\{\tilde{c}_{t+i}^t, \tilde{n}_{1,t+i}^t\}_{i=0}^{I-1}} E_t \left\{ \sum_{i=0}^{I-1} \beta^i \Psi_i u(\tilde{c}_{t+i}^t, \tilde{\ell}_{t+i}^t) \right\},$$

subject to:

$$\tilde{c}_{t+i}^t \leq (1-\tau)\tilde{w}_t \tilde{h}_{t+i}^t \tilde{n}_{1,t+i}^t + su_{t+i}^t, \tag{5}$$

and $\tilde{h}_{t+i+1}^t = (1-\delta_h)\tilde{h}_{t+i}^t$ where $\tilde{w} \cdot \tilde{h}$ is the real effective labor wage rate for unskilled workers. Also, τ is a social security tax rate used to fund payments su to the old households. Again, the individual has no ability to accumulate human capital beyond their initial endowment given the credit constraints; thus, unskilled human capital merely depreciates over time.

The Firm

The representative firm is assumed to be infinitely lived, behaves competitively, and maximizes the current value of the firm by renting physical capital from the old and hiring labor hours -- human capital -- from the skilled and unskilled young. Physical capital is assumed homogeneous, while labor differs in its productive ability. The firm utilizes capital and labor, both skilled and unskilled, subject to a constant elasticity of substitution (CES) production technology. More specifically, the aggregate output from a firm is produced according to:

$$Y_t \equiv F(K_t, N_t, \tilde{N}_t) = \left[\alpha K_t^{\sigma_2} + (1-\alpha)(\lambda N_t^{\sigma_1} + (1-\lambda)\tilde{N}_t^{\sigma_1})^{\frac{\sigma_2}{\sigma_1}} \right]^{\frac{1}{\sigma_2}}, \tag{6}$$

where $K_t = \sum_{i=0}^{I-1} k_t^{t-i}$ represents aggregate physical capital, $N_t = \sum_{i=0}^{I-1} h_t^{t-i} n_{1,t}^{t-i}$ is aggregate skilled labor, and $\widetilde{N}_t = \sum_{i=0}^{I-1} \widetilde{h}_t^{t-i} \widetilde{n}_{1,t}^{t-i}$ is aggregate unskilled labor. The parameter α is the income share parameter of physical capital in total income. The parameter λ represents the income share of skilled labor in total labor income. The parameters σ_1 and σ_2 govern the elasticity of substitution between physical capital, skilled labor and unskilled labor. Specifically, $1/(1-\sigma_1)$ is the elasticity of substitution between skilled and unskilled labor, $1/(1-\sigma_2)$ represents the elasticity of substitution between physical capital and labor - skilled and unskilled.

Profits of the firm, that are to be maximized, are:

$$\pi_t = F(K_t, N_t, \widetilde{N}_t) - r_t K_t - w_t N_t - \widetilde{w}_t \widetilde{N}_t .$$

Competitive behavior by the firms ensures that factors are paid their marginal productivity. The marginal productivity conditions are given by:

$$F_1(K_t, N_t, \widetilde{N}_t) = r_t, \quad F_2(K_t, N_t, \widetilde{N}_t) = w_t, \quad F_3(K_t, N_t, \widetilde{N}_t) = \widetilde{w}_t,$$

where $F_1(\cdot) = \partial F(K_t, N_t, \widetilde{N}_t) / \partial K_t$, for example.

Characterization of the Stationary Equilibrium

Optimal behavior by the households ensures that the following Euler equations, in addition to the budget constraints, hold for each agent in each time period. Every skilled agent will have three Euler equations: (i) investment in physical capital; (ii) amount of skilled work in production; and (iii) investment in human capital - the amount of skill acquisition. The Euler equations are derived by comparing the marginal costs and marginal benefits associated with each type of consumption and saving activity.

First, the Euler equation for investment in physical capital is derived by considering the trade-off between consumption and saving. Suppose the household from generation $t-i$ invests in a unit of time t physical capital. The marginal cost is the lost time t unit of consumption; in utility this is defined as the marginal utility of a unit of consumption**:**

$$u_{1,t}^{t-i} = \frac{\partial u(c_t^{t-i}, \ell_{1,t}^{t-i})}{\partial c_t^{t-i}}.$$

In terms of marginal benefit, the agent receives the discounted gross return on capital $(1+r_{t+1}-\delta_k)$; discounted by $\beta\psi_{\tau+1}$ and the marginal utility of one more unit of consumption:

$$u_{1,t+1}^{t-i}=\frac{\partial u(c_{t+1}^{t-i},\ell_{1,t+1}^{t-i})}{\partial c_{t+1}^{t-i}}.$$

Equating marginal benefits and costs gives the Euler equation in (9):

$$u_{1,t}^{t-i}=E_t\beta\psi_{\tau+1}\left\{u_{1,t+1}^{t-i}(1+r_{t+1}-\delta_k)\right\}. \tag{9}$$

Second, the Euler equation for a skilled worker is derived by considering the trade-off between work and leisure. Suppose that the agent works one extra hour at time t. Then the marginal cost is the time t lost leisure; in utility this is defined as the marginal disutility of a unit of labor:

$$u_{2,t}^{t-i}=\frac{\partial u(c_t^{t-i},1-n_{1,t}^{t-i}-n_{2,t}^{t-i})}{\partial n_{1,t}^{t-i}}.$$

In terms of marginal benefit, the agent receives an extra hour of effective wages times the marginal utility associated with an extra unit of consumption, $w_t h_t^{t-i} u_{1,t}^{t-i}$. Equating the marginal benefits to the marginal costs gives another Euler equation (10):

$$-u_{2,t}^{t-i}=u_{1,t}^{t-i}(1-\tau)w_t h_t^{t-i}. \tag{10}$$

Third, the Euler equation for investment in human capital is derived by considering the trade-off between obtaining an additional unit of human capital and leisure. Suppose that the agent invests in one unit of time t human capital. The marginal cost is the out-of-pocket and opportunity cost associated with purchasing one more unit of human capital and the time t lost leisure; in utility this is defined as the marginal utility of a unit of human capital, $-u_{3,t}^{t-i}/q_{n,t}^{t-i}$. In terms of marginal benefit, the agent receives the discounted gross return on human capital from work $w_t q_{n,t}^{t-i} n_{1,t}^{t-i}$ discounted by $\beta\psi_{\tau+1}$ and the marginal utility of one more unit of human capital. Additionally, given the investment in human capital, it is now easier for the household to obtain future human capital - implying *learning begets learning* or that skills acquired early facilitate later learning by increasing the marginal product of n_2. The benefit of learning begets learning is the marginal product of the human capital production function, $q_{h,t}^{t-i}$. Equating the marginal benefits and costs gives (11):

$$\frac{-u_{3,t}^{t-i}}{q_{n,t}^{t-i}} = E_t \beta \psi_{t+1} \left\{ u_{1,t+1}^{t-i}(1-\tau) w_{t+1} n_{1,t+1}^{t-i} + \left(\frac{-u_{3,t+1}^{t-i}}{q_{n,t+1}^{t-i}} [q_{h,t+1}^{t-i} + 1 - \delta_h] \right) \right\} \tag{11}$$

By the same logic, one could derive the Euler equation for the unskilled worker. Since that set of workers cannot invest in either human or physical capital, there will be only one Euler equation and it is found by considering the trade-off between work and leisure:

$$-\tilde{u}_{2,t}^{t-i} = \tilde{u}_{1,t}^{t-i}(1-\tau)\tilde{w}_t \tilde{h}_t^{t-i} \tag{12}$$

Extensive versus Intensive SBTC

The parameter λ is skilled labor's share in total labor. Alternatively, we can reinterpret λ as skilled labor's share times a technological parameter that determines the productivity of the skilled. The ratio $\lambda/(1-\lambda)$ is skilled labor's relative technological progress that occurs in the production of final goods. Since firms pay labor their marginal products, the relative wage of skilled to unskilled is directly determined by $\lambda/(1-\lambda)$. Therefore, an increase in λ is a SBTC. We denote this type of technological change as *extensive SBTC.*

An interesting feature that results from the model's skill acquisition sector and limited participation assumption is that biased technological improvements (in favor of skilled labor) can enter in another important way: the skill acquisition sector. If the labor's productivity in the acquisition of skills increases, then the demand for skills is affected causing the skill premium to change. Technological change occurring through the supply of labor via skill acquisition is denoted *intensive SBTC*. Intensive SBTC can occur from changes in the set of parameters $\{h_t^t, \theta_1, \theta_2, a_t\}$.

An example of the extensive type of technological change may be the introduction of computers; the productivity of skilled-workers, who most likely use the technology, increases relative to the unskilled (Johnson 1997). Intensive skill-biased technological change arises in the skill acquisition sector and occurs when the marginal product of skilled workers increases without necessarily decreasing the marginal product of unskilled workers. An example of this type of technological change may be the introduction of the Internet at campus libraries. The actual acquisition and, potentially, the retention of skills become more efficient.

Calibration

Calibration of the model requires the length of the life-cycle, a functional form for utility, and a variety of parameters to be set. The parameters form four groups: preferences, production, skill acquisition, and policy. Table 1 below provides a listing of the initial model parameters, descriptions, and values.

First, the length of the life-cycle, I, must be determined. In the OLG literature, agents typically make economic decisions over a 63-year period with retirement beginning at age 66. For this analysis, economic life starts at age 18, which implies that the terminal age is 80. To keep computation of the equilibria manageable, however, the life-cycle is condensed. Because few people graduate from college in less than 5 years, each period in the model chosen represents a 5-year time span. As such, the length of the life-cycle becomes $I = 12$ periods. Each agent dies at age 77 or at the end of period 12. For the skilled, retirement is assumed to begin at age 63, or at the end of period 9. Retirement represents the three periods where skilled labor hours are exogenously set to zero, $n_{1,t}^{t-10} = n_{1,t}^{t-11} = n_{1,t}^{t-12} = 0$. As a result of the exogenously set retirement age, skill acquisition hours stop after period eight since workers would not have enough time to be in the labor force to make skill acquisition worthwhile; thus, $n_{2,t}^{t-9} = n_{2,t}^{t-10} = n_{2,t}^{t-11} = n_{2,t}^{t-12} = 0$. These assumptions are also made for the unskilled; the unskilled are required to retire at the end of period 9.

Table 1: Baseline Model Parameters, Descriptions, and Values	
Parameter	**Description**
Preferences	
$\mu_1 = 1$	Arrow-Pratt measure of risk aversion
$\mu_2 = 2 = 1$	Determines the intertemporal labor supply elasticity
$\varphi = 1.225$	Weight parameter on leisure
$\beta = 0.8626$	Discount factor for time preferences
Production	
$\sigma_1 = 0.3333$	Determines demand elasticity of substitution between skilled and unskilled labor
$\sigma_2 = -0.05$	Determines demand elasticity of substitution between physical capital and labor
$\alpha = 0.34$	Share of physical capital to total labor
$\lambda = 0.51$	Share of skilled labor to total labor
$\delta_K = 0.266$	Depreciation rate of physical capital, 6% per year
$= 0$	Initial level of physical capital
Skill Acquisition	
$\theta_1 = 0.52$	Private return on existing human capital stock
$\theta_2 = 0.52$	Private return on study hours
$= 13.62$	Initial level of human capital of skilled
$= 9.53$	Initial level human capital of unskilled
$= 0$	Ability to learn
$\delta_h = 0.00005$	Depreciation rate of human capital

Table 1: Baseline Model Parameters, Descriptions, and Values	
Parameter	**Description**
Policy	
$\tau = 0.124$	Social Security tax rate

Preferences utilizing the conventional power utility specification are chosen:

$$u(c, n_1, n_2) = \frac{c^{1-\mu_1}}{1-\mu_1} + \varphi \frac{(1-n_1-n_2)^{1-\mu_2}}{1-\mu_2}.$$

The separable form of utility is chosen for two main reasons: (i) it permits one to separate the intertemporal elasticities of consumption and leisure; and (ii) it is commonly used in the dynamic macroeconomic literature (*e.g.*, Heathcote, Storesletten, Violante, 2004). The parameter μ_1 represents the Arrow-Pratt coefficient of relative risk aversion. The parameter's value is restricted to the limiting case where $\mu_1 = 1$ so that preferences will be consistent with balanced growth. As μ_1 approaches 1, the consumption portion of the utility function collapses to the log of consumption. The parameter μ_2 determines the intertemporal labor supply elasticity; setting $\mu_2 = 2$ falls within the range of existing estimates found in the micro and macro literature (Browning et al. 1999). Following Heathcote et al. (2004), the parameter φ denotes the weight parameter on leisure and is set such that the average fraction of time devoted to work is roughly 0.33; this results in a value of $\varphi = 1.225$. A value is needed to discount preferences over time; $\beta = 1/(1.03)^5 = 0.8626$ is chosen to be compatible with a yearly psychological rate of three percent. The survival probabilities are estimated by converting the annual mortality probabilities from the U.S. Life Tables of the National Center for Health Statistics (1992) to the $I = 12$ life-cycle. The values for survival probabilities are presented in Table 2.

Table 2:Calibrations for Survival Probabilities			
$\Psi_0 = 1.00000$	$\Psi_1 = 0.99819$	$\Psi_2 = 0.99731$	$\Psi_3 = 0.99717$
$\Psi_4 = 0.99306$	$\Psi_5 = 0.98510$	$\Psi_6 = 0.97070$	$\Psi_7 = 0.95365$
$\Psi_8 = 0.92483$	$\Psi_9 = 0.87436$	$\Psi_{10} = 0.81549$	$\Psi_{11} = 0.73835$
$\Psi_{12} = 0.63981$			

As indicated in equation (6), production has five main parameters to calibrate, σ_1, σ_2, δ_k, α, and λ. The parameter σ_1 represents the demand elasticity of substitution between skilled and unskilled labor. This value is set at $\sigma_1 = 0.3333$ giving an elasticity of 1.5, consistent with estimates found in the literature (*e.g.*, Browning et al., 1999; Autor, Katz, and Kearney, 2008). Krusell, Ohanian, Rios-Rull, and Violante (2000) estimate the parameter governing the demand elasticity of substitution between capital and labor at $\sigma_2 = -0.05$, resulting in an elasticity of substitution close to 1 that is not too different than the Cobb-Douglas specification between capital and labor ($\sigma_2 = 0$) found by Heckman, et al. (1998). As a consequence, α is roughly capital's share of output which Heckman et al. (1998) report at $\alpha = 0.34$. Next, the value for depreciation of physical capital is needed; $\delta_k = 1-(1-0.06)^5$ which implies a six percent annual depreciation rate, an average of the estimates most commonly found in the dynamic macroeconomic literature. The remaining parameter of the production function λ is set to match the wage premium for the beginning of the 1980's decade of approximately 1.30 (Card and DiNardo, 2002) which gives a share of skilled labor in total labor of $\lambda = 0.51$.

A final group of parameters is needed for skill acquisition. As stated previously, the parameter θ_1 represents the private return on the existing stock of human capital while the parameter θ_2 measures the private returns to study hours. There is a wide range of estimates found in the literature (*e.g.*, Ben-Porath, 1967; Heckman, 1976; Rosen, 1976; Browning et al., 1999). The two parameters are restricted by $0 \le \theta_1 < 1$ and $0 \le \theta_2 \le 1$ so as to guarantee that the human capital production function is concave in the control variables. Because we conduct comparative statics on these parameters, we utilize the lower end of the parameter estimates listed in Browning et al. (1999): $\theta_1 = \theta_2 = 0.52$. The initial levels of skilled and unskilled human capital must be set. The skill levels are set according to those identified by Heckman et al. (1998). Initial skilled human capital is set to $h_t^t = 13.62$ and unskilled human capital is set to $\widetilde{h}_t^t = 9.53$. Estimates for a and δ_h are needed to complete the calibration of skill acquisition. The ability to learn parameter is initially set to $\overline{a} = 0$. The level of human capital depreciation is initially set very close to zero, $\delta_h = 0.00005$ to allow for some loss in skill if human capital is not developed.

The current U.S. social security payroll tax is 12.4% implying $\tau = 0.124$. Though the program is pay-as-you-go, benefits are tied to contributions so as to guarantee a specific replacement rate of return. We take this to imply that the social security contributions of the skilled are used to fund the retired skilled work force; they are equally split between the three oldest generations of skilled retirees. Likewise, the contributions of the unskilled are used to fund the retirement of the unskilled workers; they are equally split between the three oldest groups of unskilled retirees.

MODELING RESULTS

Using the initial calibrations identified in Table 1, the baseline model is solved. Because the baseline results will be used as comparison for the forthcoming experiments, it is important to assess the model's performance. First, Table 3 shows that the model is able to replicate,

$$\tilde{w}_{i,t} = \tilde{w}_t \tilde{h}_{i,t}$$

roughly, aggregate labor hours. Though skilled workers do not work as many hours as unskilled workers (their human capital is more valuable and brings a higher wage rate), the average time spent in goods production is (31.33 + 34.75) / 2 = 33.04%. Consumption is rather unequal; the implied Gini coefficient for skilled to unskilled consumption is 26%. In the data, the U.S. consumption Gini is in the range of 25-29% (Blundell 2006). Given that the skilled investment in human capital is about 3.28% of total consumption (0.0417 / (0.0417+1.2283) = 0.0328), human capital non-trivially increases with age to 15.054 from the initial starting point - the acquisition of skills is an important margin of choice for the skilled. Finally, the average skill premium of 1.308 is consistent with that reported by Card and DiNardo (2002). Recall that skill-specific wages are given by: $w_{i,t} = w_t h_{i,t}$ and $\tilde{w}_{i,t} = \tilde{w}_t \tilde{h}_{i,t}$. The wage gap, or the logged skill premium, is defined as: $log(w_{i,t}/\tilde{w}_{i,t}$

Table 3: Selected Steady State Allocations – Baseline	
Measure	Mean
Skilled Labor Hours	0.3133
Unskilled Labor Hours	0.3475
Skilled Consumption of Goods	1.2283
Unskilled Consumption of Goods	0.7199
Skill Acquisition Expenditures	0.0417
Human Capital	15.054
Skill Premium	1.3088

Figure 2 illustrates the steady-state profiles of the baseline model. Figure 2(a) shows that consumption exhibits the typical hump shape consistently found in the life-cycle literature. The implication is that households do not perfectly smooth consumption by age. This is a direct result of the assumption of no income insurance markets. Skill acquisition expenditures, Figure 2(b), appear to be consistent with economic logic and with those found throughout the literature as well. For example, as one ages there is less time to recoup the benefits of additional years of schooling. As such, it makes sense that spending on higher education services (*i.e.*, skill acquisition expenditures) should fall with age. Given that the young are relatively poor in human capital, it is not surprising to see human capital, Figure 2(c), rise with age as well as the logged skill premium, panel (d). The wage gap corresponds nicely to Figure 1that is taken from Card and DiNardo (2002).

The next step is to evaluate the effect of changes in skill-biased technology; the following several paragraphs accomplish this task. The first experiment adjusts the baseline model by increasing λ from 0.51 to 0.561; roughly a 10% increase. Figure 3(a) plots the effects of this extensive SBTC on the wage premium. As expected, the relative marginal product of skilled workers increases for all ages. As a result, the wage gap increases uniformly across age. The impact on the average wage gap is about 28%, increasing from 0.308 to 0.596. Although the increase in λ is relatively small, the impact on the wage premium is large but consistently within the range of skill premiums in the literature (Card & DiNardo, 2002; Krueger, 2003). Figure 4(a) plots the effect of increasing λ by 10% on skill acquisition expenditures. We see for the young, skill acquisition expenditures rise; this is a substitution effect. Apparently, the higher relative wages from having skills induces the young to substitute into the acquisition of skills.

Figure 2: Steady State Profiles for the Baseline Model

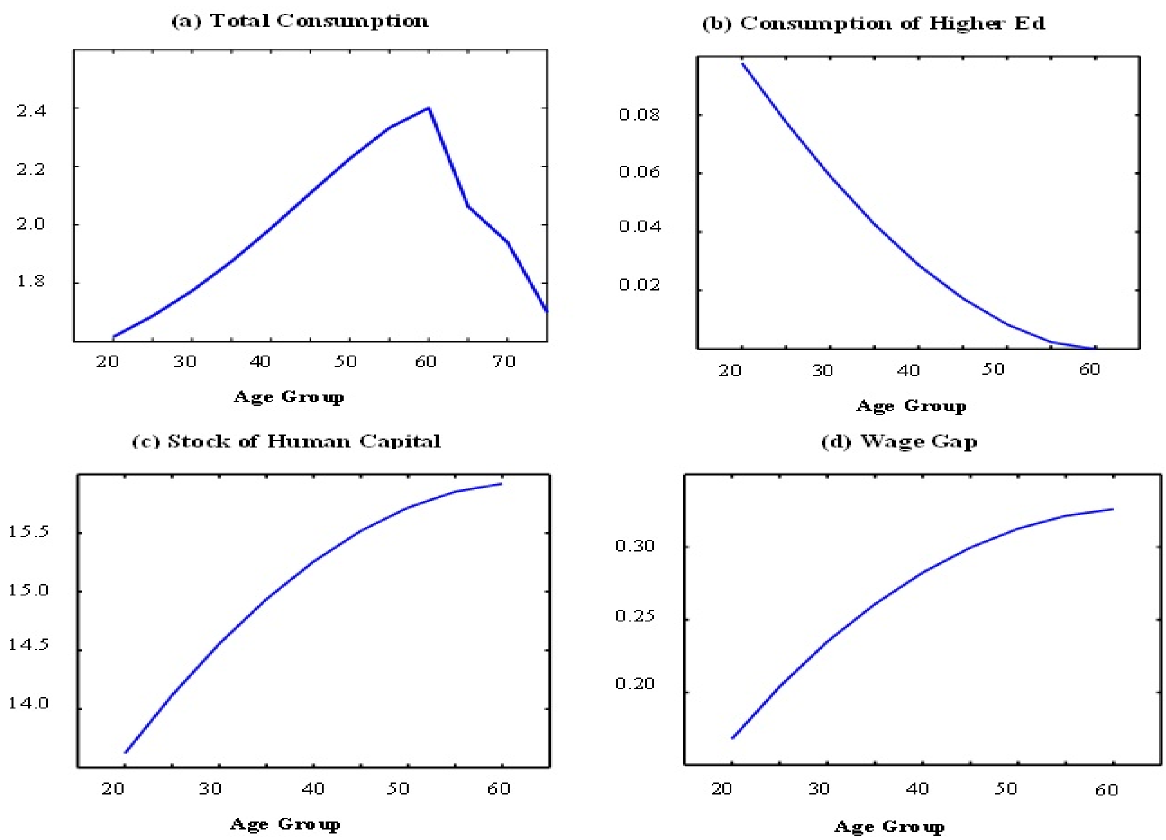


Figure 3(b) plots the effect on the wage gap of a 10% increase in the initial stock of skilled human capital (the ability to earn). The higher level of human capital increases the wage gap evenly across all age groups. However, the average increase in the wage premium is about 3% implying that the extra supply of human capital somewhat diminishes the skilled-to-unskilled wage. Presumably, the combination of increased supply of skilled labor and increased productivity of the unskilled (since they are complements) causes $\log(w_{i,t} / \tilde{w}_{i,t})$ to fall. Figure 4(b) shows the effect on human capital expenditures; there is little to no change in expenditures on higher education. This total effect is due two competing intermediate effects cancelling. In the first case, the extra initial human capital increases the wage return of an additional human capital unit and, as a result, the household demands more human capital. Alternatively, the marginal product of the actual return to skill production falls since $\partial q_h / \partial h < 0$. As a result, both effects cancel thus leaving consumption of higher education unchanged.

Now consider the effects of a 10% increase to the private return on the existing stock of human capital θ_1. Figure 3(c) plots the effects of this type of intensive SBTC; we see that the wage gap starts below and then rises above the existing profile. The increase in the private rate of return on existing human capital increases the acquisition of human capital; this is confirmed in Figure 4(c). The increase in skilled human capital has three competing effects. First, the increase in human capital increases the wage for the unskilled, $\tilde{w} \cdot \tilde{h}$, as they are relative complements to the skilled. Second, because the skilled wage rate, w, is a decreasing function of skilled human capital, the wage for the skilled falls. Alternatively, for a given skilled wage rate, the effective skilled wage rate, $w \cdot h$, increases. In total, the young skilled - who are relatively human capital poor - see their relative wage fall since they have not accumulated enough human capital to offset the negative effects on their relative wage rate.

Figure 3(d) plots the effects of a 10% increase to the private return on study hours θ_2. The wage gap starts above and falls below the existing profile. Because study hours are more effective, the household can shift more time into leisure activities; this is an *income* effect. The shift into leisure activities is evident in Figure 4(d) where investment in human capital falls for all age groups. As a result, the skilled enjoy the increase in study hour productivity when they are young. Those with relatively more skills (middle to older aged workers) see a lower skill premium since they economized on their skill acquisition activities when they were young.

Figure 3(e) plots the effects on the wage gap of a 10% increase to the ability to learn a. Just like the increase in the private return on the existing stock of human capital in Figure 3(c), the wage gap starts below and rises above the existing profile. Again, the increase in the productivity of human capital acquisition has three competing effects. The resulting effect is that the young see their relative wage fall since they have not accumulated enough human capital to offset the negative effects on their relative wage rate.

Figure 3: The Effects of Different Types of SBTC on the Wage Premium

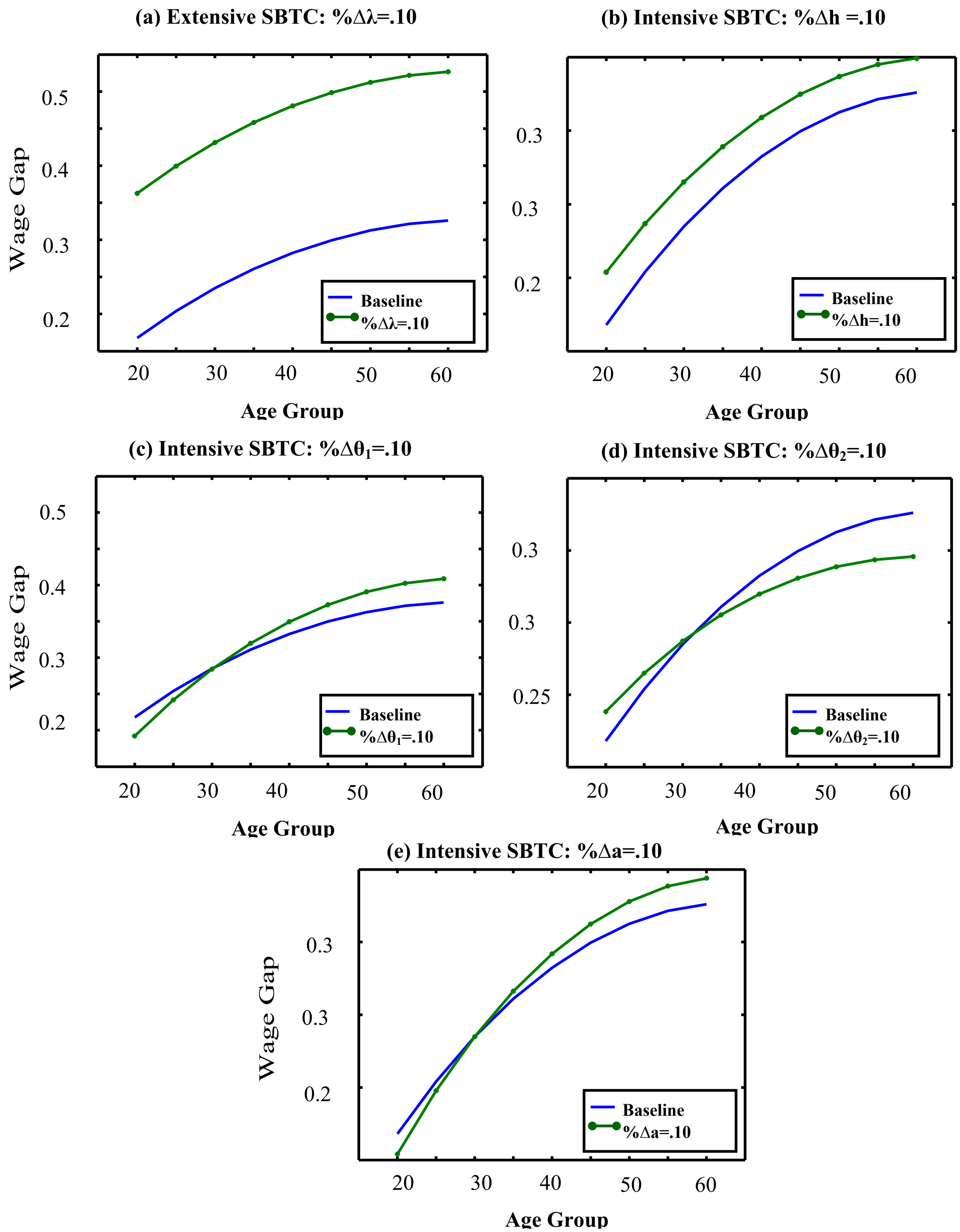


Figure 4: The Effects of Different Types of SBTC on Skill Acquisition

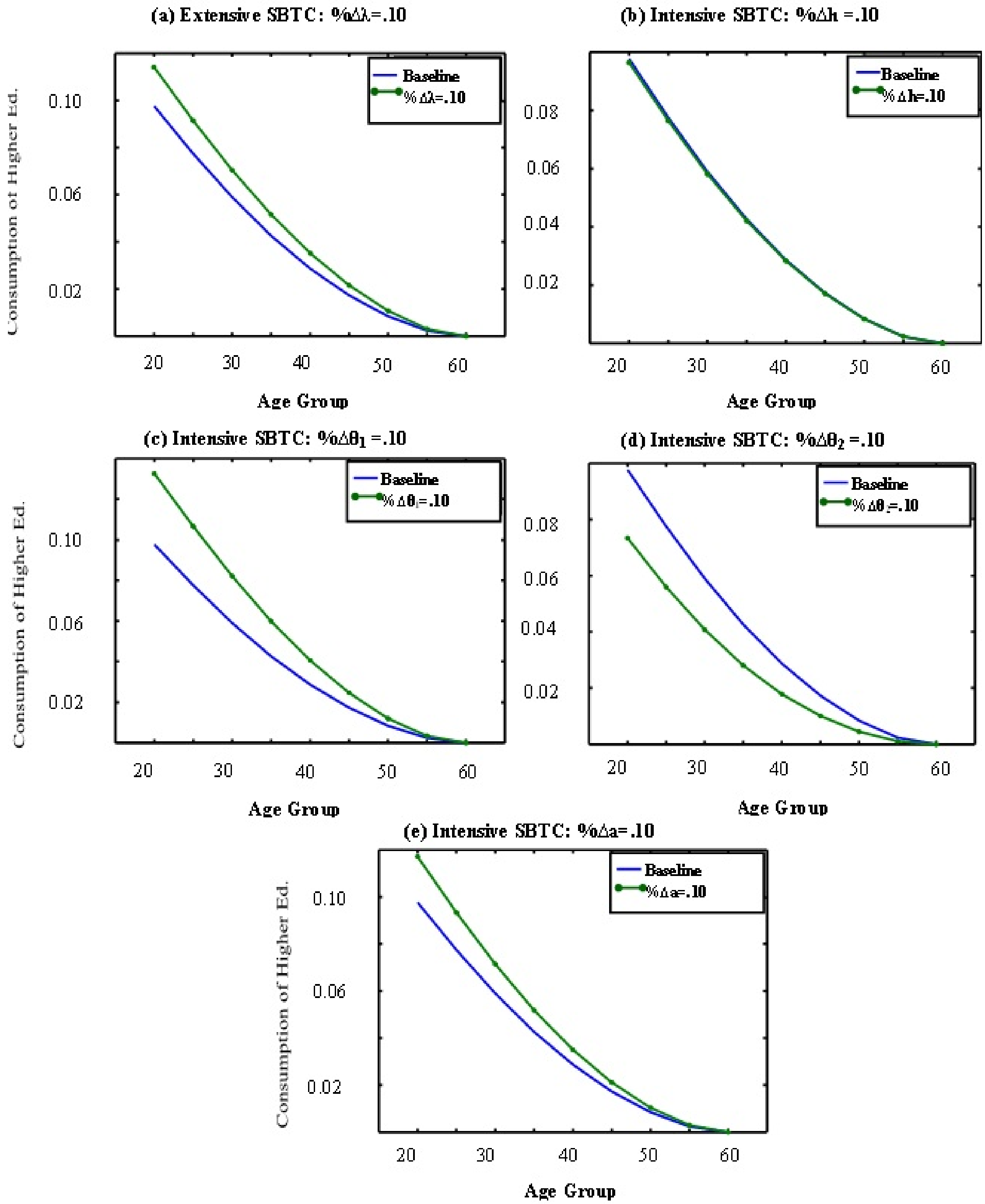
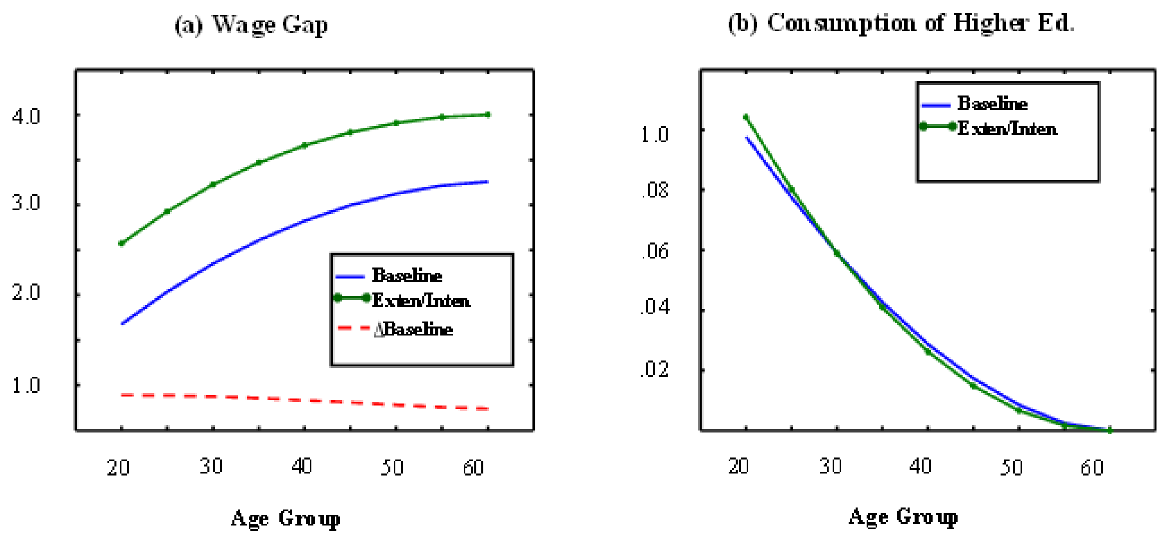


Figure 5: The Effects of Combined Types of SBTC on the Wage Premium & Skill Acquisition



Now consider Figure 5 that plots the effects of a combination of different types of SBTC. More specifically, we increase λ by 5% and increase θ_2 and a by 10%. Figure 5(a) shows that the wage gap profile shifts up at an unequal rate. More specifically, the increase in relative wages is larger for the young than the old. Figure 5(b) shows that the unequal shift in the wage gap is attributed to the fact that each household intertemporally substitutes their consumption of higher education more towards their younger years. The fact that the rate of return to human capital is higher causes the young the increase hours of study time. Alternatively, the old substitute away from study hours and presumably into consumption and leisure.

Graphically, it is apparent that the extensive SBTC parameter has the greatest impact on the skill premium and its associated wage gap. But, in terms of the empirical facts of the wage gap, extensive and intensive SBTC alone do not provide an answer to Card and DiNardo's (2002) critique of the SBTC hypothesis found in Figure 1; namely that the wage gap changes very little in older age groups. Instead, a combination of *both* extensive and intensive SBTC is needed to account for the flattening of the wage gap profile.

THE EMPIRICAL MODEL OF HUMAN CAPITAL ACQUISITION

The theoretical results show that household spending on higher education services shifts when SBTC occurs. Though a variety of macroeconomic studies have estimated life-cycle consumption profiles (Gourinchas and Parker 2002; and Fernandez-Villarverde and Krueger

2002), none have specifically focused on higher education expenditures and, if they exist, shifts across the life-cycle. Thus, our study builds upon the work of Gourinchas and Parker (2002) and Fernandez-Villarverde and Krueger (2002) - who estimate reduced form demands for consumption excluding higher education services - and extends their framework to the consumption of higher education.

The Data

To develop and estimate the higher education consumption profiles and subsequent changes over time, a variety of data sources are utilized. First, and foremost, U.S. Bureau of Labor Statistics' (BLS) Consumer Expenditure Survey (CES) is utilized to gather spending and demographic data on households. The CES has the best available data on household consumption. Approximately 5,500 households are interviewed quarterly across the United States. Each household remains in the survey for four consecutive quarters after which they are rotated out and replaced by a new household - also called a rotating panel. The data used cover the time period of 1982:1-2002:4; a time frame consistent with Card and DiNardo (2002). Next, the BLS average U.S. regional unemployment rates are used to proxy business cycle effects. Finally, the BLS's regional Consumer Price Index - All Urban Consumers 1982-1984 base year - is used to deflate all dollar denominated data.

We make several modifications to the data. First, we drop the households that do not complete all four quarterly interviews. This reduces the sample to about 78,431 households. Second, the CES asks each member of the household if they are enrolled in college and an acceptable missing response is reported if the family member is not qualified for college. For example, a missing response is reported for a two year old as well as a 70 year old who has not completed high school. Households who do not have at least one qualified member for each quarter are dropped from the sample leaving 67,726 households.

A plot of real higher education expenditures by age of the head of household would not necessarily give the skill acquisition profile of an individual - an empirical profile would presumably be upward sloping for certain age groups. There are two main reasons why spending on higher education may be upward sloping. First, spending by households most likely includes spending on other family members who would be of college age further into the head's life-cycle. Second, part-time student enrollments have a clear humped shaped pattern with a distinct peak; the peak occurs in the late twenties.

Therefore, for identification of the individual and full-time skill acquisition profile, we jointly pursue two identification strategies. In the first, we identify the members of the family who are in college. Though the CES only gives family expenditures on higher education (aggregated), the *incol* variable allows us to model the aggregation of the individual to the family level. Specifically, because the family members enrolled are identified, we are able to compute the average age of family members enrolled (*age1*) so that it may be related to the average real spending, relative to those enrolled, on higher education (*hied1*). Real spending on higher education is defined as tuition for college plus school books, supplies and equipment for college all deflated by the price index. In the second part of the strategy, we identify those individuals who are part-time students (*part1*) from the *incol* variable. Then, the *part1* variable is interacted with the age of the enrolled member, *age1,* so as to compute the average age, relative to those enrolled, of part time students (*age1part1*). The next section more formally describes the estimation model.

Figure 6 illustrates the average real higher education expenditures of enrolled students, *hied1*, by the average age of enrolled students *age1* for the time periods of 1982:1 to 2002:4. The data used for Figure 6 were split into 11 age cohorts, meaned by decade, by spenders (those households who spend on higher education), and by full-time students. The data anecdotally verify that real spending has consistently increased over the periods 1982:1-1992:2 to 1992:3-2002:4 for most, but not all, age groups. In fact, the old have appeared to decrease their spending.

Figure 6: Mean Household Higher Education Expenditures

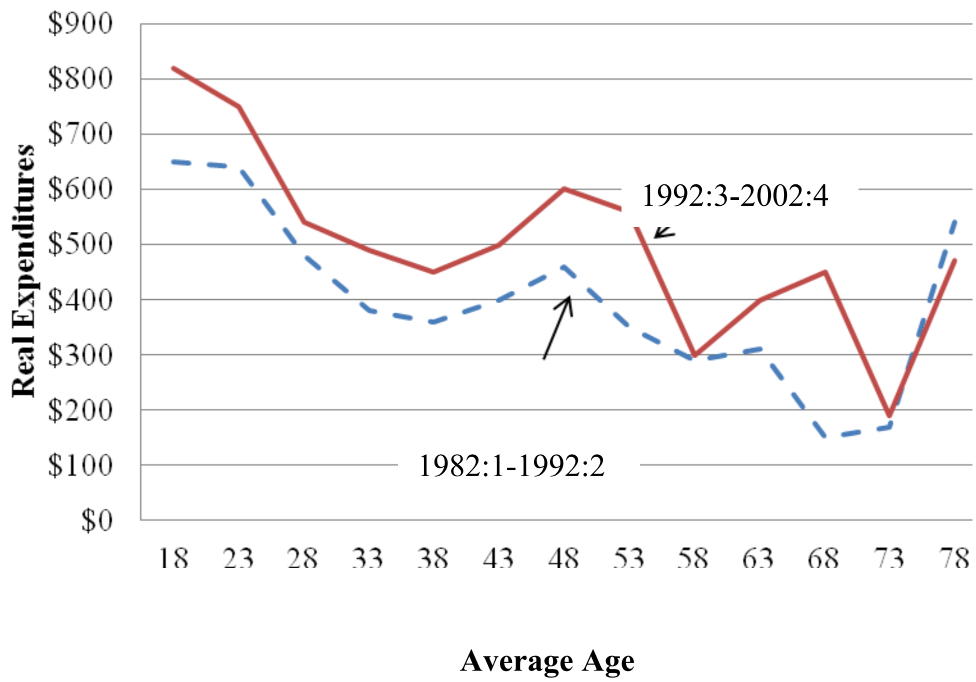


Table 4 lists the other variables that are extracted from the data sets for the purpose of identification of the skill acquisition profile. Most variable descriptions are self-explanatory but some may need further explanation. The variable *childeq0* represents a scale of the number of children age 18 and under in each household. Employing a methodology similar to Fernandez-Villaverde and Krueger (2002) and Browning and Ejrnæ s' (2002), a household equivalence scale, *childeq0*, is estimated for family j of size $famsize_j$ as follows:

$$childeq0_{j,t} = \sum_{i=1}^{famsize_j} \left(\mu_0 + \mu_1 \left(\frac{age_i}{18} \right) + \mu_2 \left(\frac{age_i}{18} \right)^2 + \mu_3 \left(\frac{age_i}{18} \right)^3 \right) (1 - d_i)$$

where age_i is equal to the maximum of the i'th family member's age or 18, $\{\mu_0, \mu_1, \mu_2, \mu_3\}$ is the set of child response parameters used to approximate the age effects of children, and d_i is a zero-one dummy representing an adult when age_i is greater than 18. Note that if the individual age is greater than 18 years old, then $d_i = 1$. The restriction $\mu_3 = 1 - \mu_0 - \mu_1 - \mu_2$ is imposed so that the function is continuous. Employing estimates from Browning and Ejrnæ s (2002), the child response parameters have the following values: $\mu_0 = -0.091$, $\mu_1 = 2.469$, and $\mu_2 = -5.73$.

Table 4:Descriptive and Summary Statistics of Data

Variable	Description	Mean: All HHS	Mean: Spenders
Dependent Variables:			
hied0	0/1: higher education participation	0.051	1.000
hied1	Real average household spending on higher education	29.393	572.157
Family Variables:			
age0	Age of head of household	48.309	42.124
age02	Squared age of head of household	2592.70	1923.42
mwst0	0/1: live in urban Mid-West	0.249	0.244
sth0	0/1: live in urban South	0.274	0.253
west0	0/1: live in urban West	0.221	0.272
rural0	0/1: rural residence	0.097	0.072
blk0	0/1: black head of household	0.097	0.073
othrc0	0/1: other than Caucasian or black race head of household	0.037	0.061
fem0	0/1: female head of household	0.353	0.309
mar0	0/1: married head of household	0.634	0.695
nohs0	0/1: no high school diploma for head of household	0.092	0.048
hs0	0/1: only high school diploma for head of household	0.351	0.174
childeq0	Number of equivalent children in household	0.280	0.290
colage0	Number of college-age people in household, excl. head	0.998	1.498
dyr0	0/1: indicator of time: 1992:3-2002:4	0.557	0.497
age0dyr0	Interaction: age of head of household and time	27.358	20.870
age02dyr0	Interaction: squared age of head of household and time	1489.02	948.635

Table 4:Descriptive and Summary Statistics of Data			
Variable	Description	Mean: All HHS	Mean: Spenders
Member Variables:			
age1	Average age of household members enrolled in college	1.459	28.391
age12	Average squared age of household members enrolled in college	46.875	912.450
age13	Average cubed age of household members enrolled in college	1714.38	33371.62
part1	Fraction of members enrolled in part-time college	0.020	0.393
age1part1	Interaction: age of member and enrolled in part-time college	0.691	13.450
age12part1	Interaction: squared age of member and enrolled in part-time college	26.074	507.552
age1dyr0	Interaction: age of enrolled member and time	27.358	20.870
age12dyr0	Interaction: squared age of enrolled member and time	24.027	467.711
age13dyr0	Interaction: cubed age of enrolled member and time	891.723	17358.00
Regional B.C.Variables			
uer2	Average regional unemployment rate	0.060	0.061
Weight Variable:			
enroll3	Average number of members enrolled in college	0.062	1.209
Households: 67,726. Total observations: 270,904. Spending on higher education observations: 13,917.			

METHODOLOGY

In order to generate higher education consumption profiles, this empirical analysis centers on a hierarchical application to the sample selection model of Heckman (1976). By utilizing a sample selection model (Heckit), two types of parameters are estimated. For the first type, a probit model - using all households - estimates the probability of household higher education participation. For the second type of parameters, a linear model is utilized to find the marginal effects of demographic and descriptive variables on the consumption of higher education. Consumption profiles are then generated from the linear model results.

More specifically, the j'th family's choice to participate is given by the following discrete choice model:

$$y_{j,t} = 1[\mathbf{w}_{j,t}\boldsymbol{\theta}_1 + \mathbf{z}_{j,t}\boldsymbol{\theta}_2 + \varepsilon_{j,t} > 0] \tag{13}$$

where $y_{j,t}$ is one if the household spends on college (*hied0*), $\mathbf{w}_{j,t}$ includes the age of the head of household (*age0*), no high school diploma for the head (*nohs0*), to name just a few, and the $\mathbf{z}$ is a vector of exogenous variables used to proxy business cycle effects that includes a regional unemployment rate (*uer2*).

Let $c^i_{j,t}$ be defined as real higher education consumption by individual i from family j at time t. Then, for an individual i who is enrolled in college and spending on college, we specify an equation that relates consumption of higher education to age by:

$$\begin{aligned} c^i_{j,t} = {} & \beta^0_{j,t} + \beta^1_{j,t} age^i_{j,t} + \beta^2_{j,t}(age^i_{j,t})^2 + \beta^3_{j,t}(age^i_{j,t})^3 + \\ & \beta^4_{j,t} part^i_{j,t} + \beta^5_{j,t} part^i_{j,t} age^i_{j,t} + \beta^6_{j,t} part^i_{j,t}(age^i_{j,t})^2 + u^i_{j,t}, \end{aligned}$$

where $age^i_{j,t}$ is the time t age of individual i (less 18) from family j who is enrolled in college, $part^i_{j,t}$ is a discrete variable equal to 1 if the individual has indicated enrollment is part-time, and $u^i_{j,t}$ is an unobserved transitory shock that is independently, identically (across families), and normally distributed: $u^i_{j,t} \sim N(0,\sigma^2_u)$. In matrix form, we write the above equation as:

$$c^i_{j,t} = \mathbf{x}^i_{j,t}\boldsymbol{\beta}_{j,t} + u^i_{j,t}. \tag{14}$$

Additionally, following a typical hierarchical approach, the parameters in $\boldsymbol{\beta}_{j,t}$ are related to family characteristics by the following relationship:

$$\boldsymbol{\beta}_{j,t} = \mathbf{w}_{j,t}\boldsymbol{\gamma} + \varepsilon_{j,t}$$

where $\varepsilon_{j,t} \sim N(0,\sigma^2_{j,\varepsilon})$ and γ are fixed coefficients to be estimated.

Unfortunately, the CEX does not give $c^i_{j,t}$. Instead, in any time period, the CEX provides total household spending on higher education. Given that the *incol* variable gives the total number of members of family j enrolled in college ($n_{j,t}$), we divide equation (14) by $n_{j,t}$ to yield:

$$c^i_{j,t}/n_{j,t} = \mathbf{x}^i_{j,t}/n_{j,t}\boldsymbol{\beta}_{j,t} + u^i_{j,t}/n_{j,t}.$$

Or, alternatively,

$$\bar{c}_{j,t} = \mathbf{x}_{j,t}\boldsymbol{\beta}_{j,t} + \bar{u}_{j,t} \tag{15}$$

where the bars indicate that the variable has been meaned across those enrolled in college. Equations (13) and (15) form the base likelihood model for our regressions. The number of members enrolled in college is used to weight the regression since the variance of the error is a function of $n_{j,t}$. Also, the standard errors are robust and clustered on the household.

Notice that we include the business cycle variable in equation (13) but not in (15). Although the state of the business-cycle is important in the initial participation stage, one can argue that once the decision to participate in higher education is made the state of the economy is no longer an important determinate of spending. While many people have the option of purchasing as few as one class per semester, significant enrollment costs in most U.S. universities place a floor on the dollar cost of attending. Additionally, due to time and course load constraints, students can take no more than a maximum of 18 to 24 credit hours per semester, thus placing a ceiling on the number of credit hours and cost of attendance. Given the existence of both a tuition floor and ceiling, the impact of business-cycle variables at the second stage - how much to actually spend - becomes less important.

Our selection of the family variables in $\boldsymbol{\beta}_{j,t}$ is determined by the restrictions placed on $\boldsymbol{\gamma}$. Most of the family variables are assumed to interact with the constant (a level shift) making most of the columns, except for the first, of $\boldsymbol{\gamma}$ zero. However, it is often the case that the head of the household is also the higher education spender. In this case, the coefficients on *age1* and *age0* are not able to be identified. To sharpen the differences between *age0* and the member variable *age1*, we interact *age0* with *age1* (denoted *age0age1*). Next, the fraction of households that spend on higher education and have a head without a high school education is small. To increase the variation in *nohs0*, it is added to *hs0* (denoted *nohs0*+*hs0*) to form a new dummy for households headed by an individual with an education at or below the high school level. Finally, all ages- for both the head of household and enrolled students - are normalized to zero on age 18.

EMPIRICAL RESULTS

Table 5 presents the results of the probit model. The age variables and the interaction terms that include age are, overall, not that significant. The most notable estimation results for the probit are the education status of the head; the variables *nohs0* and *hs0* are each negative and significant at any reasonable critical level implying that an increase in these variables leads to an decrease in the probability of spending for the family on higher education. Also notable is the age composition of the family. For example, when the number of children, *childeq0*, increases in the household, the probability of spending on higher education falls presumably due to the need to substitute toward other goods and services such as food and clothing. Finally, as the number of people in the household who are of college age rises, the probability of spending on higher education rises, the coefficient on *colage0* is positive and significant at any reasonable critical level.

Table 5: Heckit Model Part 1 – Probit Selection

Probability that hied0 = 1

hied0	Coefficient	Robust Std. Error	z	Pr>|z|
age0	.0026269	.0029885	0.88	0.379
age02	-.0003163	.0000494	-6.40	0.000
mwst0	.0463135	.0205362	2.26	0.024
sth0	.0025115	.0202449	0.12	0.901
west0	.075089	.0208541	3.60	0.000
rural0	-.0266413	.0278553	-0.96	0.339
blk0	-.1320247	.0245546	-5.38	0.000
othrc0	.0353989	.031871	1.11	0.267
fem0	.0185132	.0151573	1.22	0.222
mar0	-.1622509	.0164435	-9.87	0.000
nohs0	-.6474605	.0309952	-20.89	0.000
hs0	-.5214397	.0159076	-32.78	0.000
childeq0	-.1861652	.0170776	-10.90	0.000
colage0	.3945015	.0077119	51.16	0.000
dyr0	.0139871	.0525902	0.27	0.790
age0dyr0	-.0058436	.0039145	-1.49	0.135
age02dyr0	.0000491	.0000639	0.77	0.442
uer2	2.060779	.4586827	4.49	0.000
constant	-1.620917	.0530227	-30.57	0.000

Number of Observations: 270,904

Table 6 presents the results for the second part of the Heckit Model. Unlike before, the age variables and the interaction terms that include age are mostly significant at the .05-level. For the most part, higher education consumption is downward sloping (*age1*'s coefficient is -26.415) with some slight curvature; the higher order coefficients for age are marginally significant. Other results indicate, for example, that relative to those in the northeast survey participants in the midwest, south, west, and rural areas spent less on higher education. The race variable, *blk0*, is negative and significant at the .01-level but other races show no significant difference from whites. Because the estimation is in reduced form, however, the causality of variables like region and race are difficult to ascertain. It may be the case that race and region are tracking income. In any event, the majority of the estimates in Table 6 appear consistent with economic intuition.

Table 6: Heckit Model Part 2: Weighted Linear Regression				
Real Spending on Higher Education				
hied1	Coefficient	Robust Std. Error	z	Pr>|z|
age1	-26.41472	7.064849	-3.74	0.000
age12	.2640707	.3870469	0.68	0.495
age13	-.0126318	.0046371	-2.72	0.006
dyr0	220.2577	55.03836	4.00	0.000
age1dyr0	-17.98413	10.45942	-1.72	0.086
age12dyr0	1.13283	.5766594	1.96	0.049
age13dyr0	-.0104936	.0067866	-1.55	0.122
part1	-305.049	37.76138	-8.08	0.000
age1part1	-2.610083	5.009091	-0.52	0.602
age12part1	.144462	.1275978	1.13	0.258
mwst0	-219.8566	39.73325	-5.53	0.000
sth0	-352.662	37.13394	-9.50	0.000
west0	-410.1195	37.26241	-11.01	0.000
rural0	-378.9035	42.97729	-8.82	0.000
blk0	-74.79774	30.3838	-2.46	0.014
othrc0	82.12133	43.32208	1.90	0.058
fem0	8.232381	24.90061	0.33	0.741
mar0	201.3869	25.96113	7.76	0.000
childeq0	-46.70799	22.55757	-2.07	0.038
colage0	-62.86587	13.20729	-4.76	0.000
nohs0+hs0	-94.70125	25.60374	-3.70	0.000
age0age1	.7845043	.1558	5.04	0.000
age0dyr0age1	-.3076398	.1822183	-1.69	0.091
constant	1057.05	81.2169	13.02	0.000
Mills:				
ρ	-.0518312	.030853		
σ	948.7052	49.98462		
λ	-49.17255	29.43049		
Goodness of fit:				
Null:	H_0: $\beta = 0$			
Wald χ^2_{26} :	524.19			
Pr > χ^2_{26} :	0.0000			
Number of Observations: 13,917				

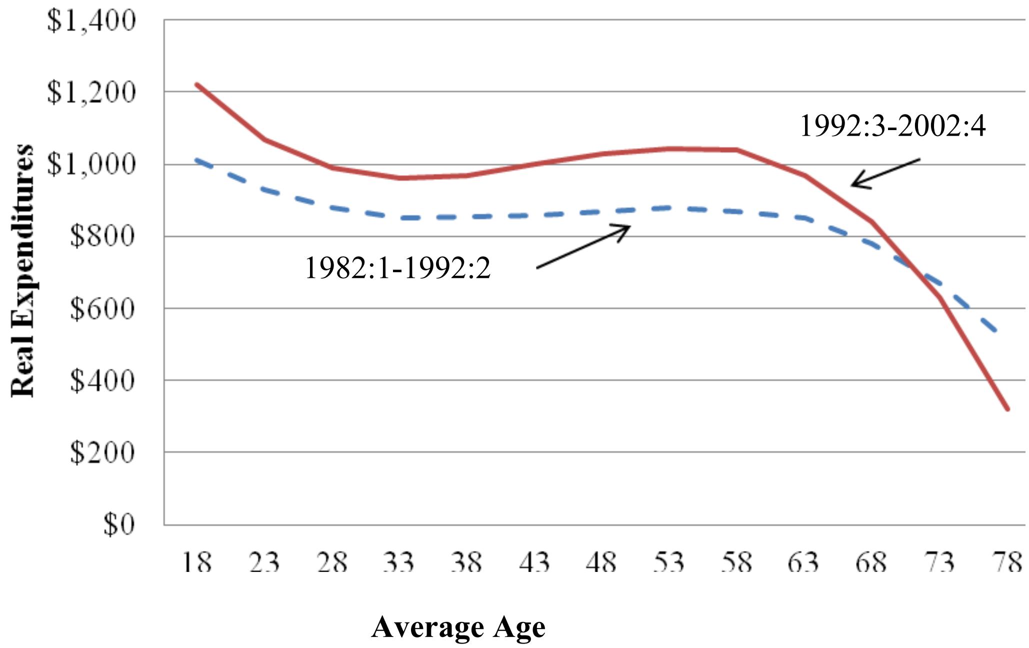
We see in Table 6 that the majority of the individual time coefficients are significant (*age13dyr1* is not significant). The test of the constants, *dyr0,* presented in Table 7 shows, that for the youngest consumers, real consumption increases by 220.26 real dollars in the 1990's. The joint test on the slopes rejects the null hypothesis that slopes, with respect to age, are the same across time periods; the test results in a $\chi^2_{(6)} = 16.16$ with a probability value equal to 0.0129. The joint test on the constants and slopes further confirms that structural change in real higher education consumption has occurred between the 1980s and the 1990s; the test results in a $\chi^2_{(8)} = 95.66$ with a probability value equal to zero.

Table 7: Tests of Coefficients

Test 1: Constants	
H_0 :	dyr0 = 0
χ^2_2 :	16.10
Pr> χ^2_2 :	0.0003
Test 2: Slopes	
H_0 :	age0dyr0 = age02dyr0 = age1dyr0 = age12dyr0 = age13dyr0 = age0dyr0age1 = 0
χ^2_6 :	16.16
Pr> χ^2_6 :	0.0129
Test 3: Joint	
H_0 :	dyr0 = age1dyr0 = age12dyr0 = age13dyr0 = age0dyr0age1 = 0
χ^2_8 :	95.66
Pr> χ^2_8 :	0.0000

Parameter estimates from Table 6 and age are used to create the household higher education consumption profiles. The typical household that generates the profile is assumed to be: a single, white, male who lives in the northeast, has some college education, does not have any children, and is the head of his household. Figure 7 depicts the results. The empirical profile appears to be consistent with the theoretical life-cycle profiles. In addition, the life-cycle profile displays structural change. Each have statistically changed between the 1980s and the 1990s - the young consume more higher education services while the old consume less in the 1990s. In terms of our theory, the position in the life-cycle appears to determine the relative importance of the income and substitution effects that arise from the increasing college skill premium**.**

Figure 7: Estimated Skill Acquisition Profile



CONCLUSION

Theoretically, the following conclusions can be drawn from the quantitative experiments presented. First, although pure substitution effects resulting from extensive SBTC are consistent with the widening skill premium over time, they do not explain why the skill premium has leveled off for the older age groups. When intensive SBTC parameters are investigated separately, they can lead to income effects - specifically changes in θ_2. A combination of extensive and intensive SBTC parameters is able to provide a flatter wage gap via a change in skill acquisition expenditures. This final quantitative result provides an explanation for one of the problems that Card and DiNardo (2002) cite regarding SBTC, namely, by showing that SBTC can lead to a flatter wage gap profile via an intertemporal substitution of skill acquisition.

Empirically, the major finding is that the higher education life-cycle consumption profiles have statistically changed between the 1980s and the 1990s implying that the position in the life-cycle appears to be an important determinate to how households respond from, presumably, an increasing skill premium. The steeper higher education consumption profile is important because it is exactly what the theory predicted from both an extensive and an intensive SBTC; a substitution effect for the young accompanied by an income effect for the old.

Several interesting conclusions flow from our analysis. First, the innovations generated by technological advancements in the goods production sector have been also incorporated in the human capital sector. Put another way, the large investments made by higher education institutions (by both administrations and faculty) on things like information technology over the last three decades have been effective. Second, though the probability of spending on higher education did not statistically change over the two periods, the changes in the spending on higher education imply changing college classroom demographics. There should be relatively more younger students.

Though the theory of SBTC is both theoretically and empirically plausible, our analysis has one caveat. We are unable to rule out other theories on the rising skill premium. However, this study can serve as a roadmap for future research in that we have shown how higher education consumption should shift over the life-cycle. That is, alternative future theories must simultaneously explain the steeping of the skill acquisition as well as Card and DiNardo's (2002) flatter wage gap profile.

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HERDING BEHAVIOR IN STUDENT MANAGED INVESTMENT FUNDS: IDENTIFICATION, IMPACT AND REDUCTION

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ABSTRACT

Student Managed Investment Funds (SMIFs) have grown in number; unfortunately, there has been little research on the efficacy of these funds. We fill this gap by exploring the potential consequences of student investment management. We find that investment decisions are often impacted by herding behavior, which results in underperformance. We further examine characteristics that influence the likelihood of herding, finding that pre-existing knowledge of the company under consideration, as well as amplified time constraints, increase the probability that herding occurs. In contrast, we find that increased education, both general and targeted behavioral education, reduces the likelihood (and impact) of herding.

INTRODUCTION

In an attempt to prepare students for the “real world,” many universities have developed hands-on activities, such as student managed investment funds (SMIFs). While the primary goal is generally to provide practical training, a related benefit is the positive impact such activities have on fundraising and marketing, particularly in cases where fund performance is especially good. Given the rise in popularity and importance of such programs, it is surprising that very little research exists surrounding their efficacy (either internal or external).

We suspect, similar to our own situation, that while returns are important, the focus of these programs is primarily educational, often viewing the educational component as being a detractor to fund performance. However, we believe that there is actually an overlap between these areas, as increased education (particularly certain types) should, in fact, improve the investment selection process. With this in mind, one particular aspect we consider is the incidence (and potential reduction) of herding among student investment managers.

Prior literature (see next section) documents the existence and impact of herding among investors. Herding is essentially “going with the crowd.” Thus, investors end up trading more based on emotion than objective evidence. The result is that performance, in the form of portfolio return, is often reduced. Given the social environment of a classroom, combined with the aspect of investing real money (for the first time in most cases), we believe that student funds may be a fertile environment for such a bias to occur. Thus, we examine the actual decisions made by student investment management teams over the course of multiple years. We document the effect of herding, but, more importantly for SMIF advisors, we identify ways to reduce the behavior and thereby potentially improve the security selection process and, potentially, fund performance.

We find that the student investment managers do exhibit herding in many decisions and that the result, particularly in situations where it tends to be most pronounced, is a reduction in investment returns. We further explore what characteristics increase (or decrease) the likelihood of herding within the context of a specific investment decision. We find that general familiarity, as opposed to specific research, with the investment being considered increases the likelihood that herding will occur, as does the existence of significant time constraints. In contrast, it appears that the presence of group members with higher education levels and/or targeted education in the field of behavioral finance decreases the likelihood that herding occurs.

Our results suggest specific actions SMIF advisors can take to mitigate the potentially negative influence of herding. For example, advisors could limit the number of trades that are allowed on a given day, thereby setting aside sufficient time for discussion of each trade. Further, requiring student teams to send out recommendations prior to meeting for discussion will provide a richer and more objective dialog by enhancing the variance of opinion. Lastly, including some readings or discussion on behavioral finance may help students recognize, and therefore overcome, potential biases, particularly as they relate to herding behavior. While these actions are all rather easy to employ, we believe the results will be valuable (both in learning and in investment return) for SMIF participants.

HERDING

Although we may like to think otherwise, it is safe to assume that almost every decision we make is influenced, at various levels and to differing degrees, by someone else. While the influence may be small on many choices, it is definitely more pronounced in environments where groups are used to make key decisions. Thus, one general setting where external influence may be most evident is in the field of investment management, and specifically in student managed investment funds.

Given the constant state of evolution in the world of finance and investments, it has become imperative that managers be able to evaluate not only more investment securities, but also increasingly complex ones. Thus, it is no surprise that management of investment funds has quickly shifted from individual managers to a team-based approach. For example, Bliss, Potter, and Schwartz (2006) report that, as of 2003, over 60% of mutual funds were managed by teams, up from just 30% in 1992. Thus, understanding the dynamics of group decision making in this framework has become more critical. As such, to prepare students for the "real world," it seems that most student managed funds have followed suit, organizing the management of the funds under a team construct.

The advantage of a team approach, particularly in complex decision environment, is well documented (Shaw, 1981). Some of the advantages include the broader variety of knowledge inputs (Campion, Medsker, and Higgs, 1993), and the greater absorptive capacity of the group (Cohen and Leventhal, 1990). However, it is the potentially negative outcomes that we aim to address in the present study. In particular, we are concerned with the impact of herding, which we rather simply define as "going along with the crowd." Similar to groupthink (see Janis, 1972), it is characterized by group members that accept the work of others without adequately challenging or vetting the idea. When it occurs in an investment context, herding implies that individual investors have a stronger propensity to make a given investment (or not) simply because they know that other investors are taking similar action.

Welch (2000) finds that herding behavior is prevalent among security analysts, as subsequent investment recommendations are more likely to follow those that have been previously released by other analysts. Further, Banerjee (1992) finds that herding becomes especially pronounced in environments where outcomes are highly uncertain, which is an apt description of the field of investments. Taken to extremes, Welch (1992) and Hirshleifer and Teoh (2003) suggest herding is further amplified by an informational cascade, as investors ignore private information and simply "go with the flow." Stated differently, even if an investor's own beliefs or opinions are counter to the consensus, when they learn that their peers favor something, they tend to follow the herd and justify the decision by reasoning that the opinion of the majority must be correct.

In the work on groupthink by Janis (1972), this phenomenon is referred to as self-censorship and is one of eight symptoms indicative of the presence of groupthink. By "going with the flow," group members that self censor dissenting opinions add to the levels of groupthink because the rest of the group views their silence as unanimity. This silence further reinforces the group's belief in the correctness of its decision. The effect of these phenomena is likely to influence decisions such as whether to participate in the market, what securities to trade, and whether to buy or sell.

The negative impact of this behavioral influence is noted by Nofsinger (2008), who suggests that moving with the herd magnifies the psychological biases associated with investing and results in a reduction in investment returns. In addition, Daniel and Titman (2006) find that the negative investment performance associated with herding may likely be driven by overreaction (investors bidding prices too high) and reversal (a subsequent market correction that establishes a more representative value).

Although herding has traditionally been associated with broad market movements, it may become readily apparent within the group dynamic as well, particularly when teams (student or practitioner) are assigned different focus areas. For example, within an investment team, different individuals or subgroups may be assigned the lead in various market sectors (e.g., financials, industrials, etc.). So, although the group as a whole is responsible for the final decision, each individual or subgroup is considered to be an expert in his or her respective area. With this in mind, Larson, Sargis, and Bauman (2004) find that when a group has a set of common knowledge (i.e., general market information), but one faction has an additional set (i.e., focus on a particular sector), the group tends to follow the faction with the greater knowledge (i.e., herding / groupthink). Similarly, Quiamzade and L'Huillier (2009) illustrate that the herding instinct may also be driven by a first-mover who may be considered an expert in the particular area under consideration.

To examine herding, prior studies have taken two differing approaches. First, some studies, such as Welch (2000), have concentrated on the cross-sectional impact of recommendations across analysts at different firms. While this gives insight into the general market impact, it does not focus on the specific group dynamic that we are concerned with in the present study. Second, and to a smaller extent, the remaining studies have primarily conducted experiments that were designed to replicate a realistic group environment. This approach was necessitated by the fact that it is extremely difficult to gain inside access to a real-world investment management team.

While our study, similar to the second approach, concentrates on a within-group decision framework, it improves on this method by studying actual investment decisions of a group of university students who are managing a sizeable portion of the school's endowment. Thus, although the students are not yet investment professionals, the situation provides a rather close proxy for the actual behavior we would observe in the "real world." So, while our primary focus is on improving the structure of SMIFs, we also believe that our results may have implications for industry practitioners as well.

OBSERVATIONAL SETTING AND THE PRESENCE OF HERDING

As identified just above, we investigate the impact of herding in the management of a real-dollar (approximately $1 million) student managed investment portfolio. We begin our analysis at the inception of the SMIF, which was Fall 2007, and we conclude with the Spring 2009 section. This timeframe provides us with four distinct groups (i.e., semesters) of student managers and approximately seventy-six unique investment recommendations to evaluate.

Each semester a new group of approximately 12-15 students (either senior undergraduate finance majors or graduate (i.e., MBA) students) take responsibility for managing the fund. When the semester begins, the students are divided into teams of roughly three students, and each team is subsequently assigned oversight of designated sectors, such as financials and consumer staples, within the S&P500 index. Whenever a team wishes to make a trade in one of their respective sectors, they must present a recommendation (written and oral) to the entire class. The class then votes by a raise of hands on the merits of the trade, with a two-thirds majority required for approval. While the exact structure and percentages may differ across

SMIFs or with that of a "real-world" investment committee, we believe there is significant overlap, such that we can offer insights for both SMIF advisors and industry practitioners.

For each trade, we record the percentage of students who vote to approve the recommendation. We also document the characteristics of the company under consideration, and, in addition, we identify other control information, such as whether the company is associated with a pre-existing position (for example, carried over from a prior semester). At the end of each semester we further match group information (such as grades) to each of the recommendations. With this information, we attempt to identify whether the students exhibit herding behavior and, if they do, to what extent it impacts investment performance. Moreover, the information we collect enables us to address what particular factors may increase or decrease the likelihood that herding occurs.

To begin our analysis, we consider whether herding is prevalent. To do so, we first identify those recommendations that receive 100% approval. While it is possible that unanimous acceptance is indicative of the best possible investment choice (at least in the minds of the student managers), the large number of investment securities available in the market, combined with the subjective nature of company selection, suggests that unanimous approval, in the absence of herding, would be relatively uncommon. Thus, we believe that a prevalence of undisputed votes would be indicative of herding behavior within the group(s).

After segmenting the recommendations, we find that 40 of the 76 trades (or 53%) received unanimous approval. Further, only seven trades were rejected (i.e., did not receive the required two-thirds majority). We believe that this approval distribution is indicative of herd-like behavior, which is further strengthened by anecdotal evidence, as students often commented that they were unlikely to disagree with the recommendation because the team presenting the trade should be the experts in that particular sector. This thought echoes the findings of Larson, Sargis, and Bauman (2004) and Quiamzade and L'Huillier (2009) discussed above.

As an informal test of our measurement approach, in a subsequent semester we experimented with voting by paper ballot rather than show of hands. We find that this approach significantly reduces the incidence of unanimous approval (29% vs. 53% above), as well as the overall approval rate. While informal, we believe this observation lends support for our measurement approach, i.e., coding unanimous approval as "herding." We also believe that paper ballots may be a useful tactic for advisors to employ should they find that herd behavior is particularly pronounced in their student funds.

THE IMPACT OF HERDING

Prior studies suggest that herding behavior is detrimental to investment performance. Much of this is attributed to the loss of information that occurs when an observer documents someone's action, but does not know whether this person is taking the action because it is believed to be the optimal choice, or whether the person is disregarding his signal and simply deciding to follow others.

To examine the potential impact of herding in our context, we calculate the return of each investment for the three-month and one-year periods after it is recommended. We choose to concentrate on these shorter time periods to match the timeframes within which the students operate, as well as to correspond to the nature of the herding behavior itself, e.g., see Daniel and Titman (2006). We report average returns, segmented by approval level (i.e., 100% versus all other), in Table 1, as well as the *t*-statistic from a difference of means test between the two segments.

Table 1: Return Comparison

Panel A: All Trades

	3-Month Returns (%)				12-Month Returns (%)			
Vote %	n	Gross	Excess	Alpha	n	Gross	Excess	Alpha
100%	40	-5.27	2.58	2.22	40	-37.64	-4.40	-1.97
<100%	36	-3.41	3.84	4.28	36	-36.61	1.30	4.80
Difference	4	-1.86	-1.26	-2.06	4	-1.03	-5.70	-6.77
t-statistic	na	-1.30	-1.50	-1.71	na	-0.13	-1.56	-1.90

Panel B: Excluding Rejected Trades

	3-Month Returns (%)				12-Month Returns (%)			
Vote %	n	Gross	Excess	Alpha	n	Gross	Excess	Alpha
100%	40	-5.27	2.58	2.22	40	-37.64	-4.40	-1.97
<100%	29	-3.00	4.82	5.54	29	-29.34	7.65	10.69
Difference	11	-2.27	-2.24	-3.32	11	-8.30	-12.05	-12.66
t-statistic	na	-1.49	-1.71	-1.97	na	-1.70	-1.89	-2.19

Panel A provides the results for all recommendations, while Panel B excludes the seven trades that were rejected. For returns, we report three different measures. First, *Gross* is the gross percentage return (percentage change in price plus dividend yield) from inception to three months (or one year) later. For all segmentations and time periods, the average gross return of trades receiving 100% approval is lower (more negative) than those that do not; however, the significance level is small, which may be expected given the volatility of the stock market during the period under consideration. Nonetheless, consistent with previous research, our results suggest that herding behavior (as proxied by unanimous approval) may indeed have a detrimental impact on investment performance.

It is possible that time period clustering could impact our results. For example, if one group (i.e., semester) of students were particularly impacted by herding and the market happened to decline that semester, our results would appear to indicate a negative impact from herding when it was simply a market-driven (i.e., time period sensitive) decline. Thus, we also calculate *Excess*, which is the return of the investment less the corresponding return of the S&P500 for the same time period. This approach adjusts for differences in market returns over time. With this adjustment the significance levels actually increase, suggesting that herding has a more negative impact than the simple gross returns would suggest.

Lastly, we examine *Alpha*, which is similar to *Excess*; however, it also adjusts for the level of market risk inherent in a particular security. For example, if a group approves the purchase of a highly volatile stock, it would be expected to decline (increase) more than the market if the market were in fact falling (rising). So, we adjust for this inherent volatility using a standard market model and repeat the comparison. Again, we find that this adjustment further strengthens our results that suggest herding (i.e., unanimous, unchallenged approval) is detrimental to long-term investment performance.

A valid question would be: why would 100% approval be associated with worse performance as compared to a less than 100% approval? Or, stated differently: if the trade is approved, why does it matter whether it is at the 100% level or the 75% level? The likely answer is that those trades that are approved at less than 100% are associated with a more intense discussion and scrutiny of the recommendation, although we are not suggesting what the best level of dissent might be. Rather, we are contending that transactions receiving less than 100% approval are often amended to reflect, among other things, different order types (for example, market versus limit orders) or entry points (in either timing or price). So, although approval still occurs, it is done so with adjustments that are often necessary to get agreement at the required level. Our results above suggest that these alterations, which are primarily a consequence of the discussion engendered by "dissension," improve investment performance relative to those trades where "blind" acceptance (i.e., herding) occurs.

CAUSES AND CONSTRAINTS OF HERDING

Given that herding appears to be detrimental to performance, the obvious question of importance becomes what causes (or curtails) herding behavior. Thus, we turn our attention to this issue by furthering our examination of the underlying characteristics associated with each investment recommendation. We rely on prior studies to identify potential behavioral biases that may be associated (either positively or negatively) with herding.

Hirshleifer and Teoh (2003) identify one particularly prevalent type of herding that is based on reputation (i.e., reputational herding). Specifically, individuals, in order to maintain status within the group, converge their decisions/behavior toward that of the other group members, particularly those that are viewed as having the highest standing. As a proxy for status, we consider the average presentation grade (*Grade*) of the group making the recommendation, expecting a positive relation between group grade and the probability of herding.

In addition to other group members, decision makers may be influenced by people that are outside the group, particularly if they are viewed as experts. For example, Sandler and Raghavan (1996) find that investors tend to follow the actions of Warren Buffett. Hirshleifer and Teoh (2003) further explore the issue of observational influence (or, the endorsement effect), finding that it may create a general herding instinct. Similar to practicing investment managers, the students in the groups were exposed to CEOs, CFOs and Vice-Presidents of Investor Relations from firms in the S&P500 (e.g., Simon Property Group, Cummins, Bristol-Myers, Lilly, etc.). In each case, the student investment managers subsequently voted whether to include the stock of the related company in the investment portfolio. If observational influence holds with these "experts," we would expect recommendations associated with outside speakers (*Speaker*) to have an increased likelihood of acceptance.

Pohl (2006) examines the recognition heuristic, finding that individuals are more likely to choose a recognized object over an unrecognized one. Paxton and Cote (2000) suggest this type of behavior is consistent with the transferring of knowledge from one decision to another (i.e., analogical reasoning). While most studies on this issue have been outside the area of finance, the behavior has been previously noted among investors. For example, Lakonishok, Shleifer, and Vishny (1994) and Chen, Kim, Nofsinger and Rui (2007) find that investors often confuse a good company with a good investment, in that investors are more likely to purchase stock in those firms with which they are most familiar (i.e., representativeness or familiarity). To explore this behavioral bias, we identify firms in the sample that have been listed in *Fortune* magazine's list of America's most admired companies (*CoRep*), hypothesizing that students are more familiar with these firms and thus more likely to accept these particular investment recommendations without dissension (i.e., more likely to herd).

Since we all have limited time and/or limited cognitive ability, we often resort to simple heuristics to make decisions. Daniel, Hirshleifer, and Teoh (2002) find that the use of such rules of thumb (and the resulting herding behavior it engenders) is even more pronounced when time is compressed. Thus, we conjecture that when the student managers must deal with an excess (*Excess)* number of trades on a given day, for which there is a defined period of time, the limits to their attention will prevent meaningful discussion, thereby resulting in an increase probability of herding.

The status quo bias (or endowment effect) suggests that people have a tendency to keep what has been given to them even if they would not otherwise pay the current value to purchase it. Samuelson and Zeckhauser (1988) and Nofsinger (2008) find that this action is not necessarily because owners overstate the value of the object, but rather they feel pain in giving up the object (i.e., an emotional attachment). This particular bias may be similar to Fennama and Perkins' (2007) finding that people tend to use sunk costs in decision making. These particular influences may be relevant to the current study as investment managers often inherent pre-existing positions or must decide whether to re-enter a position that was previously held. Thus, we denote trades that correspond to this situation (*Existing*), hypothesizing that these trades will be easier to get approved and, correspondingly, be increasingly associated with herding behavior.

Nofsinger (2008) states, "Psychological biases inhibit one's ability to make good investment decisions. By learning about your psychological biases, you can overcome them and increase your wealth." While this refers specifically to education of biases, more formal education may also increase one's confidence and the ability to interact with others. So, we consider the potential impact of two aspects of education (formal business education and targeted behavioral finance education), hypothesizing that both will reduce herding. Thus, we identify each group (i.e., semester) of students that were either (1) graduate level MBA students (*MBA)* and/or (2) assigned to read the book *Psychology of Investing* (*Psych*).

Lastly, we examine whether students are influenced by the bias associated with a lack of knowledge. Specifically, it is possible that at the inception of the semester, students are unwilling to give a conflicting opinion due to their inexperience and perceived lack of knowledge on the particular subject at hand. If this bias does impact the trading behavior, we would expect herding behavior to decline over time. Thus, we create the variable *FirstHalf*, which identifies if the trade occurred during the first half of the semester.

As a preliminary analysis, for each of the variables (and associated biases) just defined, we calculate the average values segmented by those trades receiving unanimous approval, which we previously suggest is indicative of herding behavior. We also test the difference between these average values, and we report these statistics in Table 2.

Table 2: Decision Characteristics Comparison

	100%	<100%	*t*-statistic
Grade	0.90	0.90	0.23
Speaker	0.05	0.06	-0.11
CoRep	0.13	0.05	2.06
Excess	0.43	0.31	2.08
Existing	0.23	0.11	2.33
MBA	0.28	0.42	-2.29
Psych	0.55	0.58	-1.01
FirstHalf	0.38	0.36	1.12

We find that the average grade of the student group making the presentation is insignificantly different between the two segments, suggesting that it is unrelated to herding behavior. This is in contrast to our expectation of reputational herding. However, while *Grade* is an objective measure that could play a role in reputation, Petty and Wegener (1998) show that the influence of highly esteemed group members may be due more to their personal characteristics (which are difficult to define and measure) rather than actual content provided, which *Grade* may be measuring. Thus, while we cannot associate grades with herding, we are also unwilling to rule out reputational herding in total, as it may simply be an issue of a poor proxy measure.

Similarly, we find that the presence of an outside "expert" speaker is insignificantly related to a trade being unanimously accepted. One possible explanation is that, while the speaker may be influential and considered to be an expert, s/he may not necessarily be viewed as independent since they are a representative of the company under consideration. Therefore, they may lose their credibility. Thus, similar to reputational herding, we are unable to find evidence of observational influence, but we are unwilling to completely rule out this impact as it may be an issue with our proxy rather than a reflection of the underlying behavior.

Consistent with our expectations, we find that company reputation is significantly related to herding behavior, with companies on the list being more likely to pass unanimously. We also find that days on which excess trade activity occurs are associated with a higher probability of unanimous acceptance. We view this as being consistent with our hypothesis associated with limits to attention. In addition, we find that existing positions are positively related to herding behavior, which we view as being consistent with the status quo bias defined above.

Turning to the education variables, we find that both have a negative relation, as increased education is associated with reduced herding. However, only the MBA variable is significant. The final variable, *FirstHalf*, is insignificant, suggesting that student managers do not change their herding behavior over the course of the semester.

While these simple univariate tests provide some interesting results, it is possible that there is overlap between the variables. For example, if outside speakers were more prevalent in MBA sections, then their impact could be offset by the participants' education level. Thus, it is possible that the significance levels (or lack thereof) that we report may not be completely representative of the underlying relationships. So, to more fully control for these potentially overlapping influences, we further our examination using a multiple variable framework. Specifically, we consider the following model:

$$\begin{aligned} Dep = \alpha + \beta_1 Grade + \beta_2 Speaker + \beta_3 CoRep + \beta_4 Excess \qquad (1) \\ + \beta_5 Existing + \beta_6 MBA + \beta_7 Psych + \beta_8 FirstHalf + \varepsilon \end{aligned}$$

where we define the dependent variable in two different ways. First, we consider a binary approach similar to Tables 1 and 2, where we segment those with unanimous acceptance (*Dep* = 1) versus all others (*Dep* = 0). As such, we employ a logistic regression for this analysis. Second, to add some robustness to our results, we consider a typical continuous variable that simply represents the percentage of students voting to accept a transaction, using a linear regression to estimate the relationships. All other variables are as previously defined. We report the results of this analysis in Table 3.

Table 3: Regression Results		
	[1] Logistic	[2] Linear
Intercept	-2.79 (.0534)	0.48 (.5915)
Grade	0.02 (.8542)	0.00 (.7089)
Speaker	0.35 (.7433)	-0.03 (.7345)
CoRep	0.59 (.1455)	0.18 (.0706)
Excess	0.95 (.1239)	0.04 (.1208)
Existing	0.92 (.0915)	0.11 (.0560)
MBA	-1.42 (.0754)	-0.14 (.0903)
Psych	-1.27 (.0756)	-0.10 (.1141)
FirstHalf	0.39 (.5233)	0.04 (.6486)
n	76	76
% Concordant / R^2	71.4	.2338

Consistent with our results in Table 2, we find that *Grade, Speaker*, and *FirstHalf* are all insignificantly related to the likelihood that a recommendation is approved by a higher percentage of the student managers. Also consistent with our previous findings, we find that *CoRep* is positively related to acceptance, although it is only nominally significant in the logistic regression. Similarly, we find that time constraints, as proxied by *Excess*, are also positively related to herding, albeit at the 12 percent level. However, these nominal levels likely still indicate a pronounced relationship as we do not have an extremely large data set from which to draw conclusions, thereby reducing our degrees of freedom and associated significance.

The next two variables exhibit an even stronger relationship to acceptance, with *Existing* being positively and *MBA* being negatively related to herding, both at the 10 percent level. Each of these is also consistent with our previous results, indicating that the investment managers are prone to status quo bias, but that increased education level may offset this (and other) behavioral influences. In contrast to our prior results, we find that *Psych* is, in fact, significantly (again at approximately the 10 percent level) related to herding behavior. The negative relationship suggests that educating participants on the potential influence of behavioral biases reduces the likelihood that biases (herding in this particular case) will surface. This result is consistent with the findings of Nikiforow (2010), who documents the impact of behavioral finance training on the actions of fund managers.

CONCLUSION

We are influenced by those around us, particularly when we are a member of a team or other interdependent group. Moreover, our desire to be accepted by our peers often results in decisions that are based more on emotion than objective evidence. While this herding instinct has been extensively studied in the psychology literature (with associated causes documented), and even in the area of sports (Hardy, Eys, and Carron, 2005), it has received nominal attention as it relates to the area of finance, and specifically to student managed investment teams. This issue, however, is becoming increasingly important due to the general movement away from individual investment managers to a team-based approach, as well as with the increasing number of SMIFs.

To fill this gap, we examine whether student investment managers operating within a team-based structure are impacted by herding instincts common to the general population. Consistent with prior studies examining broad market influences, we find that these students do appear to herd within the group context as well, as a disproportionate number of investment recommendations receive unanimous approval. Further, we find that the recommendations associated with herding are also more likely to have a lower subsequent return, on both a gross and market adjusted basis.

With the herding instinct documented, the primary issue becomes identifying which factors or characteristics exaggerate or reduce the behavior. Our results suggest that student investment managers are influenced by the familiarity bias and are therefore more likely to accept investments in companies with which they are more familiar. Further, we find that status quo bias, which may also be related to familiarity, induces students to add to positions that they already have (or have had in the recent past). Moreover, it appears that time constraints further exaggerate biases and thus the likelihood that herding behavior will occur. Fortunately, we find that there are ways to reduce the impact of behavioral bias and that this primarily comes through education, whether it be general education or targeted behavioral learning.

Our results provide meaningful insights for advisors who are creating or currently overseeing student managed funds, as well as for practitioner investment managers operating under a group construct. First, while many investors may avoid delaying decisions for fear of missing potential investment returns, we find that this type of implicit time constraint may actually result in worse decisions, thereby negating any added return earned in the short run. Thus, we suggest that advisors/managers be sure to provide adequate time for discussion (and dissension) surrounding proposed investments. Second, our findings suggest that organizations should support increased education for group members, both general education and behavioral-specific instruction. In the context of SMIFs, we believe this can be achieved by having a set of required readings on general behavioral biases. We have found *The Psychology of Investing* by Nofsinger (2008) to be a good choice.

Third, the presence of vigorous discussion about decisions is highly valuable. Steps should be taken by advisors/managers to ensure that discussion takes place by using such techniques as assigning a devil's advocate. Finally, groups must recognize the importance of objective criteria in making decisions as this may help to overcome the subjectivity associated with the herding instinct. Highlighting which criteria are subjective and which are objective will help the decision team understand its biases. Implementing such features may help to improve the investment performance of the teams and better prepare them for life as "real world" investment managers.

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EFFECT OF TAX-RATE ON ZONE DEPENDENT HOUSING VALUE

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ABSTRACT

This study explores the role of zoning effect on the housing value due to different zones. In general, housing value may depend on various internal and external factors and zoning being one of them. Zoning differentiates land use as designated by its categorization. Different zoning categorizations have different conditions and characteristics. Thus, implementation of zoning on a certain land for its designated purposes reduces the availability of the land. In turn, this results in increased price value of the property. Therefore, this research observes the effect on housing value due to different zoning classifications. As a result, this research will help the policy makers to modify and improve long term policy decisions in urban planning. In this paper, we provide evidence of zoning effect on the housing value for two different zoning classifications. The observations are taken from different parcels of neighborhoods. We use associative model to explore the effect of zone and understand its impact on the housing value. In particular, statistical significance and magnitude of zone dependent housing factors on the "value of the house" is observed. Moreover, after controlling for lot dimensions, bedrooms, bathrooms, square footage, and other related factors, higher tax-rate is found to be instrumental in affecting the housing value more in multi-family zone.

INTRODUCTION AND RESEARCH BACKGROUND

This study explores the role of zoning characteristics and other information externalities in the determination of home value. Housing price depends on various internal and external factors. These factors may contain zoning information as well as physical characteristics of the home. Zoning differentiates land use as per its classifications. Different zoning classifications have different conditions and characteristics (see, Phoebe, Koenig, and Pynoos 2006; Shoked, 2011). Any major alteration or modification to a structure needs to have permission from the appropriate authority depending on the zone the structure is located. Thus, zoning limits the functionality and affects the value of the property. Zoning restricts the use of land differently due to different classifications. Implementation of zoning thus helps to use of a certain land for its designated purposes and thus reduces the availability of land. As a result, the process of zoning increases the value of the land an indirect effect of urban planning.

Due to increased urban planning, relationship between different types of zones and its effect on the price of house has been studied by many researchers (Cho, Kim, and Lambert, 2009; Mukhija, Regus, Slovin, and Das, 2010). Studies suggest that zoning significantly affects housing prices (see, Chressanthis, 1986; Glaeser and Gyourko, 2002). Thus, the empirical results of these studies tend to confirm that major zoning changes significantly affect housing prices. The evidence also suggests that zoning is responsible for higher housing costs and plays a dominant role in inflating house prices. Although, other factors such as, inventory of houses on the market and housing starts may affect the current housing value in a longitudinal study (see, Choudhury, 2010); our research is primarily focused on the zoning patterns and its effect on the housing value for single-family and multi-family housing. Different zones are created for different land use purposes in an urban planning. Even though the price differential of a house is primarily due to the zoning factor; other factors, such as, location may also contribute to its price variations.

In this study we have used the following zones in our analysis:

A. Single family housing zone.
B. Multi family housing zone.

Internal factors that are considered:

Age of the house, Number of bedrooms, Number of bathrooms, Condition of the house (0.00 to 0.99), Lot dimension-A (Frontage/width), Lot dimension-B (depth/side), Total building square footage.

External factor that is considered: Tax rate.

Zoning's stated purpose is to protect residential property from the negative externalities associated with neighboring commercial or other development and this may be the reason that studies on zoning's impact have focused on whether zoning is effective in raising the economic value of a home. Pogodzinski and Sass (1990) in their paper have extensive discussions on the economic theory of zoning and the effects of zoning on six economic agents. In their review of the zoning literature they have examined the strengths and weaknesses of theoretical models on the effects of zoning. In general, housing prices differ in different areas depending on the zoning classification. Groves and Helland (2002) in their study estimated the transfer of wealth between owners of existing homes that results from the creation of zoning ordinance. They have observed that properties best suited for residential use gains in value while property with relatively higher potential as commercial property experiences a decline in the value and therefore, they conclude that zoning is distributive. Their results indicate that zoning does in fact redistribute wealth between existing homeowners.

This research will use associative models to analyze how zoning affects the housing value. We will build two different models, one for single-family zone classification and the other for multi-family zone. Regression model of the value of house will be estimated using multiple predictor variables. The interesting observation of this research would be the findings in usage of different zone in different neighborhoods and its value that are dependent on tax-rate.

DATA AND METHODOLOGY

For our analysis data is obtained from the local county assessor's office. The data set includes the entire population of residential properties in this town. However, only two different types of residential properties data are used in the analysis. In addition, any observation with missing data was eliminated. For the first model, the sample includes only those residential properties with a single-family detached building. For the second model, the sample includes residential properties which have multi-family building.

TABLE-1A: Summary Statistics of single-family housing zone.

Variables	N	Mean	Std Dev	Minimum	Maximum
LOTDIMA	3887	87.46	29.45	22.00	600.00
LOTDIMB	3887	141.07	45.53	15.00	644.40
LOTSQFEET	3887	12784	12600	1350	386640
CONDITION	3668	0.88	0.08	0.34	0.99
BATHROOMS	3878	2.36	0.84	1.00	7.00
TOTBLDGFT	3878	1612	584.11	288.00	4542
BEDROOMS	3878	3.22	0.63	1.00	6.00
VALUE	3887	57474	18114	1166	218434
AGE	3878	38.84	20.23	1.00	192.00
TAXRATE	3887	7.68	0.05	6.82	7.69

Variables and Statistical Techniques

To isolate the effect of zoning on the value of the house, we control for variety of internal factors, such as, age of the house, number of bedrooms, number of bathrooms, lot dimension-a (frontage/width), lot dimension-b (depth/side), total building square footage, condition of the building. Location characteristics, such as, recreational facilities, roads, shopping centers, etc. may be relevant in analyzing zoning effect on the housing value. However, they may impact the value both positively and negatively and thus offsets each other in its outcome. Therefore, they are not considered in this study. Public policy constraints and subsidies that include all types of land-use regulation and taxes will affect the value of a property by increasing or decreasing the incentive to obtain the property. One must also consider the influence of public good provision and the presence of amenities. They generate appealing differences between properties and thus create differences in price value. Therefore, tax-rate is also considered as an external factor in our study to observe any tax dependent effect on the housing value. Cross-section data on these factors that are stated above are collected and analyzed using associative models. Our research considers two separate modeling to study the zoning effect; one for single-family housing and the other for multi-family housing. For each model, the dependent variable is the total property value.

TABLE-1B: Summary Statistics of multi-family housing zone.					
Variables	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**
LOTDIMA	622	84.86775	85.78059	11.00000	1320
LOTDIMB	622	148.26273	73.66276	11.50000	1150
LOTSQFEET	622	13853	24132	989.00000	334208
CONDITION	584	0.86567	0.11512	0.45000	0.99000
BATHROOMS	617	2.07780	0.85115	1.00000	6.00000
TOTBLDGFT	617	1402	459.69175	583.00000	3336
BEDROOMS	617	3.00486	0.69668	1.00000	6.00000
VALUE	622	94200	189030	797.00000	2975037
AGE	617	44.20421	25.58777	1.00000	122.00000
TAXRATE	622	7.69186	0.00343	7.60654	7.69200

To observe the association between housing value and the internal-external factors; two separate analyses were performed. First, correlation analysis is done (see Table-2A and Table-2B) to examine the direction of the association between factors. Second, housing value (amount of assessed value of the property) is regressed on the predictors to observe the difference in association between two different zones separately for single-family and multi-family. Thus, there are two separate regression models estimated in this study. In general, it is assumed that there is a difference between excellent and poor condition of the building in the process of estimating the value of the house and therefore, condition is introduced into the model as an independent variable. However, these differences may affect single-family houses more compared to multi-family houses.

Thus, a multiple regression model was run using SAS software (see, SAS/STAT User's Guide, 1993) on several different independent variables separately for single-family zone and multi-family zone. These separate analyses by zone are to observe the differential effect of zone on the value of houses due to zone differences. This measure is designed to test the hypothesis that housing value fluctuation is zone dependent. Specification of the regression models are of the following form:

$$Value = \beta_0 + \beta_1 Lot\dim a + \beta_2 Lot\dim b + \beta_3 Bathrooms + \beta_4 Bedrooms + \beta_5 Totbldgft + \beta_6 Taxrate + \beta_7 Age + \beta_8 Condition \quad .... \quad (1)$$

Where:

Value: Total dollar value of the property (building and land) as assessed by county authorities.
Age: The age of any building (number of years) included in the property.
TOTBLDGFT: The area in square feet of all buildings on the property.
Bathrooms: Number of bathrooms on the property.
Bedrooms: Number of bedrooms on the property.
Condition: Condition of the building ranges from 0.00 (poor) to 0.99 (excellent)
TaxRate The tax levy rate for the property (as a percentage of value).
Lotdima: Lot dimension (Frontage/width)
Lotdimb:Lot dimension (depth/side).

TABLE-2A: Correlation Matrix of single-family housing zone.

	Lotdima	**Lotdimb**	**Lotsqfeet**	**Condition**	**Bathrooms**	**Totbldgft**	**Bedrooms**	**Value**	**Age**	**Taxrate**
Lotdima	1.00000	0.33250 <.0001	0.80045 <.0001	0.03265 0.0480	0.07746 <.0001	0.10778 <.0001	0.04649 0.0038	0.32152 <.0001	-0.0407 0.0113	-0.3413 <.0001
Lotdimb	0.33250 <.0001	1.00000	0.68294 <.0001	-0.01725 0.2962	0.04200 0.0089	0.13521 <.0001	0.00241 0.8809	0.18416 <.0001	0.03940 0.0141	-0.3019 <.0001
Lotsqfeet	0.80045 <.0001	0.68294 <.0001	1.00000	0.01298 0.4320	0.04182 0.0092	0.08230 <.0001	0.01474 0.3587	0.25780 <.0001	-0.0089 0.5800	-0.3994 <.0001
Condition	0.03265 0.0480	-0.01725 0.2962	0.01298 0.4320	1.00000	0.47683 <.0001	0.34241 <.0001	0.26947 <.0001	0.35625 <.0001	-0.8962 <.0001	-0.0149 0.3668
Bathrooms	0.07746 <.0001	0.04200 0.0089	0.04182 0.0092	0.47683 <.0001	1.00000	0.63378 <.0001	0.44350 <.0001	0.38587 <.0001	-0.4893 <.0001	0.01158 0.4708
Totbldgft	0.10778 <.0001	0.13521 <.0001	0.08230 <.0001	0.34241 <.0001	0.63378 <.0001	1.00000	0.50916 <.0001	0.47505 <.0001	-0.3316 <.0001	-0.0111 0.4898
Bedrooms	0.04649 0.0038	0.00241 0.8809	0.01474 0.3587	0.26947 <.0001	0.44350 <.0001	0.50916 <.0001	1.00000	0.23686 <.0001	-0.2298 <.0001	0.02400 0.1351
Value	0.32152 <.0001	0.18416 <.0001	0.25780 <.0001	0.35625 <.0001	0.38587 <.0001	0.47505 <.0001	0.23686 <.0001	1.00000	-0.3609 <.0001	-0.0290 0.0707
Age	-0.0406 0.0113	0.03940 0.0141	-0.00889 0.5800	-0.89619 <.0001	-0.48928 <.0001	-0.3316 <.0001	-0.2298 <.0001	-0.3609 <.0001	1.00000	0.01750 0.2758
Taxrate	-0.3413 <.0001	-0.30192 <.0001	-0.39936 <.0001	-0.01491 0.3668	0.01158 0.4708	-0.0111 0.4898	0.02400 0.1351	-0.0290 0.0707	0.01750 0.2758	1.00000

An increase in either land area or building area should increase the value of a property; however, the effect diminishes as they grow larger. Similar effect is expected for an increase in the number of bathrooms or bedrooms. As property's age increases, the value of the property is expected to decrease. An increase in tax rate should decrease the value of the property also, since higher tax burden will be capitalized into a lower value of housing. To test these hypotheses in our study we have employed associative models in our analysis.

TABLE-2B: Correlation Matrix of multi-family housing zone.

	Lotdima	Lotdimb	Lotsqfeet	Condition	Bathrooms	Totbldgft	Bedrooms	Value	Age	Taxrate
Lotdima	1.00000	0.20129 <.0001	0.75208 <.0001	-0.05613 0.1755	-0.01674 0.6782	0.03187 0.4293	-0.1192 0.0030	0.40648 <.0001	0.08086 0.0447	-0.0668 0.0961
Lotdimb	0.20129 <.0001	1.00000	0.67727 <.0001	-0.01864 0.6531	-0.05003 0.2146	0.02145 0.5948	0.00316 0.9376	0.69244 <.0001	0.02052 0.6109	-0.5462 <.0001
Lotsqfeet	0.75208 <.0001	0.67727 <.0001	1.00000	0.00213 0.9590	0.03946 0.3278	0.07506 0.0624	-0.0468 0.2451	0.83157 <.0001	0.00810 0.8409	-0.4124 <.0001
Condition	-0.0561 0.1755	-0.01864 0.6531	0.00213 0.9590	1.00000	0.52433 <.0001	0.20811 <.0001	0.16940 <.0001	0.00083 0.9841	-0.9240 <.0001	-0.0448 0.2801
Bathrooms	-0.0167 0.6782	-0.05003 0.2146	0.03946 0.3278	0.52433 <.0001	1.00000	0.49911 <.0001	0.36073 <.0001	0.03849 0.3399	-0.5197 <.0001	-0.0437 0.2786
Totbldgft	0.03187 0.4293	0.02145 0.5948	0.07506 0.0624	0.20811 <.0001	0.49911 <.0001	1.00000	0.53177 <.0001	0.06398 0.1123	-0.1366 0.0007	-0.0785 0.0513
Bedrooms	-0.1191 0.0030	0.00316 0.9376	-0.04686 0.2451	0.16940 <.0001	0.36073 <.0001	0.53177 <.0001	1.00000	-0.0071 0.8598	-0.0766 0.0571	-0.0576 0.1530
Value	0.40648 <.0001	0.69244 <.0001	0.83157 <.0001	0.00083 0.9841	0.03849 0.3399	0.06398 0.1123	-0.0071 0.8598	1.00000	-0.0068 0.8646	-0.5695 <.0001
Age	0.08086 0.0447	0.02052 0.6109	0.00810 0.8409	-0.92403 <.0001	-0.51974 <.0001	-0.1366 0.0007	-0.0766 0.0571	-0.0068 0.8646	1.00000	0.05863 0.1458
Taxrate	-0.0667 0.0961	-0.54615 <.0001	-0.41239 <.0001	-0.04477 0.2801	-0.04369 0.2786	-0.0784 0.0513	-0.0576 0.1530	-0.5695 <.0001	0.05863 0.1458	1.00000

EMPIRICAL RESULTS

Descriptive statistics for the various measures of dependent and independent variables are calculated (see, Table-1A and Table-1B). Relatively larger differences in standard deviations (18114 and 189030) of property values with averages of 57,474 and 94,200 do indicate much fluctuations in the aggregate property values due to different zones. However, tax rate ranges from 6.82 to 7.69 for single-family zoned houses compared to multi-family zoned houses of 7.61 to 7.69 respectively. Similar differences also observed with other factors as well. This suggests that due to some unobservable factor(s) housing value may differ in different zone. Thus, the idea of this exploratory analysis is to observe the association between housing value and its related characteristics for two different zones.

TABLE 3A: Regression results of Housing Value on Property Characteristics (Single-Family Zone).					
Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	8	4.562487E11	57031088931	268.44	<.0001
Error	3659	7.773584E11	212451062		
Corrected Total	3667	1.233607E12			
R-Square	0.3698		**Adj R-Sq**	0.3685	
Parameter Estimates					
Variables	**DF**	**Parameter Estimates**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	-267854	39134	-6.84	<.0001
LOTDIMA	1	171.58830	8.94319	19.19	<.0001
LOTDIMB	1	37.88942	5.84738	6.48	<.0001
BATHROOMS	1	994.93068	399.75903	2.49	0.0129
BEDROOMS	1	-871.53211	456.68758	-1.91	0.0564
TOTBLDGFT	1	10.63388	0.56662	18.77	<.0001
TAXRATE	1	36813	4983.58417	7.39	<.0001
AGE	1	-157.57846	27.15388	-5.80	<.0001
CONDITION	1	12839	6196.73099	2.07	0.0383

Simple pair-wise correlation analysis (see Table-2A and Table-2B) among the variables, reveal that housing value is negatively impacted by the tax rate in both zone. The impact is much larger for the multi-family zone ($r = -0.57$, $p < 0.001$) compared to single-family zone ($r = -0.03$, $p < 0.10$). Age of the property and the property value are negatively correlated for both zone. However, the correlation is not statistically significant for the multi-family zoned properties. It is possible that understanding the importance of other unobserved factors and including them in the analysis may change the outcome. Similar results also observed between the relationships of housing value and condition of the property and thus supporting our above hypothesis of differences in housing value is due to differences in zone classification.

Results of multiple regression analysis are reported in Tables 3A and 3B. All these models appeared to fit well in estimating the housing value. Reported coefficients of determination (R^2) are 0.37 and 0.62 respectively for single-family zone and multi-family zone, with highly significant F values. Results indicate that age of the property in general is less likely to impact the housing value in multi-family zone (not statistically significant) than single-family zone (see, Tables 3A and 3B). Analysis also reveals that, better condition of the property impacts single-family zone housing value positively as opposed to multi-family zone.

TABLE 3B: Regression results of Housing Value on Property Characteristics (Multi-Family Zone). Analysis of Variance					
Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	8	1.364092E13	1.705115E12	115.96	<.0001
Error	575	8.454915E12	14704199326		
Corrected Total	583	2.209583E13			
R-Square	0.6174		**Adj R-Sq**	0.6120	
Error! Bookmark not defined.Parameter Estimates					
Variables	**DF**	**Parameter Estimates**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	120409954	13162365	9.15	<.0001
LOTDIMA	1	640.62390	59.41244	10.78	<.0001
LOTDIMB	1	1240.53349	81.05502	15.30	<.0001
BATHROOMS	1	16567	8375.62381	1.98	0.0484
BEDROOMS	1	-3041.04346	8886.21686	-0.34	0.7323
TOTBLDGFT	1	-1.18725	14.08491	-0.08	0.9329
TAXRATE	1	-15661486	1710779	-9.15	<.0001
AGE	1	-353.85837	526.70784	-0.67	0.5020
CONDITION	1	-111043	117054	-0.95	0.3432

Therefore, the property characteristics affect the housing value differently given that which zone they belong. Specifically, after controlling for lot dimensions, bedrooms, bathrooms, square footage, etc., tax rate has a very large impact on the value of the house negatively for multi-family zone. Another interesting finding is that lot dimensions impact housing value differently for different zoning. As for example, frontage/width lot dimension affects the housing value more for single-family house as opposed to the depth/side dimension. This result is opposite for multi-family zone. A number of possible explanations can be explored for this dimension dependent zone effect. However, considering that the maximum housing value is about 3 million for multi-family zoned housing compared to 2 hundred thousand for single-family zoned housing, direct comparison may be complicated. Nonetheless, this study suggests that housing value is zone dependent and more specifically the zone effect is significantly substantial with tax rate for the multi-family category.

CONCLUSION

This study, examines the internal and external characteristics based zone effect on the housing value. In particular, statistical significance and magnitude of zone dependent housing factors on the "value of the house" is observed. As expected, after controlling for lot dimensions, bedrooms, bathrooms, square footage, etc., higher tax rate is found to be instrumental in affecting the housing value in multifamily zone. This suggests that tax rate influence on the housing value is zone dependent in this sub-population of neighborhoods. Thus, we may conclude that property characteristics affect the value of the housing differently depending on the zone they belong. Although the data indicate much variability in the property values due to different zones, zone effect is substantially higher for multi-family zone for most of the factors considered in this study. This differential effect of zone on the value of the housing is most significant when tax-rate is incorporated.

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