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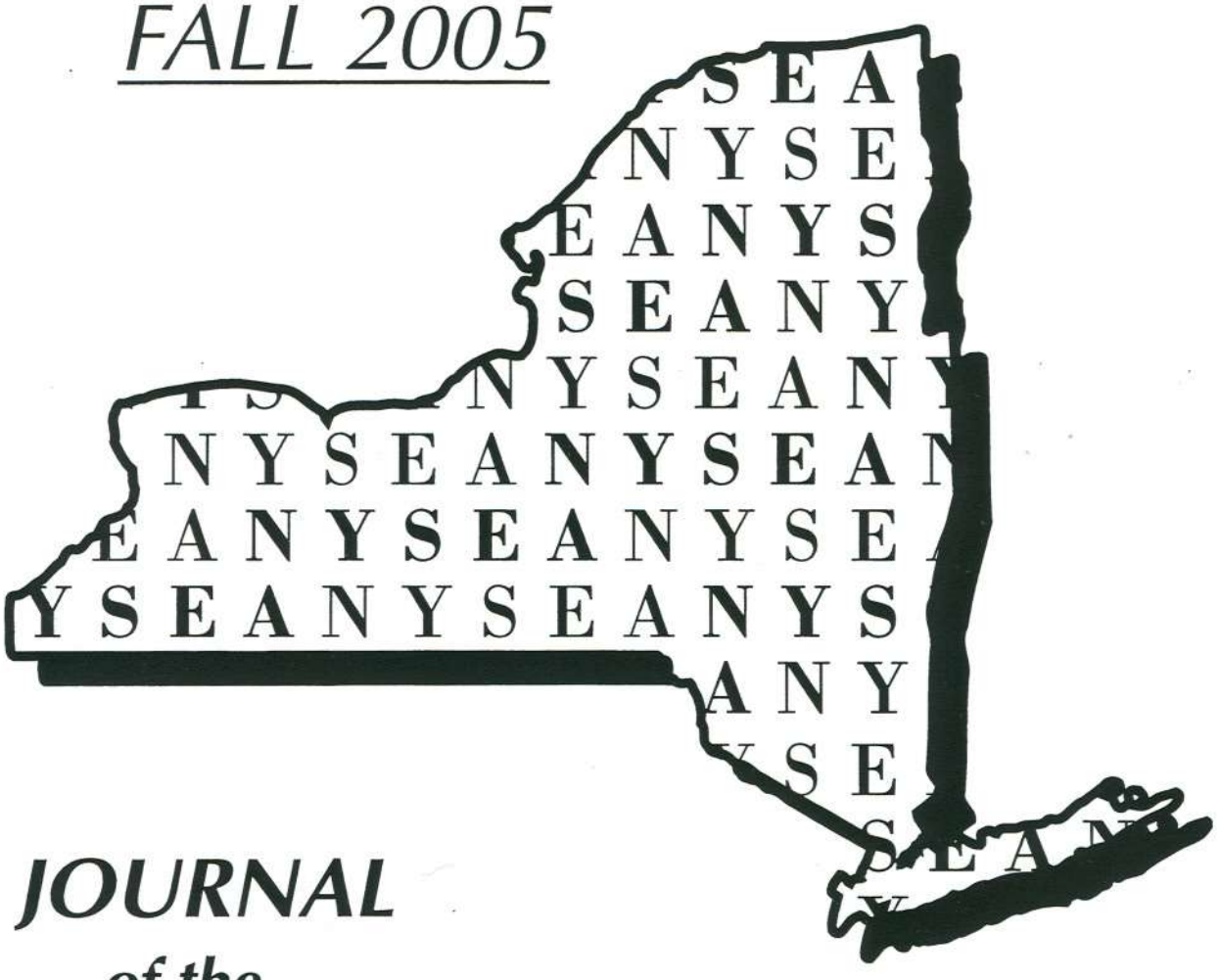

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CONTENTS

ARTICLES

EDITORIAL

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THE VALUATION OF HUMAN CAPITAL IN NEW YORK STATE COURTS

Larry Lichtenstein and Mark P. Zaporowski*

I. INTRODUCTION

Courts are often asked to adjudicate disputes that are economic in nature or have economic components. Attorneys and judges frequently lack formal training in economics and must rely on their intuition to guide their decisions. This shortcoming can lead to poorly reasoned decisions that have inequitable financial consequences. This paper explores the difficulties that the New York State courts have encountered in the valuation of human capital in the form of academic and professional degrees and licenses. This became an important consideration after the 1985 New York Court of Appeals decision in O'Brien v. O'Brien (66 NY2d 576), where the court ruled that human capital acquired during marriage is an asset subject to equitable distribution upon dissolution of the marriage. Prior to this decision, the distribution of marital wealth in divorce was confined to tangible assets. O'Brien opened the door to valuation of intangible human capital, which dramatically increased marital wealth. This ruling has had a profound impact in New York State since it affects all those who obtain education or training during a marriage that ultimately ends in divorce.

We begin this paper by developing a simple formula for valuing a license based on human capital theory. We then examine the human capital methodology sanctioned by the O'Brien decision. Subsequent to O'Brien, the courts wrestled with valuation issues not specifically addressed in the case: the simultaneous valuation of human capital in the form of a professional degree or license and the valuation of a professional practice. Valuing multiple intangible assets proved to be problematic for the courts. Initially, the courts under-valued human capital by invoking a court created notion of "merger," whereby the value of a license *merged* with the practice and lost its value as a separately identifiable asset [Marcus v. Marcus (137 AD2d 131), Vanasco v. Vanasco (132 Misc2d 227), Finochio v. Finochio (556 NYS2d 1007) and DiCaprio v. DiCaprio (556 NYS2d 1011)]. Eventually, the courts realized the

*Associate Professor and Professor of Economics & Finance, respectively, Canisius College, Wehle School of Business, Buffalo, NY. The authors would like to thank the Editor and an anonymous referee for their helpful comments.

fallacy of the "merger" doctrine, but sanctioned an estimation procedure that systematically over-valued these assets [McSparron v. McSparron (87NY2d 275, 639 NY2d 265)]. How these issues have evolved over time and how they have been resolved are discussed below.

II. HUMAN CAPITAL THEORY

It has been established both theoretically and empirically by Becker (1975), Becker (1981), Mincer (1974), and Mincer and Polachek (1974) that investments in human capital by an individual through additional education raise his or her lifetime earnings. The costs of this investment are comprised of explicit cost such as tuition and opportunity cost in the form of foregone earnings while the education is being obtained. An individual makes the decision to seek additional education when the expected return in the form of enhanced compensation exceeds the cost of the investment. The individual would view the investment in human capital as being worthwhile as long as the present value of the future after-tax enhanced compensation associated with the education exceeds its cost. The present value of the enhanced compensation generated by the human capital can be expressed in the following form:

$$(1)\ \sum_{i=1}^{n} \frac{(CWE_i - CWOE_i)(1-T)}{(1+R)^i}$$

where CWE_i represents compensation with enhanced education in period i, $CWOE_i$ is compensation without enhanced education in period i, T is the aggregate incremental tax rate and R is the nominal discount rate. CWE and CWOE are comprised of wages, fringe benefits, and the value of non-pecuniary characteristics. Although the methodology for valuing human capital is straight forward, there are many practical issues involved in implementing the valuation procedure. For example, both CWE and CWOE must be projected over the worklife of the individual, the length of worklife must be estimated, and the appropriate discount rate must be selected.

III. THE O'BRIEN DECISION

The human capital valuation methodology was employed by valuation experts and sanctioned by the New York State Court of Appeals in the O'Brien v. O'Brien (66 NY2d 576) decision. Mr. O'Brien entered his marriage having completed almost all the requirements for his Bachelors degree. During the marriage, he completed all requirements for his medical degree and license. Upon being licensed, he commenced a divorce action. During their marriage, Mrs. O'Brien worked and provided financial and emotional support that allowed Mr. O'Brien to complete his education. The Court ruled that Mrs. O'Brien was entitled to recompense for her contribution to the family's investment in Dr. O'Brien's human capital.

The court accepted a license valuation technique in O'Brien that was based on the enhanced compensation that the license affords its holder. However, compensation was comprised solely of earnings. As Dr. O'Brien had just completed the requirements for his medical license and lacked an earnings history, future earnings were projected on the basis of statistical averages[1]. At the time of trial,

Dr. O'Brien had completed a residency in surgery. Therefore, the license was valued by projecting the difference between the earnings of an average surgeon and those of an average college graduate over the remainder of Dr. O'Brien's worklife. This difference was then placed on an after-tax basis and discounted back to the commencement date of the divorce action. CWE_i and $CWOE_i$ were based on the average wages of a surgeon and the average wages of a Bachelors degree holder in year i, respectively. Dr. O'Brien's statistical worklife expectancy[2] was used for n. The nominal risk-free discount rate, R, was based on the market yield on U.S. Treasury securities on the commencement date.

The O'Brien methodology, although accepted and reaffirmed over time by the New York State Court of Appeals, is not without shortcomings. The Court failed to consider and account for fringe benefits and the value of non-pecuniary job characteristics. It interpreted enhanced compensation as being comprised solely of enhanced earnings. It is unfortunate that the court failed to include the value of differential fringe benefits in the human capital calculation. Omitting the valuation of differential fringe benefits is not a serious problem as long as the fringe benefit package is comparable in both career paths. Addressing the issue of the non-pecuniary characteristics however, is fraught with practical difficulties since it would require a hedonic approach to estimating the value of these attributes.

The Court approved the projection of enhanced earnings based on the difference in the *average* wages of a surgeon and the *average* wages of a Bachelors degree holder. Since Dr. O'Brien lacked an earnings history both as a surgeon and as a Bachelors degree holder, it was not possible to project future earnings based on actual historical earnings. This is likely to have led to an overvaluation of the medical license. Given that Dr. O'Brien completed rigorous medical school training, it is probable that he would have earned more than the average Bachelors degree holder since he is above average for this cohort in ability, intelligence, and motivation. Therefore, the court approved methodology overstated the enhanced earnings attributable to the education. In order to address this error, the counterfactual career earnings should have been adjusted upward to reflect a higher than average ability level.

The Court sanctioned the use of a risk-free discount rate based on U.S. Treasury securities to reduce future cash flows to present value. Given that the enhanced cash flows are not guaranteed, the use of a risk-free discount rate overstates the value of the asset. For example, the licensee may experience periods of unemployment due to economic contraction or may suffer from ill health that results in a lengthy absence from work. Additionally, wages may grow less rapidly than predicted due to the vicissitudes of the marketplace.

Although the O'Brien methodology is imperfect, it is superior to the accepted practice prior to O'Brien, which was to ignore the value of acquired human capital entirely in determining the value of marital assets.

To illustrate the application of the O'Brien methodology, consider the following hypothetical case. Mr. and Mrs. X commence a divorce action on January 1, 2005. Mr. X is an attorney who received his Bachelors degree before the marriage, his law school education and law license during the marriage. Mr. X was 50 years of age on the commencement date of the divorce action and had a statistical worklife

expectancy of 15 years. His projected wages in 2005 as an employee of a law firm are $200,000 based on his historical earnings at the firm. Additionally, we make the following assumptions:

1. The wage that Mr. X would earn if his terminal degree were a Bachelors degree is $75,000 per annum. This is based on the average wage of a 50-year old male with a Bachelors degree and 25 years of labor force experience.
2. Wages with a Bachelors degree and as an attorney are both projected to grow by 3 percent per annum over the remainder of Mr. X's worklife. This is the approximate rate of growth of economy-wide wages over the past fifteen years[3].
3. The aggregate tax rate (the sum of FICA, federal and state income tax rates) that Mr. X faces is 30 percent of gross income[4].
4. The nominal discount rate is 5 percent. This is based on present conditions in the U.S. Treasury security market.

The present value of Mr. X's law license appears in Table 1[5]. The present value of the enhanced after-tax earnings that Mr. X's law license affords him over his remaining worklife is $1,123,410.

TABLE 1

O'BRIEN METHODOLOGY FOR VALUING A LAW LICENSE

FOR MR. X

(1)	(2)	(3)	(4)	(5)	(6)
YEAR	AGE	EARNINGS WITH BACHELORS DEGREE	EARNINGS WITH LAW LICENSE	AFTER-TAX ENHANCED EARNINGS (30% TAX RATE)	PRESENT VALUE OF AFTER-TAX ENHANCED EARNINGS
2005	50	$75,000	$200,000	$87,500	$85,391
2006	51	$77,250	$206,000	$90,125	$83,765
2007	52	$79,568	$212,180	$92,829	$82,169
2008	53	$81,955	$218,545	$95,614	$80,604
2009	54	$84,413	$225,102	$98,482	$79,069
2010	55	$86,946	$231,855	$101,436	$77,563
2011	56	$89,554	$238,810	$104,480	$76,085
2012	57	$92,241	$245,975	$107,614	$74,636
2013	58	$95,008	$253,354	$110,842	$73,214
2014	59	$97,858	$260,955	$114,168	$71,820
2015	60	$100,794	$268,783	$117,593	$70,452
2016	61	$103,818	$276,847	$121,120	$69,110
2017	62	$106,932	$285,152	$124,754	$67,794
2018	63	$110,140	$293,707	$128,497	$66,502
2019	64	$113,444	$302,518	$132,352	$65,236
				PRESENT VALUE OF LAW LICENSE	**$1,123,410**

IV. VALUATION OF PROFESSIONAL PRACTICES AND LICENSES

The concept of valuation evolved over the period 1986-1995 as the courts were confronted with more complicated situations in which the licensed parties maintained established professional practices [Marcus v. Marcus (137 AD2d 131), Vanasco v. Vanasco (132 Misc2d 227), Finochio v. Finochio (556 NYS2d 1007) and DiCaprio v. DiCaprio (556 NYS2d 1011)]. If the licensed party maintained an established practice for a number of years, the courts ruled that the license *merged* with the practice and lost its character as a separate distributable asset. The merger concept, unlike the O'Brien decision, is completely flawed and makes no economic sense. The license and the practice are two distinct assets that are based on different future cash flows, and never merge in value. This becomes evident when we consider how practices are valued.

Valuation experts typically use the *excess earnings* method to value a practice. This approach capitalizes any earnings over and above fair owner earnings. Fair owner earnings are defined as the amount paid to professionals of similar age and background, in the same geographic area, without ownership interest in the practice. The value of a practice[6] can be expressed as:

$$(2)\ \sum_{i=1}^{k} \frac{(PE_i - FOE_i)(1-T)}{(1+R)^i}$$

where PE_i is the projected earnings for the owner of the practice in year i and FOE_i is the opportunity cost of the owner's time in year i. FOE represents the earnings the owner could receive if not self-employed. Projected future values of PE are based on the owner's past actual earning levels. Projected future values for FOE are based on the historical average earning levels for professionals with comparable experience. The expected life span of the business is k, which may or may not be equal to the statistical worklife expectancy of the owner (n). If the practice terminates at the end of the worklife of the current owner then n equals k. If the goodwill associated with the practice is enterprise rather than personal goodwill, where enterprise goodwill is defined as intangible but marketable characteristics such as location, name recognition or business reputation, then k is likely to be greater than n.

Both the value of a license and the value of a practice are based on enhanced earnings. The license value is based on the earnings differential between an individual with the education and an individual without the education. The practice value however, is based on the earnings differential between an owner-practitioner and an employee-practitioner with the same level of education. A practice may have little or no value, while a license may have considerable value. Consider a situation where an owner-practitioner earned wages comparable to an employee-practitioner. In this case, the value of the practice would be small or zero, while the license of the owner-practitioner would be of significant value if the wages commanded by the owner-practitioner were considerably higher than the wages of a Bachelors degree holder.

To illustrate the flaw of the merger doctrine, consider our initial example with the following modifications. Mr. Y is identical in all respects to Mr. X, except that Mr. Y is the owner of his own law firm rather than an attorney-employee. His wages, as an owner-practitioner, are $220,000 per annum and are

projected to grow by 3 percent per year. It is assumed that the law practice has a lifetime of 30 years. We value Mr. Y's law practice in Table 2[7]. Fair owner earnings amount to $200,000 in 2005. The present value of the practice amounts to $314,449[8]. This contrasts with the license value in Table 1 of $1,123,410. Clearly the value of Mr. Y's law license has not been subsumed into the value of his practice.

TABLE 2
VALUE OF LAW PRACTICE
FOR MR. Y

(1)	(2)	(3)	(4)	(5)
YEAR	EARNINGS IN LAW PRACTICE	FAIR OWNER EARNINGS	AFTER-TAX ENHANCED EARNINGS (30% TAX RATE)	PRESENT VALUE OF AFTER-TAX ENHANCED EARNINGS
2005	$220,000	$200,000	$14,000	$13,663
2006	$226,600	$206,000	$14,420	$13,402
2007	$233,398	$212,180	$14,853	$13,147
2008	$240,400	$218,545	$15,298	$12,897
2009	$247,612	$225,102	$15,757	$12,651
2010	$255,040	$231,855	$16,230	$12,410
2011	$262,692	$238,810	$16,717	$12,174
2012	$270,572	$245,975	$17,218	$11,942
2013	$278,689	$253,354	$17,735	$11,714
2014	$287,050	$260,955	$18,267	$11,491
2015	$295,662	$268,783	$18,815	$11,272
2016	$304,531	$276,847	$19,379	$11,058
2017	$313,667	$285,152	$19,961	$10,847
2018	$323,077	$293,707	$20,559	$10,640
2019	$332,770	$302,518	$21,176	$10,438
2020	$342,753	$311,593	$21,812	$10,239
2021	$353,035	$320,941	$22,466	$10,044
2022	$363,626	$330,570	$23,140	$9,853
2023	$374,535	$340,487	$23,834	$9,665
2024	$385,771	$350,701	$24,549	$9,481
2025	$397,344	$361,222	$25,286	$9,300
2026	$409,265	$372,059	$26,044	$9,123
2027	$421,543	$383,221	$26,825	$8,949
2028	$434,189	$394,717	$27,630	$8,779
2029	$447,215	$406,559	$28,459	$8,612
2030	$460,631	$418,756	$29,313	$8,448
2031	$474,450	$431,318	$30,192	$8,287
2032	$488,684	$444,258	$31,098	$8,129
2033	$503,344	$457,586	$32,031	$7,974
2034	$518,444	$471,313	$32,992	$7,822
		PRESENT VALUE OF LAW PRACTICE		**$314,449**

The Court of Appeals eventually recognized the flaws in the merger principle in the 1995 McSparron v. McSparron (87NY2d 275, 639 NY2d 265) decision. The Court concluded that professional licenses retain their status as independent assets and never merge into a practice. Consequently, both the license and the practice may have value. Although the Court of Appeals didn't specify the procedure for valuation of a license and practice in McSparron, it did warn against double counting when separately valuing the practice and the license. Additionally, the Court asserted that when an individual possesses an actual work history that makes use of the license, future values for earnings with the license should be based on the licensee's past actual earnings rather than statistical average earnings for license holders.

Complying with the Court's ruling in McSparron ensures that the combined value of the license and practice are overstated. The license value under McSparron is expressed as:

$$(3)\ \sum_{i=1}^{n} \frac{(PE_i - EWOE_i)(1-T)}{(1+R)^i}$$

where EWOE represents earnings without the enhanced education (the earnings of a Bachelors degree holder). Practice earnings are used to value both the practice and the license. This is the source of the overvaluation. To illustrate this problem, consider Table 3, where the value of Mr. Y's law license is projected under McSparron. The present value of the law license amounts to $1,303,155, with a practice value previously computed in Table 2 of $314,449. Following McSparron, the Y household possesses marital assets amounting to $1,617,604. Suppose that as a result of the divorce settlement, Mr. Y sold the practice for its market value. In 2005, Mr. Y can no longer earn $220,000 in wages as an owner-practitioner, but rather fair owner earnings of $200,000. Clearly the enhanced earnings differentials computed in Table 3 overstate the enhanced earnings that Mr. Y can now expect to earn in the future.

This overvaluation can be redressed by basing the value of Mr. Y's license on fair-owner earnings rather than owner-practitioner earnings. This has already been computed in Table 1. The correct value of the Y household's marital assets is $1,437,859 (License value = $1,123,410, Practice value = $314,449)[9].

The Court of Appeals refined its McSparron ruling in the 2000 Grunfeld v. Grunfeld (255 AD2d 12) decision to eliminate the double counting. It ruled that when a practitioner has both a practice and a license, the license is valued by computing the differential between fair owner earnings and earnings of Bachelors degree holder instead of the differential between owner-practitioner earnings and the earnings of a Bachelors degree holder.

TABLE 3
VALUE OF LAW LICENSE
FOR MR. Y

(1)	(2)	(3)	(4)	(5)	(6)
YEAR	AGE	EARNINGS WITH BACHELORS DEGREE	EARNINGS WITH LAW LICENSE	AFTER-TAX ENHANCED EARNINGS (30% TAX RATE)	PRESENT VALUE OF AFTER-TAX ENHANCED EARNINGS
2005	50	$75,000	$220,000	$101,500	$99,054
2006	51	$77,250	$226,600	$104,545	$97,167
2007	52	$79,568	$233,398	$107,681	$95,316
2008	53	$81,955	$240,400	$110,912	$93,501
2009	54	$84,413	$247,612	$114,239	$91,720
2010	55	$86,946	$255,040	$117,666	$89,973
2011	56	$89,554	$262,692	$121,196	$88,259
2012	57	$92,241	$270,572	$124,832	$86,578
2013	58	$95,008	$278,689	$128,577	$84,929
2014	59	$97,858	$287,050	$132,434	$83,311
2015	60	$100,794	$295,662	$136,408	$81,724
2016	61	$103,818	$304,531	$140,500	$80,168
2017	62	$106,932	$313,667	$144,715	$78,641
2018	63	$110,140	$323,077	$149,056	$77,143
2019	64	$113,444	$332,770	$153,528	$75,673
				PRESENT VALUE OF LAW LICENSE	**$1,303,155**

IV. CONCLUSION

The New York State Court of Appeals recognized the importance of human capital as a marital asset in its 1985 O'Brien decision. The valuation methodology it accepted in O'Brien was conceptually sound but imperfect. Lower courts have wrestled with the interpretation and application of the O'Brien decision. The most serious difficulties arose when a license holder also owned a practice. Early rulings from 1985 through 1995 applied the faulty merger principle that led to an under-valuation of marital assets. From 1995-2000, a strict interpretation of the McSparron ruling led to an over-valuation of these assets. Finally, in Grunfeld, the Court affirmed a procedure that eliminates the most egregious errors in valuing marital assets.

ENDNOTES

1. Subsequent to O'Brien, courts have consistently ruled that when a licensee possesses an actual earnings history, actual earnings rather than statistical average earnings should be used to project future earnings.
2. For example, one could use the following to find statistical worklife expectancy "Worklife Estimates: Effects of Race and Education," U.S. Department of Labor, Bureau of Labor Statistics, Bulletin 2254, February 1986.
3. See *Economic Report of the President 2004*, Table B-47, Percent change of average weekly earnings in current dollars.
4. The aggregate tax rate depends upon a multiplicity of factors such as: the number of exemptions, the value of itemized deductions, and the maximum earnings subject to the social security payroll tax.
5. The cash flows are being received at discrete equidistant intervals throughout the year. To approximate the present value of these cash flows, we have assumed that they are all received at the midpoint of the year. Therefore, year 2005 cash flow is divided by $1.05^{½}$ to arrive at present value. The same discounting technique is used throughout the paper.
6. For ease of exposition, we assume that the practice owns no tangible assets, and all capital is leased. The initial purchase price of the practice is irrelevant for valuation purposes. Suppose that the cost of the equity share of the practice was financed by a personal loan. If the loan has been repaid at the time the marriage is dissolved then it is irrelevant in determining the value of marital assets. If the loan has not been fully repaid at the time the marriage is dissolved then the outstanding debt is a relevant consideration. In this case, the Court will reduce the value of the marital assets by the outstanding debt in arriving at an equitable distribution. However, the market value of the practice is unaffected by the debt.
7. We have assumed that the purchaser of Mr. Y's practice could receive the same enhanced earnings that Mr. Y would have received had he continued to work beyond age 65. Consistent with the assumption that the business has only a 30-year time-horizon, the terminal date for the practice valuation is 2034.
8. We have used the same discount rate to value both the practice and the license. It can be argued that the practice is a risky enterprise and one should use a higher discount rate in its valuation. Since we are primarily interested in demonstrating the fallacy of the merger principle, the discount rate issue has been ignored.
9. The value of the license for Mr. Y is the same as that for Mr. X (Table 1). This occurs because the earnings with the law license for Mr. Y are based on fair owner's earnings rather than practice earnings.

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ON "ARBITRAGE" AND MARKET EFFICIENCY: AN EXAMINATION OF NFL WAGERING

Mark Burkey*

ABSTRACT:

For several decades researchers have searched for possible inefficiencies in sports gambling markets. Most profitable strategies have failed to produce profits over the long run. The one consistently profitable strategy that has been studied extensively involves taking advantage of differences between contracts offered in different regional gambling markets. The main purpose of this paper is to explain why and how these differences affect the profitability of wagers. I describe two ways that one could take advantage of these different contracts, loosely defining one of these opportunities as "arbitrage". This paper examines the circumstances under which inter-market gambles in the NFL can be made with an expected profit. Of course, it is expected that as with all arbitrage opportunities, such circumstances are expected to be rare and short-lived, except when betting against a local team.

Pankoff (1968) was the first to test the efficient markets hypothesis for sports gambling markets, and found little evidence of inefficiency in NFL markets. A search for strategies that can "beat the market" ensued, and though researchers appear to report conflicting results, a pattern of regularity has emerged over time. Most findings of inefficiency appear to fall in one of three categories:

1) Testing many strategies and producing possible type I errors
2) Risk neutral strategies against risk averse (or risk loving) bettors
3) Taking advantage of different odds or lines offered by different bookmakers

Over time, the only profitable strategies proposed in the literature that have been shown to remain profitable in out of sample tests fall into category 3, where a bettor finds an "advantage". Such advantages involve choosing the best odds or lines offered from among several bookmakers. These advantages were found to be profitable in papers by Vergin and Scriabin (1978), Tryfos et al. (1984), and Badarinathi and Kochman (1996a), as well as other authors in the economics literature. However, no previous research has examined these

*Department of Economics and Transportation/Logistics, North Carolina A&T State University, Greensboro, NC 27411, Phone: (336) 334-7744 ext. 7030, Fax: (336) 256-2055, E-Mail: burkeym@ncat.edu

advantages in detail, explaining the theory behind how these advantages result in profitable opportunities. This paper explains the theoretical and empirical underpinnings of such advantages, and proposes a method for exploiting them if they can be found. We construct pairs of bets that can loosely be termed *arbitrage*: buying and selling contracts in different markets that have either an expected (when betting using lines) or guaranteed (when betting in odds) profit.

We begin with a brief discussion of several examples of research in each of the above categories. In Section 2 we will describe why different bookmakers often offer different lines or odds. Section 3 briefly introduces vocabulary and explains the structure of the NFL wagering market. Section 4 will suggest a method for taking advantage of different lines offered by bookmakers by making opposite bets in two markets. Section 5 examines recent data from the NFL and finds the necessary conditions for profitable wagers. Sections 6 and 7 discuss and extend the results. Section 8 derives the necessary conditions for profitable wagers in odds between two markets, followed by the Conclusion (Section 9).

1. Previous work on betting

While in 1998 $2.3 billion was spent on *legal* sports gambling in Nevada, it is estimated that between $80 and $380 billion was spent gambling on sporting events illegally (Macy 1999).[1] The sheer size of the illegal market relative to the legal one makes it clear that focusing on the legal market alone fails to capture the complete picture. However, as evidenced by the huge range of estimates of the size of the illegal market, little can be said with certainty. We are severely limited in our ability to study these illegal markets, so most authors focus on the "Vegas line". Many authors have tried to uncover inefficiencies in Vegas lines for NFL games and construct betting strategies that have a positive expected return.

Type I Errors?

Many studies test historical data using a large number of strategies. Often without a guiding theoretical basis, the data are searched for possible profitable wagers that *would have won* more than $\frac{11}{21}$ of the time. The tested strategies range from the simple [bet on the underdog (Vergin and Scriabin 1978), bet on (against) teams that consistently beat (lose to) the point spread (Sturgeon 1974)] to the complex [using regressions to predict winners (Zuber et al. 1985, Osborne 2001)].

Most findings of inefficiencies in markets have been found to be sample specific, implying that the researchers may have committed type I errors. Researchers should always be mindful of this possibility for error, although discussion of type I errors is extremely rare in this literature. In studying gambling market efficiency, setting an alpha = .05 means that for every 20 strategies tested, we expect that one will appear profitable even when the market is truly efficient. Of course when many hypotheses are tested, more type I errors will likely occur.

For example, after testing 15 hypotheses, Gandar et al. (1988) find one profitable strategy with alpha = .05. Woodland and Woodland (2000) test 48 hypotheses, and reject 7 at alpha = .10. The numbers of profitable strategies found are similar to (but slightly greater than) what one would expect to find when, in fact, no profitable strategies exist. Little can be done to ameliorate this problem in practice[2], however authors should use caution when interpreting results. For example, when Badarinathi and Kochman (1996b) test 116 hypotheses, and reject 7 at alpha = .05, they correctly conclude that the findings of inefficiency are likely to be spurious.

Risk Preference

Several authors, most notably Woodland and Woodland (1991) have examined the effects of risk aversion on bettors. Bettors are often risk loving, evidenced by making wagers with negative expected values, and betting on teams with which they have an emotional connection. Consistent with this proposition, several authors have found that racetrack bettors overbet longshots (e.g. Asch, Malkiel, and Quandt 1982). However, Woodland and Woodland (1994) find weak support for the opposite case in baseball.

When focusing on wagering in football, risk aversion plays little part because when betting using point spreads, each wager has approximately even odds of winning. On the other hand, risk loving behavior actually drives the main premise of this paper. Because bettors tend to bet heavily on the local favorite, regional differences between lines may appear. Sometimes these differences can give a bettor an advantage.

Finding an Advantage: Differing Lines

Picking a strategy (such as betting the underdog) **AND** obtaining an "advantage" in a local bookie's line relative to the Vegas line is one tactic that has appeared profitable in many studies over many samples (e.g. Vergin and Scriabin 1978, Tryfos et al. 1984, Badarinathi and Kochman 1996a). For example if a betting rule suggests that you should bet on Team A, and the Vegas line indicates that Team A is favored by 5 points, only bet on Team A if you can find a line of 4, 3.5, or 3 in another market. This is referred to as finding an advantage of 1, 1.5, or 2 points, respectively. Vergin and Scriabin, Tryfos, and Badarinathi and Kochman obtained winning percentages of 60.59, 59.26, and 56.03 in three different samples when betting on underdogs, assuming one could obtain a two-point advantage. As will be shown, the essential element is not the strategy itself, but the size of the advantage obtained. The key element is finding different lines or odds offered in different markets.

2. Different odds for the same game

One large factor that differentiates gambling from other financial markets is that gambling on sporting events is illegal almost everywhere in the U.S. This fact likely causes inefficiencies in the market due to separation of local, illegal gambling markets and increased information costs. Vergin and Scriabin(1978) discuss the importance of getting the "best" odds or lines possible when placing bets.

They note that the point spreads often change two to three points after they are initially published in Las Vegas, and usually vary across cities. Regardless of your strategy, it is important to make sure that you select the most favorable line or odds, increasing your expected profits. Rosecrance(1988) describes a typical betting day at Lake Tahoe:

> Bettors frequently get together ... to compare numbers (odds or points offered by the various sports books) and to discuss wagering opportunities with other regulars. Some call acquaintances in Las Vegas or Reno to check the numbers being offered in those locations.

An example of such a difference occurring was the 1969 Super Bowl, where the Colts were favored over the Jets by 20 in Baltimore, but only by 17 in New York (Merchant 1973, p. 41). The fact that different terms are offered on the same event brings up an interesting question: since spreads differ across space, and also change over the time before a game starts, what are the conditions necessary to find profitable opportunities to bet across markets?

3. A primer for the risk averse

In order to be concrete, we now give an introduction to this market and define some terms. A bookmaker, or **bookie** is one who accepts bets from individuals. These individuals normally serve a limited geographic area because of legal restrictions. When a bookie accepts a bet, it is a contract as follows:

> **The bookie sells the buyer n units of a contingent claim such that if team A scores more than *x* more points than team B, the buyer wins $n. If team A scores less than *x* more points than team B, he loses $(1+v)n. If team A scores exactly *x* more points than team B, the purchaser does not win or lose any money** (a *push*).

Let's call the type of bet just described a **bet on team A**.

The variable ***x*** is often called the **line** or the **spread**. A favored team must win by more than ***x*** points to win a bet on that team, and conversely an underdog must lose by fewer than ***x*** points (or win outright) in order to win a bet on an underdog. Thus let ***x*** be positive if A is favored to win, and negative if A is the underdog. Local bookies will increase or decrease the line to try to keep the amount bet equal on each side, with the goal of taking no personal risk.[3] However, when a bet is made, it is "locked in" at the ***x*** given at that time. The variable *x* can either be an integer, in which case pushes are possible, or non-integer (e.g. 3½) which makes ties impossible. If too many bets on team A are being bought, the bookie can make bets against team A look more attractive by increasing the amount ***x*** (i.e., by increasing the probability that a bet on team B will win). Bookies normally try to act as a broker between bettors, and profit only from their commission, ***v***.

The variable ***v*** is called a **vigorish**(vig). This is a percentage (usually 10 percent) added to all losing bets as a commission.[4] This is where the bookie makes most of his income, and for now we will

assume that this is his only income. Of course, the bookie can strategically choose to bet against his customers, as opposed to simply acting as a broker. Strategic actions by bookies will not be considered in this paper.

4. On arbitrage opportunities

Because most bookies serve only a small geographical area, regional demand differences (and lack of information) may generate different spreads in different markets. Whenever a wedge in prices between markets occurs, there may be the opportunity to bet on a team to win a bet in one market, and lose in another.

Though these transactions do not obviously lend themselves to being called arbitrage (because profit is not *certain*), they come very close to meeting the definition supplied in *The MIT Dictionary of Modern Economics* (Pearce 1986):

> **arbitrage.** *An operation involving the simultaneous purchase and sale of an asset (e.g. a commodity or currency) in two or more markets between which there are price differences or discrepancies. The arbitrageur aims to profit from the price difference; the effect of his action is to lessen or eliminate it.*

Some readers may quibble with whether or not the transactions described in this paper constitute arbitrage; I implore the reader to forgive my loose usage of the word.

A simple example will make arbitrage in these markets more clear. Suppose that Miami is better than Denver, and everyone believes it (even the fans of Denver). Also suppose that the fans of each team demand bets on their team more than other consumers. In equilibrium, suppose that the line in Miami is 10 points and in Denver it is 5 points. If we buy n units of "bet on Miami" in Denver and n units of "bet on Denver" in Miami, we will see one of the following five outcomes *ex post:*

I. In region I to the left of zero, Miami loses the game. Just to the right of zero, Miami wins, but just barely. So, we will win our bet on Denver and lose our bet on Miami. Our payoff is
$(n - n(1+v)) = -vn$.

II. In region II we win both bets. Miami wins by more than 5, and Denver loses by less than 10, winning both bets. Our payoff is (2n).

III. Region III is similar to region I, winning our bet on Miami, and losing our bet on Denver. Our payoff is -vn.

IV & V. The score could also be **exactly** a 5 or 10 point win for Miami. In the case of the 5 point differential, we win our bet on Denver and have a "push" on Miami. So, in these cases we simply win n.

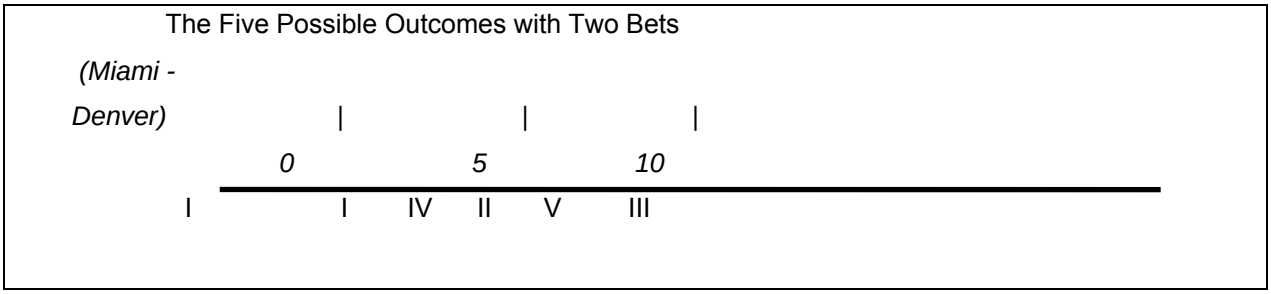


Figure 1: Five possible outcomes from an arbitrage using different point spreads of Miami favored by 10 (*in Miami*) and Miami favored by 5 points (*in Denver*). In regions I and III, we win one bet and lose one bet. In region II, both bets are won. If the outcome is that Miami wins by exactly 5 or 10 points, we win one bet, and neither win nor lose the other.

In order to make money in this above scenario, the probability that the score is in the arbitrage region or equal to one of its boundaries must be p* and $\overline{p}$ such that:

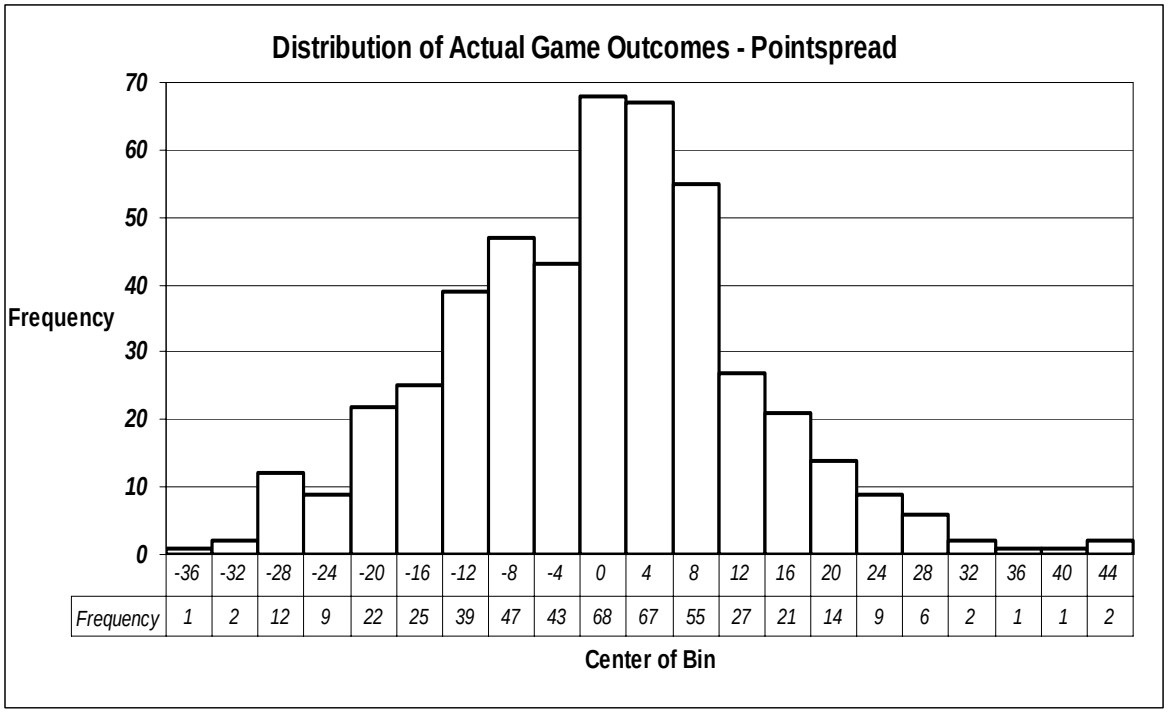
$$\overline{p}(n) + p^*(2n) > (1 - p^* - \overline{p})vn \qquad (1)$$

where $\overline{p}$ is the probability that the difference in scores equals one of the lines, and p* is the probability that the difference falls within the two lines. If we assume for just a moment that the points are distributed continuously, so that $\overline{p}$ = 0, then

$$p^* > \frac{v}{2+v} \qquad (2)$$

If the vig is the customary 10 percent, then p*, the probability we win both bets, must be at least 4.76 percent. Of course, these unrealistic simplifying assumptions are only for illustrative purposes; a more realistic derivation follows in section **5.**

When Pankoff(1968) analyzed the distribution of actual NFL game outcomes around the Vegas line using 1956-1965 data, he found a standard deviation of 15.58. Stern(1991) analyzed the accuracy of point spreads using NFL data from 1981, 1982, and 1984. He found that distribution of the difference between actual game outcomes and point spreads was not significantly different from a normal distribution with mean zero and a standard deviation of 13.86. Using data from 1997 and 1998[5] (473 games) and Las Vegas lines, we found that the standard deviation was 12.91 (Figure 2), and the data are still approximately normal with mean zero.[6] It is interesting to note that the Las Vegas lines seem to be more accurate in more recent data, less varied from the actual game outcomes. A more detailed exploration and explanation of this apparent trend would be an interesting addition to the literature. Are lines more accurate because of more efficient markets, or are the average score differences becoming lower, making them easier to predict?



	-36	-32	-28	-24	-20	-16	-12	-8	-4	0	4	8	12	16	20	24	28	32	36	40	44
Frequency	1	2	12	9	22	25	39	47	43	68	67	55	27	21	14	9	6	2	1	1	2

Figure 2: Histogram showing the distribution of game outcomes relative to the spread (Actual Game Point Differences - Las Vegas Line) for 1997 and 1998 seasons. The sample mean was -.23, standard deviation 12.91. A goodness of fit χ^2 test could not reject the assumption that the data come from a normal distribution with mean 0, standard deviation 12.91.

The unbiasedness of the Las Vegas lines as seen from the zero mean is also as expected, suggesting that the Vegas line is an unbiased estimate of true game outcomes. However, as the variance decreases, the difference in observed lines required to generate a sufficient p* decreases. Continuing with the simplification in equation (2), using Stern's estimate would require a minimum difference in the lines of 1.65 points to break even, whereas the more recent estimate requires only 1.54. Because we are constrained by ½ point intervals, this means that a with a **two point** difference between markets, one could expect to make money. This agrees with the research discussed in section **2** that found that a two point "advantage" could lead to a profitable wager.

If we suppose that an unbiased point spread is announced, and observe the line move up by one point in one market, and down by one point in another, then we would have a positive expected payoff from arbitrage. However, the above analysis is an unjust simplification derived in order to introduce the reader to the issues. Because ties and ½ point lines sometimes affect the probabilities substantially, we now offer a more accurate solution to our arbitrage problem.

5. A more formal treatment

Suppose that there is some true discrete distribution of ***x***, ***f(x)***. Let ***X*** be the expected value for a given game, which bookies know. Suppose that bookies are acting merely as brokers, and market forces drive a wedge between the lines in two local markets to x_A and x_B, with $x_A < x_B$. Then the expected profit from risking 1+v in each market is:[7]

$$E(\pi)= f(x_A)+ f(x_B) + 2\sum_{XA+}^{XB-} f(x) + (-v)(1- f(x_A)- f(x_B) -\sum_{XA+}^{XB-} f(x)) \qquad (3)$$

The first two terms are the probability (and expected payoff) that the score equals one of the observed lines. Note that $f(x_i)$ will be zero if x_i is not an integer, since outcomes of games must have integer point differences. Also important to note is that a tie game is extremely rare in the NFL, so if a tie game is one of the possibilities under consideration in equation (3), that event will have a near zero probability. The third term represents the expected value associated with winning both bets. The last term is the loss associated with winning one bet and losing the other, in which case we lose one vig. Equation (3) can be simplified to:

$$E(\pi)= (1+v) f(x_A)+(1+v) f(x_B)+\sum_{XA+}^{XB-} f(x)(2+v)-v \qquad (4)$$

Using (4) and a "discretized"[8] normal distribution $N(0,12.91^2)$, we calculated expected profits for the following proposition: suppose that an unbiased line is announced, and due to the bookies in two markets acting merely as brokers, the line moves up in market A and down in market B.

Table I gives the expected return from risking \$1.10 (\$1 + .10 vig if you lose) to win \$1 in each city. Table I assumes that the starting line is an integer. Values will be slightly different if the initial announced line is not an integer. For example, if the true, expected point spread suggests that team A should win by 6, suppose we see the line in city A move to 8, and down to 4 in city B. If the actual point difference is 5, 6, or 7 then we will win both bets, with an estimated probability of 9.2 percent. If the actual point difference is 4 or 8, we will win one bet and lose nothing on the other, with an estimated probability of 6.1 percent. Otherwise, we win one bet and lose the other, for a loss of \$.10. Looking at Table I in row 2, column 2 tells us that for risking a maximum loss of \$.10, the expected profit from our gamble in this situation is \$.161. Table I will of course be symmetric, since a symmetric (Normal) distribution was assumed. Similar to what we approximated in Section 4, any time one sees a line in one market that is two or more away from the line in another market, an expected profit will be made.

Payoff Table for Arbitrage on Different Lines								
Number of points moved (down) in city B	Number of points moved (up) in city A							
		0	**.5**	**1**	**1.5**	**2**	**2.5**	**3**
	0	-0.097	-0.066	-0.032	-0.001	0.032	0.063	0.096
	.5		-0.035	-0.012	0.029	0.063	0.094	0.127
	1			0.033	0.063	0.097	0.128	0.161
	1.5				0.094	0.128	0.158	0.191
	2					0.161	0.192	0.225

Table I : Expected payoffs (profit) from risking $1.10 in each of two cities in order to win $1. For example, is the line moves up one point from the initial line in city A, and down 1 point in city B, the expected profit would be 3.3 cents.

6. Why arbitrage is appealing

There are several factors that make this method of betting appealing. No complicated data analysis is required for an individual. By simply observing two different lines, one can roughly approximate the expected return from Table 1. Also, bettors and bookies are acting rationally within their markets. The inefficiency that is being exploited stems from the lack one of single, national market. By taking advantage of different preferences in different geographical locations, we can make a profit. The person betting the arbitrage simply has to observe the lines and estimate a probability that the actual point spread will lie in the interval between the two lines. A significant amount of money is never at risk for the bettor under this strategy: the worst outcome for any one game would be to lose 10 percent of a losing bet, since the worst outcome is wining one bet, and losing the other. One final appealing attribute is that as the bookmaker's information on lines gets better (the variance of the line around the true point spread gets smaller), this technique becomes more profitable.[9] Simply put, this will increase the probability of the actual spread falling within some interval close to the mean expected spread.

Of course, there are also some obvious drawbacks to this strategy. It may be costly to find two bookies in two different cities to place bets with. This is especially true given that we are dealing in a region where gambling is illegal. Also, there is definitely a cost associated with acquiring information on the lines from these bookies. However, given the fact that many people derive pleasure from the act of gambling itself (and not necessarily the money made), the additional cost may not be too large for some. In addition, in today's gambling market it may be possible to arbitrage between a local bookie and an internet gambling house on occasion.

One final interesting use of arbitrage is to act as a hedge for a previously placed bet. If a gambler placed a bet on Team A, and later the line adjusts due to a star player on that team becoming injured, then the first bet would have a very low probability of winning. Ceteris paribus, placing a bet for or

against Team A with the new line would have an expected negative payoff. However, given the fact that a bet was placed on Team A previously, also placing a bet against Team A would have an expected positive return as long as the line adjusted by two or more points.

As with all papers in economics, there are some additional practical considerations one must pay attention to that have been ignored in order to make the analysis tractable. One must consider possible heterogeneity in the variance of the distribution of score differences between certain pairs of teams. For instance, the variance for two strongly defensive teams may be less than that of two strongly offensive teams.[10] Another consideration is that some score differences are more common than others. Differences of three and seven points will tend to be more common than differences of say, two, six or eight.

Nevertheless, the theoretical potential for arbitrage opportunities does exist. The burning question remains: How often do arbitrage opportunities arise between two different local markets, or between a local market and a more centralized market like Las Vegas? Unfortunately, this specific question remains unanswered. Collecting accurate data on a largely illegal market is difficult, at best. The closest answer can be found by looking at lines published by various on-line bookies. While it is still illegal for most Americans to place bets at these establishments, their lines are easily verifiable. A recently developed website, findyourbet.com , has been constructed to allow users to simultaneously compare lines offered at different internet sports bookies. Personius (2002) has found that differences of ½ point between these online bookies are common, and differences of one to two points have occasionally been seen.

7. Vegas as an unbiased estimate

The biggest drawback to this strategy is the necessity of finding a partner in crime in another city, forming what might be called a *syndicate*. Suppose that two members of a syndicate work together, sharing information and coordinating bets when sufficient deviations from the Las Vegas line occur. Sometimes both bets win, and sometimes one bet loses. The syndicate could meet once each year to divide the profits. But, what if the syndicate did not divide up the profits? Obviously, it does not matter. If we know that over many bets, the syndicate would make a profit together, then independently, each member should expect to make half of the profit (in the long run). Simply put, one will make an expected profit if one ever sees a point spread offered which is at least one point different from the Las Vegas line. The Las Vegas line, being unbiased, conveys information about the probability of different outcomes. Thus, one can make money from simply betting one side of the arbitrage suggested earlier, while also eliminating the transaction costs associated with forming a syndicate. The only significant difference is that that amount of potential "risk" has increased because the worst outcome is now to lose the bet (e.g. $1.10) rather than a worst case of losing one vigorish (e.g. $.10 net for both bets).

This kind of proposition is almost precisely what Vergin and Scriabin(1978), suggested, and more recently Tryfos et al. (1984) and Badarinathi and Kochman(1996a) studied. Badarinathi and Kochman's strategy was to bet on the underdog when the point spread was greater than 5 points. This

rule alone was no better than chance, providing winners 50.6 percent of the time. However, if one were to obtain an "advantage" over Las Vegas line of 1, 1.5, or 2 points, one would have seen a 53.52 percent, 54.78 percent, and 56.03 percent winning bets over the years 1984-1993, which are consistent with the theoretical findings in this paper. It is well known in the NFL gambling literature that in order to cover the vigorish, a gambler must win $\frac{11}{21} \approx 52.38$ percent of bets in order to break even. As mentioned previously, the key is not in the strategy chosen, but in the advantage gained from comparing lines.

Strumpf (2003) recently used data acquired from the Kings County (Brooklyn) District Attorney in raids on illegal bookmakers. This data contains lines issued by bookies in the New York area during the late 1990's. He finds that when New York area teams play, that the line is shifted by approximately one point against the local team. This finding confirms the fact that it is possible to find profitable opportunities by betting against the team in a bookie's home area. If the same holds true in other local markets across the U.S., then it is likely to be possible to form betting consortia as described in Section 5.

8. Arbitrage in odds

To be complete, the odds market for NFL games should be discussed. Until the 1940's, betting on NFL games was done on an odds system instead of the current spread system. Currently, legalized betting on NFL games is still done using the odds system (called the "Money Line"), although it is much less common than using lines. Woodland and Woodland(1991) show that risk averse bettors will bet more under a line system than under an odds system.[11] They define an odds bet as the following:

Bet (1+c)n dollars to win (B-c)n dollars (5)

where c is some commission charged for betting.[12] For example(ignoring commissions), if Miami is favored over Denver 2 to 1, then a $1 bet on Denver will win $2 if Denver wins the game, and a $2 bet on Miami will win $1 if Miami wins the game. There are two things to take note of. First of all, ties are rare in NFL games. If a tie does occur, then the bets are neither won nor lost, so they are not important in the case of odds. Also note that if B = 1, this is roughly equivalent to a bet with a spread of zero.

Suppose that the odds reflect the true probability of winning, or

$$\text{P(winning the odds bet)} = \text{P(team wins)} = \frac{1}{(1+B)} \qquad (6)$$

If B is greater than one, then the team in question is an underdog. In the case above, Denver would be expected to have a $\frac{1}{3}$ chance of winning.

Pope and Peel(1989) look at Britain's betting market for soccer and make some interesting observations. First, there are four main, independent betting houses.[13] Second, the odds are fixed several days before each game, and are not changed. They found one instance in a database of odds where profitable arbitrage was guaranteed. Below we will derive the necessary conditions on odds that would give positive returns from arbitrage.

Consider the following arbitrage strategy: Suppose you wish to bet so that if you win a bet the guaranteed payoff is \$1. Bets in odds are such that if you bet n units, you bet (1+c)n to win (B+c)n. If in cities 1 and 2 there exist two different odds on one game, B1 > B2 ≥ 1, then we can choose bets:

(1+c)n1 to win (B1 - c)n1 (7)

(B2 + c)n2 to win (1- c)n2 (8)

We place one bet on the underdog, and place that bet in the city with the higher payoff(B1). We also place one bet on the favorite, and place that bet in the city where it is cheaper to place the bet(B2).

We must choose n1 and n2 so that each bet will win us \$1 **plus** the amount of the other bet that we will lose. This fact gives rise to the following two equations:

$$(B1-c)n1=1+(B2+c)n2 \quad (9)$$

$$(1-c)n2=1+(1+c)n1 \quad (10)$$

The first equation states that our winnings from our bet on the underdog must equal \$1 plus the amount that we bet on the favorite. The second equation states that our winnings from our bet on the favorite must equal \$1 plus the amount that we bet on the underdog. Solving these two equations simultaneously for n1 and n2 gives:

$$n1=\frac{1+B1}{B1-B2-2c-CB2-CB1}, n2=\frac{1+B2}{B1-B2-2c-cB2-cB1} \quad (11)$$

The opportunity for profitable arbitrage will exist when n1 and n2 are positive. This simply puts conditions on B1 and B2 such that the denominator is positive. We have constructed the bets assuming that B1 is larger than B2. How much larger it must be is given by the denominator:

$$B1-B2-2c-cB2-cB1>0 \quad (12)$$

or:

$$B1>\frac{B2+2c+cB2}{1-c} \quad (13)$$

The difference in odds necessary is increasing in c. If c is zero, then B1 need only be slightly larger than B2. Woodland and Woodland (1991) found that on average, c is about .05.[14] Making this assumption, then:

$$B1>1.1053B2+1.053 \quad (14)$$

A graph of this relationship is depicted in Figure 3.

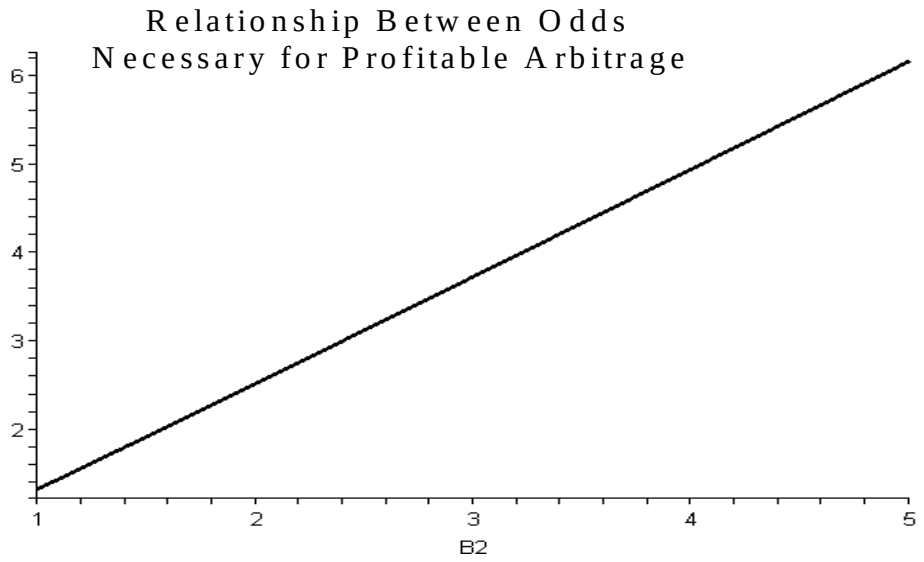


Figure 3: The relationship between odds necessary for profitable arbitrage assuming a 5 percent average commission rate (B1 as a function of B2)..

For example, if we observe the odds of 4 to 1 and 3.5 to 1 for the same game, a bettor could make as much money as he liked, with certainty. Of course, such bets are restricted by a bettor's available funds as well as the willingness of a bookie to take the bet. In this case, the .5 difference in odds is barely over the critical difference of .487. Using equation (11), we would need to buy 180 bets on the underdog, and 200 on the favorite. Thus, the total amount needed to win $1 with certainty is $899. However, if we see odds of 4 to 1 and 3 to 1, this amount decreases to $35.36.

Strumpf (2003) found evidence that sometimes local bookmakers set odds on baseball so that they themselves could arbitrage with Vegas odds. He found that this occurs when a gambler who is known to always bet on a certain team is given very unfavorable odds. This does not imply that the average bettor can take advantage of this, but does suggest that bettors loyal to one team can improve their profitability if they watch the Vegas odds and bet against the home team on occasion, perhaps making an offsetting bet using an online bookmaking service.

9. Conclusion

As Gray and Gray (1997) point out, "The existence of consistent statistical biases in point spreads is not, in itself, evidence of inefficiency. In the strict sense, market inefficiency requires that trading strategies can exploit biases to earn consistent profits." In other words, retrospectively rejecting a null hypothesis does not imply that gambling markets are inefficient. While many different strategies have been tested on NFL market data, few have measured up in out of sample tests.

This paper has shown that in some clearly observable cases, the gambling market is subject to arbitrage of a sort, buying two bets in different markets when at worst one will be lost, and perhaps both will be won. The main reasons this may occur are because of market separation, local bookmakers trying

to act as brokers between gamblers, and the tendency of local gamblers to bet on the local team. Unlike well-organized markets, gambling must often occur in a thin, spatially separated market due to its illegality. Just how often arbitrage opportunities occur is an empirical question which may never have a good answer, due to the lack of data on these small markets. One might expect that as the gambling market on the internet becomes a larger share of the market, arbitrage opportunities may appear less frequently. Even if this is the case, as the local bookie's market becomes thinner, the internet may open up even more opportunities as discussed in this paper.

While arbitrage across markets was shown to be low-risk, it is also understandably costly because of information and other transaction costs. However, bettors can much more simply bet one side of the arbitrage whenever one sees a difference of one or more points between any local line and the Las Vegas line. We also saw that the lines in recent years appear to be better predictors of the actual outcome of a game than in previous years. If this is a continuing trend, the methods discussed will become even more profitable. Of course, there are costs involved with pursuing these transactions that have an expected profit. Whether or not the type of arbitrage highlighted in this paper measures up to an inefficiency in the market is left up to the reader's judgment.

ENDNOTES

1. Many studies have been done estimating the amount of illegal gambling. For a review of these studies, see Rosecrance(1988), Ch. 6.
2. Two possibilities are reducing alpha, or multiplying p-values by the number of tests performed (Bonferroni approach). Both approaches will increase the probability of a type II error, however.
3. Rather than change the line, bookies will often try to pool their risk by "laying off" some of the bets with another bookie if they receive too many bets on one team.
4. Bookies also sometimes change the vig to 5 percent or 15 percent to encourage or discourage bets on a certain team.
5. Data was from Marc Lawrence's Playbook (2000), a retrospective view of football statistics published yearly.
6. An F test determined that the variance has decreased from Stern's estimate (p=.0486). A chi-square test on the more recent data was unable to show that the data are different from a normal distribution with mean zero and standard deviation 12.91 (p=.277).
7. The notation summing from "XA+ to XB-" means "all possible score differences in between x_A and x_B".
8. Finding the area under the normal curve surrounding each possible outcome over a range of one. For example, the probability of the game score being equal to the stated line is the area under the normal curve from -.5 to +.5.
9. That is, if we make the simplifying assumption that lines will still move at the same magnitude.

10. If we assume that a low scoring, defensive team averages scoring μ points with standard deviation σ, it might make sense to think that a team scoring 2μ points on average might have a standard deviation of $\sqrt{2}\,\sigma$, ceteris paribus.
11. For a given, positive expected return.
12. We will continue to use Woodland and Woodland's notation describing an odds bet. The reader should note that while odds bets are actually made in a different form, odds bets can easily be converted into one using this notation.
13. Some consolidation in this market has occurred since Pope and Peel wrote their paper.
14. As Woodland and Woodland(1991) point out in footnotes 2 and 3, a rough average commission for football is (was) .05, however, the rate of commissions for odds bets tend to rise as the odds rise. Recently, it is very common to see higher commission rates.

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SPILLOVERS THROUGH IMPORTS AND EXPORTS

Maryanne Clifford* and Robert Quinn**

Abstract

International trade is growing in importance and in real terms for many countries. As technology expands, so too does international communications which in turn can result in more knowledge spillovers. This paper explores the possibility that importing may not be the only means by which international knowledge spillovers occur. It analyzes international knowledge spillovers by examining the role of exporting as a mechanism for transmitting these spillovers. Unlike previous research this work pulls together both channels of international trade for transmitting knowledge spillovers.

This paper extends David Coe and Elhanan Helpman (1995) by examining the relationship between total factor productivity and the acquisition of productive knowledge and illustrating the importance of knowledge spillovers. This paper shows that for the OECD countries examined, including the United States, international knowledge spillovers are transmitted and received as a result of trade. Both importing and exporting facilitate knowledge spillovers but they are not identical. In this analysis, some countries receive and provide more productive knowledge spillovers than others. The production of new productive knowledge leads to an ever-increasing stock of knowledge and this capital stock is not national but international.

JEL Classification: F1, O3, O4

Keywords: technology transfer, trade, spillovers.

*Department of Economics, Eastern Connecticut State University, Willimantic, CT 06226 phone: 860-465-5512, fax: 860-465-4469, and email:cliffordm@easternct.edu

**Department of Economics, Northern Michigan University, Marquette, MI 49855

1 Introduction and Literature Review

International trade is a frequent topic in the news. Concern over the benefits and costs of international trade are frequently discussed by a wide variety of people including newscasters and politicians. Many people want to know how international trade will affect their future. International trade is rising in importance as importing and exporting sectors of most countries grow. This growth is fueled at least in part by knowledge spillovers transmitted by the international flow of goods and services as firms forge contacts with rivals, potential rivals, and non-rivals in an attempt to gain an advantage or increase market share. It is through these international contacts that productive knowledge flows either explicitly as when a customer discloses proprietary knowledge to a subcontractor or implicitly. It is clear that both intraindustry and interindustry knowledge spillovers play a role in the innovation process. Total factor productivity is affected by the initial development of productive knowledge. Yet while the mechanism of transmission may be identical for imports and exports, the recipient industries are not identical as most industries are importers or exporters but not both. This paper will assess the impact of geography, international boundaries, and international relations on knowledge spillovers that occur as a result of international trade.

New innovations along with new methods of production are frequently the end results of research and development, but the accumulation of productive knowledge at a particular firm may not solely be due to that firm's own research and development efforts. As Griliches (1992) notes, much of the recent interest in knowledge externalities is in the area of changes in productivity. Productivity research is pursued on two very different levels. One looks at changes in the productivity of firms and industries, while another examines increases at the national level. The new economic growth theorists, such as Richard Levin (1998), focus on the role played by the accumulation of knowledge, and the subsequent knowledge spillovers this causes, in aggregate economic growth. At the same time, microeconomists such as Acs and Audretsch (1988) and Jaffe et al. (1993) focus their efforts on the effects of this unintentional knowledge transmission on the productivity of specific firms or industries. Their research focuses on the relationship between productivity gains and research spending.

The Micro-Foundations of Spillovers

A large number of studies investigate inter-firm, intraindustry spillovers of knowledge. Acs and Audretsch (1988) find that knowledge spillovers affect some recipients differently than others. They discover that the spillovers are more important to the innovation process in small firms than in large firms, when defining large and small firms as those with more or fewer than five hundred employees. The authors found that the majority of new inventions came from large firms in industries with high barriers to entry and high levels of concentration. Acs and Audretsch find that small firms are responsible for most of the innovation in industries with lower barriers to entry or lower levels of concentration. Noting this difference, the authors attempt to discover an explanation and to examine the process of innovation. Their model estimates the extent to which industry characteristics can affect innovative output and explores the reason for innovative differences between small and large firms. The authors discover that

firms have different responses due to the market structure of industries and to distinct technological and economic stimuli. Their findings suggest that innovative output is affected not only by R&D but also by the market structure characteristics of an industry.

Once the authors discover that small firms are the basis for the majority of innovation in some industries, they then uncover how this might occur. Their discovery questions the general perception that the majority of research occurs in the largest industrial corporations. In a second paper by Acs et al. (1994), the authors uncover where small firms obtain most of their innovative inputs. Examining the inputs of inventive knowledge in large and small firms using a production function approach, the authors show that small firms benefit greatly from the knowledge spillovers from larger firms and universities. For smaller firms, a major and very important input in their knowledge production function is the spillovers they receive from other organizations. In larger firms, external knowledge spillovers are of less importance to the firm, presumably because firms are also receive internal knowledge spillovers illustrating the importance of scope economies. Small firms have a more limited base of research projects and are more dependent on information from external sources, while this is not true of the larger firms. The larger firms benefit from scope economies and internal knowledge spillovers from the variety of research projects they can support, so they are less dependent on knowledge spillovers.

Geography and International Spillovers

Jaffe et al. (1993) summarize the empirical findings of the past decade on knowledge spillovers, and note that while there is much research on knowledge spillovers, there has been very little research on where these spillovers might go. As Jaffe et al. point out, there are many policies devoted to increasing the United States' international competitiveness and all of these policies implicitly assume that there is a geographical component to knowledge spillovers. Additionally the results from knowledge accumulation can be localized within the United States', if not in a particular region. Jaffe and his co-authors attempt to empirically illustrate that there is some geographical component to knowledge spillovers.

Unlike spillovers at the industry level, at the national level there are many preconceived ideas about the existence and the welfare effects of knowledge spillovers. Early studies of knowledge spillovers implicitly assumed that knowledge spillovers were important within a nation but did not cross international boundaries. Clearly, this is not true. More recent research allows for international knowledge spillovers without clearly identifying the channels of this transmission and the costs of transmitting this knowledge.[1]

Park (1995) attempts to prove that spillovers of domestic governmental policy and knowledge are not geographically localized within national boundaries. To accomplish this, Park examines the effects of knowledge spillovers that occur at the global level as he assumes that knowledge spillovers transmit domestic policy and technological innovation to other nations. He also uses research spillovers as a measure of knowledge spillovers as he examines how the national stock of productive knowledge creates these flows of information and policy. It is through knowledge spillovers that Park believes national governments are able to influence other economies. In essence, he implies that these knowledge spillovers create government policy spillovers. Park uses OECD data in an input-output framework and a

total factor approach to examine the international spillovers of knowledge and government policy. Empirically Park is able to show that knowledge spillovers are an important component of growth and total factor productivity.

Park is able to illustrate that international knowledge spillovers are more important for some countries than for others. This is partly because the majority of research occurs in a small number of countries. Most countries, except the United States, are like small firms, in that the external pool of knowledge and thus knowledge spillovers are more important than internal R&D in explaining the country's ability to innovate.

Bernstein and Mohnen (1998) empirically investigate the boundaries of knowledge spillovers. These authors use industry data from the United States and Japan to examine the extent of inventive knowledge spillovers to determine if these spillovers are predominantly localized within a country, or whether they occur across national boundaries. The authors note that with the growing importance of international trade, foreign direct investment, and the existence of international knowledge diffusion, there is also a growing interdependence of each nation's productivity growth. Thus, a nation's growth is dependent not only on its own capital accumulation but also on knowledge capital accumulated by other countries. Bernstein and Mohnen show that international knowledge spillovers do occur and effect both economies in the short run and the long run through labor, intermediate inputs, R&D capital, and physical capital. The knowledge flows alter variable costs and factor intensities used in the production process; affecting both countries' research-intensive industries. Bernstein and Mohnen estimate that international spillovers between these two countries increase aggregate growth in Japan by sixty percent and in the United States by twenty percent. The difference is because knowledge spillovers have higher elasticities in the Japanese economy.

Grossman and Helpman (1991) investigate how the theory underlying comparative advantage and the gains from trade fits in quite neatly with our understanding of knowledge spillovers and growth. Grossman and Helpman set up a theoretical model that describes the relationship between endogenous growth, trade, and the accumulation of knowledge capital. Coe and Helpman (1995) in turn take this model and test it to analyze the importance of international knowledge spillovers by creating a single pair of elasticity coefficients. One coefficient measures the elasticity for domestic spillovers while the other measures international spillovers.

This paper follows from the empirical model build by Grossman and Helpman (1991) and tested by Coe and Helpman (1995), but it follows an approach more similar to Park (1995) in that it examines the empirical results for each country rather than the more comprehensive approach used by Coe and Helpman who aggregated across multiple countries to generate their elasticity coefficients. This paper examines domestic and international spillovers by country, looking at imports as well as exports as a mechanism for transmitting the spillovers. Challenging the assumptions made by other authors including Coe and Helpman, this paper examines whether imports and exports as mechanisms for transmitting international spillovers are identical or not. In the next section, this paper describes the theory, outlines

the hypothesis, and describes the model used as well as the data. Section three describes the results and section four presents the conclusions on international knowledge spillovers and their channels.

2 Analysis

The Theory

To understand international knowledge transfers it is important to know the channels for that spillover. The studies by Grossman and Helpman (1991) and Coe and Helpman (1995) suggest that international trade, through imports, primarily transmits international knowledge spillovers. While Coe and Helpman examine the importance of imports on determining international contacts, this paper examines the relative impact of imports and exports. The channels for information acquisition include the disclosure of patents and interpersonal communication with suppliers, customers, and rivals. While Coe and Helpman focus on the flow from foreign suppliers to domestic customers, this paper also considers the flow from foreign customers to domestic suppliers. The channels of information include the interaction between foreign suppliers and domestic producers that frequently occurs in the general course of business. A foreign producer commonly reveals information about innovations to its customers as a sales tool. Interpersonal communication with rivals occurs through publications, technical or informal meetings with employees of other firms, and the movement of employees between positions. As noted previously in this paper, this less expensive acquisition of knowledge is generally not as effective as licensing technology, using reverse engineering on a product, or independent R&D. While considerably less expensive, it is not free, as transmissions of spillovers still require potential recipients to commit resources in order to learn about these knowledge externalities and to discover how to use them.[2]

At the same time, exporting to other countries can result in the inflow of technological knowledge gains, from the countries of origin to the destination country. When a domestic company exports goods to a foreign country the domestic producer often receives information concerning preferences of foreign customers. Additionally foreign regulations often come with shared technologies to assist the exporter with compliance. Moreover, the exporter will often work with foreign nationals, which may facilitate knowledge spillovers. By examining these potential channels of international knowledge spillovers, the importance of contact across and among international industries can be examined.[3]

The Hypothesis

This paper will show that information is not only transmitted across industries ; it is also transmitted across countries. Total factor productivity for a particular sector of an economy depends on research done within a nation's industries and from outside of that particular nation. These equations will look at the importance of the acquisition of domestic and foreign productive knowledge across all the sectors in a particular country for achieving increases in total factor productivity. These productivity gains, if any, appear in the industries of the nation being examined and consequently can affect the country's overall measured productivity. This paper examines the effects of intranational and international knowledge

spillovers on the growth of each industry. The use of Coe and Helpman's method of modeling allows for the separating of the national and international sources of these spillovers and to determine the relative importance of each. This paper hypothesizes that increases in research and development in an industry in one country lead to increases in total factor productivity in both its domestic sector and in foreign sectors. For some countries the international flows will be statistically significant while for others they may not be as countries with more international trade in technologically similar, and in sophisticated industries, will more often receive significant international flows than other countries.

Using the model first developed by Grossman and Helpman (1991), this paper separates the effects of research and development upon total factor productivity into two different types. The first variable represents all R&D accomplished across each industry within a specific country and the other measure represents all productive knowledge acquisition done within each industry in the foreign economy. By breaking research and development into two different variables, this paper will attempt to show the importance of intranational and international knowledge flows to each country. This paper will also show that for many countries international knowledge flows are at least as important as intranational knowledge spillovers. This separation of the two different aspects of research and development is also important because the acquisition of international and intranational productive knowledge may have different effects upon the level and type of R&D within the national economy and the growth of the country's total factor productivity. Depending on the industry, more knowledge spillovers may be channeled through export channels than import channels. Coe and Helpman (1995) implicitly assume that knowledge spillovers from both sources are identical. This may not be true, so the model will also test to see if exports and imports provide identical channels for knowledge spillovers.

Furthermore, this paper will examine the importance of geographical and technological distance on international knowledge flows. Traditionally, knowledge has been described as diffusing across countries through trade and multinational corporations from the more advanced country to the less developed country. This allowed the less developed country access to the information of its more developed counterpart and gave firms within that country the chance to imitate their more successful foreign counterparts. This explanation assigns no role to geography since only technological distance matters. Examining the importance of geographic and technological distance on international knowledge flows will explain more about the localization of knowledge spillovers. Examining a country's relationships with neighboring countries will allow us to see if knowledge spillovers are geographically localized even when the spillovers happen to cross international borders and to determine the extent of this localization.

There is an important on-going relationship between each pair of the countries. The types of relationships are: historical, geographical, competitive, and economic. These relationships explain why contact between these nations arose. These foreign contacts in turn lead to business relationships that spread knowledge spillovers. A good example of an economic relationship built on the supply of a critical input is Japan's relationships with Canada and Norway. Since Japan has very few raw materials available domestically, Japanese firms turn to foreign producers. One input of great importance to these

firms is oil. Norway is a large exporter of oil. Canada on the other hand exports many primary products and is a large oil refining country. Any knowledge flows about the conservation, new uses of oil, or product improvements would be of great value to Japanese firms.

Another relationship where the knowledge spillovers can be valuable is in a competitive relationship. An example of a very competitive relationship is the relationship between United States and Japan (or the United States and Switzerland) in pharmaceuticals. A geographical relationship occurs where two countries in close proximity have a continuous relationship due to that proximity. Examples of this geographical relationship exist between the United States and Canada where each country is the other's major trading partner or the relationship between Germany and the neighboring countries of France, Italy, Netherlands, and Switzerland. Other countries not in close proximity might still possess close ties due to shared history. Relations that fall into this category include the ones between Australia and Great Britain, Australia and the United States, and Canada and France.

Investigating the importance of technological distance, where producers use similar production processes or produce similar products, is also important because this traditional explanation of knowledge diffusion and knowledge flows explains little about the flows between more advanced countries. Bernstein and Mohnen (1998) show that there are knowledge flows between United States and Japan even though these two countries both have technologically advanced industries. In fact, much of the trade between industries is between technologically similar firms. Therefore discovering how much insight this traditional explanation of knowledge diffusion gives us about knowledge spillovers, could be interesting.

Empirical Model

When investigating the acquisition of productive knowledge by firms and industries within a country, Coe and Helpman (1995) examine the importance of foreign and domestic productive knowledge acquisition in their model. Based on the model used by Coe and Helpman, this paper employs more than one measure of R&D. The first research and development variable measures the acquisition of productive knowledge within a specific country while the other one measures all the research and development done outside of the country by a trading partner. In this model

$$TFP_t = \alpha_t^0 + \alpha_t^d RAD_t^d + \alpha_t^f RAD_t^f$$

where t is time.[4] In this specification of the model, TFP is the log of total factor productivity. The intercept term is the country specific factor that allows each country to have different stocks of research and development. RAD^d represents the log of domestic R&D capital stock within a county's manufacturing industry, and RAD^f represents the weighted lagged log of foreign R&D capital stock. Coe and Helpman weighted RAD^f by the ratio of imports relative to gross domestic product since the amount of information that is transmitted between countries depends upon the amount of contacts between them. In this specification, in half of the equations RAD^f is weighted by the ratio of imports to gross domestic product and in the rest of the equations it is weighted by the ratio of exports to gross domestic product. This

model is then used to determine the importance of intranational and international productive knowledge spillovers.

The Data

To accomplish this task a series of regressions are run to examine the effect of the relative location of research and development on the total factor productivity for the manufacturing sector in thirteen countries between 1973 and 1994. The countries are Australia, Canada, Denmark, Finland, France, Great Britain, Germany, Italy, Japan, Netherlands, Norway, Sweden, and the United States and are selected due to the availability of data. The data is collected from several OECD data sources namely: ANBERD (Analytical Business Enterprise Research and Development database), the International Sectorial Database, and the International Direct Investment Statistics.

3 Empirical Results for the Manufacturing Industries

The regressions use time series data for each country's manufacturing industry. In the tables, the country name represents the nation whose industries are being examined. Below the country name is the designation for which trading partner and which weight is being examined. The effects on total factor productivity for the manufacturing industries are provided.

The tables each provide interesting insights into the long-term relationship between total factor productivity, growth, research and development, and the importance of the international knowledge transfers. It is not only the existence of knowledge transfers that are important, but also their origin since access to this knowledge spillover may be limited. Each of the tables illustrates the importance of international knowledge transfers to most of the countries where at least on a few occasions it is international rather than intranational knowledge transfers that are significant.

Table 1 provides an overview of the importance of international contact. The table uses side by side comparisons, of the benefits of the import versus export weights to measure the impact of foreign contacts upon the domestic economy. Table 1 illustrates that as a channel of knowledge spillovers both imports and exports are effective in some cases. For example, growth in the Canadian economy occurs due to increases in research and development from domestic sources but also from international knowledge spillovers from the United States. In this table, the omitted columns are the results of non-performing regressions. The second set of Tables labeled 2, 3, and 4 provide more detail on all of the regressions that underlie Table 1. These tables sort the countries from Table 1 into Non-European countries (2), Geographically Large European Nations (3), and Smaller European countries (4).

The omitted equations appear in Table 1 as blank columns. Of the remaining regressions shown in this table, most of these equations have more than one significant R&D coefficient. The equations that appear in Table 1 appear due to the stationary relationship between total factor productivity, domestic R&D, and foreign R&D.

Table 1: An Overview

Country	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS	AUS
Country-Foreign	CAN	CAN	DEN	DEN	FIN	FIN	FRA	FRA	GBR	GBR	GER	GER	ITA	ITA	JPN	JPN	NLD	NLD	NOR	NOR	SWI	SWI	USA	USA	
Weight	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	
Significant R&D	D	D					B	D	D	D	D		D						D	D					
Sign on R&D[d]	+	+					+	+	+	+	+		+						+	+					
Sign on R&D[f]							+																		
Country	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN	CAN
Country-Foreign	AUS	AUS	DEN	DEN	FIN	FIN	FRA	FRA	GBR	GBR	GER	GER	ITA	ITA	JPN	JPN	NLD	NLD	NOR	NOR	SWI	SWI	USA	USA	
Weight	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	
Significant R&D	D	B	D	B		B	F		F	F	B	D			D	B		B	D	D	D		B	B	
Sign on R&D[d]	+	+	+	+		+					+	+			+	+		+	+	+	+		+	+	
Sign on R&D[f]		+		+		+	-		-	-	+					+		+					+	+	
Country	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN	DEN
Country-Foreign	AUS	AUS	CAN	CAN	FIN	FIN	FRA	FRA	GBR	GBR	GER	GER	ITA	ITA	JPN	JPN	NLD	NLD	NOR	NOR	SWI	SWI	USA	USA	
Weight	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	
Significant R&D	D	F	D	D	D	F		D	B	B	B	B			D	B	F	F	D	D	D	D	B	F	
Sign on R&D[d]	-		+	+	+			+	+	+	+	+			+	+			+	+	+	+	+		
Sign on R&D[f]		+				-			+	+	-	-				-	-	+					-	-	
Country	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN	FIN
Country-Foreign	AUS	AUS	CAN	CAN	DEN	DEN	FRA	FRA	GBR	GBR	GER	GER	ITA	ITA	JPN	JPN	NLD	NLD	NOR	NOR	SWI	SWI	USA	USA	
Weight	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	
Significant R&D			D	B										D			B			D					
Sign on R&D[d]			+	+										+			+			+					
Sign on R&D[f]			-	-													+								
Country	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA	FRA
Country-Foreign	AUS	AUS	CAN	CAN	DEN	DEN	FIN	FIN	GBR	GBR	GER	GER	ITA	ITA	JPN	JPN	NLD	NLD	NOR	NOR	SWI	SWI	USA	USA	
Weight	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	
Significant R&D			D	D		D		B			B	D				B		B			D	B	D	D	
Sign on R&D[d]			+	+		+		+			+	+				+		+			+	+	+	+	
Sign on R&D[f]								+			+					+		+				+			
Country	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR	GBR
Country-Foreign	AUS	AUS	CAN	CAN	DEN	DEN	FIN	FIN	FRA	FRA	GER	GER	ITA	ITA	JPN	JPN	NLD	NLD	NOR	NOR	SWI	SWI	USA	USA	
Weight	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	
Significant R&D					B	B		D	F	F	D	B	F	F		D							B	B	
Sign on R&D[d]					+	+		+			+	+				+							+	+	
Sign on R&D[f]					+	+			-	-		+	-	-		+							+	+	
Country	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER	GER
Country-Foreign	AUS	AUS	CAN	CAN	DEN	DEN	FIN	FIN	FRA	FRA	GBR	GBR	ITA	ITA	JPN	JPN	NLD	NLD	NOR	NOR	SWI	SWI	USA	USA	
Weight	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	
Significant R&D	D	D	D	B	D	D	D	B	D	D	D	B	B	D	D	B	D	B	D	D	D	D	D	D	
Sign on R&D[d]	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Sign on R&D[f]				+				+				-	-			+		+							
Country	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA	ITA
Country-Foreign	AUS	AUS	CAN	CAN	DEN	DEN	FIN	FIN	FRA	FRA	GBR	GBR	GER	GER	JPN	JPN	NLD	NLD	NOR	NOR	SWI	SWI	USA	USA	
Weight	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	
Significant R&D	D	D	D	D	D	D	D	D	D	D	D	D	B	D	D	B	D	D	B	D	B	D	D	D	
Sign on R&D[d]	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Sign on R&D[f]													+			+			+						
Country	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN	JPN
Country-Foreign	AUS	AUS	CAN	CAN	DEN	DEN	FIN	FIN	FRA	FRA	GBR	GBR	GER	GER	ITA	ITA	NLD	NLD	NOR	NOR	SWI	SWI	USA	USA	
Weight	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	
Significant R&D	D	D	D	B	B	B	D	D	D	D	D	D	D	B	D	B	B	B	B	B	D	D	B	B	
Sign on R&D[d]	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Sign on R&D[f]				-	-	-								-		-	-	-	+	+			-	-	
Country	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD	NLD
Country-Foreign	AUS	AUS	CAN	CAN	DEN	DEN	FIN	FIN	FRA	FRA	GBR	GBR	GER	GER	ITA	ITA	JPN	JPN	NOR	NOR	SWI	SWI	USA	USA	
Weight	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	
Significant R&D	D	D	D	D	D	D	D	D	D	D	D	D	D	B	B	D	D	D	D	D	D	D	D	D	
Sign on R&D[d]	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	
Sign on R&D[f]														+	-										
Country	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR	NOR
Country-Foreign	AUS	AUS	CAN	CAN	DEN	DEN	FIN	FIN	FRA	FRA	GBR	GBR	GER	GER	ITA	ITA	JPN	JPN	NLD	NLD	SWI	SWI	USA	USA	
Weight	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	
Significant R&D	B			D	B			D	B			F					D				B	F			
Sign on R&D[d]	+			+	+			+	-								+				+				
Sign on R&D[f]	+				+				+			+									+	-			
Country	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI	SWI
Country-Foreign	AUS	AUS	CAN	CAN	DEN	DEN	FIN	FIN	FRA	FRA	GBR	GBR	GER	GER	ITA	ITA	JPN	JPN	NLD	NLD	NOR	NOR	USA	USA	
Weight	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	
Significant R&D			D	D	B														B		B	B			
Sign on R&D[d]			+	+	+														+		+	+			
Sign on R&D[f]					+														+		-	-			
Country	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA
Country-Foreign	AUS	AUS	CAN	CAN	DEN	DEN	FIN	FIN	FRA	FRA	GBR	GBR	GER	GER	ITA	ITA	JPN	JPN	NLD	NLD	NOR	NOR	SWI	SWI	
Weight	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	M	X	
Significant R&D	D	B	B	D	D	B		B	F	B	F	F	B	B			B	B	D	B	D	D	D	D	
Sign on R&D[d]	+	+	+	+	+	+		+		+			+	+			+	+	+	+	+	+	+	+	
Sign on R&D[f]		+	-			+		+	-	-	-	-	+	+			-	+		+					

Key: M: Imports, X: Exports, D: Domestic, B: Both, F: Foreign, N: Neither, AUS: Austria, CAN: Canada, DEN: Denmark, FIN: Finland, FRA: France, GBR: Great Britain, GER: Germany, ITA: Italy, JPN: Japan, NLD: Netherlands, NOR: Norway, SWI: Switzerland, and USA: United States.

The question being investigated in this paper is not the existence of these relationships but rather how well the two different channels for knowledge transfer work. Coe and Helpman (1995) are among the first to empirically examine this idea. Coe and Helpman use a similar model with country level data across several OECD countries. They find that RAD^f and RAD^d both have positive coefficients. Coe and Helpman estimate that the elasticity coefficient of RAD^f is 0.294 and the elasticity coefficient of RAD^d is 0.0078. While both of these elasticities are positive, incomplete information, in particular the lack of standard errors or t-statistics, means the significance levels of the coefficients can not be determined. Table 1 shows that the positive relationship between foreign and domestic R&D displayed by Coe and Helpman in their work is not always replicated. In 172 of the 210 equations, the significant variables are all positive. This corresponds with Coe and Helpman's results and corresponds with the underlying economic theory. Increases in research and development regardless of where it occurs increase total factor productivity in the countries that are able to receive them.

The other 38 equations fail to follow the results generated by Coe and Helpman. In each of these regressions, a variable possesses a significant negative coefficient; although none of these equations possesses two significant and negative variables. This divergence may explain more about whether international knowledge spillovers are a good substitute for domestic research or a compliment for it than a flaw in the underlying theory. The equation examining the effect of increases in Australian research and development upon Danish productivity is the only regression in which RAD^d is both the only significant R&D variable and negative which means it failed to pass a one-tailed test on the relative contribution of R&D.

In 24 of these 38 regressions, both measures of research and development are significant, but one coefficient is negative while the other is positive. Each of these regressions illustrates that an increase in one source of research and development increases domestic productivity while increases in the other reduce it. For most of these 24 equations, RAD^d is positive while RAD^f possess a negative sign. When investigating total factor productivity for Japan, 15 equations produce significant variables that replicate the results by Coe and Helpman. In nine equations, RAD^d is positive and significant while RAD^f is negative and significant. Of these 9 equations, both regressions for Denmark, the Netherlands, and the United States appear as well as export weighted RAD^f for Canada, Germany, and Italy. These results are not restricted to Japan, they are replicated in several other countries including Denmark and the United States. There are also 13 equations where only RAD^f is significant as well as negative. Four of these equations occur when investigating total factor productivity in Great Britain where RAD^f from France and Italy are negative and significant. Another example of a significant negative variable occurs when examining the impact of increases in Canadian research and development upon the growth of total factor productivity in U. S. manufacturing industries. In this regression, increases in Canadian and domestic research and development significantly effect productivity. An unexpected result occurs as increases in Canadian R&D decrease U. S. productivity growth. This is contrary to the results uncovered by Coe and

Helpman and the underlying economic theory. It is not the only example of this however, as the 37 other equations also produce similar results.

A potential explanation for these results does exist. In some cases, increases in foreign research and development may not require additional research and development to adapt the knowledge spillovers to business within the country. The foreign research and development provides information that is a good substitute for domestic research and development. Foreign increases in research and development increase market share of imported goods and decreasing market share of domestically produced goods that have yet to deal with this innovation. In this case, countries are competing for the same pool of customers and the delay in innovation is initially costly to domestic producers but ultimately increases productivity and national output. An increase in Canadian research and development then has a negative impact upon productivity gains in the United States. The competition for American customers forces American firms to acquire the innovation, through international knowledge spillovers, so they can compete effectively with all their competitors.

In Table 1, research and development from the United States has a significant impact on total factor productivity in Canada, Denmark, Great Britain, and Japan. It does not significantly influence the other countries in the table, or at least this influence is not immediately apparent. Other countries including Germany, Great Britain, and Japan do provide significant knowledge spillovers to several trading partners. Germany provides significant knowledge spillovers to Canada, Denmark, Great Britain, Italy, Japan, the Netherlands, and the United States. Great Britain sends significant amounts of productive knowledge to Canada, Denmark, France Germany, Norway, and the United States. Japan generates research and development that is significant to Canada, Denmark, France, Germany, Italy, and the United States. In fact, all three of these countries are an important source of innovation for American manufacturing industries. All the countries in this series of tables send and receive knowledge spillovers.

Differences in a country's dependence on foreign research and development may be due to the relative openness of the industry and the economy. Relatively more trade and a relatively larger proportion of GDP that is the result of trade could lead to relatively more foreign contacts. The United States and other several other economies, can still be considered relatively closed economies and thus have fewer foreign contacts than their relatively more open counterparts which in turn may explain the disparity between these results. There may also be another reason for these differences. Unlike previous papers including the one by Coe and Helpman, this model does not control for indirect effects. This means that information flows originating from the United States and influencing production in Germany or France, which flow through an intermediary country, appear as if they originated in that intermediary instead of from the United States. This may also be the reason for the existence of the discrepancies between the results in Table 1 and those from Coe and Helpman.

Further examination of the significant research and development coefficients reveals no obvious single origin for the knowledge spillovers that flow through Table 1. In tables 2, 3, and 4, many of the countries provide international knowledge spillovers to their trading partners. This data also show that

none of the countries, including the United States is the single dominant force in transmitting knowledge spillovers. This is contrary to the results produced by Park (1995), which show that most of the knowledge spillovers originated in the United States, while other countries are largely receivers of them.

Another result by Park that is contradicted here is the importance of international knowledge spillovers to the United States. He illustrates with country level data that international knowledge spillovers are much more important to the rest of the world than they are to the United States. His results are not reproduced here. Depending upon which channel is being examined, several countries including Germany and Japan provide significant knowledge spillovers to the United States. In many instances in Table 1, the external pool of knowledge and thus knowledge spillovers is more important than the internal R&D in explaining the country's ability to innovate. This is also true for the United States. Acs and Audretsch (1988) develop definitions of large and small firms to define the importance of external research and development. This paper uses an extension of this concept with international spillovers and uses a slightly different terminology. Extending Acs and Audretsch's work, the equivalent of a large firm in terms of a country can be identified as an inwardly focused country. It is like a large firm and independent of foreign knowledge spillovers whereas the equivalent of a small firm could be described as dual focused economy since it is significantly affected by international knowledge spillovers. By this definition, the results provided by Park show that only the United States could be considered an inwardly focused country and all the other countries are dual focused as they are much more responsive to international knowledge spillovers. However, Table 1 refutes this by showing that all countries, including the United States, are dependent upon international knowledge spillovers and so all the countries could be considered dual focused countries.

Since productivity in a dual focused country is sensitive to international knowledge transfers, the continued transmission of productive information is important. For many of the countries in Table 1 the importance of international knowledge spillovers depends upon which of the two channels is being examined. Often one of the equations shows the significant impact of foreign knowledge transfers upon the domestic economy's total factor productivity while the other shows international information flows to be insignificant. This means one channel may transmit the knowledge spillovers more effectively than the other. One of the details that needs to be clarified is the difference between imports and exports as channels of knowledge transfers.

The two different channels for dispersing productive information do not always have the same impact upon a recipient. In Table 2, the significant knowledge spillover coefficients produced by the two channels show no clear pattern. These results show that the significant coefficient in 6 regressions is RAD^f, in 38 others it's RAD^d, and in the last 27 both RAD^f and RAD^d are significant. Of the equations that use imports as the primary means of transmitting information between countries, one set of significant coefficients includes 24 regressions for RAD^d, 4 with RAD^f, and 8 where both measures of R&D are significant. The group of regressions using exports as the primary mechanism for knowledge spillovers includes 14 regressions where RAD^d is significant, 2 where RAD^f is significant, and 19 where both

Table 2: Countries Outside Europe: Japan, United States, Canada, and Australia

Country	Japan	Japan	Japan	Japan	Japan	Japan	Japan	Japan	Japan	Japan	Japan	Japan
Foreign Country	Australia	Australia	Canada	Canada	Denmark	Denmark	Finland	Finland	France	France	Great Britain	Great Britain
Direction	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Intercept	-5.724*	-5.140*	-6.085*	-6.041*	-5.267*	-5.022*	-5.128*	-5.549*	-6.070*	-5.961*	-5.570*	-5.585*
	(0.4095)	(0.6321)	(0.5472)	(0.3158)	(0.4104)	(0.4812)	(0.7960)	(0.5993)	(0.6400)	(0.6648)	(0.6551)	(0.6984)
RAD[d]	0.191*	0.171*	0.203*	0.200*	0.176*	0.168*	0.171*	0.185*	0.203*	0.199*	0.186*	0.187*
	(0.0140)	(0.0215)	(0.0182)	(0.0107)	(0.0140)	(0.0164)	(0.0268)	(0.0203)	(0.215)	(0.0224)	(0.0220)	(0.0234)
RAD[f]	-0.045	-0.354	0.876	-3.993***	-6.701***	-8.518***	-3.552	-1.226	32.406	19.087	-0.177	-0.164
	(0.2409)	(0.3061)	(2.0960)	(2.2231)	(3.6406)	(4.2721)	(4.0306)	(2.7955)	(58.4651)	(56.6120)	(0.5054)	(0.5509)
R^2	0.9394	0.9435	0.9457	0.9538	0.9489	0.9503	0.9418	0.9399	0.9403	0.9397	0.9397	0.9396
Adj R^2	0.9327	0.9372	0.9394	0.9485	0.9432	0.9447	0.9353	0.9332	0.9337	0.9330	0.9330	0.9329
Observations	21	21	21	20	21	21	21	21	21	21	21	21
Country	Japan	Japan	Japan	Japan	Japan	Japan	Japan	Japan	Japan	Japan	Japan	Japan
Foreign Country	Germany	Germany	Italy	Italy	Netherlands	Netherlands	Norway	Norway	Switzerland	Switzerland	United States	United States
Direction	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Intercept	-5.878*	-5.407*	-4.571*	-4.760*	-5.487*	5.406*	-5.860*	-5.870*	-5.809*	-6.033*	-5.113*	-5.037*
	(0.4200)	(0.3726)	(0.9888)	(1.2539)	(06694)	(0.9730)	(0.2587)	(0.2657)	(0.3880)	(0.4305)	(0.4253)	(0.4440)
RAD[d]	0.196*	0.181*	0.152*	0.159*	0.183*	0.181*	0.195*	0.195*	0.194*	0.201*	0.171*	0.168*
	(0.0142)	(0.0127)	(0.0333)	(0.0422)	(0.0225)	(0.0326)	(0.0089)	(0.0091)	(0.0133)	(0.0142)	(0.0144)	(0.0151)
RAD[f]	6.611	-21.526***	-2.754	-1.828	-2.855	-3.451	6.647*	5.973*	1.098	32.293	-12.166**	-12.023**
	(15.235)	(12.3409)	(2.1538)	(2.1966)	(5.9173)	(8.7247)	(1.8787)	(1.7981)	(5.1281)	(34.0584)	(5.6344)	(5.4342)
R^2	0.9399	0.9481	0.9443	0.9415	0.9400	0.9398	0.9642	0.9624	0.9394	0.9422	0.9518	0.9523
Adj R^2	0.9332	0.9423	0.9381	0.9350	0.9334	0.9331	0.9602	0.9582	0.9327	0.9357	0.9464	0.9470
Observations	21	21	21	21	21	21	21	21	21	21	21	21
Country	United States	United States	United States	United States	United States	United States	United States	United States	United States	United States	United States	
Foreign Country	Australia	Australia	Canada	Canada	Denmark	Denmark	Finland	France	France	Great Britain	Great Britain	
Direction	Imports	Exports	Imports	Exports	Imports	Exports	Exports	Imports	Exports	Imports	Exports	
Intercept	-4.062*	-7.352*	-2.409*	-3.406*	-4.307*	-6.251999*	-7.111*	-0.844	-1.906***	-0.346	-0.405	
	(0.7091)	(0.8870)	(0.7483)	(0.5922)	(0.7960)	(0.72219821)	(0.7406)	(0.7355)	(1.0485)	(0.4822)	(0.6222)	
RAD[d]	0.160*	0.291*	0.097*	0.136*	0.170*	0.247064*	0.281141*	0.034	0.075***	0.014	0.017	
	(0.0285)	(0.0355)	(0.0294)	(0.0236)	(0.0320)	(0.02887049)	(0.0296)	(0.0291)	(0.0416)	(0.0191)	(0.02458)	
RAD[f]	0.467	1.914*	-5.970**	-4.322	8.816	26.862*	17.737535*	-283.428*	-155.96**	-2.875*	-2.848*	
	(0.3877)	(0.4018)	(2.7652)	(4.0050)	(6.5673)	(5.9753)	(3.2350)	(64.10628)	(84.7592)	(0.3571)	(0.4732)	
R^2	0.6907	0.8562	0.7365	0.6858	0.6964	0.8466	0.8787	0.8438	0.7200	0.9303	0.8982	
Adj R^2	0.6543	0.8393	0.7055	0.6488	0.6607	0.8286	0.8645	0.8255	0.6871	0.9220	0.8802	
Observations	20	20	20	20	20	20	20	20	20	20	20	
Country	United States	United States	United States	United States	United States	United States	United States	United States	United States	United States	Canada	Canada
Foreign Country	Germany	Germany	Japan	Japan	Netherlands	Netherlands	Norway	Norway	Switzerland	Switzerland	United States	United States
Direction	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Intercept	-5.038*	-4.757*	-3.651*	-4.880*	-5.198*	-10.528*	-3.605*	-3.6083*	-3.817*	-3.569*	-1.930*	-1.884*
	(0.6107)	(0.6159)	(0.5376)	(0.5830)	(1.2058)	(1.6211)	(0.5707)	(0.5600)	(0.6787)	(0.8146)	(0.5117)	(0.5591)
RAD[d]	0.198*	0.187*	0.145*	0.191*	0.205*	0.414*	0.143*	0.144*	0.150*	0.140*	0.087*	0.085*
	(0.0244)	(0.0246)	(0.0219)	(0.0232)	(0.0478)	(0.0639)	(0.0232)	(0.0228)	(0.0273)	(0.0316)	(0.0234)	(0.0257)
RAD[f]	73.568*	58.176*	-0.583***	0.848*	15.416	61.074*	-5.109	-5.638	6.333	1.490	24.392**	20.724***
	(20.5325)	(18.8804)	(0.2912)	(0.2374)	(10.0337)	(13.7503)	(4.0671)	(3.7334)	(8.3395)	(60.9275)	(10.4312)	(10.5467)
R^2	0.8087	0.7846	0.7283	0.8082	0.7052	0.8446	0.6928	0.7040	0.6753	0.6643	0.4436	0.4027
Adj R^2	0.7862	0.7592	0.6963	0.7856	0.6705	0.8263	0.6566	0.6691	0.6371	0.6248	0.3818	0.3363
Observations	20	20	20	20	20	20	20	20	20	20	21	21
Country	Canada	Canada	Canada	Canada	Canada	Canada	Canada	Canada	Canada	Canada	Canada	Canada
Foreign Country	Australia	Australia	Denmark	Denmark	Finland	France	Great Britain	Great Britain	Germany	Germany	Japan	Japan
Direction	Imports	Exports	Imports	Exports	Exports	Imports	Imports	Exports	Imports	Exports	Imports	Exports
Intercept	-1.147**	-2.853*	-1.298**	-2.073*	-2.919*	0.537	0.781***	0.811	-1.836*	-1.338*	-1.005**	-1.770*
	(0.4590)	(0.7133)	(0.5149)	(0.5935)	(0.6109)	(0.5219)	(0.4316)	(0.4879)	(0.4230)	(0.4556)	(0.3639)	(0.3787)
RAD[d]	0.052**	0.130*	0.051**	0.094*	0.1353*	-0.023	-0.034	-0.035	0.083*	0.060*	0.047**	0.079*
	(0.0214)	(0.0329)	(0.0239)	(0.0273)	(0.0281)	(0.0237)	(0.0196)	(0.0221)	(0.0194)	(0.0209)	(0.0172)	(0.0174)
RAD[f]	-0.213	1.5286**	2.393	17.578**	15.527*	-259.630*	-2.561*	-2.602*	67.582**	27.280	-0.312	0.828*
	(0.4183)	(0.5331)	(7.0670)	(8.1284)	(4.3914)	(73.2892)	(0.5120)	(0.5913)	(23.6064)	(23.2473)	(0.3254)	(0.2561)
R^2	0.2849	0.5021	0.2792	0.4242	0.5719	0.5726	0.6965	0.6506	0.5015	0.3261	0.3098	0.5410
Adj R^2	0.2055	0.4467	0.1991	0.3602	0.5243	0.5251	0.6628	0.6117	0.4462	0.2513	0.2331	0.4899
Observations	21	21	21	21	21	21	21	21	21	21	21	21
Country	Canada	Canada	Canada	Canada	Australia	Australia	Australia	Australia	Australia	Australia	Australia	Australia
Foreign Country	Netherlands	Norway	Norway	Switzerland	Canada	Canada	France	France	Germany	Italy	Norway	Norway
Direction	Exports	Imports	Exports	Imports	Imports	Exports	Imports	Exports	Imports	Imports	Imports	Exports
Intercept	-3.710**	-0.983**	-0.974**	-1.099**	-2.218*	-2.211*	-3.250	-2.668*	-2.525*	-2.061*	-2.453*	-2.450*
	(1.3657)	(0.3621)	(0.3578)	(0.4359)	(0.3242)	(0.1899)	(0.3813)	(0.3876)	(0.2183)	(0.3747)	(0.1916)	(0.1928)
RAD[d]	0.167**	0.046**	0.046**	0.050**	0.107*	0.109*	0.156*	0.129*	0.122*	0.101*	0.119*	0.119*
	(0.0616)	(0.0170)	(0.0168)	(0.0203)	(0.0151)	(0.0090)	(0.0181)	(0.0185)	(0.0106)	(0.0180)	(0.0094)	(0.0095)
RAD[f]	38.266***	-4.472	-4.898	3.524	-0.783	-3.227	145.438**	37.675	9.111	-1.771	-0.021	-0.177
	(18.7555)	(4.0970)	(3.7730)	(8.9257)	(2.1465)	(2.3010)	(62.7445)	(59.6336)	(14.4627)	(1.4811)	(2.5423)	(2.3791)
R^2	0.4108	0.3196	0.3367	0.2808	0.8968	0.9068	0.9225	0.9016	0.9016	0.9068	0.8994	0.8994
Adj R^2	0.3454	0.2440	0.2630	0.2009	0.8847	0.8958	0.9139	0.8906	0.8906	0.8964	0.8882	0.8882
Observations	21	21	21	21	20	21	21	21	21	21	21	21

Note: Significant at: * a 1% level of significance, ** a 5 % level of significance, and *** a 10% level of significance.

coefficients are significant. Using exports as the channel means that, more often, both variables will be significant.

In Table 3 and 4, the elasticity coefficient results from Table 2 are replicated. Once again it appears that using exports instead of imports as the mechanism for the flows of information across countries means that more often both foreign and domestic sources of innovation will provide significant contributions to economic growth. For many of the countries including Japan, changing from imports to exports makes the country appear even more dependent on international knowledge flows. Japan, Canada, and the United States all conform to this explanation. Using imports to explain knowledge spillovers, in Japan the significant variables are only domestic research and development in 9 of the 12 equations. In the other 3 regressions, both domestic and foreign sources of innovation are significant sources of productive growth. Shifting to exports as the source of knowledge spillovers, in Japan 7 of the 12 regressions reveal that only domestic research and development is a significant source of innovation. Now however, the other 5 equations present evidence that both foreign and domestic knowledge acquisitions are significant. This explanation is true for non-European countries as well as for countries in Europe.

To further examine the channel of knowledge transfers, one must examine the impact of using imports versus exports as a channel to transmit knowledge transfers. There are 91 pairs of regressions; one equation uses the fraction of imports to GNP as a weight while the other uses the corresponding fraction with exports replacing imports in the weight. Forty-six equations exist where both the import and export regressions appear in the table, and the signs and significant variables in these pairs are identical. There is no difference in the significance of each variable or in the signs for the R&D coefficients. Most of these pairs of equations possess significant variables that are positive. Some of these pairs show only one of the measures of research and development to be positive and significant, while the insignificant variable may or may not have a positive coefficient. In others of these identical pairs both sets of variables are significant and the sign on each of the research and development variables is positve. These results are consistent with the theory, but some exceptions do exist. Two notable exceptions occur when examining the importance for total factor productivity in Switzerland of RAD^f from Norway and in the United States of RAD^f from Great Britain. Both sets of regressions have foreign research and development as a significant variable, however the sign of these coefficients is negative for each equation in both of the pairs. The importance of British knowledge spillovers for the United States is different from the importance of Norwegian knowledge flows to Switzerland as the latter regression also produces a significant RAD^d with the correct sign. In the former equation, RAD^d has the correct sign but remains insignificant. The equations, regardless of which channel of information spillovers is examined, appear to contradict the theory, when in fact these signs simply expose the relationship between domestic and foreign research and development. In these regressions foreign R&D is a very good substitute for

Table 3: Large European Countries: France, Germany, Great Britain, and Italy

Country	France	France	France	France	France	France	France	France	France	France	France	France
Foreign Country	Canada	Canada	Denmark	Finland	Germany	Germany	Japan	Netherlands	Switzerland	Switzerland	United States	United States
Direction	Import	Export	Export	Export	Import	Export	Export	Export	Import	Export	Import	Export
Intercept	-2.851*	-3.130*	-3.332*	-3.731*	3.569*	-3.204*	-3.506*	-4.713*	-3.188*	-3.595*	-3.229*	-3.273*
	(0.3170)	(0.2053)	(0.3402)	(0.3549)	(0.2202)	(0.2561)	(0.2103)	(0.5196)	(0.2441)	(0.2398)	(0.3056)	(0.3201)
RAD^d	0.113*	0.123*	0.132*	0.148*	0.141*	0.127*	0.138*	0.186*	0.126*	0.141*	0.128*	0.130*
	(0.0124)	-0.0082	(0.01369263)	(0.0143)	(0.0088)	(0.0103)	(0.0085)	(0.0206)	(0.0100)	(0.0093)	(0.0123)	(0.0129)
RAD^f	-1.389	1.828	2.054068	3.912***	29.214**	1.756	0.330**	18.545*	0.294	62.313**	1.144	1.918
	(1.54066)	(1.8365)	(3.86834729)	(2.1193)	(10.2258)	(10.8547)	(0.1184)	(5.9455)	(4.1391)	(24.0645)	(5.1796)	(5.0148)
R^2	0.9292	0.9299	0.9244	0.9355	0.9472	0.9234	0.9463	0.9502	0.9233	0.9441	0.9235	0.9239
Adj R^2	0.9208	0.9216	0.9160	0.9283	0.9413	0.9148	0.9403	0.9446	0.9147	0.9379	0.9149	0.9154
Observations	20	21	21	21	21	21	21	21	21	21	21	21
Country	Great Britain	Great Britain	Great Britain	Great Britain	Great Britain	Great Britain	Great Britain	Great Britain	Great Britain	Great Britain	Great Britain	Great Britain
Foreign Country	Denmark	Denmark	Finland	France	France	Germany	Germany	Italy	Italy	Japan	United States	United States
Direction	Import	Export	Export	Import	Export	Import	Export	Import	Export	Export	Import	Export
Intercept	-4.747*	-6.189*	-5.645*	-0.629	-1.125	-3.614*	-4.808*	0.970	2.604	-3.857*	-5.617*	-5.374*
	(1.17238)	(1.4670)	(1.6508)	(0.3773)	(0.9630)	(1.0792)	(1.0400)	(1.8373)	(1.6737)	(0.9865)	(1.1761)	(1.3490)
RAD^d	0.207*	0.272*	0.247*	0.027	0.047	0.156*	0.209*	-0.047	-0.119	0.166*	0.245*	0.235*
	(0.0531)	(0.0661)	(0.0742)	(0.0168)	(0.0430)	(0.0486)	(0.0467)	(0.0817)	(0.0743)	(0.0444)	(0.0527)	(0.0607)
RAD^f	20.416***	34.349**	14.997	-412.967*	-264.607**	30.665	81.116**	-11.395**	-12.902*	0.569	44.295**	36.237***
	(11.4141)	(14.4319)	(8.6694)	(43.1286)	(100.1393)	(42.3935)	(37.1009)	(4.8632)	(3.6000)	(0.4709)	(17.1532)	(18.2271)
R^2	0.5912	0.6425	0.5862	0.9335	0.6649	0.5159	0.6256	0.6393	0.7381	0.5453	0.6598	0.6084
Adj R^2	0.5328	0.5914	0.5271	0.9240	0.6170	0.4467	0.5721	0.5877	0.7007	0.4803	0.6112	0.5524
Observations	17	17	17	17	17	17	17	17	17	17	17	17
Country	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany
Foreign Country	Australia	Australia	Canada	Canada	Denmark	Denmark	Finland	Finland	France	France	Great Britain	Great Britain
Direction	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Intercept	-3.278*	-3.734*	-3.014*	-3.335*	-2.953*	-3.557*	-3.534*	-4.267*	-3.077*	-3.627*	-2.548*	-2.374*
	(0.3756)	(0.6328)	(0.4987)	(0.3020)	(0.4066)	(0.5128)	(0.7578)	(0.5004)	(0.5350)	(0.5701)	(0.5292)	(0.5369)
RAD^d	0.133*	0.152*	0.122*	0.133*	0.120*	0.144*	0.143*	0.173*	0.125*	0.147*	0.104*	0.097*
	(0.0155)	(0.0260)	(0.0201)	(0.0124)	(0.0168)	(0.0211)	(0.0308)	(0.0205)	(0.0218)	(0.0233)	(0.0215)	(0.0218)
RAD^f	0.010	0.231	-0.855	3.446***	-3.646	2.856	1.330	4.972**	-19.053	32.552	-0.595	-0.744***
	(0.1996)	(0.2769)	(1.7275)	(1.9160)	(3.2580)	(4.1135)	(3.4716)	(2.1098)	(44.2563)	(43.9345)	(0.3697)	(0.3835)
R^2	0.8593	0.8645	0.8502	0.8724	0.8638	0.8629	0.8604	0.8925	0.8607	0.8634	0.8770	0.8836
Adj R^2	0.8437	0.8495	0.8326	0.8574	0.8538	0.8477	0.8449	0.8805	0.8452	0.8483	0.8633	0.8707
Observations	21	21	20	20	21	21	21	21	21	21	21	21
Country	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany	Germany
Foreign Country	Italy	Italy	Japan	Japan	Netherlands	Netherlands	Norway	Norway	Switzerland	Switzerland	United States	United States
Direction	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Intercept	-1.532***	-2.305**	-3.259*	-3.713*	-3.131*	-4.809*	-3.264*	-3.260*	-3.101*	-3.150*	-3.467*	-3.545*
	(0.8139)	(1.0408)	(0.2917)	(0.3089)	(0.6256)	(0.8265)	(0.3026)	(0.3021)	(0.3451)	(0.3807)	(0.4582)	(0.4797)
RAD^d	0.062***	0.093**	0.133*	0.150*	0.127*	0.1950*	0.133*	0.133*	0.126*	0.128*	0.141*	0.144*
	(0.0332)	(0.0424)	(0.0121)	(0.0127)	(0.0255)	(0.0336)	(0.0126)	(0.0126)	(0.0143)	(0.0153)	(0.0188)	(0.0197)
RAD^f	-3.623**	-1.592	-0.186	0.322**	-1.250	13.269***	-0.750	-0.885	-3.882	-13.886	3.172	3.931
	(1.6040)	(1.6499)	(0.1511)	(0.1228)	(5.0025)	(6.7075)	(1.9893)	(1.8511)	(4.1208)	(27.3704)	(5.4836)	(5.3032)
R^2	0.8904	0.8662	0.8702	0.8983	0.8598	0.8844	0.8604	0.8610	0.8659	0.8613	0.8618	0.8634
Adj R^2	0.8782	0.8513	0.8558	0.8870	0.8442	0.8716	0.8449	0.8456	0.8510	0.8458	0.8465	0.8483
Error Correction	-4.074*	-3.383*	-3.243*	-3.434*	-2.611**	-3.273*	-3.024*	-3.108*	-3.563*	-2.549**	-3.613*	-4.062*
Observations	21	21	21	21	21	21	21	21	21	21	21	21
Country	Italy	Italy	Italy	Italy	Italy	Italy	Italy	Italy	Italy	Italy	Italy	Italy
Foreign Country	Australia	Australia	Canada	Canada	Denmark	Denmark	Finland	Finland	France	France	Great Britain	Great Britain
Direction	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Intercept	-4.666*	-4.651*	-4.478*	-4.550*	-4.361*	-4.355*	-4.141*	-4.922*	-4.709*	-4.790*	-4.203*	-4.250*
	(0.2852)	(0.5033)	(0.3453)	(0.2551)	(0.3164)	(0.3950)	(0.5219)	(0.4419)	(0.4228)	(0.4384)	(0.4113)	(0.4334)
RAD^d	0.157*	0.156*	0.151*	0.154*	0.146*	0.146*	0.139*	0.165*	0.158*	0.161*	0.141*	0.143*
	(0.0099)	(0.0173)	(0.0113)	(0.0083)	(0.0110)	(0.0136)	(0.0176)	(0.0152)	(0.0143)	(0.0148)	(0.0138)	(0.0145)
RAD^f	0.146	0.067	-0.952	-1.769	-4.078	-3.610	-3.956	2.939	24.563	35.336371	-0.566	-0.504
	(0.2542)	(0.3756)	(2.5754)	(8.1976)	(4.2513)	(5.3335)	(4.3164)	(3.16925)	(63.0410)	(60.0993)	(0.5267)	(0.5760)
R^2	0.9589	0.9581	0.9584	0.9581	0.9604	0.9593	0.9602	0.9603	0.9584	0.9590	0.9610	0.9601
Adj R^2	0.9534	0.9525	0.9528	0.9526	0.9552	0.9538	0.9549	0.9550	0.9528	0.9535	0.9558	0.9547
Observations	18	18	18	18	18	18	18	18	18	18	18	18
Country	Italy	Italy	Italy	Italy	Italy	Italy	Italy	Italy	Italy	Italy	Italy	Italy
Foreign Country	Germany	Germany	Japan	Japan	Netherlands	Netherlands	Norway	Norway	Switzerland	Switzerland	United States	United States
Direction	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Intercept	-4.975*	-4.431*	-4.564*	-4.892*	-4.816*	-5.502*	-4.457*	-4.474*	-4.676*	-4.964*	-4.315*	-4.284*
	(0.2853)	(0.3000)	(0.2378)	(0.2766)	(0.4745)	(0.7252)	(0.2169)	(0.2253)	(0.270)	(0.3038)	(0.3425)	(0.3634)
RAD^d	0.167*	0.149*	0.153*	0.164*	0.162*	0.185*	0.148*	0.149*	0.157*	0.165*	0.145*	0.144*
	(0.0098)	(0.0103)	(0.0085)	(0.0095)	(0.0161)	(0.0244)	(0.0079)	(0.0082)	(0.0094)	(0.0099)	(0.0117)	(0.0125)
RAD^f	31.882***	-10.845	0.044	0.329***	3.860	13.811	5.876***	4.740	4.019	65.078***	-6.886	-6.829
	(15.4474)	(14.8235)	(0.2244)	(0.1816)	(6.5195)	(10.2505)	(2.9571)	(2.9376)	(5.3896)	(35.9505)	(6.8608)	(6.7391)
R^2	0.9673	0.9595	0.9581	0.9656	0.9590	0.9625	0.9668	0.9642	0.9595	0.9655	0.9607	0.9607
Adj R^2	0.9629	0.9541	0.9525	0.9610	0.9535	0.9576	0.9623	0.9595	0.9541	0.9609	0.9554	0.9555
Observations	18	18	18	18	18	18	18	18	18	18	18	18

Note: Significant at: * a 1% level of significance, ** a 5 % level of significance, and *** a 10% level of significance.

Table 4: Small European Countries: Denmark, Finland, Norway, Netherlands, and Switzerland

Country	Denmark	Denmark	Denmark	Denmark	Denmark	Denmark	Denmark	Denmark	Denmark	Denmark	Denmark	
Foreign Country	Australia	Australia	Canada	Canada	Finland	Finland	France	Great Britain	Great Britain	Germany	Germany	
Direction	Imports	Exports	Imports	Exports	Imports	Exports	Exports	Imports	Exports	Imports	Exports	
Intercept	-1.177*	0.200	-1.949*	-1.428*	-2.160*	-0.167	-2.217*	-2.960*	-2.683*	-0.945**	-0.940**	
	(0.3559)	(0.3631)	(0.4448)	(0.3024)	(0.6926)	(0.3839)	(0.5467)	(0.4232)	(0.5378)	(0.3428)	(0.3218)	
RAD[d]	-0.054*	-0.008	0.087*	0.069*	0.098*	0.009	0.101*	0.133*	0.121*	0.045**	0.044*	
	(0.0164)	(0.0166)	(0.01953)	(0.0147)	(0.0310)	(0.0175)	(0.0246)	(0.0189)	(0.0240)	(0.0156)	(0.0147)	
RAD[f]	-0.374	-1.310*	3.976	-4.304	5.952	-10.181*	112.741	2.012*	1.670**	-39.304**	-38.069**	
	(0.2945)	(0.2500)	(2.6905)	(7.5946)	(5.1713)	(2.5456)	(67.8041)	(0.4843)	(0.6350)	(17.3366)	(14.8386)	
R^2	0.6143	0.8437	0.6263	0.5837	0.6078	0.7876	0.6379	0.7957	0.7035	0.6786	0.6991	
Adj R^2	0.5661	0.8242	0.5796	0.5317	0.5588	0.7611	0.5927	0.7701	0.6665	0.6384	0.6615	
Observations	19	19	19	19	19	19	19	19	19	19	19	
Country	Denmark	Denmark	Denmark	Denmark	Denmark	Denmark	Denmark	Denmark	Denmark	Denmark	Finland	Finland
Foreign Country	Japan	Japan	Netherlands	Netherlands	Norway	Norway	Switzerland	Switzerland	United States	United States	Canada	Canada
Direction	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Intercept	-1.419*	-0.964*	-0.426	0.834	-1.426	-1.418*	-1.823*	-1.361*	-0.546	-0.543	-4.083*	-4.186*
	(0.2921)	(0.3213)	(0.5408)	(0.6669)	(0.3035)	(0.3005)	(0.3296)	(0.4232)	(0.3192)	(0.3633)	(0.4219)	(0.2341)
RAD[d]	0.643*	0.046*	0.021	-0.035	0.065*	0.064*	0.055*	0.063*	0.027***	0.026	0.184*	0.193*
	(0.0137)	(0.0146)	(0.0243)	(0.0298)	(0.0143)	(0.0141)	(0.0152)	(0.0184)	(0.0145)	(0.0166)	(0.0185)	(0.0106)
RAD[f]	0.300	-0.490**	-14.694**	-31.112*	1.911	2.513	-9.404	-12.175	-22.838*	-20.290*	-2.930	-8.801**
	(0.2461)	(0.1968)	(6.8177)	(8.5945)	(3.4928)	(3.2617)	(6.1190)	(46.8662)	(5.9337)	(6.2514)	(3.1083)	(3.1953)
R^2	0.6115	0.6940	0.6709	0.7665	0.5831	0.5905	0.6300	0.5771	0.7795	0.7439	0.9387	0.9554
Adj R^2	0.5629	0.6557	0.6298	0.7374	0.5310	0.5394	0.5837	0.5243	0.7519	0.7119	0.9315	0.9502
Observations	19	19	19	19	19	19	19	19	19	19	20	20
Country	Finland	Finland	Finland	Norway	Norway	Norway	Norway	Norway	Norway	Norway	Norway	Norway
Foreign Country	Italy	Netherlands	Norway	Australia	Canada	Denmark	Finland	France	Great Britain	Japan	Switzerland	Switzerland
Direction	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Imports	Exports
Intercept	-6.512*	-5.879*	-4.626*	-1.913*	-1.084***	-2.381*	-1.573***	1.319**	0.676	-1.247**	-1.756*	0.098
	(1.3641)	(0.6481)	(0.3385)	(0.5386)	(0.5374)	(0.5360)	(0.8761)	(0.6078)	(0.8673)	(0.5060)	(0.5438)	(0.5241)
RAD[d]	0.293*	0.264*	0.210*	0.084*	0.047***	0.105*	0.069***	-0.059**	-0.030	0.056**	0.077*	-0.002
	(0.0614)	(0.0292)	(0.0158)	(0.0244)	(0.0240)	(0.0242)	(0.0394)	(0.0271)	(0.0386)	(0.0232)	(0.0246)	(0.0231)
RAD[f]	6.474	23.720**	-5.141	0.597**	-0.242	12.077*	2.076	-207.566*	-1.329**	-0.321	11.608**	-104.734*
	(4.6481)	(11.1464)	(4.5489)	(0.2286)	(8.6626)	(3.4366)	(3.0178)	(43.8620)	(0.5594)	(0.2246)	(5.1667)	(30.5549)
R^2	0.9112	0.9214	0.9081	0.4548	0.2067	0.5649	0.2310	0.6818	0.4235	0.3019	0.4064	0.5551
Adj R^2	0.9013	0.9127	0.8979	0.3821	0.1010	0.5069	0.1284	0.6393	0.3466	0.2088	0.3273	0.4958
Observations	21	21	21	18	18	18	18	18	18	18	18	18
Country	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands
Foreign Country	Australia	Australia	Canada	Canada	Denmark	Denmark	Finland	Finland	France	France	Great Britain	Great Britain
Direction	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Intercept	-4.177*	-3.802*	-4.029*	-4.099*	-3.818*	-3.841*	-4.335*	-3.934*	-4.335*	-4.351*	-4.262*	-3.906*
	(0.2369)	(0.3713)	(0.2970)	(0.1955)	(0.2462)	(0.3012)	(0.4600)	(0.3382)	(0.3752)	(0.3733)	(0.3944)	(0.4071)
RAD[d]	0.170*	0.155*	0.165*	0.167*	0.156*	0.157*	0.177*	0.160*	0.177*	0.177*	0.174*	0.159*
	(0.0099)	(0.0154)	(0.0119)	(0.0086)	(0.0103)	(0.0125)	(0.0188)	(0.0140)	(0.0153)	(0.0153)	(0.0161)	(0.0166)
RAD[f]	0.101	-0.210	-0.489	1.056	-4.535	-3.638	1.733	-1.169	32.982	32.507	0.192	-0.229
	(0.1734)	(0.2263)	(1.5984)	(4.3086)	(2.7169)	(3.3370)	(3.0465)	(1.9859)	(44.6260)	(41.0482)	(0.4003)	(0.4266)
R^2	0.9629	0.9641	0.9624	0.9623	0.9678	0.9648	0.9629	0.9630	0.9634	0.9636	0.9627	0.9628
Adj R^2	0.9583	0.9596	0.9577	0.9576	0.9637	0.9604	0.9583	0.9583	0.9588	0.9590	0.9580	0.9582
Observations	19	19	19	19	19	19	19	19	19	19	19	19
Country	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands
Foreign Country	Germany	Germany	Italy	Italy	Japan	Japan	Norway	Norway	Switzerland	Switzerland	United States	United States
Direction	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Intercept	-4.090*	-3.846*	-3.100*	-3.006*	-4.108*	-4.061*	-4.102*	-4.101*	-4.181*	-3.953*	-3.866*	-3.852*
	(0.2505)	(0.2183)	(0.5800)	(0.7267)	(0.1909)	(0.2400)	(0.1968)	(0.1966)	(0.2253)	(0.2649)	(0.2678)	(0.2828)
RAD[d]	0.167*	-0.157*	0.126*	0.123*	0.168*	0.166*	0.167*	0.167*	0.171*	0.162*	0.158*	0.157*
	(0.0104)	(0.0091)	(0.0238)	(0.0298)	(0.0081)	(0.0100)	(0.0084)	(0.0084)	(0.0094)	(0.0106)	(0.0111)	(0.0117)
RAD[f]	-0.523	-17.328***	-2.953***	-2.561	-0.134	-0.034	-0.444	-0.3645	2.646	-20.612	-5.326	-5.003
	(11.2174)	(8.9158)	(1.6335)	(1.6511)	(0.1420)	(0.1302)	(1.9995)	(1.8843)	(3.6974)	(26.1038)	(4.4083)	(4.3083)
R^2	0.9622	0.9694	0.9686	0.9671	0.9641	0.9623	0.9623	0.9622	0.9633	0.9636	0.9653	0.9651
Adj R^2	0.9574	0.9656	0.9646	0.9630	0.9597	0.9576	0.9575	0.9575	0.9587	0.9590	0.9610	0.9607
Observations	19	19	19	19	19	19	19	19	19	19	19	19
Country	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland						
Foreign Country	Canada	Canada	Denmark	Netherlands	Norway	Norway						
Direction	Imports	Exports	Imports	Imports	Imports	Exports						
Intercept	-2.601*	-2.749*	-4.056*	-4.871*	-3.103*	-3.090*						
	(0.4349)	(0.2702)	(0.3425)	(0.5175)	(0.3011)	(0.3008)						
RAD[d]	0.110*	0.118*	0.171*	0.204*	0.133*	0.132*						
	(0.0179)	(0.0113)	(0.0147)	(0.0217)	(0.0130)	(0.0130)						
RAD[f]	-2.180	-4.794	18.056*	26.812*	-7.634**	-7.212**						
	(2.5660)	(2.9324)	(4.8057)	(7.1812)	(3.4700)	(3.2290)						
R^2	0.8629	0.8765	0.9013	0.9007	0.8612	0.8621						
Adj R^2	0.8468	0.8620	0.8903	0.8897	0.8458	0.8468						
Observations	20	20	21	21	21	21						

Note: Significance terms: * is a 1% level of significance, ** is a 5 % level of significance, and *** is a 10% level of significance.

additional domestic research and development, so an increase in foreign R&D decreases domestic R&D regardless of which channel is being observed.

However in 45 of these pairs of regressions, there is a discrepancy between the two regressions when the two different channels of knowledge spillovers are inspected. There could be a difference in a sign or the level of significance of one or both of the research and development coefficients. In 22 of the equations the difference is due to a change of significance for one of the variables. In one of the equations from each of these pairs only domestic R&D is significant while in the other equation both sources of R&D provide a significant contribution to improvements in a country's total factor productivity. Clearly, one of the channels is undervaluing the importance of foreign productive knowledge acquisition upon the domestic economy. This may be a consequence of the types of goods traded between these two countries as one of the channels fails to catch the relative importance of intraindustry trade versus interindustry trade between these two nations.

Some of the pairs of regressions also have another difference between the two equations. In 11 of the equations the difference is due to opposite signs on at least one of the research and development variables. Nine of these incidents occur in connection with the insignificant one, while the other 2 involve the significant one. Japanese research and development significantly affects total factor productivity in the United States through imports and its effect is positive whereas through exports it has a negative impact. The other instance involving a significant research and development variable is generated for Danish total factor productivity and RAD^f from the Netherlands. In both of the equations, RAD^d is insignificant and RAD^f is significant. The difference between these equations is using imports RAD^d is positive and RAD^f is negative while the signs of the coefficients reverse when exports are used as the channel for knowledge spillovers.

Differences in the use of the two channels for knowledge spillovers appear when categorizing countries as large and small. Here a large country is a member of the G-7 and a small one is not a G-7 member. Table 5 demonstrates that international knowledge spillovers are important to both groups of countries. Each grouping illustrates a range of the relative importance of international knowledge spillovers. It is interesting to note that large countries are more reliant on the export channel for knowledge spillovers than smaller nations, while the spillovers transmitted by imports display only slight differences between large and small countries. Looking at the results in terms of whether the country is in Europe or not also provides additional information. In general countries not in Europe tend to have more significant international spillovers than the countries of Europe especially when examining export transmitted spillovers. In Table 5, these international knowledge spillovers seem more important to Canada, Japan, and the United States than to their European counterparts. Additionally, Table 5 illustrates an aspect of the relationship between RAD^d and RAD^f that does not change with the channel of knowledge spillovers, regardless of the channel used, domestic and international knowledge spillovers are inputs for future economic growth.

Table 5: Significant channels of R&D by Country

Imports	Domestic	Percentage	Foreign	Percentage	Both	Percentage	Number of Equations
Australia	5	.83	0	0	1	.17	6
Canada	5	.56	2	.22	2	.22	9
Denmark	6	.60	1	.11	3	.30	10
Finland	1	.50	0	0	1	.50	2
France	3	.75	0	0	1	.25	4
Germany	11	.92	0	0	1	.08	12
Great Britain	1	.20	2	.40	2	.40	5
Italy	10	.83	0	0	2	.17	12
Japan	8	.67	0	0	4	.33	12
Netherlands	11	.92	0	0	1	.08	12
Norway	1	.20	0	0	4	.80	5
Switzerland	1	.25	0	0	3	.75	4
United States	5	.50	2	.20	3	.30	10
G-7	43	.67	6	.09	15	.23	64
Non-G-7	25	.64	1	.03	13	.33	39
European	45	.68	3	.05	10	.27	66
Non-European	23	.62	4	.11	10	.27	37
Exports	Domestic	Percentage	Foreign	Percentage	Both	Percentage	Number of Equations
Australia	4	1.00	0	0	0	0	4
Canada	2	.22	1	.11	6	.67	9
Denmark	4	.36	4	.36	3	.18	11
Finland	2	.67	0	0	1	.33	3
France	4	.50	0	0	4	.50	8
Germany	7	.58	0	0	5	.42	12
Great Britain	2	.29	2	.29	3	.43	7
Italy	10	.83	0	0	2	.17	12
Japan	5	.42	0	0	7	.58	12
Netherlands	11	.92	0	0	1	.08	12
Norway	2	.50	2	.50	0	0	4
Switzerland	1	.50	0	0	1	.50	2
United States	3	.27	1	.09	7	.64	11
G-7	33	.46	4	.06	34	.48	71
Non-G-7	24	.67	6	.17	6	.17	36
European	43	.61	8	.11	20	.28	71
Non-European	14	.39	2	.06	20	.55	36

This table looks at the significant sources of R&D for the equations presented in tables 1, 2,3, and 4. The top part of the table looks at imports and the bottom half looks exports as the channel for transmitting the spillovers. The term Domestic refers to equations with only the domestically produced R&D variable as being significant. The term Foreign refers to equations with only the foreign produced R&D variable as being significant. The term Both refers to equations where both sources of R&D are significant. Percentages are calculated separately for each row.

Advances in total factor productivity are determinants of economic growth. The information provided in this inspection, of the manufacturing sector's total factor productivity, illustrates some important points. Each economy's response to changes in domestic and international knowledge acquisition provides evidence for the importance of foreign research and development for each of the national economies studied here. Some nations provide more productive knowledge spillovers than others, while other economies are much more reliant on domestic knowledge spillovers. The importance of information flows from one nation to another in part depends on the relationship between the countries, the types of goods in which each nation tends to specialize, and the amount of contact between them.

Once these facts are taken into account, it is possible to see how interconnected the national economies truly are as well as the importance of these international contacts for continued growth of domestic manufacturing industries. However, national economies are changing. The service sector is becoming relatively more important in advanced economies and the information provided here does not directly address these service sectors.

4 Conclusions

This paper illustrates the importance of trade as a channel for knowledge spillovers. In particular it examines the implicit assumptions made by others that imports and exports are prefect substitutes as channels in transmitting knowledge spillovers. In some instances, they do provide similar results but in many others, the results are not identical. For example, in this paper international knowledge flows between France and Great Britain, using either measure, affect the total factor productivity in the other country. Other examples include American total factor productivity with knowledge spillovers from Great Britain, Canadian total factor productivity with informational flows from the United States and Great Britain, German total factor productivity with spillovers from the United States. Sometimes imports provide more significant foreign informational flows than exports, while at other time the reverse is true. A couple of the instances occur for the United States, with knowledge spillovers from Australia, Denmark, and France. Additional instances include total factor productivity in Canada, France, and Switzerland with knowledge spillovers from Germany. Clearly both channels are important but the significance and impacts are not always identical.

International trade provides participants with a network of international contacts through which knowledge transfers occur. International trade is based on comparative advantage and through international knowledge spillovers, it has the potential to alter the comparative advantage of a firm, industry, or nation. Research and development is often the basis of comparative advantage so profit maximization often necessitates export of the product to the rest of the world market to reduce research costs per unit to the lowest possible level. Through international trade a firm with a comparative advantage exports, and hence transmits knowledge spillovers to competitors and non-competitors alike, and which in turn dissipates its comparative advantage through contact with other firms. Importers acquire knowledge spillovers and possibly comparative advantage as well. This explanation corresponds with the Product Life Cycle Model stated by M. V. Posner and expanded by Raymond Vernon where comparative advantage in a particular good changes as the product becomes more standardized.[5]

Acquiring knowledge spillovers through exports is very different. Gaining knowledge spillovers through exports may strengthen comparative advantage, aid advancement of a domestic industry up the quality ladder, and improve the competitive position of an industry. Taiwan is an example of a country that initially exported low quality goods that took advantage of its comparative advantage in unskilled labor. However, foreign customers wanted more, which pushed the firms up the quality ladder as they acquired flows of productive information.

International knowledge spillovers may improve the performance of domestic industries and the nation as a whole, but it may also harm economic growth. As productive knowledge flows in and out of a country, neoclassical theory suggests comparative advantage and competitive position are either strengthened or weakened for the firm or industry. More imports and exports mean more trade. More trade means more access to gains from trade, access to international knowledge spillovers, and possibly more productive knowledge flowing to trading partners. Since receiving more spillovers means more growth, while transmitting more knowledge spillovers may reduce comparative advantage and growth, any policy initiative that alters trade alters transmission and reception of productive information flows and ultimately may alter the rate of growth in an economy.

ENDNOTES

1. Note one such article is H. Gersbach and A. Schmutzler, *Journal of Economics and Management Strategy*, Summer 2003, 12(2), pp. 179 - 205.
2. R. C. Levin, "Appropriability, R & D Spending, and Technological Performance", *American Economic Review*, May 1988, 78 (2), pp. 424 - 428.
3. For more information on the theory of Learning by Doing see Nancy Stokey (1988) and Alwyn Young (1991). For more information on acquiring knowledge through exports see Grossman and Helpman (2005) and Keller (2004).
4. Note for a more theoretical set up of the model see G. M. Grossman and E. Helpman, 1991, "Trade, knowledge spillovers, and growth*", European Economic Review*, 35 (5), 517-526.
5. A. Deardoff, "Testing Trade Theories and predicting Trade Flows" in R. Jones and P. Kenen (eds.), *Handbook of International Economics, Volume 1: International Trade*, New York: North-Holland, 1984, pp. 493-499.

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New York Municipal Bonds As A Leading Fiscal Indicator

Joseph Cheng* and Vigdis Boasson**

Abstract

The S&P 500 has often been used as one of the leading economic indicators for predicting overall economic growth. However, there have been few studies done in the area of leading indicators for predicting the fiscal condition of municipalities. In this paper, we used a lagged regression model to compare the S&P 500 with New York municipal bonds as a leading indicator for the overall economic health of municipalities across the nation. We found that the return on New York State municipal bonds is a more reliable leading indicator than the S&P for predicting future returns of municipal bonds across the nation. Since the returns for national municipal bond funds are associated with the outlook for the local economies of all states, this finding suggests that changes in growth expectation or the level of investor confidence in the New York economy may precede that of the nation in general.

Introduction to Municipal Bond

Municipal bond prices are affected by several factors, including default risk, liquidity, tax status, coupons, interest rates, and term to maturity. As prices of corporate bonds are related to the financial conditions of the firm, so municipal bond prices are affected by the strength of their respective local economies. Unlike interest earned from corporate bonds, interest income from municipal bonds is exempt from federal income taxes. Most states also exempt the coupon interest earned from their own municipal bonds from internal state taxes. This tax exemption feature offers a greater tax advantage during periods when federal income tax rates increase and a smaller advantage during periods when federal income tax rates decline. Thus, prices of municipal bonds are mainly driven by three factors:

1. change in federal income tax rates
2. change in interest rates, which affect the present value of bonds
3. change in the expected growth and stability of municipal government tax revenue, which affect the risk of the bonds.

The latter, expected growth and stability in tax revenue, is a key factor in determining municipal bond yields and prices. As higher earnings expectation leads to higher stock prices, so higher tax revenue growth leads to higher municipal bond prices.

*Associate Professor, School of Business, Ithaca College, Ithaca, NY 14850, Email: cheng@ithaca.edu
**Assistant Professor, School of Business, Ithaca College, Ithaca, NY 14850, Email: vboasson@ithaca.edu

Tax revenue growth and stability are primarily determined by the robustness of the local economy. As the local economy improves, the tax base expands and revenue increases. This would reduce risk and thus lend to higher municipal bond prices.

The expectation of higher growth drives up the stock market but also drives up interest rates, causing municipal bond prices to drop. This means that while the stock market recovery helps the states by increasing their tax bases, it also increases the cost of debt for states. So a stock market recovery may be a mixed blessing for the municipal bond market.

Since tax revenue growth is primarily determined by the health of the local economy and higher tax revenue growth leads to higher municipal bond prices, could we then use the returns on municipal bonds to monitor a local economy's condition? Could changes in the level of investor confidence in one region spillover to other regions? In order to answer these questions, we investigate whether the returns on the New York municipal bonds could be used as a leading indicator for explaining future returns on municipal bonds across the nation. We also examine whether the recovery of investor confidence in New York, the financial center of the nation, could have a spillover effect. Specifically, since the S&P 500 is one of the components in the index of leading economic indicators, the goal of this study is to compare the S&P 500 with New York State municipal bonds as leading indicators for investor confidence in regions outside of New York.

The remainder of this paper I organized as follows: Section 2 reviews the relevant literature; Section 3 describes our data and research method. Section 4 presents our empirical results.

Literature Review

Since municipal bonds are tax-exempt, reviewing the literature on tax-exempt bonds or bond funds is relevant to our understanding of the role municipal bonds play in regional economic development. Continued effort to understand the pricing of tax-exempt bonds is worthwhile for at least two reasons. First, municipal bonds comprise a significant segment of the U.S. capital markets. In 1995 there was $1.3 trillion in outstanding municipal debt. For a point of reference, outstanding marketable U.S. Treasury debt totaled $3.3 trillion in 1995. Second, the role of taxes in asset pricing is unresolved. Unlike tests for tax effects in the equity markets, tax-exempt and taxable bonds provide the opportunity to study the valuation of certain rather than expected before-tax cash flows. Theoretically, after-tax cash flows arriving at the same time should be discounted at identical after-tax discount rates. Calculating the tax effect with fixed cash flows appears straightforward. The fact that economists cannot explain the role of taxes in such a simple case underscores the complexity that taxes introduce to asset pricing. A more complete understanding of the simple case of tax-exempt and taxable bonds is likely to provide insight into the role taxes play in the pricing of other assets.

Singh and Dresnack (1997) examine the investment performance of two types of open-end municipal bond mutual funds: mutual funds whose objective is generating income free from federal income taxes; and funds whose objective is generating income free from not only federal but also a particular state's income taxes. They find that a municipal bond fund's monthly returns either mirror or lag

the Lehman Brothers Municipal Bond Index returns on a risk-adjusted basis, and when state taxes are significant, such as in California and New York, the investor benefits from investing in state-specific municipal bond funds.

Fama (1977) and Miller (1977) predict that one minus the corporate tax rate will equate after-tax yields from comparable taxable and tax-exempt bonds. Chalmers (1998) examines the muni bond puzzle which refers to the unexplained relation between the yields of tax-exempt and taxable bonds. More specifically, long-term tax-exempt bond yields appear to be too high relative to yields on taxable bonds, while short-term tax-exempt yields are generally consistent with financial theory. Empirical evidence shows that long-term tax-exempt yields are higher than the theory predicts. Two popular explanations for this empirical puzzle are that, relative to taxable bonds, municipal bonds bear more default risk and include costly call options. One clear difference between municipals and Treasuries is that while municipal defaults are possible, U.S. government bond default is unthinkable. Not surprisingly, a widely cited explanation for relatively high municipal yields is that municipal default risk exceeds the default risk of corporate and U.S. Treasury bonds [e.g., Fama (1977), Trzcinka (1982), Yawitz, Maloney, and Ederington (1985), Scholes and Wolfson (1992), Stock (1994)].

Although there is a rich body of literature on municipal bond performance and tax-related issues, there has been virtually no extant literature at all examining the correlation between the returns of municipal bonds of different states. Thus, our paper is an attempt to fill this void.

Data and Research Method

Since the fiscal health of a municipality is generally linked to local economic strength, one might expect that the S&P, a leading economic indicator, would be a viable leading indicator for the fiscal health of municipalities as well. Since New York is a financial center, the performance of its municipal bonds might also be used as a leading fiscal indicator for other states. The purpose of this study is to determine whether the S&P 500 or New York State municipal bond is a better leading indicator for the fiscal health of municipalities across the nation.

We use monthly returns of municipal bond closed end funds as a proxy for the expected fiscal health of municipalities. This has an advantage over the GDP of New York since the latter is not observable on a monthly basis. Furthermore, the returns for municipal bonds reflect not only past performance but also expectations of future economic strength (or weakness) as well. A municipal bond closed end fund is an investment fund whose portfolio is comprised mainly of municipal bonds. Unlike mutual funds, closed end funds are traded on the stock exchanges and their prices reflect the value of their portfolio holdings. Thus, the returns of the municipal bond funds mimic the municipal bonds which they hold. In this study, we use data from one national municipal bond closed end fund which holds municipal bonds from many states. We use monthly return data from three funds specializing in New York municipal bonds. The portfolio descriptions given for the funds are as follows:

Nuveen Municipal Value Fund (NUV) is a diversified, closed-end management investment company incorporated in the USA. The Fund seeks to provide current income exempt from regular

federal income tax. The Fund invests primarily in a diversified portfolio of municipal obligations issued by state and local governments.

Nuveen New York Investment Quality Municipal Fund (NQN) is a diversified, closed-end management investment company incorporated in the USA. The Fund's objective is to provide current income exempt from both regular federal and New York state income taxes. The Fund invests in a diversified portfolio of municipal obligations issued by state and local government authorities within New York.

Muni Yield New York Insured Fund (MYN) is a non-diversified, closed-end management investment company incorporated in the USA. The Fund seeks to provide a high level of current income. The Fund invests primarily in a portfolio of long-term New York municipal obligations.

Muni Holdings New York Insured Fund (MHN) is a non-diversified, closed-end management investment company registered in the USA. The Fund's objective is to provide shareholders with current income exempt from Federal income taxes and New York State and New York City personal income taxes. The Fund invests primarily in a portfolio of long-term, investment-grade New York municipal obligations.

The monthly returns (October 1997-Decemeber 2003) of these funds are obtained from CRSP (Center for Research of Security Prices). Since there are only a few New York municipal closed-end funds, we derive the proxy for New York bond returns by averaging the returns of the three New York funds.

$$NYA = (NQN+MYN+MHN)/3 \qquad (1)$$

where NYA represents the average of the three New York municipal bond fund returns, and NQN, MYN, and MHN represent the monthly returns for the three New York municipal bond funds

Changes in New York municipal bond prices may be attributed to several possible factors, including general changes in interest rates and federal income tax rate changes. To filter out most of these effects, we create a variable NYEXCESS, which equals New York municipal bond returns minus the municipal bond returns at the national level.

$$NYEXCESS_t = NYA_t - NUV_t \qquad (2)$$

NYEXCESS is a variable that captures the performance of New York municipal bonds relative to the national average. It is the return of New York municipal bonds in excess of returns of municipal bonds across the nation in general. When NYEXCESS is positive, New York municipal bonds outperform the national average. When NYEXCESS is negative, New York underperforms the average. Since the general interest rate and federal income tax rates are determined at the national level, any difference between New York municipal bond fund returns and the national municipal bond fund returns would be primarily attributed to differences in revenue stability and risk perception.

Since general changes in interest rates and federal income taxes affect municipal bonds of all states, including New York, the return differentials (NYEXCESS) will only change when something other than these common effects changes. Thus, NYEXCESS may be viewed as a residual that captures primarily the differentials in revenue stability and growth. In other words, if New York outperforms the

national average, then expected revenue and growth have stabilized more than the national average, indicating that the perceived fiscal health for the state has improved more than the national average. Thus, NYEXCESS is the variable we used to gauge the investors' sentiment regarding the expected fiscal strength of New York State relative to the rest of the nation.

To see whether there is any lead or lag relationship between the expected fiscal condition of New York municipalities and those in other states, we could regress the monthly returns on the national fund (NUV) against NYEXCESS of the previous month. However, it is likely that a portion of the portfolio held by NUV is invested in New York municipal bonds. Assuming that this portion is relatively stable over the sample period, we can strip out the effect of holding New York securities on the fund's monthly returns by first regressing the monthly returns on the national fund (NUV) against the monthly returns on the New York funds (NYA). The regression results may be summarized as follows:

$$NUV_t = .002 + .583 * NYA_t \qquad (3)$$

(7.8)

The R^2 for the regression of (3) is .454, which indicates that there is a modestly strong and positive correlation between the returns on NUV and the returns on NYA. The estimated residuals from (3) represent the portions of returns for the national municipal bonds which are uncorrelated with or unexplained by those of New York, such as portion of returns resulting from growth expectations specific to those regions. By using the residuals, not only have the returns derived from investments in New York bonds been stripped out, but also the correlation between returns on municipal bonds in general and the returns on New York bonds, including price co-movements caused by general interest rate changes. In effect, any price movements due to changes in common factors affecting all regions are eliminated. Thus, this set of residuals may serve as an index of monthly returns linked primarily to growth expectation specific to the non-New York regions. To see whether the growth expectation for the New York region leads those for other states, we regress the index (residuals from (3)) against the excess returns for New York municipal bonds in the previous month:

$$USMUNI_t = a + b \times NYEXCESS_{t-1} + e \qquad (4)$$

where USMUNIt represents the index for monthly returns on the national municipal bond fund exclusive of New York bonds. Estimating equation (4) helps us to see whether the change in investor confidence in the economy of New York leads the changes in investor confidence in those of the other states. Another regression equation similar to (4) is specified as:

$$USMUNI_t = a + b \times SPEXCESS_{t-1} + e \qquad (5)$$

where $SPEXCESS_{t-1}$ represents the monthly return of the Standard & Poor's 500 in excess of treasury return for the previous month. Again, the treasury returns are being subtracted from S&P in order to eliminate the returns due to interest rate changes. Thus, SPEXCESS reflects the portion of stock market returns due to a general improvement in the economic outlook. The regression results from (5) are compared with those of (4) so that we can evaluate the relative strength of the S&P and New York municipal bonds as leading indicators of the fiscal health of municipalities across the nation.

The sample period spans 75 months. The monthly returns are from October 1997 to December 2003. The data for monthly returns begin on October 1997 because one of the New York municipal bond funds (MHN) began trading on that date.

The regression results for (4) and (5) are as follows:

Table 1. Regression Results Comparison

	Coefficient	R- Square
Equation (4)	.22 (2.314)	.07
Equation (5)	-.03 (.87)	.01

The coefficients in (4) and (5) may be interpreted as the sensitivity of the overall returns of the municipal bonds of other states to New York municipal bond returns and to S&P returns, respectively. As seen in Table 1, the t-statistic for the coefficient NYEXCESS is 2.314, which is significant at the ninety five percent level, whereas the result for SPEXCESS is statistically insignificant. The results suggest that the performance of the New York municipal bond market may be a better leading indicator for the fiscal health of localities than the performance of the stock market. Since the returns of the municipal bond returns have been adjusted in order to reflect the fiscal expectations for municipalities, the study suggests that the changes in investor confidence in the municipalities of New York may precede those of other states. Since the t-statistic for the coefficient in (4) is significant, one may interpret this as meaning that when New York's fiscal outlook improves, the fiscal condition for municipalities across the nation, as perceived by the market, tends to improve as well in the following period, and vice versa.

In general, economic recovery is measured by actual economic growth such as changes in GDP. But since the market is driven by expectations and the returns on municipal bonds reflect investors' expectations about the respective local economies, it is important to note that our study focuses on growth as expected by the financial market (rather than actual growth). Thus, the term "leading indicator" being used in this paper may be interpreted as a leading indicator for growth expectation or investor confidence. Furthermore, the word "leading" used in this paper pertains to chronological order, not to order of importance or ranking. While the state of New York may have lost many manufacturing jobs in the last decade, it retains its status as a national financial and commercial center. If New York leads the rest of the nation in the realm of growth expectation and investor confidence, then the next logical question is why. Searching for such underlying factors would make an interesting topic for future research.

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THE INFLUENCE OF CREDIT UNIONS ON BANK CD RATE PAYMENTS IN THE U.S.

Robert J. Tokle*

Historically, banks in the U.S. were the only depository institution that could offer checking deposits. They also tended to specialize in commercial lending, while thrifts (S&L's and mutual savings banks) tended to specialize in home mortgage lending and credit unions tended to specialize in consumer lending. Since 1980, the powers of these depository institutions have became more similar, due to legislation such as the Depository Institutions Deregulation and Monetary Control Act of 1980 and regulatory changes. Consequently, credit unions have been increasingly in more direct competition with banks and thrifts.

Because credit unions are cooperatives, if they can operate efficiently, they should have overall better interest rates than banks on both deposits and loans since they do not pay out dividends to stockholders[1]. This has been shown many times in past surveys. For an example, see the September 27, 2004 issue of ***U.S. News and World Report***.

However, credit union advocates and consumer groups have also argued that the credit union industry provides competition that also benefits banks customers. For example, Evans and Shull (1998, p. 26) in a report for National Economics Research Associates wrote that "coupled with the large number of individuals who have access to credit unions and the widespread presence of credit unions, these favorable rates reinforce credit unions' competitive presence in commercial banks and other banking service providers." Similar comments have come from Lutz (1998) and ***Credit Union News Watch*** (1997). And, banker Harris Simmons said in the January 31, 2005 issue of the ***American Banker*** that "pressure from other banks and specifically credit unions in Utah prompted it to raise rates on money market accounts by 20 basis points late in the fourth quarter" (CUNA News Now, 2005). But, it has only been since December 2000 that any articles have shown in the peer-reviewed economic literature that indeed credit union competition with banks does in fact also benefit bank customers.

This paper uses the regression estimates from two such studies to estimate the benefit in certificates-of-deposits (CDs) payments to bank customers that results from credit union competition. Of

*Professor of Economics, Idaho State University, Revised July 2005

course, this implies, as banker Harris Simmons stated above, that this benefit is a transfer from the bank stockholders to the bank customers.

First Generation of Credit Union Competition Studies

Four studies, Rhoades (1979), Hannan (1984), Rhoades and Heggestad (1985) and Rhoades (1987) examined the effects of credit union competition or various thrift (including credit unions) measures of competition on bank behavior. Using various data sets from somewhere between 1968 and 1982, they found virtually no evidence that credit union competition affects bank performance. However, since this time period, as stated above, credit unions have been given authority to offer more products that compete with banks, such as checking accounts. This helped credit unions to grow relative to banks. Even though credit unions as a group equaled only about 7 percent of the total bank assets in 1999, their assets grew at a rate that was roughly double that of banks from 1970 to 1999 (Mishkin, 2001, p. 39). Consequently, the second generation of credit union competition studies, using data from the 1990s, did find evidence that credit unions had a competitive influence on bank behavior.

Second Generation of Credit Union Competition Studies

Tokle and Tokle (2000) was the first study in the economic literature to find that credit union competition can affect bank behavior and hence benefit bank customers. Also, this was the first study since Hannan (1984) to use a separate variable for credit union competition. They used data from 1998, an update of Hannan by 26 years. The dependent variables were interest rates on savings accounts and one and two-year CDs for all banks in Idaho and Montana in cities with a population of 8,000 or more. The independent variable of interest (the credit union competition variable) was computed as the credit union market share of deposits, or as total credit union deposits divided by total credit union plus S&L plus bank deposits. In their regression results, the credit union competition variable was positive and significant at the 5 percent level for both one and two-year CDs, while it was insignificant for savings deposits. Thus, credit union competition appears to benefit bank customers as banks paid higher interest rates on CDs in markets that had a larger credit union presence. On the banks' asset side, Feinberg (2001), using data from 1992 to 1997, found that credit union competition had a negative and significant effect on bank loan interest rates.

Hannan (2002) examined the effect that credit union competition might have on bank-deposit interest rates. He states that "in contrast to previous studies, the sample employed covers the nation as a whole, incorporates all large urban areas, and employs survey data on deposit rates for a substantially larger number of institutions than previously employed" (p. 4). Using data from 1998 for about 80 large metropolitan areas, the dependent variables were interest rates on money market, interest checking and three-month CD deposits. Hannan used three different specifications for the independent variable of interest (the credit union competition variable). One was the credit union market share, composed

similarly to the credit union competition variable used in Tokle and Tokle (2000) and Feinberg (2001). Hannan also used credit union population percentage (credit union members divided by population over age 18 in each market) and potential credit union population (potential members of occupational credit unions divided by population over age 18 in each market) as alternative credit union competition variables. In Hannan's regression results, credit union market share was positive and significant at the 5 percent level for three-month CDs, while credit union population percentage was positive and significant at the 5 percent level for all three equations. And, the potential credit union population was positive and significant at the 10 percent level for money market deposits. In sum, these three second-generation studies yielded very "robust" results, suggesting that an increased presence of credit unions in local markets cause banks to offer more competitive interest rates, benefiting bank customers.

Some Conservative Estimates of Bank Customers Benefiting on Their CD Holdings

Using data from 1998, but employing much different samples with somewhat similar regression models, both Tokle and Tokle (2000) and Hannan (2002) produced positive coefficients at the 5 percent significance level for the effect of credit union market share on bank CD interest rates. Note that Hannan (2002) points out that when a credit union market share variable is used in these models, the resulting coefficients are probably somewhat biased downward[2]. In other words, the true coefficients are probably larger, indicating even a larger effect of credit union market share on bank CD interest rates that benefits bank customers.

Table 1 estimates the loss in interest payments[3] to bank customers holding CDs if credit union market share drops by one standard deviation. One standard deviation is used because it is a standard statistical measure of variation and will keep the estimates well within the range of the data. For Tokle and Tokle, the credit union market share mean was 13.8 percent, with a standard deviation of 7.3 percent. For Hannan, the credit union market share mean was 7.5 percent, with a standard deviation of 4.7 percent.

In Tokle and Tokle, the credit union market share (CU) coefficients in their regression analysis were 0.0034 for one-year CDs and 0.0042 for two-year CDs. Hence, an average of 0.0038 will be used for all CDs. This means that a fall in local markets of CU of one standard deviation or of 7.3 percent (from 13.8 percent) would lead to a drop in bank CD interest rates of 0.0038 times 7.3 or 2.8 basis points. Column 4 shows the estimated reduction in interest earned by bank customers in 2004 in the U.S. (by state) on small CDs (CDs less than $100,000) resulting from a decrease of CU by one standard deviation. This estimate assumes that the 1998 estimate from Idaho and Montana [4] (on 1 and 2-year CDs) can be applied to the U.S. as a whole in 2004. The total lost interest payments would for bank customers on CDs would be $203 million.

In Hannan, the CU coefficient was 2.11 for three-month CDs. This means that a fall in local markets of CU of one standard deviation or of 4.7 percent (from 7.5 percent) would lead to a drop in CD interest rates of 2.11 times 0.047 or 10 basis points. (Note that Tokle and Tokle would put CU, measured as a percentage, say thirteen percent, as 13, while Hannan would put it as 0.13). Assuming that

Hannan's 1998 estimate holds up in 2004, column 5 shows the estimated effect for bank customers (by state) in reduced interest earned on small CDs resulting from a decrease of CU by one standard deviation. The total lost interest payments would for bank customers on CDs would be $726 million.

Table 1. **Total Deposits and CDs at Banks and Savings Institutions in 2004. Also Estimated Benefits in CD Interest Payments Due to Credit Union Competition in Columns 4 and 5. (All Figures in Thousands of $).**

1	2	3	4	5
State/Territory	Total Deposits	Small CDs	(Tokle & Tokle) (CDs times 0.00028)	(Hannan) (CDs times 0.001)
Alabama	$ 62,424,000	$ 8,295,987	$ 2,323	$ 8,296
Alaska	5,952,000	791,005	221	791
American Samoa	142,000	18,871	5	19
Arizona	61,810,000	8,214,388	2,300	8,214
Arkansas	38,682,000	5,140,737	1,439	5,141
California	671,111,000	89,188,907	24,973	89,189
Colorado	64,470,000	8,567,895	2,399	8,568
Connecticut	73,841,000	9,813,277	2,748	9,813
Delaware	105,825,000	14,063,867	3,938	14,064
District of Columbia	18,605,000	2,472,556	692	2,473
Fed. States of Micronesia	74,000	9,834	3	10
Florida	300,961,000	39,996,934	11,199	39,997
Georgia	132,041,000	17,547,906	4,913	17,548
Guam	1,551,000	206,124	58	206
Hawaii	23,060,000	3,064,614	858	3,065
Idaho	13,840,000	1,839,300	515	1,839
Illinois	281,924,000	37,466,966	10,491	37,467
Indiana	81,097,000	10,777,580	3,018	10,778
Iowa	51,238,000	6,809,397	1,907	6,809
Kansas	46,549,000	6,186,241	1,732	6,186
Kentucky	56,858,000	7,556,280	2,116	7,556
Louisiana	55,171,000	7,332,082	2,053	7,332
Maine	16,705,000	2,220,051	622	2,220
Marshall Islands	0	0	0	0
Maryland	82,056,000	10,905,029	3,053	10,905
Massachusetts	172,721,000	22,954,172	6,427	22,954

Michigan	136,073,000	18,083,748	5,063	18,084
Minnesota	94,437,000	12,550,432	3,514	12,550
Mississippi	33,475,000	4,448,740	1,246	4,449
Missouri	87,090,000	11,574,035	3,241	11,574
Montana	11,911,000	1,582,941	443	1,583
Nebraska	32,893,000	4,371,394	1,224	4,371
Nevada	40,738,000	5,413,974	1,516	5,414
New Hampshire	29,365,000	3,902,532	1,093	3,903
New Jersey	211,318,000	28,083,613	7,863	28,084
New Mexico	18,172,000	2,415,012	676	2,415
New York	637,592,000	84,734,319	23,726	84,734
North Carolina	163,898,000	21,781,618	6,099	21,782
North Dakota	11,400,000	1,515,030	424	1,515
Northern Mariana Islands	522,000	69,372	19	69
Ohio	200,200,000	26,606,059	7,450	26,606
Oklahoma	46,322,000	6,156,073	1,724	6,156
Oregon	39,165,000	5,204,927	1,457	5,205
Palau	9,000	1,196	0	1
Pennsylvania	210,672,000	27,997,761	7,839	27,998
Puerto Rico	44,410,000	5,901,974	1,653	5,902
Rhode Island	19,881,000	2,642,133	740	2,642
South Carolina	48,085,000	6,390,371	1,789	6,390
South Dakota	53,278,000	7,080,508	1,983	7,081
Tennessee	90,194,000	11,986,548	3,356	11,987
Texas	310,346,000	41,244,176	11,548	41,244
Utah	102,048,000	13,561,914	3,797	13,562
Vermont	9,014,000	1,197,937	335	1,198
Virgin Islands	1,713,000	227,653	64	228
Virginia	147,775,000	19,638,913	5,499	19,639
Washington	87,424,000	11,618,422	3,253	11,618
West Virginia	22,660,000	3,011,455	843	3,011
Wisconsin	96,111,000	12,772,902	3,576	12,773
Wyoming	7,883,000	1,047,630	293	1,048
Totals	**5,464,782,000**	**726,255,316**	**203,351**	**726,255**

Source: FDIC and Author's calculations. For more detail on the source of total deposits and CDs, see endnote 5.

In sum, using the estimated coefficients of credit union market share from Tokle and Tokle and Hannan, a fall in credit union market share of one standard deviation would lead to a large decrease (in the aggregate) in interest payments to bank customers. Because Hannan's study used nationwide data, the credit union market share coefficient from his study probably provides a better estimate of the effect of credit union competition on bank CD rates. But, the robustness from using both studies adds the evidence of the effect of credit union competition on bank behavior. In addition, the size of the estimated reduced interest payments to bank customers for all consumer deposits, if credit union market share fell by one standard deviation, are probably larger for two reasons. As mentioned in endnote 2, the credit union market share coefficients are probably biased downward. And second, I have just made estimates for CDs since the credit union market share coefficient was significant in both Tokle and Tokle and Hannan for CD rates. However, Hannan also found that the potential credit union population was positive and significant in interest checking and money market accounts as well. Thus, credit union competition probably leads to higher interest rates for other bank deposits.

Conclusion

Survey data of interest rates from banks and credit unions readily shows the benefits of credit union membership. However, the results of Tokle and Tokle (2000), Feinberg (2001) and Hannan (2002) all show evidence that credit union competition also benefits bank customers. Using estimates for the effect of credit union market share on bank CD rates from Tokle and Tokle and Hannan, if credit union market share fell by one standard deviation, the loss of interest payments to bank customers on CDs would be considerable in 2004, as shown in table 1. And, from Hannan's results, it appears that credit union competition also increases the bank interest rates of other types of deposits. It appears that the presence of credit unions in local markets benefits credit union members and nonmembers alike.

ENDNOTES

1. Credit unions' federal income-tax exemption dates back to the Revenue Act of 1916 (Srinivasan and King, 1998) and is another reason sometimes cited for the better interest rates offered by credit unions. However, by far, most of the credit union advantage is due to its cooperative structure rather than its non-income tax status. About a third of bank income was paid in income taxes in 2002 (Emmons and Schmid, 2003). In other words, about two thirds of bank income went to stockholders. In addition, this difference in tax revenue going to the federal government (because credit unions are income tax exempt) is overstated because credit union members pay more in personal income tax due to the higher interest rates paid on their deposits. This was conservatively estimated to be over $600 million in 2000 (U.S. Treasury, 2001). Also, banks can branch nation wide while credit union are restricted to serving a particular field-of-membership. In addition, banks can offer a much wider range of products and services than can credit unions. Lastly, many of the smaller banks also are exempted from federal income tax by becoming Subchapter S Corporations. In 1999, more than 1,260 banks reaped this tax benefit (U.S.

Treasury, 2001). In comparison, credit unions tend to be much smaller than banks. For example, about 80 percent of credit unions had an asset size less than $50 million in 2003 (Credit Union National Administration, 2003).

2. Hannan (2002, p. 8) states that coefficients of the credit union market share variable are likely to be underestimated for a couple of reasons. First, credit union market share "is likely to exhibit the greatest degree of endogeneity, since differences in the deposit rates observed for institutions in the sample are likely to influence the extent to which credit union members hold their deposits in credit unions. … Because higher rates offered by banks and thrift institutions should, if anything, cause a reduction in the deposit share of credit unions in the market, this form of endogeneity should impart a negative bias to an OLS estimate of the coefficient $cudepshare_{j.}$" (Note the cudepshare stands for the independent variable credit union market share). In addition, Hannan (2002, p. 8) points out that "the deposit share of credit unions probably underestimates the true proportion of retail deposits accounted for by credit unions, since the deposit data for banks and thrift institutions necessarily include substantial amounts of large-denomination "wholesale" and commercial deposits. To the extent that this introduces noise into the measurement of credit unions' true deposit shares, the coefficients of $cudepshare_j$ will be biased toward zero."
3. The credit union market share coefficients used in these estimates were computed using 1998 data, when the CD interest rates (the dependent variable) were higher than in 2004. However, it seems that these coefficients could be of the same magnitude if estimated using 2004 data because while the levels of banks CD rates would be lower, the differences of CD rates between banks could certainly be of similar magnitudes.
4. Statistically, this estimate has gone beyond the "scope of inference." But the estimate still can be reasonable to the extent that the relationship between bank CD rates and credit union market share is similar for the rest of the US as it is for Idaho and Montana. In addition, the estimate made using the coefficient from Hannan, who did use a nation-wide sample, for the effect of a credit union market share decline on bank CD interest payments is larger.
5. Total deposits of all FDIC-insured institutions (banks and S&Ls) come from the June 2004 ***FDIC Summary Tables Report*** and are reported by state. Total small CDs (less than $100,000) come from the September 2004 ***FDIC Statistics on Depository Institutions Report***. However, the CD data were not given by state. So, the author assigned the CD data by state based on the percentage that the state had of total deposits from the ***FDIC Summary Tables Report***.

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REGULATING UNDERGROUND INDUSTRY: AN ECONOMIC ANALYSIS OF SPORTS BETTING

Jonathan A. Schwabish*

Abstract

Estimates suggest that up to $380 billion is illegally gambled on sporting events every year. This paper estimates the potential tax revenue the United States could collect if it acted as the legal operator of two separate types of sports betting games. Building on previous work the basic calculations suggest that by operating a legal head-to-head sports betting operation, the U.S. could generate anywhere from $977 million to $24 billion annually in tax revenue while a parlay card-type game could generate between $189 million and $1.4 billion. This paper is one of the first to calculate the potential revenues from legalizing this underground industry.

Introduction

The debate over how to meet budget imbalances occurs almost every year at every level of government. To meet those gaps, a variety of revenue-raising options are often proposed and one option that makes regular appearances is introducing or expanding some form of gambling. New casinos, expanded lottery games, video lottery terminals (VLTs), and off-track betting parlors (OTBs), are the most common forms of legal gaming available. In fact, two out of every three Americans place a bet in casinos, lotteries, or office sports pools every year (Jones, 2004).

Many forms of gambling are legal in the United States and most create significant profits for retailers and revenues for state and local governments. The large illegal sports betting market in the U.S. generates between $80 billion and $380 billion annually (National Gambling Impact Study Commission (NGISC), 1999), easily exceeding the roughly $80 billion annual gross revenues from casinos and

*Associate Analyst, Congressional Budget Office, Second and D Streets, SW, Washington, DC 20515, jonathan.schwabish@cbo.gov

◊The views expressed here are those of the author and should not be interpreted as those of the Congressional Budget Office. The author wishes to thank William O'Dea for his comments and suggestions.

lotteries (Kearney, 2005). Although estimates for individual states are not available, the Kings County District Attorney (2004) estimates that in New York State, illegal sports betting reaches $30 billion a year; 8 percent to 38 percent of the nationwide total.

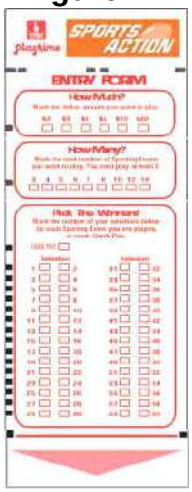
In 1992, the federal government banned legal sports gambling in all states save four (Delaware, Montana, Nevada and Oregon) because those states had established gaming already in place. Recently proposed legislation in New Jersey (New Jersey Assembly Bill, No. 3493) has re-opened the discussion about sports betting and the real possibility of a challenge to the federal prohibition. In Nevada, $2 billion in legal sports betting per year generates approximately $8 million in tax revenues. In Oregon, sports betting is operated in the same way as a lottery with annual revenues around $2.5 million. New Jersey estimates that the state would collect $4 million to $5 million per year if the industry were legalized. These amounts are less than 1 percent of total state revenues and hence would have a marginal impact on the state's fiscal condition.[1] But legalizing sports betting introduces a number of questions, not only about the potential economic impacts, but the appropriateness of using gambling revenues for a number of government services, ranging from education to transportation.

This paper reports the potential tax revenue the United States could collect if it acted as the operator, or legal bookmaker, of two separate types of sports betting games. Although the Professional and Amateur Sports Protection Act (PASPA), passed in October 1992, currently prohibits sports betting at the state level and would require states to challenge the law at the federal level, the calculations estimate the *total* tax revenue that could be raised if the law were repealed. The estimates are based on previous research by Schwabish and Simas (2005), where we suggested that by operating a legal head-to-head sports betting operation, New York State could generate anywhere from $290 million to $1.9 billion in annual tax revenues. Extending the analysis to the entire nation, the analysis suggests a range of $977 million to $24 billion, based on the two estimates of total illegal betting from the NGISC (1999). A parlay card-type sports betting game would generate significantly less revenue—between $189 million and $1.4 billion—but may incur fewer social costs. The paper is one of the first attempts to calculate the potential revenues from sports betting. The analysis omits significant negative and positive potential spillovers from legal sports gambling and although a substantial literature has analyzed these spillovers with respect to lotteries and casinos, sports betting introduces a new dynamic that has yet to be evaluated.

History of Sports Betting[2]

The 1992 Professional and Amateur Sports Protection Act barred states from constructing local sports betting programs. Only four states—Delaware, Montana, Nevada, and Oregon—where sports betting systems were already in existence, were omitted from the ban. To date, only Nevada and Oregon allow legal sports betting, although Oregon only permits betting through its lottery-based games. In Nevada, a wide range of sports betting is available, with head-to-head betting the most common. Estimates put total sports betting at approximately $2 billion per year. Large sporting events, such as the Super Bowl, generate additional economic benefits in tourism-related dollars.

Figure 1



Oregon's Sports Action game, introduced in 1989, provides odds for a number of football games every play week with bettors choosing a winner for each game (see Figure 1).[3] By creating a lottery-style sports betting game, the state protects itself against changing odds and because the odds are designed to create a 50-50 chance of winning, Sports Action is purely a game of chance. Sports Action bettors may choose to wager $2, $3, $4, $5, $10, or $20 per ticket, but a majority of bettors purchase the $5 tickets. Weekly payouts range from 60 percent to 65 percent (Oregon Lottery, 2004a) and the roughly 2 million bets placed each year raise between $1.5 million and $2.5 million for a range of services in the state.

In New Jersey, in an effort to capture revenue from sports betting, Assemblyman Jeff Van Drew proposed to legalize the practice (New Jersey State Assembly, 2005), which would first require a state constitutional amendment and then a challenge to the 1992 federal law. Regardless, Van Drew predicts that introducing legal sports betting would provide the state with $5 million to $8 million a year in additional casino tax revenues (New Jersey State Assembly. 2005). The New Jersey experiment will help set the tone for other states looking to cash in on the gambling industry. The estimates in the next section will attempt to quantify the potential revenues accruing from legal sports betting but, as in Schwabish and Simas (2005), omit a number of related effects.

The Economics of Gambling[4]

There is a well-established literature on gambling and its effects on consumers, businesses and communities. There remain a host of unanswered questions: What impact does gambling have on crime, bankruptcy, and suicide rates? How does gambling reduce other forms of consumption and what are the effects on other forms of state and local revenues? What place does government regulation have in gambling markets? As states and localities debate ways to fill budget holes, gambling provides a way to generate millions of dollars. This paper does not quantify all of the potential impacts from sports betting but provides a reasonable approximation of the gross revenues the government could expect if specific forms of sports betting were allowed.

Over the past thirty years, nearly every state in the U.S. has added some form of gambling. From casinos to lotteries to horseraces, Americans can now bet on a wide range of activities with an ever-expanding list of options within each. Gross revenues from legalized gambling reached $72.9 billion in 2003 with over 80 percent accounted for by casinos and state lotteries (Kearney, 2005). The nearly $14 billion in revenues raised from state lotteries are dedicated to a variety of areas, including education, economic development, transportation and the environment, to name a few (North American Association of State and Provincial Lotteries (NASPL), 2005).

The gambling industry generates jobs and creates a magnet for tourists. Commercial casinos employ roughly 370,000 people and generate an additional 450,000 jobs in related businesses (American Gaming Association, 2004a). Over the past decade, more than 157,000 jobs were created in the casino industry, a growth rate of 79 percent. These gross job creation figures are supported by the work by Evans and Topoleski (2002), who find that counties with new Indian casinos have approximately a 5 percent increase in the number of jobs.

Opponents of gambling and related activities point to a series of negative spillover effects, the most prevalent being increases in crime. Using national data between 1977 and 1996, Grinols and Mustard (2001) find increases in crime rates following casino openings. Pathological gambling problems are also part of this literature (see Lesieur, 1998). Volberg (1996) shows that the lifetime prevalence of problem gambling ranges across states from 1.7 percent in Iowa to 7.3 percent in New York.[5] A number of studies have examined the distributional impacts of gambling showing that lotteries are generally regressive (see Clotfelter and Cook, 1989; Oster, 2004; Kearney, 2005 and references therein).

The growth in Internet gambling has produced an array of complications for the domestic gambling market—What role does international law play? How can governments track Internet gambling winnings? The General Accountability Office (GAO) (2002) suggests that the online gambling industry generates approximately $5 billion in revenues each year, a number that continues to grow. The near-universal availability of the Internet in offices now makes online gambling easily accessible. ComScore (2002)—a consultant company specializing in consumer behavior—found that people spent an average of 20.2 minutes per month at gambling websites, although those who visited gambling sites from home spent about three times as long as those who visited these sites from work. Compared to 9.8 average monthly minutes people spent at health-information sites, 35.8 minutes at travel sites, 52.8 minutes for general news sites, and 62.0 minutes at sports sites, online gambling may have a noticeable impact on worker productivity. As states ponder legalizing sports betting, it is unclear how Internet gambling will affect potential revenues and subsequent behavioral decisions by residents.

The spillover effects can also affect other industries and total government revenues. In an interesting study of Indian casinos and the Arizona state lottery, Siegel and Anders (2001) find that a 10 percent increase in the number of slot machines decreases state lottery sales by 2.8 percent. Elliott and Navin (2002) show that lottery revenues decline (or are “cannibalized”) by the introduction of both casinos and pari-mutuel betting. Madhusudhan (1996) argues that casino revenues are a limited and unstable revenue base for states to base projections upon. Hence, the total impact of legal gambling combines the potential negative effects from bankruptcy, poverty, and crime with the positive spillover effects of job creation and tourism markets. Research continues to explore these issues to help inform and educate policy makers looking to raise additional revenue for a variety of government-sponsored services.

Economic Impact

While backers of legal sports betting argue that legalization will help control the existing underground economy, sufficient data to assess the economic impacts of legal gambling are difficult to

obtain. In this section, a series of calculations estimate the potential revenue the United States could capture from legalizing sports betting. These calculations are based on those found in Schwabish and Simas (2005), along with available research on lotteries, casinos and other underground economic activities. As in Schwabish and Simas (2005), two scenarios are proposed. In the first, the U.S. government would be the legal operator of head-to-head sports betting. In this scenario, the government would operate sports books as an OTB-type operation where the bettor would place head-to-head bets on any number of games. The second scenario is a parlay card-type game, where bettors pick winners for an entire menu of games, similar to the Sports Action game in Oregon. This creates a pure chance betting game for final outcomes in professional sports.

As outlined in Schwabish and Simas (2005), there are four reasons why legalizing sports betting will not result in a complete shift from the illegal market to the legal market. First, either due to tax avoidance or conflict of interest (i.e., professional athletes), many bettors simply do not want the government to know that they are gambling. Second, bookmakers in the illegal market extend significant lines of credit; due to debt concerns, government-sponsored sports betting will arguably not offer the same convenience. Third, as a way to reduce the amount of risk, the government may adjust the odds, either nationally or locally. This will effectively reduce the bettors' probability of winning. Finally, neighborhood bookmakers offer a convenient and familiar way to place bets. A government-sponsored system will not maintain the same familiarity and thus lose potential clients.

Although a full shift from the illegal market to the legal market may not occur with legalized gambling, it may attract people who had previously never bet on sports. This is clearly the missing counterfactual for this study. Results from a recent Gallup Poll (Jones, 2004) however, suggest that two out of every three Americans have played some form of gaming with nearly one-half having purchased a state lottery ticket. Prior to the introduction of Oregon's Sports Action game, Buursma (1989) found that 71 percent of Oregonians said they would play the game. Since the late-1980s, only video poker and casino gambling have increased while gambling on professional sports has declined by 12 percentage points and betting on college sports has fallen by 6 percentage points (Jones, 2004). Although the popularity of most types of gambling have declined, there is still a large potential market for sports and other types of gambling.

In addition to new gamblers and people who shift their betting from the illegal market to the legal market, there is a third group of potential bettors—people who substitute sports betting for other forms of legal gambling. If legalizing sports betting "cannibalizes" other forms of legal gambling, the overall increase to state revenues could be negligible (see Siegel and Anders (2001) and Elliott and Navin (2002) as discussed in the previous section). Kearney (2002) shows that households finance new lottery gambling not by substituting away from other forms of gambling but by reducing their non-gambling consumption. Hence, the reduction in consumption spending will reduce sales tax revenue and have an impact in other areas of the economy, but it also suggests that legal sports betting might not replace existing lottery or casino revenues.

This methodology misses a wide range of secondary negative (and positive) spillover effects. For example, legal sports betting would create jobs and subsequent tax revenues, but also introduce potential increases in crime, bankruptcy rates and gambling addiction rates. Schwabish and Simas (2005) provide a comprehensive list of elements, which are not captured by the calculations. The most important include impacts on labor market behavior (e.g., hours worked or participation rates)[6]; sports betting's behavioral impact on different parts of the income distribution[7]; influence of enforcement and prosecution of organized crime; and moral and social issues (NGISC, 1999).

Head-to-Head Sports Betting

Schwabish and Simas (2005) calculate the total revenue impact of legal sports gambling for New York State in two steps—the analysis in this section extends this approach to the nation. The first step estimates gross profits by adding the amount of money new bettors would bring to the market to the share of the illegal market that would shift to the legal sector. In the second, net revenues are calculated by subtracting operating costs and contributions to problem gambling prevention programs.

The potential revenue shift from the illegal market to the legal market is based on two sources. For New York State, as used in Schwabish and Simas (2005), an estimate of $30 billion is taken from the Kings County District Attorney (2004). Nationwide, an $80 billion to $380 billion range is taken from NGISC (1999). Both of these include gambling on college sports, which account for approximately one-third of all sports bets (American Gaming Association, 2004b). Following New Jersey's legislation, which prohibits gambling on college sports, it is assumed that legal sports betting nationwide would also prohibit gambling on college sports; hence, one-third of these totals are deducted. This leaves a potential illegal sports betting market of $20 billion in New York States and between $53 billion and $253 billion nationwide.

Of course, the government only captures a share of these totals—payouts to winners must first be deducted. Using arrest records from six New York City bookmakers between 1995 and 2000, Strumpf (2003) finds that illegal bookmakers paid out more than 85 percent in total betting volume to winners. At this rate the government would keep only 15 percent of total betting volume, which translates to $3 billion in New York State and $8 billion to $38 billion for the country as a whole.[8] Given the earlier discussion of the possible less-than-full shift from the illegal to the legal sports betting market, it is certainly conceivable that the government would only capture a share of the pool of money remaining after prize payouts. As in Schwabish and Simas (2005), four different percentages (10 percent, 25 percent, 50 percent, 75 percent) represent a range of take-up rates.

The second source of legal bettors are new bettors. Again, following Schwabish and Simas (2005), 10 percent of the 18-and-over population for New York State (1.5 million people) and the U.S. (100.9 million) is multiplied by the median annual sports betting expenditure ($240) as found by Goldfarb Consultants Inc. (1999; see also Clotfelter and Cook, 1989, p. 24). These inputs result in new bets worth $353 million in New York State and $2.4 billion nationwide. Again adjusting for payouts to winners using Strumpf's (2003) 15 percent figure, the total possible pool of money from new bettors is $53 million for

New York State and $363 million nationwide. Before arriving at final revenue estimates, operating costs—estimated at 15 percent of total profits (Cornstein, 2004)—are deducted from total profits. Finally, a donation of 1 percent of gross profits to problem gambling programs is deducted, following the rate used by the Oregon Lottery (2004b).

The entire methodology is captured in Table 1 and combines the $80 billion to $380 billion estimate of the nationwide illegal sports betting from NGISC (1999) with $363 million generated from new bettors (10 percent of the 18-and-over population wagering $240 per year) and take-up rates and costs used in Schwabish and Simas (2005). At the low end ($80 billion), legal sports betting across the nation could generate between $977 million and $5.3 billion. At the high end ($380 billion), legal sports betting could generate between $3.5 billion and $24.2 billion. Estimating these potential impacts in New York State, the analogous State Net Profit totals from Schwabish and Simas (2005) are $296 million, $674 million, $1.3 billion, and $1.9 billion.

Table 1. Economic Impact of Head-to-Head Sports Betting in the United States ($ in millions)

Gross Profit from Illegal Market*	***Times* Portion move to Legal**	***Plus* Gross Profit from New Gamblers****	***Equals* Total Legal Gambling**	***Minus* Operating Costs (15%)**	***Minus* Problem Gambling Prevention (1%)**	***Equals* Total Net Profit**
Low Estimate						
$8,000	10%	$363	$1,163	($174)	($12)	$977
$8,000	25%	$363	$2,363	($354)	($24)	$1,985
$8,000	50%	$363	$4,363	($654)	($44)	$3,665
$8,000	75%	$363	$6,363	($954)	($64)	$5,345
High Estimate						
$38,000	10%	$363	$4,163	($624)	($42)	$3,497
$38,000	25%	$363	$9,863	($1,479)	($99)	$8,285
$38,000	50%	$363	$19,363	($2,904)	($194)	$16,265
$38,000	75%	$363	$28,863	($4,329)	($289)	$24,245

*Calculated by subtracting one-third of the NGISC's (1999) estimate of the illegal sports betting market (Low Estimate: $80 billion; High Estimate: $380 billion) for college sports (American Gaming Association, 2004b) and then multiplying by Strumpf's (2003) estimate of net revenue share (15 percent).

**Calculated by assuming 10 percent of U.S. 18-and-over population wagers $240 per year, multiplied by Strumpf's (2003) estimate of net revenue share (15 percent).

Sources: Jones, 2004; Goldfarb Consultants Inc., 1999; Oregon Lottery, 2004b; Schwabish and Simas, 2005.

Christiansen (2003) is perhaps the only other researcher who has attempted to calculate the potential revenues accruing from sports gambling. His calculations are based on the NGISC's (1999) $80 billion estimate of total nationwide illegal sports betting. Assuming sports books' takeout[9] equals either 4.6 percent or 5.79 percent, he estimates gross revenues for retailers at either $3.68 billion or $4.63 billion (see Table 2). Applying a state-level 7.5 percent tax rate, he then estimates total revenues for U.S. states would equal either $276 million or $347 million. Although the approach taken here is slightly more sophisticated, applying Christiansen's (2003) methodology to the $30 billion estimate provided by the

Kings County District Attorney (2004), New York State revenues would be either $104 or $130 million. Subtracting one-third of each figure for collegiate gambling, as assumed in Table 1, decreases potential (low-end) revenues to $184 million and $232 million (Table 2, bottom panel).

The key difference, of course, is that the calculations in Table 1 assume that the state would operate the sports book as opposed to Christiansen's (2003) assumption that a private entity would operate the sports book. Hence, the appropriate comparison to the state-operated scenario in Table 1 is the shaded rows in the bottom panel of Table 2. These estimates, upwards of $5.3 billion at the low-end and over $24 billion at the high end fall within the range of figures reported in Table 1. Furthermore, the reported figures for New York State ($920 million to $1.16 billion in Table 2) are well within the $296 million to $1.93 billion range found in Schwabish and Simas (2005).

Table 2. Potential Sports Gambling Revenue (based on Christiansen, 2003) ($ in millions)

	Nationwide-Low Estimate[1]	Nationwide-High Estimate[2]	New York State[3]
Total Handle	$80,000	$380,000	$30,000
Gross Gambling Revenue			
Takeout percentage (4.60%)	$3,680	$17,480	$1,380
Takeout percentage (5.79%)	$4,632	$22,002	$1,737
Net Gambling Revenue			
State Tax Rate (7.5%)	$276	$1,311	$104
State Tax Rate (7.5%)	$347	$1,650	$130
Total Handle Minus Collegiate Betting	$53,333	$253,333	$20,000
Gross Gambling Revenue			
Takeout percentage (4.60%)	$2,453	$11,653	$920
Takeout percentage (5.79%)	$3,088	$14,668	$1,158
Net Gambling Revenue			
State Tax Rate (7.5%)	$184	$874	$69
State Tax Rate (7.5%)	$232	$1,100	$87

Sources: [1]Christiansen (2003), NGISC (1999); [2]Author's calculations, NGISC (1999); [3]Author's calculations, Kings County District Attorney (2004).

The bottom line from Tables 1 and 2 is twofold. First, the methodology used in Schwabish and Simas (2005) and adopted here falls reasonably close to the only other set of published estimates (Christiansen, 2003). Second, if the objective of legalized sports betting is to raise revenue for states, it in the states' interest to run the sports book themselves rather than allow private businesses to run the sports book and tax their profits.

Parlay Card Sports Betting

The revenue implications are significantly different if legal sports betting is instituted as a parlay card game (Table 3). Since the illegal sports betting market is a different form of gambling than parlay card games, it is conceivable that the state would not capture any of the illegal market. In fact, the two markets are so different that a parlay card-type game is more akin to introducing a new lottery than to introducing sports betting. As such, it is assumed that parlay card games do not capture any of the existing illegal sports betting

market.[8] Instead, some portion (10 percent, 25 percent, 50 percent, or 75 percent) of the existing 18-and-older population is projected to gamble $240 per year (as assumed earlier). The higher capture rate (75 percent) is based on Buursma's (1989) results from a 1989 survey in Oregon, and the lower rates (10 percent, 25 percent, 50 percent) are included to illustrate the range of potential state revenues. Combining these four inputs, Total Legal Gambling is estimated to fall between $6.8 billion and $50.7 billion (Table 3, Column 4).

The Sports Action parlay card game in Oregon pays out approximately 65 percent of total revenues in prizes, although by law Oregon lottery games must pay out 85 percent of *total* revenues (from all lottery games) in prizes and to other programs; hence, the payout rate could be much higher. However, the 65 percent payout rate is similar to the approximate 70 percent payout rate for lotteries across the country (NASPL, 2004), and at that rate, total taxable profits range from $2.4 billion to $17.7 billion. If an 8 percent tax rate were assessed, this type of game would raise between $189 million and $1.4 billion for the federal government. At the state level, if an 8 percent tax rate were assessed in New York, the parlay card game would only raise between $10 million and $76 million (see Appendix Table). This low estimate is not surprising—if revenue from Oregon's Sports Action game is adjusted for differences in the two state's populations, a parlay card game in New York would be expected to generate approximately seven times as much revenue as Oregon's 2.7 million residents, or roughly $16 million.

The calculations in Table 3 assume that the private market would run the parlay card game and the government would capture the assumed 8 percent sales tax. In this case the last three columns in Table 3 calculate the potential total net profits retailers would earn from the game. Assuming 15 percent of revenues go toward labor costs and a mandatory 1 percent contribution to gambling prevention programs, retailers' net profits would range from $1.8 billion to $13.5 billion. In New York State, these estimates range from $94 million to $702 million and bound the $356 million in 2004 retailer profits from the New York State Lottery (New York State Lottery, 2005). If state governments acted as operators of the game—similar to state-level lotteries—the tax revenue amounts could be used as retailer commissions and the dollar figures in the final column would then be considered states' net profits. The revenue implications of this latter scenario are substantially larger than those from a game where retailers collect net profits.

Table 3. Economic Impact of Parlay Card Sports Betting ($ in millions)

U.S. Population ('000s)	*Times* Portion of New Gamblers	*Times* Annual Bet Amount	*Equals* Total Legal Gambling	*Minus* Payouts (65%)	*Equals* Taxable Profits	*Yields* Revenue at 8% Tax Rate*	*Minus* Labor Costs (15%)	*Minus* Problem Gambling Prevention (1%)	*Equals* Retailer Net Profit ($M)
281,421	10%	$240	$6,754	($4,390)	$2,364	$189	($355)	($24)	$1,797
281,421	25%	$240	$16,885	($10,975)	$5,910	$473	($886)	($59)	$4,491
281,421	50%	$240	$33,771	($21,951)	$11,820	$946	($1,773)	($118)	$8,983
281,421	75%	$240	$50,656	($32,926)	$17,730	$1,418	($2,659)	($177)	$13,474

*Oregon currently charges an 8 percent tax on its sports betting games and the pending New Jersey sports betting games would also charge this rate (New Jersey Assembly Bill No. 3493, 2004). Nevada, which has a full range of sports betting operations in its casinos, currently assesses a state tax rate of 6.25 percent, the lowest in the nation.

Sources: Jones, 2004; Goldfarb Consultants Inc., 1999; Clotfelter and Cook, 1989; Oregon Lottery, 2004b; Schwabish and Simas, 2005.

Conclusion

Illegal sports betting generates up to $380 billion a year across the country. If legalized, between $977 million and $24.4 could be collected in tax revenue across the country, which, if divided equally, translates to approximately $500 million per state. This amounts to roughly 4 percent of states' total tax revenues in 2001 and around 4 percent of state's total revenues. With parlay card games, like that found in Oregon, total revenues would yield a fraction of that amount—less than $1.5 million, but total retailer revenues could exceed $13 billion. And although gambling is typically legislated at the state level, the estimates in this paper demonstrate the significant monetary returns legalizing the industry might provide to the government.

The analysis misses a wide range of secondary effects and those effects may dwarf the positive revenue gains presented in this study. Increases in crime rates, bankruptcy rates and gambling addiction rates threaten the social fabric and ultimately the economic health of the country. Further, dedicating gambling revenues to a variety of services—most notably education—raises questions of how society should set its goals with respect to government revenues and the public provision of goods and services. These questions, and many more, need to be more fully explored and this paper is a very simple addition to a growing literature.

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Appendix Table. Economic Impact of Parlay Card Sports Betting ($ in millions)

NYS Population ('000s)	***Times*** **Portion of New Gamblers**	***Times*** **Annual Bet Amount**	***Equals*** **Total Legal Gambling**	***Minus*** **Payouts (65%)**	***Equals*** **Taxable Profits**	***Yields*** **State Revenue at 8% Tax Rate***	***Minus*** **Labor Costs (15%)**	***Minus*** **Problem Gambling Prevention (1%)**	***Equals*** **Retailer Net Profit ($M)**
15,000	10%	$240	$360	($234)	$126	$10	($19)	($1)	$96
15,000	25%	$240	$900	($585)	$315	$25	($47)	($3)	$239
15,000	50%	$240	$1,800	($1,170)	$630	$50	($95)	($6)	$479
15,000	75%	$240	$2,700	($1,755)	$945	$76	($142)	($9)	$718

*Oregon currently charges an 8 percent tax on its sports betting games and the pending New Jersey sports betting games would also charge this rate (New Jersey Assembly Bill No. 3493, 2004). Nevada, which has a full range of sports betting operations in its casinos, currently assesses a state tax rate of 6.25 percent, the lowest in the nation.

Sources: Jones, 2004; Goldfarb Consultants Inc., 1999; Clotfelter and Cook, 1989; Oregon Lottery, 2004b; Schwabish and Simas, 2005.

ENDNOTES

1. Revenue data from U.S. Census Bureau (2004-2005), Table No. 441.
2. This section includes a very brief description of the recent history of legal sports betting in the United States. A more thorough treatment can be found in Schwabish and Simas (2005).
3. Oregon offered a second lottery-based sports betting game called Scoreboard in 2003. The concept is the same as in Sports Action and is designed as a game of chance.
4. This is not a summary of the entire literature. For an excellent and thorough review, see Kearney (2005).
5. Volberg (1996) included those states that had legal gambling in the state at the time. The prevalence of problem gambling in New York State rose from 4.2 percent in 1986 to 7.3 percent in 1996.
6. Imbens et al. (1999) show that large lottery winnings result in a decline of about 9 work-hours per year. Also certainly of interest is the impact of gambling on worker productivity, especially with the availability of online gambling.

7. Existing gambling research (Kearney, 2002; Forrest and Simmons, 2003) has shown that low-income households often experience the greatest negative impacts from problem gambling by foregoing expenditures on food, mortgage, rent or other bills.
8. This 15 percent figure may be underestimated because bookies have greater payout rates than comparable state-run games. However, this figure is the only one available in the literature and is used in Schwabish and Simas (2005). If, say, a 30 percent take-out rate were used instead, potential profits (see Table 1) would essentially double.
9. The takeout is defined as the percentage of total bets retained by the sports book; in other words, the sport books' gross revenues.

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5. Elia Kacapyr
6. Dong Koo Kim
7. Kent Klitgaard
8. Micahel McAvoy
9. Bryan McCannon
10. J. Patrick Meisler
11. David Ring
12. Jonathan Schwabish

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1:30 – 2:30 Concurrent Sessions: Group III
2:45 – 4:30 Concurrent Sessions: Group IV
4:45 – 6:00 Business Meeting (Klingenstein Lounge, open to all members)

Concurrent Sessions

8:30am – 10:00am

Session A Country Studies — **Klingenstein Lounge**

Chair: Raquibez Zaman, Ithaca College

Ansari, Mohammed, Albany State University
Impact of Foreign Direct Investment on the Domestic Economy of South Africa
Discussant: Kopp, Thomas (Siena College)

Karaaslan, Mehmet, Southwestern University
Privatization by Franchising: Commissioned Entrepreneurs of Summer Holding Sales Outlets in Turkey
Discussant: Thomas, Wade (SUNY Oneonta)

Henry, Tracyann, Union College
Grade Repetition and Incomplete Schooling Among Adolescents in Rural Kenya
Discussant: Osterreich, Shaianne (Ithaca College)

Session B Environmental Economics — **Clark Lounge**

Chair: William Kolberg, Ithaca College

Farias, Christine, Fairleigh Dickinson University
Deforestation and Global Climate Change - An Economic Perspective
Discussant: Klitgaard, Kent (Wells College)

MacDermott, Raymond, Western Illinois University
A Panel Study of the Pollution Haven Hypothesis
Discussant: Kolberg, William (Ithaca College)

Rasak, Kevin, Colgate University
The Environmental Effects of Title IV of the Clean Air Act Amendments of 1990
Discussant: Farias, Christine (Fairleigh Dickinson)

Session C Microeconomics 1 — **Conference Room**

Chair: William O'Dea, SUNY Oneonta

Bosshardt, Donald, Canisius College
Lichtenstein, Larry, Canisius College
Zaporowski, Mark, Canisius College
A Model of Expected Tuition Profit Maximization
Discussant: Meister, Patrick (Ithaca College)

McCannon, Bryan, Elmira College
Mathematical Miscalculations and Quantity Bundling
Discussant: O'Dea, William (SUNY Oneonta)

Eisenhauer, Joseph, Canisius College
Ethics, Risk Aversion, and Taxpayer Behavior
Discussant: Schwabish, Jonathan (Partnership NYC)

Session D Earnings **North Meeting Room**

Chair: James Booker, Siena College

Conger, Darius, Ithaca College	Does the Race go to the Swift? Wage Payoff and Timely Degree Completion *Discussant:* Booker, James (Siena College)
Hutton, Patricia, Canisius College	Monopsony, Minimum Wages, and the Business Cycle *Discussant:* Liu, Gang (University of Albany)
Palumbo, George , Canisius College Richard Schick, Canisius College	Biases in the Computation of Enhanced Earnings for Individuals Whose Income is Not "Average" and a Solution *Discussant:* Smith, Lynn A. (Clarion University of PA)

10:15am – 11:45am

Session A Service Learning and Applied Research Klingenstein Lounge

Chair: Susan Davis, Buffalo State University

Davis, Susan, Buffalo State University	The Living Wage Campaign in Buffalo, NY
Haynes, Curtis, Buffalo State University	Using Mondragon as a Model for African American Urban Development
Koritz, Douglas, Buffalo State University	Prospecting for Gold: Service Learning Development in Economics *Discussants*: Abrams, Lerone, Buffalo State University Asledy, Joe, Buffalo State University Bails, Eddie, Buffalo State University Leclaire, Joelle, Buffalo State University

Session B Economic Development: Key to the Future Clark Lounge

Chair: Randall Capps, W. Kentucky University

Capps, Randall, W, Kentucky University	Trends and Growth of Economic Development Activities
Clermont, Paul, University of Quebec/Montreal	The Role of the University in Economic Development
Reber, Robert, Western Kentucky University	Human Capital and Economic Development: Implications for the Business School Curriculum

Session C International Economics **Conference Room**

Chair: James Booker, Siena College

Klitgaard, Kent, Wells College	Looking Critically at the Doctrine of Comparative Advantage in the Age of Globalization *Discussant:* Ganley, William (Buffalo State College)
Osterreich, Shaianne, College	Indonesia and the Expiration of the Multi-Fiber Agreement *Discussant:* Simpson, Nicole (Colgate University)
McCannon, Bryan, Elmira College	Trade Embargoes and Quality *Discussant:* Schmidt, Ted (Buffalo State College)
Unsal, Fahri, Ithaca College and Zaman Raquibez, Ithaca College	The European Union and Its Enlargement: The Challenges Ahead *Discussant:* Hadsell, Lester (SUNY Albany)

Session D Labor Economics **North Meeting Room**

Chair: Darius Conger, Ithaca College

Liu, Gang, University of Albany	Technological Changes and Return-Dispersion Links in Education *Discussant:* Tussing, A. Dale (Syracuse University)
Jones, Robert, Skidmore College	Employment Cycles and Holders of Associates Degrees *Discussant:* Hutton, Patricia (Canisius College)
Schwabish, Jonathan, Partnership for NYC	Employment Spillover Effects in New York City *Discussant:* Dietz, Richard (New York Fed – Buffalo)
Shu, Florence, SUNY Potsdam and Fowler, Shaun, SUNY Potsdam and Nathaniel, SUNY Potsdam	The Role of Scientists and Engineers in Economic Performance: An Examination via the Cobb-Douglas LaGarry, Approach *Discussant:* Meister, Patrick (Ithaca College)

12:00pm – 1:15pm

Luncheon Speaker: Ronald G. Ehrenberg, Irving M. Ives Professor of Industrial and Labor Relations and Economics at Cornell University and Director of the Cornell Higher Education Research Institute

1:30pm – 2:30pm

Session A Health Care Economics — **Klingenstein Lounge**

Chair: Florence Shu, SUNY Potsdam

Gius, Mark, Quinnipiac University — The Impact of the American with Disabilities Act on Per Student Public Education Expenditures at the State Level 1987-2000
Discussant: Veeramachaneni, Bala (SUNY Farmidale)

Musgrave, Frank, Ithaca College — American Health Care Policy
Discussant: Smith, Lynn A. (Clarion University of PA)

Tussing, A. Dale, Syracuse University and Martha Wojtowycz, Upstate Medical University — Do Small-Area Variations in Practice Styles Persist in Obstetric Delivery in New York State? A Multivariate Analysis
Discussant: Ring, David (SUNY Oneonta)

Session B Education Economics — **Conference Room**

Chair: Steven Gold, Rochester Inst of Tech

Cheng, Joseph, Ithaca College and Movassaghi, Hormoz, Ithaca College — Integrating Financial Theory into Curriculum Assessment
Discussant: Thomas, Wade (SUNY Oneonta)

Tiefenthaler, Jill, Colgate University — The Gender Imbalance in Undergraduate Economics: Too Few Women? - Or Too Many Men?
Discussant: Farias, Christine (Fairleigh Dickinson)

Session C Microeconomics 2 — **Clark Lounge**

Chair: Michael McAvoy, SUNY Oneonta

Kolberg, William, Ithaca College — Inventory Carryover in Advanced Production Posted Offer Market Experiments
Discussant: O'Dea, William (SUNY Oneonta)

Meister, J. Patrick, Ithaca College — An In-Class Corporate Auction
Discussant: Booker, James (Siena College)

Hadsell, Lester, SUNY Albany — An Empirical Examination of Spot Price Volatility in the NYISO Electricity Market, 1999-2004
Discussant: Eisenhauer, Joseph (Canisius College)

2:45pm – 4:30pm

Session A Finance	**Conference Room**
Chair: Florence Shu, SUNY Potsdam	
Veeramacheneni, Bala, and Vogel, Richard SUNY Farmingdale	Do Computer Viruses Impact Corporate Profits: An Empirical Analysis *Discussant:* McAvoy, Michael (SUNY Oneonta)
Kopp, Thomas, Siena College	International Diversification Then and Now: The Changing Face of Optimally Diversified International Portfolios *Discussant:* Mulugetta, Abraham (Ithaca College)
Vitaliano, Donald, Rensselaer	On the Cost of Corporate Social Responsibility *Discussant:* Smith, Lynn A. (Clarion University of PA)
Ganley, William, Buffalo State College	Keynes and Veblen on Financial Markets *Discussant:* Klitgaard, Kent (Wells College)
Jestaz, David, Columbia University	Expansion of Firms without New Stocks: Anglo-American Debts versus European Cash Flows *Discussant:* McAvoy, Michael (SUNY Oneonta)

Session B Regional Economics	**Klingenstein Lounge**
Chair: Wade Thomas, SUNY Oneonta	
Jones, Robert, Skidmore College	Geographic Information Systems for Economists *Discussant:* Booker, James (Siena College)
Schwabish, Jonathan, Partnership for NYC	Easy Come, Easy Go: Migration in NYC, 1995-2000 *Discussant:* Tiefenthaler, Jill (Colgate University)
Cheng, Joseph, Ithaca College and Boasson, Vigdis, Ithaca College	Analyzing NY as a Leading Indicator for Economics of Other States *Discussant:* Thomas, Wade (SUNY Oneonta)
Gottschall, Tiffani, St. Lawrence University	Income Inequality in NY: A Report on Gini Coefficients Across Counties *Discussant:* Eisenhauer, Joseph (Canisius College)
Dietz, Richard, New York Fed – Buffalo	Regional, Industrial, and Occupational Restructuring in the Manufacturing Workforce *Discussant:* Conger, Darius (Ithaca College)

Session C Macroeconomics **Clark Lounge**

Chair: Elia Kacapyr, Ithaca College

Froyen, Richard, University of North Carolina and Hakan Berumet, Bilkent University - Turkey	Monetary Policy and Long-Term US Nominal Interest Rates *Discussant:* Hinderliter, Roger (Ithaca College)
Schmidt, Ted, Buffalo State College	Alternative Theories of Consumption and Saving *Discussant:* Ring, David (SUNY Oneonta)
Tomljansvich, Marc, Colgate University	What Color is Alan Greenspan's Tie? How Central Bank Policy Announcements have Changed Financial Markets *Discussant:* Hinderliter, Roger (Ithaca College)
Simpson, Nicole, Colgate University	Public Education Expenditures, Taxation and Growth *Discussant:* Osterreich, Shaianne (Ithaca College)

Session D Workshop on Computer Applications North Meeting Room

Gold, Steven, Rochester Inst of Tech and Gold Harvey, Gold Simulations	An Interactive Computer Game for Microeconomics Classes
O'Brien, Kevin, Addison Wesley	Online resources for Economics:MyEconLab

4:45 – 6:00

Business Meeting (open to all members) **Klingenstein Lounge**