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### Is It Truly a Building Ground? A Returns to Skill and Learning by Doing Study of the PGA Tour and the Web.com Tour

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**Is It Truly a Building Ground? A Returns to Skill  
and Learning by Doing Study of the PGA Tour  
and the Web.com Tour**

By:

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A Thesis Submitted to

The Department of Economics

Skidmore College

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Thesis Advisor: Qi Ge

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## **Abstract**

A study is carried out on the Web.com Tour from the 2007-2016 seasons using a panel data regression, to identify which shot making skills offer the highest return in earnings. The Web.com results are then compared to the shot making skills that were found to be most valuable on the PGA Tour during the 2015-2016 season. The results show that putting and greens in regulation are the two most lucrative statistics on both professional golf tours. The second portion of the study analyzes the effect of the theory of learning by doing on golfers playing on the Web.com Tour. The results show some diminishing returns in the improvement of some skills over time, however these findings were not consistent for all the shot making skills measured.

## **I. Introduction**

The PGA Tour has long been known as the most competitive professional golf tour in the world, with the golfers that play on it every season being considered the most skilled players in the world. The PGA Tour hosts 40-50 tournaments every season. The average purse for each tournament is over \$6 million with the winner of each tournament earning over \$1 million. Furthermore, the PGA Tour attracts the most media coverage as well as the most sponsorship deals compared to any other golf tour in the world. It is because of these benefits that the PGA Tour provides that all of golf's best players (the highest ranked players) are drawn to play on the PGA Tour and want to play as many events they can on the tour.

The path required for golfers to attain membership and play on the PGA Tour is one that takes countless hours of practice and one that only few are able to see to the end. Furthermore, there are a limited number of avenues to go about achieving one's PGA Tour membership.<sup>1</sup> One of these avenues is through playing on the Web.com Tour, which is considered the PGA Tour's developmental tour. Every season the top 25 money earners on the Web.com Tour are granted PGA Tour membership for the following season. Many players who now play on the PGA Tour today took this path through the Web.com Tour in order to achieve their PGA Tour membership.

This study compares the skills that offer the highest returns in earnings on both the PGA Tour and Web.com Tour. As a stepping stone tour to the PGA Tour, it should be expected that the most valued skills on the PGA Tour should also be valued on the Web.com Tour. The final results show that putting and iron play are the most important

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<sup>1</sup> For explanation of all the ways to earn PGA Tour membership refer to the Appendix section

skills on both the Web.com Tour as well as the PGA Tour, with putting being the most important skill. On the Web.com Tour, putting had a coefficient of -2.731, which means that if a player can decrease his putting average by one stroke then his earnings will increase by 273%. The coefficient for greens in regulations was 0.028, which means if a player can increase his greens in regulation by one percentage point his earnings will increase by 2.8%. On the PGA Tour, putting had a coefficient of -10.42 and greens in regulation had a coefficient of 0.046. These results can be interpreted to mean that if a player decreases his putting average by one stroke then his earnings will increase by 1,042%. Additionally, if a golfer can increase his greens in regulation percentage by one percentage point, then his earnings will increase by 4.6%. The results of this study suggest that the players that are proficient in putting and iron play on the Web.com Tour should be able to find success on the PGA Tour easier than players who are not proficient in these shot making skills.

The learning by doing results found in this study are very inconsistent. They show that players with a higher ability should perform better than players with lower ability, and that players of lower ability can see greater returns if they improve specific shot making skills. The learning by doing results have inconsistent implications based on the diminishing marginal return players have on specific skills over a period of time. The skills of driving distance and scrambling were found to have diminishing marginal return in improvement for players on the Web.com Tour, with the returns from improving those skills being less after already graduating once to the PGA Tour.

Overall due to the environment that the Web.com Tour provides, golfers are able to learn what skills are the most valued while they compete, and improvement of those

specific shot making skills can lead to future success on the PGA Tour. Additionally, the Web.com Tour provides golfers an ability to learn how to handle other variables that come with playing competitive golf that cannot necessarily be measured statistically while a golfer is on the golf course. Some of these variables include how a player handles traveling from one tournament to another, a player's natural talent level, how a player handles adverse playing conditions, how to make a schedule that brings the best out of one's game, etc. The Web.com Tour serves as a great learning environment for golfers to learn how to improve their craft while at the same time playing competitively and earning a living.

This study will provide a returns to skill analysis of the Web.com Tour versus the PGA Tour, as well as an implementation of the theory of learning by doing in the context of the Web.com Tour and competitive golf. A returns to skill study does not exist in the current returns to skill golf literature. Furthermore, there has yet to be a learning by doing study addressing competitive golf, which provides an opportunity for future studies to look into this theory and its relevance in competitive golf more closely. Lastly, the returns to skill findings in this study differ from that of previous studies of the PGA Tour, with the statistic of greens in regulation being found to be a more lucrative statistic than the statistic of driving distance. This creates an opportunity for future research to investigate whether the importance of specific skills have changed since past studies or if the results of this study prove to be an outlier in the otherwise consistent trend seen in past studies.

The second section of the paper will discuss the previous and related literature to returns to skill in golf, as well as other literature regarding other theories that I deem to

have an effect on this study. The third part of the paper will breakdown the data and methodology that was used in the study. The fourth section of the paper will analyze the results found in the study, followed by the interpretations of these results in the fifth section of the paper. The sixth section of the paper will draw conclusions and provide opportunities for future research as well as the limitations of the study. Lastly, the appendix section will provide all the definitions and details of terms used in the world of golf.

## **II. Literature Review**

This section of the paper will provide an overview of the literature of three specific fields. The first will be the theory of learning by doing, a theory that is very relevant in the context of the Web.com Tour as the building ground for golfers who want to make the jump to the PGA Tour. The second field of study that will be analyzed is returns to skill in professional golf. There are different manners in which returns to skill have been measured in professional golf and they will be examined here. The last field of study examined will be regarding other secondary leagues of major sports leagues. More specifically the performance of players in these leagues and how it affects their career advancement will be discussed.

### **Learning By Doing**

Anzai & Simon (1979) outline the theory of learning by doing. The authors propose a theory of specific processes that help a student to learn while trying to solve a problem. The authors tested students on their proficiency to solve a problem on a computer program. The authors point out that the purpose of this experiment was to

examine what and how an individual is thinking while they are solving a problem. Anzai and Simon also discuss how when solving a problem an individual can realize that their solution will not be the correct one while they are actually implementing it.

Consequently, the individual can then use what they learned from their first attempt in solving the problem and use that information to craft a new solution to the problem. By the end of their study the authors describe the process of learning by doing as a person being able to learn how to complete a task most efficiently while carrying out said general task.

Haggag, McManus & Paci (2017) carry out a learning by doing study of New York City taxi drivers. The authors analyze how NYC taxi drivers make improvements over time while they are on the clock. The authors divide the taxi drivers into specific groups based on their level of experience. Drivers' experience level was measured using the number of full workdays each driver worked. There were 7,664 drivers included in the study, and 3,298 of those drivers were classified as "new" drivers. The authors measure the drivers' level of productivity and compare that to the level of each driver's experience. Productivity is measured based on taxi fare earnings per hour of each driver. By comparing this data of both experienced and new drivers, the authors were able to establish control for earning opportunities for each hour of the day in their dataset. The authors find that the productivity of a new driver is 8.1% less than an experienced driver when the new driver is on his first shift. Additionally, the new driver's productivity will increase 0.19% for every 10% increase in the number of their shifts. It was also found that by a driver's 70<sup>th</sup> shift, they have the same amount of experience as an average driver in the industry, and by their 120<sup>th</sup> shift their earnings are 1% greater than the average



driver in the industry. Furthermore, the authors find that a new taxi driver could be up to \$344 more productive, on average, if the new driver could skip to the experience level of a driver with one hundred shifts. Lastly, they find that experienced drivers not only performed better than new drivers, but the largest separation in performance between experienced and new drivers came in the most difficult situations. A critique of this paper is that the authors neglect to address some of the other variables that contribute to a consumer's decision to take a taxi. Some possible variables that could affect a consumer's decision could be distance from the desired destination, the weather at the time of the fare, a consumer's past experience in a taxi and the current traffic conditions at the time of the fare. The findings in this study could be compared to tournament golf by the difficulty of situations that golfers find themselves in. For example, a more inexperienced golfer may perform worse when leading a golf tournament than a veteran player. The inexperienced player may perform worse because they are not familiar with the situation that they are in, while the veteran player may be more confident and comfortable and as a result perform better.

Bohmer, Edmondson & Pisano (2001) perform a study that observed sixteen hospitals that were implementing new technology for cardiac surgery. The authors find that when a new technology is implemented, usually new routines must be developed in order to operate this new technology efficiently. The study looks at whether or not new routines were developed upon the introduction of this new technology, and if so, the process by which they were developed is broken down. The authors relate the formation of these new routines to the theory of learning by doing and how individuals must adapt the way activities are performed in order to find the most efficient method. The concept

of routines is very important in golf. Golfers have a deliberate routine for every type of shot that they hit throughout a round of golf. The implementation of new routines in golf in order to find more success could be an interesting aspect of the learning by doing theory when applied to professional golf.

Murnane & Phillips (1981) carry out a study that compares learning by doing and a teacher's experience and performance in the classroom. The authors describe teaching as an occupation that requires a specific set of skills, some of which can only be learned and practiced while teaching in a real classroom. As teachers gain experience, they are essentially learning how to teach through teaching and thus become more effective at their occupation. The authors test learning by doing by estimating the relationship between a teacher's experience and a teacher's performance through a cross section analysis. Learning by doing's impact on a teacher's performance was found to be double when the individual abilities of the teachers were included in the analysis. Furthermore, it was discovered that students' reading level progressed three or four months more when they were taught by a teacher with five or more years of experience as opposed to a teacher that was a first-year teacher. A critique of this study is that the authors do not provide any way that inexperienced teachers can improve their skills other than by only teaching. It would be interesting to see if there are opportunities outside of the classroom that teachers could utilize in order to improve their performance in the classroom. Competitive golf as a profession is very similar in this manner. Golfers can practice their skills as much as they want, but in order to learn if their skills are effective and successful they must test them on the golf course and in competition.

Learning by doing is a theory that has yet to be tested in the context of competitive golf. The theory could be measured in competitive golf rather easily due to how controlled tournament golf is. For example, the majority of professional tournaments all have the same number of entrants as well as the same number of players that make the 36-hole cut, which cuts the field in half following the first two rounds of the tournament. Furthermore, all golfers play the golf course from the same distance, the par of the course is the same for every player, golfers play all the same holes, the same number of holes and in close to the same time period.<sup>2</sup> These learning by doing studies mentioned previously look into environments that are not nearly as controlled as competitive golf. For example, in the Haggag, McManus & Paci (2017) study regarding NYC taxis, there are variables such as weather, traffic, length of the time for each ride, and other factors that are nearly impossible to control on an individual driver level. Golf does have some variance, for example the weather conditions and the conditions of the course could change from day to day. However, in a tournament golf setting, all the players are subject to the same conditions, making it a very controlled environment to test learning by doing.

### **Returns to Skill in Golf**

Shmanske (1992) was one of the first studies to examine the relationship between a golfer's skills and the earnings they make, otherwise known as returns to skill. Shmanske uses data from the 1986 PGA Tour season, of which he includes the top 70 money earners from that season. Shmanske examines human capital formation in the context of professional golfers using a three-step process. The first using production functions to relate golfers earnings to their specific skills. Driving distance and putting

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<sup>2</sup> For definitions of these golf specific terms refer to the Appendix section

were found to be the most important skills and offer the highest return to earnings, with putting being the most important. The second step was to test the relationship between an individual golfer's skill and their practice time. Additionally, building on the second step, the third step uses values of marginal products to measure how much value an hour of practicing a certain skill has for specific golfers. Shmanske finds that putting and driving distance, putting still being the most important, are the skills that golfers should practice most if they want to maximize their return. I will base my cross section model for the PGA Tour on the model used here with the hope that my results are similar or the same the results found by the author.

Alexander & Kern (2005) build upon Shmanske's (1992) findings regarding whether or not the returns generated from specific golf skills change over time. The authors look at PGA Tour golfers from 1992-2001 and their specific skills and the returns that they offer. The key variable being studied in this paper is whether or not advances in technology in the golf industry have changed the value of specific skills. The authors used a regression with two vectors; the first vector ( $X$ ) measured the golf skills that were measured for each player in order to find the optimal practice time for each skill in order to maximize their productivity. The other vector ( $Y$ ) factored in technology innovations in the golf industry and the impact it has had, the experience of players, the number of events they have played and lastly the extent in which the size of the purses have increased over the time period being studied. The specification ( $t$ ) accounts for the specific year or season that a specific variable is being measured. Lastly, the error term ( $\epsilon$ ) absorbs all the other variables that may be affecting the impact on a golfer's wage that are not accounted for by the variables being tested in the study.

$$\text{MONEY}_{it} = \alpha + \mu_i + \beta X_{it} + \gamma Y_t + \varepsilon_{it}$$

The study finds that advancements in technology actually have increased returns for driving skills, like driving accuracy and driving distance, and returns in putting skills have decreased. However, this decrease in putting skills should not deter golfers from reducing their practice time of that skill because it still offers the most return of all other skills. This study did not discuss or account for the way the golf ball itself has evolved due to technology improvements. The golf ball is a piece of equipment that is used on every shot and improvements to the golf ball must have some sort of effect on all the golf skills. Additionally, the golf ball has changed significantly over the last 50 years and now performs a lot differently than it once did. The study would be a lot more comprehensive if the authors accounted or controlled for the technological advancements of the golf ball. In my study of the Web.com Tour I will base my panel data regression based on the model used in this study. Additionally, the time span of the data is the same as the data set I utilize for the Web.com Tour (ten consecutive seasons) making this a good model to base my empirical work on.

Rishe (2001) contributes to the research in this field with his study comparing the returns to skill as well as the earnings gap on the PGA Tour versus the Senior PGA Tour. Rishe used data from the 1999 season on both the PGA Tour and Senior Tour. There were 118 PGA Tour golfers and 82 Senior Tour golfers examined in the study. Rishe finds that the difference in earnings between the two tours is mostly due to the popularity of the two tours. The PGA Tour is the best golf tour in the world, in the sense that it has the most prize money, television coverage, sponsorships and the most publicity of all other golf tours. As a result, all of the best golfers in the world are drawn to play on the

PGA Tour because of all of the perks that come along with it. Additionally, in order to qualify to play on the Senior Tour a golfer must be over the age of fifty. As a result of this, due to their age, these golfers are in most cases of a lower skill level than the golfers that play on the PGA Tour. Due to all of these factors, the purses at PGA Tour events are larger than those at Senior Tour events; therefore PGA Tour players earn more.

Furthermore, there is a cut at PGA Tour events, where only the top 70 players after two rounds advance to play the remaining two rounds, and only those players that make the cut will accumulate any sort of earnings for that event. There is no cut in place on the Senior Tour, which means that every player that enters an event will subsequently be paid upon the event's completion based upon his position relative to the rest of the field. The fact that the Senior Tour does not have any cuts adds to the argument why earnings are greater on the PGA Tour because PGA Tour golfers are not guaranteed income upon entering a tournament, and must make the two-day cut to ensure any sort of income. In terms of returns to skill, it was found that PGA Tour golfers drove the ball farther, had a better sand save percentage and were better at putting than Senior Tour golfers. On the contrary, Senior Tour players hit more fairways and greens in regulation on average than PGA Tour players.<sup>3</sup> Rishe finds that these differences in what skills are most important have to do with the difficulty of the courses being played on the respective tours. The Senior Tour plays on courses that have wider fairways and rough that is not as severe as the PGA Tour, which lead to a greater overall performance for skills like driving accuracy and greens in regulation compared to that of the PGA Tour. Due to the fact that the PGA Tour plays courses with tighter fairways and longer rough, the average PGA

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<sup>3</sup> For in-depth definitions of these skills refer to the Appendix section

Tour player did not perform as well at these skills than the players who compete on the Senior Tour. However, if the players from both tours played on golf courses of similar difficulty, PGA Tour players on average should be more proficient at most shot making skills compared to Senior Tour players. The comparison of the two tours discussed in this paper is important to my study because it also contains a comparison of two different golf tours. The disparity in earnings between the PGA Tour and the Web.com Tour is similar to the disparity between the PGA Tour and Senior Tour. The PGA Tour is more popular thus generating more earnings for the players, and furthermore the golfers on the PGA Tour are deemed to be the most efficient and proficient compared to players on the other golf tours.

Rinehart (2009) discusses how golfers on the PGA Tour take part in an elite labor market. The payouts in this market are highly concentrated towards the top of the leaderboard for every event. Rinehart finds that the player that finishes 70<sup>th</sup> at an event (the first player to make the cut) earns 0.2% of the total purse while the player that wins the tournament earns about 18% of the total purse. Furthermore, the top 10% of the field earns around 55% of the purse. This creates a “winner-take-all” scenario where it is beneficial from a monetary perspective for players to try and win every tournament they play in. Rinehart discusses how if the payout structure was not as top-heavy as it is, players would not be incentivized to try and win every tournament that they play, and as a result collusion would occur. Collusion would occur by the best golfers taking turns of who gets to win the tournament each week as long as everyone still gets a substantial portion of the purse. Rinehart also finds that because these golfers are competing against each other for the select number of high paying positions at each tournament, the

marginal improvement of skills becomes even more important. Rinehart builds upon Alexander & Kern's (2005) analysis of practice time in this study. Due to the fact that there is a very small difference in the specific skills of the players on the PGA Tour, but a very large difference in pay depending on where you place in a tournament, it makes practice time devoted to improving and maintaining certain skill levels very important. Players are incentivized to practice certain skills that they may not necessarily excel at to possibly increase the amount of revenue they earn at a specific tournament and over the course of a season. This breakdown of practice time is a theory I can elaborate on in my study regarding how Web.com players can change their allocation of practice time on different shot making skills to make themselves more efficient, and as a result increase their performance.

Kahane (2010) analyzes the returns to skill in professional golf using a quantile regression approach. Kahane discusses his reasoning for this method by identifying that early papers have a problem that is overlooked due to the fact that golf earnings are positively skewed. Furthermore, more recent papers have tried to avoid this problem by converting the earnings of golfers into a natural log prior to regressing them on the selected golf skills. However, this also causes a problem because although the natural log approach reduces the skew of earnings, it does not capture some characteristics of the earnings distribution that the skew provides. The author believes that the quantile regression approach is a better way to measure returns to skill in professional golf because the quantile regression handles skewed data better than the natural log method, but also allows non-central points on the conditional earnings distribution to be investigated in the context of returns to skill. Kahane uses data from the 2004 PGA Tour



season to the 2007 PGA Tour season. The author also looks at practice time and its relationship to an increase in earnings. The results in this paper show that golfers can figure out how much time they need to spend practicing specific skills depending on how proficient they are at those skills. Kahane finds that different amounts of practice time must be spent on different skills in order to see the same return in earnings from each skill. For example, if a player is a very proficient putter and an average driver of the ball, that player will need to practice putting for a longer period of time than he would have to practice driving in order to see the same increase in return. Furthermore the study finds that if a player in the 25<sup>th</sup> percentile for earnings per event were to improve a skill by one standard deviation he would see a greater percentage increase in his earnings than if a player in the 75<sup>th</sup> percentile for earnings per event were to improve the same skill by one standard deviation. However, the 75<sup>th</sup> percentile player would see a larger pay jump from a strictly nominal perspective from this improvement of said skill than the 25<sup>th</sup> percentile player because of the unbalanced distribution of earnings on the PGA Tour. The 75<sup>th</sup> percentile player will as a result finish closer to the top of the leaderboard than the 25<sup>th</sup> percentile player, and the prize money for positions at the top are much larger than for players that finish around the middle, as discussed in Rinehart's (2009) study.

Nero (2001) discusses the salary efficiency of golfers on the PGA Tour relative to each player's expertise in skills. Nero is able to measure these skills using statistical data of each player in relation to how much money each player made over the course of one season. The author comprises a list of the top 25 most efficient golfers and a list of the 25 least efficient golfers on the PGA Tour for the 1996 season. Nero is able to determine how efficient a player is based on the return that their specific shot making skills should

provide. Tom Lehman was found to be the most efficient golfer on the PGA Tour in 1996, he was predicted to make approximately \$420,000 but his actual earnings for that season were nearly \$1,800,000. This means that while Tom Lehman's shot making skills from a strictly statistical stand point may not be the best, he was able to use the skills that he does have to his advantage, more than any other golfer on the PGA Tour. On the contrary, Paul Azinger was found to be the least efficient golfer on the PGA Tour in 1996, he was predicted to make approximately \$660,000 but his actual earnings were just over \$230,000. Paul Azinger was the opposite of Tom Lehman in the sense that his shot making skills were superior to those of some or most of the players on the PGA Tour, however he was not able to effectively use his skills to his advantage. Nero was able to find the efficiency of these golfers by comparing the residual value of the player's observed salary and the player's predicted salary. If the residual was positive then the golfer was deemed to be efficient and if the residual was negative then the golfer was considered to be inefficient. Nero discusses that perhaps the most efficient golfers are the one's with the ability to give themselves' the opportunity to take advantage of their strengths and avoid their weaknesses. Lastly in this paper, Nero is able to confirm that an improvement in putting as a skill has a much larger effect on a golfer's earnings than an improvement in driving. This finding is very similar to findings in other papers that discuss returns to skill in professional golf. Whether or not a golfer is efficient or not could directly relate to how a golfer performs, as discussed in this paper. A golfer's efficiency could be an interesting detail to analyze in my study. It is very possible even though a golfer's specific skills should lead to advancement in their profession, their efficiency could hold them back from advancing to the next level.

## **Minor Leagues in Other Sports**

There have been no economic studies done prior to this one regarding the Web.com Tour in any sort of manner. However, studies have been carried out on other sports' minor league institutions. As mentioned previously, the Web.com Tour serves as a building ground for players that want to eventually play on the PGA Tour. A similar situation takes place in major league baseball. In professional baseball, the major league organizations have teams in each of the lower level leagues. The purpose of this is to develop players within each organization to identify which players have the capability to play at the highest level.

A study carried out by Spurr & Barber (1994) discusses how the performance of minor league baseball pitchers affects how far they advance in their careers. The authors outline that the purpose of the minor leagues are, "no longer to win the pennant for the home team but to train ballplayers for the big city" (Spurr & Barber, 1994). On the Web.com Tour, there is a similar goal to minor league baseball, and that is to identify the players that are good enough to play on the PGA Tour. However, this determination of the best players is directly associated with the performance results of these players as the top 25 money earners for the season will earn a promotion to the PGA Tour for the next season. Conversely, while golf is an individual sport and baseball is a team sport, they are similar in the fact that the best performing players are generally those that are promoted to the next level. Spurr and Barber find that the best pitchers (based on performance) are promoted to the higher performing leagues the fastest, and the worst pitchers are demoted to the lower performing leagues or cut from the teams the fastest. This could be compared to the Web.com Tour as well. It is likely that the best players will gain the promotion to

the PGA Tour in their first season on the Web.com Tour, while others it might take them a few seasons in order to become a top 25 money earner. Furthermore, the lower performing players may never be able to improve their performance to become a top 25 earner and may never reach the PGA Tour or could stop playing professional golf as a whole.

### **Contribution**

To my knowledge, there has yet to be an academic study on the returns to skill on the Web.com Tour. In this paper I will be looking at the past 10 seasons on the Web.com Tour and the top 25 players from each year. I limit the sample to the top 25 players from each season because the top 25 money earners on the Web.com Tour at the end of every season are promoted to the PGA Tour for the following year. I want to examine if the skills that are deemed to offer the greatest return on the Web.com Tour are the same or similar year in and year out. I will run a panel data regression of the past 10 seasons on the Web.com Tour and compare the results to a cross section of the most recent season on the PGA Tour. Alexander & Kern (2005) and Kahane (2010) do have time series models, however none of them look at the Web.com Tour. Furthermore, I will be using a different short game variable, the statistic known as scrambling, in my study. No other golf paper to my knowledge has used this statistic in a returns to skill study.

Another contribution of this study will be looking at professional golf through the lens of learning by doing. Learning by doing is a concept that has not been explored in the context of professional golf. The Web.com Tour was designed to be a building ground and learning tour for professional golfers that are trying to elevate their game to play on the best tour in the world, the PGA Tour. One goal of this study is to see whether

learning by doing takes place on the Web.com Tour and how many golfers use the tour as a stepping-stone to ultimately playing on the PGA Tour. Players could potentially improve their games by playing on the Web.com Tour in a variety of ways. One way is simply identifying areas of their game that need to improve relative to their peers, and allowing an adequate amount of practice time to better themselves at these skills that need improvement. Another way could be identifying the best way to schedule their play. By virtue of playing on the Web.com Tour, golfers can identify what specific types of courses they play their best at based upon their specific set of skills. Furthermore, they can identify the frequency at which they play. Some golfers may be able to play four to five straight weeks without needing a break, while other golfers may do best playing a few weeks in a row and then taking a break to reassess and identify where they need to improve. One last area that learning by doing could be seen on the Web.com Tour could be learning how to travel. While this aspect is often not explored in academic studies, it is a variable that should be accounted for. Traveling across the country week in and week out can be taxing on a golfer both physically and mentally, and being able to learn how to travel to tournaments in an effective manner that allows a golfer to perform at his very best is a very important skill for a professional golfer.

One way that this could be measured is by creating sub groups of a few golfers that are in the dataset for the Web.com Tour and looking into whether or not they were able to make the jump to the PGA Tour successfully or not. I will compare players that graduated from the Web.com Tour and were able to continue to keep their status on the PGA Tour following their graduation, to players who have graduated to the PGA Tour through the Web.com but were unable to successfully play at the highest level. I can then

compare the different types of players and see what exactly the reasoning is behind the success and failures of these players. Ideally the differences between the types of players would be solely based on the difference in their proficiency in shot making skills, however, it is possible that other factors that cannot be or are very difficult to measure could account for the difference in performance as well.

### **III. Data & Methodology**

#### **Web.com Tour Panel Data Regression**

There are two models that are to be used in this paper. The first empirical model explored is a panel data regression of the top 25 money earners on the Web.com Tour from the 2007 season to the 2016 season. The data from this data set was obtained from [pgatour.com](http://pgatour.com) and [foxsports.com](http://foxsports.com). There were 250 observations in this data set, however 6 observations had to be eliminated due to a lack of data on the golfer's specific shot making skills. The model for this data set is constructed as follows:

$$\log\text{Earnings}_{it} = \beta_0 + \beta_1\text{DrivingDistance}_{it} + \beta_2\text{DrivingAccuracy}_{it} + \beta_3\text{GreensInRegulation}_{it} + \beta_4\text{Scrambling}_{it} + \beta_5\text{PuttingAverage}_{it} + v_{it} + u_{it}$$

This model will measure the returns to skill of golfers on the Web.com Tour over the ten-season period. This model is based upon the models and skills used in Shmanske (1992) and Alexander & Kern (2005). Many golf papers use cross sectional data for their studies rather than panel data, so this method of research will be new to the study of returns to skill in golf. The dependent variable in the model, *logEarnings*, is the log of a player's earnings over the course of one season on the Web.com Tour. The earnings are logged because the percentage increases will make the results of the regression easier to compare. The top money earner for every season in the sample made at least over

\$400,000, and the highest earner made upwards of \$600,000. The independent variables in this study are all statistical skills that are measured as a year long average over one Web.com Tour season. The skills are broken up into two types of skills, long game and short game skills. The long game skills consisted of a player's average driving distance (*DrivingDistance*), driving accuracy (*DrivingAccuracy*), and greens in regulation (*GreensInRegulation*) over the course of one Web.com Tour season. The short game skills consisted of a player's average scrambling (*Scrambling*), sand saves (*SandSaves*), and putting average (*PuttingAverage*) over the course of one Web.com Tour season. There is also a variable ( $v$ ), which represents certain skills/characteristics, like talent or physical/mental characteristics, that have an effect on earnings. However, these skills/characteristics cannot be measured so their effect on earnings will be absorbed by the error term. The combination of all these variables is what determines the level of a professional skill and how these skills affect a golfer's earnings.

Due to this condition with the error term, there is an endogeneity issue present in this study. In this study, there is an omitted variable bias regarding the natural ability of golfers that is not being measured in this study. Caponi & Plesca (2009) perform a study that discusses the earnings gap that is present in Canadian individuals who attend university and those who attend community college. The authors identify that there are some returns in education that cannot be observed due to an individual's innate ability. Furthermore, the authors find that when controlling for this ability the gap between individuals that attend university and individuals that attend community college, the earnings gap is decreased greatly. The same can be said for my study regarding Web.com Tour golfers. Some golfers have an innate ability that cannot be measured through the

statistics that measure a golfer's specific shot making skills. It is this natural ability that could possibly be the difference between a player making the jump to the PGA Tour and being stuck at the lower level.

Most of the previous papers mentioned prior only use the sand saves statistic as a measure of a player's short game ability. However, in my model the variable *Scrambling* will be used in substitute of *SandSaves*. The reason for this is that the variable *SandSaves* is a statistic that makes up a part of the statistic *Scrambling*. Due to this detail I believe that *Scrambling* is a better measure of a player's short game ability because it is a more holistic statistic, and accounts for every time a player misses a green in regulation, not just when they miss the green in a sand trap. As a result, I decided to only use *Scrambling* as a measure of short game in my regression and do not include the statistic *SandSaves*.

### **PGA Tour OLS Regression**

The other data set that is analyzed is a cross section regression of the top 125 money earners on the PGA Tour in the 2015-2016 season. The data was obtained from [pgatour.com](http://pgatour.com). The model for this dataset is constructed as follows:

$$\log \text{Earn}_i = \beta_0 + \beta_1 \text{DrivingDistance}_i + \beta_2 \text{DrivingAccuracy}_i + \beta_3 \text{GreensInRegulation}_i + \beta_4 \text{Scrambling}_i + \beta_5 \text{PuttingAverage}_i + \varepsilon_i$$

This model will measure the returns to skill on the PGA Tour for the 2015-2016 season. This model is based upon Shmanske (1992) using all the statistics in Shmanske's model except for *Scrambling*. As mentioned above, *Scrambling* will replace the statistic *SandSaves* in the regression because it is more comprehensive as a measure of a golfer's short game. The dependent variable in this model is also the log of a player's earnings over one season. The money made on the PGA Tour in comparison to that of the Web.com Tour is much higher. The top money earner on the PGA Tour in the 2015-2016



season was Dustin Johnson. Johnson earned \$9,365,185 over the 2015-2016 season. This cross section regression includes the same long game and short game skills that are included in the panel data regression. It is the golfer's proficiency in these skills that determine the amount of money that each golfer earns over the course of a season.

### **Analysis of Shot Making Skills**

The variable *DrivingDistance* represents the average distance a golfer hits their first shot on every par four or par five hole. This statistic is measured on two holes of every round that these golfers play on both respective tours. Generally, the two holes on which this statistic is measured usually run in opposite direction to account for the influence that wind may have on the distance the ball travels. Additionally, the holes are generally holes that require or allow the players to hit with their driver in order to capture how far each player can actually hit it.<sup>4</sup> The distance that the ball has traveled is measured from the tee box of the hole that is being played to where the ball eventually comes to rest. A positive coefficient is expected for this skill because the further a golfer hits it from the tee; the shorter that same golfer will have left to get to the green. In golf, the shorter the ball is from the hole, the easier it is to get it close to the hole, thus the greater likelihood that the golfer will make a lower score on the hole.

The variable *DrivingAccuracy* represents the percentage of shots a golfer hits into the fairway on their first shot on any par four or par five hole. A positive coefficient is also expected for this skill because it is easier to hit the ball closer to the hole from the fairway than the rough. The more fairways a golfer is able to hit, the closer they should hit it to the hole and consequently should shoot lower scores.

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<sup>4</sup> Description of golf equipment provided in Appendix section

The variable *GreensInRegulation* represents the percentage of time a golfer hits the green on a hole in the appropriate amount of shots. The way to decipher how many shots is considered to be the regulation for each hole is to take the par of the hole and subtract it by two. For example, on a par four the amount of shots to hit the green in regulation is two shots. A positive coefficient should be expected for this skill because it is easier to make a lower score on a hole when one is putting on the green rather than chipping from off the green.

*Scrambling* is the variable that denotes the percentage of time a player makes a par on a hole when they miss the green in regulation. This variable should have a positive coefficient because the higher percentage of time a player is able to make par when they miss a green the lower score they will shoot.

The last skill in both models is putting average (*PuttingAverage*). Putting average represents the average amount of putts that a golfer has on every hole. In order for a stroke to be considered a putt, the golfer must be using their putter and their ball must be resting on the putting surface. Putting average should have a negative coefficient because the least amount of putts a golfer can average per hole, the lower the scores they will shoot.

### **Improvement of Skills**

Another important factor is how easily a player is able to improve these specific skills. Kahane (2010) discusses in his study that the amount of time spent practicing a skill in order to improve depends on the player's current proficiency in that specific shot making skill. Thus, a player who is considered to be a very good putter will have to practice longer to see the same amount of improvement as a player who is considered to

be a poor putter. This same logic is consistent through all the shot making skills that are measured in this study. However, I would hypothesize that short game skills are easier to improve than long game skills. The reason for this being that physical characteristics such as a player's height, weight, and strength are directly correlated with a player's long game skills. For example, a golfer that is taller and stronger is able to drive the ball further than a player who is shorter and weaker. Conversely, these physical characteristics are not important in the mastery of short game skills. Therefore, these skills should be easier to improve for a golfer on average because performance in these skills is not dependent on a player's physical attributes, of which they have no control.

### **Summary Statistics**

The summary of the statistics measured in the study can be seen in Tables 1 and 2. On the PGA Tour, the average earnings for the top 125 players on the PGA Tour is \$2,138,807, while the average earnings for the top 25 players on the Web.com Tour is \$257,696. This large difference makes sense as the PGA Tour is a more prestigious golf tour and as a result the prize money is significantly higher. Furthermore this large difference in prize money not only between tours, but also within the tours, allows for regressions to be run on the top players. Comparing the skills between the two tours, the data shows that players on the Web.com Tour drive the ball farther, hit more fairways and hit more greens in regulation on average than players on the PGA Tour. Web.com players also scramble for par a higher percentage of the time than the PGA Tour players. On the contrary, PGA Tour players save par from the sand more than Web.com Tour players. Lastly, the players average almost the same amount of putts per hole on both tours.

Table 1: Web.com Tour Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Earnings	250	257,696	81260.23	140,540	644,142
Driving Distance	244	297.286	8.951	272	324
Driving Accuracy	244	65.381	5.113	52.97	78.93
Greens In Regulation	244	70.336	2.356	63.84	76.65
Sand Saves	244	48.392	6.866	25.45	67.19
Scrambling	244	60.234	3.55	49.84	70.8
Putting Average	244	1.758	0.027	1.634	1.818
Year	250	2011.5	2.878	2007	2016
Playerid	250	102.2	58.304	1	205

Table 2: PGA Tour Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Earnings	125	2,138,807	1,476,037	745,735	9,365,185
Driving Distance	120	292.138	9.633	269.7	314.5
Driving Accuracy	120	60.737	5.2 <sup>3</sup> 1	45.56	73.36
Greens In Regulation	120	66.251	2.375	59.26	71.63
Sand Saves	120	50.511	5.347	39.53	62.42
Scrambling	120	58.973	3.076	52.39	66.01
Putting Average	120	1.767	0.021	1.71	1.811
Events	125	24.296	4.741	9	34

An important detail to note is that one would think the PGA Tour players should be better at every skill than the Web.com tour players because they play on a better tour. The reason that it does not appear this way in the data is because of the sample that is being taken from each tour. The sample from the PGA Tour is of the top 125 earners from the 2015-2016 season while the sample for the Web.com Tour is the top 25 players

for each season over a ten-season period. Due to the fact that the Web.com sample is so much smaller on a per season basis than the PGA Tour, and only includes the best players on the Web.com Tour, it seems that the average skills of the Web.com Tour players are better than the PGA Tour. However, if a sample were taken from each tour of the same number of players, it would be likely that the PGA Tour players would have superior average skill numbers than the Web.com Tour players. Lastly, the courses that the Web.com Tour golfers play are on average easier than the courses that are played on the PGA Tour, which could be another reason the averages for the Web.com Tour skills are so high.

From the results of the two models mentioned above, I will compare what skills offer the highest return in earnings from each tour. A critical aspect to observe is that some of the variation in the effects the shot making skills have on earnings may differ between the two tours because of the variation in earnings that exists. The PGA Tour as mentioned has significantly more rewarding purses than the Web.com Tour which may have some effect on how much these shot making skills effect the earnings of a golfer. As mentioned previously, the Web.com Tour is a building ground for the PGA Tour, with the top 25 money earners earning their PGA Tour status for the next season. Ideally, the skills that are valued as the most lucrative skills on the Web.com tour will align with those on the PGA Tour.

After this comparison has been completed, a comparison will be done of players that were on the Web.com Tour during one or a few of the studied seasons and are now on the PGA Tour as a consistent member, or players that once had PGA Tour membership but now are back playing on the Web.com Tour or are not playing at all on

either tour. Specific players from the Web.com Tour dataset were selected and divided into three groups. The first group contains all “star” players. These “star” players are players that were top 25 finishers on the Web.com Tour and have been able to retain their PGA Tour membership following their promotion. Furthermore, these players have all won on the PGA Tour following their top 25 finish on the Web.com Tour money list.

The second group contains all “learning” players. These players have finished in the top 25 on the Web.com tour money list on several occasions, but now have retained PGA Tour membership. This is the most important group to study in context of the theory of learning by doing. These players were at first unable to consistently play on the PGA Tour but were also considered the best players on the Web.com Tour. However, these “learning” players were able to improve some area of their golf game in order to allow them to be skilled enough to consistently play on the PGA Tour after their second or third promotion from a top 25 finish on the Web.com Tour money list.

The third group of players contains all “Inefficient” players. These players are golfers that finished in the top 25 on one occasion but were not able to retain their PGA Tour membership for a substantial period of time. Furthermore, after these players were demoted back to the Web.com Tour, they were unable to finish as a top 25 money earner on the Web.com Tour again. These players likely had shot making skills that had more value on the Web.com Tour than the PGA Tour. Additionally, it is likely that these players either lost proficiency in one or some of their shot making skills, or for some reason were not able to efficiently use their skills to retain their PGA Tour membership or once again gain a promotion to the PGA Tour via a top 25 finish on the Web.com Tour money list. It is also possible that new players entering the Web.com Tour had higher

levels of confidence or had superior psychological skills that helped increase the performance of their shot making skills, thus allowing them to perform better than the players in the “Inefficient” group.

I will run OLS regressions for each sub group similar to the OLS regression used for the PGA Tour dataset. I will then test the differences of the coefficients pertaining to each skill between two different sub groups. The first comparison will be between the “Star” group and the “Learning” group. The expected result in this comparison is that players in the “Star” group will have coefficients with higher magnitudes for all the shot making skills and that the difference between the two groups will be significant. The next comparison will be between the “Learning” group and the “Inefficient” group. It is expected in this comparison that the “Learning” group golfers will have higher magnitudes for the shot making coefficients than the “Inefficient” group and that the difference between the two groups will be significant. The last comparison will be within the “Learning” group, comparing the first season that the players were able to graduate to the PGA Tour and the last time they were able to graduate to the PGA Tour. It is predicted in this comparison that group of players following their second promotion to the PGA Tour should have lower magnitudes to the shot making coefficients than the golfers following their first promotion to the PGA Tour, this will be due to a diminishing marginal return in improvement of the specific shot making skills. The goal in this comparison is to observe the reason for why some individuals were able to successfully make the transition to the PGA Tour and why others were not. The reason for this may or may not be solely based on the skills of these individuals but it should account for some portion of the difference in success that these players attain.

## Hausman Test

In running my panel data regression for the Web.com Tour, I needed to decipher whether a fixed effects model or a random effects model fits the data the best. In order to test which is more appropriate, I ran both a fixed effects panel data regression and a random effects panel data regression and compare them using a Hausman test. The results of this Hausman test are shown below.

	Coefficients		(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
	(b) fe	(B) re		
DrivingDis~e	.028023	.0059544	.0220686	.0136787
DrivingAcc~y	.0012333	.0113164	-.0100832	.015647
GreensInRe~n	.0259267	.0282006	-.0022739	.0239422
Scrambling	.0113998	.0056851	.0057148	.0161613
PuttingAve~e	.1401287	-2.730887	2.871015	2.799547

b = consistent under Ho and Ha; obtained from xtreg  
 B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(5) = (b-B)'[(V\_b-V\_B)^(-1)](b-B)  
 = 4.43  
 Prob>chi2 = 0.4891

The results of the Hausman test show that the null hypothesis of the random effects model being the appropriate measure cannot be rejected. The coefficients between the random effects and fixed effects models are all very similar for all the shot making skills that are measured except for *PuttingAverage*. In the fixed effects model, the coefficient for *PuttingAverage* is positive. This is the opposite of the expected sign for the skill of putting. A player should increase their earnings by lowering the amount of putts that they have per round, which would constitute a negative coefficient. The random effects model does have the expected negative coefficient for *PuttingAverage*. Due to the fact that all



the coefficients are very similar, except for the coefficient for *PuttingAverage*, between the random effects and fixed effects regressions and the Hausman statistic is relatively low, I cannot reject the hypothesis that the random effects model is the appropriate measure.

#### **IV. Results**

##### **Web.com Results**

The results of the Web.com panel data regression are shown in Table 3. All of the skill variables in the regression have the expected sign for their coefficients. Furthermore, all of the skill variables are statistically significant except for scrambling. Putting average and greens in regulation are significant at the 1% level. Driving distance and driving accuracy are significant at the 5% level.

##### **PGA Tour Results**

The results for the cross section PGA Tour regression are presented in Table 4. The skill variables all have the correct sign for their coefficients. All of the skills in this regression were found to be statistically significant. Driving distance, scrambling and putting average were significant at the 1% level. Driving accuracy and greens in regulation are significant at the 10% level.

##### **Comparisons of the Tours**

In terms of comparing the results of the Web.com Tour and PGA Tour regressions, the skills have a greater influence overall on earnings on the PGA Tour than the Web.com Tour. This as mentioned previously is due to the prize money on the PGA Tour being considerably larger than that of the Web.com Tour. The driving distance

coefficients were 0.0293 for the PGA Tour and 0.00595 for the Web.com Tour. These coefficients denote that if a player increases his driving distance average by one yard, he will experience a 2.93% increase in earnings on the PGA Tour and a 0.595% increase in earnings on the Web.com Tour. The PGA Tour had a coefficient of 0.0230 for driving accuracy while the Web.com Tour had a coefficient of 0.0113. These coefficients indicate that if a player increases his driving accuracy by one percentage point he will experience a 2.30% increase in his earnings on the PGA Tour and a 1.13% increase in earnings on the Web.com Tour. The PGA Tour had a coefficient of 0.0465 for greens in regulation that was almost double that of the Web.com Tour with a coefficient of 0.0282. These coefficients signify that if a player increases his greens in regulation percentage by one percentage point he will observe a 4.65% increase in earnings on the PGA Tour and a 2.82% increase in earnings on the Web.com Tour. There was a huge difference in the coefficients between the two tours in terms of scrambling, however the scrambling statistic was not found to be significant on the Web.com Tour. The PGA Tour had a coefficient of 0.045, which indicates that a one-percentage increase in a golfer's scrambling percentage will result in a 4.5% increase in his earnings on the PGA Tour. These results demonstrate that scrambling is not a significant determinant of earnings on the Web.com Tour, but an important determinant of earnings on the PGA Tour. Lastly, the coefficients for putting average were -10.444 for the PGA Tour and -2.731 for the Web.com Tour. These coefficients imply that if a player is able to decrease his putting average by one stroke per green then he would experience a 1,044% increase in earnings on the PGA Tour and a 273.1% on the Web.com Tour. However, it is impossible for a player to decrease his putts per green by one stroke, a reduction of 0.05 to 0.1 strokes per

green would be considered a large improvement in putting. These results suggest that putting is far more important on the PGA Tour than the Web.com Tour; however, putting is by far the most important skill on both tours.

### **Learning By Doing Results**

The results for the learning by doing portion of the study were not as conclusive or consistent as the returns to skill portion. I expected that the magnitudes of the all the shot making skills to be larger for the players in the “Star” group than the players in the “Learning” group. The t-test comparison results between the “Star” group and the “Learning” group showed that the difference in success between the two groups was due to the difference in the proficiency of certain shot making skills. The results indicate that differences in driving accuracy, greens in regulation, scrambling and putting average are responsible for the difference in performance between the two groups. Driving accuracy, greens in regulation and putting average all have the expected sign for coefficients and additionally the “Star” group has a greater magnitude in these skills as well. However, the scrambling statistic for the “Star” group has a negative sign, which is the opposite sign that is expected, and furthermore the “Learning” group has a greater magnitude than the “Star” group. It can be assumed that the differences between the two groups is due to the “Star” players being more proficient in the skills that are found to be most significant like putting average and greens in regulation.

The t-test comparison results between the “Learning” group and the “Inefficient” group are not as convincing as the comparison between the “Star” group and the “Learning” group. It is expected that the players in the “Learning” group should have higher magnitudes for all of the shot making skills than the players in the “Inefficient”

group. However, the results show that for all of the shot making skills, except for greens in regulation, the magnitudes of the coefficients were larger for the “Inefficient” players. Although the difference in skills between the two groups is deemed to be significant, due to the “Inefficient” group having higher magnitudes, no conclusions can be drawn in the context of learning by doing.

The last t-test comparison within the “Learning” group had inconsistent results. It was found that players in their second promotion season on the Web.com Tour they had diminishing marginal returns in improvement for specific skills, which is logical after trying to improve a skill for an extended period of time or after a skill has already been improved to a certain extent. The skills that diminishing marginal returns were present were driving distance and scrambling. A diminishing in marginal return was also observed for driving accuracy, however the difference in the skills between the two groups was not found to be significant. Furthermore, the skills of putting average and greens in regulation saw increasing marginal returns from the first promotion season to the second promotion season, however the differences in skills was not found to be statistically significant. Due to these results no concrete learning by doing conclusions can be drawn, yet there were some significant findings implying that learning by doing may in fact be present on the Web.com Tour.

## **V. Discussion**

The goal of this study was to identify which specific golf skills offer the greatest return for golfers that play on both the PGA Tour and Web.com Tour, and whether or not Web.com players were able to improve these skills while competing throughout the

season. Due to the fact that the Web.com Tour was created as a building ground for golfers that are trying to elevate their golf game to be able to play on the PGA Tour, identifying the skills that offer the largest return on both tours is vital for those players trying to make the jump to PGA Tour. By recognizing the specific skills that are most important on the PGA Tour, Web.com Tour players can decide what skills they need to practice and improve on in order to tailor their game towards playing on the PGA Tour.

### **Returns to Skill Implications**

The results above clearly show what specific skills are valued on each tour. The one skill that is the most important in terms of offering the highest return on both golf tours is putting. As a result of this, individuals who are playing on the Web.com Tour who are considered to be one of the better putters on that tour should have a better chance of finding success on the PGA Tour than players who are not as skilled in putting. Additionally, based on the results, both the PGA Tour and Web.com Tour value greens in regulation as the second most important skill in relation to earnings. Web.com players who are good iron players should therefore have an easier time transitioning their game to the PGA Tour than players who do not excel with iron play. These results show the importance on both tours of hitting the ball as close to the hole as possible, while still keeping the ball on the putting surface. If a player is able to consistently give himself opportunities to make a birdie, he therefore should shoot lower scores. Consequently, this should result in a player finishing higher up on the leaderboard, which will result in more earnings.

However, while both the PGA Tour and Web.com Tour value putting and greens in regulation as the two most important skills, with putting being the most important, they

differ in what other shot making skills are seen as valuable. On the Web.com Tour, the third most valuable skill is driving accuracy. This skill complements the skill of greens in regulation well because it is easier to hit the green with one's approach shot from the fairway versus the rough due to the fact that it is harder to control the golf ball from the rough. However, the driving stat that is valued more on the PGA Tour is driving distance. This may be because it is easier to control a shorter club rather than a longer club, so by trying to hit the ball as far as possible and using the shortest club possible to get onto the green it should be easier to get the ball closer to the hole, regardless if hitting from the fairway or the rough.

The next most important skill on the PGA Tour, next to putting and greens in regulation, is the skill of scrambling. As mentioned previously, scrambling identifies a player's ability to make par when he misses the green in regulation. The results show that scrambling is almost as equally important as greens in regulation on the PGA Tour. The reason that scrambling may be so important on the PGA Tour is that the difficulty of the golf courses on the PGA Tour is greater than any other golf tour. Due to the difficulty of the golf courses, it will be harder for players to make as many birdies as players can make on other golf tours. It is because of this that scrambling is such an important statistic on the PGA Tour. If golfers are able to make more pars when they make the mistake of missing the green, it allows them to not have to make a birdie to make up for that mistake. On the Web.com Tour, scrambling is not seen as an important skill compared to the other shot making skills. This could also be a result of the difficulty of the golf courses on the Web.com Tour. The golf courses on the Web.com Tour are easier than those on the PGA Tour. By playing easier golf courses, it is easier for a golfer to make

birdies. So when a player makes a mistake and makes a bogey, it is not as difficult for him to make up for that mistake by birdieing the next hole. Rishe (2001) finds that course difficulty changes what specific skills offer greater returns on respective tours. In Rishe's (2001) study, he finds this with a comparison between the PGA Tour and Senior Tour. Similar assumptions can be drawn in this study between the PGA Tour and Web.com Tour.

Another implication from the returns to skill finding is that short game skills should be easier to improve than long game skills. One reason for this is that short game skills are not contingent on a player's physical attributes, making it easier for all types of players to improve the short game skills. Furthermore, the most benefit is seen from improving your putting skill, thus even marginal improvements in putting compared to other shot making skills will have a more drastic impact to a player's earnings.

Based on the results, it can be inferred that the Web.com Tour is in fact an effective building ground for the PGA Tour. With the two most valuable skills on both tours, putting and iron play, it is likely that the top players on the Web.com Tour who are proficient in those skills should be able to also find success on the PGA Tour. However, this does not mean that players who gain their PGA Tour membership by finishing as a top 25 money earner on the Web.com Tour but are not great putters or iron players cannot find success. Nero (2001) discusses in his study that the most efficient golfers are those that give themselves opportunities to take advantage of their strengths and avoid their weaknesses. These golfers that do not specialize in the most valued shot making skills could find success if they are able to play golf in a manner that takes advantage of

their best skills. Nevertheless, these individuals may struggle to adjust to the PGA Tour more than their peers who are more proficient at the valued shot making skills.

An important factor to note in the results from the PGA Tour is the importance of specific skills compared to past studies. Shmankse (1992) and Alexander & Kern (2005) both find that putting is the most important skill, which is also found true in this study. However, in these studies it is found that driving distance is the next important. This differs greatly from the results in this study, with both greens in regulation and scrambling being more important than driving distance. These results could have occurred due to the fact that I used the statistic of scrambling in the regression, as opposed to the statistic of sand saves that was used in the studies mentioned above. These findings are a first in the context of returns to skill on the PGA Tour. An explanation for this could be that the most valued skills have changed since the previous studies have been conducted. Due to these results, future research could be done looking into whether this trend is consistent in future years on the PGA Tour or if these results are more of an outlier rather than a new trend.

### **Learning by Doing Implications**

Based on the learning by doing results, there are inconsistent findings about the theory of learning of doing in the context of the Web.com Tour. The results did show that there was a significant difference in skills between the “Star” players and the “Learning” players. It can be inferred that the “Star” players have a superior natural ability than the “Learning” players, thus leading to the “Star” players having superior shot making skills. However, the more important comparisons in the context of learning by doing were the comparisons between the “Learning” and “Inefficient” groups as well as within the



“Learning” group. The comparison between the “Learning” group and the “Inefficient” group had inconclusive results regarding the difference in shot making skills. Conversely, the comparison within the “Learning” group did have some findings that showed a presence of learning by doing, but the results were inconsistent. Diminishing marginal returns were present for driving distance and scrambling statistics, but all the other statistics were not found to be significant. From these results it can be inferred that there may be some learning by doing implications on the Web.com Tour, however a more expansive study needs to be carried out in order to confirm these findings.

## **VI. Conclusion**

Overall, this study has shown that the Web.com Tour provides a great environment for aspiring PGA Tour players to hone their golf games in order to prepare for a career on the PGA Tour. There are many different variables that go into tournament golf besides just an individual’s shot making skills. An individual needs to learn how to play a full tournament schedule, how to deal with travel, as well as other factors that can affect a golfer’s play. More importantly, competing on a tour similar to the Web.com Tour, a player gets to experience what a career is like on the PGA Tour but on a smaller scale, with tournament purses and tournament attendance also being smaller. Furthermore, it provides a golfer an environment to learn his game and what specific adjustments or changes he can make in order to get the most out of his game.

Additionally, the Web.com Tour provides a learning opportunity for golfers beyond just adjusting to life as a tour professional. With the skills required to be successful on the Web.com Tour aligning with the skills that also foster success on the

PGA Tour, the Web.com Tour provides golfers who are proficient in those skills an avenue to test those skills before a career on the PGA Tour. Additionally, for individuals that do not find immediate success on the Web.com Tour, they can use the setting that the Web.com Tour provides to improve their skills to fit what is required to be successful on the Web.com Tour first, and then eventually take those skills to the PGA Tour. This logic can be extended to other developmental leagues for other professional sports. For example, similar developmental sports leagues such as all leagues of minor league baseball (A, AA, AAA), minor league hockey (AHL & OHL) as well as the NBA Developmental League could provide environments for athletes to hone their skills at a lower level of competition before making the leap to the highest level of their sport.

### **Limitations**

One limitation of this study is that a golfer's innate ability is not taken into account in this study. While physical characteristics like a player's height, weight, strength, talent and other athletic abilities are absorbed by the error term in both regressions; they are not included in any regressions as a control variable. This causes an omitted variable bias within the study due to a lack of accounting for a player's natural ability. Another limitation of the study is that the Web.com Tour data is limited to just the top 25 players from each season. Comprehensive data was not available for players outside the top 25 on the money list in the earlier years of this study. To improve the accuracy of the findings, being able to run the panel data regression used in this study with all the players on the Web.com Tour for all of the seasons included in the dataset may provide more complete results. Furthermore, with more players in the sample size, comparisons could be carried out between players who competed against each other in

the same season. More specifically, one could identify reasons why some players were able to graduate to the PGA Tour that season and why others were not.

There were a few limitations regarding the learning by doing portion of this study. The first limitation comes with the sample sizes used in order to test the existence of learning by doing. The largest sample for all the groups in the study was thirty observations. It is likely that if there were larger samples used in the testing of learning by doing the results would have been more conclusive. Another limitation in the learning by doing portion of the study comes with the method in which learning by doing was tested. In order to more accurately test learning by doing in professional golf a more comprehensive method of testing needs to be used. The method used in this study failed to capture other variables that could be affected by learning by doing other than purely shot making skills.

### **Future Research Opportunities**

This study has provided some areas where further research can be pursued to test the legitimacy of the results that this study offers. One avenue for further research comes from the specific skills that were found to be the most valuable in this study. While putting proved to be the most important shot making skill in relation to earnings, which is consistent with past studies done on returns to skill in professional golf, the greens in regulation statistic and a golfer's iron play was found to be the second most lucrative skill on both the PGA Tour and Web.com Tour. This finding is a new finding compared to past studies, which find a player's driving distance to be the most important skill, second to putting. Further studies of future seasons on both the Web.com Tour and PGA Tour could provide evidence if a player's iron game has now become more important in

professional golf today, or if these results are an outlier in what has normally been a consistent trend.

Another avenue for future research is present in the context of learning by doing in professional golf. Future studies will need to establish a more comprehensive method of testing learning by doing that encompasses both shot making skills as well as other aspects of professional golf that do not have do with on-course performance. If variables such as a player's natural ability, schedule management, traveling expertise, adaption to different styles of courses and other off-course skills are able to be measured, as well as on-course shot making skills, more empirical evidence may be found on the effect of learning by doing in professional golf.

The last area where future studies could expand on the findings in this study comes with the autocorrelation between the shot making skills in golf. In this study, I look at all of the shot making skills at an individual level. However, in the sport of golf a player uses all of his/her skills all at the same time during a round of golf. Furthermore, the skills are generally used in a sequential manner, starting with long game skills at the beginning of a golf hole and transitioning to short game skills as a player gets closer to finishing the hole. Due to the manner in which these skills are used, it is likely that the performance of one skill has an effect on how proficient a subsequent skill can then be. Future studies could account for the impact that shot making skills have on each other in order to get a better understanding of how a golfer's earnings are actually affected by a their specific skill make-up.

## VII. Appendix

\*All the definitions of these statistics and processes were obtained from pgatour.com

### 1. Ways To Qualify for the PGA Tour:

- Finish in the Top 25 on the money list on the Web.com Tour
- Make the equivalent amount of the money made by the 125<sup>th</sup> money finisher from the season prior
  - Usually this scenario occurs when a player is playing in PGA Tour events through sponsor exemptions, which is when the host of a tournament invites a player to play in the event when they do not have status on the PGA Tour

### 2. Common Golf Terms:

Par: The amount of strokes that is required for a given hole based on characteristics of the hole. These characteristics are generally length, curvature and overall difficulty. There are three types of holes: par threes, par fours and par fives. This term is also used in regards to the amount of shots required to play an entire course.

Bogey: One stroke more than par on a hole

Birdie: One stroke less than par on a hole

Tee Box: Area on a course where a golfer hits his/her first shot on a hole. It is only in this area that a golfer can put the ball on a tee prior to hitting his/her shot.

Fairway: Area of short grass that a golfer tries to hit his/her shot in from the tee box.

Rough: Longer grass that lines the fairway, due to the length of the grass it is harder to control the golf ball.

Sand Trap/Bunker: A hazard area on the golf course that is filled with sand.

Putting Green: Area at the end of each golf hole, where the hole itself is located. Grass is cut very low on this area to allow the ball to roll smoothly.

### 3. Golf Statistics:

Driving Distance: The average number of yards measured per drive. These drives are measured on two holes per round. Care is taken to select two holes which face in opposite directions to counteract the effect of wind. Drives are measured to the point at which they come to rest regardless of whether they are in the fairway or not.

Driving Accuracy Percentage: The percentage of time a tee shot comes to rest in the fairway (regardless of the club).

Greens In Regulation Percentage: The percent of time a player was able to hit the green in regulation. Note: A green is considered hit in regulation if any portion of the ball is touching the putting surface after the GIR stroke has been taken. (The GIR stroke is determined by subtracting 2 from par (1st stroke on a par 3, 2nd on a par 4, 3rd on a par 5))

Scrambling Percentage: The percent of time a player misses the green in regulation, but still makes par or better.

Sand Save Percentage: The percent of time a player was able to get 'up and down' once in a greenside sand bunker (regardless of score). Note: 'Up and down' indicates it took the player 2 shots or less to put the ball in the hole from that point.

Putting Average: The average amount of putts per green in regulation.

#### **4. Golf Equipment**

Driver: Club that travels the furthest and is generally used on the first shot on par fours and par fives.

Iron: Club that is used to hit a golfer's shot onto the green. This club is also usually hit from the tee box on par threes.

Putter: Club used to putt the ball on the putting green.

Table 3: Web.com Tour Results

Skills	Log Earnings
Driving Distance	0.00595*** (0.0027)
Driving Accuracy	0.0113** (0.0053)
Greens In Regulation	0.0282*** (0.0088)
Scrambling	0.00569 (0.0052)
Putting Average	-2.731*** (0.690)
Observations	244

Table 4: PGA Tour Results

Skills	LogEarnings
Driving Distance	0.0293*** (0.0083)
Driving Accuracy	0.0230* (0.0137)
Greens In Regulation	0.0465* (0.0243)
Scrambling	0.0450*** (0.0154)
Putting Average	-10.42*** (2.203)
Observations	120

Table 5: Star Players vs. Learning Players

Skills	Star	Learning	P-Value
Driving Distance	-0.007 (0.002)	-0.003 (0.001)	0.158
Driving Accuracy	0.035 (0.005)	0.003 (0.002)	0.000
Greens In Regulation	0.095 (0.009)	0.053 (0.005)	0.000
Scrambling	-0.037 (0.007)	0.005 (0.003)	0.000
Putting Average	-4.693 (0.623)	-2.777 (0.483)	0.020
# of Observations	17	30	

Table 6: Learning Players vs. Inefficient Players

Skills	Learning	Inefficient	P-Value
Driving Distance	-0.003 (0.001)	0.012 (0.006)	0.001
Driving Accuracy	0.003 (0.002)	0.020 (0.008)	0.005
Greens In Regulation	0.053 (0.005)	-0.015 (0.013)	0.000
Scrambling	0.005 (0.003)	0.012 (0.008)	0.327
Putting Average	-2.777 (0.483)	-9.660 (0.756)	0.000
# of Observations	30	10	



Skills	Learning – 1 <sup>st</sup> Promotion	Learning – 2 <sup>nd</sup> Promotion	P-Value
Driving Distance	0.012 (0.003)	-0.013 (0.004)	0.000
Driving Accuracy	0.013 (0.005)	0.005 (0.008)	0.480
Greens in Regulation	0.025 (0.021)	0.060 (0.014)	0.184
Scrambling	0.022 (0.008)	0.001 (0.007)	0.079
Putting Average	-2.241 (1.977)	-3.526 (1.420)	0.602
# Of Observations	13	13	

## References

- Alexander, D. L. & Kern, W. (2005). Drive for Show and Putt for Dough? An Analysis of the Earnings of PGA Tour Golfers. *Journal of Sports Economics*, 6(1), 46-60.
- Anzai, Y. & Simon, H. (1979). The theory of learning by doing. *Psychological Review*, 86(2). 124-140.
- Bohmer, R., Edmondson, A. & Pisano, G. (2001). Disrupted Routines: Team Learning and New Technology Implementation in Hospitals. *Administrative Science Quarterly*, 685-716.
- Caponi, V., & Plesca, M. (2009). Post-secondary Education in Canada: Can Ability Bias Explain the Earnings Gap between College and University Graduates? *Canadian Journal of Economics*, 42(3), 1100-1131.
- Haggag, K., McManus B. & Paci, G. (2017). Learning by Doing: Productivity Improvements by New York City Taxi Drivers. *American Economic Journal: Applied Econometrics*, 9(1): 70-95.
- Kahane, L. H. (2010). Returns to Skill in Professional Golf: A Quantile Regression Approach. *International Journal of Sport Finance*, 5(3), 167-180.
- Murnane, R. J. & Philips B. R. (1981). Learning By Doing, Vintage, and Selection: Three Pieces of the Puzzle Relating Teacher Experience and Teaching Performance. *Economics of Education Review*, 1(4), 453-465.
- Nero, P. (2001). Relative salary efficiency of PGA Tour golfers. *The American Economist*, 45(2), 51-56.

(2016, October 10) PGA Tour Statistics. Retrieved from

<http://www.pgatour.com/stats/>

Rishe, P. J. (2001). Differing Rates of Return to Performance: A Comparison of the PGA and Senior Golf Tours. *Journal of Sports Economics*, 2(3), 285-296.

Rinehart, K. L. (2009). The economics of golf: An investigation of the returns to skill on the PGA tour golfers. *Major Themes in Economics, Spring*.

Shmanske, S. (1992). Human Capital Formation in Professional Sports: Evidence from the PGA Tour. *Atlantic Economic Journal*, 20(3), 66-80.

Spurr, S. J. & Barber, W. (1994). The Effect of Performance on a Worker's Career: Evidence from Minor League Baseball. *Sage Publications, Inc*, 47(4), 692-708.

Web.com Tour Rankings. Retrieved from

<http://www.foxsports.com/golf/rankings?association=4&season=2007&country=0&type=0>