

Taxation and International Migration: Evidence from Professional Male Tennis Players

Kevin Hunt

University of Rochester

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Abstract

I study the international migration of top ranked male professional tennis players from 2007 to 2017 in response to top marginal personal income tax rates and find some evidence that these taxes do influence where a player claims residence. Each year, numerous top ranked professional tennis players choose to live abroad in a country with no taxes on personal income such as the Bahamas. I find evidence that top tax rates in a player's Olympic country influences their decision to live abroad in zero-tax countries. In a linear probability model, players whose Olympic country has a 1% higher top tax rate are 0.53 percentage points more likely to live abroad in a zero-tax country after controlling for other factors that influence migration decisions. This effect is stronger for players from countries with more tennis players.

1. Introduction

In 2018, seven of the top 25 ranked professional tennis players claimed residence in the same country. The next closest country had only three residents in the top 25. A casual fan might guess the country is France or Spain, whose players have achieved great success in the past decade, but they would be wrong. The country is in fact Monaco, a micro-state in southeast France controlling only 0.78 square miles with a population of about 30,000 people.¹ Despite residing in Monaco, none of these seven players represent Monaco at the Olympics or had a strong connection to the country before becoming a professional tennis player. Why do so many professional tennis players choose to live abroad in Monaco? It has fantastic weather, high standards of living, and privacy from crazed tennis fans. It also has no taxes on personal income, which might be attractive to professional tennis players earning millions of dollars each year. Along with these seven players, two top 25 ranked players lived abroad in the UAE and one lived abroad in the Bahamas, which also do not tax personal income.

The response of high paid workers to taxes could have a large impact on government policy. High paid workers pay a large share of income taxes, which are a significant source of revenue for governments.² If many high paid workers choose to leave a country after a tax increase, this could constrain the government's ability to raise revenue. In addition to raising revenue, governments often have the goal to use taxes to redistribute income from the rich to the poor, and the international migration of high paid workers in response to taxes may undermine this. High paid workers are often high skilled workers, and research has shown these workers can have benefits for their chosen destination when migrating (Kerr, 2013). If tax increases (decreases) dissuade (persuade) high skilled workers to move to a country, these costs need to be considered in setting tax policy. Because of these effects, understanding how taxes influence international migration decisions of high paid workers should have significant influence on government policy. Despite this importance, this topic has been understudied because of a lack of micro-data on high paid workers moving between countries.

An empirical literature exists on the effect of tax differentials within countries on domestic migration decisions, but little research has been conducted on how taxes influence the international migration of high paid workers. Recently, two papers have begun to address this question. Kleven, Landais, and Saez (2013) use data on professional soccer players in fourteen Western European countries and find large responses in migration to tax policy. A 1% increase in taxes decreases the number of foreign soccer players in a country by about 1% and the number of domestic players in a country by 0.15%. Akcigit, Baslandze, and Stantcheva (2016) study "superstar" inventors from the USA, Canada, UK, Germany, Italy, Japan, and Switzerland. They also find significant but smaller responses in inventor migration patterns to taxes. A 1% increase in taxes decreases the number of foreign inventors in a country by 1% and decreases the number of domestic inventors in a country by 0.03%.

I aim to contribute to this literature by studying the international migration decisions of top ranked professional tennis players. Top ranked professional tennis players are a high paid and highly mobile group with publicly available income and residence information. This makes them a useful data set to study migration that may shed light on the decisions of other high paid workers. Numerous

¹ See <https://www.cia.gov/library/publications/the-world-factbook/geos/mn.html> for information about Monaco.

² For the USA in 2014 according to DeSilver (2016), only 2.7% of tax returns in the USA reported income over \$250,000, but these returns paid 51.6% of all income taxes collected. Income taxes also account for about 47.4% of US government revenue and are the government's largest source of revenue.

professional tennis players reside in countries with a 0% marginal tax rate on personal income, such as the Bahamas, Monaco, Switzerland, the UAE, and Qatar.³ Of these countries, Switzerland is the only country whose Olympic players have achieved professional success in tennis. Fans aware of players living abroad in zero-tax countries believe that these moves are for tax purposes. Some players have even admitted to this, while others claim their moves to zero-tax countries are a result of these countries' high standards of living, safety, training facilities, and privacy from fans in their Olympic country (Clarey, 2014 and Gatto, 2018). Because of the money players can save from avoiding personal income taxes, I expect that higher top marginal personal income tax rates in a player's Olympic country will increase the probability that the player will live abroad in a zero-tax country.

To see whether taxes in a player's Olympic country influence their decision to live abroad in a zero-tax country, I collect data on each player's ranking, income, and residency from the Association of Tennis Professionals (ATP) website and Wikipedia. I also collection information about a player's Olympic country that would influence their decision to live abroad in a zero-tax country including top marginal personal income tax rates, safety, and standards of living. I also discuss limitations with the data and potential unobserved factors influencing the results. Using this data, I estimate the probability that a player lives abroad in a zero-tax country. My results show some evidence that top marginal personal income tax rates in a player's Olympic country do influence their decision to live abroad in a zero-tax country. The coefficient on top tax rates is negative in both linear and logit probability models, but only statistically significant in the linear probability model. In a linear probability model, players from Olympic countries with 1% higher top marginal personal income tax rates are 0.53 percentage points more likely to live abroad in a zero-tax country. For players from Olympic countries with more tennis players, this effect is even stronger; I hypothesize this stronger correlation is because of a networking effect for players moving abroad to zero-tax countries. Players from countries with more tennis players are more likely to know another player living abroad in a zero-tax country, and this reduces the cost of moving to a zero-tax country.

The paper proceeds as follows: Section 2 reviews the relevant literature. Section 3 presents information about tennis player and country data. Section 4 presents econometric models of the probability a player lives abroad in a zero-tax country. Section 5 presents results from estimating this econometric model. Section 6 concludes.

2. Literature Review

The international immigration and emigration of high skilled workers may have large impacts on countries through "brain gain" and "brain drain". Kerr (2013) reviews the literature on high skilled international migration. He finds there is evidence to suggest that these migrants benefit innovation and entrepreneurship in the country they migrate to. According to Kerr, immigrants have been integral to the growth of STEM fields in the USA and played an increasing role in patent filing over the last few decades. There is also some research suggesting that high skilled immigrants have increased employment and wages for native workers in the USA. Moser, Voena, and Waldinger (2014) study Jewish scientists migrating to the USA around World War II, finding large increases in patenting by US

³ Switzerland does have marginal tax rates on personal income for workers in the country, but foreigners who do not work in the country may negotiate a lump sum tax instead of being taxed on global earnings (Van den Eeckhaut, 2018). Because the marginal tax rate on personal income for these foreigners is zero, I include Switzerland as a zero-tax country.

inventors after the immigration of Jewish-German scientists. Gauthier-Loiselle and Hunt (2010) also find large positive effects of high skilled immigrants on the number of patents in the USA.

Immigrants' migratory responses to taxes are also important for calculating optimal taxation policies. Bhagwati and Hamada (1982) studying a model of optimal taxation note that if workers migrate from high tax to low tax countries, countries may be constrained in their abilities to raise revenue from taxes. Mirrlees (1982) studies alternative models to answer the same questions and finds similar results. Both papers find that taxing the foreign earnings of citizens allows a country to raise taxes without losing revenue. Wilson (1982) studies a redistributive taxation model with workers differing in ability, a progressive tax rate, and a lump-sum subsidy. His results show that if high and low skill workers can migrate, then both optimal tax rates and subsidies decrease. Recently Lehmann, Simula, and Tranoy (2014) model optimal taxation allowing for migration and note "that the level and the slope of the semi-elasticity of migration (on which we lack empirical evidence) are crucial to derive the shape of optimal marginal income tax" (p. 1995).

The first paper to thoroughly study the relation between taxation and international migration was Kleven, Landais, and Saez (2013) by looking at the migration decisions of professional soccer players in 14 Western European countries, finding large responses in migration to tax policies. They estimate that a 1% increase in taxes decreases the number of domestic players playing in the home country by about 0.15% and decreases the number of foreign players by about 1%; they also find that high skilled football players crowd out lower ability players after a tax decrease. In addition to these results, they study specific tax programs in Spain and Denmark that were used to attract high paid foreign workers. According to the paper's results, these programs attracted professional soccer players. Using data from the Danish tax scheme to attract foreign workers, they also find evidence that workers in the "sports and entertainment" industry move at a much higher rate than other industries, so the authors consider their estimates upper bounds for the migratory response of labor to taxation. Akcigit, Baslandze, and Stantcheva (2016) study the response of inventors' international mobility to taxes using data from the US and European Patent Offices. Their research includes inventors from USA, Canada, UK, Germany, Italy, Japan, and Switzerland. They find that a 1% increase in taxes decreases the number of domestic inventors living in a country by 0.03% and decreases the number of foreign inventors living in the country by 1%. They also study the location of Russian scientists after the collapse of the Soviet Union, finding that these scientists were more likely to move to countries with lower tax rates. In addition to these results, they find that a preferential tax scheme for highly paid foreign workers in Denmark in 1992 attracted superstar inventors.

Although few studies have investigated international migration, many studies have looked at the response of domestic migration to tax differentials in different countries. Coomes and Hoyt (2008) find that in metropolitan areas in the USA stretching across state borders, state taxes influence which side of the city people move to. Moretti and Wilson (2017) look at star scientists migrating within the USA and find significant responses in migration patterns to both personal income and corporate taxes. Bakija and Slemrod (2004) find that state-level estate taxes in the USA have a statistically significant but modest effect on the number of estates filed in that state, suggesting wealthy elderly people move to states with low taxes. In addition to research on US tax differentials, studies have been done on tax differentials in Spain and Switzerland. Agrawal and Foremny (2019) find that tax differentials in Spanish states have a significant effect on location choices conditional on moving. Schmidheiny (2006) finds that the rich in Switzerland are more likely to move to low tax states than the poor.

The literature suggests that international migration can have long run effects on the growth of a country's economy from the innovation and entrepreneurship of migrants. Optimal taxation is also influenced by the international migration of workers in response to taxes. The empirical literature on domestic and international migration finds evidence that taxes do influence worker's location decisions, but the magnitude of the response differs depending on numerous factors. More research is needed to understand the magnitude at which taxes influence migration decisions.

3. Data

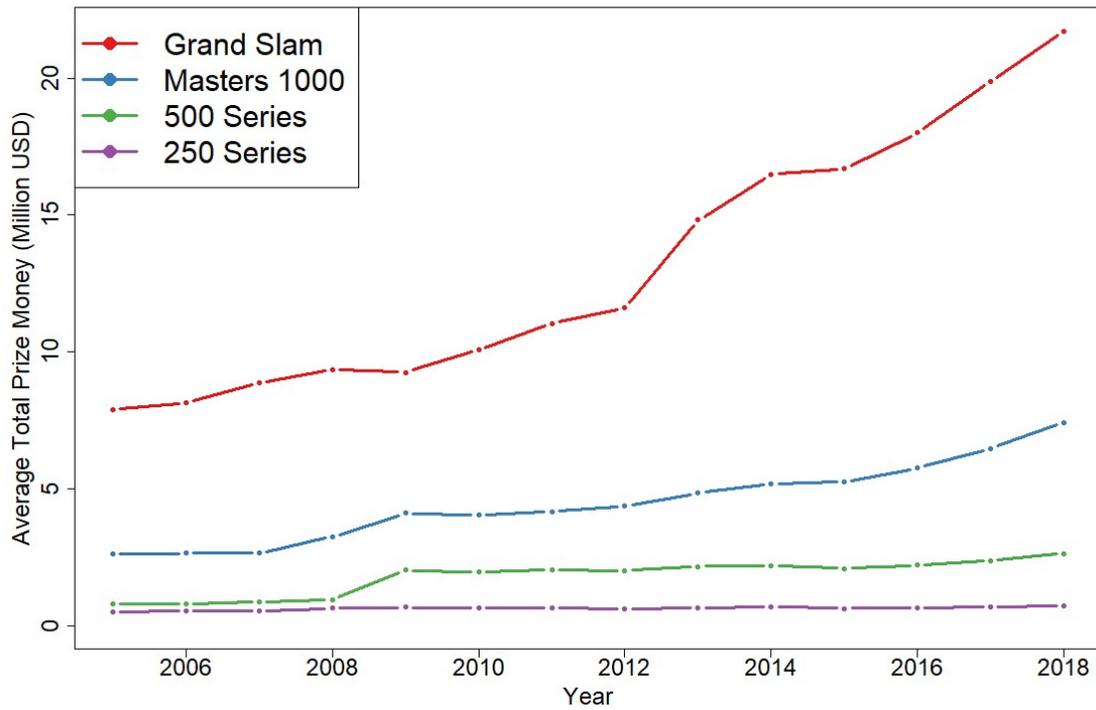
3.1. Tennis Players

Professional tennis players compete in tournaments on the ATP World Tour, ATP Challenger Tour, the International Tennis Federation's Future Series, or a combination of these tournaments. Top 100 ranked players typically play on the ATP World Tour, while players outside the top 100 compete in Challenger and Future events. Each tournament typically consists of a main draw and a qualifying draw. Higher ranked players are directly entered into the main draw, while lower ranked players compete in the qualifying draw for entry into the main draw. Each tournament also awards wildcards to lower ranked players to gain direct acceptance to the main draw. Wild cards are usually given to talented young players to jump-start their careers or to popular veterans that will attract fans to the tournament. Prize money and ranking points are awarded based on what round of the main draw each player loses in, with limited prize money and ranking points awarded in the qualifying draw.

The ATP World Tour beginning in January and ending in mid-November is the highest tier of professional tournaments, and in 2018 consisted of four Grand Slams, the ATP Finals, nine Masters 1000s, thirteen 500 Series, and forty 250 Series. Players are admitted to these tournaments based on their ATP ranking, which is updated each week by adding the ranking points a player has earned in the four Grand Slams, eight mandatory Masters 1000s⁴, the ATP Finals, and the player's best six results from all other tournaments played from the previous 52 weeks. If a player's ranking did not qualify them for a Grand Slam, Masters 1000, or the ATP Finals, they may replace that event with any other event for ranking purposes. Because nineteen tournaments contribute to a player's ranking, each player competes in about twenty tournaments around the world each year with each lasting between one and two weeks. This schedule forces players to be away from their residence for most of the year either traveling between or competing at tournaments. Because players spend little time at their residence, they might not have a strong connection to it and may find it easier to move. The number and location of the 250 and 500 series tournaments has fluctuated over time, while the other tournaments have remained consistent in number with slight variation in locations. Figures 3.1 and 3.2 present information about these tournaments, including locations and prize money over time. These tournaments span the globe, with order of importance for both ranking points and prize money being first the Grand Slams, followed by the Masters 1000s, 500 Series, and 250 Series. The top 8 ranked players at the end of each year compete in the ATP Finals held in mid-November. Because Grand Slam tournaments have the largest prize money payments and the cut off for direct acceptance into the Grand Slam is usually around the 100th ranked player, I restrict my analysis to players in the top 100.

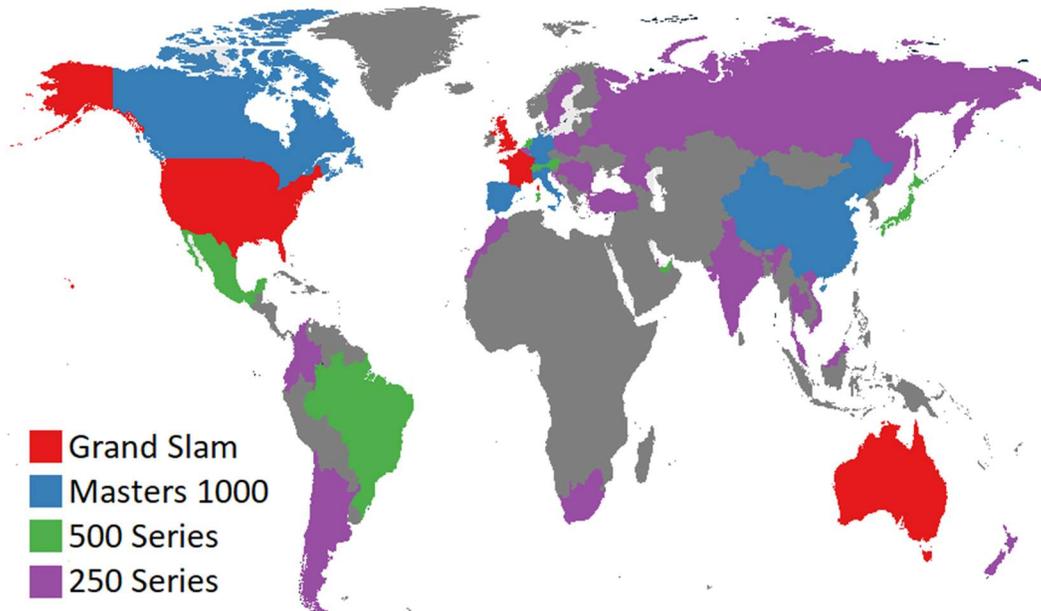
⁴ The Monte Carlo Masters 1000 is a non-mandatory tournament.

Figure 3.1: Tournament Total Prize Money



Source: ATP Tour Website

Figure 3.2: Highest Level Tournament by Country



Source: ATP Tour Website

I collect data on tennis players that have been ranked within the top 100 at the end of the year at least once from 2005 to 2018, which includes 306 players from 52 Olympic countries. Ranking and prize money are easily accessible for a player’s entire career on the ATP Tour website. The player’s residence is also listed on the website, but there is no easy way to see previous residence information and track changes to residence on the website. Fortunately, a player’s residence information is almost always included on their Wikipedia page, and Wikipedia edit histories are publicly available. Because tennis players play numerous tournaments each year and ATP rankings are published each week, their Wikipedia pages are updated at a high frequency. For this reason, I assume that the residence information on Wikipedia is updated consistently using information from the ATP website, making this an accurate representation of a player’s residence. This may in fact not be true, and residence information on Wikipedia may not accurately reflect a player’s residence. As shown in Table 3.3, before 2007 Wikipedia only contains residence information for some Top 100 tennis players, but for almost all players from 2007 onward. For this reason, I restrict my analysis to the years from 2007 onward.

Table 3.3: Number of Players in Ranking Group with Residence Information on Wikipedia

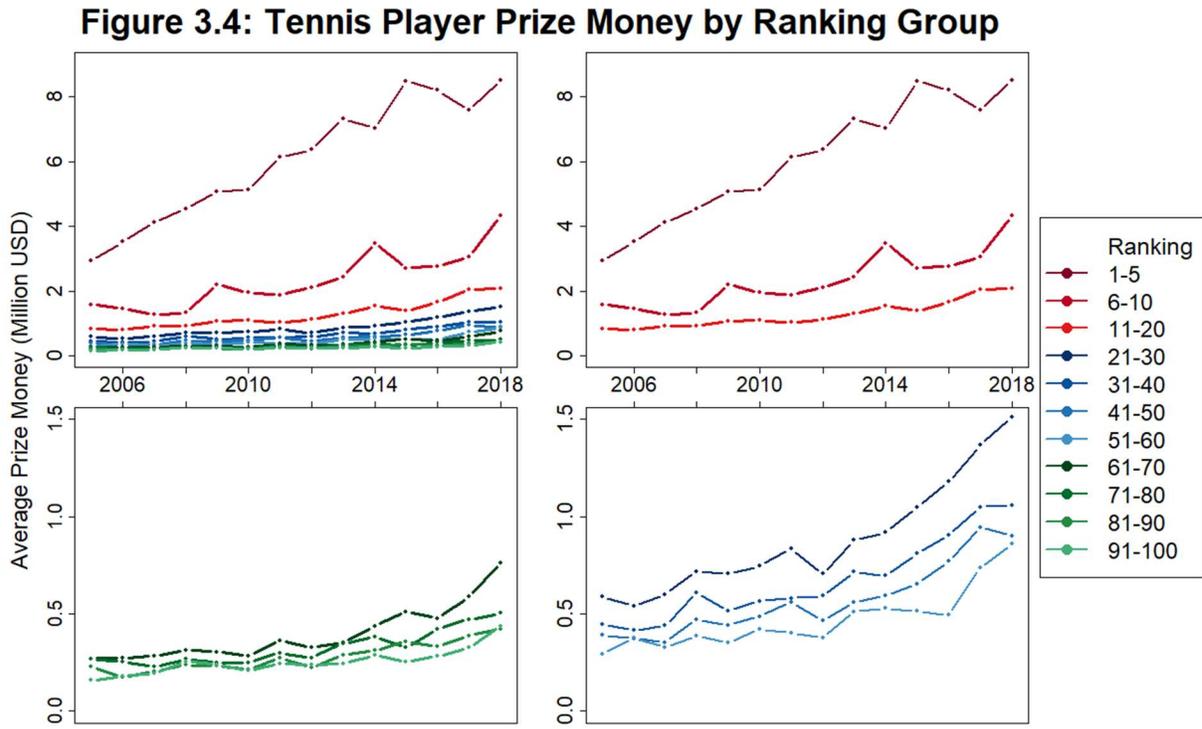
Ranking Group	Year													
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1 to 25	17	24	25	25	25	25	25	25	25	25	25	25	25	25
26 to 50	8	17	24	25	25	25	25	25	25	25	25	25	25	25
51 to 100	10	28	44	48	49	50	50	48	50	48	48	48	49	50
1 to 100	35	69	93	98	99	100	100	98	100	98	98	98	99	100

Source: Wikipedia Page of Each Player

Although top 100 tennis players between 2007 and 2017 represented 52 Olympic countries, many countries were only represented in the top 100 on a few occasions. Appendix Table A.1 shows the proportion of top 100 tennis-player-years from 2007 to 2017 attributed to each Olympic country. Spain, France, the USA, Germany, and Argentina account for a just below 50% of all top 100 tennis-player-years, while numerous countries account for less than 1% of all tennis-player-years.

Tennis players in the top 100 are well compensated through prize money, which has increased substantially from 2005 to 2018. Figure 3.4 shows the prize money in USD for players ranked in the top 100 over time. A player at the top of the rankings earns multiple millions of dollars, while players near the bottom of the top 100 earn several hundred thousand dollars. Because of these large earnings,

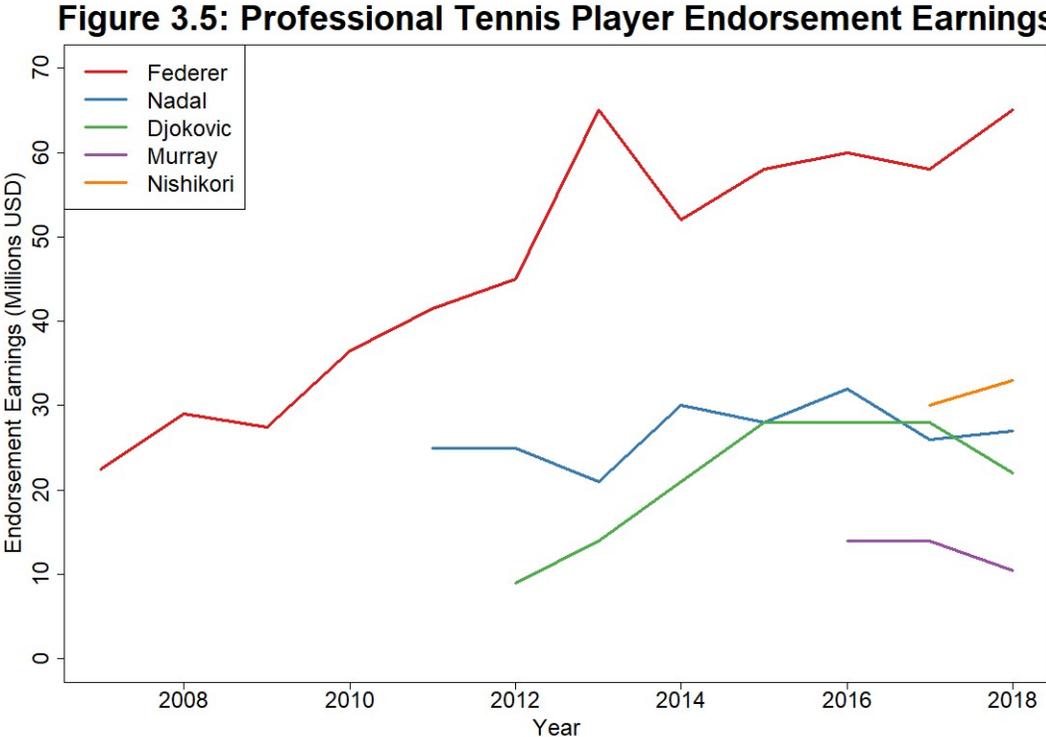
tennis players, particularly those near the top of the rankings, should be paying large sums in personal income taxes. Average prize money in each ranking group has at least tripled from 2005 to 2018. As players earn more money, they should increasingly feel the burden of income taxes and move to lower tax countries at higher rates over time.



Source: ATP Tour Website

While players receive large and increasing earnings from prize money, they may also receive money through endorsements from racquet, clothing, and various other companies. Unlike prize money, information about endorsement deals is not publicly available. Figure 3.5 shows endorsement earnings reported by Forbes for tennis players as available. All players in this chart are at the top of the rankings when endorsement earnings are available, but endorsement earnings are not perfectly correlated with performance. Several key metrics of performance about these players are shown in Table 3.6. Both Rafael Nadal and Novak Djokovic are more successful than Roger Federer by all metrics from 2009 to 2018, but Federer still earns more money from endorsements. Kei Nishikori of Japan is quite unsuccessful compared to Andy Murray, Nadal, and Djokovic, but he earns more from endorsements than these players; this is likely because Kei Nishikori is the most successful Asian tennis player, and his image has high value to companies advertising in Asia. Because I have no way to collect endorsement earnings information for most players, it is difficult to say what measures will predict endorsement earnings for top 100 tennis players. Measures of success such as ranking and prize money are likely to be correlated with endorsement earnings, but the available information about endorsement earnings suggests this correlation is far from perfect. It is also unclear what the relative size of endorsement

earnings is for most players in the top 100 because the available information about endorsement earnings shown in Figure 3.5 is for players near the top of the rankings.



Source: Forbes

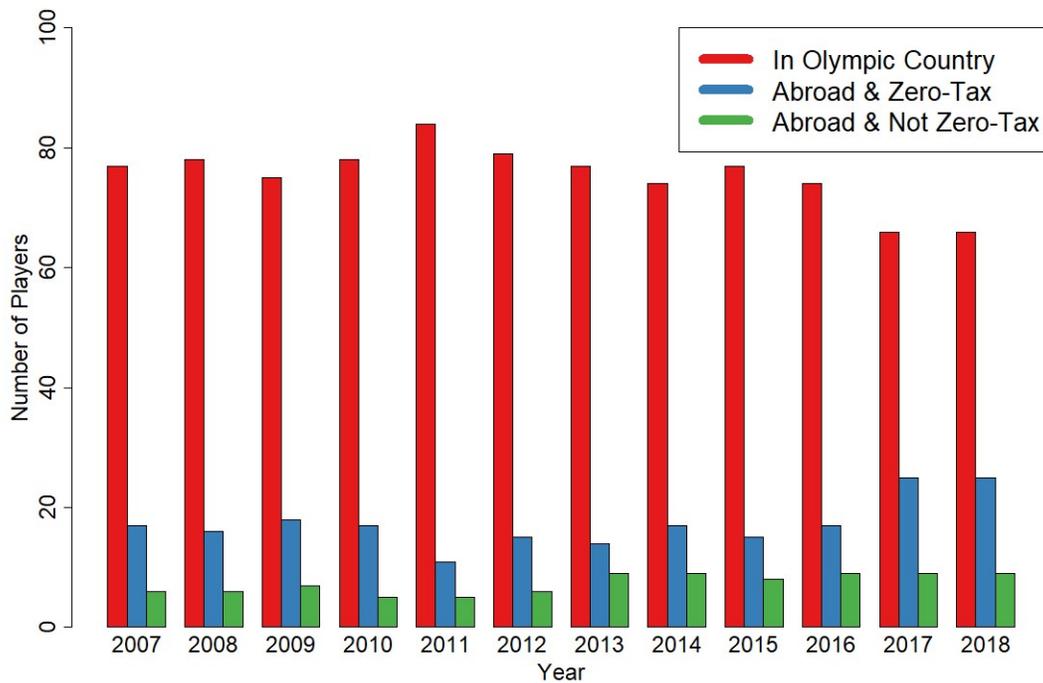
Table 3.6: Success of Professional Tennis Players with Observable Endorsement Earnings

	Federer	Nadal	Djokovic	Murray	Nishikori
Weeks at #1 2004-2008	237	20	0	0	0
Weeks at #1 2009-2018	73	176	243	41	0
Grand Slams 2004-2008	13	5	1	0	0
Grand Slams 2009-2018	7	12	13	3	0
Masters 1000s 2004-2008	13	12	4	2	0
Masters 1000s 2009-2018	13	21	28	12	0

Source: ATP Tour Website

For each player, we have information on the exact prize money they earned each year but no information on endorsement earnings other than the six players mentioned previously. It is also unknown how tennis players report earnings on personal income tax returns, which is the income influencing a player’s decision to live abroad in a zero-tax country in response to personal income tax rates. Some tournaments present the champion with oversized checks at the trophy ceremony, suggesting prize money is paid by check in the player’s name and should be reported on a personal income tax return. Endorsement earnings may also be reported this way, or they may be paid to some sort of corporation made in the player’s name. If this is representative of how tennis players receive endorsement earnings, then endorsement earnings should not influence their moves to zero-tax countries in response to personal income taxes in their Olympic country. A lack of understanding how tennis players receive income and report it for tax purposes is a concern for this paper. I continue under the assumption that players report prize money and possibly endorsements as personal income for tax purposes in their residence country.

Figure 3.7: Residence of Top 100 Tennis Players



Source: ATP Tour Website

Many top 100 ranked tennis professionals each year reside in countries that are not the country they would represent in the Olympics. Figure 3.7 presents information about where the top 100 ranked tennis players reside each year broken into three categories: living in their Olympic country, living abroad in a zero-tax country, or living abroad in some other country. Zero-tax countries are the Bahamas, Monaco, Qatar, UAE, and Switzerland. These countries are all commonly referred to as “tax-havens” in popular discussions of tax avoidance. The first four countries in this list do not tax personal

income. Switzerland taxes its workers' income but allows non-working foreigners living there to pay a lump sum tax that is lower than the usual tax rate on income and therefore would be attractive to workers with large incomes from outside Switzerland such as professional tennis players (Van den Eeckhaut, 2018). For players who live abroad, a disproportionate number choose to live in a zero-tax country. The number of players living abroad in zero-tax countries follows an increasing trend, going from 17 players in 2007 to 24 players in both 2017 and 2018. This is consistent with the increasing prize money earned by professional tennis players making tennis players more sensitive to taxes over time.

Although top 100 ranked professional tennis players commonly live abroad in zero-tax countries, this alone does not prove that these moves are for tax purposes. Players are occasionally asked about their residence choices in interviews, and some have mentioned taxes as a reason for living in these countries. During the 2014 Davis Cup final, which is the tennis equivalent of the World Cup, France played Switzerland, and every player involved in the match including the French players lived in Switzerland at the time. When asked about this, a French player said, "After my first year, I saw what I earned and then I saw what was left in my bank account, and then I moved" (Clarey, 2014). Other players have mentioned other reasons for living in these countries, including privacy, training, safety, and standards of living (Clarey, 2014 and Djokovic, 2011). Many other locations have all these luxuries without the zero-tax system, and fewer tennis players choose to live there. Tennis players also have an incentive to lie about the true reason for their residence in a zero-tax country, because fans in the player's home country may view them as unpatriotic for fleeing from taxes.⁵ This suggests that taxes are influencing these location decisions.

3.2. Country-Level Data

I collect data on the top marginal tax rates on personal income for the Olympic countries of top 100 ranked professional tennis players. The primary source of this information is the OECD Tax Database, which contains detailed tax data for member countries from 2000 to 2017. For countries that do not appear in the OECD Tax Database, I collect information on top marginal tax rates from KPMG, which presents only top marginal personal income tax rates from 2003 to 2018 as available for most countries. Surprisingly, KPMG and the OECD disagree on what the top marginal tax rates are in some countries in some years. For this reason, I use the KPMG data only when a country does not exist in the OECD Tax Database and restrict my analysis to 2017 and earlier years. If a country does not appear in the OECD Tax Database or KPMG, which only happens for four countries, I collect information from Trading Economics, a website that publishes historical economic data. Top marginal tax rates are certainly not effective tax rates that workers face when living in a country, but for workers earning several hundred-thousands or millions of dollars, it should well approximate the effective tax rate that these workers face. Kleven, Landais, and Saez (2013) and Akcigit, Baslandze, and Stantcheva (2016) both make the same assumption. Tennis players' tax filings are even more complicated than soccer players and inventors, because the global tournament schedule has a tennis player earning most or all of their income outside of his residence country. According to Ernst and Young (2018), all the top ranked tennis players' Olympic countries tax their residents on their global income, but tax treaties between countries

⁵ Andy Murray and Rafael Nadal have been praised by some fans for claiming residence in their Olympic countries and (presumably) paying high taxes, while Novak Djokovic of Serbia has occasionally been derided by fans for residing abroad in Monaco. Djokovic has numerous interviews claiming his residence in Monaco has nothing to do with taxes, but few people believe taxes had no impact on his decision.

and other laws will influence how much tennis players pay in taxes. Ideally, I would know the effective tax rate that a tennis player would have faced if they had lived in their Olympic country, but I continue under the assumption that tennis players are strongly affected by the top marginal personal income tax rate.

In addition to tax data, I also collect measures of other factors that tennis players have mentioned as reasons for moving abroad to a zero-tax country. To measure the crime and safety level in a country, I collect the number of homicides and robberies per 100,000 people from the United Nations Office on Drugs and Crime. These variables are reported for most countries for most years from 2007 to 2017 with some gaps. If the gap appears at the beginning or end of the time series, I assume that crime was constant from the closest year before or after the missing observation. If the gap appears in between two years with reported crime data, I assume a linear trend in crime between the two years of reported data. Along with crime data, I also collect GDP per person measured in PPP for all Olympic countries of professional tennis players from the World Bank; this is meant to measure the standards of living in a tennis player's home country. These measures may not perfectly represent the safety and standard of living concerns of tennis players, as different parts of countries and even cities can have vastly different levels of crime and standards of living. Ideally, I would know how tennis players rate the safety and standard of living in the precise locations they live in each country. Other factors players have commonly mentioned as influencing their decisions to live abroad in a zero-tax country are privacy from fans and training. For privacy, I would like to know the intrusiveness of the media into athlete's lives, how troublesome the countries' sports fans are, and how these have changed over time. Unfortunately, no such measures exist. For training, I would like to know how many coaches and training facilities are in each country, their quality, and how they have changed over time. There is no objective way to measure this.

4. Econometric Model

This paper explores whether top marginal personal income tax rates in a top ranked professional tennis player's Olympic country influence a player's decision to live abroad in a country with no taxes on personal income. Because these players earn between several hundred thousand and several million dollars each year, avoiding paying personal income taxes will significantly increase their take-home pay. My hypothesis is that players from countries with higher top marginal income taxes are more likely to live abroad in a zero-tax country than players from countries with lower top marginal personal income taxes. I choose living abroad in a zero-tax country as the dependent variable because players living abroad in zero-tax countries are more likely to be doing so for tax purposes. Players living abroad in countries without zero-tax systems such as the USA or Spain are likely to be living there for reasons other than taxes, such as training facilities or location. Nevertheless, I also estimate the probability that a player lives abroad in any country, which I expect taxes to have a weaker effect on. To accurately estimate the effect of top marginal personal income taxes on a player's decision to live in a zero-tax country and abroad in general, I must control for a range of player and Olympic country factors that may also be influencing a player's decision to live abroad in these zero-tax countries.

I estimate a linear probability model of the likelihood player i from Olympic country c_i lives abroad in a zero-tax country in year t by:

$$\mathbb{P}(\text{Living abroad in zero tax country}) = \beta_{0,t} + \beta_1 \log(1 - \text{tax}_{i,t}) + \beta_2 v_{i,t} + \beta_3 c_{i,t} + c_i + e_{i,t}$$

where $tax_{i,t}$ is the top marginal personal income tax rate in country c_i at time t , $v_{i,t}$ is a vector of player specific characteristics that vary over time, $c_{i,t}$ is a vector of Olympic country specific characteristics that vary over time, c_i is an Olympic country fixed-effect, and $e_{i,t}$ is the error term normally distributed with mean zero and variance one. I use log of taxes because I expect the effect of taxes is to be non-linear and that changing the top tax rate from 0% to 5% should have a much stronger effect on a player's location decision than changing the tax rate from 45% to 50%. If my hypothesis that top marginal personal income taxes are influencing player's decision to live abroad in a zero-tax country is true, then β_1 should be negative and statistically significant.

The player specific characteristics included in $v_{i,t}$ are prize money and ranking during the previous, current, and next year along with age and years of professional experience. Players earning more money must pay more taxes and should be more likely to move abroad to a zero-tax country. Prize money is an observed source of income for tennis players that I expect is reported on personal income tax returns. If players report endorsement earnings on their personal income tax returns, then this will also influence their decision to live abroad in a zero-tax country. Endorsement earnings are unobserved, but should be correlated with a player's success, which is why I include a player's ranking in the model. As shown in Figure 3.5, endorsement earnings have increased over time, so I also incorporate an interaction between ranking and a linear time trend. The player's Olympic country may also influence the endorsement earnings of a player, as some countries have more or wealthier tennis fans. The country fixed effects should control for this effect if the value of endorsing players from each country is constant over time. Country fixed effects will not control for any changes in the value of endorsing players from each country over time.

The country specific variables in $c_{i,t}$ that vary over time include variables that tennis players have mentioned as influences on their decision to move abroad to a zero-tax country, such as measures of safety and standards of living. Safety measures include the number of homicides and robberies per 100,000 people in each country. The higher the crime rate, the more likely a high paid worker such as a professional tennis player would want to move abroad to the zero-tax countries, which have little to no crime. Standard of living is measured by GDP per person in PPP. Countries with lower GDP per person are less likely to have the amenities to attract high paid workers such as tennis players, while the zero-tax countries have these amenities. Unobserved factors known to influence a player's decision to move abroad are privacy from fans and training. If these factors are relatively constant in each country over time, then country fixed effects will control for this but not if these factors are changing over time. Country fixed effects will also help control for numerous factors at the country level that influence a player's decision to live abroad but do not change over time including weather, language, culture, and location of the Olympic country in relation to tennis tournaments and zero-tax countries. Players from cold weather countries should be more likely to live abroad in a zero-tax country, as these countries have tropical weather. If a player's Olympic country has a language and culture like a zero-tax country, then that player will find it easier to live abroad in that zero-tax country. Tennis players from Olympic countries far away from zero-tax countries may find the move difficult because it is then harder to visit friends and family. If a player's Olympic country is not near any high-level tennis tournaments, then this player may want to live in a zero-tax country for tournament travel purposes.

My main sample will be players ranked inside the top 100 at the end of the year from 2007 to 2017, which is 1081 observations from 52 different Olympic countries. One concern is that even if top marginal tax rates have a significant influence on player location decisions, including 52 different

country fixed effect variables along with other controls will dilute the power of my model. Some countries have very few tennis-player-years over this time in my sample, so to address the concern about power, I will also run my regressions over only countries with at least 1% of all tennis-player-years in my sample, which includes 22 countries and 969 tennis-player-years; I will also run my regressions on players from countries with at least 2% of all tennis-player-years in my sample, which includes 14 countries and 733 observations. Because the ratio between observations and country fixed effects will be higher, my regressions will have a better chance of observing a significant effect if it exists.

One advantage of a linear probability model is that its coefficients are easily interpreted and put in an economic context. In the model described above, players from a country with a 1% higher top marginal personal income tax rate will have a $-\beta_1$ percentage points higher probability of living abroad in a zero-tax country after controlling for other factors. The disadvantage of a linear probability model is that it may estimate probabilities that are greater than one or less than zero. For robustness, I also estimate a logit probability model, which will guarantee probability estimates between zero and one, but the coefficients are not as easily put in an economic context. If $p_{i,t}$ is the probability that player i at time t lives abroad in a zero-tax country, a logit probability model estimates:

$$\frac{p_{i,t}}{1 - p_{i,t}} = \exp(\alpha_{0,t} + \alpha_1 \log(1 - tax_{i,t}) + \alpha_2 v_{i,t} + \alpha_3 c_{i,t} + c_{i,t} + e_{i,t})$$

with the variables the same as before and $\exp(\cdot)$ being the exponential function. Here, $p_{i,t}/(1 - p_{i,t})$ is the odds the player lives abroad in a zero-tax country. Suppose $p_{i,t}$ is the probability player i at time t lives abroad in a zero-tax country, and $p'_{i,t}$ is the probability a player identical to player i at time t lives abroad in a zero-tax country except the top marginal personal income tax rate in this player's Olympic country is 1% higher, specifically he faces the top marginal personal income tax rate $tax_{i,t} * 1.01$. Then we have

$$\exp(-\alpha_1 * \log(1.01)) * \frac{p_{i,t}}{1 - p_{i,t}} = \frac{p'_{i,t}}{1 - p'_{i,t}}.$$

This tells us that controlling for other factors players from countries with 1% higher taxes will have a $\exp(-\beta_1 * \log(1.01))$ times higher odds of living abroad in a zero-tax country.

5. Results

I first estimated the probability of a player living abroad in a zero-tax country using a linear probability model, with results shown in Table 5.1. Regression 1 includes all 1081 top 100 tennis-player years from 2007 to 2017. The coefficient on $\log(1 - tax)$ is negative and statistically significant at the 0.1 level, suggesting that taxes do influence a player's decision to live abroad in a zero-tax country. Player's from countries with a 1% higher top marginal personal income tax rate after controlling for other factors have a 0.53 percentage points higher probability of living abroad in a zero-tax country. Prize money in the previous, current, and next year increase a player's probability of living abroad in a zero-tax country as expected, but only prize money in the future and past have a statistically significant effect. Most measures of a player's ranking are small and statistically insignificant. A player's ranking in the next year and the interaction between next year's ranking and the linear trend are positive and statistically significant. A positive effect from ranking in the future means that players with larger rankings in the future, which are players who are less successful in the future, have a higher chance of living abroad in a zero-tax country, which does not make intuitive sense. Ranking was included as a

measure that should correlate and partially control for endorsement earnings. The small and statistically insignificant effect of the previous and current ranking variables on probability of living in a zero-tax country could mean that these rankings do not strongly correlate with endorsement earnings, or that endorsement earnings do not have a strong effect. The positive and statistically significant effect of future ranking may suggest that these rankings are correlated with something else that is influencing players to live abroad in zero-tax countries.

Homicide rates, robbery rates, and GDP in a country do not have a statistically significant effect on living abroad in a zero-tax country. This may mean that we are not properly measuring safety and standard of living concerns of professional tennis players, or that these do not vary much over time for these countries. If these variables do not change much over time, then country fixed effects would absorb these effects. Age has a statically significant and negative effect, while experience has a statistically significant and positive effect. This make sense when considering that more talented player become professional at younger ages, 16 or 17, while less talented players wait longer to turn professional, age 18 or 19. For two players with similar ages, the player with more experience turned professional earlier, and is likely to be more talented. For two players with similar experiences, the older player would have turned professional later and is likely to be less talented. More talented players will earn more money over the course of their careers and have more to gain from living abroad in a zero-tax country.

I was concerned that the regression over all players would lack power to observe any effect from taxation on location decisions. Table 5.1 shows results for a regression when restricting the sample to countries with more tennis-player-years. Regression 2 has only players from countries with at least 1% of all tennis-player-years, while regression 3 has only players from countries with at least 2% of all tennis-player-years. Regression 1 and 2 observe nearly identical effects and significances. Regression 3 has the same directions and significances as the other regressions, but a much larger effect from taxation. Players from Olympic countries with 1% higher taxes have a 0.86 percentage point higher probability of living abroad in a zero-tax country. The effect of prize money variables on the probability of living abroad also increases in magnitude. These results suggest that tennis players from countries with more top 100 ranked tennis players are more sensitive to tax policy than players from other countries. One potential explanation is that there is a networking effect for players living abroad in a zero-tax country. Players from countries with more top ranked tennis players are more likely to know another player already living abroad in a zero-tax country, while players from countries with few or no other top ranked tennis players are less likely to know a player living abroad in a zero-tax country. Knowing a player living in a zero-tax country may reduce the costs of living abroad in a zero-tax country and make players more sensitive to changes in tax policy.

I expected that taxes in a player's Olympic country would have a stronger effect on the decision to live in a zero-tax country compared to the decision to live abroad in any country. Table 5.2 shows results from a linear probability model estimating the probability a player lives abroad in any country, not just a zero-tax country. Results for this model are similar to the results from modelling the probability of living abroad in a zero-tax country. Surprisingly, the effect of taxation is now larger; for players from any Olympic country, players from a country with 1% higher top tax rate have a 0.63 percentage point higher probability of living abroad in any country. For players from countries with at least 1% of all tennis-player-years, a 1% higher top tax rate increases the probability the player lives abroad in any country by 0.79 percentage points. For players from countries with at least 2% of all

tennis-player years, a 1% higher top tax rate increases the probability of living abroad in any country by 0.78 percentage points. These results may suggest that players moving abroad to non-zero tax countries are also influenced by taxes in their home country. For example, in 2017 two players from Japan, which had a top marginal personal income tax of 45%, lived in the USA, which had a top marginal personal income tax of 39.6%. Taxes may have influenced this location decision, even though USA is not a zero-tax country.

Linear probability models may estimate probabilities greater than one or less than zero, so I also estimate a logit model with results shown in Table 5.3 for both the probability a player lives abroad in a zero-tax country and any country. Because many countries with few tennis-player years never have a player living abroad in a zero-tax country, these countries' fixed effect variables will perfectly predict failure, and I am unable to accurately estimate the logit regression using maximum likelihood. This forces me to only present results for players from countries with at least 2% of all tennis-player-years. The effect of taxation in these models is still negative, but it is no longer statistically significant. In the linear probability model, taxes had a larger effect on living abroad in any country rather than just a zero-tax country, but in the logit regression taxes have a larger effect on the probability of living abroad in a zero-tax country. From the coefficient of -5.99 on $\log(1 - tax)$ in regression 1, we see that after controlling for other factors players from countries with 1% higher top marginal personal income tax rates have about 1.03 times higher odds of living abroad in a zero-tax country. The coefficient of -4.34 on $\log(1 - tax)$ in regression 2 says that players from a country with a 1% higher top marginal personal income tax rate have about 1.02 times higher odds of living abroad in any country. The lack of statistical significance may suggest that my results from the linear probability model are biased by allowing probabilities greater than one and less than zero. This may also just be a problem with power of the regression in the logit model, and it is possible that with more observations I would still observe a statistically significant negative effect.

Table 5.1: Linear Probability Model of Living Abroad
in a Zero-Tax Country

	Regression 1	Regression 2	Regression 3
Proportion Cutoff	0%	1%	2%
log(1-tax)	-0.5252* (0.2991)	-0.5655* (0.3150)	-0.8640** (0.4014)
log(prize money)	0.0168 (0.0269)	0.0111 (0.0285)	0.0063 (0.0374)
log(prize money next year)	0.0420** (0.0197)	0.0426** (0.0208)	0.0898*** (0.0293)
log(prize money previous year)	0.0569*** (0.0178)	0.0561*** (0.0191)	0.0656*** (0.0250)
ranking	0.2541 (0.2150)	0.2104 (0.2259)	0.2842 (0.2838)
ranking next year	0.0476** 0.0237	0.0514** (0.0247)	0.0638** (0.0298)
ranking minus1	0.0546 (0.0489)	0.0563 (0.0507)	0.0588 (0.0569)
ranking * year	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)
ranking next year * year	0.00002** 0.00001	-0.00002** (0.00001)	-0.00003** (0.00001)
ranking previous year * year	-0.00003 (0.00002)	-0.00002 (0.00002)	-0.00002 (0.00002)
homicide	0.0027 (0.0101)	0.0030 (0.0105)	-0.0069 (0.0298)
robbery	-0.00009 (0.0007)	-0.00008 (0.0007)	-0.000006 (0.000640)
GDP	0.000004 (0.000006)	-0.000004 (0.000006)	-0.000001 (0.000008)
age	-0.0292*** (0.0067)	-0.0297*** (0.0069)	-0.0259*** (0.0079)
experience	0.0363*** (0.0071)	0.0366*** (0.0073)	0.03500*** (0.0084)
Year Fixed Effects	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes

Standard errors are given in parentheses; *** indicates significance at the 0.01 level, ** 0.05 level, * 0.1 level.

Table 5.2: Linear Probability Model of Living Abroad
in Any Country

	Regression 1	Regression 2	Regression 3
Proportion Cutoff	0%	1%	2%
log(1-tax)	-0.6316* (0.3400)	-0.7894** (0.3567)	-0.7883* (0.42733)
log(prize money)	0.0140 (0.0306)	0.0092 (0.032)	0.0096 (0.0398)
log(prize money next year)	0.0591*** (0.0224)	0.0609** (0.0236)	0.0896*** (0.0312)
log(prize money previous year)	0.0595*** (0.0202)	0.0534** (0.0216)	0.0604* (0.0266)
ranking	0.2441 (0.2445)	0.2400 (0.2558)	0.1184 (0.3021)
ranking next year	0.0768*** (0.0269)	0.0783*** (0.0280)	0.0795* (0.0318)
ranking minus1	0.0649 (0.0556)	0.0656 (0.0574)	0.0587 (0.0606)
ranking * year	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.00005 (0.00015)
ranking next year * year	-0.00003*** (0.00001)	-0.00003*** (0.00001)	-0.00003** (0.00001)
ranking previous year * year	-0.00003 (0.00002)	-0.00003 (0.00002)	-0.00002 (0.00003)
homicide	0.0158 (0.0115)	0.0165 (0.0119)	-0.0081 (0.0317)
robbery	-0.0001** (0.00008)	-0.0001* (0.00008)	0.0002 (0.0006)
GDP	-0.000006 (0.000006)	-0.000006 (0.000007)	0.0000001 (0.000008)
age	-0.0259*** (0.0076)	-0.0284*** (0.0078)	-0.0188** (0.0085)
experience	0.0367*** (0.0080)	0.0401*** (0.0083)	0.0328*** (0.0090)
Year Fixed Effects	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes

Standard errors are given in parentheses; *** indicates significance at the 0.01 level, ** 0.05 level, * 0.1 level.

Table 5.3: Logit Probability Model

	Regression 1	Regression 2
Dependent Variable	Living abroad in a zero-tax country	Living abroad in any country
Proportion Cutoff	2%	2%
log(1-tax)	-5.9897 (4.4810)	-4.3438 (4.1354)
log(prize money)	0.4308 (0.5085)	0.3688 (0.4465)
log(prize money next year)	1.1174*** (0.3809)	1.0166*** (0.3494)
log(prize money previous year)	0.7809** (0.3167)	0.6091** (0.2845)
ranking	5.4093 (3.5921)	2.2794 (3.2104)
ranking next year	0.5126 (0.3425)	0.8213* (0.4196)
ranking minus1	1.0070* (0.5603)	0.8709* (0.5062)
ranking * year	-0.0026 (0.0017)	-0.0011 (0.0015)
ranking next year * year	-0.0002 (0.0001)	-0.0004* (0.0002)
ranking previous year * year	-0.0004* (0.0002)	-0.0004* (0.0002)
homicide	0.4377 (0.5284)	0.1758 (0.4364)
robbery	-0.0158 (0.0164)	-0.0089 (0.0145)
GDP	-0.00006 (0.00011)	-0.00003 (0.00010)
age	-0.4379*** (0.1293)	-0.2472*** (0.1044)
experience	0.5954*** (0.1466)	0.4076*** (0.1180)

Standard errors are given in parentheses; *** indicates significance at the 0.01 level, ** 0.05 level, * 0.1 level.

6. Conclusion

My results provide some evidence that tax rates influence the decision for top 100 ranked professional tennis players to live abroad in a zero-tax country. When estimating a linear probability model, players from countries with 1% higher top marginal personal income tax rates after controlling for other factors have about 0.53 percentage points higher probability of living abroad in a zero-tax country. For players from countries with more tennis players, the effect of taxation on the probability of living abroad is larger. For players from a country with at least 2% of all tennis-player years, players from country with 1% higher top marginal personal income tax rates after controlling for other factors have about a 0.86 percentage points higher probability of living abroad in a zero-tax country. I conjecture that this is because there is a networking affect for living abroad in a zero-tax country; players from countries with many tennis players are likely to know someone already living abroad in a zero-tax country and this may lower the cost of living abroad there. In a logit probability regression, the higher top marginal personal income tax rates also increase the probability that a player lives abroad in a zero-tax country, but this effect is not statistically significant. This may suggest that the results from the linear probability are biased, or that the small sample size did not have enough power to observe a significant result in the logit regression.

If the estimates from the linear probability model are taken to be accurate, then these are quite large compared to other estimates of the international migration response to taxation. Kleven, Landais, and Saez (2013) using data on professional soccer players find that a 1% increase in taxes increases the number of domestic players from a country living abroad by 0.15%. Akcigit, Baslandze, and Stantcheva (2016) using data from “super-star” inventors find that a 1% increase in taxes increases the number of domestic inventors from a country living abroad by 0.03%. The larger estimates I find are not surprising, as tennis players spend little time in their residence and their employment is not tied to one location because of their global tournament schedule; this makes it comparatively easier to live abroad in a zero-tax country. Soccer players and inventors in contrast are constrained in location choices to places where they can find employment. Because soccer players and inventors will spend most of their time in one place, or at least one country, they are much more sensitive to non-tax related factors influencing a location decision. It is unclear that any profession today has comparable location flexibility as professional tennis players, but in the future some workers may exhibit similar location choices as technology increases allow more work to be done remotely.

More research needs to be done on the international migration of high skilled workers to understand how taxation and other government policies affect their location decisions. An interesting question would be the difference in international migration between genders, and a potential source of data would be professional women’s tennis players. Men and women may have significantly different preferences when choosing a country to live, and their responses may have different magnitudes. Many professional tournaments pair a men’s and a women’s tournament together on the same dates, and the men’s and women’s players have recently been earning the same prize money at many events. Since women professional tennis players face the same global tournament schedule as the men, I would expect them to have a similar response to taxation. According to the Women’s Tennis Association’s website, three of the top 10 ranked women’s tennis players on April 15, 2019 lived abroad in Monaco. This paper and Kleven, Landais, and Saez (2013) study only professional male athletes. Akcigit, Baslandze, and Stantcheva (2016) study superstar inventors from 1977 to 2000, in which males are likely a substantial majority. If women exhibit different preferences for international migration, then our

results may not accurately represent international migration in a future world with more women represented in top income brackets.

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7. Appendix

Table A.1: Proportion of Top 100 Tennis-Player-Years Representing Each Country in the Olympics

Greece	Hungary	Peru	Turkey	Ecuador	Georgia
0.000925	0.000925	0.000925	0.000925	0.00185	0.00185
Korea	Moldova	Bosnia and Herzegovina	Dominican Republic	India	Tunisia
0.00185	0.00185	0.002775	0.002775	0.002775	0.002775
Lithuania	Chile	Uruguay	Bulgaria	Luxembourg	Sweden
0.0037	0.00555	0.00555	0.006475	0.006475	0.006475
Uzbekistan	Finland	Latvia	South Africa	Israel	Portugal
0.006475	0.007401	0.007401	0.007401	0.008326	0.008326
Romania	Slovenia	Slovakia	Cyprus	Poland	Taiwan
0.008326	0.008326	0.008326	0.009251	0.009251	0.009251
Canada	UK	Kazakhstan	Netherlands	Colombia	Japan
0.011101	0.012951	0.012951	0.012951	0.013876	0.013876
Brazil	Austria	Ukraine	Belgium	Switzerland	Czech Republic
0.014801	0.015726	0.016651	0.021277	0.021277	0.029602
Australia	Serbia	Croatia	Italy	Russia	Germany
0.031452	0.032377	0.037003	0.042553	0.047179	0.070305
Argentina	USA	France	Spain		
0.074006	0.074006	0.112858	0.126735		

Table A.2: Source of Taxation Information by Country

Country	Source
Argentina	KPMG
Australia	OECD
Bahamas	KPMG
Belarus	Trading Economics
Belgium	OECD
Bosnia and Herzegovina	KPMG
Brazil	KPMG
Bulgaria	KPMG
Canada	OECD
Chile	OECD
Colombia	KPMG
Croatia	KPMG
Cyprus	KPMG

Czech Republic	OECD
Denmark	OECD
Dominican Republic	Trading Economics
Ecuador	KPMG
Estonia	OECD
Finland	OECD
France	OECD
Greece	OECD
Hungary	OECD
India	KPMG
Israel	OECD
Italy	OECD
Jamaica	KPMG
Japan	OECD
Kazakhstan	KPMG
South Korea	KPMG
Latvia	OECD
Lithuania	KPMG
Luxembourg	OECD
Malta	KPMG
Moldova	KPMG
Monaco	Trading Economics
Netherlands	OECD
Peru	KPMG
Poland	OECD
Portugal	OECD
Qatar	KPMG
Romania	KPMG
Russia	KPMG
Serbia	KPMG
Slovakia	KPMG
Slovenia	OECD
South Africa	KPMG
Spain	OECD
Sweden	OECD
Switzerland	OECD
Taiwan	KPMG
Thailand	KPMG
Tunisia	KPMG
Turkey	OECD
Ukraine	KPMG
United Arab Emirates	KPMG
United Kingdom	OECD
United States of America	OECD
Uruguay	KPMG
Uzbekistan	Trading Economics