

The Impact of Economic and Technological Change on the Careers of American Men Tennis Players, 1960–1991

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Introduction

The past three decades have been a time of explosive economic change in the labor markets of America's major professional sports. Dramatic increases in firm revenues have combined with increases in players' property rights in their own services to make multimillion-dollar salaries commonplace in baseball, basketball, and football. Many of the causes and consequences of the economic changes in the salaries and careers of athletes in these sports have received attention in academic journals as well as the popular press.¹

The transformation of tennis has received less attention, in spite of the fact that tennis has undergone changes perhaps as extensive as any other sport. Tennis has certainly had economic changes as extreme as those of other sports. Prior to 1968, the sport's important tournaments did not give money prizes, and all of its most prestigious competitions were open exclusively to amateurs. The arrival of Open tennis in 1968 established money prizes for all world-class tennis tournaments, and allowed all tennis players to compete in all tournaments for the first time in the sport's history. Since 1968, the prize money available in tennis has increased considerably: in 1991 no American football player earned as much as the world's highest-paid tennis player, and the highest-paid American man tennis player earned a total income 60 percent greater than the highest-paid baseball player.²

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2. Peter Newcomb, "Madonna is the Model," *Forbes* (August 19, 1991): 80–84.

The changes in tennis have not been only financial, however, for the sport has also been affected by fundamental innovations in technology. From the origins of tennis until the 1960s the best tennis rackets were all made of wood. This first changed during the 1960s with the introduction of metal rackets. In the 1970s new rackets made of graphite and other synthetic materials were introduced. These new materials have allowed manufacturers to produce new designs, so that rackets in use today are simultaneously larger, lighter, and stronger than conventional rackets. The advantages of the new materials and designs are so great that wood and metal rackets, and rackets of conventional design, are no longer manufactured.

This paper will consider the impact of these economic and technological changes on the careers of world-class male tennis players. Within the past 10 years, the world's three most prestigious tournaments, each more than a century old, have all had their youngest men's singles champions.³ These performances have raised intriguing questions concerning possible changes in the relationship between age and performance in competitive tennis. Specifically, the economic and technological innovations of the past three decades may have resulted in changes in playing techniques and training methods that have lowered the optimum age of tennis players. Thus the lure of large financial rewards appears to have led to intensive coaching of more players at younger ages, which may lead to earlier success than in the past, and the greater speed of the game associated with the new rackets may have shifted the competitive advantage to faster, younger players. Yet beyond the dramatic example of the small number of champions who have won major tournaments at young ages, little is known of the experience of the great majority of competitive players. Do tennis players typically become successful at younger ages than in the past? Do they reach their competitive peak sooner, and retire earlier? This paper presents quantitative evidence on the careers of a large group of competitive players in order to provide a basis for systematic answers to these questions. To gain perspective on the recent changes in the sport, this study examines evidence that begins in the amateur era, before any of the major economic and technological innovations, and continues to the present.

The Data

No available data source contains information on the ages of all world-class tennis players over a substantial period of time. In the absence of such a source, this study has constructed a data set that covers a significant subset of world-class players over an extended period.

3. Boris Becker won Wimbledon in 1985 at age 17 years, 7 months; Michael Chang won the French Open in 1989 at 17 years, 3 months; and Peter Sampras won the U.S. Open in 1990 at 19 years, 1 month.

The United States Tennis Association annually issues national rankings for men's singles.⁴ This study attempted to obtain the ages of all men who appeared in these rankings from 1960 through 1991. The published men's rankings do not include information on the ages of those ranked. The ages of the great majority were obtained through searches of the USTA's published national rankings for boys' 18 and under and 16 and under singles, which do include the birthdates of all boys ranked. For two reasons, however, some nationally ranked men could not be found in junior rankings from earlier years: some had immigrated to the United States as adults, while others simply had never been nationally ranked as juniors. The birthdates of some of these remaining men were found in other published sources, while birthdates for others were obtained from the records of the USTA and its sectional associations, from the records of universities, or from interviews with players.⁵

The number of men ranked annually is not fixed, but is determined each year by the USTA ranking committee. While the total number varies from year to year, over time there has been a tendency to increase the number ranked: this increase has been moderate, from an annual mean of 55 during the 1960s to 64 during the '70s, 68 during the '80s, and 63 during 1990–91. In total, 459 different men were ranked by the USTA from 1960 through 1991; the data set used in this study includes birthdates for 449 of these, or 98 percent of the total. Those with missing birthdates tended to be less successful players: birthdates were obtained for all men ever ranked among the top 30 in the U.S. during 1960–91, and eight of the 10 men with missing birthdates appeared in the rankings for only one or two years. Table 1 presents the distribution of number of years ranked for all individuals ranked during 1960–91. Just over a quarter of all those ranked appeared in only one year, and more than a half appeared in three years or less. The greatest number of years ranked was 21, by Jimmy Connors, while 15 percent of those ranked appeared 10 or more times.

Competitive tennis is an international industry, and it is unfortunate that this study cannot consider evidence on players from all countries; only American citizens and resident aliens are eligible for USTA ranking. Yet the United States is the largest single producer of world-class tennis players. In 1991, for example, 17 of the top 100 players in the year-end international

4. These rankings appear in the *USTA Tennis Yearbook*, published annually throughout the period studied here for the USTA by H. O. Zimman, Inc., Lynn, Mass.

5. The published sources examined were *World Championship Tennis, International Who's Who in Tennis* (Dallas, 1983), and *1992 Player Guide, IBM/ATP Tour* (Ponte Vedra Beach Fla., 1992). I thank the following officers of USTA sectional associations for their help in providing birthdates of their members: Peter Herb, Northern California TA; Steven Jacques, Missouri Valley TA; Chip Powers, Western TA; Doug Booth Florida TA; Donnal Montee, Pacific Northwest TA; Stephanie Reiss, Eastern TA; John Callen, Southern TA; Charles Peix, New England TA; Margaret Meyer, Intermountain TA; Laura Canfield, Middle States TA; and Ken McAllister, Texas TA. I appreciate the help of Peggy Murphy, national USTA Ranking Coordinator. I also thank Joni Thomas of the University of Texas-Pan American, and the Admissions Offices of Florida State University and Lamar University for providing birthdates of alumni. And I am grateful to those players and their relatives who provided birthdates to me in telephone conversations or in person.

singles rankings were Americans. while no other country accounted for as many as 10. In the same year, more than one fifth of the men who played singles at Wimbledon were Americans, as were more than one quarter of those who played at the U.S. Open.⁶

Course of Economic and Technological Change

Although there is no available time series of the total prize money available in competitive tennis. an indication of this is given by Table 2, which shows the official earnings of the world's numbers 1, 10, and 20 players annually since 1968, as compiled by the Association of Tennis Professionals (ATP). The figures are for players of all nationalities, so they do not apply directly to the players considered in this study, but they obviously include many Americans. While these data suggest that rapid growth of earnings early in the Open era has given way to somewhat lower rates of growth in the past decade. they clearly demonstrate that at least some tennis players have reached levels of official earnings that compare favorably with those of many other professions, including other major sports.

In addition, it should be emphasized that the figures in Table 2 do not include many sources of earnings for tennis professionals. In addition to prize money. many top players receive substantial guarantees from individual tournaments in order to induce them to play in these events. Another source of earnings not included in Table 2 is the prize money of tournaments that are not sanctioned by the ATP. There are many such tournaments, and it is difficult to estimate the total money they pay annually to tennis players. The amount is considerable, however. A dramatic illustration of this is afforded by a single unsanctioned event, the Grand Slam Cup, which annually since 1990 has awarded \$6 million to a field of 16 players. including \$2 million to the winner. Another significant source of earnings. particularly for the top players. is exhibitions. And yet another source of income, again most important for the top players, is commercial endorsements of tennis equipment and other products.

Although the earnings of tennis players from all sources cannot be determined precisely, it is clear that tennis has become very lucrative for the best players. Thus. for example, *Forbes* placed nine tennis players on its list of the world's 40 highest-paid athletes in 1991, and estimated that individual male

6. 1992 *Player Guide, IBM/ATP Tour*, 428, 530-33. It might be noted that the demographic trends identified in this study for Americans should not be assumed to be the same as those for players of other nationalities. For a variety of reasons, the economic conditions facing players from other countries may be very different from those for Americans. In the absence of systematic study, a few differences can be mentioned as illustrations. Intercollegiate sports are unimportant in most countries other than the United States, and unlike Americans, foreign players have consequently not traditionally attended college. In the United States, players have typically received no financial support from the USTA unless they were among the top players in the world, or promising young players. In some countries, however, players with very low world rankings may receive substantial support from their national associations throughout their careers because they are the best players in their own countries, and represent them in Davis Cup, the Olympics, and other international competitions. Consideration of these and other economic differences among countries would be necessary before attempting to generalize from American demographic trends.

tennis players earned as much as \$7.4 million annually.⁷ During the past 25 years, tennis has clearly become one of the elite professional sports in which many can earn a living, and some can become very wealthy.

The major innovations in tennis racket technology began in the mid-1960s, when former French champion Rene Lacoste developed the steel racket.⁸ First sold by Lacoste in Europe, the racket was introduced in the United States by the Wilson Sporting Goods Company in 1967. Other innovations quickly followed. In 1968, A.G. Spalding & Bros. introduced an aluminum racket. Also in 1968, the Head Ski Company, which had earlier revolutionized the ski industry with aluminum skis, introduced a composite tennis racket, made of a plastic core sandwiched between sheets of aluminum. All the new metal rackets were stronger than wood rackets, and consequently more powerful, while weighing the same.

In 1975 Aldila, Inc., originator of graphite golf shafts, introduced graphite-reinforced tennis rackets. Mixed with plastic, graphite provided greater strength than wood or metal with less weight, and Aldila's new line included a racket that weighed just 11 ounces, compared to normal weights of 12.5–13 ounces for wood and metal rackets. In 1976, Prince Manufacturing introduced another major innovation. After selling the Head Ski Company in 1969, Howard Head had continued to experiment with new racket designs. He took his research to Prince Manufacturing, and in 1976 the company obtained a patent for an oversized aluminum racket, with a wider and longer face that had a surface area more than 50 percent larger than conventional designs. Head found that his new design not only disproportionately increased the racket's effective hitting area, as he had intended, but that it also had the unanticipated benefit of increasing the power generated by the strings. Also during the mid-1970s, several companies began molding glass fiber with polyethylenes and polyurethane components to make fiberglass tennis rackets.

The late 1970s and the 1980s saw continued experimentation with the new materials and designs used to make tennis rackets. Wood and metal gave way altogether to the new synthetic materials, used in a variety of composite blends. Conventional head sizes disappeared in favor of oversized and new intermediate, mid-sized heads. Most rackets produced today are composites, made of graphite, fiberglass, and newer synthetic materials such as boron and kevlar. These composites are considerably stronger than wood or metal, and both the

7. One indication of the significance of these other sources of income for the top players is afforded by recent estimates of the total incomes of the highest-paid players. During 1991, Andre Agassi's estimated total income of \$7.3 million was more than seven times as great as his official earnings of \$980,000; Pete Sampras' estimated total income of \$4.4 million was more than twice his official earnings of \$1.9 million. The estimates of total income are given in Newcomb, "Madonna is the Model."

8. The following summary of changes in racket technology is drawn from a number of sources. Notices of innovations include Charles Friedman, "Steel Racquet Kicking Up a Storm," *New York Times*, Sept 3, 1967; Parton Keese, "Aluminum Racquet Introduced," *New York Times*, May 8, 1968; Robin Herman, "A New Racquet for Tennis Fans," *New York Times*, March 28, 1976; Holcomb Noble, "Secret Weapon or Barn Door?," *New York Times*, November 21, 1976; and Martha Smilgis, "Graphite, Anyone? It's the Last Word in Snob Value, the \$200 Tennis Racket" *Sports Illustrated*, August 11, 1975.

new materials and new racket designs have substantially reduced the vibration caused by hitting the ball, thus transmitting less shock to a player's arm. Today's rackets have heads 25–60 percent larger than those of conventional rackets. Rackets currently produced are also lighter than wood or metal rackets, with some new models under 10 ounces, and virtually all less than 12.5 ounces.

Competitive tennis techniques and styles of play have been greatly affected by the new racket technology. The two-handed backhand, popularized in the men's game during the 1970s by Bjorn Borg and Jimmy Connors, proved to be ideally suited to the new, larger racket heads; the larger effective hitting area allowed players to produce more topspin that provided control for the greater power generated by the two-handed stroke. While the two-handed backhand might have gained in popularity even in the absence of the new racket designs, it is likely that its adoption would not have been as widespread without the new technology. The two-handed backhand has become a staple of the competitive game; in 1970, none of the top 10 American men used the stroke, whereas in 1991 seven of the top 10, and six of the seven in the top 10 aged 25 or under, normally hit two-handed backhands. The effect on the game has been great, for the backhand has become an offensive weapon for many more players than in the past. The serve has, of course, also been affected by the new rackets, as today's game places an even greater emphasis on power serving than was true in the past. Indeed, although opinions differ enormously on the desirability of recent changes in men's tennis, there is virtually unanimous agreement among both defenders and critics of today's competitive game that the new racket technology is directly responsible for a much greater reliance on power in all areas of the game than was ever true in the past.⁹

The trend toward greater power may continue in the near future, due to another recent innovation in racket technology. In 1987, Wilson brought to the United States another new racket design. Called the widebody because of the extreme thickness of the racket head, the new design generates even greater power. The design was quickly adopted by all other major manufacturers, and widebodies now dominate sales of rackets for recreational use. Yet widebodies are not used by most world-class men singles players, many of whom say that the power of the new rackets causes them an unacceptable loss of control. Some current players have predicted, however, that a new generation of young players will learn to use the widebodies more effectively, and that the result will be an even faster and more powerful men's game.

Thus major economic and technological changes have affected competitive tennis since the mid-1960s. The remainder of this paper will look for their effects on players' careers. The next section will examine quantitative evidence derived from the data set described earlier: a concluding section will then suggest interpretations for this evidence.

9. For example, see the symposium on power in *Tennis* (August, 1992), and the ATP Tour White Paper, "The Speed of the Game" (Key Biscayne, Fla., March, 1992).

Trends in the Ages of Tennis Players

Nationally ranked American men tennis players are on average older now than in the past. Table 3 presents the mean ages of all men nationally ranked annually for 1960–1991; these are graphed in Figure 1.¹⁰ This series demonstrates a clear upward shift over time. During the part of the amateur era covered, 1960–67, the mean age was always below 24, and in seven of the eight years it was below 23. In 1963, the mean age of all those ranked was as low as 21.7 years. For the first five years of the Open era, the mean remained below 24, though in the last three of those years it was above 23. In 1973, the mean age first rose above 24, and it has remained over 24 during all 19 years from then to the present; in three of those years it reached 25.

Thus one clear finding is that there was an increase in the mean age of all nationally ranked players, which occurred following the change from amateur to Open tennis. In the amateur era, the annual mean ages of all those ranked fell between 21.7 and 23.6 years, whereas after the first five years of Open tennis, the mean ages of all those ranked have ranged from 24.1 to 25.1 years.

Within the national rankings, over time the top players have become younger relative to the others ranked. Table 4 presents separately the mean ages of the top 10 and of the rest of the top 50 men ranked. The top 10 were older on average than the others ranked in nine of 10 years during both the 1960s and '70s. The age difference between the top players and the others decreased during the '80s, and in 1990 the top 10 were considerably younger on average than the others. So the traditional relationship, in which the top players were older than the others ranked, has not only been reduced in size over time, but has actually been reversed in some recent years.

Additional evidence on the ages of the best players is given in Table 5, which presents the annual mean ages of the top five men; this series is graphed in Figure 2. While the smaller numbers make the behavior of the series more volatile, the mean age of the top five also shows an increase from the amateur to the Open era. Thus while the mean was below 23 years in six of the eight years from 1960–67, it was above 24 in all 16 years from 1973–88, it was over 25 in 12 of those years, and it was actually over 27 in four years. Over the last five years, however, the mean age of the top five falls sharply from its highest level of the whole period examined, 27.6 years in 1987, to its lowest level of the whole period, 20.2 in 1991. This decline of more than seven years at the end of the series reinforces the possibility that recent years have seen the establishment of a new relationship, in which the very best players tend to be younger than the rest of those ranked.

10. All ages were calculated as of July 1 of the ranking year. These means include all men numerically ranked in each year, as well as all those ranked in Class A: they do not include players listed under Insufficient Data. (The USTA ranking regulations stipulate that a Class A category may be used "for giving recognition to players [who] qualify for a ranking but did not receive specific numbers : an Insufficient Data category may be used "for those player . . . with an outstanding record but who do not meet the minimum ranking requirements." i.e. who faded to play in the required minimum number of tournament.)

The increasing mean age of all ranked players over time suggests that career patterns have changed. One significant aspect of this is considered in Table 6, which shows the mean age at which those players who were ever ranked in the top 20 last appeared in the rankings. This age, which normally can be considered to indicate a player's age at retirement from competitive tennis, shows a dramatic increase, from 26.5 and below during the 1960s to 30.6 and over during the 1970s and early '80s. Successful players' careers were thus clearly extended in the change from amateur to Open tennis. Interestingly, however, the second half of the 1980s shows a decline of nearly two years in the mean age at last ranking.¹¹

The increase in the length of successful players' careers that occurred in the Open era is confirmed by Table 7. The mean number of years ranked for players who ever appeared in the top 20 rose from under 7.5 years during the '60s and early '70s to 12.5 years and over during the late '70s and early '80s. The recent decline in retirement ages seen above is also reflected in Table 7, which shows a drop to a mean of 9 years ranked for successful players who retired during the late '80s.¹²

Table 8 shows that there was also an increase in the early Open era in the typical age at which successful players first became ranked. The mean age at first ranking for players ever ranked in the top 20 rose from 19 during the '60s to 20 in the early '70s and has remained near 20 in the subsequent years. Though not large, the increase from the '60s to the '70s and '80s does point to an average delay of a year or perhaps slightly more in the age at which successful players first became ranked after the advent of Open tennis.

The advent of Open tennis also delayed the arrival of the best players at the top of the rankings. Table 9 shows the mean ages at which successful members of different birth cohorts achieved their personal best rankings. The mean age at best ranking was quite stable, at 22–22.5, for players who matured during the 1950s and the early '60s then rose above 24 for the first cohort that entered competition around the beginning of Open tennis, that of 1950–54.¹³ The mean age has remained near 24 for later birth cohorts. Thus the transition to Open tennis not only shifted upward the age at which successful players entered competitive tennis, but also delayed by an average of more than one year their achievement of their peak rankings.

Another view of changing career patterns is afforded by Table 10, which

11. The increase from 25.4 in 1965–69 to 30.6 in 1970–74 is statistically significant at the .02 level; the decline from 30.9 in 1980–84 to 29.0 in 1985–89 is statistically significant at the .03 level.

12. Both the increase in mean years ranked between 1970–74 and 1975–70 and the decline from 1980–84 to 1985–89 are statistically significant at the .01 level. In comparing Tables 6 and 7, it might be noted that the increase in retirement ages, during 1970–74, preceded the increase in mean years ranked, that occurs in 1975–79. In part, this is a result of the reappearance in the national rankings of three players—Barry MacKay, Pancho Gonzales, and Alex Olmedo—who had been contract professionals, and consequently excluded from amateur competition, during the 1960s. All three retired during the early 1970s, at the ages of 34, 45, and 37, respectively, but with relatively few years ranked, because of their ineligibility for USTA ranking during the amateur era.

13. The increase between the birth cohorts of 1945–49 and 1950–54 is significant at the .03 level.

examines changes in the tails of the annual age distributions. During the 1960s, many ranked players were teen-agers: in both 1960 and 1961, players under the age of 20 made up more than a quarter of the top 50, while on average during the '60s there were 10.2 players under the age of 30 ranked in the top 50 annually, or more than one fifth. This number fell during the Open era, so that from 1975 through 1987, teen-agers never made up as much as one tenth of the top 50, and in five of these years there were only one or two teen-agers in that group. The last four years have seen some increase, as in each year six of the top 50 players have been teen-agers.

As Table 5 would suggest, however, these nationally ranked teen-agers of recent years have been much more heavily concentrated at the top of the rankings than were the larger numbers of teen-agers nationally ranked during the '60s. During the '60s, on average only 1.1 teen-agers were ranked annually among the top 10, and this mean fell to 0.7 during the '70s, and to 0.6 during 1980–87. In contrast, in the past five years teen-agers have accounted for an annual average of 2.5 of the top 10 players.

Table 10 also shows that there were few players aged 30 and above ranked in the top 50 during the 1960s: in three years there were only two, and the annual average for the decade was just 3.2. The number of older players increased considerably during the following decade, as on average there were 6.3 players over 30 in the top 50 during the '70s, and this increase continued in the early '80s, with as many as 10 of the top 50 over age 30 in 1982, and an annual average of 7.8 during 1980–85. This trend was reversed after 1985, as there have been on average only 4.5 players over age 30 ranked in the top 50 during the past six years.

Although few players over 30 were ranked during the 1960s, in the amateur and early Open eras it was clearly possible for players to remain competitive even into their forties. Four different men above the age of 40 achieved national rankings during the 1960s, and a fifth did so in the early '70s; one of these was actually ranked in the top 10 in 1966, at age 42, while another reached the top 10 in 1972, at age 44.¹⁴ In striking contrast, no man above 40 held a national ranking from 1974 through 1991. Thus the national rankings included men above 40 in eight of the 14 years from 1960 to 1973, but in none of the 18 years that followed. With the disappearance of players over 40 from the rankings during the Open era in spite of the greatly increased economic incentives, it would appear that the ability of older players to compete in world-class tennis has diminished sharply over time.

The objection might be made that the prize money of the Open era has so increased the wealth of players that the disappearance of players over 40, and perhaps also the recent decline in the number over 30, are evidence not of a decreased ability to compete, but rather of a decreased desire to play: wealthier

14. The players over 40 who achieved national rankings are: Gardnar Mulloy, 1961–62; Thomas Brown, 1964, 1969–70; Richard Sorlien, 1964; Victor Seixas, 1966; Richard Gonzales, 1972–73. Jimmy Connors turned 40 on September 2, 1992; he will become the first 40-year-old to be nationally ranked since 1973.

players can now afford to retire at younger ages. While this effect may influence the decisions of a few very successful players—the wealth of the Swedish stars Bjorn Borg and Mats Wilander may have contributed to their decisions to retire while still in their twenties¹⁵—the skewed distribution of prize money, and the even more highly skewed distribution of income from other sources, probably severely limit the significance of this effect for most players. Evidence from the careers of American players reveals no increasing tendency for players to retire when they were still able to compete successfully. On the contrary, Table 11 shows that during the Open era successful American players were much less likely to retire from high rankings than was the case during the 1960s: during the '60s, seven players retired while ranked in the top 10, and another 13 while ranked in the second 10, compared to only three players from the top 10 during the '70s and '80s together, and six from the second 10.¹⁶ Furthermore, in spite of the increasing prize money during the Open era, there has been no recent increase in the tendency for players to retire from high rankings: only one player retired while ranked in the top 10 during the 1980s.

The significance of this evidence on players' final rankings is underscored by Table 12, which shows the official 1991 earnings of American players by ranking. More than two fifths of the players with reported incomes who were ranked below the top 20 earned less than \$50,000.¹⁷ Since the evidence on earnings is taken from a press guide, the less successful players are generally omitted; it is likely that players without reported incomes also earned less than \$50,000, and this would raise to more than 60 percent the share of the players ranked below 20 who earned gross incomes below \$50,000. With the high travel costs involved in playing the international tour, it is unlikely that many of these players could have been able to enjoy substantial net earnings. In light of this evidence on earnings, it appears likely that few players recently have retired while they still had significant positive net earnings from tennis.

15. Borg and Wilander are probably the two men most often mentioned in speculation about the role of psychological stress in retirement from competitive tennis. Borg retired after the 1981 season, during which he won the French Open and was runner-up at Wimbledon and the U.S. Open, at the age of 26. Wilander left tennis in 1991, at age 27; three years earlier, in 1988, he had won the Australian, French, and U.S. Opens. Borg's official earning totaled \$3.6 million, Wilander's \$7.4 million; *1992 Player Guide, ATP/IBM Tour*, 369-392.

16. Table 11 show that eight players were last ranked in the top 10 during the 1960's, whereas the text states that seven retired while ranked in the top 10 during that decade. The discrepancy results from a case in which a player's disappearance from the USTA rankings did not result from his retirement from competitive tennis, as Earl Buchholz, Jr., became a contact professional—and thus ineligible for USTA ranking—after last being ranked by the USTA in 1960. In all other cases, final disappearance from the USTA rankings does appear to have resulted from a player's retirement from competitive tennis. Thus several other Americans ceased to be ranked by the USTA during the '60s as a result of turning professional, but in all cases they were again ranked by the USTA after the advent of Open tennis, and in consequence none of these disappearances appears as a departure from the ranking in Table 11.

17. An aspect of Table 12 that might appear puzzling is the weak correlation between ranking and earnings at low ranking. The major explanation for this is that whereas the rankings are based exclusively on singles competition, the earning include prize money from both singles and doubles play. In all seven cases in which a player ranked below 25 had earning above \$100,000, the player's earning came primarily from doubles.

Interpretation: Regimes of Competitive Tennis, 1960–1991

The evidence examined above clearly indicates that there have been at least two distinct labor market regimes in American men's tennis during the past three decades. Less definitely, the evidence also suggests the possibility that a third regime recently may have begun.

The first regime was that of amateur tennis. The average age of all competitive players was low, normally below 23. Many of the ranked players, typically a fifth and sometimes a quarter, were teen-agers, while less than a tenth were over 30. The top players were on average somewhat older than other ranked players, but even successful players, those ever ranked in the top 20, left competitive tennis at average ages of only 25 or 26.

The lack of financial rewards during the amateur era was directly responsible for the youth of competitive players. Few players could afford to play competitive tennis for long after they left college. because of the difficulty of earning a living as a tennis player, and the consequent pressure to get a job or pursue graduate studies. The resulting typicality of early retirement from competitive tennis limited the number of full-time players. One consequence of this was that talented players could become nationally ranked at very young ages; many players were ranked while attending college. and playing competitive tennis only part-time. The top players could earn some money while playing competitive tennis, either within the limits defined by amateur restrictions or through unofficial means. and this allowed them to play somewhat longer than those ranked lower. Yet these earnings were moderate at best, and it was very rare for anyone to compete full-time as late as the age of 30; some players over 30 who were ranked had entered other careers, and continued to play competitive tennis during their vacations. The presence of several players over 40 in the national rankings during the '60s further emphasizes that it was the lack of economic rewards that led most players to retire early, rather than an inability of older players to compete successfully.

The second regime began with the arrival of Open tennis in 1968. Following a transition period, the average age of nationally ranked players rose above 24. Teen-agers fell to less than a tenth of those ranked. while the share of players over 30 increased to consistently more than a tenth, and even as high as a fifth. The age difference between the top players and the rest of those ranked diminished over time, leaving no real difference by the 1980s. The length of the careers of successful players under Open tennis rose sharply, as those ever ranked in the top 20 remained in the national rankings until average ages over 30.

The prize money of Open tennis removed the economic pressure for players to retire young. Many players now found they could earn more playing tennis than in other careers, and they responded by playing longer than in the amateur era. As the number of active competitive players increased. it became more difficult to become nationally ranked, and fewer players gained

rankings in their teens; the larger pool of competitive players, and the resulting greater commitment of time and effort needed to succeed, also meant that few players could obtain rankings while attending college.¹⁸ Those players who reached the top of the rankings now did so at a somewhat older age. The greater intensity of competition also reduced the ability of older players to compete, and players over 40 disappeared from the rankings after the early years of the Open era. With many more players able to support themselves by playing tennis, the advantage of the top players in this regard was reduced, and the age difference between the best players and the others disappeared.

The quantitative evidence of these differences between the amateur and Open eras is strong, and leaves no doubt of the distinct contrast in the labor market regimes. That this change was the direct result of economic forces seems equally clear. But the quantitative evidence also suggests that another change may be occurring, and that the late 1980s may have begun a transition to yet a new regime.

Contrary to the trend of the 1970s and early '80s, the recent past has seen an increase in the importance of young players in American competitive tennis. Although this has not involved a substantial change in the mean age of all ranked players, it has appeared most obviously among the best players. In 1990, the top 10 were almost two years younger on average than the rest of the top 50, and the mean age of the top five has fallen sharply during the past five years, reaching its lowest level of the past 30 years—and probably its lowest level ever—in 1991, at a mere 20.2 years. In sharp contrast to both the amateur era and earlier in the Open era, when virtually all American competitive tennis players attended college, none of the top four players in the 1991 rankings had ever enrolled in college: all had become professionals by the age of 18.¹⁹ Since 1985 the proportion of all ranked players over the age of 30 has fallen generally to less than a tenth, and the mean age at which those ever ranked in the top 20 last appear in the rankings has fallen below 30.

The late 1980s and early 1990s may prove to have been a period of transition to a third distinct labor market regime. Alternatively, this may prove to be simply a temporary deviation within the earlier Open regime marked by the arrival of a small group of exceptional players almost simultaneously. Some observers do believe that a new regime is beginning, as a result of a combination of economic and technological forces that have given an advantage to younger players.²⁰ The basis for their belief can be summarized as follows.

18. In recognition of the increasing numbers of competitive players, in 1984 the USTA increased the minimum number of tournaments required for ranking in men's singles from five to nine.

19. During the 28 years from 1960 to 1987, the top men's ranking in the United States was held in only one year by a player who had never attended college. In contrast, two players who held the top ranking in three of the four years 1988–91 never enrolled in college.

20. For an early discussion of this belief, see Peter Alfano, "The Oversized Generation: Big Rackets Help Youth Rule in Tennis," *International Herald Tribune*, June 27, 1989.

The advent of Open tennis increased both the earnings and the fame of the game's top players. As tennis became more prominent during the 1970s, many more children began playing the game than in the past.²¹ Junior competitions and training programs proliferated, and for the first time, tennis academies were established where children could live and train year-round. The construction of many indoor tennis clubs during the tennis boom of the 1970s also greatly increased the amount of practice time available for junior development in many places. The arrival of larger cohorts of tennis players by itself would be expected to increase the average quality of competitive players, as larger numbers of excellent athletes chose tennis over other sports and occupations. So from economic causes alone, we would expect that recent years would have seen an increased intensity of competition in men's tennis, as the cohort of players who began to play during the tennis boom of the 1970s reached ages at which they began adult competition. The more intensive early training of this cohort might also have been expected to result in greater success at earlier ages, as the greater time and effort spent on tennis in childhood made teen-aged players more advanced technically than in the past. And the increasing amounts of prize money might be expected to lure players into professional tennis at younger ages, as a result either of dropping out of college or of bypassing college altogether.

The impact of this tennis boom cohort may have been increased by the availability of the new racket technology. The development of the new larger composite rackets during the 1970s and early 1980s made it possible to hit harder with less effort, and therefore increased the rewards for offensive tennis. While this had some immediate impact on men's competitive tennis, its effect on mature players was much less than on young players who had never used the old rackets, and who could consequently adapt their games more fully to the new technology. Beginning with players who first took up tennis during the 1970s, a new style of play emerged, with techniques and strategy designed to take advantage of the power and size of the new rackets: prominent among the changes are the more widespread USC of considerable topspin on groundstrokes, normally with two-handed backhands, a greater reliance on power serving, and generally a greater emphasis on offensive tennis. This new style of play has increased the pace of the game, and consequently places a greater premium on players' reflexes and speed; it has reduced the effectiveness of defensive play and complex tactics, and has therefore tended to reduce the value of experience. As this new cohort reached the late teen ages, some of its members rose quickly to the top of the adult rankings: the top five players in the 1991 rankings, born during 1969–72, are all members of the first cohort that grew up using exclusively the larger composite rackets, and playing with the new style. At the same time,

21. Survey estimates indicate that the number of Americans who played tennis at least once during a given year rose from 5 million in 1960 to more than 30 million in the late '70s, fell to 13 million in the mid-'80s, and rose to 23 million in 1992; *Tennis Week*, Vol. 19, No. 15 (March 25, 1993): 17.

the greater speed of the new style of play may have reduced the ability of older players to compete, and this may have caused retirement ages to begin to fall. It is also possible that the fall in retirement ages has resulted in part from greater injury rates, caused by the more violent and physically demanding nature of the new style, as well as the cumulative effects of the greater duration and intensity of training and competition at younger ages.

The demographic changes in men's tennis since the mid-1980s may therefore mark the beginning of a new regime in which tennis attracts larger numbers of excellent athletes who play a new brand of power tennis, and become successful—and perhaps also retire—at significantly younger ages than earlier in the Open era. Alternatively, there may prove to be no completely new labor market regime: the greater availability of training programs and the new racket technology may have made it possible for more players to become successful at younger ages even as the greater prize money increased the incentive for them to do so, without necessarily making it impossible for older players to remain competitive.²² Furthermore, the tennis boom of the 1970s was followed by a sharp decline in interest in the 1980s, and the smaller numbers of children attracted to the sport in that decade may result in a drop in the number of exceptional American players in the cohort entering adult competition during the 1990s. The coming decade will tell whether economic and technological forces together have produced a genuinely new regime in the tennis labor market, in which the top positions in the rankings will be dominated by young players and retirement ages will continue to decline, or whether the regime of the earlier Open era will continue, with generally long careers of successful players, and perhaps only occasional exceptionally talented individuals who become champions at young ages.

22. It is also possible that the extraordinary early success of the current top American players is not simply the result of the economic and technological changes described above, but is in part the result of an extraordinary investment by the USTA in developing these players during the 1980s. With the mean age of the top five Americans above 27 during the mid-'80s, and with no new stars on the horizon to replace Jimmy Connors and John McEnroe—aged 31 and 28, respectively, in 1987—during the mid-'80s the USTA undertook a substantial and perhaps unprecedented investment program in the training of a number of promising juniors, including Michael Chang, Pete Sampras, and Jim Courier. It is possible that this program succeeded in accelerating the development of these players, as all three of those named entered the U.S. top 10 by the age of 18, two of the three won Grand Slam events while still in their teens, and the third became the top-ranked player in the world at the age of 21. If the USTA program was a principal cause of the recent decline in the mean age of the top American players, and if the USTA does not maintain the same level of expenditure on junior development, the dramatic recent trend shown in Figure 2 may be reversed in future.

Table 1: Distribution of Number of Years Ranked, For All Men Ranked During 1960–1991		
Years Ranked	Number of Men	Percent
1	121	26.4
2	74	16.1
3	43	9.4
4	36	7.8
5	30	6.5
6	34	7.4
7	22	4.8
8	12	2.6
9	18	3.9
10	15	3.3
11	11	2.4
12	9	2.0
13	4	0.9
14	12	2.6
15	8	1.7
16	4	0.9
17	4	0.9
19	1	0.2
21	1	0.2
All	459	

Source: The and all other tables in this study (except where noted) are based on the data set constructed for the study and described in the text.

Table 2: Official Earnings of Numbers 1, 10, and 20 Players, 1968–1991 (thousands of dollars)

Year	No. 1		No. 10		No. 20	
	Nominal	Real	Nominal	Real	Nominal	Real
1968	64	184	6	17	N.A.	—
1969	124	338	42	114	21	57
1970	201	518	67	173	32	82
1971	293	723	75	185	32	79
1972	176	421	68	163	40	96
1973	229	516	88	198	49	110
1974	285	578	116	235	63	128
1975	327	608	138	257	86	160
1976	484	851	209	367	82	144
1977	766	1,264	219	361	124	205
1978	575	882	350	537	166	255
1979	1,009	1,390	235	324	141	194
1980	972	1,180	280	340	171	208
1981	991	1,090	245	270	183	201
1982	2,029	2,103	401	519	263	273
1983	1,747	1,754	307	308	221	222
1984	2,026	1,950	320	308	208	200
1985	1,971	1,832	395	367	252	234
1986	1,988	1,814	442	403	228	208
1987	2,004	1,764	459	404	257	226
1988	1,727	1,460	506	428	317	268
1989	2,344	1,890	479	386	303	244
1990	1,996	1,527	638	488	349	267
1991	2,364	1,754	672	499	411	305

Source: 1992 Player Guide, IBM/ATP Tour (Ponte Vedra Beach, Fla., 1992), pp. 4347–39.

Note: Real values were obtained by deflating by CPI, 1982–84=100.

**Table 3: Mean Age of All Nationally Ranked American Men
1960–1991**

Year	Mean Age (yrs.)	N
1960	22.14	50
1961	22.98	45
1962	22.33	55
1963	21.67	63
1964	23.61	70
1965	22.74	53
1966	22.54	52
1967	22.55	58
1968	22.73	55
1969	22.78	40
1970	23.38	55
1971	23.02	57
1972	23.29	59
1973	24.12	60
1974	24.15	61
1975	24.42	65
1976	24.52	65
1977	24.30	61
1978	24.60	75
1979	24.97	71
1980	24.74	74
1981	25.14	69
1982	25.06	70
1983	24.80	69
1984	24.86	70
1985	25.01	75
1986	24.67	73
1987	24.52	62
1988	24.64	56
1989	24.52	56
1990	24.25	64
1991	24.39	61

Note: Means include all men numerically ranked and all those in Category A. Men listed in Insufficient Data are excluded.

Table 4: Mean Ages of Top 10 and Nos. 11–50, 1960–1991

Year	Mean Age Nos. 1–10	Mean Age Nos. 11–50	N
1960	22.5	22.1	40
1961	23.7	22.8	35
1962	23.2	22.2	40
1963	22.1	22.2	40
1964	23.5	23.3	39
1965	23.0	22.8	38
1966	25.1	21.9	42
1967	24.0	22.4	38
1968	24.5	22.0	39
1969	24.2	22.3	30
1970	25.9	22.4	39
1971	24.0	23.0	40
1972	24.4	23.5	39
1973	25.7	24.2	40
1974	25.9	24.0	40
1975	24.4	24.8	40
1976	25.5	24.3	40
1977	25.0	24.7	40
1978	25.8	24.8	40
1979	26.0	25.1	40
1980	26.4	25.2	40
1981	25.2	25.7	40
1982	26.4	24.8	40
1983	26.4	24.4	40
1984	24.5	25.3	40
1985	25.0	25.6	40
1986	25.6	24.4	40
1987	25.8	24.7	40
1988	25.0	24.7	40
1989	24.9	24.7	40
1990	22.4	24.7	40
1991	25.0	24.2	40

Note: N is less than 40 in some years because less than 50 men were ranked and/or because of missing birthdates. In years when less than 50 were numerically ranked, if available, Class A players were included; this occurred in 1960, 1961, 1966, and 1969. since Class A players were listed alphabetically, they were considered to be tied, so all were included whenever Class A was used.

**Table 5: Mean Age of Top 5
1960–1991**

Year	Mean Age
1960	22.2
1961	25.6
1962	23.4
1963	21.8
1964	22.4
1965	21.2
1966	21.6
1967	22.8
1968	22.2
1969	24.0
1970	24.2
1971	23.8
1972	22.4
1973	25.8
1974	26.6
1975	24.0
1976	25.4
1977	24.6
1978	24.0
1979	26.4
1980	24.8
1981	25.4
1982	27.0
1983	25.0
1984	25.2
1985	27.2
1986	27.4
1987	27.6
1988	25.8
1989	22.8
1990	24.0
1991	20.2

**Table 6: Mean Age at Last Ranking
For Players Ever Ranked in the Top 20**

Date	Mean Age	N
1960-64	26.46	24
1965-69	25.44	18
1970-74	30.65*	17
1975-79	31.29	14
1980-84	30.86	22
1985-89	29.00*	27

*Significantly different from previous period at .05 level.

**Table 7: Mean Numbers of Years Ranked at Time of
Retirement, for Players Ever Ranked in the Top 20**

Date	Mean Years	N
1960-64	6.0	24
1965-69	6.4	18
1970-74	7.4	17
1975-79	12.5*	14
1980-84	12.6	22
1985-89	9.0*	27

*Significantly different from previous period at .01 level.

Table 8: Mean Age at First Ranking for Players Ever Ranked in the Top 20 1961–1989

Years	Mean Age	N
1960–64	19.1	25
1965–69	18.8	22
1970–74	19.9	16
1975–79	19.7	15
1980–84	20.4	20
1985–89	20.4	20

Table 9: Mean Age at Which Players First Achieved Personal Best Ranking, for Players Ever Ranked in the Top 20, by Birth Cohort

Birth Years	Mean Age	N
1935–39	22.5	17
1940–44	22.2	26
1945–49	22.1	20
1950–54	24.3*	22
1955–59	23.8	19
1960–64	23.7	21

*Significantly different from previous cohort at .05 level.

Table 10: Numbers of Men Under Age 20, Age 30 and Over Ranked in Top 50

Year	No. Under 20	No. 30 and Over
1960	14	3
1961	13	4
1962	11	2
1963	9	2
1964	6	4
1965	7	3
1966	12	4
1967	11	4
1968	10	4
1969	9	2
1970	12	4
1971	9	3
1972	8	6
1973	4	8
1974	5	8
1975	2	6
1976	4	8
1977	4	7
1978	4	7
1979	2	6
1980	1	6
1981	2	6
1982	3	10
1983	3	9
1984	3	7
1985	1	9
1986	3	4
1987	3	4
1988	6	4
1989	6	6
1990	6	4
1991	6	5

Table 11: Distributions of Last Ranking Held, For Players Ever Ranked in the Top 20, by Period

Ranking	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89
1-10	4	4	1	1	1	
11-20	6	7	1	1	2	2
21-30	6	2	5		2	5
31-40	3	1	2	2	3	9
41-50	5	3	5	5	5	7
51-60			3	4	6	4
61-70				1	3	
Total	24	17	17	14	22	27

Table 12: Official Earnings of American Players by Rank, 1991

Rank	\$ (thousands)	Rank	\$ (thousands)
1	1,748	28	108
2	1,908	29	47
3	983	30	41
4	462	31	28
5	479	32	47
6	400	33	35
7	224	34	62
8	344	35	165
9	321	36	75
10	333	37	N.A.
11	224	38	N.A.
12	328	39	109
13	208	40	35
14	95	41	33
15	139	42	N.A.
16	243	43	41
17	257	44	28
18	87	45	N.A.
19	138	46	N.A.
20	n.a.	47	284
21	125	48-53	N.A.
22	339	54	195
23	79	55-57	N.A.
24	88	58	41
25	48	59	19
26	330	60	77
27	59	61	124

Source: Earnings are taken from 1992 Player Guide, IBM/ATP Tour.

Figure 1: Mean Age of All Nationally Ranked Men, 1960-1991

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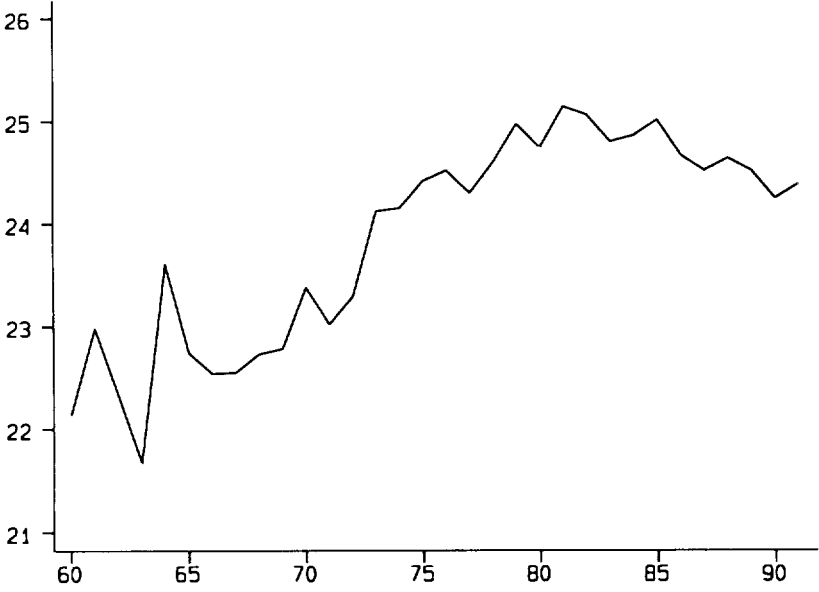


Figure 2: Mean Age of Top Five Men, 1960-1991

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