They Don't Make Economics (or Economists!) Like they Used To

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PRELIMINARY

This paper contributes to the long-standing literature on life-cycle creativity by studying how the age at which important contributions are made changes over time within a discipline. Using data on the most important publications of Nobel laureate economists and papers from the *American Economic Review*, we show that the age or experience level at which economists make important contributions has increased over time, leveling off in the early 1970s. This pattern cannot be explained by the two most prominent explanations - trends in more technical or theoretical conceptual work relative to more empirical experimental work or an increasing burden of knowledge. The one factor that may explain the observed age patterns are trends in coauthoring, which increases around the time that ages stop increasing and may allow people to make contributions at younger ages.

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I. Introduction

Research on the relationship between age and creativity dates back to the 19th Century (Beard [1874]). Psychologists, sociologists, and economists have all studied differences across disciplines in the age at which innovators do important work however, until recently, scholars have not studied differences within fields in the age at which scholars make important contributions. The age or experience level at which innovators make important creative works can both vary within fields at a point in time and change over time. This paper studies trends in the nature of economics work over the second half of the 20th century and how they are related to the age at which economists do important work. Economics is a particularly interesting discipline to study insofar as over the period studied, the nature of work in economics has changed substantially in ways that are objectively measurable.

We explore three aspects of work that have been shown to affect the age or experience level at which contributions are made. First, we distinguish the extent to which work is experimental versus conceptual. Galenson [2001, 2006], Galenson and Weinberg [2000, 2001], and Weinberg and Galenson [2007] identify inductive work, which is frequently empirical, as experimental and deductive work, which is frequently theoretical, as conceptual and show that experimental innovators make their important contributions later in life than conceptual innovators. For instance, Weinberg and Galenson [2007] find that experimental Nobel Laureates in economics do their most important work in their mid-50s whereas their conceptual counterparts do their most important work in their mid-20s. We show that until the 1970s economics was becoming more conceptual, but that this trend has, if anything, reversed in recent years, which would generate an upside-down V in ages.

Jones [2005] and Jones and Weinberg [2008] consider a second set of factors, arguing that the accumulation of knowledge generates a burden for innovators. As knowledge accumulates, it takes longer to acquire and parse the knowledge that is necessary to make important contributions, leading to an increase in the age at which important contributions are made as knowledge accumulates. Our measures of the stock of knowledge drawn on by papers shows little increase until the early 1980s.

Lastly, it is possible that one or both of these forces can be offset by changes in the number of coauthors. Jones [2005] and Wutchy, Jones, and Uzzi [2007] argue that one way to compensate for a greater burden of knowledge is to increase the size of teams and show that the number of co-author on scientific papers has increased over time.

We explore how economics has changed and how these changes are related to the age at which economists make important contributions in two data sets. The first data set comprises the important works of Nobel Laureates in Economics, identified using citations. The second data set comprises one full-length article taken from each issue of the *American Economic Review* from 1950 to 2000.

Both these datasets show that the age or experience level at which important contributions are made in economics has increased over time. This finding is similar to that found in chemistry, medicine, and physics (see Jones and Weinberg [2008]). The experience level at which people publish in the *American Economic Review* stops increasing in 1980.

Interestingly, these changes in ages do not line up with either the extent to which work is experimental versus conceptual or the burden of knowledge. As indicated, until the 1970s, work in economics was becoming more conceptual and less experimental, which would be expected to lead to a decline, not an increase, in the age at which contributions are made. This shift toward conceptual work decelerated or reversed around the time when the experience of contributors stopped increasing. The knowledge burden argument does not do any better - the amount and age of knowledge appear to have increased around the time when ages stopped increasing. A shift to more coauthoring in the early 1980s may explain why the age at which people make important contributions stopped increasing at that time.

As indicated, research on of life-cycle creativity, much of which has been done by psychologists, has aggregated individual creators to the discipline-level, studying differences across disciplines in age of peak creativity. These studies tend to find relatively small variations across disciplines in the age of peak creativity, with creativity peaking in the mid or late 30s or early 40s in most disciplines (e.g. Lehman 1953, Chaps. 15-16; Simonton 1988, pp. 66-71). The handful of economists who have studied life cycle creativity have also treated disciplines as the unit of analysis (see Lillard and Weiss 1978; Diamond 1986; Levin and Stephan 1991; Stephan and Levin 1993; Hamermesh and Oster 1998; Van Dalen 1999).

This paper is part of a larger research agenda showing that (1) cross-sectional variations in the age at which people do their important work within a disciple and (2) changes over time in the age at which people in a discipline do their important work are both large relative to the cross-disciplinary differences that are the focus of existing work. The relationship between age and creativity is particularly timely as our workforce ages.

We also depart from most of the existing literature by paying particular attention to very important innovators under the belief that important individuals are particularly interesting for understanding innovation. Most exiting work focuses on less important scholars (exceptions are Stephan and Levin 1993; van Dalen 1999; Jones 2005; and Jones and Weinberg 2006).

II. Data

We employ two datasets for the analysis. The first comprises the most important works of Nobel Laureates in Economics. These works are a sample of the most important contributions in economics. The second comprises one article from each issue of the *American Economic Review* from 1950 to 2000. This sample captures important contributions, but ones that are, as a whole, less extreme and thereby better indicators of trends in broader section of economics work.

Experimental and Conceptual Work

As indicated, we focus on two aspects of work that have been related to the age at which innovators make important contributions. First, we distinguish the extent to which work is experimental versus conceptual (see Galenson [2001, 2006], Galenson and Weinberg [2000, 2001], and Weinberg and Galenson [2007]). Experimental innovators work inductively. Their innovations derive from knowledge accumulated with experience. Because empirical research frequently involves generalizing from a body of evidence, empirical innovators are often, but not always, experimental. Experimental work because accumulating a large body of knowledge takes time, important experimental work tends to be done relatively late in the career. For instance, Weinberg and Galenson [2007] find that experimental Nobel Laureates in economics do their most important work in their mid-50s.

By contrast, conceptual innovators work deductively. There innovations derive from *a priori* logic. Theorists tend to be conceptual. The most abstract and mathematical theorists tend to be the most conceptual. Conceptual innovations are made more quickly, and can occur at any age. Yet the most radical conceptual innovations depend on perceiving and appreciating the most radical departures from existing conventions, and this ability tends to decline with experience, as habits of thought become more firmly established. Thus, Weinberg and Galenson [2007] find that conceptual Nobel Laureates in economics do their most important work in their mid-20s.

We have obtained objective characteristics of the works in our sample.[1] As indicated, experimental work relies on direct inference from fact. The characteristics that measure the use of facts with the least processing are (1) references to specific items – places, time periods, and industries or commodities; (2) the presence of a data description, including a data appendix; (3) tables or figures presenting data or cross-tabulations.

Conceptual work involves deriving results from assumptions made *a priori*. The characteristics that are most associated with conceptual work are (1) the use of assumptions and proofs; (2) the use of equations; (3) the presence of a mathematical

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[1] We examined 19 pages from each piece. When the work contained 20 or more pages, we sampled 19 pages evenly spaced through the work – the pages that were 5%, 10%, 15% and so forth through the work. When a work contained less than 19 pages, we inspected all pages. To obtain estimates that would be comparable to works with 19 or more pages, we calculated the number of each item per page and multiplied these per-page figures by 19. When a page partially or completely blank, we used the following page or, if that page was partially or completely blank, the preceding page. Complete pages of references were replaced by the last page that was not in the references section. Appendix pages and pages of notes

appendix or introduction; and (4) the use of theoretical figures and tables (including payoff matrices).

As indicated, Economics is appealing for our purposes because of the large observable and objective differences between conceptual and experimental works in economics and the shifts that have occurred over the period studied. While many of the criteria we use to distinguish conceptual and experimental work in economics relate to the use of mathematics, our work on artists shows that the same variations between conceptual and experimental work arise even in fields where mathematics is not used.

The use of statistical procedures has a non-monotonic relationship to the type of work. It tends to be highest in works that are neither extremely conceptual nor extremely experimental because the most extreme conceptual work rarely involves any empirical work and the most extreme experimental work usually uses data, but with less processing. The increase in the use of statistical procedures through much of the range from the most experimental laureates toward more conceptual laureates is significant in that it indicates that there are large variations in the nature of work even among empirical laureates. Thus, our distinction between conceptual and experimental work captures variations in the nature of work beyond whether it is empirical or theoretical.

Knowledge Burden

Jones [2005] and Jones and Weinberg [2006] emphasize the importance of knowledge accumulation and the burden of knowledge for the age at which innovators make important contributions. As knowledge accumulates, it takes longer to acquire and parse the knowledge that is necessary to make important contributions, thus we expect

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were included.

the age at which important contributions are made will increase as knowledge accumulates.

We have two variables that capture the burden of knowledge in works published in the *American Economic Review*. The first is the total number of citations in a work. The second is the average age of citations.

Jones [2005] and Wutchy, Jones, and Uzzi [2007] argue that one way to compensate for a greater burden of knowledge is to increase the size of teams and that the number of co-author on scientific papers has increased over time. We also have the number of coauthors on publications in the *American Economic Review* and study trends in co-authorship.

II.A. Nobel Laureates

Our data cover Nobel laureates in economics born in or before 1926 who published primarily in English.[2] To identify the most important works of the Nobel Laureate Economists, we use citations. Citations were collected from the Web of Science, an on-line database comprising the Social Science Citation Index, the Science Citation Index, and the Arts and Humanities Citation Index.[3]

We collected the number of citations to all works in each year of each laureate's career made between 1980 and 1999 inclusive.[4] These data on citations to the works each

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[2] Maurice Allais, Leonid Kantorovich, Tjalling Koopmans, and Reinhardt Selten were excluded because of language of publication. (Koopmans' began his career as a physicist and his most cited publication, *Über die Zuordnung von Wellenfunktionen und Eigenwerten zu den einzelnen Elektronen eines Atoms*, is in Physics in German.

[3] We searched for citations under each Nobel laureate's last name and initials. For laureates who published with their middle initial, we searched for citations with and without the middle initial. To exclude citations to other authors with the same last name and initials, citations were checked against publication lists. The database lists coauthored papers under the lead author's name. Citations to the Modigliani-Miller papers were included in the counts for both laureates.

[4] Collecting citations to individual works would have been prohibitively costly given the number of

laureate published in each year of his career are our units of analysis. For the purpose of the empirical analysis, laureates are included in our sample from the time they received their doctorate or from the time of their first cited publication if it preceded their doctorate or if they never earned a doctorate.

A scholar's importance rests primarily on his or her most important contributions. To identify the Nobel Laureates' important contributions, we identify all years in which a laureate's citations are above a threshold -- 2 of his standard deviations above his mean, which we refer to as his *two standard deviation peaks*. We also identified each laureate's single best year as the year in which he published the works that received the most citations.

Most other analyses of Nobel laureates, especially of those in the hard sciences, have sought to identify when people did the work for which they received their Nobel Prizes. Unfortunately, the Nobel Committee does not systematically indicate the publications for which economics prizes were awarded. Consequently, researchers who have sought to use the Nobel Committee's statements to date when economists did their most important work have, in fact, been forced to rely on a wide variety of approaches. (For instance, van Dalen 1999 uses reports of the Nobel Prize committee, but also uses autobiographies, biographies, and citations.) Citations provide a widely-accepted,

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published works and the number of citations. In virtually all years with high citations, a single work dominates the citations. Citations to important books were assigned to the year the first edition was published. The period 1980-1990 was chosen based on the availability of online data. Citations to works that have been incorporated into the literature will be lower. Works published around 1980 will receive more citations than those published earlier or later. The dates reflect when works were published, which will be after the work was done, because of publication lags. We are not aware of reasons why any of these factors would bias our estimates for age or trends in content.

objective method that can be consistently applied to all the laureates.[5]

Our measure identifies scholars' most influential work, which will reflect a combination of the originality of the work and the importance of the question to other scholars.[6] While the receipt of a Nobel Prize may increase an individual's citations (see Merton 1968), we do not use citations to make inter-personal comparisons, only to determine when each laureate did his most important work. We are not aware of evidence that receiving a Nobel Prize increases citations to work from particular ages nor are we aware of reasons that additional citations would be to relatively experimental or conceptual works or why the types of works cited would change over time. Appendix Table 1 details the construction of the variables used and reports their means and standard deviations.

II.B. The American Economic Review

To obtain a sense of how work is changing among a broader selection of important economics work we study one article from each issue of the *American Economic Review* from 1950 to 2000. We focused on the fourth article to ensure that we obtained a full-length article that was not a presidential address or Nobel lecture.

The age of the Nobel laureates can be calculated from publicly available data on their years of birth. Systematic data is not available for authors in the *American Economic Review*. Consequently, instead of measuring age for these authors, we use experience, defined as the difference between the publication date and the date a person

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[5] While our understanding of the Nobel citations, when they are sufficiently explicit, indicates that the most cited works and the works for which people received the Nobel Prize frequently coincide, when they do not, it is not clear that the opinion of the Nobel Prize committee is preferable to that of the discipline as a whole.

[6] On citations as a measure of scientific importance, see Simonton 1988, pp. 84-85.

received his or her doctorate. Data on when doctorates were received was obtained from the UMI Dissertation Database, which was hand matched to the sample of authors. The UMI Dissertation database, has limited coverage for non-American institutions, especially in the early years, and this data was supplemented by web searches.

We also collected data on the first 49 works cited in each article, which can be used to study the age and amount of knowledge drawn on by each paper. The construction of the variables in the *American Economic Review* differs somewhat from that for the Nobel laureates. Appendix Table 2 details the construction of the variables used and reports their means and standard deviations.

III. Results

III. A. Nobel Laureates

We begin by estimating how economics publications have changed over time. The model for this analysis is

$$Char_{ij} = \beta_0 + \beta_1 PubYear_{ij} + \varepsilon_{ij}$$

where $Char_{ij}$ denotes a characteristic of work *j* by laureate *i*; and $PubYear_{ij}$ denotes the year in which work *j* by laureate *i* was published. The figures also show local-linear regressions, which capture high-frequency patterns, although the linear model is usually quite close to the non-parametric estimates.

The estimates for all variables are reported in Table 1. Figure 1 shows estimates for conceptual content. Conceptual content is generally increasing over the time period covered. There is a slight upward trend for equations and theoretical figures and tables. The share of works with mathematical introductions or appendices declines slightly, but proofs, assumptions, lemmas and the like all increase substantially.

The estimates for experimental and statistical content are shown in Figure 2. There are no statistically significant relationships for any of the variables shown.

Figure 3 shows the relationship for age. Ages have increased substantially. Whereas highly cited publications by Nobel laureates were published in the early 30s in 1940, by 1990 Nobel laureates were publishing highly cited works in the late 50s. The estimate in the last column of Table 1, indicates that the age at which Nobel laureates publish their most cited works increases by just under half a year for every calendar year that passes. While the changes in the content of the Nobel laureates' publications is relatively stable over this period, there is, if anything, a shift toward more conceptual work, as indicated by the increase in equations. This increase in conceptual work would imply a decrease, not an increase, in the age at which Nobel laureates are doing their work.[7]

III. B. Publications in the American Economic Review

To obtain an indication of how the content of work has changed over time for works that are less exceptional, we turn to the data on publications in the *American Economic Review*. Because many of the series appear to have breaks, the models allow for breaks. The model for this analysis is

$$Char_i = \beta_0 + \beta_1 PubYear_i + \beta_1 \max(0, PubYear_i - Break) + \varepsilon_i \, .$$

As above, $Char_i$ denotes a characteristic of work *i*; $PubYear_i$ denotes the year in which

[7]Although the estimates do point to a reverse-causality explanation, it is plausible that changes in ages may affect the content of work. Weinberg and Galenson [2007] study how the content of work changes over the lifecycle using these data on Nobel laureates. When an index for the extent to which a given publication was experimental versus conceptual was regressed on author dummy variables and age, the laureate fixed effects account for 71.6% of the variance in the index, while age accounts for only 1.1% of the variance. Thus the vast majority of the variation in content is due to time-invariant, individual differences with very small systematic variations due to aging.

work was published; and *Break* denotes a breakpoint estimated to maximize the fit of the model and allowed to vary across the various measures of content. As above, the figures also show local-linear regressions.

The estimates for conceptual content are shown in Table 2 and Figure 4. All four measures of conceptual content are increasing in the early portion of the period. The number of equations increases by .11 per year; the number of formal proofs increases by .369 per year, and probability of a mathematical appendix increases by .01 percent per year, all of which are statistically significant. (The use of theoretical figure and tables increases slightly, but the increase is not statistically significant.) Starting some point in at then end of the 1960s or early 1970s, however the increase in conceptual content slows or reverses.

Table 2 and Figure 5 show results for experimental and statistical content. Experimental content declines or is stable until the early 1980s, but then increases rather substantially. Specific references are, perhaps, the most striking, declining by one every 4 years until 1985 and then increasing by .4 per year afterward. The use of statistical procedures increases until 1965 and then declines.

Table 3 and Figure 6 show results for the mean experience among the coauthors on a paper, the number of authors, and citation patterns. There is a striking increase in the mean experience level of people publishing in the *American Economic Review* until 1980. The mean experience increases by just under 1 year every four years that elapse, but that trend stops in 1980. Neither the early aging nor the subsequent halt, can be explained by trends in the content of publications. Until the early 1980s, there was an increase in conceptual content and a decrease in experimental content, both of which would have led to a decline in experience at publication. Both of these trends in content stop or reverse in the early 1980s, which would be expected to lead to a positive trend break in experience (either less decrease, if experience were trending down, or a more rapid increase).

The alternative explanation is knowledge accumulation. This hypothesis does not do particularly better. The two measures of knowledge accumulation are the mean age of citations and the number of citations. The mean age of citations is remarkably flat over the period, which may indicate that the age distribution of knowledge is in a steady state. The number of citations, which increased very slightly in the early years, increases markedly after 1978. This trend break only increases the puzzle of the flattening experience at publication.

Perhaps part of the explanation for why experience at publication stops increasing in 1980 can be seen in the bottom right panel of Figure 6. The number of co-authors per paper is remarkably stable throughout the early period, but begins to increase by .36 per year in 1985. This is clearly visible in Figure 6, where the only triple-author and quadruple-author papers are in the later years. Thus, the additional burden from knowledge accumulation and the reversal of the shift from conceptual to experimental work may have been neutralized by the increase in coauthoring. It is not clear, however why coauthoring should have remained so stable while ages increased in the early years and why it would be optimal to fully offset the later increase with coauthoring.

IV. Conclusion and Future Work

This paper contributes to the long-standing line of work on life-cycle creativity by studying how the age at which important contributions are made changes over time within a discipline. We study economics, which is particularly interesting -- over the period studied, the nature of work in economics changed substantially in ways that are objectively measurable.

Our estimates show that the age at which economists make important contributions has increased over time, leveling off in the early 1970s. This pattern cannot be explained by the two most prominent explanations. Economics research was shifting to conceptual work, which tends to be done at younger ages, and away from experimental work, which tends to be done at older ages, as ages were increasing and the trend to conceptual work reversed as ages stopped increasing. Our measures of knowledge accumulation, begin increasing at the time that ages stop increasing, pointing against a knowledge burden explanation for trends in the age at which people make important contributions. The one factor that may explain the observed age patterns are trends in coauthoring, which increases around the time that ages stop increasing and may allow people to make contributions at younger ages.

There are a number of avenues for future work. First, we plan to augment our data on Nobel laureates with citation and coauthorship data comparable to that in our data from the *American Economic Review*. It may also be possible to explain trends in ages by changes in the age distribution of economists. We can say something about that distribution because we have data on doctorates granted by American institutions over the course of the 20th century.

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Figure 1. Trends in Conceptual Content in Important Publications of Nobel Laureate Economists.

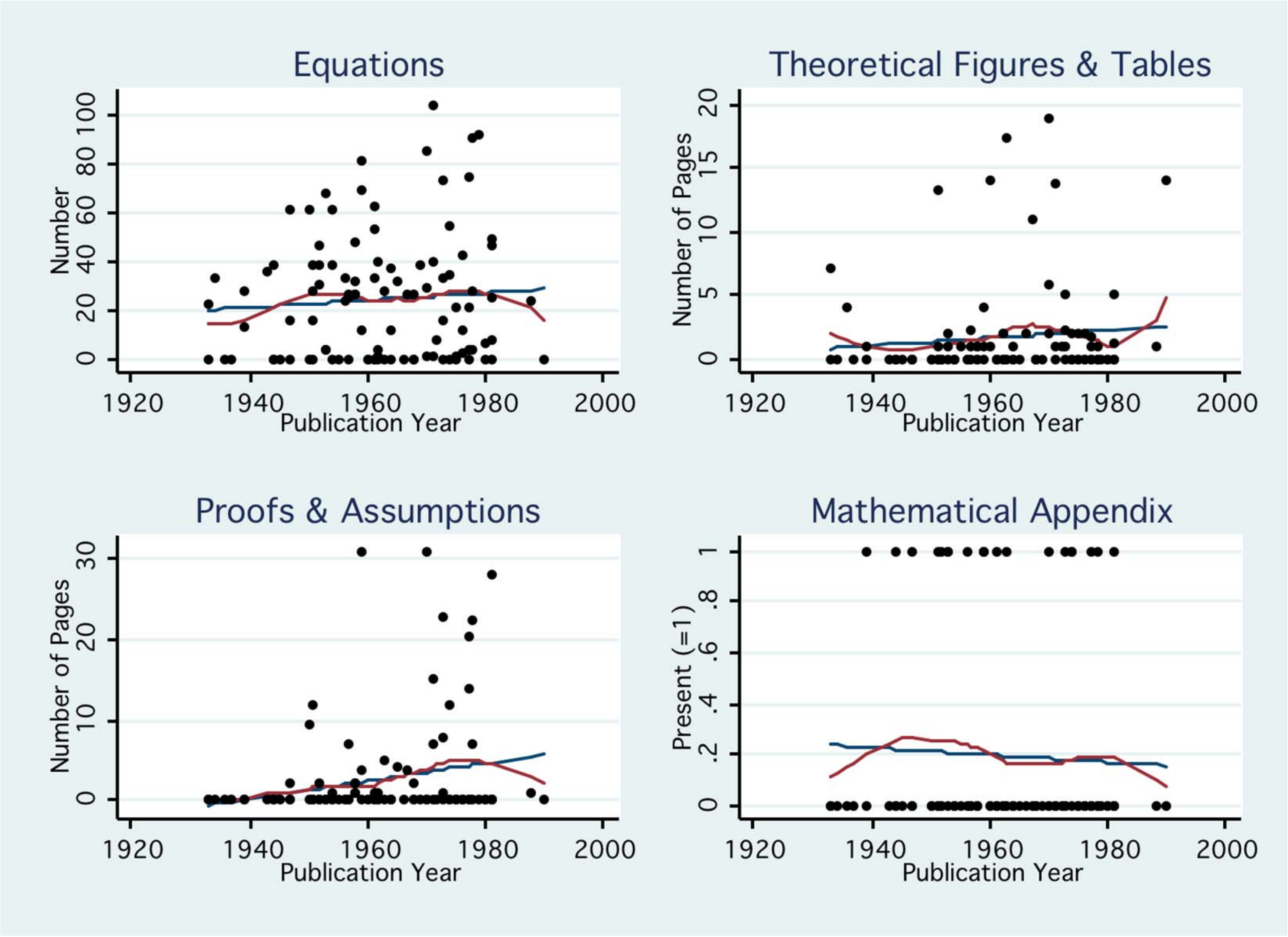

Figure 2. Trends in Experimental and Statistical Content in Important Publications of Nobel Laureate Economists.

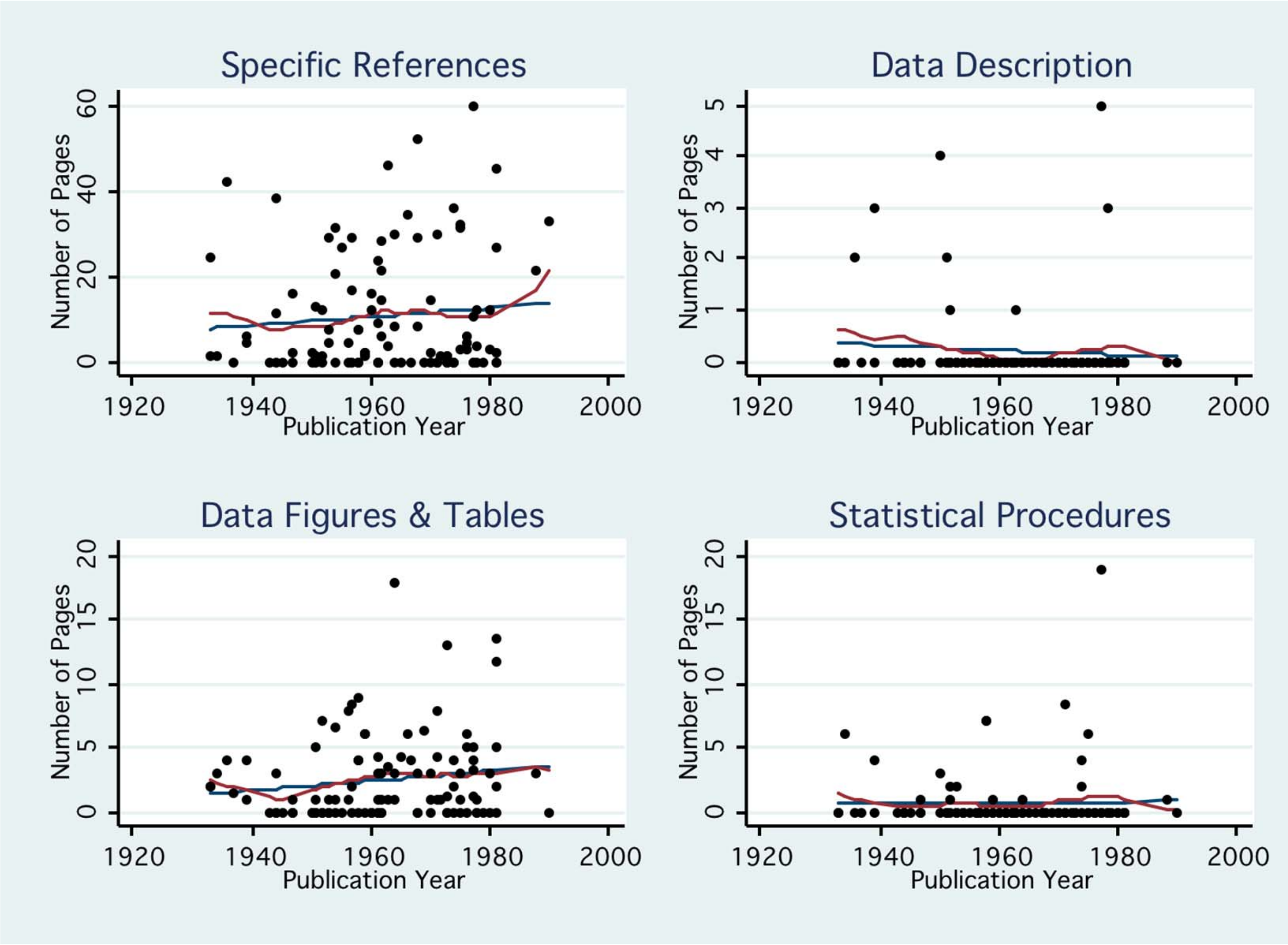

Figure 3. Trends in Ages at Important Publications of Nobel Laureate Economists.

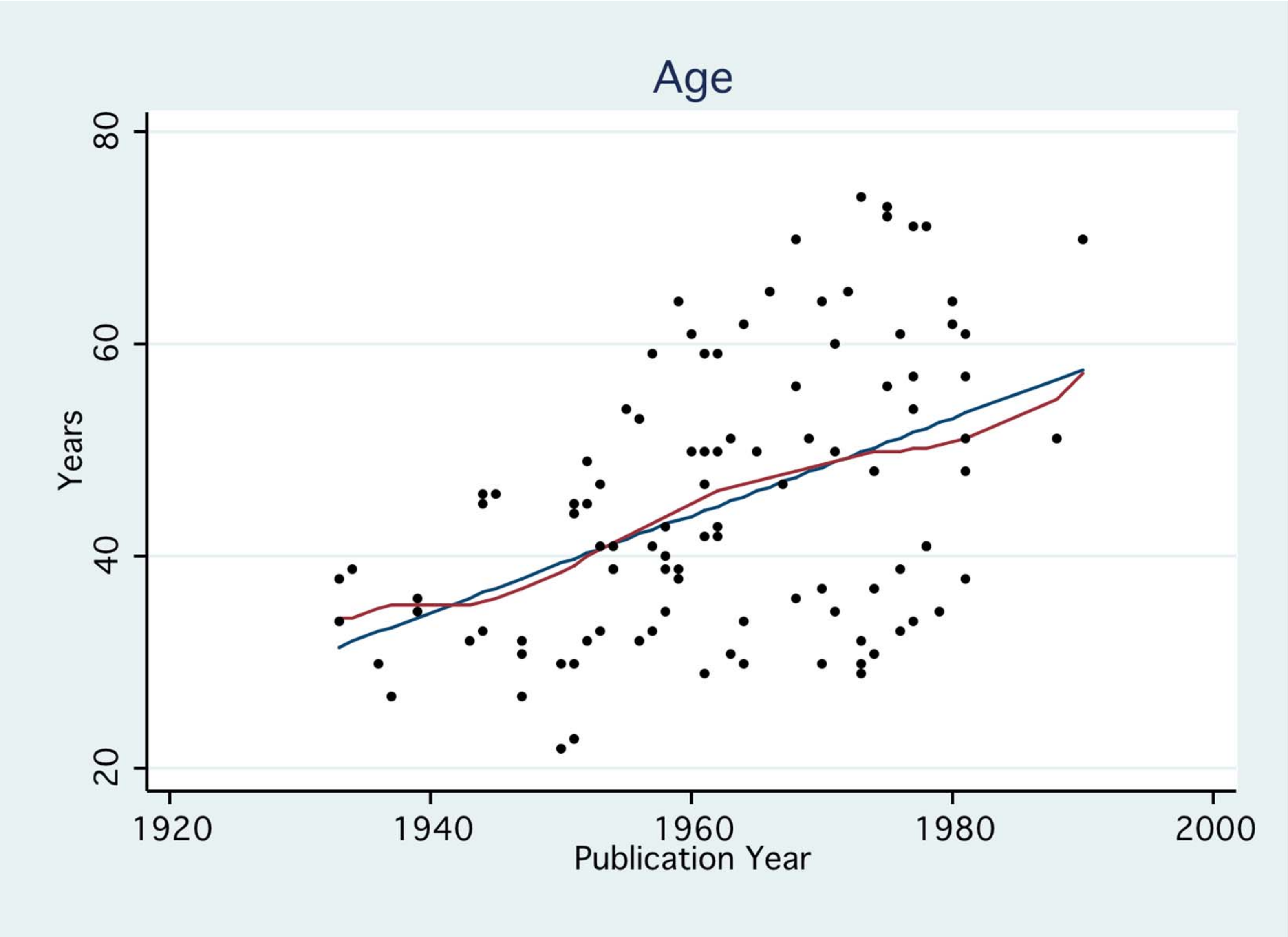

Figure 4. Trends in Conceptual Content in Publications in the *American Economic Reivew*.

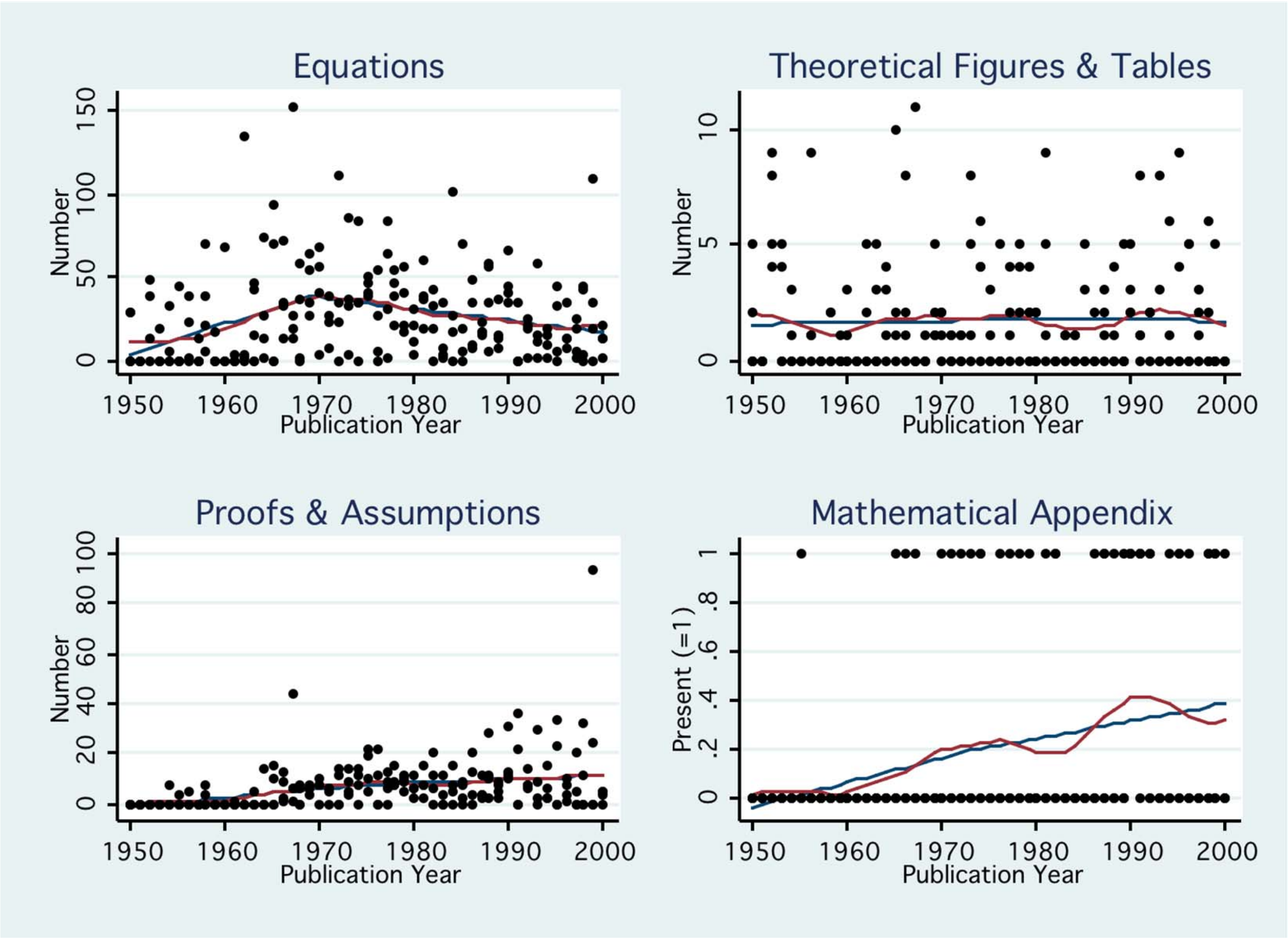

Figure 5. Trends in Conceptual Content in Publications in the *American Economic Reivew*.

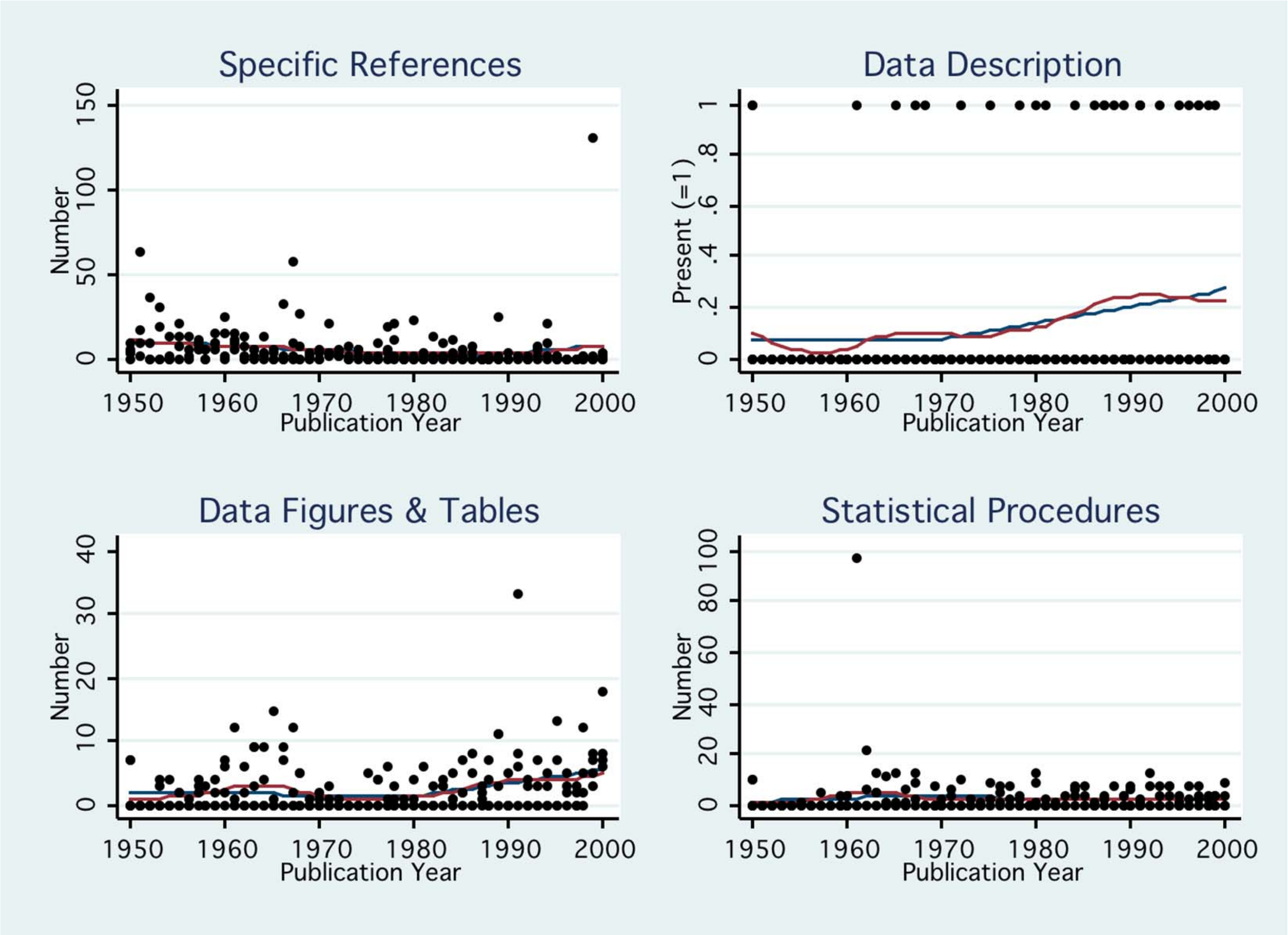

Figure 6. Trends in Ages, Citing Patterns, and Co-Authoring in Publications in the *American Economic Review*.

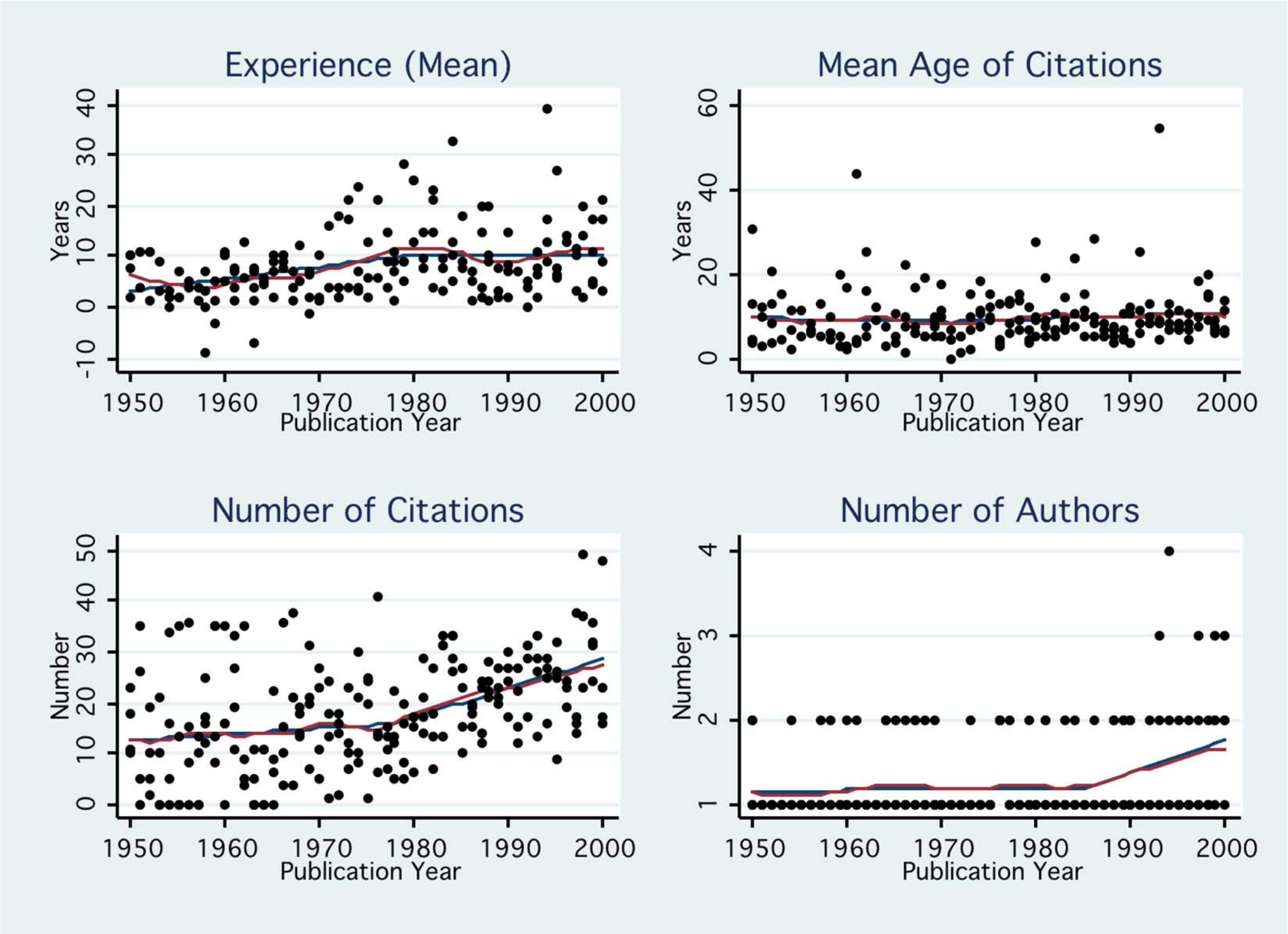

Table 1. Trends in Content in and Age at Important Publications of Nobel Laureate Economists.

	Conceptual Content				Experimental Content				
	Theoretical Figures and Tables	Formal Proofs	Mathematica l Appendix	Equations	Statistical Procedure s	Data Tables, and Figures	Data Description	Specific References	Age
Year	0.031	0.111	-0.001	0.151	0.005	0.038	-0.005	0.101	0.456
	(0.029)	(0.049)	(0.003)	(0.195)	(0.018)	(0.025)	(0.006)	(0.106)	(0.087)
Constant	1.672	2.736	0.194	24.294	0.732	-71.818	9.772	10.628	45.029
	(0.375)	(0.641)	(0.039)	(2.545)	(0.241)	(48.980)	(11.820)	(1.389)	(1.139)
R-Squared	0.011	0.048	0.002	0.006	0.001	0.022	0.006	0.009	0.213

Note. All regressions have 103 observations. Year is demeaned so that the constant gives the value in the mean year, which is 1962.4.

Table 2. Trends in Content in Publications in the *American Economic Review*.

	Conceptual Content					Experimental Content		
	Equations	Formal Proofs	Mathematical Appendix	Theoretical Figures and Tables	Statistical Procedures	Data Tables, and Figures	Data Description / Appendix	Specific References
Year	0.118	0.369	0.010	0.008	0.120	-0.021	0.000	-0.250
	(0.018)	(0.101)	(0.004)	(0.026)	(0.069)	(0.032)	(0.005)	(0.085)
Break	-0.149	-0.230	-0.003	-0.008	-0.129	0.231	0.006	0.652
	(0.028)	(0.173)	(0.007)	(0.046)	(0.087)	(0.076)	(0.007)	(0.291)
Intercept	-229.292	-720.282	-19.549	-13.211	-233.791	43.041	-0.683	496.801
	(36.296)	(198.263)	(8.601)	(52.050)	(135.895)	(63.362)	(8.922)	(167.420)
Break Year	1969	1974	1973	1974	1965	1980	1970	1985
R-Squared	0.1081	0.1459	0.0989	0.0006	0.006	0.0917	0.0405	0.0408

Note. All regressions have 206 observations.

Table 3. Trends in Citation Patterns in and Age at Publications in the *American Economic Review*.

	Number of Authors	Experience (Mean of Authors)	Mean Age of Citations	Number of Citations
Year	0.001	0.240	-0.047	0.120
	(0.003)	(0.062)	(0.094)	(0.088)
Break	0.036	-0.242	0.126	0.464
	(0.012)	(0.143)	(0.139)	(0.185)
Intercept	-1.400	-465.422	101.209	-221.927
	(6.848)	(122.437)	(184.156)	(173.214)
Break Year	1985	1980	1971	1978
R-Squared	0.1082	0.1076	0.0092	0.2084

Note. All regressions have 206 observations.

Appendix Table 1. Objective Characteristics of Highly-Cited Works of Nobel Laureates.

Characteristic	Description	Mean
Age at Publication	Age	45.029 (12.967)
References to Specific Items	The sum of: • The number of pages with references to specific places • The number of pages with references to specific time periods • The number of pages with references to industries or commodities	10.628 (14.087)
Data Description	The number of pages with a data description including any data appendices	.204 (.797)
Data Figures & Tables	The number of figures and tables reporting data or cross-tabulations	2.522 (3.327)
Statistical Procedures	The number of pages with tables reporting regressions, standard errors, R-squared statistics, or hypothesis tests	.732 (2.436)
Theoretical Figures & Tables	The number of theoretical figures and tables, including illustrative examples and payoff matrices	1.672 (3.804)
Assumptions and Proofs	The sum of: • The number of pages with formal proofs • The number of pages with proof structure • The number of pages with explicit statements of assumptions, axioms, lemmas, postulates, theorems, formal definitions	2.736 (6.638)
Equations	The number of (whole-line) equations	24.294 (25.782)
Mathematical Appendix	A binary variable equal to 1 if the work has a technical appendix or introduction	.194 (.397)

Note. Standard deviations in parentheses. Publications pro-rated to be the equivalent of a 19 page publication.

Appendix Table 2. Objective Characteristics of Publications in the *American Economic Review*.

Characteristic	Description	Mean
Experience at Time of Publication	The beginning of the career was dated from the time that an author received his or her doctorate based on data from the UMI Dissertation Database augmented by web searches	8.290 (6.986)
Mean Age of Citations	The mean age of cited works (up to the first 49)	9.380 (6.820)
Number of Citations	Top coded at 49	17.811 (10.707)
Number of Authors		1.267 (.515)
References to Specific Items	The sum of: • The number references to specific places • The number references to specific time periods or historical facts • The number of references to industries or commodities • The number of references to specific laws • The number of references to specific people (other than in citations)	5.194 (12.134)
Data Description	A binary variable for whether the paper has a data description, including a data appendix	.131 (.338)
Data Figures & Tables	The sum of: • The number of figures tables reporting data or cross-tabulations • The number of figures displaying data	2.417 (3.958)
Statistical Procedures	The number of tables reporting regressions, standard errors, R-squared statistics, or hypothesis tests	2.466 (7.452)
Theoretical Figures & Tables	The number of theoretical figures and tables, including illustrative examples and payoff matrices	1.670 (2.395)
Assumptions and Proofs	The sum of: • The number of formal proofs • The number of pages with theorem-and-proof structure • The number of explicit statements of assumptions, axioms, lemmas, postulates, theorems, formal definitions	6.388 (9.867)
Equations	The number of (whole-line) equations, excluding those in mathematical appendices or formal proofs	24.650 (27.006)
Mathematical Appendix	A binary variable equal to 1 if the work has a technical appendix or introduction	.194 (.397)

Note. Standard deviations in parentheses.