

**The (Formal) Return to Openness:  
A Quantitative Contribution to the History of Economic Thought**

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**Abstract:**

We develop a comprehensive quantitative account of changing practices in Economics in the last 122 years. The analysis uses “word detection” algorithms to appraise the prevailing practices. We document a shift toward isolation from other disciplines during most of the twentieth century. In sharp contrast, the most recent decades show a strong move towards a more connected discipline. Periods of more connectedness are associated with openness to a broader set of features of economic agents and the economic environment. In parallel, the 1960s and 1970s show a notable acceleration in the move towards a more mathematical approach. This development did not reverse. As a result, the current state of the discipline is characterized by an embrace of mathematical tools together with openness to a wider set of aspects and findings developed in other disciplines. Most of the reported variables show surprisingly high correlations across disciplines and across journals.

**1. Introduction**

Economic events are complex processes. They involve the interaction of agents characterized by countless features in an environment where multiple economic and non-economic processes are jointly in progress. Under limited capacity to incorporate and examine information, a researcher selects which aspects are deemed central for the inquiry and which features are ignored. In this context, the purpose of this study is to describe, in very general terms, the level of attention assigned to different aspects by an evolving community of researchers.

The study is based on the analysis of the contents of journals published in the English language in the last 122 years. Our approach uses “word detection” statistics to characterize the contents. The application of quantitative techniques provides an

extensive view of developments in the discipline that is hard to generate and convey otherwise.

The contributions in this study can be divided into three groups. First, we report clear patterns in the extent of the connections of economics to other disciplines. Second, we analyze changes in attention levels assigned to specific features of economic agents and specific characteristics of the economic environment. Finally, we provide a novel account of the movement towards a mathematical approach.

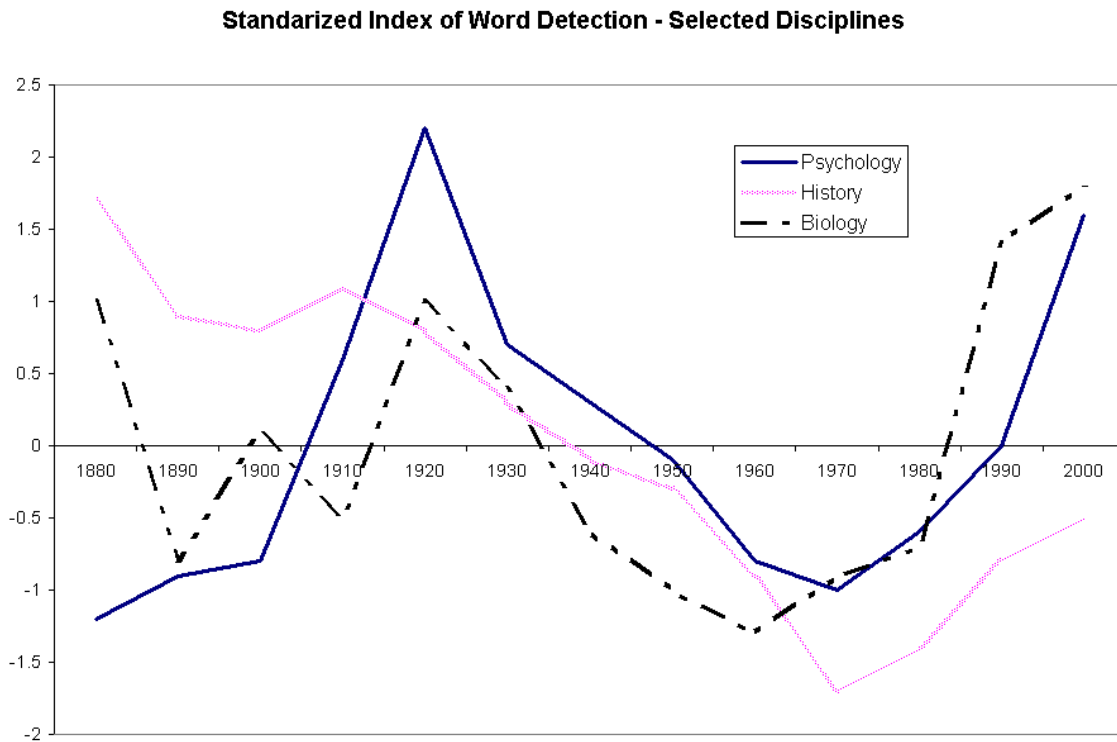


Figure 1

Our first set of contributions is related to the evidence on the interaction of economics with other fields of study. Figure 1 shows the evolution of our measure of connectedness of economics to three selected disciplines: Psychology, History and Biology. For each discipline, we calculate the fraction of journal contents that include in its full text the word or phrase that denotes each discipline. To facilitate the comparison, the figure reports standardized values of the index.<sup>1</sup> The figure suggests that starting approximately in the 1930s a period of less connectedness begins. This trend is sharply reversed in the

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<sup>1</sup> The mean value of the index for each discipline can be very different. The standardization is used mainly to have an index that facilitates comparison across different fields/words at the same time. We calculate the mean and the standard deviation for each word. The standardization consist of subtracting the mean to the index and then dividing the difference by the standard deviation.

past decades. The indices capture significant changes in the word detection in journal articles. For example, for the 1920s, 50% of the articles include the word “History”. In the 1970s, the value of the index dropped to 19%. The latest number for the 2000s is 33%. We believe these numbers are compelling indications of profound changes in the prevailing practices and attitudes in a discipline. Section 3 provides an analysis of the results for a larger sets of disciplines. Among other issues, we report a surprisingly high correlation of the indices across disciplines and across journals.

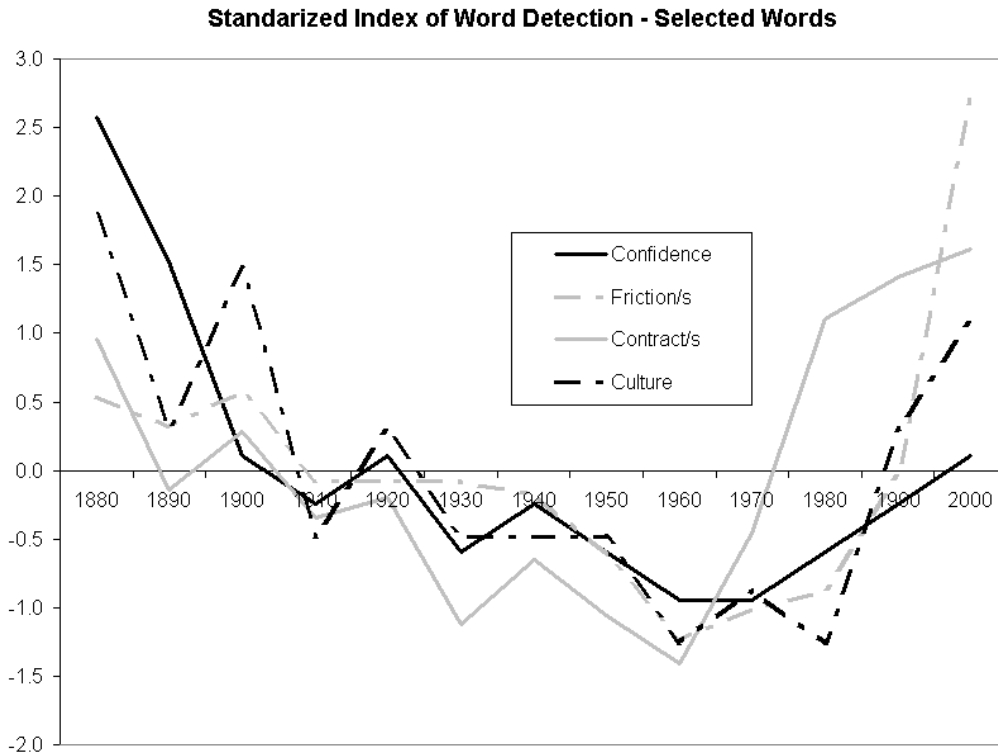


Figure 2

In the second set of findings, we evaluate the attention assigned to specific features of the economic agent or the economic environment. As an opening example, figure 2 presents standardized indices for the use of four words of interest: confidence, friction/s, contract/s and culture. The word “confidence” can be associated with the idea that economic agents form expectations without a complete understanding of their environment through a process that does not necessarily follow formal reasoning. The detection of “friction/s” suggests an interest in the possibility that the environment can present conditions that interfere with the smooth functioning of markets. In turn, the presence of the word “contracts” denotes a focus on the architecture of transactions and relationships. Finally, the detection of the word “culture” signals an interest for the set of beliefs and practices shared by a community. The first word is related to perspectives on the economic agent while the other three words are related to characteristics of the environment. For each of

the selected words we find that there is an initial decline in the respective indices. With some variations with respect to the starting date, this trend is reversed towards the end of the sample. For example, the index for “contract/s” exhibits an important increment starting in the 1970s, while the index for “culture” and “friction/s” do not exhibit a notable increase until the 1990s. The reported variations in attention levels are of significance; for example the word “culture” is detected in 7.1% of the contents in the 1920s; this figure drops to 2.9% in the 1980s. The last number for the 2000s is 8.9%. These examples are suggestive of nontrivial changes in the attention allocated to these issues by researchers that published in the sampled publications.

In section 4 we present a more systematic analysis that focuses on general aspects that characterize economic agents and the environment where the agents interact. For the economic agent, we evaluate the interest in cognitive limitations and more flexible representation of preferences. With respect to the economic environment, we consider features related to: frictions, contracting, politics, social preferences and culture. With some variations, the observations suggest an across-the-board initial cycle of narrowing focus and a second period of increasing openness to the inclusion of a wider range of issues in economic analysis.

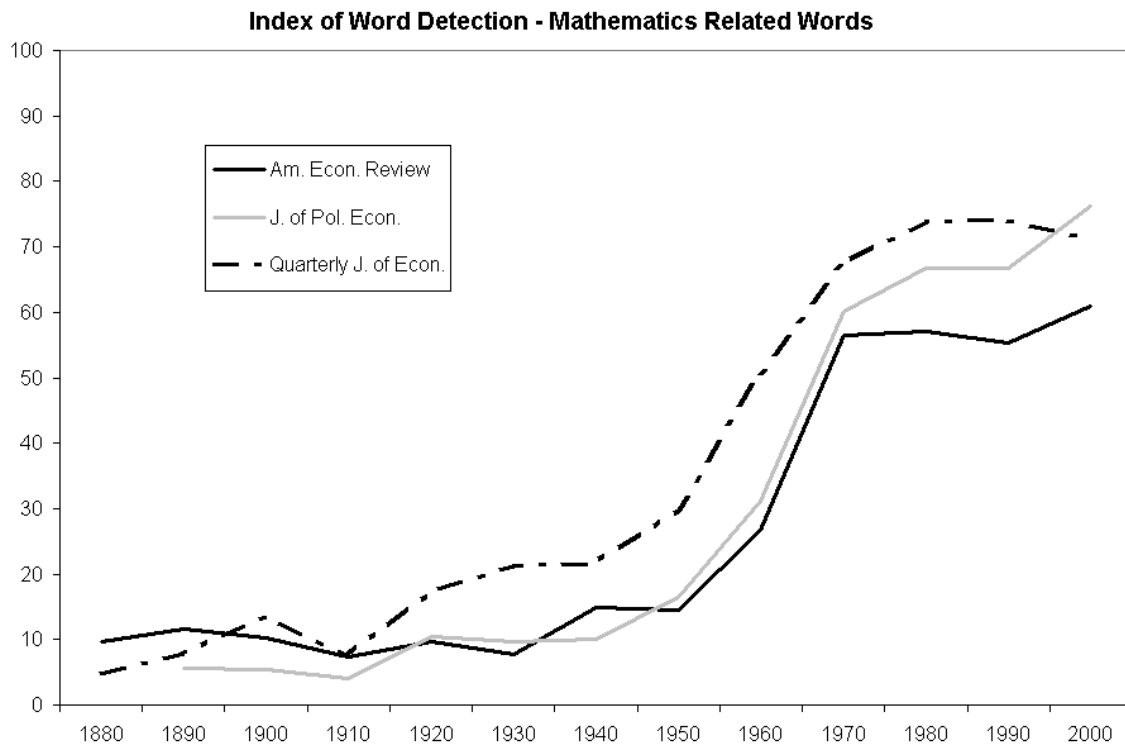


Figure 3

The economic discipline has to a large extent embraced mathematic techniques as a tool for its analyses. The last set of contributions in this paper deals with documenting the prevalence of the use of mathematical techniques in the last 122 years. For that purpose, we compute the fraction of journal articles that include mathematics related words in their full-texts. Figure 3 shows the values of the computed indices for the three oldest journals in the United States of America.<sup>2</sup> According to the figures, during the 1960s and the 1970s, the discipline shifts drastically towards the adoption of mathematical tools. The shift is especially noteworthy considering the absence of similar developments in the previous and in the following decades. The correlations in the measures are surprisingly high. According to our knowledge, this is the first attempt to quantify and date the well known shift of the economic discipline towards a more mathematical methodology.

In summary, this study reports quantitative evidence that suggests that the evolution of the prevailing approach in economics experienced two regimes. There was a first regime of decreasing connectedness with other disciplines, a focus on a narrower set of aspects and increasing embrace of mathematical tools. According to our observations, the stage of massive adoption of a more mathematical approach seems to have occurred after an important fraction of the decline in the connections with other disciplines already occurred. The second stage is characterized by a high degree of adherence to a formal approach together with increasing openness toward other disciplines and the consideration of a broader set of aspects.

We would like to emphasize that we consider the traditional approach to the history of ideas to be irreplaceable. The detailed understanding and comparison of complex objects, such as conceptual maps developed to advance the understanding of economic phenomena cannot be replaced by computer algorithms. The use of quantitative techniques most of the time involves reducing the analysis to a low number of dimensions, and disregarding all information that is not captured in the quantification stage. The value of techniques such as the one used in this study is the ability to analyze and summarize large amounts of data. The largest version of our dataset involves approximately 290,000 economic journal contents. In this way, it is possible to have comprehensive descriptions of the literature that would not be available otherwise. These descriptions can be used to verify assertions that are based on more traditional and not as comprehensive analyses of the literature.<sup>3</sup> In addition, the quantification of observations allows for the use of statistical techniques and facilitates the exchange of information. It

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<sup>2</sup> The words used in the search are: mathematics, axiom, equation and theorem. For the purpose of the index, any journal content that includes these words is considered a journal with mathematical content.

<sup>3</sup> It is possible that some seminal contribution in a particular date can bias the perception on the prevailing views for that period. For example, the publication of Paul A. Samuelson's "Foundations of Economic Analysis" in 1947 is considered a landmark moment in the application of mathematical techniques to economics but, according to our measures, this date should not be viewed as a close approximation to the date in which the discipline embraced these techniques. A comprehensive analysis might help substantiate the validity of that perception.

is our view, that historic accounts of developments in the discipline can be complemented with comprehensive quantitative observations. For example, we believe that the measures we provide complement works such as the account of the interwar period fight for preeminence by the neoclassical and institutionalist schools reported in Yonay(1998) and the account of the incorporation of contractual and psychological considerations in mainstream economics reported in Bowles et al. (2002).

This study is related to other quantitative analyses of economic literature. For example, Stigler et al. (1995) analyze citation patterns to evaluate influence and specialization across economic journals between 1987 and 1990. Pieters et al. (2002) develop citation analysis to assess intra- and interdisciplinary communication patterns between journals between 1995 and 1997. This study concludes that the citation patterns observed between Economics and sister disciplines suggest limited cross fertilization.

This study is also connected to a growing literature in financial economics that use computer algorithms to form statistics of word content of financial documents or news articles. For example, Tetlock (forthcoming) and Engelberg (2008) count words of news articles and financial statements respectively, to evaluate predictability of stock returns.

Our analysis is inspired by the view, prominent since Kuhn (1962), that the practice of science involves the adherence to a set of assumptions that are shared by a scientific community and have a great influence on the theories and methodologies. These assumptions might be sustained even in front of evidence that proves them not completely accurate. Our work intends to partially characterize the evolution of the prevailing assumptions through the quantitative analysis of a large piece of the literature.

In the next section we describe the data and methodology. Section 3 describes the statistics on the connections of economics with other disciplines. Section 4 deals with the evidence on consideration of specific features in the economic literature. The embrace of quantitative techniques is presented in section 5. Section 6 concludes.

## **2. Data and methodology**

Our dataset is based on the contents of economic journals provided by “jstor.org”, a commercial journal database. The service provides access to 92 journals in the category “Economics”. The first articles correspond to 1886 while the last ones correspond to 2007. The total number of articles is 289,475. For the purpose of our analysis, each content is an observation. Table 1 provides information about the number of articles by decade.

Table 1: Number of contents in the dataset by journal and decade

	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	Total
All Economics	197	2180	3015	4834	6105	11117	13813	21274	30570	47113	54491	58200	36566	289475
AER	72	188	344	1692	1617	2286	2721	3133	3416	2264	2299	1983	1615	23630
QJE	125	363	423	434	426	505	486	546	626	626	672	554	254	6040
JPE	0	507	883	1385	752	1295	1313	1372	1409	1390	956	708	413	12383
The Econ. J.	0	1128	1333	1201	1308	1614	941	1520	1796	2010	1906	2497	960	18214
R. of Econ&Stat	0	0	0	62	380	417	443	898	898	886	1113	942	402	6441
Economica	0	0	0	0	561	838	780	1110	1250	1110	918	669	605	7841
Econometrica	0	0	0	0	0	323	414	850	1155	1618	1456	963	794	7573
R. of EconStud	0	0	0	0	0	189	194	297	408	634	638	510	453	3323

For many parts of the analysis we will focus on a smaller fraction of the dataset. The restriction to a smaller number of publications responds to the objective of focusing on a uniform set of publications over long periods of time and is used to focus on what might be called “core of the mainstream”. In some cases we will only consider the three oldest American journals: The Quarterly Journal of Economics founded in 1886, The Journal of Political Economy founded in 1892 and the American Economic Review founded in 1911<sup>4</sup>. In other analysis we also include: The Economic Journal (founded in 1891), The Review of Economic and Statistics (founded in 1919), Economica (founded in 1921), Econometrica (founded in 1933) and The Review of Economic Studies (founded in 1933). The above listed publications contain approximately 30% of total number of contents in the full dataset of 92 journals.

The basic measure in the analysis is an “index of word detection”. For a specific word/phrase A, a specific time range and list of publication, the index is equal to the percentage of listed contents that include the word/phrase A in its full text.<sup>5</sup> To calculate the index value we use the search algorithm provided by jstor in its website. In some cases we calculate indices for a list of words using the “or” logical condition.

In some cases, to facilitate comparison among different words, we find it convenient to calculate standardized versions of the indices. The standardization is implemented by calculating the mean and the standard deviation for the index corresponding to a given word, and correcting the original index by deleting the mean and dividing the difference by the standard deviation.

The economic literature considered in this study consists of contents published in mainstream English language economic journals. This focus leaves out economic

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<sup>4</sup> We have extended the time series of articles corresponding to the American Economic Association through 1886 by taking into consideration the American Economic Association Quarterly 1908-1910 and Publications of the American Economic Association 1886-1907

<sup>5</sup> The search algorithm we use includes “all journal contents”; this means that other objects which are not articles, such as reviews or tables of content are included in the search. Our objective is to describe the state of the discipline in a certain point in time. We consider that “all journal contents” defines an adequate sample universe for such analysis.

literature in a different language and literature that did not belong to the mainstream in each period of the analysis. At the same time, this includes studies whose object has not been traditionally viewed as economic problems but where published in economic journals. The data coverage implies that the observations of our analysis, especially when we consider a reduced number of publications, correspond to the practice of economics by mainstream professionals. In other words, our study is about prevailing practices in a given community, changes in the practices can be due to changes in the views of the members or the inclusion/expulsion of members. We would like to emphasize that the literature we evaluate is not all encompassing; it is mainly focused on the practices of an evolving community mainly settled in Western capitalist economies.

### **3. Economics and other disciplines**

In this section we present a novel account of the extent to which economics has been connected to other disciplines in the last 122 years. Our findings suggest that there is an important degree of correspondence in the connection measures for different disciplines. As anticipated in the introduction, we find clear patterns indicating periods of isolation and connectedness.

Economics can establish a connection to another discipline by using findings and concepts developed by other fields to explain economic phenomena. For example, economics might use insights from psychology to explain investment decisions. Alternatively, a connection might result from the study in economic journals of issues that are traditionally associated with a different discipline. For example, an economic journal might publish an article that studies voting in an election for a public office, a topic typically associated with political science. Our measures capture both types of connections. Our measures are not able to separate these two types of relationship. Nevertheless, in some cases, the type of relationship can be inferred from the nature of the disciplines. For example, we believe that most mentions of Psychology or Biology in economic journals are mainly related to cases in which economist use insights from these disciplines as inputs in an analysis of an economic issue.

Table 2 presents the mean values and the correlation coefficients for the indices of word detection corresponding to 9 different disciplines. The statistics are calculated using information corresponding to the sub-sample of 8 publications indicated in the previous section<sup>6</sup>. The first column reports data on the sample value of the index for each discipline. History is the discipline with the highest mean value for the index. On average, 39.72% of the contents in the journals include the word History. Other five disciplines have average index values that range between 3.8 and 7.73. These five

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<sup>6</sup> Similar observations result when all the journals of the sample are considered. The appendix provides a table for the values of the indices for that case.

disciplines are: Psychology, Sociology, Political Science, Philosophy and Ethics. Finally, three natural sciences: Physics, Biology and Chemistry, have average index values which are below 1.7. In the Appendix we provide tables with the values of the indices for each discipline and each decade.

The indices exhibit surprisingly high correlations. The values of the correlation coefficients are higher for the calculations that exclude the first decades of the sample, as shown in the second panel of table 2. The co-movement is specially notable for computations among the first six disciplines in the matrices that is, when the natural sciences are excluded. For example, the coefficient of correlation for History in the 1910-2000 period is above 0.89 when the other series considered is the one corresponding to Psychology, Sociology, Political Science or Ethics. These high correlations suggest that the practice of Economics, as evidence by the sampled journals, was characterized by wide raging movements toward more connectedness or openness and equally extensive shifts toward of isolation.

Table 2: Correlations of “word detection indices” across disciplines

1880-2000	Mean Index	Correlation Coefficients										Mean Corr. Coef.
		PSY	HIST	SOC	P.SC	ETH	PHI	BIO	PHY	CHE		
Psychology	5.33	-	0.92	0.27	-0.16	0.11	0.10	0.53	0.16	-0.14	0.22	
History	39.72	0.92	-	0.92	0.76	0.94	0.83	0.27	0.36	0.84	0.73	
Sociology	5.91	0.27	0.92	-	0.61	0.87	0.74	0.40	0.50	0.78	0.64	
Pol. Science	6.96	-0.16	0.76	0.61	-	0.72	0.69	0.36	0.39	0.94	0.54	
Ethics	3.80	0.11	0.94	0.87	0.72	-	0.73	0.31	0.43	0.83	0.62	
Philosophy	7.73	0.10	0.83	0.74	0.69	0.73	-	0.08	0.46	0.71	0.54	
Biology	1.44	0.53	0.27	0.40	0.36	0.31	0.08	-	0.46	0.36	0.35	
Physics	1.69	0.16	0.36	0.50	0.39	0.43	0.46	0.46	-	0.47	0.40	
Chemistry	1.17	-0.14	0.84	0.78	0.94	0.83	0.71	0.36	0.47	-	0.60	
1910-2000	Mean Index	Correlation Coefficients										Mean Corr. Coef.
		PSY	HIST	SOC	P.SC	ETH	PHI	BIO	PHY	CHE		
Psychology	6.15	-	0.91	0.91	0.84	0.78	0.49	0.73	0.46	0.86	0.75	
History	35.66	0.91	-	0.91	0.89	0.90	0.79	0.26	0.19	0.84	0.71	
Sociology	5.37	0.91	0.91	-	0.94	0.87	0.74	0.50	0.47	0.96	0.79	
Pol. Science	5.69	0.84	0.89	0.94	-	0.75	0.74	0.38	0.30	0.84	0.71	
Ethics	3.22	0.78	0.90	0.87	0.75	-	0.64	0.39	0.24	0.87	0.68	
Philosophy	7.11	0.49	0.79	0.74	0.74	0.64	-	-0.02	0.34	0.71	0.55	
Biology	1.43	0.73	0.26	0.50	0.38	0.39	-0.02	-	0.55	0.40	0.40	
Physics	1.63	0.46	0.19	0.49	0.30	0.24	0.34	0.55	-	0.49	0.38	
Chemistry	0.90	0.86	0.84	0.96	0.84	0.87	0.71	0.40	0.49	-	0.75	

Notes: The index are calculated using information corresponding to eight selected publications: AER, QJE, JPE, The Economic Journal, Review of Economic and Statistics, *Economica*, *Econometrica* and *Review of Economic Studies*.

Given the high correlations found across disciplines, we find it convenient to calculate an index that succinctly describes the state of economics in terms of connectedness to a group of other disciplines. For that purpose, we calculate the equally weighted average of

the standardized indices for: Psychology, History, Political Science, Sociology, Philosophy and Ethics. Figure 4 presents this index calculated separately for the three oldest American economic journals.

The correlations across journals are extremely high, especially for the last 60 years.<sup>7</sup> The figure shows that in the 1920s the indices for the three journals display a peak. From the 1920s until the 1970s the predominant tendency is towards more isolation. This tendency is reversed, starting in the 1980s. These observations are similar to what we described in the introduction for a smaller set of disciplines.

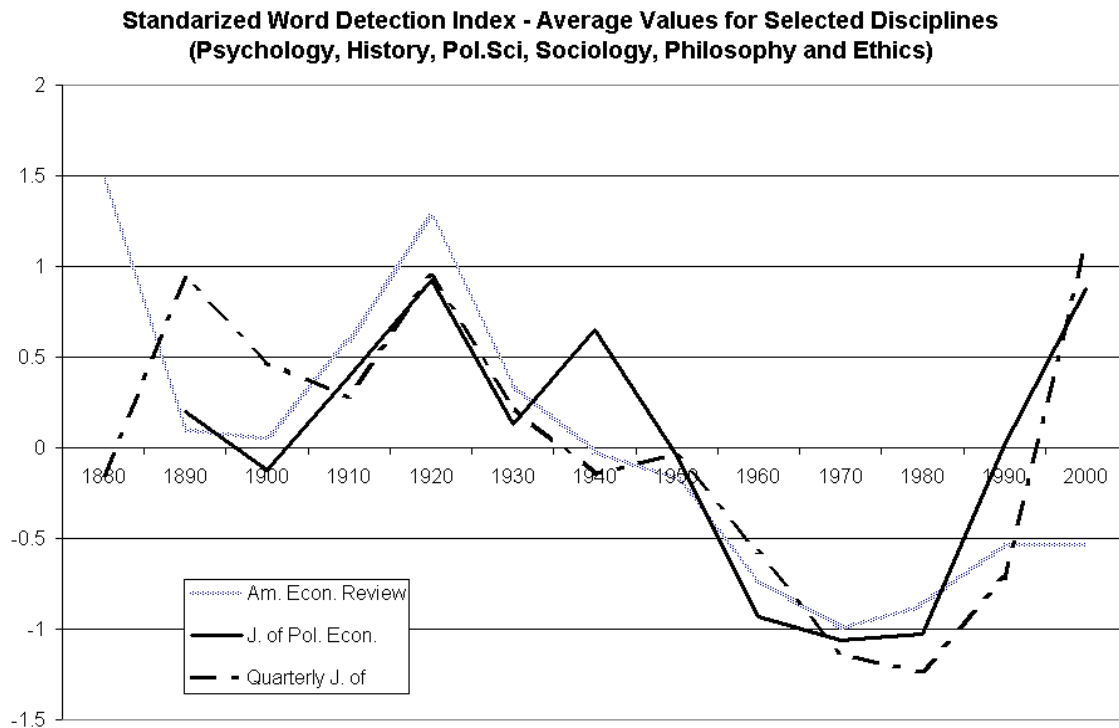


Figure 4

These findings are indications of profound changes in the prevailing practices of the discipline. We have identified periods, particularly the 1960s and 1970s, in which the low frequency of references to other disciplines suggest increased prevalence of the view that the understanding of economic issues does not involve recurring to concepts and findings developed by other disciplines. These trends are all-encompassing, in the sense

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<sup>7</sup> In the appendix we provide a table with calculations of the correlation coefficient across journals for the sub-sample of 8 journals.

that it is identified for different journals and different disciplines.

#### **4. The approach to the economic agent and its environment**

Conducting economic research requires making choices about which are the features of the economic agent and its environment that belong to the core of the analysis and which features should be ignored. These choices might not be explicitly stated, but are inevitable given the complexity of economic events and economic actors and the limited tools of the analyst. The selection of specific features is shaped by the objectives of the study in question, the prevailing practices in the community to which the researcher belongs to and the original insights of the researcher. Some of the features of the economic agent that might be considered or ignored in the analysis include cognitive limitations, the effect of context on choice, non-economic motives and the endogeneity of preferences. With respect to the environment, there are features such as informational and coordination frictions, limited contract enforceability, political processes and cultural aspects that might be judged not sufficiently relevant to be incorporated among the evaluated features of the economic environment.

The focus in this section is placed on identifying the attention assigned to specific features of economic events. In contrast to the previous section, where the focus was placed on connections with other disciplines, in this section the focus is on the consideration of aspects of economic agents and the economic environment in which agents interact. These aspects sometimes can be linked to a specific disciplines, but that is not always the case. For example, the introduction of more realistic aspects of the economy that generate “frictions” is not necessarily linked to other disciplines. Our observations detailed below, suggests patterns in the consideration of specific features that are consistent with the observations reported in the previous section on connectedness of the economic discipline.

Our analysis intends to capture attention to features that characterize the economic environment. This means that our objective is to infer prevailing approaches even when they are not explicitly stated. For example, regarding the economic agent, we infer consideration of limits in cognitive abilities from the frequency of the use of words such as “memory”, “learning” or “intelligence”. We do not reduce our analysis to the cases in which these concepts are explicitly or formally incorporated to a conceptual or mathematical model. The underlying assumption is that words included in the full text of the documents are informative of which features were considered pertinent in economic analyses.

Compared to the previous section, this section provides more specific evidence about the content of economic journals. As a result, it allows for more precise inferences about the extent to which some of the changes in the word content measures are the result of economic imperialism or are mainly a reflection of the use of foreign concepts and

findings to study issues that are traditionally associated with economics.

In the next subsection we consider the representation of the economic agent, next we evaluate attention levels to aspects of the economic environment. Social preferences and culture are the topics that, due to the mutual reference, we are not able to classify as an aspect of the agent or the environment. For presentation convenience, it is presented at the end of this section as the last subject area.

#### *4.1 Features of the economic agent*

In this subsection we focus on the approach to the economic agent and its behavior. As in the rest of the analysis, we evaluate attention assigned to specific features. We will group the features into two broad areas: cognitive limitations and more general preferences.

The approach to the economic agent, whether explicitly stated or implicitly employed, can take different degrees of generality, simplification and sophistication. On one extreme, we could consider an ideal type of agent, with a set of stable goals or preferences, unlimited abilities to process information, and the capacity to make optimal decisions based on that information. In addition, in its most radical form, the interaction with other agents does not go beyond prices and exchange and the agent possesses full information. This approach could be based on an explicit set of axioms that fully characterize the economic agent. Alternatively, the approach can be implicitly assumed and it can be inferred, for example, from verbal descriptions of behavior.

It is well understood that this approach is not realistic; but, in certain circumstances, the researcher finds it convenient to simplify the conceptual model in this direction in order to provide insights on economic phenomena. Different researchers or different schools arrive to different solutions about which simplifications are useful and which assumptions should be relaxed in order better tackle different economic problems.

As a preliminary exercise, the first group of words we consider intends to assess in general the level of interest in the thought process that underlies decision making. For that purpose we consider the words: Psychology, mind, brain and intellectual. Beyond some differences, we observe that the path of the indices show some common patterns that are in line with observations we made in the previous section. There is a downward trend that depending on the word chosen begins somewhere between the start of the sample and the 1920s. The last 2 or 3 decades are characterized by higher index values. The early upward trend for “Psychology” might be driven by a rise in the popularity of the term. “Mind” is the word with the highest average index value.

More realistic representations of the economic agent incorporate limits to cognition and more general preferences. Below we describe our findings for words related to these two directions.



understanding of their environment through a process that does not necessarily follow formal reasoning.

The index for the word “learning” presents a case of early growth in awareness of limits to cognition. The values of the index for the 1960s and 1970s, 6.6 and 10.3 respectively, are not as high as the ones observed in the following decades, but are clearly higher than the values corresponding to the previous decades. This is an example of some heterogeneity in the trends. When evaluated together with our other measures, this reading would indicate that this early interest in “learning” was mainly developed in relative isolation from other similar aspects or concepts of other disciplines. There is a less marked but similar path for the index corresponding to the words “naïve credulous trusting”; this is more surprising in terms of our results since, while “learning” could be modeled as a rational process, these words suggest a non-rational perspective, in the sense that agents are not aware of their ignorance.

#### *4.1.2 More general preferences*

The second group of features, are related to more a dynamic and flexible characterization of goals, motivations or preferences of the economic agent. Economic analyses assume that agents act in accordance to a set of goals or preferences. These preferences are the explicit or implicit explanations of behavior. In the most simple representation of these goals, they are individualistic, stable, generate consistent plans and there is homogeneity across agents. We evaluate interest in preferences or goals characterized by: heterogeneity, endogeneity and inconsistency. Social preferences are considered in the next section. For features analyzed in this subsection, we calculate six indices that are shown in table 3.

We use the words “habit” and “personality” to assess the interest in heterogeneity and the endogeneity of preferences. Both terms are inferred to indicate consideration of preference that can be affected by experience and present diversity.

An additional feature involves the existence of preferences that lead to inconsistent ranking of choices. This can be the result of the effect of context on choice or might be due to the way the agent discounts future consumption flows. The indices with the groups of words “self-regulation self-control” and “temptation procrastination” are used to measure attention to preferences that do not lead to consistent plans. Another reason for inconsistency is the fact that goals might be regulated by changing attitudes, moods or emotions. The indices for “fear” and “emotion feeling mood sentiment” provide evidence on the consideration of these features.

We find that for all the words enumerated above, the indices behave similarly to what we observed in the previous section. In particular, the consideration of more flexible and dynamic preferences seems to become less prevalent during the middle decades of the twentieth century and more prevalent in the last three decades of the sample.

#### *4.2 The representation of the environment and interactions*

As in the case of the economic agent, at the time of selecting a representation of the environment in which the agents interact, the researcher must select which aspects of situation are considered and which aspects are ignored. In some circumstances, the analyst might select a representation of the environment where agents interactions only involve the exchange of goods and services in a highly efficient setting. For example, the interaction of consumers and producers in a market might be represented through a model in which there are no informational or legal frictions, there are no externalities, and an algorithm is able to extract all relevant information from the agents to determine equilibrium allocations and prices. This is an example of a simplified representation of an economy in which only economic factors affect economic outcomes and the environment plays a minor role.

Alternatively, the representation of the environment might include more realistic features of exchange and production economies and consider the impact of non-economic aspects on economic outcomes. We are interested in the consideration in economic literature of different aspects of the environment. We find it convenient to divide different aspects of the environment into four groups: frictions, contracts, politics and social preferences and culture. Table 4 shows the indices calculated to evaluate the consideration of these features in economic journals.

##### *4.2.1 Frictions*

Economic interactions are not always smooth. Coordination failures might hinder mutually beneficial transactions. For example, agents might not be connected through a central auctioneer and would need to search for each other in order to trade. Similarly, informational failures can get in the way of economic activities. Incomplete or asymmetric information can affect the efficiency of the allocation in markets. The indices calculated for the group of words “friction frictions” and “informed uninformed” indicate that the 1960s and 1970s were the decades with the least interest in these features, while the last decade of the sample shows an unprecedented level of interest.

##### *4.2.2 Contracts*

Institutions, contracts and the judicial system are elements that play a key role in economic interactions. They provide the foundations for economic activity. Real word exchanges occur in a framework of rules or institutions that determine the final payoffs for the actors. In addition counterparties sign contracts to govern specific relationships. The judicial systems is in place to enforce rules and contracts. To assess the attention assigned to these features we consider the indices corresponding to: “institution”, “contract contracts”, “judicial”, “court” and “fraud fraudulent”. All indices show some variation of a U-shaped pattern with the exception of “institution”. For this case a W is observed with a middle peak in the 1930s and 1940s. Also, we note that for “fraud

fraudulent” the value of index in the 2000s is higher than the value for the 1960s but it is approximately one half of the value observed in the 1920s. This suggest that while the interest for contracting issues revived, the interest for all related topics did not increase in the same way.

Table 4: Word detection index - Words related to features of the economic environment

	1886	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
<b>Frictions</b>													
friction or frictions	5.3	4.8	5.4	3.9	3.9	3.9	3.7	2.7	1.3	1.8	2.1	4.0	10.3
informed or uninformed	12.8	8.4	7.2	7.2	7.3	5.8	6.9	6.3	5.4	5.4	10.0	14.1	15.0
<b>Contracts</b>													
institution	18.2	14.3	14.1	11.7	14.1	17.0	15.8	11.1	12.4	12.4	18.4	21.9	20.1
contract or contracts	28.3	20.8	23.7	19.4	20.4	14.1	17.3	14.5	12.1	18.6	29.3	31.4	32.8
judicial	10.7	7.2	10.5	8.8	7.5	5.4	4.8	2.3	1.4	1.1	1.4	2.0	3.4
court	20.3	14.6	20.8	19.1	18.9	12.0	10.7	5.8	3.9	3.6	5.8	8.9	10.1
fraud or fraudulent	9.1	7.0	4.1	4.6	3.1	2.3	1.4	1.0	0.7	1.0	1.1	2.0	1.5
<b>Politics</b>													
authority	31.0	23.0	22.0	19.9	18.1	16.1	19.4	14.0	10.1	8.9	9.4	9.9	11.5
political party/ies	4.8	3.8	3.3	2.4	2.3	1.5	1.7	1.6	1.1	0.9	1.1	2.8	2.9
politics	24.1	15.7	14.9	11.6	12.9	10.2	13.5	9.8	8.1	7.1	8.9	15.3	13.1
<b>Social Preferences and Culture</b>													
culture	10.7	6.6	9.9	5.4	7.1	5.3	4.6	5.3	3.1	3.8	2.9	7.4	8.9
moral	22.5	16.8	13.9	10.8	9.8	6.3	8.1	6.7	5.1	5.6	8.8	11.7	13.7
conformity	3.7	4.6	3.3	3.0	4.0	2.8	2.8	3.1	2.3	2.0	1.8	2.2	2.8
corruption	6.4	4.2	3.8	1.6	0.9	1.1	0.9	1.1	1.0	0.7	0.8	3.2	5.7
honesty honest	18.7	11.7	11.2	7.2	5.6	3.9	3.3	3.1	2.0	2.0	3.0	3.0	3.0
fairness	4.8	2.3	3.7	3.1	3.8	2.2	2.3	2.0	1.2	2.0	3.4	4.5	5.7
social rank or social status or social hierarchy	0.5	0.8	0.8	0.5	0.6	0.5	0.6	0.8	0.5	0.7	0.4	1.0	1.5
resentment or pride or anger or greed or shame or embarrassment or hatred	16.6	9.4	9.8	6.6	7.4	4.3	4.3	4.0	2.8	2.3	2.5	2.4	4.0

Notes:

The index is calculated using the contents corresponding to the three oldest American journals: Quarterly Journal of Economics, The Journal of Political Economy and American Economic Review.

The index is equal to the percentage of journal contents that include the word that denotes the discipline.

#### 4.2.3 Politics

Societies are hierarchically organized; there is asymmetrical distribution of the capacity to influence the rules of a society and the allocation of resources. The political process determines which members have more influence and the decisions that are selected. While the interaction of these processes with economic phenomena is clear, the attention to these processes has varied in time. We evaluated the indices for the words: “politics”,

“authority” and “political party/ies”. The U-shaped pattern, with a modest middle peak in the 1950s, is predominant.

#### *4.2.4 Social preferences and culture*

Individual preferences and attitudes are not exclusively defined by references to an isolated agent. There are also elements on agent’s goals that are defined in a social context. For example, members of a society are concerned about “social status”. They have views about what constitutes acceptable behavior and about justice in a society. There is also a rich set of social emotions that regulates agent’s attitudes and decisions.

In addition, human societies are characterized by practices and beliefs that are socially transmitted and shared by the members of a community. This complex object is known as “culture”. Culture might have an important impact on economic outcomes. It can involve issues such as attitudes toward thrift or over-consumption, trust or corruption in business enterprises, views on fair distribution of resources and respect for the rule of law. The idea of culture, implicitly requires some level of “conformity” at the society level.

While “social preference” and “culture” as described above are two different concepts, we find it difficult to perform analyses of this two concepts separately. This is because, there are many social preferences that are socially transmitted as part of a culture. For example “fairness” and “honesty” might refer to social preferences that are innate or socially transmitted. As a consequence, we are going to consider interest for these two concepts in a single analysis.

We start by assessing general interest for these features by calculating indices for: “culture”, “moral” and “conformity”. We further evaluate the issue of beliefs regarding proper social behavior by calculating indices for: “honesty honest”, “corruption” and “fairness”. The interest in individual’s concern for positions in a hierarchical society are evaluated through an index for “social rank social status social hierarchy”. Finally the focus on social emotions is evaluated considering the ranking for a list of social emotions: “resentment pride anger greed shame embarrassment hatred”. Table 4 shows that the values of the indices are consistent with what we have documented for other features. The cases of the words “culture” and “moral” deserve special attention. By the 1920s approximately 7% and 10% of the contents included, respectively the words “culture” and “moral”. By the 1970s those figures dropped by approximately 50%. The 2000s show a strongly contrasting scenario with values of 9% and 14% which are even higher than the corresponding values to the 1920s. The reading of this indices are suggestive of big changes in the prevailing views regarding the relevance of non-economic factors for economic analysis.

## **5. The Mathematical Approach**

The economic journals are currently characterized by a heavy use of mathematical techniques in their contents. In this section we provide a novel account of how this process developed. Following the approach of previous analyses detailed in the previous sections, we assess the embrace of mathematical techniques detecting the presence of specific words. In this case we select the words: mathematics, equation, theorem and axiom. The index equals the percentage of contents that include at least one of those words in its full text.

We already anticipated some of the result in figure 3 in the introduction. That figure details how the index for three selected journals shows a dramatic embrace of mathematical techniques in the 1960s and 1970s<sup>8</sup>. For each of the three journals, the variation of the indices during these two decades, adds up to almost to 40. This implies that the percentage of contents that include at least one of the words related with mathematics, jumped from the 17%-30% range in the 1950s to a range of 67%-77% by the 1970s. We consider these developments in premium journals to indicate a violent change in the prevailing practices and views of a community of researchers.

**Index of Word Detection - Mathematics Related Terms - All Journals**

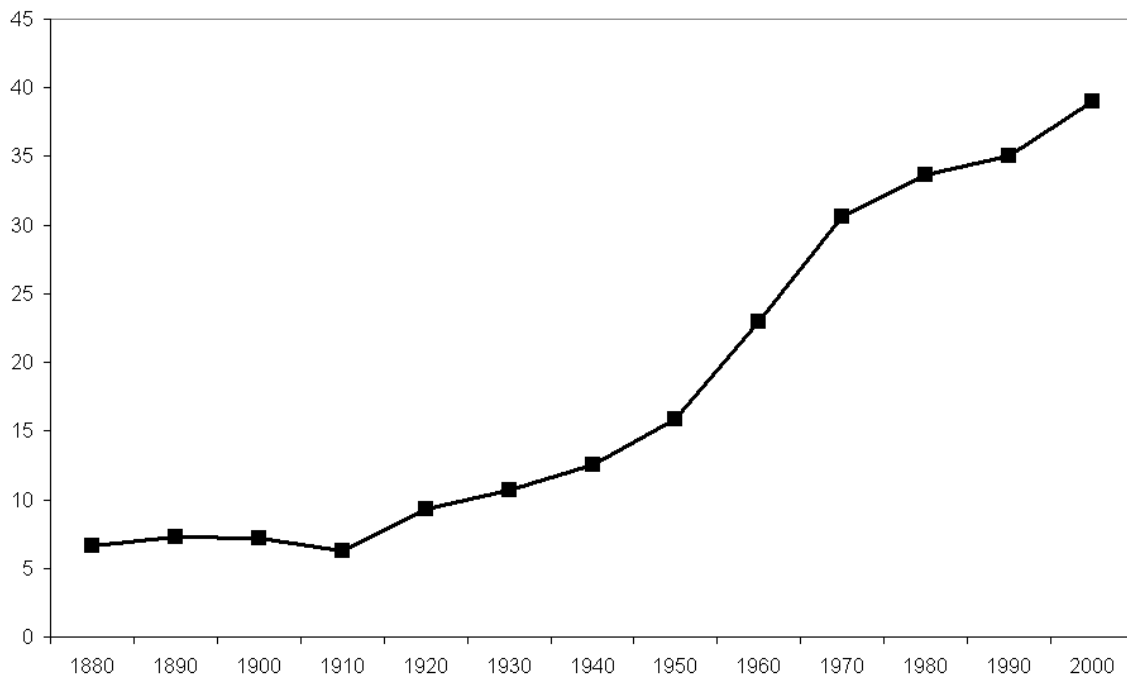


Figure 5

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<sup>8</sup> The three journals considered are: American Economic Review, The Journal of Political Economy and Quarterly Review of Economics.

We also Consider a broader set of publications to capture the practices in the discipline beyond the “core mainstream” measured by the three traditional journals. Figure 5 presents the evolution of the index calculated for the 92 journals included in the full database. The aggregate index indicates a more smooth evolution that is still in progress during the last decades. But, in line with what we observed in the previous case, the 1960s and 1970s are the decades with the largest variation in the index, both in absolute and percentage terms. The change in the index equal 7.1 and 7.6 in the 1960s and 1970s respectively. This represents percentage changes of 45% and 33% respectively.

We would like to note that, for these decades, the three traditional journals represent between 10% and 20% of the total number of contents for the sample, this means that it is not the case that the variations for the complete sample are mainly explained by developments in those three journals. Also, we would like to note that the second exercise provides an additional robustness check to our findings, since in this case, we are allowing for new journals to enter the calculation of the index. That is, we observe that both, under a constant set of journals and a growing set of journals, the 1960s and 1970s appear as the decades in which mathematical techniques were broadly embraced by the discipline.

## 6. Discussion

We start this section by providing some quotes by well-known past and contemporaneous economists. “Out of context quotes” do not provide a complete picture of an economist’s views. But, properly used, they can provide a sketch of the inclinations of the researcher. Below we provide some quotes that illustrate the diversity in views regarding the practice of Economics<sup>9</sup>:

"no part of man's nature or his institutions must lie entirely outside” an economist's  
“regard.”

John Maynard Keynes (1924)

"Noneconomic motives are an essential element of economic theory,"

Joseph A. Schumpeter (1942)

“A meaningful scientific hypothesis or theory typically asserts that certain forces are, and other forces are not, important in understanding a particular class of phenomena.”

Milton Friedman (1953)

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<sup>9</sup> The first two quotes were originally quoted by Robert Heilbroner, NYT January 23 1999.

“The combined assumptions of maximizing behavior, market equilibrium and stable preferences, used relentlessly and unflinchingly, form the heart of the economic approach as I see it.”

Gary Becker (1978)

“Economics, as a field, got in trouble because economists were seduced by the vision of a perfect, frictionless market system.”

Paul Krugman (2009)

“It is therefore necessary for us to renew our understanding of how capitalist economies - in which people have not only rational economic motives but also all kinds of animal spirits- really work.”

Akerlof and Shiller (2009)

As can be inferred from the quotes above, the opinions expressed involve stances on more than one characteristic of economic analyses. They refer to the scope of features that should be considered by an economist, as well as to the emphasis on optimal behavior and equilibrium versus a vision of a world with frictions.

Economic phenomena are very complex. They involve the interaction of economic agents characterized by goals and cognitive abilities that are shaped by a combination of innate tendencies, transmitted inclinations and directly acquired experience. Multiple economic and non-economic interactions occur simultaneously through a social network. The system is in constant evolution, with significant changes in terms of technology, the ability to satisfy basic needs, the organization of trade and production, information diffusion, mechanism for social choice and cultural values.

Facing such a scenario, the researcher intends to advance the understanding of economic events using observation, intuitive judgment and logical reasoning as interactive tools. The interplay of these tools determines, in particular, the features of economic events that are considered in the analysis. Intuitive judgment guides observations which in turn inform intuitive judgment. How many and which features are attended to, is mainly determined by this feedback process. On the other hand, a decision to use logical reasoning intensively will typically reduce the number of features considered in the core of the analysis. In this case, the focus on a narrow set of issues is a natural consequence of the inability to arrive to relevant logical conclusions when operating with a large set of variables.

From this perspective, we can describe three states of economic research as suggested by

our quantitative observations. A first stage in which a broad set of features is attended to. These features were jointly considered in analyses with heavy use of intuitive judgment and limited use of logical reasoning. A second stage is characterized by a markedly increased role for logical reasoning and a focus on a narrow, and mostly strictly economic, set of features. The evidence in this work is consistent with the view that, in the last decades, the discipline entered a third stage in which the use of logical reasoning remains strong but the features considered are more diverse. Still, due to the heavy use of logical reasoning, the number of features considered in the core of each analysis is necessarily kept low; otherwise logical reasoning cannot be applied.

## **7. Concluding Remarks**

This is a descriptive contribution. Our objective is to report, in very general terms, comprehensive assessments of changing practices in the profession. The measures we use are novel and informative. As it is the case with any quantification, there is room for further inspection of the results and refinement of the indices. Nevertheless, we do not think that the main message would change significantly. We report that the quantitative measures provided are able to identify significant variations in the way in which economic analyses are developed. Variations are related to the attention to different features of economic events and to the use of mathematical techniques. The last decades are characterized by the prevalent use of mathematical techniques and the consideration of an ample set of features of economic events.

There are many directions in which this analysis can be extended. First, this analysis could be extended to other social sciences to be able to assess whether similar cycles of isolation and connectedness occurred. In the same spirit, the analysis could be extended to economic journals in other languages. It would be interesting to observe whether the detailed patterns were simultaneously developing in other communities of researchers. The analysis could be extended in time. The main challenge in this case would be identifying, for early dates, a similar sample of scientific writings.

Another possible extension would involve analyzing developments in the way in which specific fields of interest are approached. This is in contrast with the very general perspective taken in the current study. For example, a study could evaluate the fraction of the works on economic growth that have considered institutions or culture as relevant aspects. Similarly, it would be interesting to learn about the evolution of the interest in concepts such as bubbles, fraud, bankruptcy and panic in studies of financial markets. Variations in the frequency of detection of these words can be interpreted as indications of different “eras” in the study of financial markets.

Finally, we believe that similar analyses could be employed to provide insights about the degree of specialization inside of the discipline. Specialization is considered a natural consequence of applying additional resources to the study of specific topics. Historic measures could be computed to assess to which degree, studies in different areas,

appealed to increasingly different inputs from other disciplines or are attentive to different features of the economic agent and the environment in which interactions occur.

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## Appendix

Table A.1: Word detection index - Value by discipline - 8 selected journals

	1886	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
<b>Psychology</b>	2.0	2.7	3.1	7.1	11.3	7.2	6.2	5.2	3.2	2.7	3.6	5.4	9.6
<b>History</b>	60.4	50.5	48.9	53.0	49.8	42.8	38.8	36.4	29.3	19.3	22.6	30.5	33.9
<b>Sociology</b>	7.6	7.5	8.0	6.5	8.0	6.3	5.8	5.6	4.0	3.4	3.0	4.9	6.1
<b>Pol. Science</b>	18.8	8.0	6.8	7.2	7.5	6.4	7.1	5.5	4.7	3.9	3.3	4.5	6.8
<b>Ethics</b>	6.6	6.0	4.6	5.4	6.0	3.5	2.8	3.0	1.8	1.8	2.0	3.0	2.9
<b>Philosophy</b>	12.2	9.5	7.7	8.6	10.3	9.6	11.2	8.3	5.2	3.9	4.5	5.3	4.1
<b>Biology</b>	2.0	1.0	1.5	1.2	2.0	1.7	1.1	0.9	0.7	0.9	1.1	2.3	2.5
<b>Physics</b>	2.0	2.1	1.6	1.0	2.2	1.5	1.9	1.9	1.5	1.3	1.2	2.2	1.7
<b>Chemistry</b>	3.0	1.5	1.7	1.1	1.6	1.0	0.9	1.1	0.6	0.6	0.4	0.7	1.0

Notes:

The index are calculated using information corresponding to eight selected publications: AER, QJE, JPE, The Economic Journal, Review of Economic and Statistics, Economica, Econometrica and Review of Economic Studies.

The index is equal to the percentage of journal contents that include the word that denotes the discipline.

Table A.2: Word detection index - Value by discipline - all Economic journals

	1886	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
<b>Psychology</b>	2.0	2.8	3.1	7.0	10.2	6.0	5.6	6.1	4.0	3.3	3.5	4.1	5.7
<b>History</b>	60.4	50.8	48.6	52.5	49.5	46.0	45.6	44.0	36.9	32.7	35.7	39.1	40.6
<b>Sociology</b>	7.6	7.5	8.0	6.5	7.9	6.6	10.8	10.1	8.4	7.4	7.4	9.1	8.7
<b>Pol. Science</b>	18.8	8.0	6.8	7.1	8.0	9.8	12.5	10.0	7.7	6.2	6.5	8.4	10.7
<b>Ethics</b>	6.6	6.1	4.5	5.3	5.4	3.0	3.0	3.1	1.9	2.0	2.4	3.8	3.8
<b>Philosophy</b>	12.2	9.5	7.7	8.5	9.5	9.6	13.2	10.2	7.3	6.2	6.9	7.6	6.8
<b>Biology</b>	2.0	1.0	1.5	1.2	1.8	1.4	1.1	0.8	0.6	0.8	1.1	1.8	2.3
<b>Phys.or Chem.</b>	3.6	3.1	2.7	1.6	2.9	2.3	2.7	2.4	1.7	1.6	1.6	2.1	2.2
<b>Chemistry</b>	3.0	1.5	1.7	1.1	1.6	1.0	0.9	1.1	0.6	0.6	0.4	0.7	1.0

Notes:

The indices are calculated using information from the 92 journals classified as Economic journals by Jstor.

The index is equal to the percentage of journal contents that include the word that denotes the discipline.

Table A.3: Average word detection index for selected disciplines - Correlation coefficient across journals

<b>1880-2000</b>	AER	QJE	JPE	TEJ	RESta	Ec mica	Ec trica	REStu	Mean
AER	-	0.53	0.72	0.08	-0.20	0.89	0.49	0.78	0.47
QJE	0.53	-	0.82	0.50	0.20	0.77	0.50	0.95	0.61
JPE	0.72	0.82	-	0.58	0.25	0.71	0.67	0.88	0.66
The Econ. J.	0.08	0.50	0.58	-	0.77	0.11	0.62	0.72	0.48
R. of Econ&Stat	-0.20	0.20	0.25	0.77	-	-0.23	0.08	0.54	0.20
Economica	0.89	0.77	0.71	0.11	-0.23	-	0.47	0.77	0.50
Econometrica	0.49	0.50	0.67	0.62	0.08	0.47	-	0.53	0.48
R. of Econ. Stud.	0.78	0.95	0.88	0.72	0.54	0.77	0.53	-	0.74
<b>1940-2000</b>									
<b>1940-2000</b>	AER	QJE	JPE	TEJ	RESta	Ec mica	Ec trica	REStu	Mean
AER	-	0.54	0.76	0.85	0.87	0.39	0.47	0.73	0.66
QJE	0.54	-	0.85	0.76	0.73	0.79	0.47	0.96	0.73
JPE	0.76	0.85	-	0.97	0.71	0.79	0.66	0.91	0.81
The Econ. J.	0.85	0.76	0.97	-	0.74	0.71	0.67	0.85	0.79
R. of Econ&Stat	0.87	0.73	0.71	0.74	-	0.48	0.19	0.85	0.65
Economica	0.39	0.79	0.79	0.71	0.48	-	0.46	0.75	0.63
Econometrica	0.47	0.47	0.66	0.67	0.19	0.46	-	0.48	0.48
R. of Econ. Stud.	0.73	0.96	0.91	0.85	0.85	0.75	0.48	-	0.79

Notes:

The average index is calculated using information corresponding to six disciplines: Psychology, History, Sociology, Political Science, Philosophy and Ethics.

The index is equal to the percentage of journal contents that include the word that denotes the discipline.