sociological science

Supplement to:

Evans, Eliza D., Charles J. Gomez and Daniel A. McFarland. 2016. "Measuring Paradigmaticness of Disciplines Using Text." Sociological Science 3: 757-778.

Online Supplement

Robustness Checks for the Construction of the Disciplinary Corpora

In our paper, we present results that describe paradigmaticness in terms of stability, rapid discovery, and consensus under two criteria: (1) seven time periods between 1991 and 2011 inclusive, and (2) using the most conservative selection of WoS SCs to sample discourse from each of the disciplines. Here we expand on the results presented in the main text to show that our results are robust when we (1) plot the main results for individual disciplines over time; (2) vary how we define our eight disciplines; and (3) use alternative n-gram measures.

First, we limit the analyses in the main text to averages of natural and social sciences over time for simplicity. Here, we expand the left panes in Figures 3, 4, and 5 by plotting these values over time for each of the eight disciplines in Figures A1, A2, and A3 for consensus, rapid discovery at the periphery, and stability at the core respectively.

Second, disciplines are ill-defined. Though we take the most conservative set of SCs to define a discipline, it may be more appropriate to also include SCs that represent sub- and interdisciplinary fields. To test the robustness of the choices we made in the main analysis, we perform the same analyses but under various permutations of what defines the boundary of a discipline. To determine what to include in the various permutations, we made pairwise cosine similarity comparisons between the eight baseline SCs groupings presented in the main results with every other SC available in WoS. For each of the eight original baseline SCs groupings in our main analysis, we iteratively add SCs to the disciplinary corpus if the cosine similarity score between the text of the baseline discipline group and the text of an additional SC is above a particular threshold (0.7, 0.8, and 0.9) for each of the seven time periods. For example, consider SC *x* being compared at the 0.9 threshold. SC *x* is added to the sample of SCs representing a

discipline if the cosine similarity between *x* and the disciplinary baseline set is above 0.9 for all seven time periods. Thus, if the cosine similarity between publications with SC *x* and publications with the SC "Psychology" is above 0.9 for all seven time periods, then SC *x* is added to the baseline set of SCs representing psychology. When the threshold is loosened to 0.8, SC *x* is included in the "Psychology" corpus, along any other SCs that may meet the 0.8 threshold value for all seven time periods. Thus, with a lower cutoff value, we more liberally include SCs and more liberally define the eight disciplines. Alongside the baseline groups used in the main analysis and the three disciplinary groups created using the cosine similarity cutoffs of 0.7, 0.8, and 0.9, we also include a qualitative set of SC groupings for comparison. These qualitative SC groups include all SCs that include the name of the discipline in the "Discipline, <subfield>" structure or, for biology, in an SC such as "Cell Biology." Taken together, we construct disciplines in five different ways, each of which are represented in Figures A4, A5, and A6. Respectively, these three figures plot consensus, rapid discovery at the periphery, and stability at the core for disciplinary corpora constructed using each of the five methods.

By and large, the relative ordering between the natural and social sciences holds with each of these groupings: natural sciences have a much higher rates of consensus, a higher rate of consolidation at their cores, and a higher rate of linguistic turnover at the periphery, as compared to their social science counterparts.

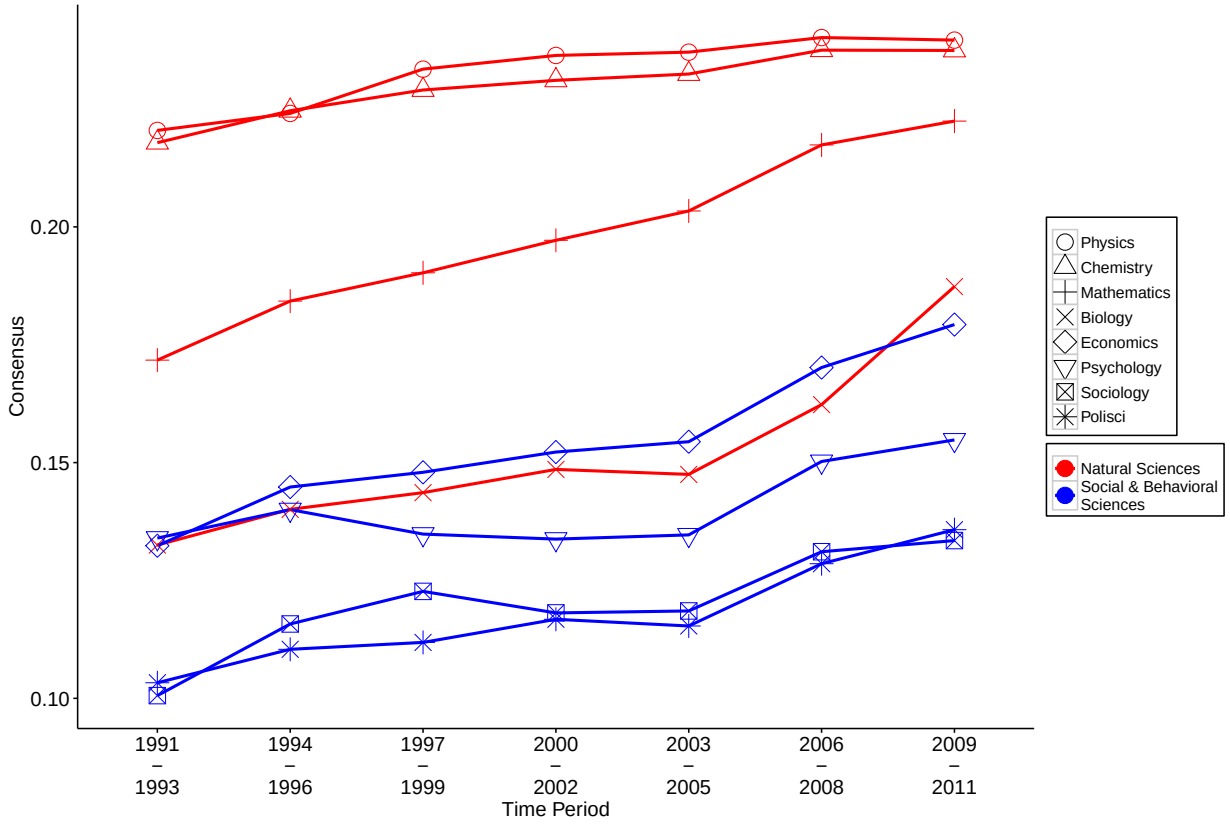
Third, the main text uses unigrams (single words) to compute cosine similarity scores for consensus, rapid discovery, and stability. Yet Vilhena et al. (2014) argue for the use of trigrams, combinations of three consecutive words, to better represent scientific ideas and concepts. To test the sensitivity of our measures to phrase length, we reconstructed our measures using trigrams (n=3) through 5-grams. Here, we run n-gram models for our three measures such that

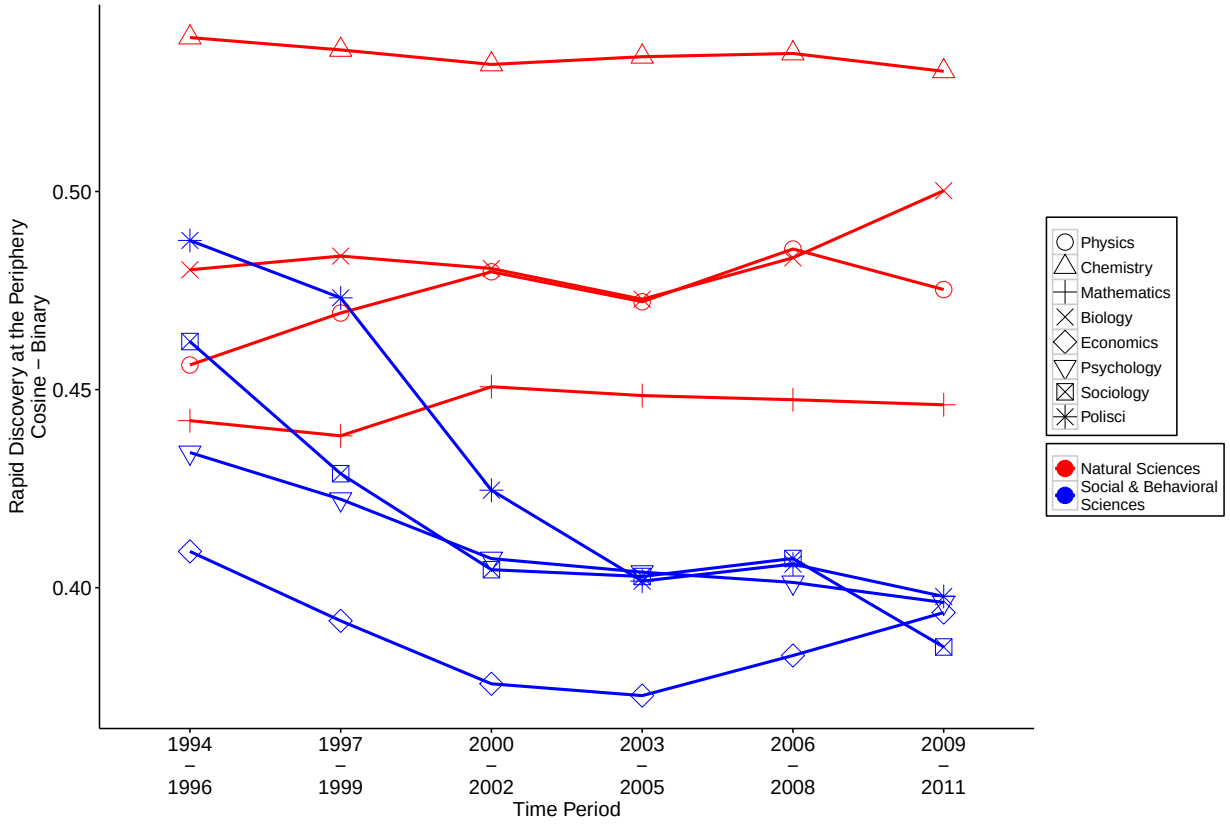
each n-gram analysis includes n-grams through unigrams. In other words, our 5-gram models includes 5-grams, 4-grams, trigrams (n=3), bigrams (n=2), and unigrams in the set of terms we use to run our cosine similarity and entropy measures. Figures A7, A8, and A9 plot n-grams from n=1 to n=5 for our consensus, rapid discovery, and stability measures, respectively. We find that increasing n-grams beyond two does not provide any additional or surprising insights as to how the paradigmatic nature of disciplines relates to their relative ordering or the nature by which knowledge is internally structured using text data. The results are very similar for the measures of rapid discovery at the periphery (Figure A8) and stability at the core (Figure A9). For consensus (Figure A7) the lower probability of observing larger n-grams over time suppresses the values, but across all models, the natural sciences show higher consensus than the social sciences.

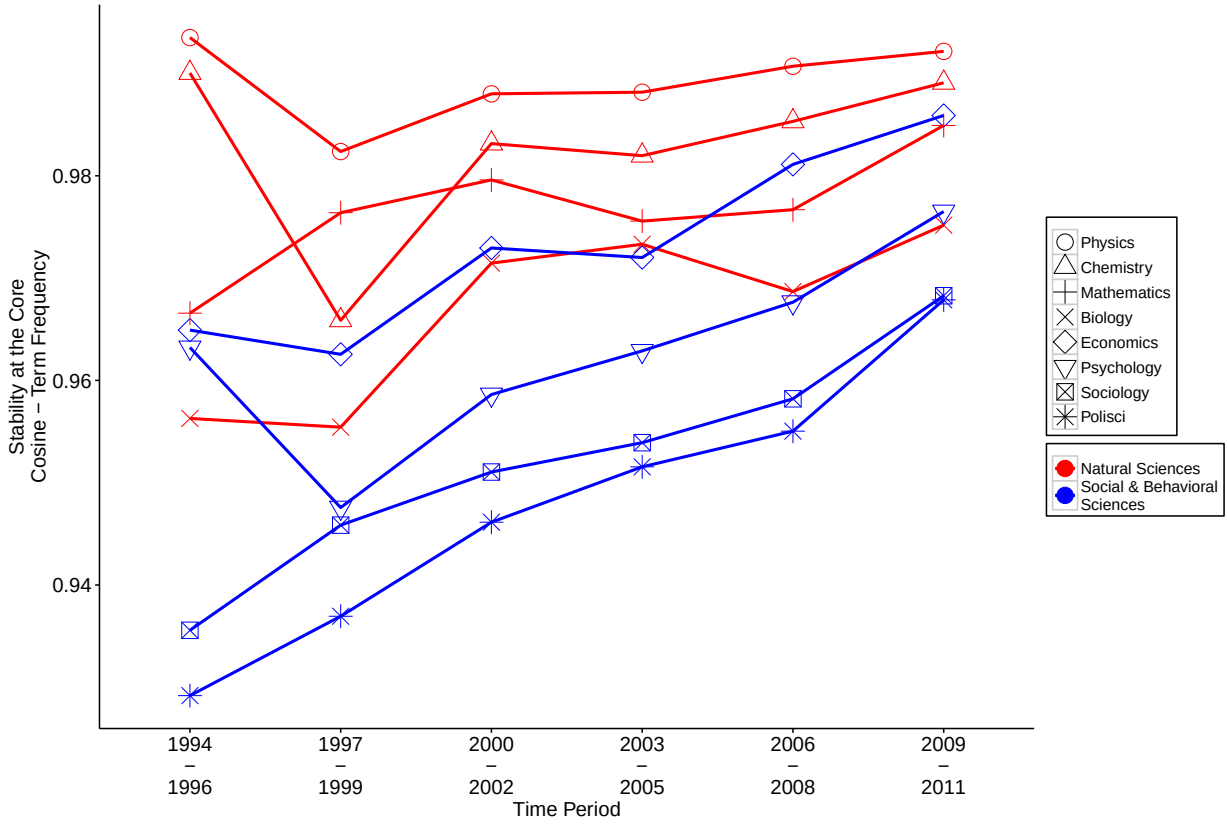
Analysis of Correlations Among the Three Measures

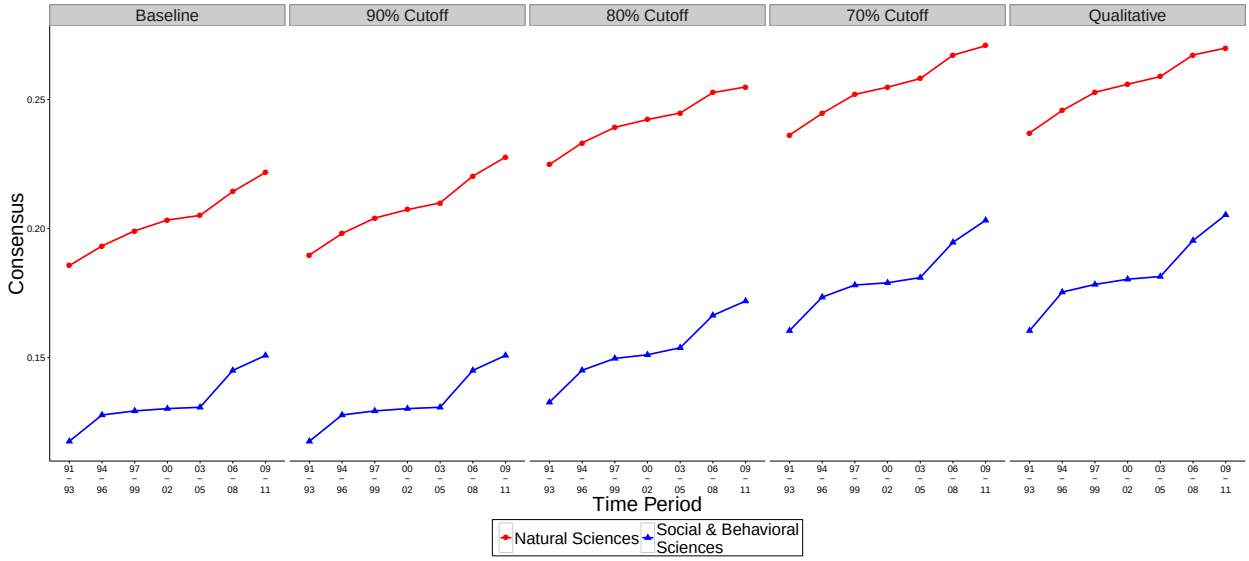
Drawing on previous work, we theorized that paradigmaticness entails several characteristics that could be measured using academic texts (consensus, rapid discovery at the periphery, and stability at the core). Because these are theoretically derived characteristics (a priori), we test whether they can be combined into a single additive measure capturing paradigmaticness. We assessed this using Cronbach's alpha and principal component analysis. The Cronbach alpha is a measure of internal consistency, or how closely related the items are as a group. The Cronbach alpha for our measure is 0.73, which suggests an acceptable level of internal consistency. Since the alpha measure does not imply that a measure is unidimensional, we also employ principal component analysis. Principal component analysis identifies a single additive component that captures most of the variation in our metrics (78% of variance). A scree plot of eigenvalues indicates that this one additive component stands apart with a value of 2.2.

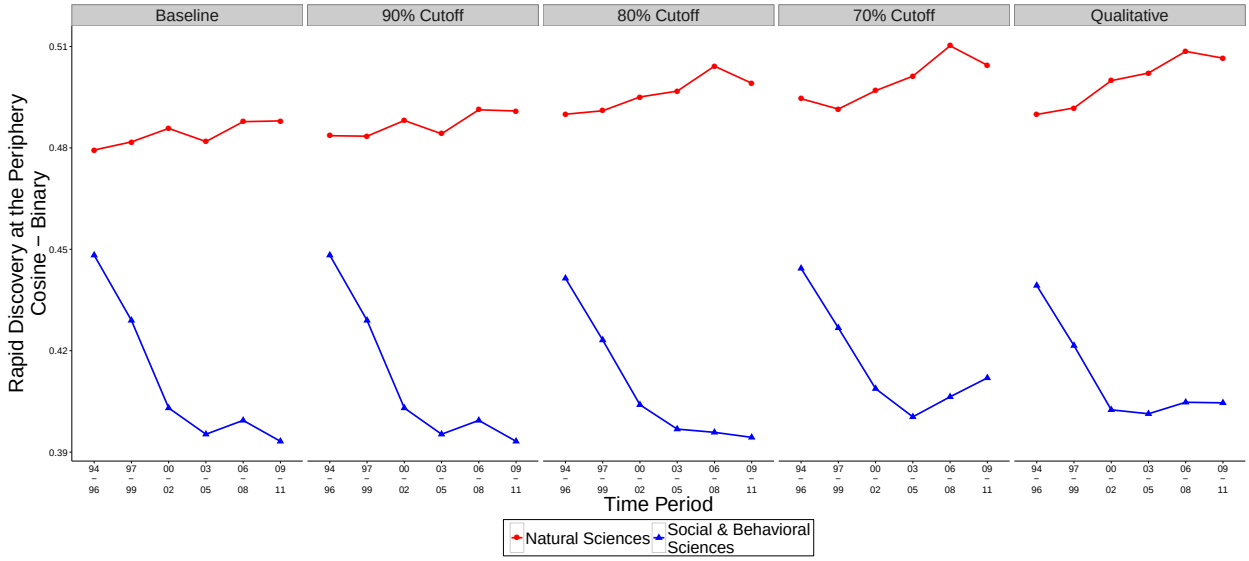
The next possible component has a eigenvalue of .73, and lands below the traditional cutoff of eigenvalue = 1. Variable weightings are in the expected directions. Both the Cronbach alpha and principal component analysis suggest our measures capture interrelated qualities of paradigmaticness, as theoretically defined.

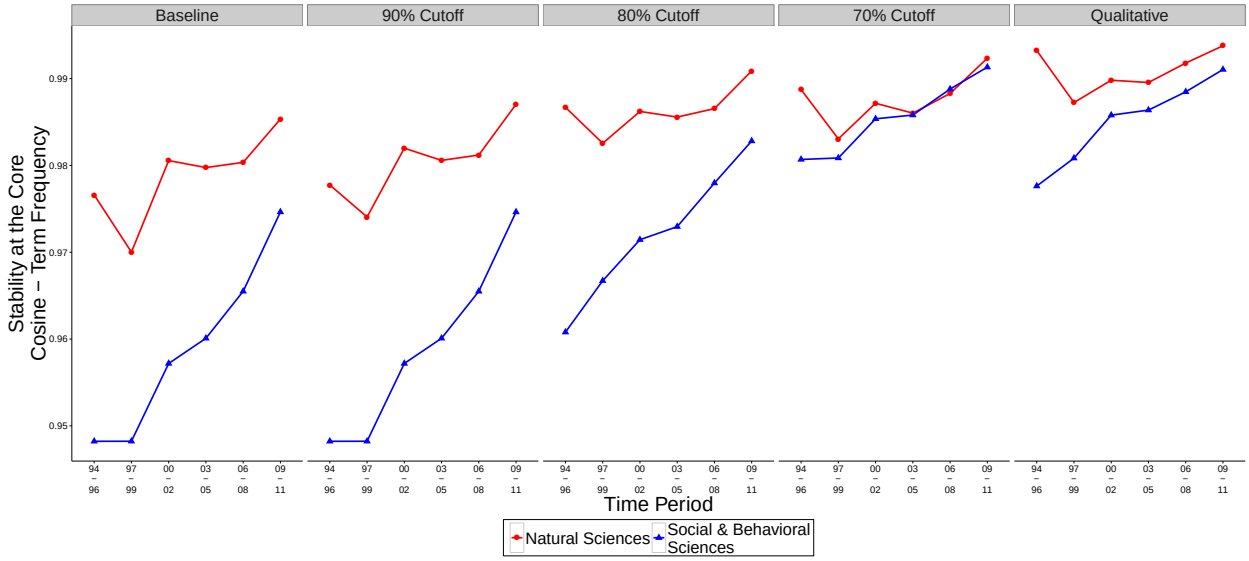

Consensus
0.20
0.15
0.10
1991 – 1993
1994 – 1996
1997 – 1999
2000 – 2002
2003 – 2005
2006 – 2008
2009 – 2011
Time Period
Physics
Chemistry
Mathematics
Biology
Economics
Psychology
Sociology
Polisci
Natural Sciences
Social & Behavioral Sciences

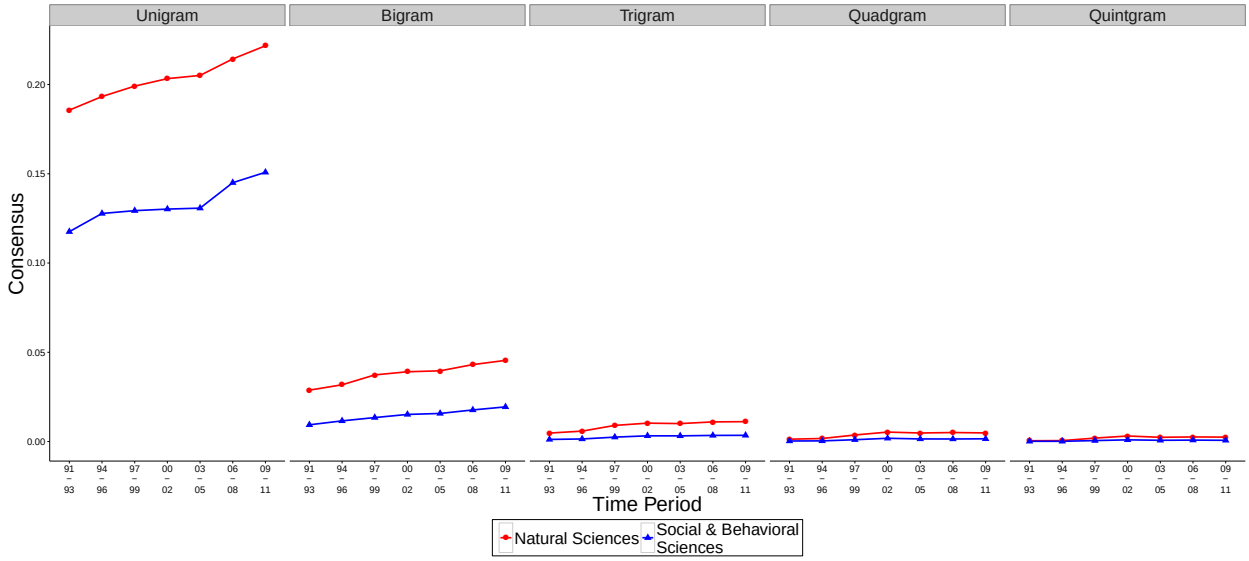

Rapid Discovery at the Periphery
Cosine – Binary
0.50
0.45
0.40
1994 – 1996
1997 – 1999
2000 – 2002
2003 – 2005
2006 – 2008
2009 – 2011
Time Period
Physics
Chemistry
Mathematics
Biology
Economics
Psychology
Sociology
Polisci
Natural Sciences
Social & Behavioral Sciences

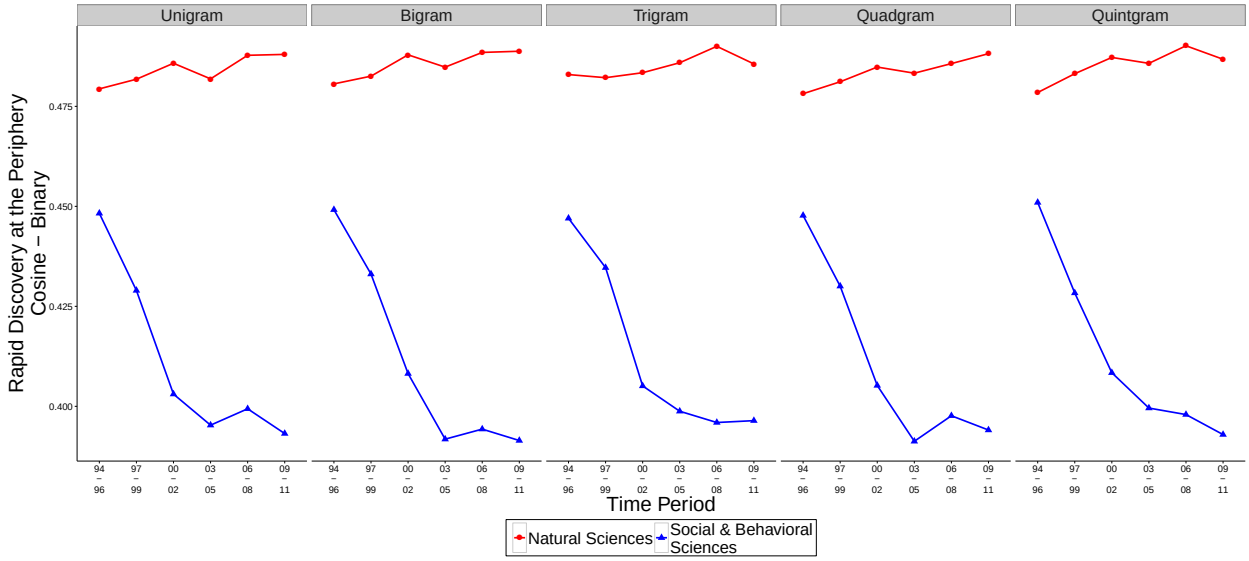

Stability at the Core
Cosine – Term Frequency
0.98
0.96
0.94
1994 – 1996
1997 – 1999
2000 – 2002
2003 – 2005
2006 – 2008
2009 – 2011
Time Period
Physics
Chemistry
Mathematics
Biology
Economics
Psychology
Sociology
Polisci
Natural Sciences
Social & Behavioral Sciences

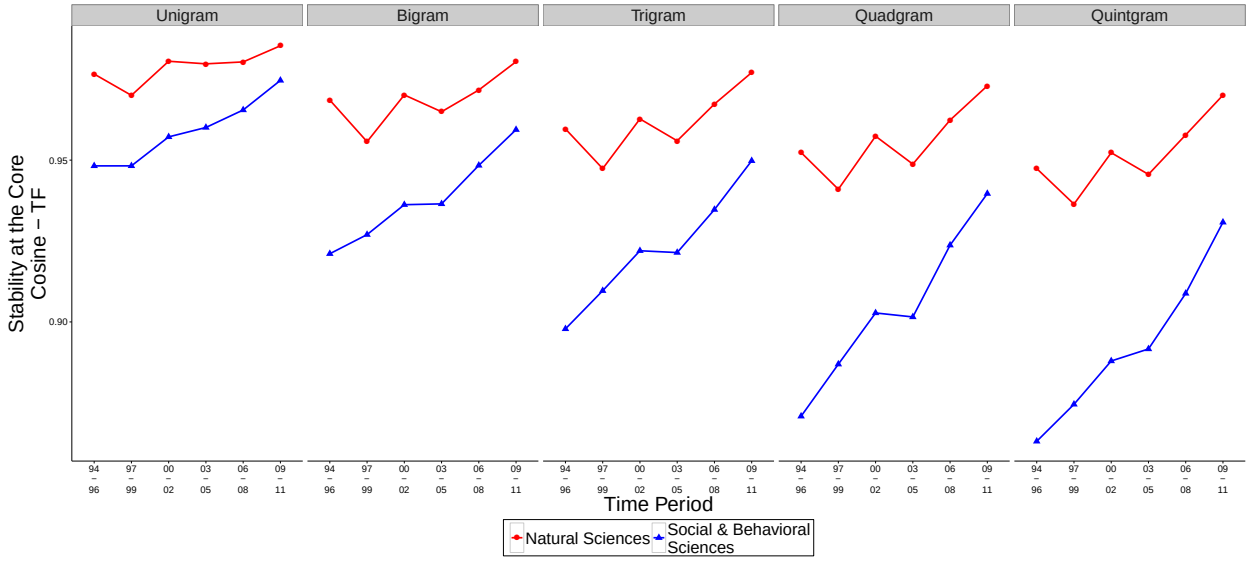

Baseline
90% Cutoff
80% Cutoff
70% Cutoff
Qualitative
Consensus
0.25
0.20
0.15
91 – 93
94 – 96
97 – 99
00 – 02
03 – 05
06 – 08
09 – 11
Time Period
Natural Sciences
Social & Behavioral Sciences


Baseline
90% Cutoff
80% Cutoff
70% Cutoff
Qualitative
Rapid Discovery at the Periphery
Cosine – Binary
0.51
0.48
0.45
0.42
0.39
94 – 96
97 – 99
00 – 02
03 – 05
06 – 08
09 – 11
Time Period
Natural Sciences
Social & Behavioral Sciences


Baseline
90% Cutoff
80% Cutoff
70% Cutoff
Qualitative
Stability at the Core
Cosine – Term Frequency
0.99
0.98
0.97
0.96
0.95
94 – 96
97 – 99
00 – 02
03 – 05
06 – 08
09 – 11
Time Period
Natural Sciences
Social & Behavioral Sciences


Unigram
Bigram
Trigram
Quadgram
Quintgram
Consensus
0.20
0.15
0.10
0.05
0.00
91 – 93
94 – 96
97 – 99
00 – 02
03 – 05
06 – 08
09 – 11
Time Period
Natural Sciences
Social & Behavioral Sciences


Unigram
Bigram
Trigram
Quadgram
Quintgram
Rapid Discovery at the Periphery
Cosine – Binary
0.475
0.450
0.425
0.400
94 – 96
97 – 99
00 – 02
03 – 05
06 – 08
09 – 11
Time Period
Natural Sciences
Social & Behavioral Sciences


Unigram
Bigram
Trigram
Quadgram
Quintgram
Stability at the Core
Cosine – TF
0.95
0.90
94 – 96
97 – 99
00 – 02
03 – 05
06 – 08
09 – 11
Time Period
Natural Sciences
Social & Behavioral Sciences