

# Mapping Evolutionary Economics

## A Bibliometric Analysis

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### **Abstract**

This paper attempts to empirically investigate the frequent claim that 'evolutionary' research has become more popular in recent years. To this end, roughly 8,500 publications are retrieved from EconLit, the most comprehensive data base of economic publications. Comparing the evolution of the data set with the evolution of all publications indexed in EconLit indeed produces a rising share. However, this is no meaningful result, since the term 'evolution' may be used in multiple contexts, not all of which qualify as 'evolutionary'. Therefore, co-word analysis is applied to isolate relevant publications, which is a bibliometric method that allows to identify in which context terms are used. Having identified the relevant share of publications in the data set by this method, preliminary results confirm that the share of 'evolutionary' publications has indeed grown over the past two decades.

## 1. Introduction

In reviews of the evolutionary economic literature it is sometimes asserted that economic research inspired by an evolutionary perspective has become increasingly fashionable in recent years (e.g. Hodgson 1998). Frequently, this is attributed to the impact of Richard Nelson's and Sidney Winter's classic book, *An Evolutionary Theory of Economic Change* (Nelson/Winter 1982), published almost 20 years ago. Most researcher labelling themselves 'evolutionary' will probably agree.

However, given the pivotal role played by bounded rationality in evolutionary economic thought, one may be tempted to wonder whether this observation is indeed true or an artefact of evolutionary economists' limited ability to survey overview the entire economic literature. Has the term 'evolutionary economics' indeed become more popular? Has evolutionary economics as a mode of economic theorising become more important?

This paper attempts to provide an empirical answer to these questions. The conventional way to measure and classify economic research output are publications. This paper will therefore use publications to determine the 'evolution of evolutionary economics' in recent years.

Identifying relevant publications requires a clear demarcation criterion to separate 'evolutionary' from 'non-evolutionary' contributions. This is rather difficult, as economic publications are rarely labelled by the theoretical approach they adopt. The problem is further exacerbated by the fact that there is no established consensus on what constitutes 'evolutionary economics' (Hodgson 1998, p. 161). In a very broad sense, evolutionary approaches in economics are concerned with economic change and its causes, the motives and the understanding of the actors involved, the process how change materialises and in its consequences (Witt 1993, p. xiii). More narrowly, evolutionary economics is sometimes defined by its use of the Darwinian or Lamarckian metaphor taken from biology (Hodgson 1998, p. 160).

These definitions can be used to survey and classify the evolutionary economic literature, as leading authors have done over the past decade (Hodgson 1993; Witt 1993; Nelson 1995; Hodgson 1998). However, identifying relevant publications by means of the above definitions essentially requires a manual classification of the entire economic literature. Apart from its practical impossibility, such an approach also introduces the problem of possible distortions due to subjective judgement. Moreover, it does not resolve the principle problem that arises due to the unclear boundaries of evolutionary economics.

This paper therefore adopts a different strategy. Relevant publications are retrieved from EconLit, the largest database of economic publications. Comparing the resulting data set with the total number of publications indexed in EconLit indeed reveals a rising share. However, due to the inherent ambiguity of the search terms, these results are not directly applicable. Therefore, a method is required to isolate relevant publications. To this end, co-word analysis, a bibliometric method that allows to identify the context in which key terms are used, is applied. This method allows to structure the publications in the data set and identify the 'evolutionary' sub-population. The resulting set of publications is then used to provide some preliminary evidence on the 'evolution of evolutionary economics'.

The paper is structured as follows: The next sections describes the search strategy and the data source. Section three analysis the properties of resulting data set. Section four introduces

the bibliometric method. Section five presents the results obtained by this method. Section six summarises the discussion and concludes with some suggestions for future research.

## 2. Data set

### 2.1. Search strategy

Publication data was retrieved from EconLit (edition 12/2000), the American Economic Association's electronic bibliography of economic literature, which holds information on economic publications since 1969. The search was performed with two search terms – 'evolution' and 'evolutionary' – in titles, subject descriptors, sources and abstract fields, which yielded a total of 8,568 records ('evolution' – 6010 records, 'evolutionary' – 3028 records<sup>1</sup>).

The terms were chosen since they are the most general terms characterising 'evolutionary' literature in economics. Moreover, many authors may chose to explicitly label their work as 'evolutionary' or focusing on 'economic evolution' to distinguish it from more orthodox contributions. Two objections may be raised against this search strategy: First, many publications that should correctly be classified as 'evolutionary' may not contain either search term in the respective fields. Second, not every record including the two search terms automatically qualifies as 'evolutionary'. Each objection shall be addressed in turn.

Since a generally accepted definition of 'evolutionary economics' does not exist, the choice of search terms may always invite criticism. When conducting the search, we therefore experimented with a number of additional search terms. The results of these experiments are summarised in Table 1. It shows that other plausible search terms would also yield a sizeable number of hits, albeit substantially lower than the two selected search terms. In total, a search with the listed additional terms would yield 2066 records, of which three in four (75.5%) do not contain either search term. Adding these would increase the population by 18 per cent, as the last line in Table 1 shows.

**Table 1: Alternative search terms**

Search term	No. of records
evolution	6,010
evolutionary	3,028
schumpeter	610
biological	553
schumpeterian	478
biology	233
routine	152
genes <sup>2</sup>	40
Total	10,127 (+ 18.2 %)

However, there is no guarantee that the extra search terms improve the quality of the search. Are publications on 'biological warfare' 'evolutionary'? Do papers in environmental and resource economics using the terms 'biological' or 'biology' adopt an 'evolutionary' perspective? Are 'routine' monetary rules 'evolutionary'? Are papers on genetic research in the biochemical industry 'evolutionary'? Probably not. Moreover, why choose these terms and omit others? Accordingly, since increasing the number of search terms would probably distort the accuracy

<sup>1</sup> The lower total is due to some records containing both search terms.

<sup>2</sup> 'Gene' is a frequent first name and hence no meaningful search term for the present purposes.

of the search as much as it would improve it, we opted for a conservative approach with the two most frequent terms only.

The chosen search strategy undoubtedly fails to capture the complete 'evolutionary' literature in economics. To get a rough indication for how much we might be missing, Table 2 displays the number of publications in EconLit 12/2000 for a list of key authors and confronts these figures with the number of records retrieved by our query. The list of authors is based on a classification proposed by Hodgson (1998, p. 163) and naturally could be extended.

**Table 2: Share of publications by key authors**

Author	Total	Query	Share
Richard R. Nelson	148	25	16.9%
Geoffrey M. Hodgson	92	55	59.8%
J. Stanley Metcalfe	60	17	28.3%
Joseph A. Schumpeter	59	28	47.5%
Giovanni Dosi	52	20	38.5%
Sidney G. Winter	43	15	34.9%
Brian Loasby	41	6	14.6%
Ulrich Witt	39	22	56.4%
Gerald Silverberg	18	13	72.2%

The table reveals marked variations in the fraction of the total number of publications (recorded in EconLit) by each author retrieved by our query, ranging from 14 per cent (Brian Loasby) to 72 per cent (Gerald Silverberg). However, similar questions as before can be raised: Is Schumpeter's work on Marxism and the history of economic thought 'evolutionary'? Should Richard Nelson's publications on productivity or the labour market be classified as 'evolutionary economics'? Is Geoffrey Hodgson an 'evolutionary economist' when he writes on institutional economics?

Admittedly, these questions are more difficult to answer than the previous ones. However, lacking an unambiguous demarcation criterion to separate the 'evolutionary' from the remaining literature, the question is hard to resolve in a satisfactory way. Obviously, a number of relevant publications are missing, yet available information does not allow to determine how many.

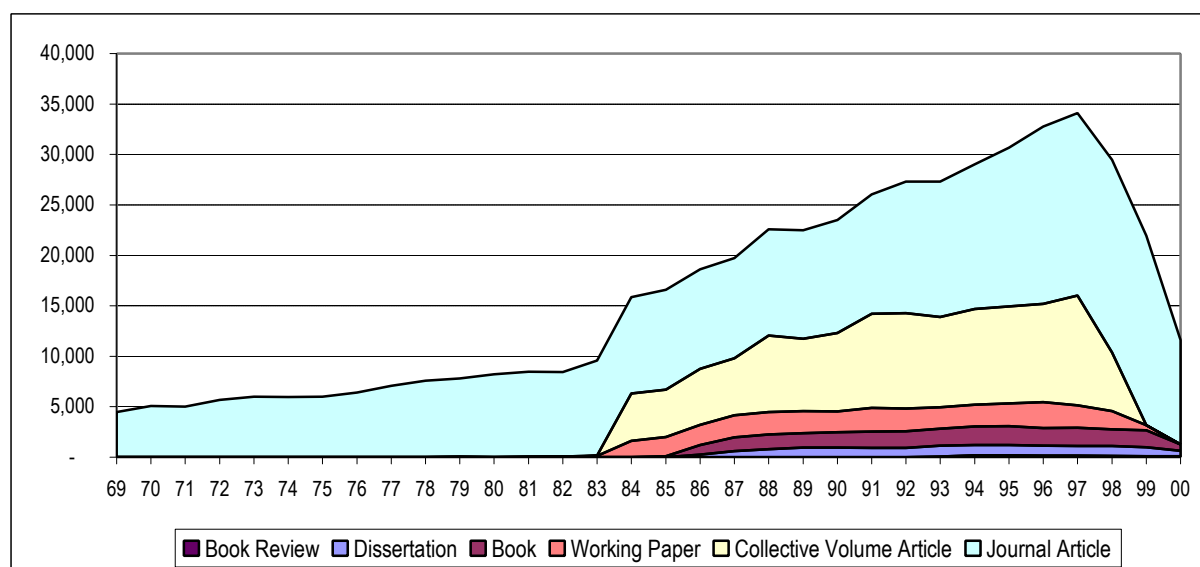
The second criticism is potentially more damaging. As observed by Hodgson (1993), 'evolution' in the sense of biological mutation and selection is a totally different concept from 'evolution' in the sense of development. The difference would not matter if both uses of the term 'evolution' would denote 'evolutionary' concepts or ideas. However, this is rather unlikely in papers like 'The Evolution of Monetary Instruments and Policy in Spain' and – short of reading the complete literature – a method is required to separate the two bodies of literature. Section 5 represents such an attempt.

## 2.2. Description of the data

The American Economic Association's EconLit web site ([www.econlit.org](http://www.econlit.org)) contains extensive information on the document types currently indexed in the database (cf. [www.econlit.org/econlit/doctypes.html](http://www.econlit.org/econlit/doctypes.html)) which therefore does not need to be restated. Figure 1 displays the composition of the publications indexed in EconLit from 1969 until Dec 2000. Four features stand out:

- ◆ First, there are two structural breaks in the time series of publications; the first in 1984 and the second in 1997.
- ◆ Second and explaining the first break, the composition of publication types changed considerably. Before 1983, (almost<sup>3</sup>) only journal articles were indexed (at present a total of 600, mostly English, economics journals<sup>4</sup>, up from 182 in 1969). In 1984, collective volume articles and working papers were added, in 1987 books and doctoral dissertations, and in 1994 book reviews from the Journal of Economic Literature (JEL).
- ◆ Third and explaining the second break, the radical slump in the last two to three years is due to indexing delays which affect all publication types (except for JEL book reviews that are administered by the same organisation). In the case of collective volume articles and working papers, the number of available records declines to virtually zero. Thus, available information on the most recent publications is highly incomplete.
- ◆ Fourth, in terms of relative importance the most frequent publication type are journal articles (ca. 50%), followed by collective volume articles (ca. 30%), working papers (ca. 8%), books (6%), dissertations (3%) and book reviews (<1%)<sup>5</sup>.

**Figure 1: EconLit 1969-2000/12 (no. of publications per year)**



Moreover, the nature of available information has changed significantly between 1969 and today. Since 1984 abstracts have been available for most books and working papers. Beginning with 1987 this also applies to journal articles (about one third until 1989, since then almost complete). Collective volumes and doctoral dissertations records do not contain abstracts. As of 1991, JEL replaced its previous classification system with the current system (available at [www.aeaweb.org/journal/elclasjn.html](http://www.aeaweb.org/journal/elclasjn.html))<sup>6</sup>. Between 1987 and 1990 the two systems co-existed.

<sup>3</sup> A handful of working papers, collective volume articles and books were also indexed prior to 1984 and 1987, respectively.

<sup>4</sup> For the list of journals that are indexed see <http://www.econlit.org/econlit/ellistjn.html#jnla>.

<sup>5</sup> Owing to significant yearly variations of the more frequent publication types, the cited shares do not add up to 100%.

<sup>6</sup> Some information on the details of the changeover can be found in the Editor's Note in JEL, Vol. 29/1, March 1991.

### 3. 'Evolution' and 'evolutionary' in the economic literature

Figure 2 displays the fraction of records containing at least one of the search terms as a percentage of the total number of records indexed in EconLit. It shows that until 1983 the share was more or less stable at around 0.3 per cent. With the introduction of working papers and collective volume articles in 1984, the share increased to 0.4-0.5 per cent. With the addition of books and dissertations, the share started to grow rapidly between 1986 and 1988 from 0.9 to 1.4 per cent. Remaining flat for two years, the share started to grow again in 1991 and rapidly rose to 2.8 per cent in 1995. In 1996, it declined steeply but immediately rebounded to its previous level in 1997. In the most recent years, the share has further increased to 3.2 per cent in 2000. However, in light of the known delays regarding indexing, the figures from the last two to three years may still change significantly.

**Figure 2: Publications containing search terms (in % of total publications)**

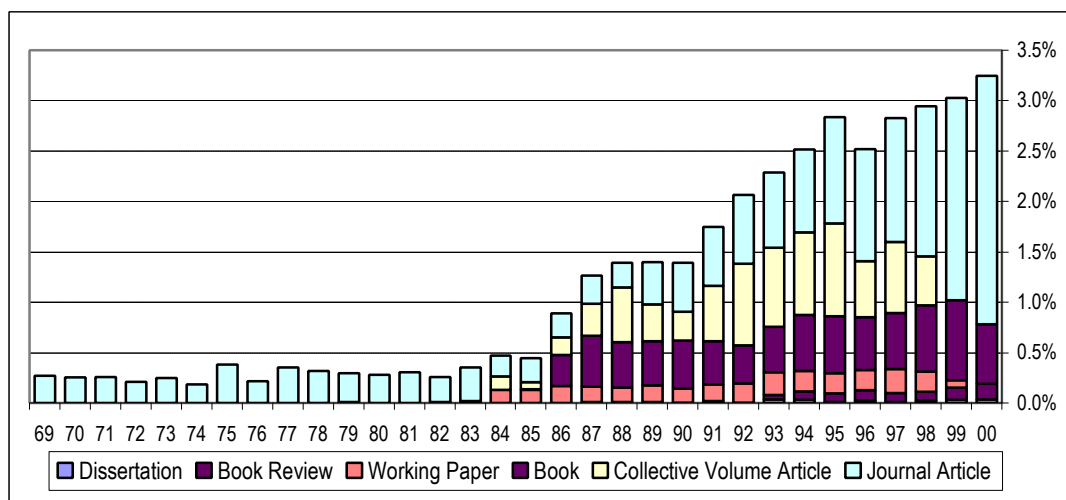


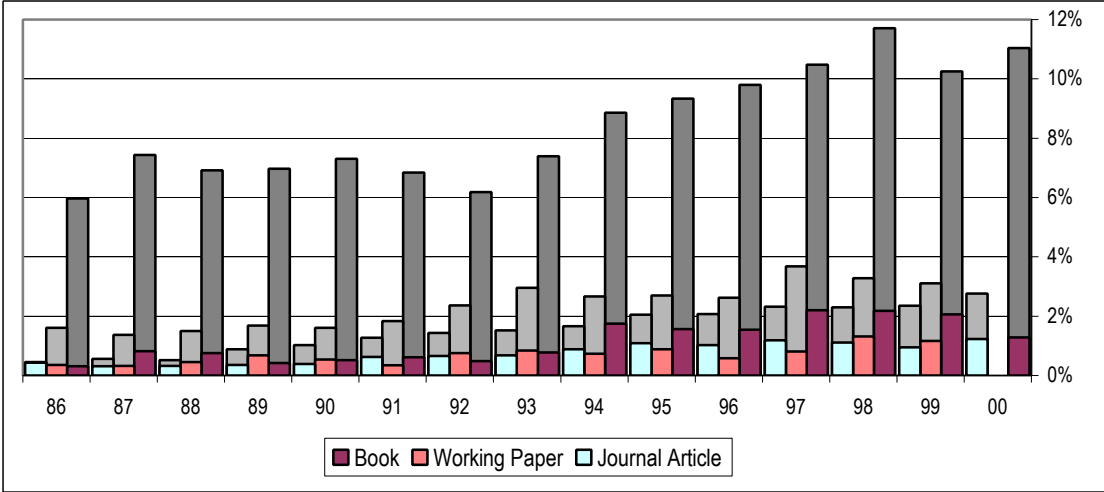
Figure 2 furthermore depicts the composition by document type, which reveals a number of interesting features. First, journal articles, by far the most important document type in EconLit, are relatively less frequent in our data set. Between 1986 and 1994, they have even been dominated by other publication types. Second, a considerable share of records have been published in collective volumes. This, however, also applies to EconLit in general. Third, since they have been indexed in EconLit, books have accounted for a major share of the retrieved publications. From 1986 to 1989, they have even been the dominant category. Finally, there are only very few dissertations that contain either search term.

The different composition of the data set is also reflected in the differential share of records of each document type containing either search term. As Figure 3 shows, while the respective share is between one and two per cent in the case of journal articles, up to four per cent of the working papers and up to twelve per cent of the books indexed in EconLit contain either search term.

This is interesting information, since it may be evidence for the frequently voiced criticism that journals are very reluctant to accept new ideas, while other publication media are less rigid. This applies above all to working papers, which usually are not subject to peer review. The fact that the gap between journal articles and working papers appears to have narrowed during the 1990ies, which coincides with the establishment of new journals, such as the Jour-

nal of Evolutionary Economics (JEE) and Games and Economic Behaviour in 1991, or Industrial and Corporate Change in 1995, may be evidence that this conservatism has declined in recent years.

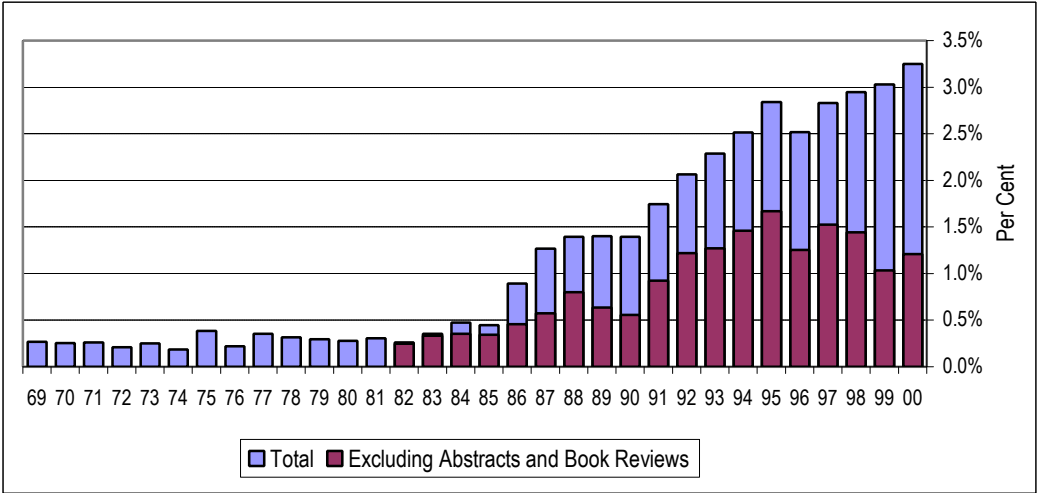
**Figure 3: Records by document type**



However, as explained above, since the mid-eighties many records contain abstracts which increases the probability of containing either search term considerably. To illustrate this effect, the striped parts of the bars show the share of records that have only been retrieved because the search terms were part of the abstract.

This exercise greatly qualifies the differences between the different publication types. The effect is particularly pronounced in the case of books where approximately 80 per cent fewer would have been retrieved in the absence of abstracts. The respective shares are more than half in the case of working papers and about half in the case of journal articles. Thus, evidence for institutional rigidity becomes much weaker.

**Figure 4: Impact of abstract and full text book reviews**



To see how the bias introduced by the availability of abstracts and full text book reviews affects the evolution of the share of records containing either search term, Figure 4 displays both data series. Although the share still rises, the increase is much more moderate than with-

out correcting for this bias. Moreover, after a steep rise until 1988, the relevant share of records declines in the subsequent two years and only resumes growing in 1991.

The corrected results in Figure 4 show that the share of articles that could be identified by means of the search terms 'evolution' or 'evolutionary' has indeed risen since the second half of the 80ies. However, this result is at best a very crude approximation of the true 'evolution of evolutionary economics' since it does not solve the problem caused by the ambiguous use of the term 'evolution'. In the following section, a method is described that allows to tackle this problem.

#### 4. Co-word analysis

To identify the content of each record in the data set, a co-word analysis was performed by means of the bibliometric software BibTechMon<sup>TM</sup> developed at the Department of Technology Management of the Austrian Research Centers Seibersdorf. Co-word analysis is a bibliometric method that allows to calculate the relation between objects, such as documents, keywords, authors or institutions. The underlying hypothesis is that the co-occurrence of terms provides information on the context as objects denoting a similar context appear more frequently in common (cf. Leydesdorf 1989; Kostoff 1993).

The present analysis is based on two types of keywords which are treated equally:

1. The EconLit subject descriptors assigned to each record which are based on the JEL classifications from the American Economic Association hierarchical classification system (cf. <http://www.econlit.org/econlit/elhomsub.html>). JEL codes are mostly assigned by the authors. In the case of books, collective volume articles and dissertations, subject descriptors are assigned by the JEL office (personal communication with D. Quint, Staff JEL).
2. Keywords generated by a stemming procedure based on the context sensitive longest-match principle and a phrase recognition algorithm (Widhalm *et al.* 1999). This automatic indexing module was applied to titles, sources and abstracts of each record.

To conduct the co-word analysis with the software BibTechMon<sup>TM</sup>, the data had to be further standardised to eliminate distortions due to differences in spellings, abbreviations and synonyms. Moreover, very frequent, but meaningless terms were eliminated to avoid distortions. This reduced the original number of 3456 key terms to 1461. Finally, wherever possible, subject descriptors based on the old JEL classifications were mapped to the new classification system introduced in 1991. Of the remaining total of 637 subject descriptors, only 61 remained from the old classification system denoting a very small number of publications.

The resulting 2098 key terms served as input for the co-word analysis. The more often two key terms are used together in records, the stronger is their relation and the stronger is the common context in which they occur. Using those co-occurrences, a matrix can be calculated which gives the intensity of the relation of any two key terms identified.

To obtain a normalised measure for the intensity of correlation between any two keywords, the co-occurrence matrix is normalised by means of the Jaccard Index, defined as

$$J_{ij} = \frac{c_{ij}}{c_{ii} + c_{jj} - c_{ij}},$$



where  $c_{ij}$  is the co-occurrence of keywords  $i$  and  $j$ , and  $c_{ii}$  is the total number of occurrences of keyword  $i$ .

To identify thematic fields among the key terms, data in the Jaccard matrix  $J$  was classified by means of a hierarchical cluster analysis using the average linking method (between groups). Ultimately, 40 clusters proved to be the optimal size to identify meaningful thematic fields. These were named after the two most frequent key terms in each cluster (e.g. banking and investment). To obtain a manageable number of thematic fields, clusters were subsequently re-aggregated whereby clusters only weakly related to the core topics of the analysis (e. g. finance) were consolidated into larger thematic fields.

The cluster analysis yielded a hierarchical structure of  $n$  homogenous groups. However, it did not inform about the relationships of key terms between and within the groups. Therefore, the  $(i-1)$ -dimensional polyeder spanned by the original Jaccard matrix  $J$  had to be transformed into an intuitive readable two-dimensional knowledge map. To this end, an iteration model based on mass point mechanics was applied as follows: Each keyword is represented by a mass point which are supposed to be connected by mechanical springs. The intensity of relation is taken as elasticity between the mass points. Masses are given by the total frequency  $c_{ii}$  of each key term, while the Jaccard Index  $J_{ij}$  determines the elasticity of the springs. This yields an  $i$ -dimensional system of differential equations which can be solved numerically by means of BibTechMon<sup>TM</sup>. The iteration process starts with a random configuration of mass points and repositions mass points until total tension has been minimised (Kopcsa/Schiebel 1998). Through this model, keywords are positioned according to their correlation and intensively correlated terms are located in close proximity to one another.

## 5. BibTechMon Results

### 5.1. Identification of clusters and fields of research

The discussion in section 3 showed that it is impossible to answer the questions raised in this paper without knowing the context in which the different records occurs. For example, few people would classify studies on the 'Evolution of the Russian gas industry' as evolutionary. However, 'Technological change and the evolution of the Russian gas industry' or 'Schumpeterian competition in the Russian gas industry' may be examples of research inspired by an evolutionary perspective. Therefore, it is assumed that terms which occur in close proximity to key terms in the evolutionary literature, such as 'technological change', 'Schumpeterian competition' or 'bounded rationality', define the region in the network where evolutionary contributions are located.

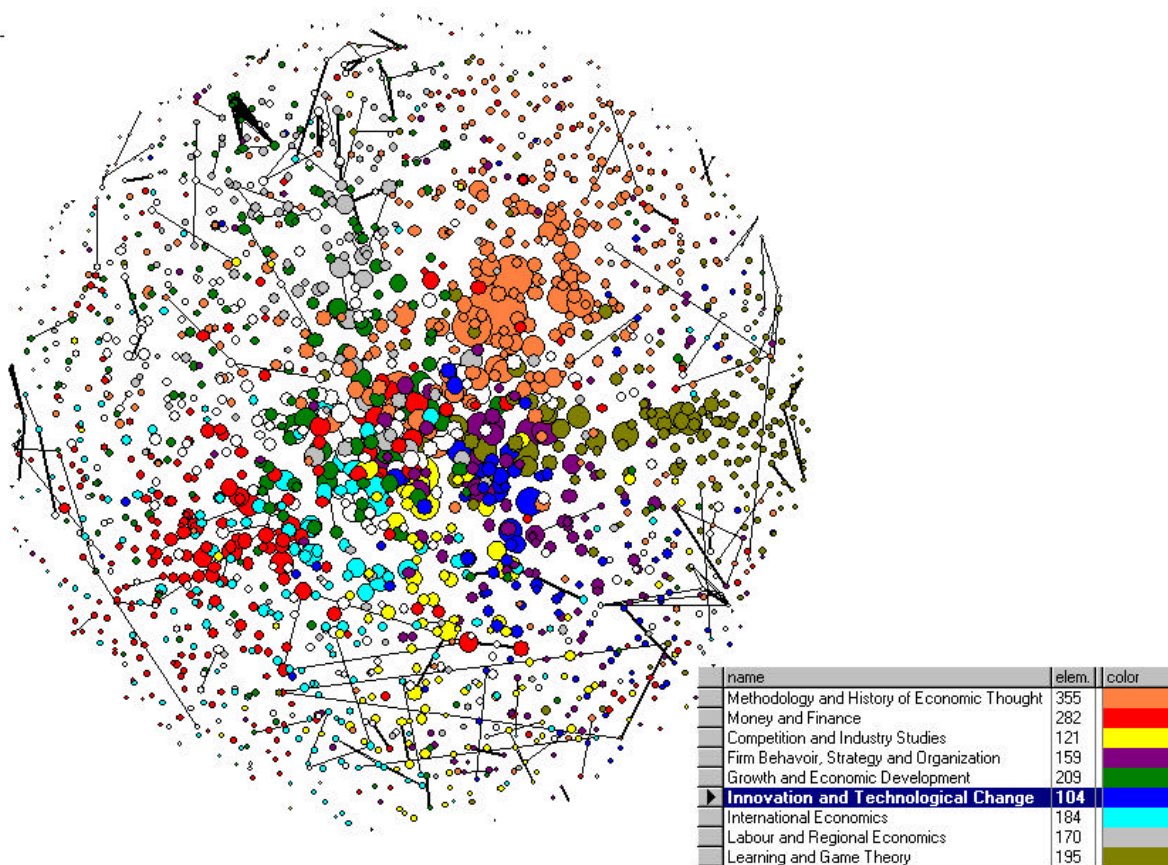
Figure 5 displays the knowledge map of all key terms generated from the data set, where each point corresponds to a key terms (such as 'technological change'). The most significant linkages appear as connecting lines. Size, position and colour of each point hold information: The *size* of the point shows how often a key term occurs in the data. The *relative position* of each point to all others indicates its context. Proximate objects form subtopics because they occur in similar contexts. The *colour* shows to which thematic field each key term belongs. Seven categories have been defined:

- *Innovation and Technological Change*
- *Learning and Game Theory*

- *Firm Behaviour, Strategy and Organisation*
- *Labour and Regional Economics*
- *Money and Finance*: Includes publications on capital market and risk theory, monetary theory and policy, and literature on the international monetary system and the monetary integration of Europe.
- *International Economics*: Deals with a broad set of topics ranging from international trade and integration, and the role of multinationals to development economics.
- *Methodology and History of Economic Thought*: Comprises most of JEL-categories A and B (General Economics and History of Economic Thought) as well as the Marxian, Sraffian and Institutionalist literature.
- *Competition and Industry Studies*: Contains publications on market structure, entry and exit, competition policy and empirical industry and market studies.
- *Growth and Economic Development*: Includes aspects of income distribution, economic growth and growth policy at the international and national level as well as Socialist systems and transition economics.

For the sake of clarity, a number of smaller topics like *Politics and Political Economy*, *Economic History* or *Environmental and Resource Economics* have not been coloured and therefore remain white on the map.

**Figure 5: Knowledge map of key terms**



*Game Theory and Learning* constitutes a quite strongly separated field in the far east of the network. Its position indicates that its key terms rarely co-occur with terms of other fields. However, there is some overlap with the fields 'Innovation and Technological Change' and

'Firm Behaviour, Strategy and Organisation' via terms like 'learning', 'equilibrium', 'co-operation', 'agents' and 'adaptation', which are relevant in each context.

A second separated field is *Money and Finance*, which is mainly situated in west-south-west of the network with only few connections to other fields. Some interconnection exist with 'Growth and Economic Development' through common macroeconomic key terms like 'saving' and terms from development economics, such as 'debt crisis' and 'international financial organisations'. There are also some linkages to 'International Economics' through terms like 'EMU' or 'European integration'.

Unlike 'Money and Finance', *International Economics* lies closer to the centre of the network which indicates a closer thematic proximity to central key terms. This is mainly due to the key terms related to growth in an international perspective, such as 'developing countries', 'structural adjustment', 'economic stabilisation' or 'external shock'. Furthermore, 'International Economics' has an interface with the more micro oriented fields 'Firm Behaviour, Strategy and Organisation' and 'Competition Policy and Industry Studies' via the literature on multinational enterprises.

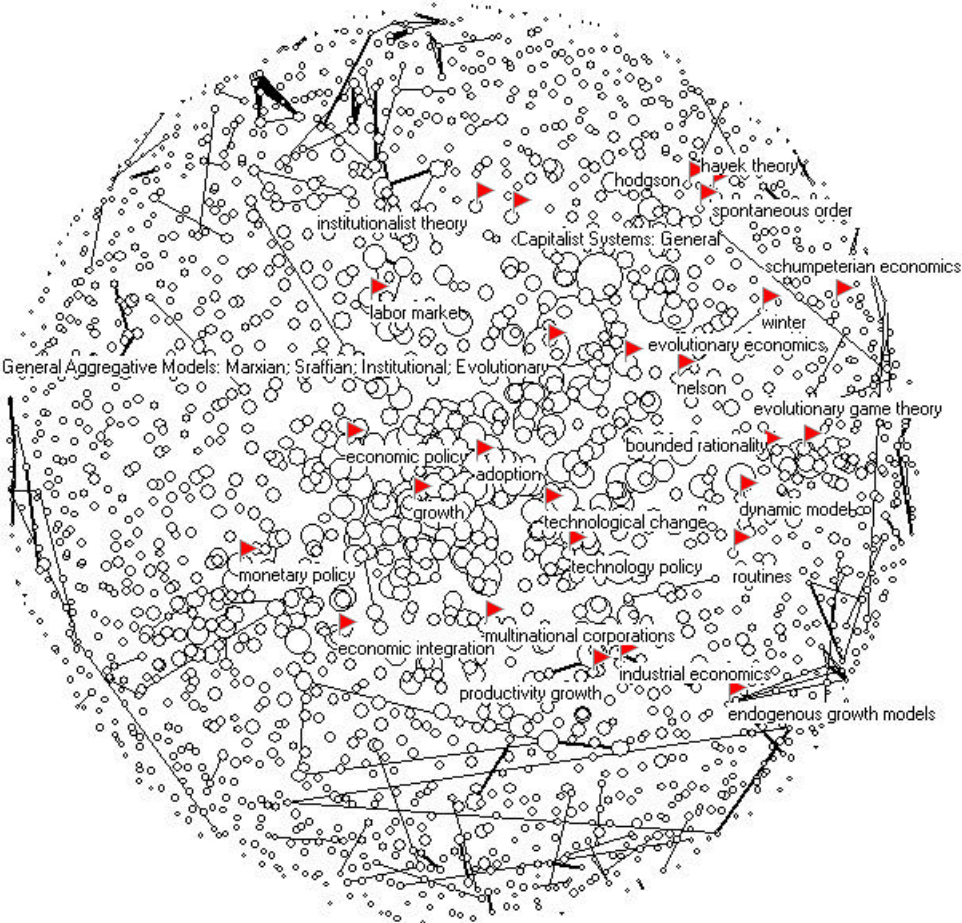
*Methodology and History of Economic Thought* is also barely connected to other fields, but is located more centrally than 'Money and Finance' and 'International Economics'. The field includes a number of almost self-contained sub-groups in the upper north-east sector, such as Post-Keynesian and Austrian publications. The fact that each is fairly remote from the centre of the network indicates limited connection with other terms.

*Growth and Economic Development* is spread over the centre and upper half of the network showing its heterogeneity and multiple connections with other fields. In the upper part, there is a close proximity to 'Labour and Regional Economics' via terms related to personal income and income distribution. Furthermore, there are close ties with other topics in the centre of the network, including 'Methodology and History of Economic Thought', 'International Economics', and 'Money and Finance'.

Surprisingly, there are only few links between 'Growth and Economic Development' and *Innovation and Technological Change*, except for the key terms 'endogenous growth' and 'endogenous growth models' situated in the far south east of the network. 'Innovation and Technological Change' is highly interrelated with *Competition and Industry Studies* and *Firm Behaviour, Strategy and Organisation*.

Where is the 'evolutionary' literature in the network? Figure 6 provides a first answer. In this figure, core terms like 'bounded rationality', 'technological change', 'technology policy', 'Nelson' and 'Winter' (connected by a line indicating strong co-occurrence) are marked with pins along with key terms from other thematic fields. The distribution of key terms shows as a first approximation that 'evolutionary' key terms are located in the right half of the network. The left-hand side of the diagram is dominated by terms used for instance in the context of monetary policy, economic integration, labour market or economic policy. The fact that all these terms are located fairly remotely from the unambiguously 'evolutionary' terms in the east of the network shows that the term 'evolution' is mainly used in the sense of long term development in this literature, rather than as continuous economic change or 'evolution' in a biological sense.

**Figure 6: Location of various key terms**



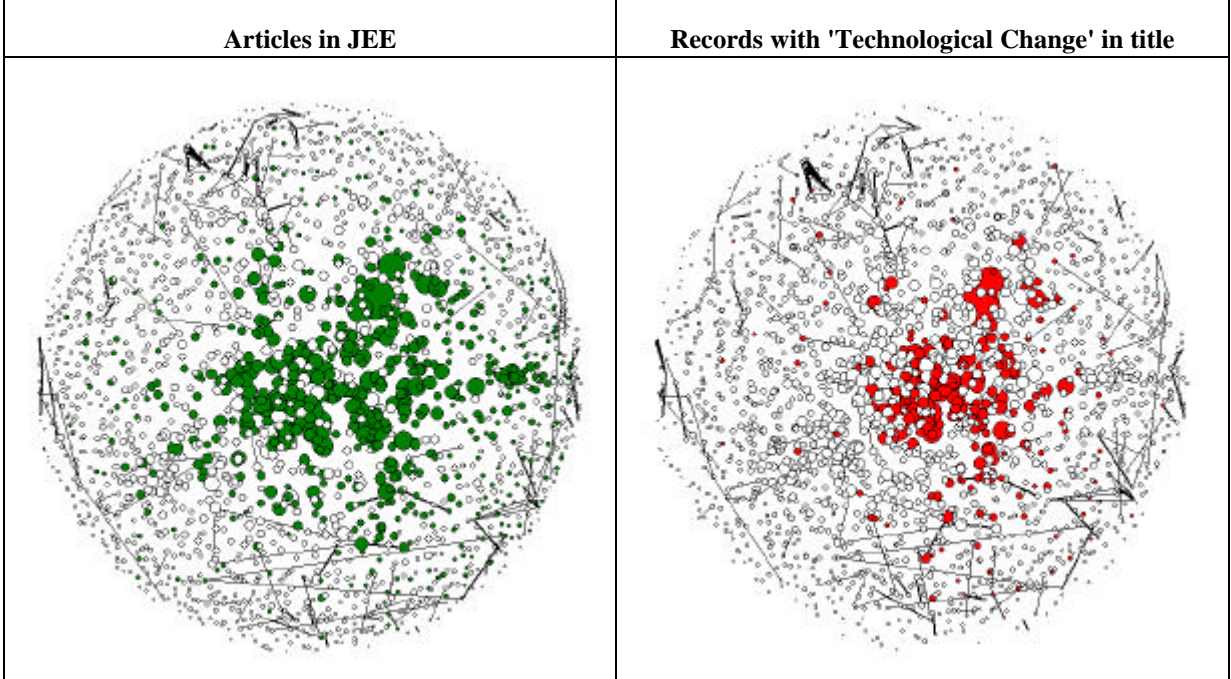
Instead of directly selecting key terms, BibTechMon™ also allows to identify all key terms pertaining to records. These records can be selected by title, abstract, publication year or source. Figure 7 depicts two selections. In the left hand network, all keywords pertaining to articles published in the Journal of Evolutionary Economics (JEE) are highlighted. In the right hand network, all records containing the term 'technological change' in their title are coloured.

Being the only explicitly 'evolutionary' journal, the Journal of Evolutionary Economics may serve as a tentative yardstick for the boundaries of evolutionary economics. The respective diagram shows that resulting key terms are clustered in the centre and east of the centre in the knowledge map, mainly in the thematic fields of 'Growth and Economic Development', 'Innovation and Technological Change', 'Firm Behaviour, Strategy and Organisation' and 'Game Theory and Learning'. In contrast, there are only few intersections with key terms belonging to 'Money and Finance' and 'Regional and Labour Economics'.

Displaying all key terms pertaining to records carrying clearly 'evolutionary' terms in their title represents an alternative strategy to separate 'evolutionary' from 'non-evolutionary' contributions in the data set. Performing this exercise for all records with 'technological change' in their title shows that the resulting key terms are also mainly located in the centre and the right of the centre in the network. The thematic fields 'Money and Finance', 'International

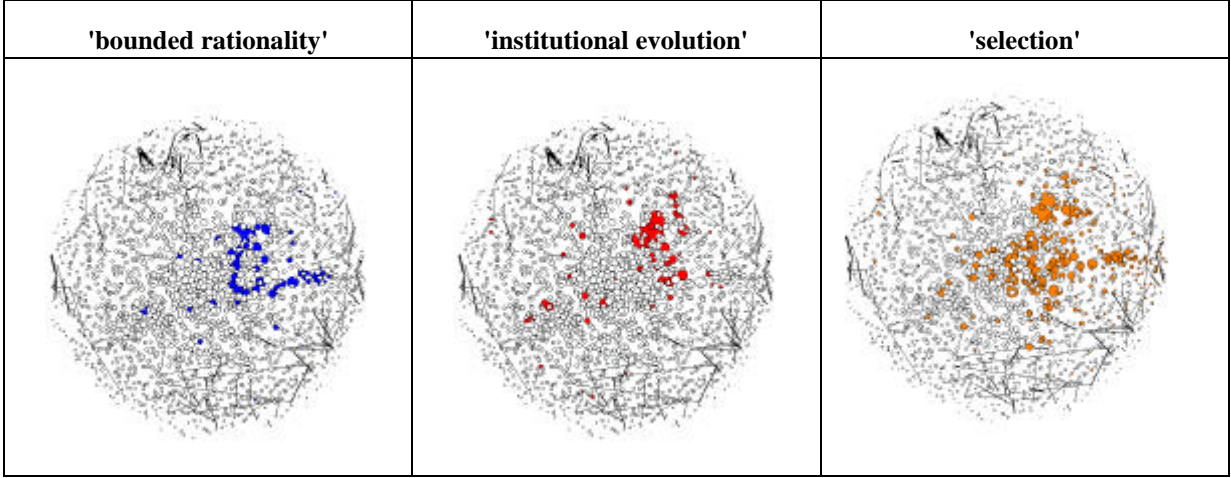
Economics', 'Labour and Regional Economics' and 'Game Theory and Learning' are only sparsely covered.

**Figure 7: Location of 'evolutionary' key topics**



The same query was performed with the terms 'bounded rationality', 'institutional evolution' and 'selection'. The results are displayed in Figure 8. Each query yielded a smaller sample than the previous search, located in different areas of the network. Key terms co-occurring with 'institutional evolution' are clustered in the north east of the centre in the thematic field 'Methodology and History of Economic Thought'. 'Bounded rationality' is mainly discussed in the context of 'Learning and Game Theory' and 'Firm Behaviour, Strategy and Organisation'. 'Selection' is less tightly clustered than the other two terms, but also located east and north east of the centre of the network. Importantly, put together the resulting area resembles the area identified in Figure 7.

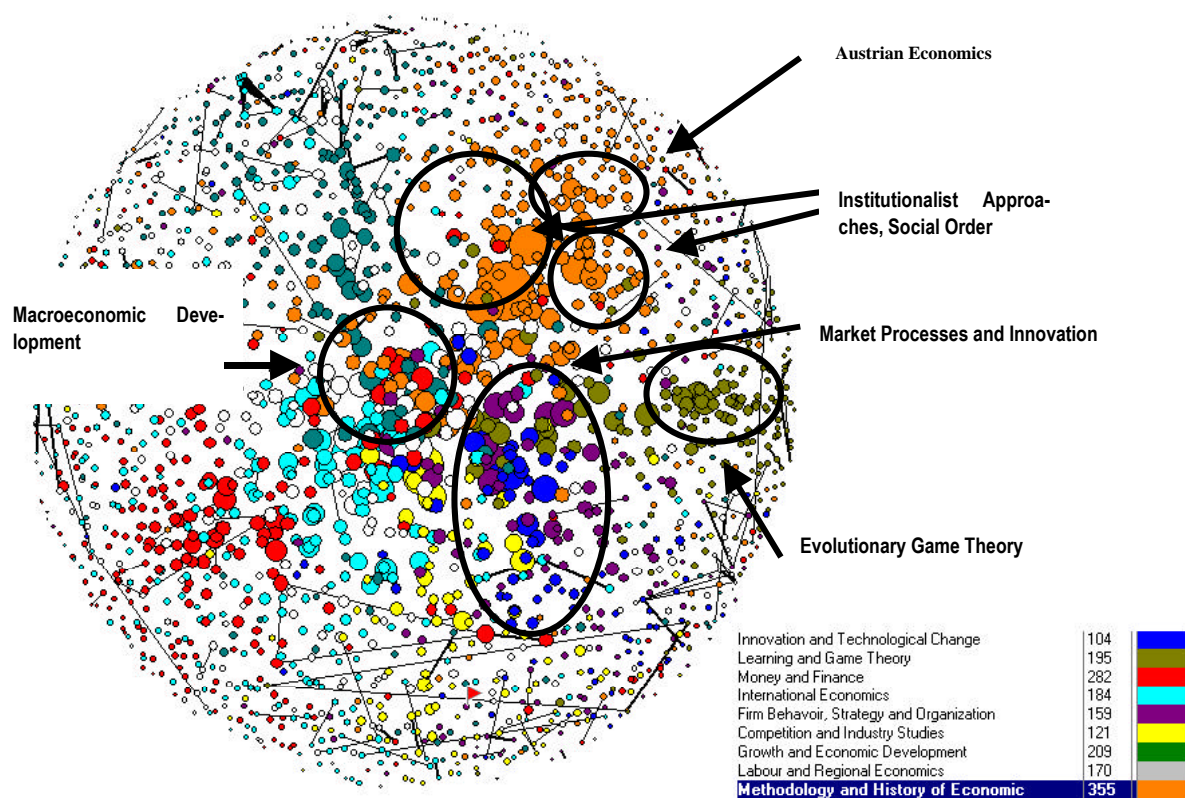
**Figure 8: Location of additional key term**



This analysis allows to tentatively delineate the 'evolutionary' literature in the network, which is displayed in Figure 9. Three main fields are identified:

- Approaches which focus on *Market Processes and Innovation*. This literature stresses the role of innovation and technology and applies selection, adaptation and inheritance on explaining the market processes. This region covers the literature inspired by Nelson and Winter (1982).
- *Institutionalist Approaches* concerned with questions of institutional and societal evolution. This area also includes macroeconomic modelling in the Sraffarian and Post-Keynesian tradition. Moreover, elements of Austrian Economics – as far as it is concerned with social order – appear on the north east fringe of this field.
- *Evolutionary Game Theory*, the most segregated group, which is located close to the first field. The reason for this proximity are shared central terms like 'learning', 'routines', 'asymmetric information' and 'agents'.

**Figure 9: Fields pertaining to evolutionary economics**



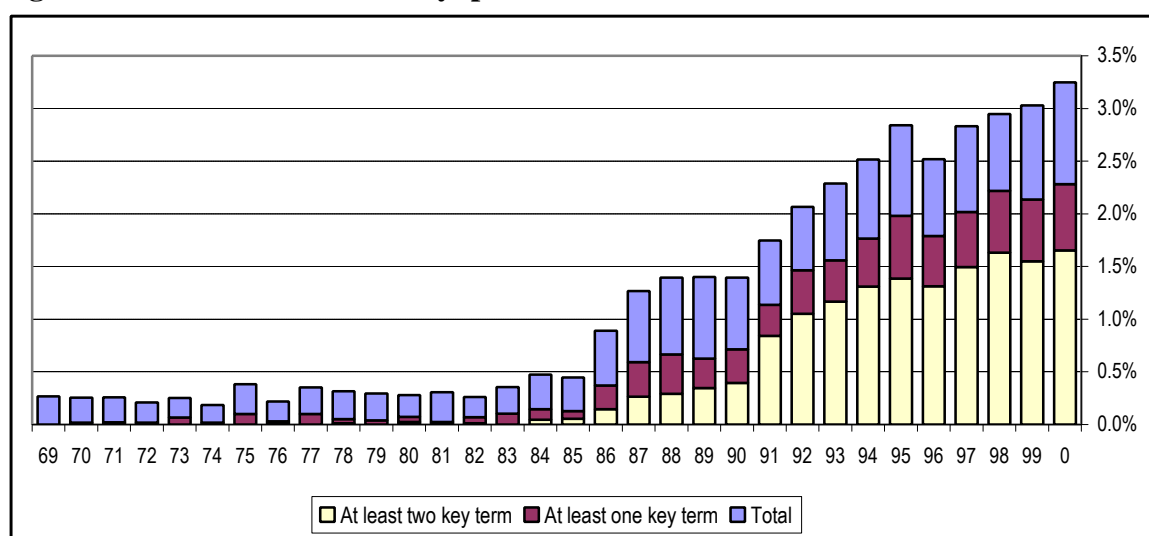
Further relevant contributions may be in *Macroeconomic Development*, which contains such universal terms as 'growth', 'economic development', 'economic policy', 'economic structure' and 'macroeconomics'. However, from these rather fuzzy terms it is difficult to gauge the precise share of evolutionary contributions in this field. On the other hand, there are clear connections between terms like 'endogenous growth' and 'endogenous growth models' and the previous core fields. Consequently, at least parts of this field also belong to the 'evolutionary' literature.

In total, the identified areas of the network comprise more than 300 key terms, which is roughly 15 per cent the total. Having isolated all 'evolutionary' key terms, this information can

be used to identify the share of 'evolutionary' publications. Each publication is labelled by at least one and at most 35 key terms. In a very loose definition, if at least one of these key terms is part of the set of 'evolutionary' terms identified by the co-word analysis above, the article deals with 'evolutionary' issues. However, if a publication is marked by a large number of key terms, a single 'evolutionary' key term may not be a sufficiently strong indicator, as key terms may be ambiguous. Therefore, more than one 'evolutionary' key terms may be required to unequivocally identify the context of a publication. However, this method automatically excludes the 5-20 per cent of publications each year that are only marked by one key term.

Figure 10 displays the evolution of all publications containing either search term (complete bar) and the fraction of publications that contain at least one (light plus dark part of the bar) or two 'evolutionary' key terms (light part of the bar). It reveals a number of intriguing features.

**Figure 10: Share of 'evolutionary' publications**



Until 1985, the share of publications with at least one 'evolutionary' key term never exceeded 30 per cent of the publications containing either search term. Since the latter group only accounted for at most 0.4 per cent of all publications indexed in EconLit, the result was a negligible share of 'evolutionary' publications at that time. Between 1986 and 1990, the share of 'evolutionary' publications in the data set climbed to 50 per cent. From 1991 onwards, the share of publications with at least one 'evolutionary' key term further rose to around 70 per cent of the data set. The share of publications with at least two key terms displays a similar trend at a lower level.

Thus, the analysis uncovers three distinct periods in the data series. Until 1985, the share of 'evolutionary' publications in the total economics literature was close to zero. In 1986 and 1987, it rose sharply to a level where it remained for the next three years. A second major increase occurred between 1991 and 1995, when the share of 'evolutionary' publications more than doubled. Since 1995, growth has levelled off and the share has risen only slightly.

Available evidence therefore confirms the popular observation that 'evolutionary' economics has become more important within the economics literature. Although still a fairly small literature, it has increased its share more than five-fold in the past two decades. However, these results are only preliminary as they fail to take into account the bias caused by the differential availability of abstracts. Although this is unlikely to affect the general trend, which Figure 4

showed to be similar, it certainly impacts on absolute values. Accordingly, a final verdict has to be postponed until this final step of the analysis has been implemented.

## 6. Conclusions and recommendations for future research

This paper has attempted to empirically measure the 'evolution of evolutionary economics' to verify the frequent claim that 'evolutionary' research has become increasingly fashionable in recent years. To this end, all records containing the terms 'evolution' or 'evolutionary' have been retrieved from EconLit, the most comprehensive database of economic publications. This search yielded a 8,568 relevant records for the period 1969 to 12/2000 out of a total of 510,320 publications indexed during this period.

A few simple descriptive analyses showed the share of publications containing the search terms has indeed increased since the mid-80ies, even after correcting for the bias introduced by the fact that abstracts have only been available since 1984. Moreover, the analyses showed that a higher than average share of records containing either search term were books or working papers, while fewer than average records were journal articles. This may be an indication of the profession's reluctance to accept new ideas. However, the differences largely vanish when correcting for the bias introduced by the availability of abstracts.

Since 'evolution' is an ambiguous term that may be used in a variety of contexts, in a next step a bibliometric analysis was performed with the bibliometric tool BibTechMon<sup>TM</sup> to isolate the 'evolutionary' literature. It showed that typical 'evolutionary' thematic fields deal with innovation and technological change, firm behaviour, strategy and organisation, industrial dynamics, economic growth, institutional and societal innovation as well as methodology and the history of economic thought.

Using this information to identify all 'evolutionary' publications in the sample showed that the share of 'evolutionary' publications has risen steeply in two waves, the first in 1986 and 1987 and the second from 1991 to 1995. These results indeed confirm the popular impression that 'evolutionary economics' is becoming an increasingly popular mode of economic theorising. However, the results are only preliminary as they have not been adjusted yet for the bias introduced by the differential availability of abstracts.

Besides filling in the remaining gaps in the present analysis, a number of routes remain how this analysis could be refined and extended. First, other search strategies may be attempted to identify the relevant population of publications. Second, sub areas of the population could be analysed in greater detail. For example, it might be interesting to examine how certain core topics like technological change have evolved over time and in which context they have been discussed. Also, it could be investigated which contexts have been discussed in certain document types or publication media. Finally, the same method could also be applied to other areas of economic research.

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