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Extracting the innovation policies for Iran based on the approximation of policy implications for comparative economic doctrines

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ABSTRACT

Due to many differences in presumptions and theoretical foundations within neoclassical and evolutionary economics, policy-makers are always confronted with the dilemma of selecting one of these two central models for technology and innovation policy. In light of widely institutionalised ineffectiveness in the field of market and systematic coordination – in Iran as well many other countries – the present investigation presumes that reliance on any of the above doctrines alone is ineffective. An intermediate concept of policy rationales to achieve a comparative structure of policy implications is proposed. Policy rationales (in innovation and technological policy) for neoclassical and evolutionary economics were derived based on a thematic analysis. A spectrum of policy implications of both doctrines was designed and completed in the form of a questionnaire for, together with theoretical foundations and policy rationales by specialists of the field of innovative and technological policy in Iran. Given the institutional conditions and structural frameworks which actually exist, and in spite of wide dissimilarities within the theoretical foundations of neoclassical and evolutionary economics, Clustering of respondents and subsequent test trials show that policy implications of the economics doctrines in the field of innovative and technological policy in Iran are complementary and convergent.

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1. Introduction

It is very difficult to study economic policy-making for technology and innovation in a developing country such as Iran. General economic characteristics of developing countries, such as a low level of competitiveness and business environment indicators, and the specific economic characteristics of Iran such as direct and indirect government presence in economic activities, the advantage of abundant natural resources (especially hydrocarbon

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resources), chronic double-digit inflation etc., have led to the targeting of innovation and technology development in Iran as a long-term goal. However, there should also be a focus on the increasing scientific production and educated workforce in recent years in Iran, along with the appropriate promotion of technological research infrastructure in the country. A theoretical model can analyse the failures of Iran in the field of science-oriented economics and industrial production in respect of scientific and research developments. The authors of this paper have particularly focused on the theoretical economic model dominating policy-making in developing technology and innovation in Iran, so that it can examine these complexities (Soofi & Ghazinoory, 2011).

Theoretically, for a period, Iranian policy-makers who were influenced by neoclassical models tried to focus on decreasing vertical interventions and selecting specific industrial activities, protecting scientific growth and the general development of research infrastructure. This approach led to the commercialisation of research and the development of market-oriented products. As a result this approach was placed at the lower end of the global value chain, particularly using resources. In the other period, the priority of supporting national industries and generating added value in advantageous industrial activities, influenced by the theoretical approaches of institution-oriented and evolutionary economics, were reinforced in Iran. In practice, this approach also resulted in non-competitive governmental industries, based on the strategy of substituting the imports that was capital intensive and loss of these industries created great difficulties in the following periods. Economic policy-makers, particularly in developing countries such as Iran, claim that these differences result from theoretical differences between two groups of advocates of neoclassical (as dominant stream) and heterodox doctrine (essentially evolutionary economics). The numerous dualities that have occurred due to this theoretical difference in the practical area include:

- development of exports or substitution of imports;
- policy-making analysis at the small and firm level, or at macro, national and regional level;
- to adapt or not to adapt selective policies;
- to generate a full competitive market or quasi-exclusive structure in order to access scale economics;
- Line or systematic view for innovation.

There is a problem that, in developing countries such as Iran, which have a weak analytical body in the field of policy-making, the theoretical economic approaches related to developing technology and innovation have not been properly understood (Ghazinoory et al., 2011). For the relevant groups in the executive area, this imperfect understanding in policy-making presents a serious challenge in the field of technology and innovation. A problem highlighted in this paper is whether economic policy-making challenges about developing technology and innovation in Iran result, as is claimed, from the theoretical economic doctrines or not. Have essential differences in the competing economic doctrines, and in particular neoclassical and evolutionary doctrines, caused policy-making instability in developing countries such as Iran, or is the root of this instability to be found in the specific institutional structures of these countries? The hypothesis of this research is that the policy implications of the competing economic doctrines of neoclassical and evolutionary economics in the field of technology and innovation are not only opposite,

but are also convergent. In the other words, specific institutional conditions in Iran mean that, despite serious differences in the two above-mentioned approaches in the field of theoretical foundations, policy-making recommendations from these two approaches are retractable and finally convergent.

As shown in the second section, the current practice between neoclassical and evolutionary economics has been transformed from a situation of opposition in past decades towards representing hybrid models and interaction. Accordingly, at the end of the second section, a threefold model (based on the theoretical grounds, policy rationales and policy implications) has been followed in order to examine the relationship between the policy implications of neoclassical and evolutionary economics in the field of developing technology and innovation in Iran. In the next sections, two theoretical approaches of neoclassical and evolutionary economics are represented in this threefold model, and the relationship between the given threefold sections in the statistical survey and fuzzy analysis is then analysed. In the final section it is shown that the policy implications of the two approaches in Iran are proximate, despite the serious differences between them in the theoretical field.

2. Overview of the theoretical literature

In the theoretical literature, there are two important approaches in the field of economics of science, technology and innovation which have different bases: the first is ordinary economics, free-market economics and/or prominent processing of economics. From the 1950s, with the Solow Growth Model, this processing was produced in the neoclassical approach and gradually developed (Solow, 1957). In this doctrine, innovation is considered as a fixed and specified outcome of some measures, called ‘research and development’. Therefore, innovation is exclusively a creature of knowledge, and knowledge is also the same as information. How the results of research activities are reduced to products and processes with economic application is concerned with mechanisms within a ‘black box’, such as a firm (Rosenberg, 1994). The second is evolutionary economics, in which all policy models intended to remove existing defects in the neoclassical doctrine, such as generality, have a linear view toward innovation and oriented equilibrium (Smits, Stefan·Kuhlmann, & Philip Shapira, 2010). Many thinkers in the field of innovative and technological economics have formulated the given cases in the form of two neoclassical and evolutionary doctrines (Lipsey & Carlaw, 1998; Smith, 2000). In this section, due to the focus of this paper on the comparison of these two approaches, they are compared through the two dimensions of theoretical foundations and policies.

2.1. Comparison of theoretical foundations

Theoretical foundations are meant as a given set which influence a priori the structure of analysis, and direct subsequent descriptions and developments in fields such as purpose of doctrine, to define features of elements, structure of decision-making and role of information. Neoclassical economics basically uses a mechanical model, and seeks to represent better forecasting ability by modelling an economics package based on definite outputs (Bach & Matt, 2005). The world of neoclassical economics is full of cause and effect relationships which are experimentally knowable. Analytically, it is focused on the model

of general balance, and different conditions are recognised with regard to the amount of distance from balanced conditions. Modelling the behaviour of factors is also assumed generally rational, and/or there is a maximum limited rationality, which will result in the choice of factors with regard to kinds of budgeting, technological, informatics limitations, etc. (Eparvier, 2005).

On the contrary, evolutionary economics seeks to represent better understanding and interpretation of the complexities of the economic environment based on objective realities. In economic analysis, evolutionary economics considers the processing of conditions as cumulative and processing, and studies dynamically innovative methods and generation of new species (Mulder, De Groot, & Hofkes, 2001). The behaviour of factors in evolutionary economics is a mixture of imitation of other methods and trial and error for learning and achieving new and innovative ways. It examines the choice of factors with respect to routines, institutions, past directions, experiences and also learning resulting from it in recognising the different capacities of persons (Verspagen, 2004).

Overall, it should be acknowledged that both doctrines are not only similar, but they have, in many cases, rigorous differences.

2.2. Comparison of policies

In the field of policies, both doctrines have some differences and much research has been done comparing them. Since this research is focused on the relationship between the policy implications of both doctrines, it is therefore very important to have an overview of this comparative research.

It should be noted that there has been much focus on the approach of mixing policy frameworks, called 'policy mix', particularly in the field of innovative policy, in recent years (Flanagan, Uyarraa, & Laranjab, 2011). Of course, most studies emphasise features such as being an appropriate, effective and/or suitable policy mix, and they have rarely focused on the mixing rationales and instruments (Muldera et al., 2001; Soete & Corpakis, 2003).

Most of the research concerning the science and technology of policy-making has been performed within the processing mentioned in the previous section, and has rarely focused on the relationship between the two approaches. One of first efforts for generating a policy mix in the field of science and technology was conducted by Sanjayalel in the form of a World Bank Research Project (Lall, 1996; Lall & Teubal, 1998). The result of this research, which was finally published as a 'policy-making approach encouraging market', sought to combine an appropriate combination consisting of policies close to the neoclassical view as functional and market-friendly policies, with developmental and selective policies based on evolutionary economics as vertical policies. Similarly, this research also considered an intermediate section between them as horizontal policies (Lall & Teubal, 1998). Selective interventions in the approach of encouraging the market involve a concept beyond winner selection and, generally, influence the vertical and horizontal policies. Market-encouraging policies consist of three matters, priorities, encouragers and institutions, which are organised at three levels, national, priority and policy.

Another inter-paradigm study pays attention to the background of growth models in both neoclassical and evolutionary economics. Muldera and others showed how studies in the field of evolutionary economics in economic growth modelling influence the proceeding of neoclassical economic growth modelling (Muldera et al., 2001). They explained

that at the same time as developing endogenous growth models in neoclassical economics, the new models were represented in the environment of evolutionary economics, based on different microeconomics. Connection of innovative efforts with uncertainty, on one hand, and connection of technology with the local implied, cumulative, firm-specific and experimental knowledge on the other hand, explain technological development in the proceedings, with two boundaries of existing firm facilities and technological paradigm concerning historical dependence. Proceedings of technological development, together with learning and research and development processes by individuals and organisations, and central features of economics, involve technological changes (Dosi, 1988). According to this micro-analytical structure, the concept of Spencer's survival of the fittest, which has been represented by a set of iterative equations in the Fisher Model, is considered as the base of evolutionary growth modelling (Fisher, 1930).

Many models were presented after Winter and Nelson's evolutionary model. According to the micro-foundations of the new models, the difference between firms not only results from their technological differences, but is also focused on firms' decisions about pricing products based on the demand of the market, and/or the firms' decision about research and development investment, regarding the diversity of existing firms (Dosi, 1988).

Further research has been conducted by Bach and Matt in the inter-paradigm environment and between two neoclassical and structural-evolutionary approaches (Bach & Matt, 2005). This study focused on the analytical framework of the two paradigms and showed the connection of suggested policies of each with its theoretical foundations. This research seeks to show that the different analytical frameworks of both approaches are supplementary. In fact, the proposed work follows the same way of directing coherent policy framework which is supported by both approaches. Typology for types of policies in the field of science and technology, and presenting their connection with the related theoretical foundations, are cases that were examined in Bach and Matt's study.

Another study conducted in this area is by Wiczorek, Hekkert, Smits (2009). In this study, while it is stated that, despite development of the evolutionary approach, different countries and, particularly, European politicians, use traditional neoclassical approaches. Several reasons are presented for this: first, policy-makers have generally graduated in the field of the neoclassical paradigm. Similarly, advocates of evolutionary approaches could not specify their own policies based on the systematic views (Nooteboom & Stam, 2008). In following, evolutionary approaches are divided into three groups:

- Evolutionary view (such as general logic of this approach)
- Systematic cases (such as performance of set)
- Cases of knowledge and learning (such as central stimulus motor)

In the following, according to the conceptual bases posed in each of the three groups, eight macro-policies have been posed as conclusions of cases related to policy of technology and science in the evolutionary approach. Finally, it is concluded that traditional approaches supporting research and development based on neoclassical linear views should have a smaller contribution to policy planning, and policy-makers should focus more on the evolutionary approach.

Similarly, Aghion, David and Foray, in another study, have considered the present different attitudes in the evolutionary environment (Aghion, David, & Foray, 2009). In this research, three evolutionary, neo-Schumpeterian and dynamic systems approaches were

considered as triple and interrelated directions posed in reaction to neoclassical models. Furthermore, the advantages and disadvantages of each of these approaches and their mutual relationship were discussed (Aghion et al., 2009). The triple approaches presented in this research are partly different from the intended triple in the study of Wieczorek and others (Wieczorek et al., 2009). The mentioned cases indicate that we are faced with a spectrum of partly similar approaches and theories which are, despite similarities, very different.

In the study of innovative and technological policies in Australia (Dodgson, Hughes, Foster, & Metcalfe, 2011), a triple model was presented based on a spectrum of policy-making foundations for technology and science, ranging from cooperation with respect to German economist Friedrich List's works, to competition and policies based on the market failure with the focus on Baumol's work, and it sought to consider an evolutionary-systematic approach based on the intermediate of these two spectrums. In the following, the experience of innovative policy-making in Australia based on the analysis of the content of important policy documents will be also examined. This paper seeks to show how innovative policies in Australia are turning from an innovative linear approach based on governmental finance and force of science toward a systematic and evolutionary approach. The cases posed in the comparison of policy implications of both neoclassical and evolutionary doctrines are shown in Table 1.

Overall, this presents comparative research performed in a triple classification. Some researchers have only focused at present on differences between theoretical foundations, presumptions, hypotheses and different analytical frameworks of two doctrines and have not considered the results of these differences. Others, by presenting differences in the analytical frameworks, have considered the effect of this difference in the varied proposed policies of two doctrines.

Others have exceeded and sought, regardless of stated differences, to drive the frameworks and hybrid models for varied applications. The noted classification is presented in Table 2.

The present research, according to the classification noted in Table 2, is in the second class. Most research conducted in the second class, which compares theoretical foundations and policies of both neoclassical and evolutionary doctrines, is faced with two defects. First, they have not used a systematic methodology to compare. Second, the kind of difference between the policy implications is not specified, i.e., whether this difference leads to a contrast in which policy-makers are faced with a non-cumulative dilemma, or this difference implies two important dimensions which are each, in turn, useful and, together, applicable. Removing these defects, particularly in recent cases, is a key objective for the research. In other words, with respect to differences between the two theoretical economic doctrines

Table 1. The science and technology of policy-making in the dual approaches.

	Policy-making of technology and innovation in neoclassical economics	Policy-making of technology and innovation in evolutionary economics
<i>Innovation:</i>	Simple and linear (maximum a probable function)	Complicated, non-linear and consequence of total system
<i>Technology connects with:</i>	Information	Implied knowledge
<i>Centrality of policy-making:</i>	Market mechanism, supplementary government	All of the elements and communication of system
<i>Purposes of policy-making:</i>	Removing the market failure, government failure	Removing the learning failure, system failure
<i>Policy-making instruments:</i>	Rules, tax and subsidy	Institutionalisation, facilitating the interactions

Source: Authors.

Table 2. Classification of comparative research between neoclassical and evolutionary economics.

The type of performed comparison	Related research	Descriptions
Comparing the theoretical foundations: <i>the difference was specified between the analytical frameworks of neoclassical and evolutionary economics.</i>	(Mulder et al., 2001) (Martina, 2012) (Nelson, 1995)	Development models of evolutionary and neoclassical based on the homogeneous or heterogeneous/ endogenous or exogenous and ...
	(Metcalf, 1994) (Eparvier, 2005) (Nelson & Winter, 1974)	Centrality of reasonable optimisation in neoclassical economics using the selective and innovative process in evolutionary economics.
Comparing the theoretical foundations and policies: <i>in addition to express differences between the theoretical foundations, its effect on the proposed policies is explained.</i>	(Wieczorek et al., 2009)	Separating three fields of knowledge management, evolutionary and systematic approach against neoclassical economics
	(Bach & Matt, 2005) (Smith, 2000) (Rosenberg, 1992) (Lipsey & Carlaw, 1998)	Comparing frameworks and policies of evolutionary and neoclassical economics.
	(Moreau, 2004) (Salmenkaita & Salo, 2002)	Different role of government in the evolutionary and neoclassical economics.
	(Laranja, Uyarra, & Flanagan, 2008)	Quintuple classification of policy-making regional rationales.
	(Nelson & Winter, 1974) (David, Hall, & Toole, 2000)	Role of the government for protecting science compared with its role for protecting technology.
	(Verspagen, 2004) (Vandenberg & Kallis, 2009)	Neoclassical predictable worldview effect and evolutionary uncertainty worldview on the proposed policies.
Comparing and representing a combined model: <i>while expressing the differences between both the doctrines, combined model will be also represented.</i>	(Dosi, Fagiolo, Napoletano, & Roventini, 2013) (Fagiolo & Roventini, 2012) (Gustafsson & Autio, 2011)	Developing the model of 'factor-oriented computational economics'. Triple combined suggestion about the market failure, system failure and institutional structures.
	(Dodgson et al., 2011) (Dolfsma & Seo, 2013)	Evolutionary model – complexity as outcome of both the models, free-market and cooperative model.
	(Lall & Teubal, 1998)	Representing model of 'policies encouraging the market'.
	(Aghion et al., 2009)	Representing model of 'science, technology and innovation systems and economic growth'.
	(Flanagana et al., 2011)	Representing model of 'combining the policy for the innovation'.

Source: Authors.

posed in the field of the science and technology of policy-making, it seems that one can appropriately integrate their concerns and objectives.

On the other hand, the noted cases in Table 2, particularly in the second class, have mainly used two concepts of theoretical foundations and operational policy. Although the concept of policy rationales has sometimes been used, it has not been followed and used as an intermediate between the foundations and policies. The present research has sought to compare the policy implications of two doctrines using policy rationale as an intermediate concept, and tested the relationship of the type of differences between them. Thereby, the existing deficiency in the theoretical literature in regard of specifying the type of difference between doctrines will be removed. Hence, it was used in the following research model (Figure 1).

Different components of this model are explained in the next section.



Figure 1. Research model used in this paper. Source: Authors.

3. Research method

It is necessary to reply to research questions and verify the related hypothesis so that an appropriate framework is provided to compare the policy implications of two doctrines of evolutionary and neoclassical economics, so that it is possible to explain the convergence proceeding. There are difficulties in this regard:

- It is not possible to compare two doctrines which are in separate environments (incommensurability of paradigms). For this reason, in order to compare policy implications of the two doctrines, it is necessary to design structures which allow such a comparison.
- The analytical framework of evolutionary economics is very qualitative and sensitive to case; hence, its widely conceptual scope makes driving the specified policy rigorous and certain implications difficult (specifying policy implications of evolutionary economics).
- The analytical framework of neoclassical economics is very abstract, and further it models theoretical problems in the economic field, and rarely seeks to specify policy implications directed to improving conditions. The policies resulting from the neoclassical doctrine are also represented by thinkers of evolutionary economics with pluralistic and critical attitude (to specify the policy implications of neoclassical economics).
- This research claims that there is a difference between presumptions and theoretical foundations of neoclassical and evolutionary doctrines, and the convergence of their policy implications.

In order to address the above-mentioned problems, some strategies are planned. An important strategy used in this research is the application of an intermediate concept such as policy rationales. Briefly, rationales are derived by concepts and theoretical frameworks which have proposed a kind of planning, using special policy instruments and denying other interventions (Salmenkaita & Salo, 2002). It is very useful to use this concept with the mentioned problems.

First, using the policy rationales such as basic rationality and main foundations of planning the policy implications makes a comparable structure between them. Although a direct analogy of the two doctrines is impossible, their responses to the same questions are comparable. Therefore, although it is impossible to compare them in the ordinary state, one can compare their responses to the same questions. Rationales are logical structures for explaining the bases of doctrines. For this reason their comparison is facilitated.

Second, using policy rationales to solve the mentioned questions is useful because it makes a common structure to codify the policy implications of doctrines. Rationales, in fact, are the intermediate concepts which connect theoretical foundations to policy implications. Codifying the policy implications of neoclassical and evolutionary economics in this research is based on the mutual contrast of rationales.

Therefore, in this study, the policy implications have been derived as an intermediate concept to codify the comparable structure of policy implications.

According to the research hypothesis, the existing theoretical literature and quartet of cases in the research framework and combined methodology in this research are examined. Combined methodology means that a qualitative methodology is required in the first step, and a quantitative methodology in the second step. Driving the policy rationales of neoclassical and evolutionary economics, as well policy implications of both of doctrines based on the policy rationales for developing countries such as Iran with a similar structure and different content, is the first step, which is based on qualitative research. This step needs thematic strategies because of the direct connection to analysis of the content of texts. In the second step a statistical survey was used to indicate the amount of convergence between the two models based on a questionnaire of related specialists.

3.1. First step: qualitative methodology

The first step of this research is based on qualitative methodology. This step has a natural and heuristic target in respect of the inter-paradigm and intermediate nature between varied economic doctrines. Heuristic studies are conducted to understand the nature of a problem which has been rarely examined. Most studies are performed in the field of innovative, technological and economic theories within certain paradigms, but rarely focus on examining the relationship and convergence between these paradigms. The present heuristic research focuses on this field.

Therefore, inevitably qualitative research planning has been used in order to analyse the existing economic concepts in the policy field. Qualitative research generally refers to any kind of research where the findings have not been obtained by statistical processes and for quantification purposes (Strauss & Corbin, 1998). Qualitative research can be undertaken based on various analytical methods. Thematic or case analysis is one of these methods. Since this research focuses on modelling based on collecting, classification, conceptualisation and evaluation of different issues in the field of innovative and technological policy in neoclassical and evolutionary economics, it uses the thematic or case method.

There are the various methods for completing a thematic process. Since research using the thematic method results from the concept data, it is focused, in most thematic methods, on the steps of collecting, coding, filtering, analysis, comparison and interpretation of data. In other words, despite the apparent difference and variety of thematic methods, most of these methods have three general steps of collecting and description, organising and setting, and finally interpretation and representation (Stirling, 2007).

Accordingly, Wolcott's simple model was followed in this research, and the report of the research is based on it (Wolcott, 2008). Wolcott's thematic model is broken down into three steps: description, analysis and interpretation. Accordingly, the process of research is explained as follows.

3.1.1. Description of data

This phase includes the study and revision of data in an active way with the aim of being drawn into the data. This step creates the basis of the next phases, because it is in this phase that good ideas form regarding the coding and templates. After this phase, the researcher tries to begin the coding process.

The date of publication for these papers was between 1994 and 2011. At the end of this step, and in order to start the initial coding, 30 papers from all the gathered papers for the two doctrines of evolutionary and neoclassical economics were selected and analysed. Of these, 15 papers are common in two analyses because they focus on interdisciplinary issues. Finally, 30 papers concerning thematic analysis of evolutionary economics are listed in Appendix Table 1, and 30 papers concerning thematic analysis of neoclassical economics in Appendix Table 2.

3.1.2. Analysis of data

In this phase, data should be organised, set up and categorised. For this reason, data is read, annotated, eventually, grouped and coded. Themes related to evolutionary and neoclassical economics are separately formulated.

In this step, codes are used to divide text data into useable and intelligible parts such as phrase, word, or other standards required for special analysis. Codes of the coding framework should have a fully specified and defined limit so that it is unchangeable and/or non-repetitive. Similarly, the codes should be confined to the research field and obviously focus on the issue to prevent coding each sentence of the original text. This step is important in terms of interpretation; but, if at this point the step is not completed, one cannot enter into the next step (Stirling, 2007).

3.1.3. Interpretation of data

This step includes two parts. The first focuses on the deduction of political rationales for evolutionary economics in the field of science, technology and innovation based on the deduced themes of this field. The second focuses on the deduction of political rationales for neoclassical economics in the field of science, technology and innovation. First, evolutionary economics rationales are deduced and then neoclassical economics rationales are extracted. To re-examine and further refine themes, it should be sufficiently content specific, separate, and non-repeated as well as macro to include a set of ideas raised in parts of the text. Data is thus reduced into sets of important, controllable and acceptable themes which show an abstract of the text.

3.2. Quantitative methodology

The second step of the research uses a quantitative strategy. In this step, the degree of convergence between the two doctrines regarding the specific political significance of Iran is evaluated using a survey based on a quantitative questionnaire. The main purpose in this step of the research is the explanation of practical convergence of the competing theoretical doctrines in science and technology policy-making, and analysis of the proportion between their practical significance and theoretical bases. Accordingly, clarification of the common and different points between the doctrines is a standard point which should be completed. Finally, this step also tries to explain the policy implications of comparing the

economic doctrines, and to deduce the specific policy-making model of technology and innovation for Iran.

3.3. Framework of convergence explanation

In this research, a survey based on a questionnaire is used to explain the convergence of policy-making significance for neoclassical and evolutionary economics.

3.3.1. Codification of questionnaire

In order to fulfil the required purpose, the research questionnaire should have three specifications as follows:

- it can distinguish advocates of both doctrines.
- it can explain convergence between comparable structures of codified policy implications.
- it can show the procedure of convergence from theoretical to practical field in the form of the appropriate parts.

To fulfil the first specification, correspondence between the theoretical grounds of both doctrines has been used. It is assumed those who do not belong to the theoretical grounds of either doctrine are considered and realised as an uncertain person. To fulfil the second attribute, a spectrum of policy implications was used which had been produced to mutually contrast the rationales in the questionnaire. To realise third attribute, a spectrum of the rationales was used as the middle part of the questionnaire.

Overall, the final questionnaire involves theoretical grounds in the first part, policy rationales in the second part and policy implications in the third part. To test the research hypothesis, policy implications of both doctrines in the field of technology and innovation concerning developing countries, with regards to a specific case such as Iran, should be derived. The third part of the questionnaire provided focus on this issue. Further, it is necessary that specialists of each doctrine choose their own intended policy implications to examine under the hypothesis of the research. Separation of the experts who tend to each doctrine is based on the theoretical grounds posed in the first part of the questionnaire. The middle part is mutual rationales derived from each doctrine, which are the interface of theoretical grounds and policy implications. Rationales are based on the theoretical grounds and policy implications derived from the mutual contrast of mutual rationales, since one can codify the appropriate explanation about the difference between policy implications on the difference of policy rationales.

At the two ends of the spectrum for each question in all three levels, an explanation concerning neoclassical and evolutionary economics was prepared. The respondents were asked to choose one of options 1–5 in this spectrum. The amount of confirmation of each doctrine at the two ends of the spectrum will be a basis for selection of the options.

The first part of the questionnaire involves six questions related to the theoretical grounds of neoclassical and evolutionary economics. The aim of this part is that respondents are divided into two groups consisting of advocates for neoclassical and evolutionary economics. The other aim in this part is the omission of the responses of uncertain people who are not necessarily placed in one of the given groups.

Table 3. Introduce framework of the questionnaire.

Evolutionary economics								Neoclassical economics							
Theoretical foundations	1	1	2	3	4	5	1	Theoretical foundations	1	1	2	3	4	5	1
	2	1	2	3	4	5	2		2	1	2	3	4	5	2
	-	1	2	3	4	5	-		-	1	2	3	4	5	-
policy rationales	1	1	2	3	4	5	1	policy rationales	1	1	2	3	4	5	1
	2	1	2	3	4	5	2		2	1	2	3	4	5	2
	-	1	2	3	4	5	-		-	1	2	3	4	5	-
policy implications	1	1	2	3	4	5	1	policy implications	1	1	2	3	4	5	1
	2	1	2	3	4	5	2		2	1	2	3	4	5	2
	-	1	2	3	4	5	-		-	1	2	3	4	5	-

Source: Authors.

The direct correspondence of policy rationales is questioned in the second part of the questionnaire. In this part, policy rationales conceptually in the same conceptual field lie at the two ends of the spectrum. This part, in fact, is the interface between the theoretical grounds part and the third part means policing-making significances. Rationales have been designed so that they have a mutual conceptual connection together. Rationales which have approximately similar content lie at the two ends of the spectrum in the questionnaire.

Twenty-five questions have been codified in terms of spectrum and in the form of noted duality in the third part of the questionnaire. The full text of the questionnaire used in this research has been attached in the final paper. The model used in codifying the questionnaire is presented in Table 3. The theoretical grounds part has been prepared to determine the advocates of each doctrine, and the rationales and policy implications parts have been used to test the convergence explanation.

One of the important limitations of this research is non-access to the appropriate respondents. The appropriate respondents for this research are those who both dominate in the theoretical field and, partly, have defined themselves in either the neoclassical or evolutionary doctrine, and have a good work record in the field of policy-making of technology and sufficient familiarity with the challenges and specific specifications of this field in the state. To simultaneously access both of the noted conditions is very difficult.

With respect to not finding similar works on which one can achieve an evaluation of the standard deviation of indexes, the final sample size of this design has been considered based on selecting an initial sample of 10 and the evaluation of the standard deviation from this sample. The defined index with evaluations related on theoretical grounds which has the highest standard deviation from the initial samples is considered as a criterion for evaluating sample size, and least detected error is also considered as 0.5 of half-distance of values of assigned codes to Likert-scale items. In this case, with one sample of 60 or more choices, one can highly confidently achieve realities within the target society. Table 4 shows the characteristics of respondents based on the suitable number and having the noted conditions.

Finally, the number of people who responded to the research questionnaire is 71. All of these people have complementary education in the field of management and economics, and have worked in economic policy-making in the economics of Iran. Five questionnaires were defaced and were omitted from the final analysis. The full information of respondents is shown in Table 4.

Table 4. Characteristics related to the respondents.

Experience	No.	Job category	No.	Special fields	No.	Education level	No.
Less than 5 years	38	Expert	56	Economics	28	M.S.	31
Between 5 to 10 years	21	manager	10	Science & Technology policy-making	10	Ph.D.	35
Between 10 to 15 years	2			Management	9		
More than 15 years	5			Industrial Engineering	5		
				Science Philosophy/ Future Studies	4		
				Energy Engineering	2		
				Engineering fields	5		
				Social studies and communications	2		

Source: Authors.

3.3.2. Survey methods

The process of analysis was started after completing the questionnaires. Two steps were taken in analysing the results. The first step is identification of persons driven to each doctrine and omission of uncertain people, and the second step is the convergence test. Identifying persons driven to each doctrine and omission of uncertain people are very important to test the research hypothesis. It is required that people who are not interested in either doctrine are omitted, since the aim of research is the explanation of convergence between neoclassical and evolutionary doctrines. Therefore, persons who are not theoretically close to either of these two doctrines cannot play any role in this aim.

Hence, in first step, data from the questionnaire based on the evaluation of its first part concerning the theoretical grounds of the two doctrines is subject to a clustering test. To identify and omit the uncertain persons and replicate the given test, the other persons were clustered into the two groups of advocates of evolutionary and neoclassical economics. The second step is conducted based on the data related to the persons of these two clusterings.

The method used is a clustering test based on the evaluations of second and third parts. If the quality coefficient of the results obtained from clustering based on the evaluations of the second part (policy rationales) lies in the normal interval, it means that it can categorise two groups into two separate clusters. Furthermore, to confirm the research hypothesis, it is required that the interval amount for the given doctrines is decreased compared with the interval amount for the evaluation of theoretical grounds, in order to show that the interval amount of the two doctrines has been decreased compared with the previous step. In the clustering test based on the measures of the third part, the hypothesis based on the convergence of two doctrines is confirmed when the quality coefficient resulting from this test is very close to zero. A quality coefficient of zero means that one cannot categorise data in the form of two separate clusters with acceptable approximation. Rather, if the quality coefficient in the normal interval is significant, it means that difference between the two doctrines in the field of policy implications is also maintained, and the research hypothesis based on the convergence of the two doctrines in the policy implications has been rejected.

The method used is fuzzy clustering. The fuzzy clustering method is a test which measures the grouping of data in certain clusters. Although the fuzzy clustering instrument was used in this research, the type of clustering conducted was not practically fuzzy because of requiring this research to access to two separate groups driven to each approach, and the two groups have been totally distinguished together. The result of the test is specified in the form of quality coefficient of clustering and, generally, normalised. The closer the

normal coefficient is to 1, the better the allocation of data is in the form of the number of clusters tested. If the coefficient is closer to 1, this means it cannot place data in the number of tested clusters.

S Plus software was used to analyse the results. In section 4, the results obtained from these two steps and examination of the research claim concerning the hypothesis are explained.

4. Results of research

The results of the research are examined in two forms. The first form consists of conceptualising five rationales of evolutionary economics and five rationales of neoclassical economics, and, in the following, codifying 25-fold spectrum of policy-making significance resulting from the mutual contrast of these policies, discussed below. In the second form, the results are obtained from the fuzzy analysis and the research hypothesis is examined based on the convergence of policy implications. These issues are explained in the second section of this part.

4.1. Deducing rationales and specific policy implications for Iran

As a result of the content analysis conducted in this research, five rationales of evolutionary economics (Table 5) and five rationales of neoclassical economics (Table 6) were deduced. Specific policy implications for Iran were codified due to the mutual contrast of these rationales for Iran. These have been explained as follows:

4.2. Codifying specific policy implications for Iran

In order to explain convergence of policy implications for evolutionary and neoclassical economics in the field of science, technology and innovation policy-making, a questionnaire consisting of three parts was designed: the first is connected to theoretical grounds of the two doctrines. The second questioned the mutual face of rationales. It was already clarified that deduction of the rationales is so that the probability of comparing the two doctrines is provided.

Table 5. Policy rationales deduced of evolutionary economics (Ghazinoory et al., 2017).

Emphasising on geographical adjacency:	Geographical adjacency based on the overflow outcomes increases the scientific, technological and innovative collective abilities.
Emphasising on chain of knowledge and technology:	It should be focused on ranging from the creative process to the use of the type of knowledge in the science, technology and innovation policy-making.
Emphasising on systematic accumulation:	Accumulated approach based on the provision of required institutions of system and increasing the interactions between them being very important in the science, technology and innovation policy-making.
Emphasising on cognitive ability:	Focusing on the cognitive capacity of endogenous factors based on shifting the cause and effect relations, having special significance in the science, technology and innovation policy-making.
Emphasising on normal stability:	Interactions between humans, economics and natural environments will result in opening the system to multiple significances in the science, technology and innovation policy-making.

Table 6. Policy rationales of neoclassical economics (Ghazinoory, Narimani, Afshari, & Hasanzadeh, 2014).

Focusing on the overflow outcomes and immobility	Using the knowledge overflows directed to the convergence and geographical adjacency require to the special policy-making.
Emphasising on the accumulation of human and intellectual resource:	Accumulating types of knowledge resource explain long-term economic growth.
Improving business environment	Institutional setting related to improve business environment decreases costs of trade-off and increases economic performance.
Expanding widely used technologies	Expanding widely used technologies to shorten economic growth courses.
Emphasising on the internalisation of costs of knowledge activities	Internalisation of secondary outcomes resulted from the knowledge activities improves allocation of resources in the market mechanism to these activities.

Source: Authors.

Deducing policy implications was conducted via the horizontal and vertical face of these rationales in the form of a table of 25 blanks (see Table 7). In order to explain the convergence of policy implications and analyse the related questionnaires, two steps were performed. Primarily, uncertain persons should be omitted, and two groups be distinguished who believe in evolutionary and neoclassical economics. This was done using the clustering method and based on the first section of questionnaire which connects to the theoretical grounds. In the second step the research hypothesis should be tested based on the convergence of responses for these two spectrums concerning policy rationales and policy implications, which make up sections 2 and 3 of questionnaire.

Table 7. Conceptual face of deduced rationales.

		Neoclassical economic rationales				
		emphasising on the overflow outcomes and immobility	reinforcing the accumulation of human and intellectual resource	improving business environment	focusing on the public technologies	internalising costs of knowledge activities
Evolutionary economic rationales	emphasising on the geographical adjacency					
	emphasising on the chain of science and technology					
	emphasising on the system accumulation					
	emphasising on the cognitive ability					
	emphasising on the natural stability					

Source: Authors.

4.3. Fuzzy clustering and test

As was previously noted, uncertain persons have been identified and omitted from the process of analysing the results. Other persons were also categorised into two groups driven to neoclassical and evolutionary economics. Therefore, the results were controlled in two phases. First is the identification of uncertain persons, and second is improvement of the allocation coefficients. In the first phase a threefold grouping on the six fold measurements of the first section for the questionnaire was performed. The amount of probability for belonging of every person to each of these three groups has been considered, and every person placed in a group which has higher allocation probability. Using 37 iterations for realising desired averages, 17 people were placed in the mean (uncertain) cluster, 24 people in the neoclassical economics and 25 people in the evolutionary economics. The normalised quality coefficient of the first phase was 0.07 because of uncertain people have concluded. So in next step, uncertain people have excluded.

In the second phase, 17 uncertain people were omitted, and double clustering was again performed based on the six fold measures concerning the theoretical grounds in the first section of the questionnaire by 12 iterations and faster than the first phase of clustering. The results of these two phases are presented in Table 8.

A quality coefficient close to 1 means the desired difference of clustering, and closer to 0 shows more approximate clustering. In the second phase, compared with the first, there was no change observed in subjects belonging to the two groups of neoclassic and evolutionary compared with the previous state, but grouping quality was considerably improved.

The next phase should also replicate the difference test of two groups consisting of the advocates of each doctrine about the measures of policy rationales and significances. The result of the difference test will specify the results obtained from the given fuzzy clustering by three existing measures in the questionnaire. In the first step, the quality coefficient was based on the measures of theoretical grounds; in the second step, it was based on the measures of policy rationales; and in the third step it was based on the policy implications in Table 9.

Table 8. Clustering results of respondents, omission of uncertain people and deduction of two groups driven to evolutionary and neoclassical economics.

	The first step: three clusters classification (neoclassical, evolutionary and uncertain)	The second step: two clusters classification (omission of uncertain individuals: neoclassical and evolutionary)
Normalised quality factor	0.07	0.28
Allocation probability factors	uncertain and close factors	acceptable and distant probability factors
Number of members of clusters	uncertain: 17, neoclassic:24 evolutionary: 25	neoclassic: 24 evolutionary: 25 (unchanged)

Source: Authors.

Table 9. Normalised quality coefficient of the difference test on the clustering.

	Theoretical foundations measures	Policy rationales measures	Policy-making of significances measures
Normalised allocation quality factor	0.27	0.17	7.5e-15

Source: Authors.

The results of the difference test on the clustering show that it can partly confirm the accuracy of difference of samples in two separated clusters using the measures of theoretical grounds and policy rationales. But, the result of the normalised quality coefficient using the measures of policy implications shows that it is not essentially confirmed for distinguishing the samples into two separate clusters and the quality coefficient is approximately zero.

The procedure of changing the clustering quality ranging from the theoretical grounds to policy implications confirms the research hypothesis based on the convergence of the two doctrines. It is observed that although there is a high difference between advocates of the two doctrines in the field of theoretical grounds, this difference is decreased in the field of policy rationales, and in the area of policy implications is decreased to the extent that the quality coefficient of clustering is basically approximate to zero. In other words, one can never accept a double clustering between two doctrines in the area of policy implications.

5. Conclusion

The main findings of the present research can be divided into the three classes: (1) findings from the thematic analysis; deducing policy rationales of evolutionary economics in the field of science, technology and innovation; (2) findings from the thematic analysis; deducing policy-making rationales of neoclassical economics in the field of science, technology and innovation; and (3) findings from research which compares the two doctrines and explains convergence between policy implications of these two doctrines related to Iran.

Two main results have been obtained from the thematic analysis concerning evolutionary economics. The first result is connected to the concept of evolutionary economics and its precise definition. Some refer evolutionary economics to all attitudes of economic heterodox which are in contrast with the balance-oriented stream. Some consider it as a specific economic attitude which is concerned about explaining innovative study. Others introduce it as policy rationales along with the other rationales. Focusing on these differences enables the different operations for the concept of evolutionary economics to be correctly understood, and controversial issues in existing disputes to be correctly explained. Similarly, deduction of fivefold rationales of evolutionary economics is the other important finding of the present research. Better understanding the difference criteria between the different versions of the concepts for this field, explaining the bases and the central rationales of technology and innovation policy-making in the doctrine of evolutionary economics, and also understanding the common and uncommon policy implications are some of the results from specifying the policy rationales.

The main finding of the present research from analysing the content of neoclassical economics is a focus on the key role of open market economics and removal of its weaknesses for developing technology and innovation. Although the literature related to science, technology and innovation policy-making in the area of evolutionary economics has been born and developed as a heterodox stream against the orthodox, the theory of neoclassical economics has been active during this period and has tried to include concepts related to this field as far as it is possible. Emphasis of the centrality of market mechanisms in developing technology and innovation is an informative insight that the neoclassical economics stream proposes to the field of policy-making. It is necessary that policy-makers always consider that centrality of policies should include contribution to market allocation and removal of its weaknesses and deficiencies, despite market functional failures in the field of

science and technology as well as institutional failures of market concerning the organising structures. Five rationales are presented in this paper, each of them typically tries to improve and reinforce the market operation.

To explain the convergence of the two doctrines of evolutionary and neoclassical economics in connect with policy implications of the field of science, technology and innovation in Iran, the present research greatly emphasises the necessity of using the combined doctrines for policy-making in this area. It should be noted that widely emphasising market centrality should not influence the importance of developing, facilitating and the role of government in developing science and technology. This should be a main focus, particularly in developing countries which suffer many institutional and functional weaknesses in their economic mechanisms. The present procedure in the theoretical literature of neoclassical economics shows that minimal governmental models are gradually marginalised, and it important to emphasise the positive roles of government in the economic development process. This aspect, although emerging in the field of neoclassical economics and is gradually expanding, has reached maturity in the field of evolutionary economics and can be transformed into applicable insights. Researchers of economics in the field of science, technology and innovation observe that the initial neoclassic–evolutionary contrast has mostly disappeared, and the existing mutual convergent procedures, but not composition and incorporation, promise these two approaches. It is, of course, a claim which has been tested on Iran in this paper (Soofi & Ghazinoory, 2011).

The other aspect of innovation in this research is use of the intermediate concept of policy rationales. The conceptual interval between the theoretical grounds and policy implications should be full. Theoretical grounds are greatly abstract in order to define a theoretical framework of the different approaches. On the other hand, policy implications are very concrete and practical. In this paper an intermediate concept of policy rationales has been used in order to make a connection between the theoretical grounds and policy implications. In fact, along with the main procedure of the research, which focuses on the explanation of convergence of policy implications for comparing economic doctrines related to economic policies of developing science, technology and innovation of developing countries, the use of the intermediate concept of policy rationales for formulating an analysing framework of the different economic approaches, along with the theoretical foundations and policy implications, is considered as the secondary innovation of the present research.

It is also important to use the threefold questionnaire of theoretical foundations, policy rationales and policy implications that has been focused upon in the present research. Since the two doctrines of evolutionary and neoclassical economics have two different conceptual spaces, their comparison and/or, as Kohn, their comparability, is severely challengeable. In order to overcome the above-mentioned problem, a same threefold structure which was proportional to the research purposes was considered as a basis, and it was tried to represent each doctrine in the form of this model. Thus, it is possible to compare two doctrines according to the research purposes.

Disclosure statement

No potential conflict of interest was reported by the authors.

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