
Understanding the Policy Instruments Mix in Higher Education R&D: A Policy Scale Development

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Abstract:

Purpose: The purpose of this paper is to understand the policy instruments mix in higher education research and development (HERD) using structural equation modeling. This modeling helps us to understand the total structure of the factors affecting the policy mix as well as its main actors in a political system.

Design/Methodology/Approach: Thirty two identified actors (official institutions) through upstream documents were designed by the method of social network analysis in the form of a political network and their role in policy instruments mix was investigated through their amount of centrality in the network. Also, indicators affecting policy instrument mix were identified using the view of 13 Iranian higher education policy experts. These indicators were categorized in the form of causal, contextual, intervening factors, main phenomena, mechanisms and outcomes. Structural equation modeling was used to confirm the model.

Findings: According to the results, the lack of policy logic is the main reason for the lack of justice in the policy instruments mix. Choosing a logic or theory of justice that is the basis of all the instruments in research and development decisions can lead to the integration of concepts and instruments mix.

Practical Implications: There is no doubt that the dominant range of thought can have a greater impact on politics in any state, but choosing observers from other aspects of thought will always lead to more effective policies.

Originality/Value: How to form policy instruments mix in policymakers' mind has not been investigated in any study so far, and this study explores the indicators governing policy instrument mix.

Keywords: Policy instrument mix, science and technology policy, social network analysis.

Paper Type: Research Paper.

JEL codes: A2, A22.

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1. Introduction

The development of the higher education system is one of the fields that have attracted little attention in the academic community (Vieira and Lepori, 2016). However, it requires public policy making and planning to be precise and based on certain principles. The point that has always been overlooked in the policies of the higher education is the multidimensional policies of this field and its inter-organizational function. In other words, current policies are always developed in isolation and only by looking at the higher education, while all national policies in all ministries can directly and indirectly affect higher education. In fact, policy mix in this field needs policymaking, which can lead to policy success (Ring and Schroter-Schlaack, 2011). According to (Ring and Schroter-Schlaack, 2011), policy mix means a policy instrument mix in a way that influences the quality and quantity of ecosystem services in the public and private section. The concept (policy mix), which originates from the field of economic policy, emphasizes the interactions and dependencies between different policies that can develop and improve the results of the policies used (Rogge and Kristin, 2013).

Although the concept of policy mix has been used in a variety of fields, such as electricity generation from renewable energy (Wiebe and Lutz, 2016) or environmental issues (Wong *et al.*, 2016), it has not been used in higher education research and development. As a result, policy mix (PM) innovation is based on the idea of policy instruments mix and the interaction of these instruments can have a different impact on research and development. i.e, the isolation of these instruments will be never occurred (UNU-MERIT, 2009). Another important point in the need to apply policy mix in research and development is that R&D is not just affected by the policy space of a particular field but other policies affect it as well. Policy mix can be defined as: policy instrument mix that interacts with each other to influence the quality and quantity of R&D in the public and private sector (UNU-MERIT, 2009). Building all bricks forming this mix that is mentioned in the scientific literature as the Mini-Mix has a great importance. Mini-Mix or sub-mix is a set of instruments that are built (in a package) by policymakers to cover different aspects of R&D and innovation.

Basically, the concept of political networks was proposed against the idea of monolithic state that controls the policy-making process. In contrast, the framework of political networks states that policymaking takes place in the shadow of systems consisting of different sectoral domains, with varying numbers of actors. Studying public policy making by studying the relationship between governmental organizations and other network of organizations supporting the interests of what is referred as theories of political networks. Theories of state-based approach political networks adopt public policy making and consider institutional behavior (Blanco *et al.*, 2011).

One of the main assumptions of the political network model is that networks influence policy outcomes. There is a fact that because network theory was manifested in response to critics on hierarchical models, it tends to focus strongly on the issue of cooperation and not consider power differences in society. Using a comparative approach, it can be said that there is a tendency in the British network of networks known as the studies of Rhodes to consider the government and social actors as contributors that have equal power. These studies emphasize the feature of self-organizing and self-guiding of networks. On the other hand, the German School of networks accepts the fact that the government has superior power in network because of controlling resources and exclusive legitimacy as the representative of the public interests. Therefore, in this perspective, the government has the role of managing and guiding the networks. Of course, there is a question of how the government can manage networks in a wide range and influence interactions among contributors, although the government has interests in different policies? Although the role of networks varies according to the field of activity, the network model has three basic assumptions that are as follows (Teye, 2013):

1. A political network is formed at the sector level of central government organizations and beneficiary groups.
2. The internal features of the network affect its results.
3. Internal and external pressures are important in the changes of network.

Although most of changes occur as a result of external elements, the degree and speed of these changes depend on the capacity of the network for minimizing it. Literature of political networks has identified at least 5 bases for beneficiaries to form a network of interactions:

1. The first and most common basis is related to the exchange of information and views related to substantive policy issues or issues related to political efficacy. This basis is particularly important about very complex issues which most people have knowledge.
2. The second basis for forming a network is the exchange of resources such as money, manpower or services.
3. Third, a support network is attempting to identify beneficiaries to form a superior coalition.
4. The fourth basis is to establish relationships with influential actors to control sensitive resources. The fifth and final basis is that a coordination network seeks to identify actors that predict their behavior regarding common goals (Teye, 2013).

Some scholars believe that the distinctive aspect of networks is their bargaining and financial resources. For example, Rhodes method states that different organizations apply various types of financial and legal sanctions in order to get what they want from other organizations. Thus, as a result of the interdependence between different organizations, network policy emerges. The view of some other scholars is that networks are derived from ideas and thoughts and they cannot be regarded as merely

a tool for bargaining. In this view, the network is referred to a coalition of actors which has a particular perspective in a particular area.

There is a consensus that studying policymaking networks led to the emergence of a relational perspective in policymaking. Proponents of this perspective believe that political and social phenomena can only be understood if individual actors are considered as a social system, not separate entities. These actors have multilateral relationships with other actors and influence decision-making and policy outcomes. As a result, researchers should not only investigate the actors' attitudes extensively, but they should analyze the relationships and structures that actors act on them. Of course, this relational perspective in the distant past has been emphasized by Weber. Power, as one of the most important concepts of the social sciences in Weber's view, means the special possibility of an agent (individual or group) for having a situation in social relations to be able to apply its will despite resistance despite the basis of relying this special possibility (Lazer, 2011).

Xu and Su (2016) present a new typology of policy instruments of innovation in transition time in China. This typology includes the instruments of government choice versus instruments of market choice and the producer tendency versus consumer tendency. The researchers in this matrix present a range of policy instruments for mixing instruments that have been investigated in theoretical foundations. Researchers obtained data needed to present this typology from policy documents available on official governmental websites and interview with experts and policy makers in the field of innovation policy in China.

Margo and Wilson (2013) also examine the policy mix in the field of innovation. For this purpose, they have investigated the concepts of policy mix while examining the importance of the need for policy mix. Then, they present a multi-step protocol for evaluating policy mix. The protocol includes the following steps:

- Step 1: Draw the policy system and specify the limits, scope, and policy instruments mix in the executive form.
- Step 2: Choose logic for policy.
- Step 3: Analyze different combinations of policy mix and policy instrument mix at different executive levels to complete the policy mix.
- Step 4: Identify the current evaluation actions and the extents that they consider the interactions among policy instruments.
- Step 5: Design and implement an integrated evaluation including the interactions of policy instruments with the policy logic adopted.
- Step 6: Evaluate the policy mix.

Gusmerotti *et al.* (2012) examined the role of negotiation among beneficiaries and policy actors in policy instruments mix in the field of environmental policies in OECD countries. Questionnaires included sections such as: management systems and instruments facilitating environmental activities, instruments deriving for

adopting innovative environmental activities, assessing the impacts of environmental activities in the form of policy packages were sent to production centers of member countries. The results of the study indicated that the negotiations and its conditions have provided the appropriate policy instruments to implement the policy mix in the countries under study. These studies show that the basis of the concept of policy mix requires a network perspective. Some of the main researches in the field of policy instrument mix, illustrated in Table 1.

The network governance is a model for policymakers to deal with the complex issues. Issues that little time is existed to respond them, as it has been mentioned, they have high transaction cost and failure, they are critical to citizens and actors play a role in solving it from different ranges. Network governance is a desirable form of administering affairs that is established by providing partnership and it is a solution that seeks to change and improve political interactions. Here, concepts such as sharing common interests, coordinating desirable communications, strengthening trust, informal interactions of institutions, and interactive negotiations have great importance. Governance is performed by interactive forms of office that many actors play a role and their interactions increase in a way that creates a relatively stable and coordinated pattern (Lester and Reckhow, 2013). Therefore, the main objective of this study is to find the most important actors in the policy field of higher education research and development and to understand their linkage network at the time of policy fix.

2. Methods and Findings

The nature of quantitative-qualitative research has been used in order to achieve the goals and answer the questions of this study. The statistical population in this phase of study consists of all the experts and academic specialists in the field of science and technology policy making in universities, National Research Institute for Science Policy, active experts in the Ministry of Sciences. As in the first step, library sources, articles, required books, domestic research as well as from valid foreign websites, analysis of documents and existing texts (formulated policies in the field of higher education research and development) according to some upstream documents (such as the 5th five-year development plan and the comprehensive scientific plan of the country) were used for gathering information on the theoretical foundations and literature of the subject and 32 organizations active in the field of policy instruments of higher education research and development was identified. In the second step, a paired comparison questionnaire was designed and distributed among the individuals to determine the social network of these actors and their relationship.

Table 1. Related Literature (researchers)

Authors / year	Research type (article, thesis, etc.)	Research design / research procedure (method)	Type of policy	Findings
Capano et al, 2019	article / research	qualitative and comparative	Science and technology policy	Among the various policy combinations and policy tools in higher education, only a few have succeeded and led to good performance. Four different instruments investigated: Legal, Financial, Tax, Information
Kubo et al, 2019	article / research	qualitative	Environmental policy	Policy mix for Indonesia Protected Areas. The policy mix and instrument mix can be negative or positive depending on the processes that make this tool combination necessary.
Wong et al., 2016	article / review	qualitative	technology policy	Policy mix to stop deforestation using the REDD treaty to protect the environment and prevent carbon emissions / For this purpose, policy tools must have the characteristics of effectiveness, efficiency, and fairness
Cunningham et al., 2013	article / review	qualitative	technology and innovation policy	Limiting the concept of policy mix in the related literature to combine tools and to make the high-tech policies closer to the concept of policy mix (i.e. a combination of tools, strategies, policy domains)
Wiebe & Lutz, 2016	article / research	quantitative / learning curve modeling	technology and innovation policy	Reviewing policy mix to generate electricity from renewable energy / Policy mix includes these elements: policy strategy, compatibility between policy-makers and implementation of policy tool, mixing tools, geographic dimension of policy
UNU-MERIT 2009	research project	qualitative / case study	technology and innovation policy	Presenting policy mix model in the domain of research and development and reviewing some of the tools for research and development incentives in the form of mini-mix
Borrás & Edquist, 2013	article / review	qualitative	innovation policy	Underscoring mixing line of tools for solving innovation system problems entitled as policy mix
Veugelers, 2012	article / research	quantitative	innovation and technology policy	Emphasizing a combination of tools in the domain of access to technology and clean innovation
Georgiou et al., 2013	article / research	quantitative	innovation policy	Providing a model of governmental procurement tools to stimulate innovation
Bach, Matt & Wolff, 2014	article / research	quantitative	innovation and technology policy	Using a range of tools considering market failure, system failure, and empowerment failure (capacities)
Mhamed, 2011	book review	qualitative / content analysis	science policy	Using three tools to achieve higher quality education

The basic aspects of network analysis are to lead the researcher from examining groups and social classes to examine links among actors that are not so intertwined to be considered group and distinguished between weak and strong links. Weak links between the two actors can be very important according to the view of researchers, because they prevent the isolation of individuals in a rigid group intertwined and allow them to be aware of what happens in other groups and integrated better in the wider community (Scott and Carrington, 2011).

Although network analysis data can be considered as ordinary data (such as survey data), the reality is that the unit of analysis is the network analysis. In this research, 32 organizations active in the field of research were extracted from upstream documents which from code 0 to 31 were placed in the network analysis software as follows:

- 0-Ministry of Science, Research and Technology (and Department of Higher Education Planning)
- 1-Ministry of Health and Medical Education
- 2-Seminary
- 3-Research Centers
- 4-Supreme Council of the Cultural Revolution
- 5-Science and Technology Park and Development Centers
- 6-International institutions
- 7-Supreme Council for Science Research & Technology
- 8-Statistical Centre of Iran
- 9-Parliament Education and Research Committee
- 10-Co-operative and Small and Medium Enterprises
- 11-Intellectual Property Exchange International and Technology Market
- 12-Registry Organization of Documents and Landed Estate
- 13-Iran's National Elites Foundation
- 14-Scientific associations
- 15-Education
- 16-The Higher Education Development Council
- 17-Specialized academies
- 18- Al-Mustafa International University
- 19-Technical and Vocational Training Organization
- 20-Islamic Azad University
- 21-University of Applied Science
- 22-Payam-e-Noor University
- 23-Non-governmental universities
- 24-Ministry of Cooperatives, Labour and Social Welfare
- 25-Vice President for Science and Technology
- 26-Academic Jihad
- 27-Presidential Center for Technology and Innovation Cooperation
- 28-Organization of Broadcasting
- 29-Ministry of Culture and Islamic Guidance

30-Supreme Council for Applied Science Education
31-Islamic Consultative Assembly

2.1 Graph Characteristics

The following Table 2 presents the graph characteristics including the number of nodes, number of edges, the mean of all nodes of graph, the largest connected component in which the nodes are connected in one component, the mean clustering coefficient of nodes of graph, the maximum Euclidean distance of graph (diameter) and the total density of the graph. Figure 1 presents the matrix from the first angle and Figure 2 from the second angle.

Table 2. *Graph Characteristics*

Number of heads (Nodes)	32
Number of edges	561
Mean degree	17.5
The largest connected component	1
Clustering coefficient of graph	0.72
Diameter of graph	2
Density of graph	0.570564516

Figure 1. *The general graph of the matrix from the first angle*

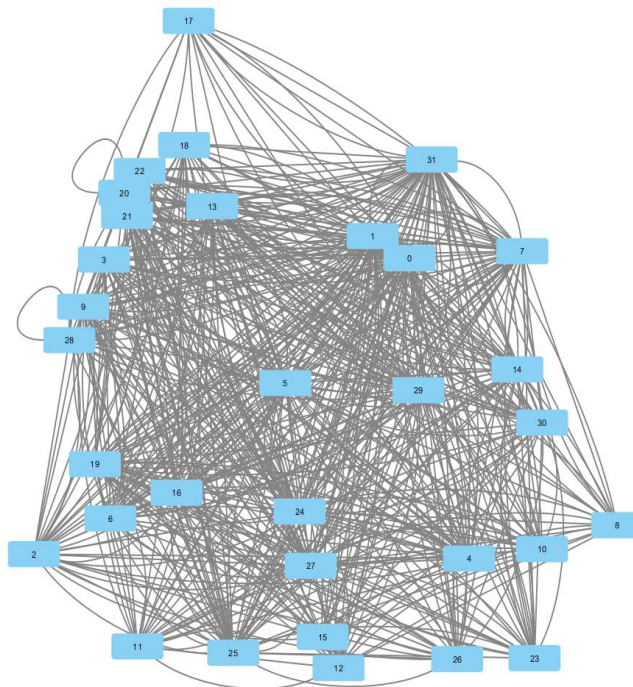
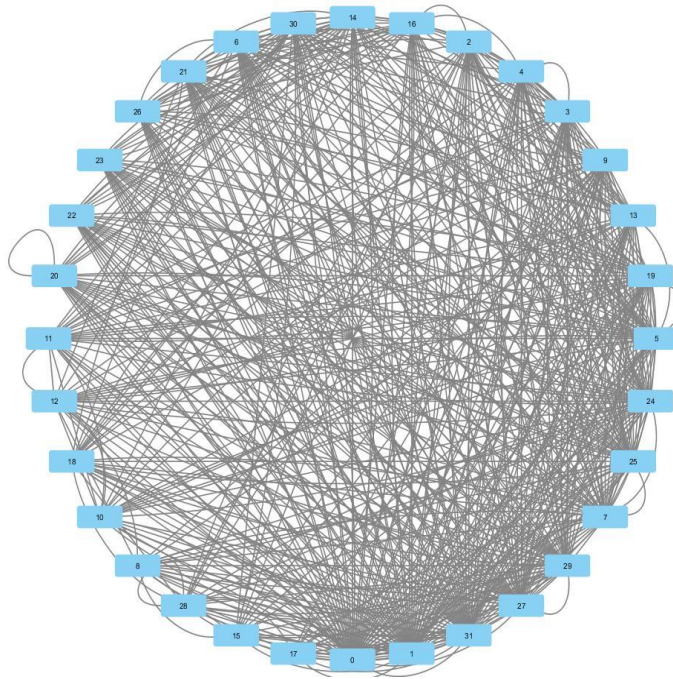


Figure 2. The general graph of the matrix from the second angle



In the second stage of research, the factors affecting policy instrument mix were identified using the view of 13 experts of higher education research and development and categorized according to the fundamental conceptual model.

In this research, structural equation modeling using Smart PLS software was used to test the research hypotheses. In the following, the stages of results have been shown. The model test consists of two parts of the measurement pattern and the structural pattern test. The measurement pattern test examines the validity and reliability of the measurement instruments and the structural pattern tests the research hypotheses and examines the effect of variables on each other. The results of this study are shown below. The path coefficients, the explained variance of the dependent variables by the independent variables and the factor loading of the observed variables are calculated by this pattern. The output of the Smart PLS software for measuring model (1) is presented in Figure 4. The variables are briefly presented in the measurement model according to the following Figure 3.

Figure 3. Total view of the extracted indices

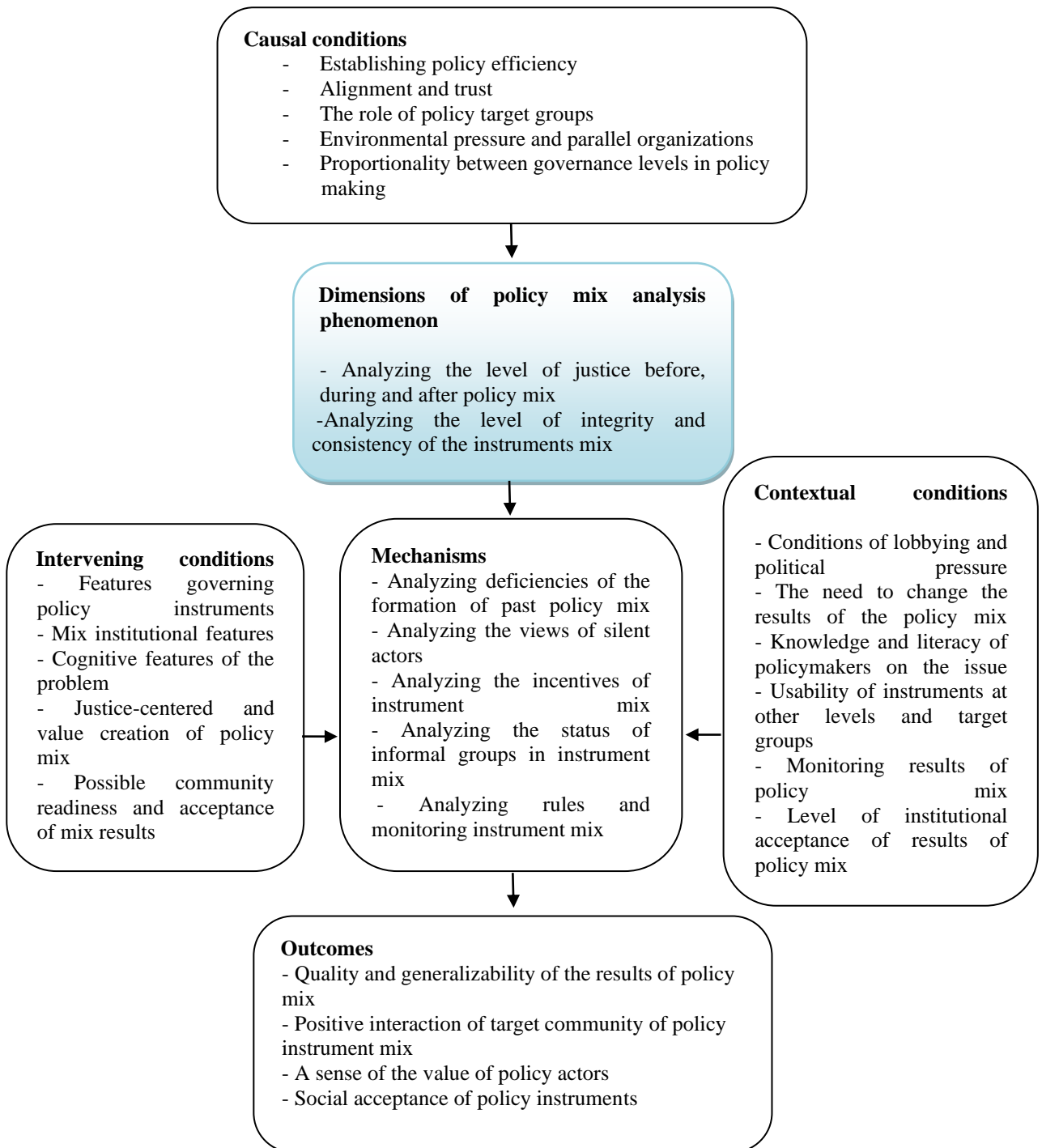
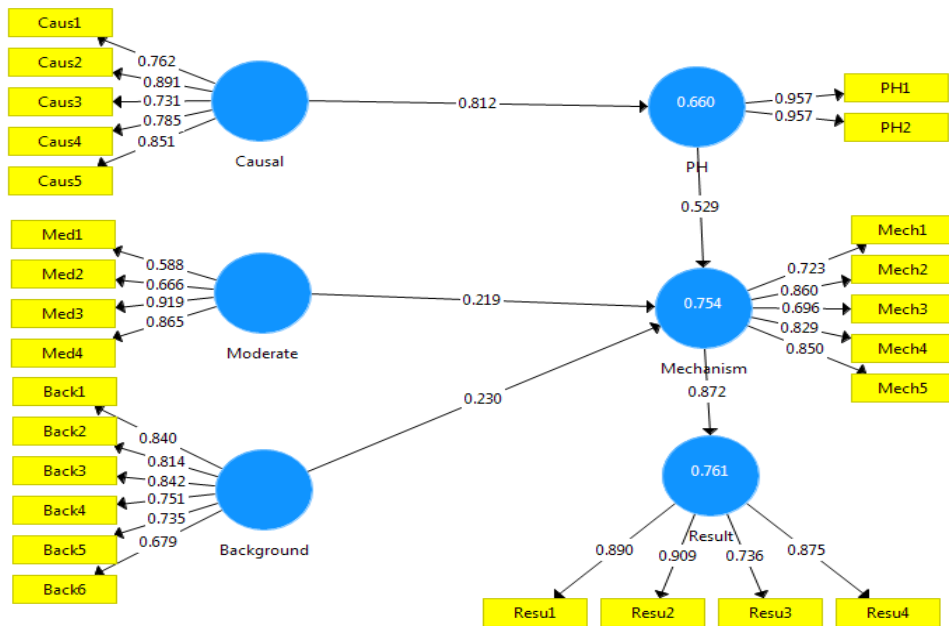


Figure 4. PLS software output for measuring model factor loadings

3. Discussion and Conclusion

In the second major phenomenon of this study i.e, network governance, general issues related to policy instrument adaptation will be proposed. According to the number of organizations listed in upstream documents 32 organizations always overlap and even interfere in each other's tasks, the only appropriate solution is network governance while the network analysis of policy makers is performed with this purpose to know which organization can have high centrality in network governance and which ones are more important in this field.

Based on the results of the network analysis of official institutions, organizations such as religious organizations mentioned in the official documents should always be considered at the time of instrument mix and even in some cases of the network, they have higher scores than organizations such as the Statistical Center of Iran. This case partly points to the superiority of some religious institutions in R&D, and indicates the necessity of aligning R&D with religious and regulatory needs. Although the Ministry of Science and the Ministry of Health have always had much more communications and power compared to other organizations throughout the network, but practically other organizations should also be considered when implementing the policy.

1-According to the results of the research interviews, the lack of policy logic is the

main reason for the lack of justice in the policy instruments mix. Choosing a logic or theory of justice that is the basis of all the instruments in research and development decisions can lead to the integration of concepts and instruments mix.

2-Proper distribution of policy makers in the instrument mix has always been referred by research respondents which indicates that the existence of decision makers from a range of thought or particular parties can lead to policy inequality and even policy corruption. There is no doubt that the dominant range of thought can have a greater impact on politics in any country, but choosing observers from other aspects of thought will always lead to more effective policies.

3-Creating a process of monitoring policy makers' decisions and ensuring accountability against the results of policies even after passing many years of policymaking. Such a process may be impossible in practice, but one factor has been suggested for this task in previous studies and it is the training of commitment and accountability to policymakers, not merely the use of coercive instrument.

4-Creating simple policy information instruments such as policy information checklists for policymakers to know that they don't have the right to mix policy instrument before completing all information such as formal and informal information, short and long-term results, identifying all beneficiary groups and identifying social outcomes.

5-Creating a policy feedback process to prevent new policies from covering the negative effects of previous policies. Many of the new policies are simply to hide the negative effects of previous policies that cause high costs on the country. Forcing policy makers for feedback of results and visibility of previous policy results for all policy networks can cover these negative effects in a large extent.

6-Identifying the most effective target groups. It has been specified that policy instruments are sometimes mixed for groups for various reasons that do not actually play a role in the results of policy. While sometimes, the most effective policy group can be the least costly. For example, in nanotechnology research and development policies, student groups were targeted as instrument mix and much more effective results were obtained, while this target group could be selected among university professors.

7-Legalizing the process of intervening beneficiary groups and social activists in policy decision-making. This process is being carried out in East Asian countries such as Singapore through the online process and the participation of the society.

References:

- Bach, L., Matt, M., Wolff, S. 2014. How do firms perceive policy rationales behind the variety of instruments supporting collaborative R&D? Lessons from the European Framework Programs. *Technovation*, 34(5-6), 327-337.
- Blanco, I., Lowndes, V., Pratchett, L. 2011. Policy networks and governance networks: Towards greater conceptual clarity. *Political studies review*, 9(3), 297-308.
- Borrás, S., Edquist, C. 2013. The choice of innovation policy instruments. *Technological Forecasting & Social Change*, 80(8), 1513-1522.

- Capano, G., Pritoni, A., Vicentini, G. 2019. Do policy instruments matter? Governments' choice of policy mix and higher education performance in Western Europe. *Journal of Public Policy*, 1-27.
- Cunningham, P., Edler, J., Flanagan, K., Laredo, P. 2013. Innovation policy mix and instrument interaction: A review. *Nesta Working Paper*, No. 13/20, 1-47.
- Georghiou, L., Edler, J., Uyarra, E., Yeow, J. 2013. Policy instruments for public procurement of innovation: Choice, design and assessment. *Technological Forecasting & Social Change*, 86, 1-12.
- Gusmerotti, N.M., Testa, F., Amirante, D., Frey, M. 2012. The role of negotiating tools in the environmental policy mix instruments: determinants and effects of the Environmental Agreement. *Journal of cleaner production*, 35, 39-49.
- Kubo, H., Wibawanto, A., Rossanda, D. 2019. Toward a policy mix in conservation governance: A case of Gunung Palung National Park, West Kalimantan, Indonesia. *Land Use Policy*, 88, 104-108.
- Lazer, D. 2011. Networks in political science: Back to the future. *PS: Political Science & Politics*, 44(1), 61-68.
- Lester, T.W., Reckhow, S. 2013. Network governance and regional equity: Shared agendas or problematic partners?. *Planning Theory*, 12(2), 115-138.
- Magro, E., Wilson, J.R. 2018. Policy-mix evaluation: Governance challenges from new place-based innovation policies. *Research policy*, 103-112.
- Mhamed, A.A.S 2011. Public policy for academic quality: Analyses of innovative policy instruments (Book Review). *International Review of Education*, 57(5/6), 763-765.
- Ring, I., Schröter-Schlaack, C. 2011. Instrument Mixes for Biodiversity Policies. *Helmholtz Centre for Environmental Research*.
- Rogge, K.S., Reichardt, K. 2013. Towards a more comprehensive policy mix conceptualization for environmental technological change: a literature synthesis. *Working Paper Sustainability and Innovation*, No. S3.
- Scott, J., Carrington, P.J. 2011. *Social Network Analysis*. London, Sage Publications.
- Teye, J.K. 2013. Analysing forest resource governance in Africa: Proposition for an integrated policy network model. *Forest policy and economics*, 26, 63-70.
- UNU-MERIT, Technopolis Group, Manchester Institute of Innovation Research, Wise Guys Limited, Joanneum Research and ZEW. 2009. Policy Mixes for R&D in Europe. Final Report of the project Monitoring and Analysis of Policies and Public Financing Instruments Conducive to Higher Levels of R&D Investments Contract No. DG-RTD-2005-M-01-02.
- Veugelers, R. 2012. Which policy instruments to induce clean innovating? *Research Policy*, 41(10), 1770-1778.
- Vieira, E.S., Lepori, Benedetto 2016. The growth process of higher education institutions and public policies, *Journal of Informetrics*, 10, 286-298.
- Wiebe, K., Lutz, C. 2016. Endogenous technological change and policy mix in renewable, power generation. *Renewable and Sustainable Energy Reviews*, 60, 739-751.
- Wong, G.Y., Loft, L., Brockhaus, M., Yang, A.L., Pham, T.T., Assembe-Mvondo, S., Luttrell, C. 2016. An assessment framework for REDD+ benefit sharing mechanisms within a forest policy mix.
- Xu, L., Su, J. 2016. From government to market and from producer to consumer: Transition of policy mix towards clean mobility in China. *Energy Policy*, 96, 328-340.