

科技资源配置理论 与 配置效率研究

刘玲利 著



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摘 要

本书是在作者博士论文基础上修改而成的。

随着各国科技经济一体化进程的不断加深，科技对经济增长的贡献程度不断提高，各国纷纷加大了对科技资源的投入力度以促进国家科技能力、竞争力的提升，从而更好地促进科技、经济、社会的协调发展。在各国不断增加科技投入的同时，科技资源的稀缺性、配置的低效性则越来越凸现出来，并且这种状况在我国尤为明显。而且，基于低效配置的科技投入的增加只能带来科技资源配置中的更大浪费，从而进一步强化了科技资源的稀缺状况，并且这种建立在科技资源低效配置基础上的能力提升是不具有竞争力和可持续性的。只有以效率提升为前提的科技投入的增加，才有利于形成科技资源的集约性配置，促进科技资源利用效率的提高；只有这种建立在效率提高基础上的能力提升，才具有长效性和竞争力。因此，与加大科技投入、提高科技资源的增量相比，优化科技资源配置，提高资源配置效率就更显其重要意义。

一、科技资源配置的国内外相关研究综述

目前国内关于科技资源配置的相关研究主要从以下四个方面展开：(1)关于科技资源及其配置概念的研究；(2)关于科技资源配置方式的研究；(3)关于科技资源配置效果的研究；(4)关于科技资源配置中存在的问题及对策的研究。国外的相关研究则主要是从宏观和微观两个层面展开，宏观层面主要是从政府视角进行论述，微观层面则主要是关于企业的研发资源配置研究。国内外上述研究的相同点在于均强调政府在科技资源配置中的导向作用；不同点主要在于研究内容的侧重点和研究方法存在差异。目前，国内外关于科技资源配置的研究，以应用研究居

多，而理论研究较少，尚未形成完整的理论框架；另外，对科技资源配置效率的研究也没有深入广泛的展开，存在评价方法单一、评价内容有限等问题。

二、科技资源配置的理论基础

科技资源配置理论与配置效率的研究是一个复合型课题，对其展开深入研究，需要我们广泛借鉴、参考各种理论，从中汲取理论及方法论上的指导。本书的理论基础主要包括：系统的基本理论、新增长理论、资源配置效率理论、新制度经济学相关理论、演化经济学基本理论和广义梯度理论。上述理论对本书的借鉴与指导意义主要体现在：系统的基本理论为本书提供了分析科技资源及其配置本质的“钥匙”，为本书展开进一步研究提供了基本思路；新增长理论为我们以科技资源要素为研究对象展开相关的理论研究并在其中突出强调政府的重要作用，提供了重要的理论依据；资源配置效率理论为我们将效率作为科技资源配置效果的基础性描述提供了理论支撑，帕累托效率则作为目前较为一致的效率评价标准为科技资源配置效率的提高指明了方向；新制度经济学的相关理论强调了制度的重要作用，对我们将制度内化为科技资源要素并强化科技资源配置中产权的重要作用，具有重要的借鉴意义；演化经济学的基本理论为整体功能性科技资源要素的研究提供了新的视角，同时也为其形成提供了理论“土壤”；广义梯度理论为我们从国家、地区、省域三个层面展开科技资源配置效率的研究提供了理论依据和进行评价、比较的“平台”。

三、科技资源配置理论研究

科技资源配置理论研究，主要从科技资源要素、科技资源配置系统及其内部结构、机制和环境等三大方面展开论述，其中效率是贯穿全文的主线。

科技资源是科技活动的基础，是能直接或间接推动科技进步，进而促进经济和社会发展的一切资源要素的集合。这里强调科技资源是一种

资源要素的集合,体现了科技资源的系统性特征。科技资源要素包括:科技人力、财力、物力、信息、市场、制度和文化等七大类资源要素;并依据其内容特征及相互作用关系,将其分为基础性核心科技资源要素和整体功能性科技资源要素。前者具有智慧性、可持续性和高增值性、可继承性、开放性、外部性、跨越性等特征;后者具有功能性、累积性、强制性和引导性、自发性、不可移植性等特征。但就科技资源要素整体而言,其具有社会性、战略性和层次性等特征。

在基础性核心科技资源要素子系统与整体功能性科技资源要素子系统相互影响及其同外部环境相互作用的过程中,整体功能性科技资源要素子系统的功能不断增强,促成了实体中间性科技资源要素作为配置主体从基础性核心科技资源要素子系统中分离出来,从而促成了科技资源配置系统的形成。科技资源配置系统的配置行为具有动态性和静态性双重行为特征。就静态性特征而言,它是一种表征全局的配置效果;就其动态性特征而言,它存在于科技活动从投入到产出的全过程,其间的每一个环节都体现出了配置主体的行为效果。科技资源配置的效率和能力均是对科技资源配置效果的描述,然而只有建立在效率基础上的能力建设才更具竞争力和可持续性。因而,效率是更为基础的科技资源配置结果的刻画,对其展开研究,相对而言更具重要意义。

科技资源配置系统的内部结构、运作机制和配置环境是影响科技资源配置效率的重要因素。科技资源配置系统的内部结构由三部分组成:科技资源配置主体(企业、高校和科研机构)、科技资源配置客体(科技人力、财力、物力和信息等基础性核心科技资源要素)、科技资源的三大配置力(科技市场、政府制度和社会文化等整体功能性科技资源要素)。科技资源配置系统的特征包括:开放有序性、整体涌现性、等级层次性、动态演化性、自组织性和与环境的互塑共生性等六大特征。科技资源配置系统的运行机制的描述则主要从科技资源的三大配置主体和三大配置力的双重视角展开,并在其中强调对基础性核心科技资源要素的配置。科技资源配置系统的环境是指由经济、教育、政治、社会、自然等环境子系统在同科技资源配置系统的相互作用过程中形成的环境超

系统, 其对科技资源配置系统起着支持与规范的作用, 且具有历史动态累积性和截面协同性特征。

四、科技资源配置效率评价研究

科技资源配置效率评价研究, 主要包括科技资源配置效率评价指标体系的设计、评价方法的选取及模型的构建。效率测度指标体系的设计主要遵循科技资源配置活动的特点和效率测度的需要, 从科技投入产出两大方面进行指标体系的设计; 影响效率变化的因素的选取, 则主要从科技资源配置主体和配置环境两大方面提出影响科技资源配置效率变化的十三个基本理论假设, 并进行相应的指标体系设计。在效率评价方法的选取及模型的构建中, 主要采用典型相关分析(CCA)方法并通过定义多投入多产出模型对科技资源投入产出弹性进行分析; 采用数据包络分析(DEA)方法中的 C^2R 模型和超效率模型对科技资源配置效率进行测度; 采用随机前沿分析(SFA)方法中的超越对数知识生产函数模型和时变非效率指数模型对研发资源配置效率进行测度; 同时, 基于DEA方法无法进行面板数据分析这一问题, 引入Malmquist指数方法以弥补DEA方法在进行科技资源配置效率测度中存在的不足。另外, 由于面板数据模型具有截面数据和时间序列模型所无法比拟的优势, 选择了基于面板数据的计量模型对影响科技资源配置效率变化的因素进行测算, 以从多角度、多层面展开关于影响效率变化因素的系统分析。

五、科技资源配置效率实证研究

科技资源配置效率实证研究主要从国家、地区和省域三个层面展开效率测度与分析, 并对影响科技资源配置效率变化的因素进行系统分析。

首先, 采用CCA方法进行弹性测度, 结果表明: 目前我国正处于科技财力资源要素产出弹性大于科技人力资源要素产出弹性阶段, 且尤以研发资本存量产出弹性较大。以上述测度结果为依据, 对 C^2R 模型和超效率模型的投入指标的相对权重进行了设定, 进而采用上述两模型

对 1991 - 2005 年国家层面科技资源配置效率进行了测算与分析, 指出我国的科技资源配置效率具有不断上升之趋势。

其次, 采用 DEA 方法、Malmquist 指数法和 SFA 方法, 以 1998 - 2005 年我国 30 个省域的科技投入产出数据为样本, 对区域层面科技资源配置效率及变化率、研发资源配置效率进行了测算与分析。就地区层面而言, 科技资源配置效率和研发资源配置效率均呈东、中、西依次递减分布, 且自 2002 年以来三大地区的科技资源配置效率有趋同倾向。科技资源配置效率增长率的顺序由高到低依次是西部、东部和中部地区。东部地区科技资源配置效率的提高主要源于科技资源配置中技术进步的发生; 中、西部地区效率的提高则主要源于科技资源配置中技术效率的提高, 这说明技术进步是决定科技资源配置效率差异的重要因素。就省域层面而言, 东部省域科技资源配置效率排名下降幅度较大, 而西部省域效率排名上升幅度较大。科技资源配置效率增长率最高和最低的省域分别是上海和广西; 有过半数的省域的科技资源配置效率处于下降阶段, 其中技术水平下降是引致效率下降的重要原因。各省域研发资源配置效率整体呈上升趋势, 但上升幅度不大。

最后, 采用随机效应模型, 以 1998 - 2005 年我国 30 个省域的面板数据为载体, 对影响科技资源配置效率变化的因素进行了系统分析, 指出区域内企业的研发角色、科研机构改革、产学研结合、产业结构调整、高技术产业发展和西部区位因素对科技资源配置效率提高具有显著的正效应; 而政府的资金支持则未起到预期的效果, 主要原因是政府在资金配置中存在浪费现象。另外, 国有化程度、西部区位因素对科技资源配置中技术效率提高具有显著的正效应; 而教育的投入、政府的资金支持则未起到预期的效果, 主要是由于我国在教育资源配置和政府的科技投入中存在资源浪费现象所致。同时, 区域内企业的研发角色、高技术产业发展、教育水平等因素对科技资源配置中技术进步的发生具有显著的正效应; 而区域人力资本存量则不利于科技资源配置中技术进步的发生, 主要是由于我国科技人力资源素质不高和科技人力资源配置中存在浪费现象所致。

六、提高科技资源配置效率的对策

结合前文的研究成果,同时借鉴发达国家的实践经验,从科技资源配置客体、配置主体和配置环境三方面提出提升我国科技资源配置效率的对策。(1)在配置客体方面,第一,加强研发资金的投入力度;第二,优化研发人员的配置。(2)在配置主体方面,第一,强化企业技术创新的主体地位,加强自主创新能力的培育;第二,深化科技体制改革,加大科研机构改革力度;第三,推进“产、学、研”相结合的技术创新模式。(3)在配置环境方面,第一,调整产业结构,大力发展高技术产业,促进产业结构的优化升级;第二,深化国有企业改革,注重创新意识的培育;第三,转换技术引进模式,培育有利于外资研发的良好环境;第四,加大教育投资,转换教育模式,提高教育水平;第五,加强政府对科技活动的资金支持,优化资金投向,提高政府资金配置效率;第六,加大知识产权保护力度,完善知识产权保护环境。

关键词:科技资源配置;配置理论;配置效率;效率测度;影响因素分析;对策

ABSTRACT

This book is rewritten on the basis of my dissertation.

With the deepening of integration of Science and Technology (S&T) and economics in every country, S&T makes increasingly contribution to the development of economy. Every country intensifies the input on S&T resources promoting S&T capability and competitive advantage in order to promote the harmonious development of S&T, economy and society. With the intensified input of S&T, the shortage of S&T resources and low efficiency of allocation apparently show themselves especially in our country. The development based on the low efficiency of resource allocation is not competitive and durable. More input on S&T based on the low efficiency only leads to more waste of S&T resources which would strengthen the shortage. Only more input with the premise of promoting efficiency is good for the formation of the intensification of S&T resources, promotion of utilization efficiency of the resources. The development based on the rising of efficiency is competitive and durable. Therefore, compared with more input on S&T resources, optimization of resource allocation and promotion of resource allocation efficiency are of more significance.

1. Research Review of Allocation of S&T Resources home and abroad

Recently the related researches about allocation of S&T resources in the country are developed from 4 aspects: (1) research on the concept of S&T resources and its allocation; (2) research on the allocation method of S&T resources; (3) research on the allocation effects of S&T resources; (4) re-

search on the problems and solutions on the allocation of S&T resources. The related researches abroad are developed from micro and macro two levels. The discussion from macro level is from the angle of the government while micro level is about allocation of Research and Development (R&D) for enterprises. The similarity of the researches home and abroad is the emphasis on guidance of government on the resource allocation. The difference lies in the focus of the content and research method. At present, the researches at home and abroad about allocation of S&T resources are more applied research and less theory ones. The complete theory frame about resource allocation has not been formed. And the research of allocation efficiency has not spread out deeply. The method of evaluation is single and the content of evaluation is limited.

2. Theory Foundation of Allocation of S&T Resources

The research on allocation theory and allocation efficiency of S&T resources is an interdisciplinary subject. As for a profound research on it, we need to use and consult to all kinds of theories broadly, and derive guidance on theory and methodology. The theory foundation of this paper includes the basic theories of the System, the New Growth Theory, the Efficiency Theory of Resource Allocation, the related theories of New Institutional Economics, the basic theories of Evolutionary Economics, the Generalized-Gradient Theory. The basic theories of the System serve as the key for the dissertation to analyze the S&T resources and their nature, and provide the basic guild line of the dissertation to develop its research. The New Growth Theory provides related theory research for our targeting elements of S&T resources as research object. Its emphasis of government function provides important theory basis. The Efficiency Theory of Resource Allocation is the theory support of treating efficiency as the basic description of allocation effects of S&T resources. At the same time, Pareto Efficiency, as the efficiency evaluation standard at present, gives direction for the efficiency promotion of S&T resources. The

related theories of New Institutional Economics emphasize the function of institution, which is of important reference significance for us to internalize institution into resource element, strengthen the importance of property right on element allocation of S&T resources. The basic theories of Evolutionary Economics provide new angle on research of integral functional elements of S&T resources, and theoretical ground for its formation. The Generalized-Gradient Theory provides theory basis and stage for evaluation and comparison for our research on allocation efficiency of S&T resources from national, regional and provincial levels.

3. Research on Allocation Theory of S&T Resources

The research on allocation theory of S&T resources is developed from 3 aspects. They are elements of S&T resources, allocation system and its internal structure, mechanism and environment. Efficiency is the line run through the dissertation.

S&T resources are the base of S&T activities, can promote the development of S&T directly or indirectly and congregation of all resource elements. Here the S&T resources as a congregation of resource elements is emphasized which reflects its systematic feature. The elements of S&T resources include 7 categories: human resource, financial resource, material resource, information resource, market resource, institution resource, and culture resource. According to their content features and reciprocity relationship, they can be divided into basic kernel elements and integral functional elements of S&T resources. The features of the former include: intelligence, durable and high increased-value property, inheritness, open property, externality, striding across property. The features of the latter include: functionality, accumulated property, mandatory and guideness, spontaneity and untransplant property. The features of the whole elements of S&T resources include: sociality, stratigical property and hierarchical level.

In the process of influence, interaction between subsystem of basic kernel elements and integral functional elements of S&T resources and their action with external environment, the function of subsystem of integral functional elements continues to increase, leads to the division of entity middle elements from the subsystem of basic kernel elements of S&T resources as allocation subject and the formation of allocation system of S&T resources. The action of allocation system of S&T resources have dual active features: dynamic and statistic. As for statistic feature, it is a collocation effect reflects the whole process. As for the dynamic feature, the allocation action of S&T resources exists during the whole process from input to output. Every link reflects the action effects of allocation subject. The efficiency and capability of resource allocation are description to allocation effects. However, the capability construction based on efficiency is more competitive and durable. Therefore, efficiency is a more basic description of allocation result of S&T resources, and of more significance on the following research.

The internal structure, operation system and allocation environment of allocation system of S&T resources are important elements that influence the allocation efficiency. The internal structure of allocation system is consist of 3 parts: the allocation subject of S&T resources (enterprise, university and institution for scientific research), allocation object (basic kernel elements as human resource, financial resource, material resource and information resource in S&T resources), and 3 allocation powers (integral functional elements as market, government system and social culture). The 6 features of allocation system include: open and orderly property, emergent property as a whole, hierarchical level, dynamic evolution, self-organizing, inter-mold and intergrowth with the environment. The description of operation system is developed from dual angles of 3 allocation subjects and 3 allocation powers, and both emphasize the allocation of basic kernel resource elements. The en-

environment of allocation system refers to the environmental super-system formed from the interaction between allocation system of S&T resources and environmental sub-system such as economy, education, politics, society and nature. It supports and regulates the allocation system and has the historically dynamic cumulative and cross-section cooperative characteristics.

4. Evaluation Research of Allocation Efficiency of S&T Resources

The evaluation research of allocation efficiency of S&T resources includes the index system design of resource allocation efficiency, the selection of evaluation method and the construction of evaluation model. The index system design of efficiency measures should be in accordance with the features of resource allocation activity and fulfill the need of efficiency measures, and is selected from the input and output of S&T. The influential elements of the change of efficiency are selected from the 13 basic theoretical assumptions that influence the change of efficiency of resource allocation derived from the action of the resource allocation subject to object and allocation environment, and the index system is designed accordingly. In the selection of evaluation method and the construction of evaluation model, the canonical correlation analysis (CCA) is adopted and the flexibility of resource input and output is analyzed through the model of more input and more output. The C^2R model and super-efficiency model in data envelopment analysis (DEA) are adopted to measure the allocation efficiency. The trans-log production function and time variant decay index model in stochastic frontier analysis (SFA) are used to measure the allocation efficiency of R&D efficiency. Concerning the issue that DEA cannot analyze the penal data, Malmquist Index is introduced to make up the deficiency of DEA in efficiency measure of resource allocation. Besides, because of the advantage of penal data model compare with cross-sectional data and time series model, and according to the measure of penal data to the influential elements of the efficiency change of resource allocation,

a multi-angle and multi-level systematic analysis is conducted on the elements that influence the efficiency.

5. Empirical Research of Allocation Efficiency of S&T Resources

The Empirical research of allocation efficiency of S&T resources is the efficiency measure and analysis conducted 3 levels: national, regional and provincial, and a systematic analysis of the influential elements of efficiency.

Firstly, the CCA method is adopted to do flexibility test. The result shows that our country is in the stage that the output flexibility of financial resource element is bigger than that of human resource. The output flexibility of capital stock of R&D is comparatively bigger. Base on the above results, the relative weighs of input elements of C^2R and super-efficiency model is set. The allocation efficiency of 1991 – 2005 national level is measured and analyzed which shows that the country's allocation efficiency is rising continuously.

Secondly, DEA, Malmquist Index and SFA are adopted; the allocation efficiency, rate, and the allocation efficiency of R&D resources of regional level are calculated and analyzed taking 30 provincial samples of input and output data from 1998 to 2005 in the country. As to the regional level, the allocation efficiency of S&T resources and that of R&D resources are descending from east to west. The rise of allocation efficiency in the east part is mainly from the rise of technology progress. The rise of efficiency in the mid and west parts lies in the rise of technology efficiency. Therefore, technology progress is the determinant of allocation efficiency of S&T resources. As for the provincial level, the rank of allocation efficiency in the provinces in the east is descending while that of the west part rising. The highest and lowest rates of increment of allocation efficiency are distributed to Shanghai and Guangxi respectively. The allocation efficiency of half of the provinces is in the descending stage. The descending of technology level is the important

reason that causes the efficiency decreasing. The allocation efficiency of R&D resources of the provinces is rising in the whole, but not to a great extent.

At last, using the Random-Effects Model, the influential elements of the change of allocation efficiency are systematically analyzed based on the panel data of 30 provinces from 1998 to 2005. It is pointed out that the R&D role of the enterprises in the region, reformation of institution for scientific research, the combination of industry, university and institution, the regulation of industrial structure, the development of high-tech industry and the locational factor of the west are all propitious to the rise of allocation efficiency. The financial support from the government has not reached the expected result. The main reason is the waste in financial distribution. Besides, the level of nationalization, and locational factor of the west are in favor of the technology efficiency in allocation of S&T resources. The input in education and financial support from the government doesn't reach an expected effect. This is due to the resource waste in education resource allocation and S&T input from the government. Meantime, the R&D role of the enterprises in the region, the development of high-tech industry, and the education level all lead to technology progress in resource allocation. The human capital stock in the region goes against the technology progress of resource allocation which is caused by the low quality of human resource and the waste existing in the human resource allocation.

6. Measures to the Rising of Allocation Efficiency of S&T Resources

Concerning the research achievements above, the measures to rise the allocation efficiency of S&T resources are put forward from 3 aspects: allocation object, allocation subject and allocation environment of S&T resources. (1) On allocation object: on one hand, the input of financial resource in R&D should be intensified; on the other hand, the allocation of R&D staff should be optimized. (2) On allocation subject: firstly, the innovation

main body of enterprises should be reinforced, self-creative capability fostered. Secondly, the reform of S&T system should be deepened, the efforts of the reform of institution for scientific research stepped up. Thirdly, the new innovation model of collaboration of industry, university and research should be promoted. (3) On allocation environment: Firstly, adjust the industrial structure, develop the high-tech industry, and promote the upgrading and optimizing of industrial structure. Secondly, deepen the state enterprise reform, and emphasize the foster of creative ideas. Thirdly, transform the import model of technology, and foster excellent environment for foreign R&D. Fourthly, enforce the input on education, promote the education level. Fifthly, enforce the financial support to S&T activities from the government, optimize the direction of financial input, and promote the allocation efficiency of government fund. Sixthly, enforce the protection of intellectual property, consummate the circumstance of the protection of intellectual property.

Key words: Allocation of Science and Technology Resources; Allocation Theory; Allocation Efficiency; Efficiency Measure; Analysis of Influential Elements; Measures