经济与金融高级研究丛书

# 宏观经济研究

Studies on Macroeconomics

邹恒甫 著

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# 前　言

本书涉及到宏观经济和金融的许多理论和实际研究。它是继本人《财政、经济增长和动态经济分析》(北京大学出版社,2000 年)之后我的合作者和我进一步探索的一个阶段性总结。我要把此书中的主要创新贡献归功于我的合作者龚六堂、Francesca Fornasari、金菁、李宏毅、Steven B. Webb、谢丹阳、徐立新和张涛。世界银行、武汉大学、北京大学和中国国家自然科学基金委给我们提供了良好的学术研究环境和必要的经济资助。

本书的第 1 章是献给邹至庄(Gregory Chow)先生的。该文试图把资本积累、产品创新、国际贸易和经济增长统一在一个简单的框架之中。邹至庄先生长期鼓励我在中国,特别是在中山大学岭南学院从事经济学教育。我把此文放在本书之首,也同时想表达我对众多世界著名经济学家的怀念和感激:Jean-Jacques Laffont (1947—2004)、董辅礽(1927—2004)、杨小凯(1949—2004)、Robert Barro、Richard Caves、Jacques Cremer、James Heckman、Edward Lazear、Robert Lucas、Eric Maskin、Paul Milgrom、Robert Mundell、Roger Myerson、Dwight Perkins、Jean Tirole、Stephen Turnovsky、Michael Woodford 等等。这是个群星灿烂的世界。没有他们的帮助和贡献,我不可能在武汉大学、北京大学和中山大学从事经济学、金融学和管理学接近世界前沿的教育事业。

本书的第 8 章是献给中国著名统计学家张尧庭老师的。它表达了我对现在患有重病的张老师的感激。在此文和本书的第 9、10 和 11 章里,我们想建立多级政府条件下税收、转移支付、政府开支和经济增长的动态分析模型。我们相信这种对多级政府的动态研究是公共财政研究的重要方向之一。张尧庭老师、黄训腾老师、吴黎明、谢丹阳和我于 1994 年向武汉大学陶德麟校长、任心廉书记、侯杰昌常务副校长等提出成立武汉大学经济科学高级研究中心。此中心的倡议书是由张尧庭老师亲自执笔的。他多年来奔波于北京大学、武汉大学、上海财经大学、中国人民大学等多所高校讲课,是我学习的楷模。今天,借此前

言我一道感谢从1987年以来支持我进行中国经济学教育的众多其他同仁：阮志华、田国强、谭国富、陈小红、陈志武、舒元、姚先国、王则柯、方炳松、郎咸平、严加安、张五常、林毅夫、张维迎、朱晓冬、张敦穆、李楚霖、艾春荣、文一、周忠全和张建波等。同时，我要感谢长辈：刘道玉、曾启贤、汤在新、吴纪先、张培刚、刘涤源、谭崇台、成思危、胡兆森和厉以宁等。

本书的第2章证明，在资本主义精神模型里，货币超中性(superneutrality)不再成立。我现在庆幸自己在哈佛大学写作博士论文时(1986—1988)把马克思和韦伯关于资本主义本质和经济发展的学说引入新古典经济增长和内生经济增长模型。这种资本主义精神和资本主义本质的模型也帮助解释金融市场里资产风险溢金之迷(equity premium puzzle，见本书第3章)。在哈佛求学的日子里，我在学习宏观经济学、微观经济学、计量经济学之外，也有幸了解到数理马克思主义的学说在二十世纪的发展。对此我要感谢 Robert Dorfman、Stephen Marglin、Murray Milgate 和 John E. Roemer 在哈佛的授业。John E. Roemer 关于剥削、阶级、公正、收入再分配和机会均等的理论不仅得到了非马克思主义经济学的承认，而且也成为世界银行2006年度《世界发展报告：公平与发展》的理论基础之一。1984年，我在巴黎蓬皮杜图书馆度过了一个痴心学习当代马克思主义的美好夏天。我狂热地阅读 John E. Roemer 的《马克思经济理论的分析基础》(Analytical Foundations of Marxian Economic Theory)、《剥削和阶级的一般理论》(A General Theory of Exploitation and Class)和 Michio Morishima 的《马克思的经济学》(Marx's Economics)。这些书把马克思主义带进了一个数理经济学的新天地。相当偶然，我居然于同一个夏天在巴黎拉丁区的一家书店里买到了董辅礽先生和刘国光先生分别发表的两本有关国民收入再生产的论文集(生活·读书·新知三联书店1980年出版)。我写了大量的笔记去评价两位先生修正和改造马克思再生产理论的算术和代数模型。当时我感到如果董辅礽先生和刘国光先生能初步了解投入—产出分析、哈罗德—多马尔经济增长模型、索洛经济增长模型和动态一般均衡理论该多好啊！若如是，他俩至少可以在青年和中年时代像 Michio Morishima 和 John E. Roemer 一样去发展当代马克思主义。从1987年开始，我多次同董辅礽先生聊起他和刘国光先生在二十世纪六十年代有关国民收入各部类平衡的模型所进行的学术争论。董辅礽先生总是要我不要再提那些幼稚的模型了。他说，他们这代人数学基础太差了，加上时代背景也不允许，不可能把马克思主义经济学带进一个新的时代。董辅礽先生谦虚而诚恳地鼓励我们后辈向 Morishima、Jon Elster 和 John E. Roemer 等学习，发展马克思的国民收入简单再生产、扩大再生产、资本主义积累和经济周期的理论。而我们这一代人也做得太差了，愧对董辅礽先生的在天之灵。我斗胆提

出,在当今中国没有一个人对当代数理马克思主义作出过基本贡献,而 John E. Roemer 或许能以马克思主义者的身份获得经济学诺贝尔纪念奖。

记得也是在 1984 年,年轻狂妄的我在哈佛第一次见到了在耶鲁大学进修的吴敬琏先生。他是代表中国政府来哈佛给中国留学生介绍国内当时的改革开放形势的。我在会上的发言一定给吴敬琏先生留下了深刻的印象。他在会上其实也没有多说话。据我后来的了解,他对 Janos Kornai 的短缺经济学和预算软约束倒是有兴趣。他的忘年交耶鲁硕士钱颖一于 1984 年秋季来到哈佛攻读经济学博士学位。恰巧 Janos Kornai 于 1985 年来到哈佛任教。钱颖一、许成钢、李稻葵和王一江四人都师从 Kornai 从事短缺经济学和预算软约束的研究。而樊纲正在 NBER 访问,他还蛮有干劲地同李稻葵和王一江等学习一年级研究生的课程。后来樊纲没有在哈佛得到博士入学通知书,大概是李稻葵、王一江和胡祖六三人同时得到哈佛的录取,把他给挤掉了。Dwight Perkins、Martin Feldstein 和我都为樊纲没有得到哈佛的录取通知书而深感遗憾。后来樊纲回国后很快拿到了中国社会科学院的博士学位,并写出了中国社会主义宏观经济学大纲的专著。我癫狂地同他们也讨论一些 Kornai 的学问,用动态优化的方法写了好几篇投资饥饿症、短缺、社会主义投资周期的文章(见邹恒甫:《财政、经济增长和动态经济分析》,北京大学出版社,2000 年)。Kornai 的一些思想也帮助我研究中央和地方的财政分权(见本书第 8、9、10、11 和 12 章),中央政府对地方政府的财政软约束给财政分权和政府规模带来的影响(见本书第 13 章),财政软约束与中央政府财政赤子和宏观经济不稳定(如通货膨胀)的关系(见本书第 14 章)。我也没想到这些问题至今还是财政理论和实践中最热门的课题。与此同时,我一直还关注着中央政府的军事开支和经济增长的关系(见本书第 15 章)以及政府开支的波动和经济增长的关系(见本书第 7 章)。

我对收入分配的研究一直有兴趣。本书中的第 4、5 和 6 章记录了我这一兴趣的连续。我们得到的收入分配不平等和经济增长之间正相关的经验结论一直为世界银行所不接受。但这一结论却在学术界还总是占有微小的一席地位。这使我同 R. Barro, W. Easterly, M. Ravallion 等众多经济学家继续争论。由于争论,我们反而走得更近一些了。对此问题有兴趣的同事,请参看他们的学术论文。

对发展中国家的援助一直是世界银行、国际货币基金组织、亚洲开发银行、联合国、美洲开发银行和许多著名的经济学家热衷的话题。龚六堂和我发表了一系列论文(见本书第 16 和 17 章),说明外国援助减少发展中国家的储蓄和投资,增加对国外贷款的依赖性,妨碍经济增长和资本积累。这些结论都不为世界银行所接受。但这些结论的生命力或许会越来越强——请容许我在此作出如此乐观的预测。比起 W. Easterly 对世界银行五十年的否定、R. Barro 对国际

货币基金组织项目的批判、Rahguram Rajan 对外援的怀疑，我们的结论或许更理论化一些、更一般化一些。

最令我高兴的是我能看到新的一代在国际学术界崭露头角的中国青年经济学家比我们这一代人在国际上发表了更高档次的文章。真的，长江后浪推前浪，前浪推到沙滩上。真的，生命是灰色的，理论之树常青。我都四十三岁过了，我在学术上还有作为吗？大概没有了吧。我不妨继续办经济学教育。中国似乎总不缺有名的新闻媒体经济学家，但中国的确缺少实实在在的经济学的教书匠。我希望我的学生都当经济学的教书匠。如果他们当中出了一批新闻媒体经济学家，那一定是我的噩梦。如果他们当中有人成为世界上知名的经济学家，那一定是我的美梦。

邹恒甫

2005 年 10 月 15 日早晨 5 点至 10 点

于北京王府饭店

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# 产品创新、资本积累与内生经济增长

Chapter 4

# Product Innovation, Capital Accumulation, and Endogenous Growth

Heng–fu Zou

## Introduction

This chapter integrates both product innovation and physical capital accumulation in a simple model of endogenous growth and examines the long–run relationship between product development and capital formation. It also studies the impact of international technology transfers and international trade on long–run capital accumulation.

This work can be regarded as a continuation of the line of research initiated by Romer (1990), Grossman and Helpman (1991), and Helpman (1992). In the Romer model, the innovative products are horizontally differentiated capital goods and are produced from the homogeneous final output. These differentiated capital goods are in turn employed to produce the final output. A different modeling strategy is adopted by Grossman and Helpman. In the Grossman–Helpman model, the innovative products are intermediate inputs into the production of a single, final good. But the final good can be either consumed by households or can be invested in the form of capital accumulation by firms. In both models, a similar, perhaps surprising, conclusion has been drawn: physical capital accumulation plays only a supporting role in the story of long–run growth because the primary sources of growth are a variety of factors such as the rate of time preference, the productivity of product innovation, and the elasticity of substitution across brands, 'while the investment rate adjusts so as to keep the rate of expansion of conventional capital in line with the growth rate of output' (Helpman, 1992). Some related approaches to the dynamics of innovation and long–run growth can be found in Stokey (1988, 1991a, 1991b), Aghion and Howitt (1992), Gort and Klepper (1992), and Stein (1997).

In this chapter, we intend to offer a different perspective on capital accumulation, product innovation, and output growth. In particular, we hope to distinguish the role of the marginal productivity of capital in determining the long–run rates of both product innovation and physical capital accumulation. In our model, all differentiated goods are produced using capital input, and can be consumed, or invested to increase capital stock, or used for product innovation. This modeling option has already been pointed out in Grossman and Helpman (1991), even though they choose to model capital as the homogeneous final good.

We should not argue about the plausibility of treating capital stock as the accumulated differentiated products, because in the real world capital does take many forms such as machinery, buildings, tools, and so on. In modeling capital as differentiated goods, our model agrees with the Romer (1990) model, but it differs from the Romer model in assuming that the final consumption in our model also consists of all differentiated goods instead of a single, homogeneous good as in the Romer model.

In this alternative framework, we will demonstrate how the long-run growth rates of capital accumulation and product innovation are determined. In particular we will show the roles of the productivity of the capital stock and the efficiency of product innovation process in determining the long-run rates. In addition, we extend the basic model to an open economy and show that trade in goods not only improves welfare, but also accelerates capital accumulation. Furthermore, for a developing country receiving technology transfers from a developed country such as in the North-South model, the rate of capital accumulation in the South is shown to be partly determined by the rate of product innovation in the North.

This chapter is organized as follows. The next section will set up the dynamic model with both capital accumulation and product innovation. The growth rates of different variables will be derived. Following this, we consider the effect of technology transfers from the developed country on product innovation and capital accumulation in the developing country. The next section extends the model to the case with international trade and shows the impact of trade on capital accumulation. We then conclude this chapter.

## The model

The consumer preference is the standard Dixit-Stiglitz CES utility function, which has been used by Krugman (1979), Judd (1985), and Grossman and Helpman (1991) among many others in studying the dynamic process of product innovation:

$$(4.1)\quad U = \int_0^\infty e^{-\rho t}\left(\int_0^\infty c(n,t)^\theta\, dn\right)dt,$$

where $c(n, t)$ is the rate of consuming good $n$ at time $t$, $\rho$ is the time discount rate, and $0 < \theta < 1$. Here $\theta$ has the usual economic implication that the elasticity of substitution between any two goods is $(1 - \theta)^{-1}$.

At any time $t$, the available variety of goods in this economy is given by $[0, N(t)]$. New product can be obtained through costly product development:

$$(4.2)\quad \dot{N}(t) = R^a,$$

where $R$ is the spending on product development, and $0 < \alpha < 1$. Obviously, $\alpha$ measures the efficiency level of product innovation as a higher value of $\alpha$ yields more new variety with the same input $R$ than a lower value of $\alpha$.

The production functions for all goods are identical:

$$(4.3) \quad x(n,t) = \beta k(n,t),$$

where $x(n, t)$ is the output of good $n$ at time $t$, $k(n, t)$ is the capital input to produce good $n$ at time $t$, and $\beta$ is the marginal productivity of capital at time $t$. In the context of endogenous growth, this constant return production function specified in (4.3) has been quite popular, see Barro (1990) and Rebelo (1991) for the arguments.

At time $t$, the total capital stock is given by $K(t)$:

$$(4.4) \quad K(t) = \int_0^{\infty} k(n,t)dn = \int_0^{N} k(n,t)dn .$$

In our model, both physical investment and product development utilize differentiated goods. For simplicity, we assume that all differentiated goods are perfect substitutes for these two purposes, even though they are imperfect substitutes in consumption. Since the utility function is symmetric in the variety of goods and since the marginal utility of each good is diminishing, the optimal consumption of each good at time $t$ is the same: $c(n, t) = C(t)$ for all $n \subseteq [0, N]$. Thus we can write the discounted utility in (4.1) as

$$(4.1') \quad U = \int_0^{\infty} e^{-\rho t} N(t) C(t)^{\theta} dt .$$

Furthermore, due to identical consumption for each good and identical production function in (4.3), and due to the perfect substitutability across goods in physical investment and product development, the optimal output of each good at time $t$ is also the same: $X(t) = x(n, t)$ for $n \subseteq [0, N]$ and

$$(4.3') \quad X(t) = \beta K(t) / N(t).$$

Therefore, all products that are not consumed can be either used for investment or for product development:

$$\dot{K}(t) = \int_0^{N} x(n,t)dn - \int_0^{N} c(n,t)dn - R - \delta K,$$

here $\delta$ is the rate of capital depreciation. Upon substituting $x(n, t) = X(t)$ and $c(n, t) = C(t)$ for all $n \subseteq [0, N]$

(4.5) $\dot{K}(t) = \beta K(t) - N(t)C(t) - R(t) - \delta K(t).$

Equation (4.5) says that the aggregate output is allocated among consumption, product innovation, the replacement of the depreciated capital, and new capital formation.

The optimization problem is to maximize (4.1') subject to the two dynamic constraints (4.5) and (4.2) with the initial values $K(0)$ and $N(0)$ given.

The current value Hamiltonian is:

(4.6)
$$H(K,C,N,R,\lambda,\omega) = N(t)C(t)^{\theta} + \lambda[\beta K(t) - N(t)C(t) - R(t) - \delta K(t)] + \omega R(t)^{\alpha}$$

where $\lambda(t)$ is the shadow price of capital, and $\omega(t)$ is the shadow price of product variety.

The first–order conditions necessary for optimization are:

(4.7) $\theta C(t)^{\theta-1} = \lambda(t),$

(4.8) $\alpha\omega(t)R(t)^{\alpha-1} = \lambda(t),$

(4.9) $(\beta - \delta - \rho) = -\dot{\lambda}(t)/\lambda(t),$

(4.10) $C(t)^{\theta} - \lambda(t)C(t) = \omega(t)\rho - \dot{\omega}(t),$

(4.11) $\dot{K}(t) = \beta K(t) - N(t)C(t) - R(t) - \delta K(t),$

(4.12) $\dot{N}(t) = R^{\alpha},$

and the transversality conditions:

$$\lim_{t\to\infty}\lambda(t)K(t)e^{-\rho t} = 0, \lim_{t\to\infty}\omega(t)N(t)e^{-\rho t} = 0.$$

Equation (4.7) implies that the marginal utility of consumption for every product and the shadow price of capital are equalized at all time. Equation (4.8) indicates that the allocation of resource for capital formation and product innovation is guided by the equality of their shadow price ratio to their marginal cost ratio: $\lambda(t)/\omega(t) = \alpha R^{1-\alpha}$. Equations (4.9) and (4.10) are the Euler conditions for the shadow prices of capital and innovation, respectively. Equation (4.11) restates the dynamic budget constraint (4.5), and equation (4.12) restates the technology generating new product variety, namely, equation (4.2).

Denote

$$g = -\dot{\lambda}(t) / \lambda(t).$$

From (4.9),

$$g = \beta - \delta - \rho.$$

For endogenous growth to be possible, $g$ is assumed to be positive as usually done, e.g., Barro (1990) and Rebelo (1991). Then take log–differentiation in (4.7):

(4.13) $\dot{C}(t) / C(t) = g / (1-\theta).$

Or

(4.13') $C(t) = C(0)e^{gt/(1-\theta)},$

where $C(0)$ is the initial consumption of every product, which is discussed in the appendix. Expression (4.13) says that the growth rate is positively related to the marginal productivity of capital $\beta$, negatively related to the time preference $\rho$, and positively related to the elasticity of substitution $(1-\theta)^{-1}$.

Substituting (4.7) into (4.10):

$$(1-\theta)C(t)^{\theta} / \omega(t) = \rho - \dot{\omega}(t) / \omega(t).$$

If we focus on a constant growth rate for the shadow price of product variety, the right–hand side of the above equation is constant. Then take log–differentiation on both sides:

(4.14) $\dot{\omega}(t) / \omega(t) = \theta\dot{C}(t) / C(t) = \theta g / (1-\theta).$

Next, log–differentiate (4.8) and use (4.9) and (4.14):

(4.15) $\dot{R}(t) / R(t) = g / (1-\theta)(1-\alpha).$

Or

(4.15') $R(t) = R(0)e^{gt/(1-\theta)(1-\alpha)},$

and $R(0)$ is the initial spending on product innovation, and it is determined in the appendix together with the initial consumption $C(0)$. In equation (4.15), the growth rate of the product–development spending is an increasing function of the marginal