

Title	英文抄録
Sub Title	
Author	
Publisher	慶應義塾経済学会
Publication year	1974
Jtitle	三田学会雑誌 (Keio journal of economics). Vol.67, No.5 (1974. 5) ,p.1- 4
JaLC DOI	
Abstract	
Notes	
Genre	
URL	<a href="https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=AN00234610-19740501-0108">https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=AN00234610-19740501-0108</a>

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## A Two-Sector, Three-Factor Model in the Theory of Trade and Economic Growth

by Michihiro Ohyama

Despite the pervasive use of the Heckscher-Ohlin model in applied economics, it is not "realistic" to adhere to its assumption of two factors of production. In this paper, we take up an alternative two-sector model with three factors of production discussed by Temin (1966) in his study of British and American technology in the mid-nineteenth century and subsequently analyzed by Jones (1971) on its own merit. The distinguishing feature of the Temin-Jones model is that while three factors of production are employed in the economy, only two enter into the production of any one sector. To be more precise, there assumed to be one kind of mobile factor, say labor, used in the production of both sectors, and two kinds of specific factors, say unshiftable capital equipments, each embedded in the production process of each sector. We consider the application of this model to the theoretical analysis of trade and economic growth.

The basic structure of the Temin-Jones model is developed *a la* Jones (1971) in Section 1. It is then applied to the analysis of a small price-taking country engaged in external trade to ascertain the incidence of tariffs on the internal distribution of income and the effect of a change in factor endowment on the ratio of outputs produced. The model is closed with the introduction of a homothetic social demand function, and employed in the rest of the section to investigate the determinants of the pattern of trade between countries with identical demand and technological conditions. It is shown that the relative endowment of specific factors plays a limited role in the determination of international division of labor.

In the remaining sections we dynamize the model to discuss various problems of growth economics. In Section 4 we consider a sort of dynamic Leontief system in which each sector absorbs a fraction of the other sector's output to add to its stock of specific factor. Given the growth rate of labor supply, the balanced growth path is demonstrated to be globally stable under standard conditions. Section 5 is devoted to the study of the balanced growth path which maximizes the utility of a representative citizen. The utility-maximizing path is shown to be characterized by the golden rule of accumulation, namely the equality of the growth rate and the rate of return to investment in each sector. This is a straightforward extension of the well-known result for neoclassical one-sector growth models. In addition to the golden rule of accumulation, we find a further interesting property of the utility maximizing path unheard of in the macroeconomic growth theory. It is shown that along any golden rule path, prices and rentals are uniquely determined relative to wage rate for a given growth rate. This entails the non-substi-

tution theorem that the golden rule production coefficients are not affected by a change in current demand conditions.

In Section 6 we discuss an alternative dynamization of the Temin-Jones model assuming that each sector saves a fraction of its own output so as to expand its stock of specific factor. This model of internal accumulation gives rise to a balanced growth path which may be unstable under certain circumstances, but exhibits the same properties along the utility-maximizing path as in the previous model. Finally, in Section 5 we turn to a yet another line of dynamization with one of the sectors producing pure capital goods and the other pure consumption goods. The capital goods sector is further assumed to use land, and the consumption goods sector to use the capital goods as their respective specific factor of production. We examine the stability of the balanced growth path on alternative (classical and neo-classical) assumptions on the supply of land and labor.

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## Existence of Competitive Equilibria in the Presence of Externalities

by Hiroaki Osana

The existence theorem of competitive equilibrium for a private ownership economy without externalities proved by Debreu in his book, *Theory of Value*, is extended to a case with externalities. We consider a private ownership economy in which external effects prevail in preference relations, consumption possibilities, and production technologies. We assume that all producers are operating subject to diminishing returns from their private points of view. This does not necessarily rule out the possibility of increasing returns from the viewpoint of the economy as a whole. Assuming other suitable convexity and continuity properties, we can prove the existence of a competitive equilibrium. The method of proof is patterned after that of Debreu used in his book quoted above.

# Idle Capacity, Unemployment & Heterogeneous Capital Goods

by Hiroshi Tanaka

In this paper, we are concerned with capital stock and investment function in the Keynes' theory. It is often pointed out that depressions are accompanied by idle capacity as well as involuntary unemployment. As is well known, Keynesian models deal with involuntary unemployment, but don't take idle capacity into account at the same time.

Investment function used by Keynes has an inherent logical inconsistency. Besides that, its criterion is inconsistent with maximization of the present value of the firm, as Alchian and Hirshleifer pointed out.

In this paper, I will try to show another version of Keynes model and to overcome these difficulties under the following assumptions—heterogeneity of capital goods, ex-ante substitutability and ex-post fixed proportions between machinery and labor.

In section two, some propositions of the "extensive" marginal principle are shown. Investment function is derived from maximization of the net discounted value of the expected revenues. In the neoclassical model, some machines are left unused because labor supply is insufficient. In the Keynes model of our version, it is shown that some laborers and associated machines are left unemployed because demand is insufficient. The actual pattern of employment of labor and machinery in use depends upon the composition of technical co-efficients embodied in the existing stock of machines and the level of output, which is in turn determined by total demand. If total demand is increased, more idle machines and laborers come into use only through reduction of the real wage rate. This is different from Kuh-Tanaka-Nikaido's conclusion, that is, additional increase of employment of capital stock and laborers is possible with the real wage rate remaining constant.

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第67巻 第5号

昭和49年(1974)5月1日 発行

定価 200円 千 24円

編 集 兼 慶 應 義 塾 経 済 学 会  
発 行 人 代 表 者 千 種 義 人

郵便番号 108  
東京都港区三田2丁目15-45  
電 話 03-453-4511  
振替口座番号 東京 44056

購 読 料 1ヵ年 2400円, 6ヵ月 1200円 (送料共)

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