International Trade Theory

Capital, Knowledge, Economic Structure,
Money, and Prices over Time

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Preface

The development of international trade theory has created a wide array of different theories, concepts and results. Nevertheless, trade theory has been split between partial and conflicting representations of international economic interactions. Diverse trade models have co-existed but not in a structured relationship with each other. Economic students are introduced to international economic interactions with severally incompatible theories in the same course. In order to overcome incoherence among multiple theories, we need a general theoretical framework in a unified manner to draw together all of the disparate branches of trade theory into a single organized system of knowledge.

This book provides a powerful – but easy to operate - engine of analysis that sheds light not only on trade theory per se, but on many other dimensions that interact with trade, including inequality, saving propensities, education, research policy, and knowledge. Building and analyzing various tractable and flexible models within a compact whole, the book helps the reader to visualize economic life as an endless succession of physical capital accumulation, human capital accumulation, innovation wrought by competition, monopoly and government intervention. The book starts with the traditional static trade theories. Then, it develops dynamic models with capital and knowledge under perfect competition and/or monopolistic competition. The uniqueness of the book is about modeling trade dynamics. We differ from the traditional trade theories in that we introduce a novel economic mechanism to determine consumers' decision on consumption and savings. Through this novel approach, the book attempts to construct an international trade theory which integrates economic growth, monetary, and value theories by a general-equilibrium analysis of the commodity and bonds markets over time and space. Economic dynamic theory has been dominated by the two – the Solow and Ramsey – analytical frameworks in the last five decades. The two modeling frameworks have co-existed in "harmony" mainly because one cannot effectively replace the other. The Solow model is empirically friendly and easy to analyze but lacks sound behavioral mechanism. The Ramsey framework is neither theoretically sound nor empirically supported, even though it has recently become the dominant framework in economic dynamics. Moreover, a model based on the Ramsey

approach tends to become analytically intractable when economic issues related heterogeneous households, or multiple sectors, or urban structure, interregional, or international interactions are introduced. The novel utility maximization approach helps us to solve the problem that there is no profound rational decision mechanism for consumers in the Solow model and avoids the complication that the Ramsey growth theory brings about. Through numerous examples, this book demonstrates that the novel utility functions help us to analytically study many trade problems in a consistent manner.

This book studies trade issues in a comprehensive manner. It is largely based on Zhang's previous book (Zhang, 2000). This book differs from the previous one in many important aspects, providing more general results, simulating many models and introducing traditional trade theories and the new trade theory more comprehensively.

I would like to thank Editors Wetzel-Vandai Katharina and Christiane Beisel at Springer for effective co-operation. I completed this book at the Ritsumeikan Asia Pacific University, Japan. I am grateful to the university's research environment.

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Wei-Bin Zhang
APU, February 2008

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Contents

1 International Trade and Trade Theory

In recent years, global economy has experienced a tremendous increase in the international movements of factors and goods, with international trade and factor flows growing much more rapidly than output.[1] One can hardly find a family that does not hold something produced by foreign countries even in a developing economy like mainland China. All the people around the world are enjoying global services such as international sport games and global supermodels. Globalization is bringing the world together in consumption of services, goods, brand names, as well as knowledge. Evidently, a comprehensive international trade theory is essential not only for professional economists but also for any people who want to understand mechanisms of globalization and relations among nations. Trade theory is supposed to provide insights into mechanisms of international trades and determinants of trade patterns, and interactions of trade and economic growth. For instance, one may ask what are the long-term implications of sustained United States current account deficits and Japanese current account surpluses. Do the both economies lose or benefit from the unbalanced trade? If not, who benefits, and who loses? How can the government budgets for R&D and education affect national growth and international trade patterns? What are the economic mechanisms that determine interest rates, trade balances, and exchange rates? One may also ask about how increasing global capital market integration affects the nature and international business cycles. Will free trade bring the per capita incomes of developing countries to converge to the levels of developed economies? Is it possible that free trade harms all the countries? The purpose of this book is to provide a coherent and comprehensive analytical framework to address basic issues of international trade.

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[1] See, for instance, Faini (2005).

1.1 A Brief Introduction to International Trade Theory

Mercantilism was the mean stream of economics throughout the 16th to the 18th century.[2] Belief in mercantilism began to fade in the late 18th century. The word comes from the Latin word "*mercari*", which means "to run a trade". Mercantilism holds that the prosperity of a nation is dependent on its supply of capital,[3] and the global volume of capital is not changed according to international trade. Capital can be increased mainly through a positive balance of trade with other nations. Hence, national wealth and power are best served by encouraging exports and collecting precious metals in return. To govern the national economy properly, the government should advance these goals by adopting protectionist policy. The so-called mercantile system is based on the idea that exports should be encouraged, imports discouraged through the use of tariffs. Different mercantilists were concerned with different ideas without a unified framework. Nevertheless, a common viewpoint is that international trade is considered as a zero-sum game, where a gain by one nation results in a loss of another. Hence, any system of policies that benefit one nation would of course harm the other.[4]

By the late eighteenth century, classical economists such as David Hume and Adam Smith began to criticize mercantilism. In his *Political Discourses* (1752), David Hume attached the mercantilist idea that a nation could continue to accumulate specie without any repercussions to its international competitive position. He reasoned that as the nation experienced trade surplus and accumulated more gold, money supply should be increased. The increase of money supply would result in rises in prices and wages. The increases in prices and wages would increase imports and reduce exports.[5] Hence, the competitiveness of the country with a surplus would be reduced. Hume hence argued that it is impossible to continue to maintain a positive balance of trade in the long run. In *The Wealth of Nation*, Adam Smith refuted the idea that the wealth of a nation is measured

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[2] Mercantilism as a whole cannot be considered a unified theory of economics. It did not present a scheme for the ideal economy, as Adam Smith did for classical economics.

[3] It should be noted that "capital" in this theory is represented by bullion (gold or silver) held by the state. Today, we measure the wealth of nation by human, man-made, and natural resources.

[4] Although Adam Smith supported that mercantilism advocated for strict controls over the economy, mercantilist domestic policy is actually fragmented than its trade policy.

[5] Hume assumed that changes in the money supply would affect prices rather than output and employment.

by the amount of treasury. He held that a nation's wealth was reflected in its productive capacity, not in its holdings of precious metals. He criticized the doctrine by demonstrating that free trade benefits both parties. Rather than a zero-sum game, Smith argued that international trade is a positive-sum game. He also argued that division of labor and specification in production results in economies of scale, which improves efficiency and growth.

Adam Smith (1776) held that a country could gain from free trade. He pointed out that if one country has an absolute advantage over the other in one production and the other country has an absolute advantage over the first in another production, both countries gain from trading. But Smith failed to create a convincing economic theory of international trade. It is generally agreed that David Ricardo is the creator of the classical theory of international trade. The theories of comparative advantage and the gains from trade are usually connected with his name, even though many concrete ideas about trade existed before his *Principles* (Ricardo, 1817). In this theory the crucial variable used to explain international trade patterns is technology. The theory holds that a difference in comparative costs of production is the necessary condition for the existence of international trade. But this difference reflects a difference in techniques of production. According to this theory, technological differences between countries determine international division of labor and consumption and trade patterns. It holds that trade is beneficial to all participating countries.

The Ricardian theory failed to determine the terms of trade, even though it can be used to determine the limits in which the terms of trade must lie. It was recognized long ago that in order to determine the terms of trade, it is necessary to build trade theory which not only takes account of the productive side but also the demand side.[6] The neoclassical theory holds that the determinants of trade patterns are to be found simultaneously in the differences between the technologies, the factor endowments, and the tastes of different countries.[7] Preference accounts for the existence of international trade even if technologies and factor endowments were completely identical between countries. The Marshallian offer curve has been often used to analyze problems such as the existence of equilibrium, the stability of equilibrium, the gains from trade, optimum tariffs and so on within static frameworks. Mill introduced the equation of international demand, according to which the terms of trade are determined so as to equate the value of exports and the value of imports. He argued: "the exports and imports between the two countries (or, if we suppose more than

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[6] See Negishi (1972), Dixit and Norman (1980), and Jones (1979).
[7] See Mill (1848) and Marshall (1890).

two, between each country and the world) must in the aggregate pay for each other, and must therefore be exchanged for one another at such values as will be compatible with the equation of the international demand" (Mill, 1848: 596). Mill initiated the theory of reciprocal demand which is one of the earliest examples of general equilibrium analysis in trade theory.

The Ricardian model and Heckscher-Ohlin model are two basic models of trade and production. They provide the pillars upon which much of pure theory of international trade rests. The so-called Heckscher-Ohlin model has been one of the dominant models of comparative advantage in modern economics. The Heckscher-Ohlin theory emphasizes the differences between the factor endowments of different countries and differences between commodities in the intensities with which they use these factors. The basic model deals with a long-term general equilibrium in which the two factors are both mobile between sectors and the cause of trade is different countries having different relative factor endowments. This theory examines the impact of trade on factor use and factor rewards. The theory is different from the Ricardian model which isolates differences in technology between countries as the basis for trade. In the Heckscher-Ohlin theory costs of production are endogenous in the sense that they are different in the trade and autarky situations, even when all countries have access to the same technology for producing each good. This model has been a main stream of international trade theory. According to Ethier (1974), this theory has four "core proportions". In the simple case of two-commodity and two-country world economy, we have these four propositions (which are of course held under certain conditions) as follows: (1) factor-price equalization theorem by Lerner (1952) and Samuelson (1948, 1949), stating that free trade in final goods alone brings about complete international equalization of factor prices; (2) Stolper-Samuelson theory by Stolper and Samuelson (1941), saying that an increase in the relative price of one commodity raises the real return of the factor used intensively in producing that commodity and lowers the real return of the other factor; (3) Rybczynski theorem by Rybczynski (1955), stating that if commodity prices are held fixed, an increase in the endowment of one factor causes a more than proportionate increase in the output of the commodity which uses that factor relatively intensively and an absolute decline in the output of the other commodity; and (4) Heckscher-Ohlin theorem by Heckscher (1919) and Ohlin (1933),[8] stating that a country tends to have a bias towards producing and exporting the commodity which uses intensively the factor with which it is relatively well-endowed.

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[8] See also Heckscher and Ohlin (1991).

The Heckscher-Ohlin theory provides simple and intuitive insights into the relationships between commodity prices and factor prices, factor supplies and factor rewards, and factor endowments and the pattern of production and trade. Although the Heckscher-Ohlin model was the dominant framework for analyzing trade in the 1960s, it had neither succeeded in supplanting the Ricardian model nor had been replaced by the specific-factor trade models. Each theory has been refined within 'small scales'. Each theory is limited to a range of questions. It is argued that as far as general ideas are concerned, the Heckscher-Ohlin theory may be considered as a special case of the neoclassical theory mentioned before as it accepts all the logical promises of neoclassical methodology.[9] The Heckscher-Olin theory may be seen as a special case of the neoclassical trade theory in which production technology and preferences are internationally identical. This loss of generality has long been held necessary in order to construct a clear picture of international trade patterns and division of labor and consumption.

Ricardo's initial discussion of the concept of comparative advantage is limited to the case when factors of production are immobile internationally. The Heckscher-Ohlin theory is similarly limited to the study of how movements of commodities can substitute for international movements of productive factors. It is obvious that if technologies are everywhere identical and if production is sufficiently diversified, factor prices become equalized between countries. But if production functions differ between countries, no presumption as to factor equalization remains. Most of early contributions to trade theory deal with goods trade only and ignore international mobility of factors of production. For a long period of time since Ricardo, the classical mobility assumption had been well accepted. This assumption tells that all final goods are tradable between countries whereas primary inputs are non-tradable, though they are fully mobile between different sectors of the domestic economy. In reality, this classical assumption is invalid in many circumstances. For instance, many kinds of final 'goods', services, are not-trade and capitals are fully mobile between countries as well as within domestic economies. A great deal of works on trade theory has been concerned with examining the consequences of departures from these assumptions. There is an extensive literature on various aspects of international factor mobility.[10]

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[9] See Gandolfo (1994a, 1994b).

[10] See Jones and Kenen (1984, 1985), Ethier and Svensson (1986), Bhagwati (1991), and Wong (1995). It takes a long space to comprehensively review this literature.

It may be true to say that most of the pure theory of international trade emerged from Ricardo's *Principles*. The further development of the subject by Mill, Marshall and Edgeworth remained largely within the bounds set by Ricardo. Since then, there had been much attention focused on the determination of the terms of trade by reciprocal demand within frameworks of many goods, countries and factors under various forms of intervention. As mentioned by Findlay (1984), one topic that was almost entirely absent from the pure theory of international trade was any consideration of the connection between economic growth and international trade in classical literature of economic theory. Almost all the trade models developed before the 1960s are static in the sense that the supplies of factors of production are given and do not vary over time; the classical Ricardian theory of comparative advantage and the Heckscher-Ohlin theory are static since labor and capital stocks (or land) are assumed to be given and constant over time. Although Marshall held that it is important to study international trade in order to be clear of the causes which determine the economic progresses of nations, it has only been in the last three or four decades that trade theory has made some systematical treatment of endogenous capital accumulation or technological changes in the context of international economics.

The consideration of endogenous capital or technological change in trade theory was influenced by development of neoclassical growth theory with capital accumulation and growth theory with endogenous knowledge. This order of development of economic theory is reasonable as it is only after we are able to explain how national economies operate that we can effectively model international economies. When economists had no compact framework to explain national economies, it is hard to imagine how international economies could be analyzed comprehensively. A national economy may be perceived as a special case of the global economy in the sense that the global economy is national when it consists of identical multiple national economies. Since there was no compact framework of national economies with endogenous capital or/and knowledge, it is reasonable to know that there was no compact framework to analyze economic growth and international trade.

Trade models with capital movements are originated by MacDougall (1960) and Kemp (1961), even though these models were limited to static and one-commodity frameworks. A dynamic model, which takes account of accumulating capital stocks and of growing population within the Heckscher-Ohlin type of model is initially developed by Oniki and Uzawa (1965) and others, in terms of the two-country, two-good, two-factor model of trade. The Oniki-Uzawa model is developed within the framework of neoclassical growth theory. The model is primarily concerned

with the process of world capital accumulation and distribution with demands and supplies as fast processes. The two-sector growth model has often been applied to analyze the interdependence between trade patterns and economic growth. These models are used to study the dynamics of capital accumulation and balance of payment accounts. There are different sets of assumptions made about the structure of trade. For instance, in the trade models by Oniki and Uzawa (1965) and Johnson (1971) free trade in both consumption and investment goods are allowed. An alternative specification of trade structure in the growth framework allows for the existence of international financial markets and for free trade in consumption goods and securities, but not in investment goods.[11] This framework emphasizes the interaction of foreign borrowing, debt service, and domestic capital accumulation. The two-sector neoclassical growth theory was also applied to analyze small open economies.[12]

Eaton (1987) proposed a dynamic two-sector, three-factors model of international trade. The dynamic specification of the model is based on Samuelson's (1958) overlapping generations model. The dynamic model at each point of time t proposed by Eaton is identical to the three-factor, two-commodity model examined in a static context by Jones (1971), Samuelson (1971) and Mussa (1974). The model tries to extend the Heckscher-Ohlin theory to include endowments of factor as endogenous variables. In this model land and capital serve not only as factors of production but also as assets which individuals use to transfer income from working periods to retirement. The model shows that changes in the terms of trade and in the endowments of fixed factors do not necessarily have the same effects on factor prices and on the composition of output as they do in a static framework. Some results obtained from the specific-factors model about the relationships between commodity prices and factor prices, factor endowments and factor rewards, and factor endowments and the pattern of production are not held in the dynamic model. For instance, a permanent increase in the relative price of one commodity does not necessarily lower the steady-state income of the factor specific to the industry producing the other commodity.

Obstfeld (1981) examined the saving behavior of a small economy facing a certain world real interest rate. Obstfeld proposes a dynamic Heckscher-Ohlin model with internationally mobile capital and overlapping generations of infinitely-lived agents. The model focuses on the effects of government debt and spending shocks. Devereux and Shi (1991) developed a trade model which includes intertemporal consumption-savings de-

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[11] Fischer and Frenkel (1972).
[12] See Bardhan (1965), Ryder (1967), and Bruce (1977).

cisions with the use of recursive preferences. These preferences make it possible to analyze heterogeneity in a representative-agent infinite horizon model with well-defined steady states. The key factors driving the steady state are the convergence of national rates of time preference with one another and the monotonical relationship between consumption and the real interest rate at the steady state. This implies that each country's share of total world output depends only on its degree of impatience and not on country-specific factors. From this model it concludes that if the country is more patient country, the economy will have a higher steady-state consumption level.

Increasing returns to scale is a characteristic feature of many economic activities. It may come from population dynamics, knowledge creation and utilization, and institutional changes. But the history of economic analysis shows that it is not an easy matter to formally model non-constant returns to scale within a competitive framework. In fact most of economic theories are developed under the assumption of constant returns to scale, even though economists have long ago recognized the significance of increasing returns to scale in production for determining international trade patterns. Nonetheless increasing returns had never played a central role in the trade theory until the recent developments of the new trade theory. The assumption that technology exhibits constant returns to scale had been accepted in most general equilibrium models. It is analytically difficult to handle with increasing returns within the framework of perfect competition. Some years ago Chipman (1965a, 1956b) pointed out two reasons for this omission. The first reason is that economies of scale tend to be ignored in theoretical models not so much on empirical grounds as for the simple reason that it is difficult to build a trade theory with increasing returns. This is indeed a poor reason; but no theoretical trade economist could avoid being criticized for neglecting one of the principle sources of international trade simply due to this reason. The second reason given by Chipman is that the presence of increasing returns in production leads to multiple equilibria. The existence of multiple trade patterns introduces an intrinsic arbitrariness into the determination of the international pattern of specification and trade. It is known that if there are multiple equilibria, comparative static analysis becomes invalid. It should be remarked that what Chipman had pointed out have been recently overcome by trade economists. Trade economists have proposed many theoretical trade models with increasing returns. They have overcome the theoretical difficulties involved in building such models[13] and they have recently accepted the existence of multi-

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[13] As shown later on, these are also built on very strict assumptions.

ple equilibria and instability as economists had accepted the existence of a unique equilibrium and stability in the 60s and 70s.

Adam Smith (1776) used the story of the pin factory to illustrate the idea that the conception of increasing returns to scale is central to the explanation of long-run growth. There is interdependence between the division of labor and learning by doing. As skill is increased, the worker will concentrate on a special task and thus further increase his skill. Smith examined the relationship between international division of labor and trade. Marshall was aware of the inevitably changing technological and social framework within which economies operated. He provided a vision of "organic growth" of economic systems. He considered individuals to respond to economic opportunities locally with partial adjustments occurring over time. Increasing return to scale economies was explicitly treated in his theoretical framework of partial analysis. He argued that returning to scale economies was due to technological changes and other social and economic factors. Marshall (1890) distinguished between internal and external scale economies and examined the possibility of multiple equilibria. He recognized possible technological and organizational sources of increasing returns to scale that are internal to establishments, business firms and industries. He noted a number of conditions, including greater possibilities for specialization in the provision of intermediate inputs, a finer division of labor, and the more rapid diffusion of innovation among specialized producers and workers. Marshall introduced the notion of an "external economy" to discuss the existence of the equilibrium of a decentralized price taking economy in the presence of aggregate increasing returns. He noted that an increase in trade represents a form of external economy when production knowledge cannot be kept secret. Marshall's argument shows that if knowledge is treated as an endogenous variable in economic growth, then the system may exhibit multiple equilibria and it is not necessary for equilibrium to be stable.

Classical trade theory does not neglect technology. Ricardo's doctrine of comparative costs presupposed that countries differed from one another in the productivity of labor in producing commodities. Although the Ricardian theory is not concerned with how technology itself may be affected by trade, the theory studies the consequence of technological differences differing between countries. Marshall was concerned with trade and increasing returns. Issues related to gains from trade and other social welfare were well raised even in the classical tradition. For instance, Marshall discussed terms of trade effects, arguing that with increasing returns to scale a country may improve its terms of trade by expanding demand for its imports. Graham (1923) argued that economies of scale may cause a country to lose from trade. For instance, consider an economy in which there is a

single production factor, labor, and equal prices of both goods. Also suppose that as a result of foreign trade a country shifts labor from the increasing returns to scale industry to the decreasing returns to scale industry. Then output per man falls in both industries, thereby reducing gross domestic product at constant prices. He held that when a country has a sector with increasing returns to scale and a sector with decreasing returns to scale it may lose from trade. He suggested that in this case a tariff is beneficial. Knight (1924) argued that Graham's analysis of the possible losses from trade is valid if the economies of scale are external to the firm and internal to the industry; but it is wrong if the economies of scale are internal to the firm. Ethier (1979, 1982a, 1982b) explored the conditions under which Graham's arguments hold: they depend on the nature of the increasing returns which are either national or international and the pattern of change in relative prices due to the transition from autarky to trade.

Economists have recognized long time ago that economies of scale provide an alternative to differences in technology or factor endowments as an explanation of international trade. But increasing returns as a cause of trade has received relatively little attention from formal trade theory. Ohlin (1933) pointed out that economies of scale serve as one explanation of foreign trade patterns. Since then, many trade theorists emphasized the role of monopolistic competition in differentiated products. In particular, there exist early attempts to extend trade theory on the basis of Chamberlin's *Monopolistic Competition* (Chamberlin, 1933). Explicit general-equilibrium analysis of trade based on external economies was initiated with Matthews (1949). Kemp and Negishi (1970) made an important contribution to the literature, showing that gains from trade are guaranteed if free trade leads to an expansion (noncontraction) of all increasing returns industries and nonexpansion of all decreasing returns industries. Eaton and Panagariya (1979) refined the Kemp-Negishi result. They proved that there are gains from trade as long as there exists an industry such that all industries with stronger degree of increasing returns (to weaker decreasing returns) do not contract in the move to free trade, and all industries with weaker increasing returns (or stronger decreasing returns) do not expand. In order to take account the relative importance of increases and decreases in the increasing returns to scale sectors, Markusen and Melvin (1984) defined a weighted average rule which applies under the assumption of convex production possibilities frontier and the absence of factor market distortions. But this rule is not valid when increasing returns lead to nonconvex production possibilities. Helpman and Krugman (1985) provided a rule that applies if aggregate factor usage is fixed between equilibria. Grinols (1992) develop a rule which applies to more general cases and does not require a convex production possibility frontier or fixed factor usage between equilibria. He

developed a sufficient condition for gains from trade when some increasing returns industries expand and others contract. His conclusions do not depend on the restrictions that the production frontier must be convex, changes must satisfy a pre-specified hierarchical pattern, or that total factor supplies must be fixed between equilibria.

Krugman (1989, 1990) developed a trade model with a single scarce factor of production, labor, on the basis of the assumptions that scale economies are internal to firms and the market structure is one of Chamberlian monopolistic competition. His treatment of monopolistic competition was influenced by the model by Dixit and Stiglitz (1977). He produced trade between identical economies where comparative advantage is not the cause of trade, whether that comparative advantage comes from Ricardian or Heckscher-Ohlin factors. It is shown that trade may be a way of extending the market and allowing exploitation of scarce economies, with the effects of trade being similar to industrial, urban, or regional agglomeration. This trade model is better suited to explain intraindustry trade (i.e., trade in similar products) between advanced countries.

Much of the early attention in the literature of modeling two-way trade with increasing returns was placed on trade at the final product level, rather than trade in intermediate products. Ethier (1979, 1982b) emphasized that returns to specification and two-way trade in intermediate products imply external returns to scale that spill over between economies. It is argued that the spillover effects associated with international scale economies are an immediate result of the global and regional integration of industries subject to external static or dynamic scale effects. In Francois (1994), a dual model of trade under international returns economies is developed and applied to examine foreign investment, labor migration, and commercial policy. It is demonstrated that spillover effects associated with international scale economies are an immediate result of global and regional integration of industries, and have important implications for commercial policy. As far as economic modeling is concerned, the models with increasing returns mentioned above were limited to static frameworks. These works did not provide much indication as to what are the dynamic effects of international trade on growth, technological progress, and welfare.

Except population and institutions, knowledge is a significant source of returns to scale economies. Classical economists such as Smith, Marx, Marshall and Schumpeter, emphasized various aspects of knowledge in economic dynamics. But there were only a few formal economic models which deal with interdependence between economic growth and knowledge accumulation before the 1960s. Development of macroeconomics and theory of international trade are intimately connected. Neoclassical growth

theory has been adopted to study relationships between trade and economic growth. But most of trade models with endogenous capital assume constant returns to scale production functions with inputs of capital and labor. Technological change is assumed to be exogenous or an ad hoc function of variables that can be analyzed separately from the basic factors of production function. The neoclassical growth theory developed in the 60s and 70s was crucially dependent on some exogenous parameters such as exogenous technological progress and an exogenous saving rate. However, it has been pointed out that the neoclassical growth theory cannot satisfactorily explain many empirical observations such as the diversity in per capita GNP growth rates across regions or countries. The neoclassical growth framework failed to provide a satisfactory framework for analyzing long-run growth. These models conclude that if countries with the same preference and technology will converge to identical levels of income and asymptotic growth rates.

In the 70s Arrow's learning by doing model (Arrow, 1962) and research models (Uzawa, 1965; Phelps, 1966) initiated a new trend of modeling interdependence between knowledge and economic growth. Although research on human capital (e.g., Becker, 1975) and technological change (e.g., Robson, 1980; Sato and Tsutui, 1984; Nelson and Winter, 1982) caused attention from economists, it may be said that growth with endogenous knowledge was not a mainstream of theoretical economics in the 80s. Since Romer (1986) and Lucas (1988) published their works on knowledge-based growth models, there has been a continuously increasing literature in the new growth theory. In the new growth theory, knowledge accumulation plays an important role in generating endogenously determined and sustained growth, even though most of the recent works in the new growth theory have neglected physical capital accumulation. Recently there have been a rapidly increasing number of publications in the theoretical economic literature concerning the relationship between knowledge accumulation and economic development.[14]

These knowledge-based economic frameworks have been extended to study small open economies or interactions of multiple countries. Trade economists have recently developed different trade models in which endogenous growth is generated either by the development of new varieties of intermediate or final goods or by the improvement of an existing set of goods with endogenous technologies.[15] These studies attempted to formalize equilibrium trade patterns with endogenous technological change and

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[14] See Aghion and Howitt (1992), Jensen and Wong (1998), and Maurer (1998).

[15] See Grossman and Helpman (1991), Aghion and Howitt (1998), and Grossmann (2001).

monopolistic competition. They often link trade theory with increasing-returns growth theory. Within such frameworks the dynamic interdependence between trade patterns, R&D efforts and various economic policies are well connected. With the development of models with endogenous long-run growth, economists now have formal techniques with which to explore the relationship between trade policy and long-run growth either with knowledge or with capital, but in most of them not both with capital and knowledge within the same framework.

Traditional trade theories failed to handle with issues of trade with increasing returns in a consistent way not because economists did not recognize the significance of increasing returns, but because free trade based on increasing returns is difficult to model formally under internationally and domestically perfect competition. One of the main obstacles to formally model economies with non-constant returns is the problem of market structure. It is generally believed that increasing returns are inconsistent with perfect competition. But before the new trade theory became a dominant school, trade theorists interested in free economies constructed models consistent with the assumption of perfect competition. Faced with increasingly significance of endogenous technological changes in affecting trading patterns among economists, economists have recently produced the new trade theory. This theory produces many clear and simple mathematical models and provides insights into international trade based on increasing returns. These models explain trade in the presence of increasing returns and imperfect competition. The new trade theory is influenced by the developments in the theory of growth with endogenous knowledge and industrial organization. It highlights the roles of knowledge accumulation and international dissemination in explaining how trade structure and trade policy affects rates of growth. Specification and the rationalization at the immediate product level, along with related effects of trade, market integration, learning-by-doing, technical innovation, and other external returns have recently emerged as central issues in the new trade theory.

There are some models which deal with technology transfer via direct foreign investment in the theoretical literature on growth and international capital movements.[16] For instance, Findlay (1978) built a international growth model under the assumption about technology transfer that the rate of technological change in a less developed country will be an increasing function of the amount of foreign capital operating in the less developed country and the extent to which the technology in the advanced country exceeds that in the less developed one. Wang (1990) proposed a dynamic two-country model to examine the interactions among growth, technologi-

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[16] See Findlay (1978), Wang (1990), and Wang and Blomström (1992).

cal change, and international capital movements. It includes capital accumulation and treats human capital as a country-specific variable. Perfect capital mobility links the two countries and human capital plays an important role in determining the effective rate of return for physical capital and affects the direction and magnitude of international capital movements. Rivera-Batiz and Romer (1991) developed a dynamic model with specification driven by R&D. Their model examines the effects of economic integration, through an increased flow of specified capital goods and of ideas, on economic growth rates. It demonstrates that to the extent that economic integration and other commercial policy changes increase the global resource or activity base over which external economies are generated, such integration may induce globally positive level and growth effects. Matsuyama (1991) developed a dynamic model to examine economic development under external economies and learning-by-doing effects. It is shown that free trade may lower the growth rate of low-income countries while accelerating the rate for high-income countries. These dynamic models exhibit instabilities and multiple equilibria. Hence, history as reflected in initial factor allocations, technology choices, and sectoral efficiency may be critical to the global economic development.

The new trade theory with endogenous knowledge has two main differences from the traditional trade theory. The first is that it is developed mainly under the assumption of imperfect competition. Although the significance of imperfect competition for the pure theory of international trade has been recognized and there are a number of macroeconomic models with imperfect competition as a crucial feature,[17] most of these models are developed within a static framework with fixed factors of production. Like in the Dixit-Stiglitz model, many of these trade models assume monopolistic competition in which each good is produced by a separate firm and labor is the only factor of production. The new trade theory combines the trade models with imperfect competition and the growth models with endogenous knowledge. The second main difference between the traditional trade theory and the new trade theory is that most of the formal models in the new trade theory omit explicit treatment of physical capital. The reason for the lack of endogenous physical capital is not that new trade theorists don't recognize the significance of physical accumulation. We mentioned that one of the reasons that traditional trade theorists did not make formal modeling of trade based on increasing returns is that they did not have some analytical frameworks to formally examine these issues. It is due to a similar reason that trade in the presence of possible physical

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[17] Dixit and Stiglitz (1977), Helpman and Krugman (1985), and Dixon and Rankin (1994).

capital accumulation is not formally examined in the formal modeling of the new trade theory with endogenous knowledge. If endogenous physical capital accumulation is introduced into trade models in the new trade theory, it will be difficult to make models tractable. It is not surprising to know that the new trade theory omits formal treatment of endogenous physical capital. This book treats both physical capital accumulation and knowledge creation and utilization as endogenous variables within the framework recently proposed by Zhang

1.2 The Purpose and the Structure of the Book

This book is concerned with dynamic relations between international division of labor, division of consumption and determination of prices structure in the global economy. We develop trade theories under two market structures – perfect and monopolistic competition. The book's original contributions are related to modeling dynamic interactions among capital accumulation, knowledge creation and utilization, economic growth, price structures and international trade patterns under perfect competition. The book not only takes account of capital accumulation, but also treats knowledge creation and diffusion, human capital accumulation and education, institutions, monopoly, population growth, and cultural communications as endogenous processes of economic evolution. We don't supplant capital accumulation as the key process of economic growth but to supplement it with these processes. Since it is difficult to get explicit solutions of some of the growth models, we simulate some models. The recent surge of simulations in growth theory has been impelled by current developments in computer processing, algorithm design, software, and data storage. We will combine analytical methods and computer simulation.

As far as perfect competition is concerned, the book builds the theory in a compact theoretical framework with a few concepts. The comparative advantage of the theory is that it uses only a few concepts and simplified functional forms and accepts a few assumptions about behavior of consumers, producers and institutional structures, but it achieves rich conclusions. It is conceptually easy to extend and generalize the theory because of its consistency and simplicity. As far as trade dynamics under perfect competition is concerned, this book is unique in the sense that it deals with international trade theory with an alternative approach to consumer behavior proposed by Zhang. In most of the models recently represented in the three books by Zhang (2005a, 2006a, 2008a), trade issues are examined not in a systematical way. This book studies trade issues in a comprehen-

sive manner. It is largely based on Zhang's previous book, *A Theory of International Trade* (Zhang, 2000). But this book differs from the previous one in many important aspects. The previous one is entirely concentrated on the analytical framework and models proposed by Zhang. This book introduces different international trade theories[18] and simulates some of the models; while the previous book includes no simulation example.

The book is structured in parallel to the history of development of trade theory. We are first concerned with static trade theories with exogenous production factors, such as population, labor force, capital and knowledge. We introduce trade theories of perfect competition and monopolistic competition, respectively, with international factor mobility and immobility. We also introduce the static IS-LM model for open economies to examine how money and exchange rates interact with the other aspects of economic systems. After examining static trade theories, we develop dynamic trade theory with endogenous production factors, such as capital and knowledge accumulation. We introduce trade theories of perfect competition and monopolistic competition with endogenous capital or/and knowledge on the basis of the analytical frameworks of static trade theories.

The book is organized as follows. Chapter 2 introduces the basic ideas and conclusions of classical international trade theories in mathematical form. Section 2.1 studies Adam Smith's trade theory with absolute advantage. Although Smith's ideas about absolute advantage were crucial for the early development of classical thought for international trade, he failed to create a convincing economic theory of international trade. Section 2.2 examines the theories of comparative advantage and the gains from trade. Section 2.3 develops a two-good, two factor model. Different from the common dual approach to examining perfectly competitive two-factor two-sector model in the trade literature, we use profit-maximizing approach to demonstrate the most well-known theorems in the Heckscher-Ohlin trade theory. These theorems include the factor price insensitivity lemma, Samuelson' factor price equalization theorem, Stolper-Samuelson theorem, and Rybczynski's theorem. In Sect. 2.4, we illustrate the dual approach for the same economic problems as defined in Sect. 2.3. Section 2.5 examines the Heckscher-Ohlin theory which emphasizes the differences between the factor endowments of different countries and differences between commodities in the intensities with which they use these factors. The basic model deals with a long-term general equilibrium in which the two factors are both mobile between sectors and the cause of trade is different countries having

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[18] Although this book does not integrate Zhang's approach and the new trade theory within a single framework, the reader can see that a higher integration is possible.

different relative factor endowments. The theory is different from the Ricardian model which isolates differences in technology between countries as the basis for trade. In the Heckscher-Ohlin theory costs of production are endogenous in the sense that they are different in the trade and autarky situations, even when all countries have access to the same technology for producing each good. Section 2.6 introduces the neoclassical theory which holds that the determinants of trade patterns are to be found simultaneously in the differences between the technologies, the factor endowments, and the tastes of different countries. Section 2.7 develops a general equilibrium model for a two-country two-sector two-factor economy, synthesizing the models in the previous sectors. Section 2.8 introduces public goods to the two-sector and two-factor trade model defined in the previous sections. Section 2.9 concludes the chapter. Appendix 2.1 represents a generalization of the Ricardian model to encompass a continuum of goods.

Chapter 3 introduces some basic models of the new trade theory. Section 3.1 studies a trade model with monopolistic competition by Krugman. The Krugman model addresses relations between trade and elements such as economies of scale, the possibility of product differentiation, and imperfect competition. The model is specially effective for providing some insights into the causes of trade between economies with similar factor endowments. The model is based on a monopolistic competitive model proposed by Dixit and Stiglitz. Section 3.2 introduces the Chamberlinian-Ricardian model proposed by Kikuchi. Rather than assuming cross-country technical homogeneity like in the model in Sect. 3.1, the model is concerned with cross-country technical heterogeneity. There are two sectors: the monopolistically competitive sector and the competitive sector – the former produces a large variety of differentiated products and the latter produces a homogeneous good. The homogeneous good is produced under constant returns to scale. Section 3.3 analyzes the interplay between factor abundance and agglomeration forces, basing on a model of agglomeration by Epifani. The model synthesizes the Heckscher-Ohlin theory and the monopolistic competition. Section 3.4 examines economic mechanism for the contemporary phenomenon that a large part of international trade is intraindustry in character. The section uses a simple model to demonstrate that although it is costly to export the product from one country to another, firms in different countries may engage in cross-hauling of an identical product, making positive profits. Section 3.5 introduces a model of extending the Heckscher-Ohlin international trade theory to include variable returns to scale. Section 3.6 analyzes the effects of transboundary pollution on trade and welfare in a general equilibrium.

Chapters 2 and 3 examine traditional trade theories with factor mobility between sectors with each country but factor immobility between coun-

tries. Looking economic activities around, we observe that the factor-immobility assumption is not valid. Chapter 4 examines trade patterns with internationally mobile factor endowments. We are concerned with capital and labor mobility. We will show that international capital or/and labor movement may invalidate some of the four core theorems developed in Chap. 2. Section 4.1 studies the validity of the four fundamental trade theorems, the factor equalization theorem, the Rybczynski theorem, the Stolper-Samuelson theorem, and the Heckscher-Ohlin theorem, in the presence of international capital movement. We are still concerned with a model similar to the 2×2 model analyzed in Sect. 2.3. The 2×2 model is extended in two ways. Capital moves freely between countries. Moreover, land is considered as a production factor. The three-factor model still has two immobile factor endowments, labor and land. Section 4.2 is concerned with immiserizing growth. We are concerned with a trade model with international factor mobility and variable returns to scale. The model of this section is a synthesis of the trade model with variable returns to scale in Sect. 3.4 and the model with international capital mobility in Sect. 4.1. Section 4.3 is concerned with a model of emigration and wage inequality proposed by Marjit and Kar. Rather than following the dual approach accepted by the authors just referred, I will use the approach as in the previous sections. The model deals with issues related to trade and wage inequality for developing economies. Section 4.4 introduces a model with Chamberlinian agglomeration, basing on the core-periphery model proposed by Krugman. The model studies interactions among transport costs, increasing returns at the firm level, and supply and demand linkages. Section 4.5 concludes the chapter on international trade with global factor mobility.

Chapter 5 introduces money and exchange rates into trade models. Section 5.1 first defines the current account balance for closed economies and for open economies. Open economies can trade in goods and services, borrow resources from the rest of world, and lend them abroad. Section 5.2 is concerned with the IS-LM model for an open economy. The model is also a standard tool for analyzing balance-of-payments (BOP) behavior when exchange rate is fixed. Section 5.3 introduces a classical model of monetary open economy with the gold standard. This model and its various extensions provide insights into many important monetary issues. The model deals with the interactions among money, spending and prices in the open economy with full price flexibility. Section 5.4 introduces a simple monetary model of international trade developed by Ohyama. The model studies an interaction of monetary and real factors affecting the terms of trade and governing the adjustment process of current account imbalances under the system of flexible rates. Section 5.5 concludes the chapter.

International factor mobility has received little attention in the literature of international trade. This is reflected by the fact that in most books on international trade, international trade is considered nearly synonymous to international trade in goods. Many trade theorems are obtained when only goods are allowed to move between countries. Chapter 6 studies some models of small open economies with international capital mobility. As mentioned before, the main deviation of this book from traditional approaches in modeling dynamics of international trade is how to model households' decision making. Section 6.1 introduces the one-sector growth (OSG) model of an isolated economy. In the rest of this book, we use the OSG framework to stand for the one sector growth model developed in this section and its variation extensions. Section 6.2 examines the Ramsey growth model (which is the most popular approach in economic growth theory with optimal foundation) also for a closed economy. As the OSG approach is an alternative approach to the Ramsey approach, we will also compare the two approaches. Section 6.3 describes dynamics of a small country economy. An open economy can import goods and services and borrow resources from the rest of the world or exports goods and services and lend resources abroad. For convenience of illustration, assume that there is a single good in the world economy and the price of the goods is unity. Section 6.4 extends the model in Sect. 6.3 to a multi-regional economy. The model examines economic growth of a multi-regional small open economy in a perfectly competitive economy. The national economy consists of multiple regions and each region has one production sector and one housing sector. Households move freely among regions, equalizing utility level among regions by choosing housing, goods and saving. A region's amenity is endogenous, depending on the region's output and population. We explicitly solve the dynamics of the multi-regional economy. As a concluding remark, Sect. 6.5 discusses the theoretical basis for the utility function used in Chap. 6. Section A.6.1 introduces a typical model of a small overlapping-generalizations (OLG) economy, proposed by Galor. Section A.6.2 studies a small country model proposed by Ikeda and Gombi to analyze the equilibrium dynamics of savings, investment and the current account. Section A.6.3 proves Lemma 6.4.1. Section A.6.4 studies the Keynesian consumption function and examines its possible relations to the consumption function obtained from the OSG approach. Section A.6.5 studies the Solow growth model and examines its possible relations to the OSG growth model.

Chapter 7 analyzes trade issues within the framework of a simple international macroeconomic growth model with perfect capital mobility. Most aspects of production sectors in our model are similar to the neoclassical one-sector growth model. It is assumed that there is only one (durable) good in the global economy under consideration. Households own assets

of the economy and distribute their incomes to consume and save. Our model, as far as trade and global growth are concerned, is influenced by the neoclassical trade theory with capital accumulation. Section 7.1 discusses the nature of the economic relations between the advanced and less developed regions of the world economy, or the North and South as it has become customary to call refer to them. The formal framework, initiated by Findlay (1980), is a synthesis of Solow-Swan's neoclassical growth model (for the North), Lewis's dual-economic model (for the South), and Johnson's trade model as a linkage between the North and the South. Section 7.2 builds a dynamic one-commodity and two-country trade model to examine interdependence between trades and global growth. We analyze trade issues within the framework of a simple international macroeconomic growth model with perfect capital mobility. Section 7.3 extends the model in Sect. 7.2, introducing a few new features to the analytical framework. We construct a dynamic one-commodity and multiple-country trade model to examine interdependence between trade and global growth with sexual division of labor. The section proposes the multi-country model with endogenous labor supply, sexual division of labor, and capital accumulation.

Chapter 7 assumes that the world has only one production sector and produces a single product. Chapter 8 is concerned with dynamic relations between growth, economic structure and trade patterns in a two-country world economy. Section 8.1 studies the standard trade model in neoclassical growth theory proposed by Oniki and Uzawa. The model examines interactions between the process of capital accumulation and the pattern of international trade. It is presented in terms of the standard two-country, two-commodity, two-factor model of international trade. Section 8.2 proposes a trade model with economic structures and endogenous saving, synthesizing the Oniki-Uzawa model and the one-sector growth trade model proposed in Sect. 7.1. Section 8.3 studies a two-country trade model in which economic product in each country is classified into goods and services. Section 8.4 concludes the chapter. Section A.8.1 extends the two-country model in Sect. 8.3 to any number of countries. Section A.8.2 presents a two-country optimal model, extending and generalizing the Oniki-Uzawa trade model.

Chapter 9 examines interactions between growth, trade, knowledge utilization, and creativity within a compact analytical framework. We consider knowledge as an international public good in the sense that all countries access knowledge and the utilization of knowledge by one country does not affect that by others. Section 9.1 introduces a growth model with endogenous human capital accumulation for a national economy. Section 9.2 proposes a multi-country model with capital accumulation and knowledge creation. This section assumes that knowledge creation is through learning by

doing and research. This section simulates the model to see how the system moves over time and how the motion of the system is affected when some parameters are changed. This section is organized as follows. Section 9.2.1 defines the multi-country model with capital accumulation and knowledge creation. Section 9.2.2 examines the case when all the countries have the same preference. We show that the motion of the global economy can be expressed by a two-dimensional differential equations system and we can explicitly determine the dynamic properties of the global economy. Section 9.2.3 shows that the dynamics of the world economy with J countries can be described by $(J+1)$-dimensional differential equations. As mathematical analysis of the system is too complicated, we demonstrate some of the dynamic properties by simulation when the world economy consists of three countries. Sections 9.2.4 – 9.2.7 examine respectively effects of changes in each country's knowledge utilization efficiency and creativity, research policy, the propensity to save, and the population. The analytical results in Section 9.2.3 are proved in Appendix A.9.1.

The new growth theory has modeled endogenous knowledge accumulation through many channels, including formal education, on-the-job training, basic scientific research, learning by doing, process innovations, industrial innovations, and product innovations. The crucial assumption that leads to sustainable endogenous growth is the existence of increasing returns to scale in economic production under monopolistic competition. Chapter 10 presents some of the key ideas in the approach in the new trade theory. Section 10.1 introduces a dynamic, two-country growth model with trade in which endogenous technical change results from the profit-maximizing behavior of entrepreneurs. Section 10.2 is concerned with the role of intellectual property rights (IPRs) in encouraging firms in developed countries to innovate and in helping developing countries gain access to knowledge on the global frontier. The section introduces a dynamic general-equilibrium product-cycle model to analyze the effects of Southern IPRs on incentives of Northern firms to innovate and to license state-of-the-art technologies to the South. The quality-ladders model with endogenous innovation and licensing integrates licensing into the theory of endogenous product cycles. Section 10.3 introduces trade costs into North-South endogenous growth model. The model tries to analyze interactions among factor endowments, trade costs, production location, and growth. Section 10.4 introduces a model of growth and innovation of a small economy. The small country faces perfectly elastic demand in world markets and trades at exogenously given prices. If the small economy trades on world capital markets, it does so at an exogenously given rate of interest. The R&D activities of the small country does not influence the rate of ac-