Abstract of a Doctoral Dissertation
学位請求論文要旨

Essays on Capital and Productivity

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The central theme of these essays is productivity and their specific focus is on capital and the dynamics of productivity.

Productivity has long been recognized as a key factor in the process of economic growth. In spite of the clarity of the concept of productivity and the exercises of productivity growth (growth accounting), the extent of the importance of productivity has been the subject of considerable debate. This is partly because a number of topics remain unresolved. This study concentrates on two of the topics giving rise to controversy. The first is the omitted capital problem, while the second is insufficient linkage between macro- and micro-level evidence.

The problem of omitted capital is that omission of a capital item causes the measured productivity to be biased. For example, expenditure on R&D is counted not as investment but as cost in the contemporary accounting rule. To be concrete, first, omission of a capital item changes the composition of input factors, whatever method is used to measure productivity. Secondly, omission

of a capital item may cause the output estimates to be biased. Omission of a capital item means that investment in the omitted capital item is treated as cost. In a national accounting framework, investment is counted as a output, whereas cost is not counted as a output but as a intermediate input which is cancelled out. In fact, a consensus has been forming among economists that today, intangible assets are mostly not regarded as capital even though they are more important than tangible assets as sources of competitiveness, sustainable growth, business success, and so on. Three chapters of this essays are devoted to this topic.

Another controversy surrounds the interpretation of productivity and its growth. As described above, contemporary growth accounting views TFP as the contribution of technology. However, as Abramovitz (1956) stated, this term is also a measure of our ignorance, because it is calculated as the residual and we do not know exactly what it contains: we neither know its components nor the processes giving rise to it. Thus, even if we know the TFP level or rate of TFP growth, we do not know what is happening at the microeconomic level. Although a large number of researchers have investigated the productivity dynamics of individual firms and establishments at the microeconomic level, the results cannot necessarily be linked to the macroeconomic level, mainly because of data deficiencies. We do know that in Japan productivity growth in the 1990s was extremely low, but we do not know what is responsible for this. Last two chapters are devoted to

this topic.

Chapter 2 provides a survey of topics related to intangible capital, including concepts and definitions, measurement issues, and classifications. The chapter shows that despite the growing importance of intangible capital, we do not know enough about it and only have imperfect methods of measuring it. While at the macroeconomic level, measurement of intangibles is now available for many countries, definitional and measurement issues pose a greater problem at the microeconomic level. The chapter points out that researchers not only have to confront data deficiencies but also need to grapple with conceptual issues. Finally, the chapter also provides brief surveys of studies dealing with particular detailed topics. Many of these studies prove the existence of intangible capital at the microeconomic level as well as at macroeconomic level.

Chapter 3 then hones in on a more concrete issue relating to intangible assets and focus on the scope and role of organization capital. The chapter illustrates that although IT as a general purpose technology plays a large role in economic growth, firms' market value is typically much greater than the sum of their tangible assets and IT investment. What is more, it was only in the United States where investment in IT has provided a significant boost to productivity. What both observations highlight is that IT investment requires supplementary assets, especially in the form of organization

capital. Against this background, this chapter employs the market valuation approach to examine various issues related to firms' intangible capital. The approach is based on the assumption that markets provide an efficient valuation of firms' intangible assets.

The analysis finds evidence of the existence of intangible capital accumulated in firms. Furthermore, using the stock of intangible capital, the Solow paradox (1987) is tested. The results show that for intangible capital to play a sufficient role takes time and is necessary for the accumulated capital to reach a certain level. In the early stage of intangible capital accumulation, the contribution of intangible capital to productivity growth is negative. In addition, estimation results indicate that the revenue-based share of organization capital in Japanese listed companies ranged from 10 percent to 17 percent and the ratio of investment in organization capital to output ranged from 10 percent to 14 percent in the period from 1990 to 2003.

Chapter 4 deals with the production function estimation when there is an unobservable idiosyncratic productivity shock and the series of the productivity shock follows a first-order endogenous Markov process which is controlled by R&D investment.

The production function approach, in general, suffers from endogeneity problems when there are determinants of production which are not observed by the econometrician but are observed by the manager of a firm. To control for this problem, recently developed econometric methods are

applied to the production function estimation. The results show that there is a possibility that other estimation methods such as OLS estimation and fixed effect estimation underestimates the contribution of capital. The results also suggest that the rate of return to R&D varies considerably across industries and within an industry. The estimation results also show that R&D returns are greater at bigger firm.

Chapter 5 returns to the topic of traditional capital and focuses on the technical progress embodied in physical capital. Capital service is difficult to measure and one reason for this difficulty is the depreciation rate of capital. To address this issue, the analysis in this chapter conceptually distinguishes two types of depreciation: (technological) obsolescence and (physical) deterioration. In the modern economy, technological progress is often very rapid. If most technological progress is embodied in machines, and one cannot enjoy the benefits from them without buying and installing them, the vintage of the capital, at least to some extent, has an effect on productivity.

This chapter first seeks to clarify the relationships between technological progress, the obsolescence of capital, and the average vintage of capital, and then estimates the rate of obsolescence of capital and the rate of technological progress embodied in capital using firm-level data. With these results, this chapter calculates the effect of one year increase of capital vintage on productivity in Japan in the late 1990s and early 2000s.

The annual rates of technological progress are estimated to be 8 to 22 percent, and are generally consistent with the results of previous studies. The economic depreciation rate, which is the sum of the obsolescence rate and the rate of physical deterioration, is estimated to be greater than the depreciation rate typically assumed in studies when estimating capital stock. The contribution of technological progress *embodied in capital* to TFP is estimated to be 0.2 - 0.4 percent on an annual basis.

Next, Chapter 6 investigates productivity dynamics at the establishment level. The chapter provides a new attempt to link the evidence on productivity at the macroeconomic and the microeconomic level. The purpose is to make clear what is happening in the "black box" of productivity growth at the macroeconomic level. Looking at Japan, the analysis finds that the downturn in productivity growth during the 1990s was not caused by the "low metabolism" of the economy but by the slowdown in productivity growth at establishments that operated throughout the period. In addition, the analysis also finds evidence of a hollowing-out phenomenon.

Chapter 7, finally, offers some concluding remarks and discusses topics that remain to be addressed in future studies.