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# Debt, R&D investment and technological progress: A panel study of Japanese manufacturing firms' behavior during the 1990s

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Based on a panel data set of Japanese manufacturing firms in research-intensive industries, we investigate quantitatively the extent to which outstanding debt affected firms' R&D activities during the 1990s. We find that massive amounts of outstanding debt had a significant, negative effect on R&D investment during that time. We also find that R&D expenditures were closely linked to firm-level total factor productivity growth over the same period. In fact, a ten-percentage-point increase in the debt–asset ratio lowered the rate of firm-level total factor productivity growth by 0.26 percentage points between 1999 and 2001, because it reduced R&D activities. *J. Japanese Int. Economies* 21 (4) (2007) 403–423. Institute of Social and Economic Research, Osaka University, 6-1 Mihogaoka, Ibaraki, Osaka, 567-0047 Japan.

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## 1. Introduction

A consensus has not yet been reached about what caused the long period of stagnancy that the Japanese economy experienced during the 1990s. The supply-siders argue that stagnancy generally results mainly from supply-side factors, such as inefficiencies in the production sector or

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a banking sector that suffers from numerous bad loans. They warn that the growth potential of the Japanese economy is falling. For example, Hayashi and Prescott (2002) demonstrate, based on the standard growth model, that the decline in the rate of total factor productivity (abbreviated as TFP) growth and the institution of shorter working hours are responsible for the current stagnancy of the Japanese economy. Convincing as their argument is, however, it does little to explain why the TFP growth rate suddenly dropped in the 1990s.

We shed light on this problem empirically. An attempt has recently been made to identify the mechanism that drove the aggregate and industry-level TFP growth rate declines in the 1990s. In particular, Nishimura et al. (2005) and Fukao and Kwon (2006) argue that efficient firms exited the market, while inefficient firms remained in the market; this behavior led to the decline of the aggregate TFP growth rate in the middle of the 1990s. In contrast, we are interested in firm-level TFP growth and its association with firms' R&D activities in the 1990s. Based on panel data for Japanese manufacturing firms, we examine firms' investment in R&D and how this is linked to the firm-level TFP growth rate. Our panel data set is composed of firms listed in the chemicals; machinery; electrical machinery, equipment, and supplies; transport equipment; and precision instrument industries, all of which are quite research-intensive. Specifically, we investigate the extent to which outstanding firm debt and bad bank loans affected firm R&D investment and, subsequently, the TFP growth rate. To this end, we compare firm R&D activities for the late 1980s with those of the late 1990s. The former period corresponds to the growth of financial bubbles, while the latter period was characterized by heavy debt in the corporate sector and mounting bad loans in the banking sector.

We now preview our main findings. The ratio of debt to total assets had a significant, negative effect on R&D investment in the late 1990s, while the effect of the debt–asset ratio on R&D investment was insignificant in the late 1980s, on the whole. Therefore, it was the massive outstanding debt of firms during the late 1990s that caused a reduction in their R&D activities, even taking into account their opportunities for growth. We also find that the TFP growth rate was positively linked to R&D investment, which implies that the debt overhang of the 1990s was responsible for lowering the firm TFP growth rate. Furthermore, we find that a larger dispersion of the debt–asset ratio across firms led to a more dispersed distribution of R&D investment during the 1990s.

The remainder of the paper is organized as follows. The next section presents the most salient characteristics of the R&D activities of the Japanese manufacturing industry as a whole, as well as of the individual firms in our panel data set, for the period of the 1990s. Section 3 then estimates the R&D investment function, and Section 4 examines the association of R&D investment with the firm TFP growth rate. Section 5 concludes the paper.

## **2. Characteristics of the R&D activities and TFP growth of Japanese manufacturing firms in the 1990s**

We now discuss the most salient characteristics of the R&D activities of Japanese manufacturing industry as a whole for the 1990s, as well as for the individual firms in our panel data set. First, the R&D activities of Japanese manufacturing industry were stagnant in the 1990s. In particular, Fig. 1 shows the rate of change of the intramural expenditures on R&D of large firms in the manufacturing sector between 1981 and 2002. We define large firms as those having equity capital in excess of 1 billion yen. In the 1980s, the rate of change of intramural expenditures on R&D exceeded 10% per annum for most of the period. However, it fell sharply in 1993 and stayed low thereafter. The average annual growth rate of intramural expenditures on

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