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Uncertainty-driven growth

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ABSTRACT

In this paper, I present a model in which firm-level uncertainty raises aggregate productivity growth. The mechanism for this is learning-by-doing in the research sector: firms undertake research to reduce uncertainty, which results in social knowledge accumulation that improves the productivity of future research. The model explains the positive correlation between TFP growth and dispersion in manufacturing industries.

1. Introduction

This paper analyzes the effect of firm-level uncertainty on aggregate productivity growth. Many researchers have examined the effect of *macro-level* uncertainty, such as disturbances in output levels or growth rates, on economic growth, although still controversial.[1] On the other hand, only a few papers investigate the effect of *micro-level* uncertainty on productivity growth. In this paper, I present a positive aspect of micro-level uncertainty in an environment without aggregate uncertainty, and explain the positive relation between firm-level TFP dispersion and growth observed in the United States manufacturing sector (see Fig. 3 in Section 3).

The current issue is relevant because several papers document significant trends in idiosyncratic risks in the United States and some other countries. For example, Campbell et al. (2001) report the increasing trend in the idiosyncratic risks of stock returns while there is no significant trend in the market level volatility. Using similar data set about Japanese stock market, Hamao et al. (2007) document a decreasing trend in the idiosyncratic risks in Japan. Comin and Mulani (2006) document that the micro-level volatility measured from firm sales has an increasing trend while the macro-level volatility

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[1] In the literature, several empirical papers report that there exists a negative correlation between growth and fluctuation (e.g. Ramey and Ramey, 1995; Martin and Rogers, 2000; Imbs, 2007); Kose et al. (2006) find that the relationship is negative for a sub-sample of developing countries but positive for a sub-sample of industrialized countries; Grier and Tullock (1989) and Andreou et al. (2008) argue that the source of macroeconomic volatility is important for its correlation with output growth.

Such inconclusiveness appears also in theoretical papers. de Hek (1999) shows that the impact of volatility on output growth depends on the degree of risk aversiveness. Blackburn and Galindev (2003) argue the effect of volatility on growth depends on the source of technological change, i.e., deliberate investment or learning by doing.

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has the opposite trend in the United States.[2] These findings imply that we need more research on the effects of such behaviors of micro-level uncertainty.

In the literature on investment, there are a lot of papers on the effect of micro-level uncertainty, both theoretically and empirically. The real option model described in Dixit and Pindyck (1994) shows a negative impact of uncertainty on irreversible investment because firms hesitate to invest under a highly uncertain environment.[3] However, even if firm-level investment is reduced, it does not necessarily imply that aggregate growth is also dampened. Gilchrist and Williams (2005) show that idiosyncratic uncertainty reduces project-level irreversible investment but increases aggregate investment and output in the general equilibrium setting. Their paper is most closely related to the current paper in terms of motivation. The difference is that I focus on the social knowledge accumulation through research activity done by each firm to reduce the uncertainty it faces, whereas the key mechanism of the model in Gilchrist and Williams (2005) is diversification over investment projects.

Another paper which is related to this paper is Comin (2000). He presents a story in which a rise in uncertainty induces replacement of old capital with flexible capital (such as information technology capital), which finally realizes a higher productivity growth after the so-called productivity slowdown. The mechanism of resurgence in productivity growth in Comin (2000) comes from the assumption that productivity growth is higher with flexible capital than with old capital. In that sense, his model is different from the model in this paper, where uncertainty itself raises growth.

The structure of this paper is the following. In Section 2, I will show the basic one-sector model where uncertainty raises productivity growth. The intuitive story is that under some uncertainty firms carry out research to reduce it. Such efforts induce new discoveries and enlarge the social knowledge base, which in turn improves the productivity of research thereafter. As a result, an increase in the level of uncertainty decreases the expected productivity level in the short run, but increases the expected productivity growth rate and, moreover, increases the expected productivity level in the long run.

Section 3 presents an extension of the basic model to analyze multiple industries. By this extension, I explain the positive relationship between productivity growth and dispersion. Dwyer (1998) observes this phenomenon among the 4-digit U.S. textile industries, and I show that the same relation is true among the 2-digit U.S. manufacturing industries, using the Compustat data set. Section 4 is the analysis of social planner's problem of the one-sector model. Section 5 is concluding comments.

2. The model

In this section, I first present the basic structure of the model and then describe the equilibrium within an instant. Later, I link the instants.

2.1. Preliminary explanation of building blocks

There exists a unit mass of risk–neutral agents. Each can choose to be a producer or a researcher in each instant without any cost. And if an agent chooses to be a researcher, he is hired by a producer to investigate into the firm-specific unknown parameter.

Producers and researchers: One producer owns one plant. A plant produces output of y without any input. However, the expected productivity of the plant depends on the number of researchers it hires, R.

$$E(y) = Af(n,s),$$

$$n = kR,$$

where A is the technology level, n is the amount of research, k is research productivity, s is a parameter, and $f(n,s)$ is the expected technical efficiency which is defined in the next subsection. As shown in the second equation, a new research output is created in a linear form. The research productivity, k, is increasing in the level of knowledge capital in the whole economy because new knowledge is created through combinations of existing knowledge. For simplicity, I assume that the research productivity is identical to the social knowledge capital.[4] I also assume that research activity is firm-specific, so that the research performed for one firm is not helpful for another.

Researcher market equilibrium: Both producers and researchers take the researcher wage w as given. The producer's optimization problem is as follows:

$$\max_{n \geq 0} Af(n,s) - \frac{nw}{k}.$$

[2] Davis et al. (2007) confirm that there exists an upward trend of volatility among publicly traded firms in the United States nonfarm sector. However, there exists a decreasing trend when privately held firms are included. So the property may depend on grouping of firms.

[3] In another context, Bertola (1994) derives a negative effect of idiosyncratic shocks in labor unit cost on output growth in an environment in which labor mobility is costly.

[4] All the main results in this paper hold if research productivity is strictly increasing in social knowledge capital.