



ELSEVIER

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

SCIENCE @ DIRECT®

Journal of Economic Theory 126 (2006) 143–164

JOURNAL OF  
**Economic  
Theory**

[www.elsevier.com/locate/jet](http://www.elsevier.com/locate/jet)

# Anticipation effects of technological progress on capital accumulation: a vintage capital approach<sup>☆</sup>

Gustav Feichtinger<sup>a</sup>, Richard F. Hartl<sup>b</sup>, Peter M. Kort<sup>c, d, \*</sup>,  
Vladimir M. Veliov<sup>a, e</sup>

<sup>a</sup>*Institute of Mathematical Methods in Economics, Vienna University of Technology, Argentinierstrasse 8, A-1040 Vienna, Austria*

<sup>b</sup>*Department of Business Studies, University of Vienna, Brünnerstrasse 72, A-1210 Vienna, Austria*

<sup>c</sup>*Department of Econometrics and Operations Research and CentER, Tilburg University, P.O. Box 90153, NL-5000 LE Tilburg, The Netherlands*

<sup>d</sup>*Department of Economics, University of Antwerp, Prinsstraat 13, 2000 Antwerp 1, Belgium*

<sup>e</sup>*Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria*

Received 15 November 2002; final version received 13 October 2004

Available online 8 December 2004

---

## Abstract

Due to embodied technological progress new generations of capital goods are more productive. Therefore, in order to study the effects of technological progress, a model must be analyzed in which different generations of capital goods can be distinguished. We determine in what way the firm adjusts current investments to predictions of technological progress. In the presence of market power we show that a negative anticipation effect occurs, i.e. current investments in recent generations of capital goods decline when faster technological progress will take place in the future, because then it becomes more attractive to wait for new generations of capital goods. In case that only investments in new machines are possible, actually a whole wave of anticipation phases arises.

© 2004 Elsevier Inc. All rights reserved.

*JEL classification:* D92; O33; C61

*Keywords:* Vintage capital; Embodied technological progress; Learning; Maximum principle

---

<sup>☆</sup> This research was supported by the Austrian National Bank (ÖNB) under grant N0. 8466-OEK. The authors thank two anonymous referees for their thoughtful comments.

\* Corresponding author. Department of Econometrics and Operations Research and CentER, Tilburg University, P.O. Box 90153, NL-5000 LE Tilburg, The Netherlands. fax: +31 13 4663280.

*E-mail address:* [kort@uvt.nl](mailto:kort@uvt.nl) (P.M. Kort).

0022-0531/\$ - see front matter © 2004 Elsevier Inc. All rights reserved.

doi:10.1016/j.jet.2004.10.001

## 1. Introduction

This paper studies the effect embodied technological progress has on the firm's capital accumulation process. Embodied technological progress implies that capital goods of later date are more productive. In order to analyze the implications of this feature, a model must be built in which capital stocks of different building years can be distinguished. To do so a vintage capital goods model is developed in which capital goods of younger vintages are more productive.

In a vintage capital goods model productivity of a capital good is completely determined by its age and the year in which it actually operates. In view of technological progress, productivity increases with time, for capital goods of a given age. On the other hand, over time workers get more experienced in working with the same machine over the years, so that the productivity per machine increases with age. For example, due to a learning curve the LCD industry experiences a so-called ramp up time (time needed to start up a production line) with a strongly increasing yield (amount of good products relative to the total amount of products) in the first quarters after the start of production. Hence, a trade-off arises: new machines are relatively productive, because they embody superior technology, but due to learning effects it can still happen that working with old machines leads to higher productivity than working with new machines.

Technological progress is increasingly embodied in new capital goods (see [14]). To illustrate, Gordon [18] has shown that the relative price of capital has declined fairly steadily and rapidly in the post-war US and other economies. Moreover, Greenwood et al. [19] found that embodied technological progress is the main driver of economic growth. They discovered that in the post-war period in the US about 60% of labor productivity growth was investment-specific. A main example is information technology as noted by Yorokoglu [32, p. 552]: *“Information technology capital has a very high pace of technological improvement. Compared with more traditional types of capital, the efficiency of information technology capital has increased much faster over the last few decades. As an example, consider the market for personal computers. IBM introduced its Pentium PCs in the early 1990s at the same price at which it introduced its 286 PCs in the 1980s. Therefore it took less than a decade for the computing technology to improve on the order of 20 times in terms of both speed and memory capacities, without increasing the cost”*.

In Chari and Hopenhayn [13] three questions are posed: (i) why are new technologies often adopted so slowly?, (ii) why do people often invest in old technologies even when apparently superior technologies are available?, and (iii) how are decisions to adopt new technologies affected by the prospect that even better technologies will arrive in the future? To answer the second question, the work by, e.g., Solow et al. [27], Malcomson [24], Benhabib and Rustichini [3], and Boucekine et al. ([6–9]) cannot be used, because there it is only possible to invest in the newest generation of capital goods. The common denominator of the just mentioned contributions is the application of delayed differential equations. Using partial differential equations for the analysis of vintage capital we were able to answer Chari and Hopenhayn's second question, because this allowed us to explicitly introduce the possibility of investing in older capital goods, thus in non-frontier vintages (see [16]). In that paper it was found that investing in older technologies can be preferred because older technologies are cheaper, due to experience effects it is easier to implement them, and due to learning

متن کامل مقاله

دریافت فوری ←

**ISI**Articles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات