# Intangible Investments in Macroeconomics

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# Chapter 1

# Introduction

Intangible capital is an increasingly important factor of production in advanced economies. Governments in Europe and elsewhere promote investment in intangible assets. However, the potential role of intangibles for business cycles and the international transmission of shocks is not well understood. In chapter 2[1], we investigate the international business cycle effects of intangible capital. To this aim, we build an otherwise standard two-country real business cycle model augmented by a production sector for intangibles and allow for the non-rivalrous use of intangible capital in the production of final output goods and new intangibles. We find that a model including intangibles is associated with international co-movement of tangible investment, which is a feature observed in the data that many models fail to produce.

In chapter 3[2], we analyze the effects of intangible investment on

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[2]This chapter was published as a discussion paper on the vwi webpage, June 2018, $https://edit.cms.unibe.ch/unibe/portal/fak_wiso/b_dep_vwl/a_inst_vwl/content/e195818/e195991/e556277/e687107/dp1810_ger.pdf?preview=preview$ [4.6.2018]. The authors, Dr. Guido Baldi and André Bodmer, would like to thank the editors for useful comments. All remaining errors are the responsibility of the authors.

international output synchronization. Using a dynamic stochastic general equilibrium model, we find that an increase in the importance of intangible capital leads to a higher degree of output co-movement across countries. Therefore, countries in which intangible capital is more important are better suited to economic integration, such as forming a monetary union. This offers an insightful perspective on the potential relation between the considerable differences in intangible capital among Eurozone members and the discussion surrounding the Eurozone as a suboptimal currency area. A high stock of intangible capital also tends to attract foreign equity investments, in particular foreign direct investments. We find that cross-border equity holdings in tangible and intangible capital further increase the degree of output synchronization. Our results imply that policy reforms to incentivize higher intangible capital formation and cross-border equity investments may not only foster economic growth but also improve the functioning of the monetary policy in the Eurozone.

Eventually, chapter 4[3] presents evidence about how research and development (R&D) expenditures affect corporate cash holdings in European country groups that differ in their innovation capacity. In theory, one can expect intangible investments such as R&D to result in higher cash stocks than fixed investments, particularly because intangible capital is less suitable as collateral for obtaining external funds. The relationship can be expected to be particularly strong in innovative countries. These countries carry out a relatively high proportion of cutting-edge R&D, which tends to be particularly risky and may be associated with substantial gestation lags before becoming productive. These features tend to increase firms' precautionary cash holdings. To investigate this issue in a European context, we examine different groups of countries that are clustered based on differences in their innovative capacity. Our estimation results confirm a

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positive relation between changes in R&D investment and changes in cash holdings, while changes in fixed investment do not seem to be related to changes in cash positions. The impact of changes in R&D on cash tends to be higher for country groups characterized by a high level of innovative capacity than for countries with moderate levels of innovative capacity. However, the differences across country groups are less pronounced than expected.
To sound the empirical results, we develop in chapter 4 an overlapping generations model to explain the fundamental mechanisms of the empirical results. We analyze a model with two sectors of capital formation that differ in the nature of innovation. The first sector is long-term oriented and has the potential to produce innovations at the technological frontier. The second sector consists of less productive firms carrying out incremental innovations. Liquidity shocks may occur to long-term oriented firms, which leads to precautionary corporate cash holdings.
Beyond the empirical analyses, we use this model to analyze the evolution of productivity and corporate savings decisions. We find that a higher level of productivity in the long-term oriented sector results in higher corporate savings, while a higher productivity level in the short-term oriented sector leads to lower corporate savings in the long-term oriented sector. Thus, we find that corporate savings tend to be low when the technology gap between high- and low-productivity firms is low. This aspect has not been discussed in previous research. Our model also allows us to show that a higher level of technology leads to higher R&D investments, but it gets increasingly difficult to achieve productivity improvements.

The appendices provide additional materials for a better understanding over all chapters. On demand further documents will be provided.

The chapters are published under these links:

Chapter 2:
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# Appendix F

# Statement of authorship

Ich erkläre hiermit, dass ich diese Arbeit selbständig verfasst und keine anderen als die angegebenen Quellen benutzt habe. Alle Koautorenschaften sowie alle Stellen, die wörtlich oder sinngemäss aus Quellen entnommen wurden, habe ich als solche gekennzeichnet. Mir ist bekannt, dass andernfalls der Senat gemäss Artikel 36 Absatz 1 Buchstabe o des Gesetzes vom 5. September 1996 über die Universität zum Entzug des aufgrund dieser Arbeit verliehenen Titels berechtigt ist.

Bern, 26. März 2018 (André Bodmer)