Measuring FDI and Its Impact on the Danish Economy

Ph.D. Thesis by

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March 2011

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Preface

The thesis at hand is the outcome of my Ph.D. studies that have taken place at Danmarks Nationalbank, University of Southern Denmark, and the International Monetary Fund (IMF) in the past few years. I am grateful to Danmarks Nationalbank for financing my studies and to the IMF for the hospitality shown me during my four-month stay in Washington DC.

I am indebted to a number of people. First of all, I would like to thank my advisor, Ulrich Kaiser, for encouraging me to start my Ph.D. studies and for his continued support and inputs throughout the entire project. The constructive advice and suggestions received from my second advisor, Nikolaj Malchow-Møller, are also highly appreciated. I am grateful to Thomas Elkjær for his support; both when he was my manager at Danmarks Nationalbank, and later when he joined the IMF. I am also thankful to my current manager at Danmarks Nationalbank, Niki Saabye, for his open-door policy and readiness to discuss any issue that was on my mind. I thank colleagues from Danmarks Nationalbank, the IMF, and the European Central Bank for countless fruitful discussions on topics related to the compilation and economic impact of FDI. Additionally, I have enjoyed the company of my fellow Ph.D. students at Danmarks Nationalbank, and I would like to express my gratitude to my "office mate", Allan Sall Tang Andersen, for exchanging ideas and making the days in the office enjoyable and inspiring. I thank Palle Bach Mindested, Lars Jul Overby, and Robert Wederkinck for regularly stopping by the office and for their interest and support in relation to my Ph.D. project. Finally, I have benefited from the enormous helpfulness of Robert Evans and his linguistic and general remarks on the thesis.

As always, any remaining errors are the responsibility of the author alone, and the views expressed in the thesis are those of the author and do not necessarily represent the views of Danmarks Nationalbank.

Copenhagen, March 2011

Jannick Damgaard

Table of Contents

Abstract

The thesis consists of an introduction and three essays related to the measurement of foreign direct investment (FDI) and its impact on the Danish economy; each essay is self-contained.

The first essay (*FDI and the External Wealth of Nations: How Important is Valuation?*) studies the importance of FDI equity valuation methods. The balance sheet approach used in macroeconomic analysis has increased the focus on stocks of external assets and liabilities, but different valuation practices for FDI positions make cross-country comparisons difficult. To enhance comparability, the recently adopted IMF Balance of Payments and International Investment Position Manual, Sixth Edition, introduces seven valuation methods for unlisted FDI equity. This essay identifies the most generally applicable methods in terms of data requirements and demonstrates, using the Danish international investment position (IIP), that both the choice of valuation method and estimation technique can still fundamentally change a country's external wealth data. For the Danish IIP, the application of different estimation techniques within the commonly used price-to-earnings method generates variation in FDI equity liabilities amounting to 131 percent of the Danish GDP, pointing to the need for further international harmonization. The price-to-book value method generates more robust market value estimates than the price-to-earnings method, suggesting that the valuation basis for the forthcoming Coordinated Direct Investment Survey — *own funds at book value* — will provide useful information for compiling the IIP.

The second essay (*Forecasting FDI Equity Income for the Danish Balance of Payments*) addresses the late and significant revisions that are often observed in FDI equity income in many countries, hampering the quality of preliminary balance of payments statistics. The empirical study tests a range of models on Danish data and finds that forecasts for FDI equity income based on a combination of past profitability and consensus data for changes in expected private consumption growth outperform forecasts solely based on historical profitability. When the refined models are applied to the Danish balance of payments, the largest improvements are observed for outward and inward FDI separately. Revisions of net FDI equity income only decrease marginally because the significant revisions in gross terms resulting from the historical models have a tendency to (partly) cancel out each other on a net basis.

The third and final essay (*Productivity Spillovers from FDI: Ownership Structures, Domestic Firm Characteristics, and FDI Characteristics*) is unique in testing the importance of the foreign ownership definition when estimating productivity spillovers from FDI to domestic firms; a crucial aspect in countries with a widespread use of holding companies. In

addition, it moves beyond the standard framework by not only analyzing aggregate productivity spillovers, but also testing the importance of both domestic firm characteristics and FDI characteristics. The empirical analysis is the first one to exploit the rich details offered by official Danish firm-level panel data. The analysis displays significant evidence of negative spillovers at the aggregate level, but the results differ widely across industries. It also reveals that not including firms under indirect foreign control in the group of foreign firms, as is done in some studies, leads to biased results. With regard to domestic firm characteristics, high export orientation and high competition mitigate some of the negative productivity spillovers. Finally, the estimations show that the negative spillovers largely stem from foreign firms (i) with low productivity, (ii) with high foreign trade orientation, and (iii) ultimately controlled by investors outside Scandinavia.

Dansk resumé (Abstract in Danish)

Afhandlingen består af tre essays, der omhandler måling af direkte investeringer og deres betydning for dansk økonomi; hvert essay kan læses selvstændigt.

Det første essay (*FDI and the External Wealth of Nations: How Important is Valuation?*) undersøger betydningen af metoderne, der benyttes til at værdisætte direkte investeringer. Brugen af balancetilgangen i makroøkonomisk analyse har øget fokus på beholdninger af aktiver og passiver over for udlandet, men forskelle i værdisætningsprincipperne gør det vanskeligt at sammenligne data på tværs af lande. For at forbedre sammenligneligheden har IMF i den nyligt publicerede betalings- og kapitalbalancemanual (*BPM6*) introduceret syv metoder til at værdisætte direkte investeringer i unoterede virksomheder. Dette papir identificerer de mest anvendelige metoder med hensyn til datatilgængelighed og viser med udgangspunkt i den danske kapitalbalance, at både valget af værdisætningsmetode og estimationsteknik stadig kan ændre data for kapitalbalancen fundamentalt. Anvendelsen af forskellige estimationsteknikker til beregning af det bredt anvendte kurs/indtjeningsforhold genererer en forskel i værdien af direkte investeringer (egenkapital, passiver) på 131 procent af det danske BNP og illustrerer dermed behovet for yderligere international harmonisering. Kurs/indre værdi er mere robust er kurs/indtjening, hvilket tyder på, at værdisætningsmetoden til IMF's kommende *Coordinated Direct Investment Survey* — indre værdi — vil indeholde værdifuld information til opgørelse af kapitalbalancen.

Det andet essay (*Forecasting FDI Equity Income for the Danish Balance of Payments*) omhandler de markante revisioner af formueindkomsten fra direkte investeringer i forbindelse med den årlige revision af betalingsbalancens løbende poster, som har en negativ effekt på anvendeligheden af de foreløbige opgørelser. Papiret tester en række modeller og konkluderer, at skøn for formueindkomsten fra direkte investeringer baseret på en kombination af historisk egenkapitalforrentning og ændringer i konsensusdata for den forventede forbrugsvækst er mere nøjagtige end de hidtidige skøn, der alene var baseret på den historiske egenkapitalforrentning. Når de nyudviklede modeller anvendes på den danske betalingsbalance, observeres de største forbedringer separat for udadgående og indadgående direkte investeringer. Revisioner på nettoformueindkomsten falder kun marginalt, da de store bruttorevisioner, som er resultatet af at anvende den hidtidige metode, har en tendens til (delvist) at udligne hinanden på nettobasis.

Det tredje og sidste essay (*Productivity Spillovers from FDI: Ownership Structures, Domestic Firm Characteristics, and FDI Characteristics*) er det første studie, der tester betydningen af definitionen af udenlandsk ejerskab i forbindelse med estimationen af produktivitetsfølgevirkninger fra udenlandsk til indenlandsk ejede firmaer; et vigtigt aspekt i

lande med en udbredt brug af holdingselskaber. Derudover bevæger det sig ud over standardrammerne ved ikke alene at teste produktivitetsfølgevirkninger på aggregeret niveau, men ved også at teste betydningen af både de indenlandsk og de udenlandsk ejede firmaers karakteristika. Den empiriske analyse er den første til at udnytte detaljerigdommen, som officielle danske paneldata på firmaniveau byder på. Analysen viser signifikante negative følgevirkninger på aggregeret niveau, men resultaterne varierer kraftigt på tværs af brancher. Den afslører også, at det fører til skæve resultater, hvis firmaer under indirekte udenlandsk kontrol ikke inkluderes i gruppen af udenlandsk ejede firmaer, som det er tilfældet i nogle studier. Med hensyn til de indenlandsk ejede firmaers karakteristika viser analysen, at en høj eksportorientering og høj konkurrence dæmper nogle af de negative produktivitetsfølgevirkninger. Endelig viser beregningerne, at de negative følgevirkninger hovedsageligt stammer fra udenlandsk ejede firmaer (i) med lav produktivitet, (ii) med høj import-/eksportorientering og (iii) ultimativt kontrolleret af investorer uden for Skandinavien.

Introduction

According to UNCTAD (2009), the world foreign direct investment (FDI) position rose nine-fold from 1990 to 2007, highlighting the growing importance of multinational enterprises (MNEs) in the world economy. Numerous theories have been presented to achieve a better understanding of the motives behind and the economic impact of FDI (see, e.g., Dunning, 1993; Görg and Greenaway, 2004). In attempts to test these theories empirically and as a widely used indicator of, for example, globalization and attractiveness, FDI statistics play a key role, which explains the high demand for these data.

Despite a strong interdependence between compilers and users of FDI statistics, the gap between the two groups is considerable. Users typically apply statistics directly without having a full understanding of the underlying concepts and without considering the accuracy of the statistics. For instance, many users are not aware that FDI statistics are, by definition, a set of financial statistics that may be heavily affected by capital in transit and therefore do not necessarily proxy real-economic impact (see, e.g., De Nederlandsche Bank, 2008). Moreover, due to coverage and other compilation issues, the accuracy and international comparability of FDI statistics are not perfect. For example, the Danish outward FDI position in Sweden shown in Danish FDI statistics is not necessarily equal to the inward FDI position from Denmark shown in Swedish FDI statistics even though the figures, in principle, should be identical.

While compilers appreciate the confidence of their users, it would be preferable if users had a deeper understanding of the statistics which they are using for their analyses. Keuning (1998) wonders why academic economists apparently take the national accounts, of which FDI constitutes an important element of the financial sector accounts, for granted. He hypothesizes that the System of National Accounts (UN et al., 1993) is perceived as a pure technical handbook with a seemingly endless list of boring definitions and that the mathematics involved is so simple and straightforward that the national accounts' real intellectual challenge is not appreciated. An alternative theory could be that with the complex theories and advanced econometric models used by academic economists, it is practical to have at least one given constant, i.e. the model input data. Regardless of the reason, it is obvious that users would benefit from understanding the details of the statistics they use.

Similarly, compilers should focus on user needs and openly share information about statistical methodology and the choices made in the production of the specific set of statistics. In recent years, the international statistical community has made significant advances with regard to increased international harmonization and development of the methodology for FDI statistics (OECD, 2008; IMF, 2009), but despite these important efforts, FDI statistics

still depend on the choices and interpretations of the individual compilers.

A key purpose of this thesis is to partly bridge the gap between FDI compilation on the one hand and the application of FDI statistics in economic analysis on the other. The first essay (*FDI and the External Wealth of Nations: How Important is Valuation?*) studies the importance of the valuation methods and estimation techniques used to estimate the market-equivalent value of unlisted FDI equity positions. While FDI and international investment position (IIP) statistics are often used for policy analyses, few users are aware of the impact that the compilers' choice of valuation method and technique has on external wealth data. To enhance cross-comparability, the IMF (2009) has introduced seven valuation methods for unlisted FDI equity, but the study presented in this essay reveals that both the choice of valuation method and estimation technique can still fundamentally change a country's external wealth data. For the Danish IIP, the application of different estimation techniques within the commonly used price-to-earnings method generates variation in FDI equity liabilities amounting to 131 percent of the Danish GDP, pointing to the need for further international harmonization as done in the IMF Coordinated Direct Investment Survey. If users are not aware of such issues, and if compilers do not share the information with users, the direct application of FDI statistics for cross-country comparisons could potentially be misleading.

The second essay (*Forecasting FDI Equity Income for the Danish Balance of Payments*) also deals with the compilation of FDI statistics and the importance of estimation techniques. Specifically, it addresses the large and late revisions that are often observed in FDI equity income in many countries, hampering the quality of preliminary balance of payments statistics. Due to resource constraints, FDI compilers often use simple methods solely based on historical information to forecast FDI equity income, which is one of the few balance of payments items where actual data can only be collected with a considerable time lag. The study tests refined model specifications and finds that the preliminary estimates can be improved by introducing a model that combines information about historical profitability with consensus forecasts for changes in expected consumption growth. This case study illustrates how economic modeling is used for the production of FDI statistics that, in turn, are used in many economic models, illustrating the interdependence between statistics compilation and economic analysis.

The third essay (*Productivity Spillovers from FDI: Ownership Structures, Domestic Firm Characteristics, and FDI Characteristics*) uses FDI/Foreign AffiliaTes Statistics (FATS) to estimate productivity spillovers from foreign firms to domestic firms. While this essay primarily is concerned with the application rather than the compilation of statistics, it also exploits the detailed information collected by statistics compilers to test the importance of the foreign firm definition. The empirical analysis reveals that not including firms under

indirect foreign control in the group of foreign firms, as is done in some studies, leads to biased results. Such a test can only be carried out if the underlying concepts of the statistics applied for the analysis are investigated in detail. The analysis reveals that productivity spillovers from foreign firms are generally negative, and by taking advantage of the detail level of the Danish data, it is found that the negative spillovers largely stem from foreign firms (i) with low productivity, (ii) with high foreign trade orientation, and (iii) ultimately controlled by investors outside Scandinavia.

In summary, this thesis addresses FDI compilation issues as well as the application of FDI statistics, thereby offering a contribution to the enormous task of reaching a better understanding of globalization and its impact on the economy.

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FDI and the External Wealth of Nations: How Important is Valuation?*

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Abstract

The balance sheet approach used in macroeconomic analysis has increased the focus on stocks of external assets and liabilities, but different valuation practices for foreign direct investment (FDI) positions make cross-country comparisons difficult. To enhance comparability, the recently adopted IMF Balance of Payments and International Investment Position Manual, Sixth Edition, introduces seven valuation methods for unlisted FDI equity. This paper identifies the most generally applicable methods in terms of data requirements and demonstrates, using the Danish international investment position (IIP), that both the choice of valuation method and estimation technique can still fundamentally change a country's external wealth data. For the Danish IIP, the application of different estimation techniques within the commonly used price-to-earnings method generates variation in FDI equity liabilities amounting to 131 percent of the Danish GDP, pointing to the need for further international harmonization. The price-to-book value method generates more robust market value estimates than the price-to-earnings method, suggesting that the valuation basis for the forthcoming Coordinated Direct Investment Survey — *own funds at book value* — will provide useful information for compiling the IIP.

JEL Classification Numbers: *C82, E01, F21*

Keywords: *Valuation methods, FDI, international investment position, macroeconomic statistical methodology, estimation techniques*

*The views expressed in this paper are those of the authors and do not necessarily represent the views of the IMF or Danmarks Nationalbank. An extended version of this paper, including additional practical advice for international investment position compilers, has been published as *IMF Working Paper WP/09/242: Valuation of Unlisted Direct Investment Equity*. The main part of this study was carried out in 2007-08 when Jannick Damgaard was visiting the Balance of Payments Division at the IMF's Statistics Department. The authors are grateful to Ralph Kozlow (Chief of the Balance of Payments Division at the IMF's Statistics Department) for guidance and many useful comments provided during the project.

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1 Introduction

The balance sheet approach is becoming widely used in macroeconomic analysis, in particular for vulnerability analysis. The external wealth of a nation, also known as the international investment position (IIP), constitutes an important part of the total national balance sheet for most countries. Similarly, foreign direct investment (FDI)[1] often makes up a major part of the IIP, but is also one of the most challenging items for the statistical compiler, making cross-country comparisons of FDI difficult. The challenges go beyond the usual compilation issues, e.g. coverage or sample frame, since the compiler in many cases has to estimate market-equivalent values for FDI. While it is well known that FDI has surged in the last two decades[2], it is much less known that the compiler's choice of valuation method and estimation technique can substantially affect the FDI figures and consequently the whole balance sheet of a country. For instance, Kozlow (2002) shows that applying different valuation methods can have a large impact on the US IIP.

The availability and quality of IIP data have increased rapidly in the past years, primarily driven by the IMF. The growing importance of balance sheet data is also reflected in the sixth and latest edition of the Balance of Payments and International Investment Position Manual (*BPM6*) (IMF, 2009), which applies an integrated approach to flows and stocks of funds. The concept of the IIP was introduced in the fourth edition of the Manual (IMF, 1977) while the fifth edition (IMF, 1993) presented a systematic IIP framework. In 1995, 25 countries reported IIP data to the IMF; by 2010, the coverage had increased to 118 reporting countries. In addition, Lane and Milesi-Ferretti (2001, 2007) have contributed significantly to the data availability by constructing external assets and liabilities estimates for 145 countries for 1970-2004 in the *External Wealth of Nations Dataset*.

These initiatives have given valuable insights into the financial wealth and exposure of nations, but additional work is still needed to give a more accurate picture. In this context, the *BPM6* features a shortlist of recommended methods to approximate market-equivalent values for unlisted FDI equity positions. The purpose of this paper is to investigate to what extent the shortlisted methods reduce the valuation issues. The effects of applying different valuation methods and estimation techniques are illustrated on the Danish IIP and are found to be highly significant. For instance, the variation in the FDI liability position corresponds to 131 percent of the Danish GDP as a consequence of using different

[1] FDI includes all cross-border investments between companies in an FDI relationship, which is defined according to control or significant influence; the operational threshold for significant influence is 10 percent equity ownership. Equity holdings below 10 percent by the investor are classified as portfolio investment. In practice, FDI enterprises are often fully-owned subsidiaries, which are not listed on exchanges.

[2] According to UNCTAD (2009), the world FDI position rose nine-fold from 1990 to 2007.

estimation techniques on the *BPM6*-recommended price-to-earnings method. This finding demonstrates that differences in country practices for valuing unlisted FDI equity make it difficult to achieve the important statistical objective of international symmetry, and thus points to a need for even narrower guidelines to ensure cross-country comparability of FDI and IIP data.

The remainder of this paper is organized as follows. Section 2 introduces the valuation methods recommended in the *BPM6* and discusses the treatment of liquidity, control value, and negative positions in macroeconomic statistics. In Section 3, the study design and data are presented while Section 4 estimates, compares and discusses the empirical models. The results are applied to the Danish IIP in Section 5. Section 6 concludes and offers suggestions for improving market value approximations and reducing bilateral asymmetries.

2 Valuation of Equity

The numerous theoretical models for equity valuation can be split into two types; absolute and relative valuation models. In absolute valuation models, equity value is determined only by the characteristics of the particular company. This value may or may not be equal to the market value, depending on the assessment of future earnings and risks compared to market expectations. Most absolute valuation models take a net present value approach. In relative valuation models, a company is valued at the same price as companies with similar characteristics since, for arbitrage reasons, similar assets must trade at similar prices.

2.1 Valuation in International Macroeconomic Statistical Manuals

Market value is the preferred valuation principle in the *BPM6* and other statistical manuals. The IIP consists of five main components: *(i)* FDI; *(ii)* portfolio investment; *(iii)* financial derivatives and employee stock options; *(iv)* other investment (mainly loans and deposits); and *(v)* reserve assets. Market values can be observed directly for most IIP components as they primarily consist of regularly traded financial instruments. For loans and deposits, valuation is also straightforward since nominal value is used as a proxy for market value.[3] FDI valuation, on the other hand, is much more complicated because it often consists of unlisted equity where market values are not directly observable and therefore must be estimated.

[3]According to the *BPM6* (paragraph 3.86), the use of nominal value is partly for pragmatic reasons such as data availability and symmetric cross-country recording, and also because nominal value constitutes the legal value in case of bankruptcy.

For position data, the term *market value* is defined as the value of assets or liabilities using closing market prices on the balance sheet reporting date. If financial instruments are not traded in a market or only traded infrequently, a market-equivalent value should be estimated instead. This value is also referred to as *fair value* and is defined in the following way:

> "*Fair value* is a market-equivalent value. It is defined as the amount for which an asset could be exchanged, or a liability settled, between knowledgeable, willing parties in an arm's-length transaction" (*BPM6*, paragraph 3.88).

To give guidance to compilers, the *BPM6* (paragraph 7.16), as a new feature, includes a list of seven[4] methods recommended for estimating market values of equity in unlisted FDI enterprises; the list includes both absolute and relative valuation methods. Some methods, e.g. *price to earnings* (P/E) and *price to book value* (P/B), are also commonly used by valuation practitioners whereas the method *own funds at book value* (OFBV) has been developed by macroeconomic statistics compilers in an attempt to reach a harmonized book value definition across countries and accounting standards. Table 1 provides an overview of the methods and their pros and cons; detailed descriptions of the methods can be found in *BPM6* (paragraph 7.16) and in Annex 7 of the Fourth Edition of the OECD Benchmark Definition of Foreign Direct Investment (BD4) (OECD, 2008).[5]

[4]The *BPM6* (paragraph 7.16) includes a list of only six methods, but the method presented in paragraph 7.16(c) can been seen as a combination of two methods, and these methods will be treated separately in this study.

[5]IMF will soon conduct a survey on country methodology in relation to the Coordinated Direct Investment Survey (CDIS), and questions on valuation methods will be included. It is expected that more than 130 countries will participate in the CDIS, and the methodology survey will give a unique overview of country practices that is not presently available.

Table 1: Overview of *BPM6*-recommended valuation methods

Method	**Name**	**Description**	**Advantages**	**Disadvantages**
A (absolute)	Recent transaction price	Use recent transaction price as market price	*(i)* Simple implementation for traded equity; *(ii)* Equals market price at time of transaction by definition	*(i)* Market prices can change rapidly; *(ii)* Not a general method because most unlisted equity is rarely traded
B (absolute)	Net asset value	Knowledgeable management or independent auditors' estimation of total assets minus liabilities (excluding equity) at current value	*(i)* Utilizes first-hand information about the company's value; *(ii)* Possible to take company-specific characteristics into account	*(i)* Unlikely that respondents use uniform valuation principles; *(ii)* Companies may have an incentive to report incorrect estimates for protectionist reasons
C1 (absolute)	Present value of earnings	Discount expected future earnings	*(i)* The theoretically best way to value equity; *(ii)* Possible to capture expectations to future earnings at company level	*(i)* Assumes that future earnings are known; *(ii)* Approximates fundamental value rather than market value
C2 (relative)	Price to earnings (P/E)	Apply P/E ratios from listed equity to unlisted equity	*(i)* Simple implementation; *(ii)* Based on actual market values	*(i)* Does not take company-specific characteristics into account; *(ii)* Assumes that a model based on listed equity can be transferred to unlisted equity
D (relative)	Price to book value (P/B)	Apply P/B ratios from listed equity to unlisted equity	*(i)* Simple implementation; *(ii)* Based on actual market values	*(i)* Does not take company-specific characteristics into account; *(ii)* Assumes that a model based on listed equity can be transferred to unlisted equity
E (absolute)	Own funds at book value (OFBV)	The sum of paid-up capital, reserves, cumulated undistributed net profits, and holdings gains and losses included in own funds	*(i)* Simple implementation; *(ii)* Promotes symmetric recording if used by all countries	*(i)* Book values do not necessarily reflect market values; *(ii)* Accounting principles differ across countries
F (absolute)	Apportioning global value	Prorate overall market value of listed group to individual entities	*(i)* Based on the actual market value of the specific group; *(ii)* Straightforward to make the estimations	*(i)* Difficult to find the best apportioning indicator; *(ii)* Not a general method because not all unlisted FDI enterprises are a part of a listed group

2.2 Issues Related Particularly to Valuation of Unlisted Equity

Valuation of unlisted equity compared to listed equity is further complicated by three issues: *(i)* liquidity; *(ii)* control value; and *(iii)* negative equity values.[6,7] These factors can have significant impact on the valuation and are discussed extensively in valuation theory, but are only briefly or indirectly mentioned in international macroeconomic statistical manuals. The issues apply to both absolute and relative valuation methods.

First, unlisted equity is typically characterized by a lower degree of liquidity than listed equity, meaning that unlisted equity is normally traded at a discount. The question is how this illiquidity discount should be treated according to international statistical manuals. The *BPM6* does not mention liquidity considerations in any of the seven recommended methods. Nevertheless, the overall valuation principle is that market-equivalent values should be estimated if market prices are not readily available. From this, it can be inferred that the illiquidity discounts on unlisted equity should be taken into account if they are significant. The *BD4* (paragraphs 521 and 525) explicitly mentions that market capitalization ratios may be adjusted for differences in liquidity.

Second, unlisted companies usually have few owners, often just one. A control premium is frequently paid when an investor obtains a controlling stake in a company because investors believe that they may be able to run the company more efficiently or achieve synergistic and strategic gains. The *BPM6* does not mention control premiums, but the *BD4* (paragraph 297) indirectly mentions how they are treated in its description of ways to avoid asymmetry in the recording of listed equity. This paragraph states that the use of market price quotations ensures that all shares are valued at the same price. In other words, a 10 percent stake of the equity in a company is to be valued relatively at the same price as a 90 percent stake. If an investor aims at acquiring another company, he would normally include a premium in his takeover bid to the existing shareholders if he could gain a controlling position in the target company. This seems to contradict international macroeconomic statistical manuals since the bid would depend on ownership share, indicating that, for instance, a 90 percent stake is valued at a relatively higher price than a 10 percent stake. However, one has to keep in mind that when an investor makes a bid to gain control of a company, the bid will usually be given to all current investors, regardless of their individual ownership share. Taking this

[6]This paper applies the asset/liability principle as presented in the *BPM6* standard components rather than the directional principle (see *BPM6*, paragraphs 6.42-6.43). Under the directional principle, a negative position could be recorded if, for example, a large reverse equity position existed between the FDI enterprise and its direct investor, or if cumulative retained earnings were negative.

[7]The empirical results presented in Sections 4 and 5 quantify the effects of including a liquidity variable and the impact of negative values. Kumah et al. (2009) discuss in detail the three issues and their importance for valuation of unlisted FDI equity.

view, it does make sense that all shares are valued at the same price.

Third, the valuation methods can generate negative positions, which are not normally consistent with the limited liability aspect of equity. For instance, the price-to-earnings method often generates negative market value estimates as earnings are volatile and frequently negative. It may be argued that such negative equity positions should not be recorded in the IIP as the direct investor would not be liable for losses exceeding the invested capital. On the other hand, many FDI enterprises are quasicorporations, such as branches and notional units created for statistical purposes, and the direct investor would be liable for the debt of these units. Moreover, FDI enterprises are often owned by a single direct investor who may recapitalize the FDI enterprise in times of financial distress. Also, sometimes direct investors are held liable for the losses of their FDI enterprises such as where they have provided an explicit guarantee, or where the FDI enterprise has caused damage or public harm. The *BPM6* (paragraph 7.19) allows the inclusion of negative FDI equity positions in the IIP, but individual country practices differ.

3 Study Design and Data

The purpose of this empirical study is to estimate valuation models based on the *BPM6*-recommended valuation methods and apply them to unlisted FDI equity to study the effect on the IIP. The *BPM6* provides open definitions of the relative valuation methods in the sense that it does not give specific recommendations regarding estimation techniques. Bilateral asymmetries between FDI positions within a given valuation method are possible if the estimation techniques do not produce robust results. For this reason, we prefer valuation methods that can be standardized and yield robust estimates within what compilers realistically can do given the data that are available for production of statistics.

3.1 Selection of Valuation Methods

While each method has different strengths and weaknesses, the empirical study in this paper will be limited to three of the seven *BPM6*-recommended methods: Two relative valuation methods — P/E (Method C2) and P/B (Method D) — and one absolute valuation method — OFBV (Method E), see Table 1. Compilers commonly use these three methods.

The two main reasons for limiting the study in this way are both related to data availability concerns. First, the methods must be based on publicly available information rather than the compiler's subjective assumptions about a company, for instance about expected future cash flows. Whereas the individual country compiler might be able to make such

assumptions in a somewhat uniform and consistent manner, it is much less likely to be the case for compilers across countries, potentially leading to bilateral asymmetries. Present value of earnings (Method C1) is eliminated because it requires assumptions about future earnings. Net asset value (Method B) is eliminated because it requires inside or first-hand information about the companies.

Second, the methods must be general in the sense that input data generally are available for most companies. Consequently, recent transaction price (Method A) is eliminated because a recent transaction price typically does not exist for unlisted equity. Apportioning global value (Method F) is also eliminated because not all unlisted FDI enterprises are a part of a listed group. The data requirements for the three remaining methods (P/E, P/B, and OFBV) are market values, earnings, and book values; these data are commonly available.

3.2 Data

Market values will typically only be available for listed companies since unlisted companies are rarely traded. Therefore, in line with standard practice for compilers, data for listed companies will be used to estimate the valuation models that are subsequently applied to unlisted equity under certain assumptions.[8] To eliminate valuation issues arising from the use of different datasets, the empirical test is limited to only one dataset: Bureau van Dijk's ODIN Database. It contains information about all public and private limited companies in Denmark, Finland, Norway, and Sweden with the exception of financial institutions and insurance companies. There are a total of 788 listed companies with a quoted closing price for December 2006 in the database.

The database contains numerous variables for each company, but only variables theoretically related to earnings potential and risks are included in this study, see Table 2. The variable concerning largest ownership share is included in the gross variable list to test whether companies with a dominant investor are valued at a higher price than other companies, see the discussion of the control premium in Section 2.2. Also, as mentioned earlier, since liquidity is likely to affect market value, a trading volume variable is included. The number of subsidiaries is included because the actual value of the subsidiaries may not be fully reflected in accounting data due to limited recording of intangibles. A company's age can be regarded as a risk measure based on the hypothesis that newly-started companies have a higher default risk because they have not been fully established and have not gained experience operating beyond the start-up phase.

[8]The application of the models to unlisted equity rests on four assumptions: *(i)* the law of one price; *(ii)* comparables exist; *(iii)* the models are transferable; and *(iv)* data projections outside the range of the input data can be made. Kumah et al. (2009) provide an in-depth discussion of these assumptions.

Table 2: Quantitative variables in the final dataset

Name	Unit	Description	Mean	Std.dev.	Min.	Max.
P	EUR million	Total market value of equity	1,042	4,052	0	63,388
B	EUR million	Own funds at book value	349	1,196	−3	11,124
E	EUR million	P/L before taxes	72	423	−637	7,404
VOL	EUR million	Equity trading volume in December	15,873	101,719	0	2,172,892
HOLD	Percent	Largest ownership share of total equity	28	20	0	90
SUBS	Number	Number of recorded subsidiaries	27	51	0	421
AGE	Years	Time from incorporation	26	26	0	110

Source: Calculations based on data from Bureau van Dijk's ODIN Database.

The detail level of the available data differs across companies. Consequently, the final dataset is reduced from the initial 788 companies to 682 companies, for which the basic variables, P and B, are available. When relevant data are missing, the company is dropped in the estimation, so the number of observations varies across models from 654 to 682.

Even though the models are developed only for the purpose of applying them to the Danish IIP, data for a total of four Nordic countries are used as input in the estimations. The depth in the Danish stock market is limited, especially at the industry group level, and by including data from markets similar to the Danish stock market, the estimations will be based on a larger number of observations. In broad terms, business potentials and risks are comparable in the four countries, and there are no capital restrictions for investors in these countries. Remaining country-specific differences such as earnings perspectives, risks, regulations, taxation, and accounting principles are picked up by a country dummy variable, distinguishing between Denmark and the other Nordic countries.

The models are only applied to the Danish IIP in this study, but they could also be applied to the IIPs of Finland, Norway, and Sweden. It would in fact be possible to estimate valuation models for most countries as the input data used for this study could be obtained for other countries from commercial data providers. For instance, the data from Bureau van Dijk's ODIN database used for this study only constitute a subset of the AMADEUS database, which covers most European countries. Nevertheless, we have chosen to solely apply the models to the Danish IIP in this study to focus on differences arising from the use of different valuation methods and estimation techniques in a single country using a single dataset. In other words, the focus is on valuation methods and estimation techniques rather than cross-country comparisons.

In addition to the quantitative variables, the dataset contains three qualitative variables:

(i) a country dummy variable, (ii) a dummy variable controlling for companies included in one of the Nordic main stock market indexes, and (iii) an industry classification variable (NACE rev. 1.1 industry), see Table 3. Detailed industry groups are desirable for the identification of peer groups because potential earnings and risks typically differ across industry groups. At the same time, the industry groups should contain a sufficient number of observations to reduce the amount of cases where a few companies can dominate the results. The 11-industry group breakdown recommendation from the Banque de France and Eurostat (2004) European Test Exercise is used as a starting point. When industry groups only include a few companies in the Nordic dataset, close industry groups are combined, resulting in six industry groups as indicated in the value column. This variable can also be used to construct industry group dummy variables.

Table 3: Qualitative variables in the final dataset

Variable	**Value**	**Description**	**NACE code**	**Frequency (%)**
DK:	1	Denmark	-	15
	0	Finland	-	18
	0	Norway	-	17
	0	Sweden	-	50
Index:	1	Included in main stock market index	-	10
	0	Not included in main stock market index	-	90
Industry:	1	Information and communication technology (ICT) activities	30, 313, 32, 332, 333, 642, 7133, 72	15
	2	Mining/energy	C + E	3
	2	Manufacturing (non-ICT)	D (except 30, 313, 32, 332, 333)	18
	2	Construction	F	1
	3	Trade	G	8
	3	Hotel/restaurants/transports/ communication (non-ICT)	H + I (except 642)	5
	4	Financial intermediation	65	7
	4	Insurance	66	0
	4	Financial and insurance auxiliaries	67	1
	5	Real estate/non-financial services (non-ICT/non-holdings)/others	K (except 7133, 72, 7415) + others	23
	6	Holdings	7415	20

Source: Calculations based on data from Bureau van Dijk's ODIN Database.

3.3 Estimation Techniques

3.3.1 Central Tendency Measures for Valuation Multiples

A range of central tendency measures can be calculated for P/E and P/B ratios, see Table 4. Ideally, all central tendency measures would yield identical results for each peer group because the single factor, E or B, would be able to explain all variation in market value across companies. In practice, the results will vary with the choice of central tendency measure. There is no general rule to determine the best measure; it depends on the distribution of the multiples, the proportion and size of the negative values, and the expected distribution of multiples for unlisted equity.

We use OFBV as the book value measure in the calculation of P/B ratios as suggested in the *BPM6* (paragraph 7.16 (d)) and earnings before taxes as the earnings measure for P/E ratios. In principle, valuation multiples are only defined when the denominator is positive. However, companies with non-positive earnings or OFBV may be included in the calculation of valuation multiples at industry group level as the industry sum of these variables is likely to be positive; companies with negative values are included in the *total summation* measure. Even though the calculation of valuation multiples is restrained to observations with positive denominator values, the multiples may in practice be applied to all companies even if they have negative earnings or OFBV. In this case, the method would yield negative market value approximations for equities in companies with negative earnings or OFBV and positive estimates for equities in companies with positive earnings or OFBV.

One of the main drawbacks of central tendency measures is that they only allow the direct inclusion of a single valuation factor. Nevertheless, additional factors, such as liquidity and control, could be introduced by applying correction factors from relevant studies to the estimated multiples.[9]

3.3.2 Regression Models

Unlike the central tendency measures, the regression approach allows the direct inclusion of several valuation factors. The fundamental idea of the regression approach is to estimate a simple ordinary least squares model with the valuation multiple as the dependent variable and a number of quantitative and qualitative variables related to future earnings and risks as independent variables. The regression model's results can subsequently be applied to unlisted FDI equity.

In a standard regression approach, the market values of companies are regressed on a

[9]Examples of studies on illiquidity discounts include Brennan et al. (1998), Damodaran (2005), Koeplin et al. (2000), and Nguyen et al. (2007). These discounts are typically in the range 20-40 percent.

Table 4: Central tendency measures for valuation multiples

Measure	**Formula**	**Excluded data**
Total summation	$\frac{P_i}{X_i} = \sum_{j=1}^{n} P_j \left(\sum_{j=1}^{n} X_j \right)^{-1}$	None
Positive summation	$\frac{P_i}{X_i} = \sum_{j=1}^{n} P_j \left(\sum_{j=1}^{n} X_j \right)^{-1}$	Listed companies where $X_j \leq 0$
Arithmetic mean	$\frac{P_i}{X_i} = \frac{1}{n} \sum_{j=1}^{n} \left(P_j \left(X_j \right)^{-1} \right)$	Listed companies where $X_j \leq 0$, and highest and lowest 5 percent of multiples
Weighted mean	$\frac{P_i}{X_i} = \sum_{j=1}^{n} \left(P_j^2 \left(X_j \sum_{j=1}^{n} P_j \right)^{-1} \right)$	Listed companies where $X_j \leq 0$, and highest and lowest 5 percent of multiples
Median		Listed companies where $X_j \leq 0$

Note: P denotes market value of equity; X earnings or $OFBV$; i unlisted companies; j listed companies in the peer group. The 5 percent outlier threshold applied in this study is in a sense arbitrary, but the purpose is to eliminate the effect of outliers, which particularly in small datasets can influence the parameter estimates of the regression models. The threshold will depend on the characteristics of the individual datasets.

number of covariates such as earnings, OFBV[10], liquidity, etc., but Kumah et al. (2009) demonstrate that the parameter estimates of level-based regression models on company data are biased due to scale effects and multicollinearity. This finding indicates that a data transformation is necessary.

Christie (1987) points out that return regressions should be used for analysis instead of level-based regressions, but in our case, the compiler needs to approximate market-equivalent values, which are level-based estimates. Barth and Kallapur (1996) recommend that scale effects are dealt with by deflating all variables by the true scale factor, but there is no general consensus regarding which variable is the true scale factor, meaning that this recommendation cannot be used directly in this study or by compilers in a standardized way. Veira (2006) argues that scale effects are a purely econometric phenomenon that is best solved by using logarithmic transformations of the model variables. However, log transformations can only be made for positive values and would exclude companies with negative earnings/OFBV from the estimation as well as in the application of the models. In addition, the intention is not to model correlations between variables, but to use the model to calculate levels, i.e.

[10]Ohlson (1995) develops a framework, in which both earnings and book value are included in the valuation model. The idea is that equity value can be regarded as a function of current book value and future earnings instead of discounted expected returns only.

market-equivalent values of the companies, for unlisted companies. Even if market value of equity is log transformed for the model estimation, it is still necessary to transform data back into non-logarithmic levels when the model has been applied, putting off the scaling problem to a later step in the process.

A solution to the transformation issue is to estimate regression models on valuation multiples rather than levels of market value of equity. If compilers observe robust multiples, i.e. low dispersion, a new variable consisting of company-specific multiples can be constructed and used in a multivariate regression analysis with valuation multiples as the dependent variable. The advantage of this approach is that the dependent variable in the standard regression approach, market value of equity, is then deflated with earnings or OFBV of the company, thus mitigating scale issues in the estimation. In addition, liquidity and other relevant variables can be included directly in the analysis.

4 Estimation of Valuation Models

4.1 Estimation of Valuation Multiples

The valuation models are first estimated based on the central tendency measures for P/E and P/B ratios, broken down by the six industry groups, see Table 5. A valuation method yielding robust central tendency measures, as measured by the dispersion, is desirable because it will promote symmetric valuations across countries. The dispersion of P/E ratios is considerably higher than for P/B ratios, which means that the compiler's choice of estimation technique has a large impact when the price-to-earnings valuation method (C2) is applied.[11] It is difficult to test reliability of valuation methods empirically, but we can conclude that at least some of the outcomes resulting from the application of the five P/E ratio central tendency measures would not be reliable since they differ significantly. The distributions of multiples are typically right-skewed because, for instance, the P/E ratio is only defined for companies with positive earnings. For this reason, the arithmetic mean in particular tends to be upwardly biased.

The general conclusion from Table 5 is that book value, as measured by OFBV, is a

[11] If debt financing ratios vary across the peer group, multiples on enterprise value (EV) are often used instead of equity value. EV is defined as the sum of market value of debt, common equity, and preferred equity minus the value of cash and investments. The idea is that EV measures are less sensitive to differences in financial leverage since the entire value of the company is taken into account and not just the equity (Koller et al., 2005). For EV multiples, earnings before interest and taxes (EBIT) are normally used as the earnings measure because EBIT, as a pre-interest figure, can be regarded as a flow to all providers of capital whereas net income only accumulates to the shareholders. Kumah et al. (2009) estimate EV/EBIT ratios and find these slightly more stable across central tendency measures than P/E ratios, but considerably less robust than P/B ratios.

Table 5: Central tendency measures for P/E and P/B ratios

	All	**Group 1**	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**
				P/E ratios			
Total summation	14.5	14.6	19.6	8.3	7.8	27.1	10.3
Positive summation	12.8	13.9	16.4	7.5	7.2	23.8	8.8
Arithmetic mean	40.5	41.4	34.0	35.3	30.9	42.0	53.8
Weighted mean	29.5	24.9	24.0	23.5	19.9	34.5	43.6
Median	20.7	30.5	21.6	15.2	11.3	27.1	24.0
Dispersion	216%	198%	107%	371%	329%	76%	511%
				P/B ratios			
Total summation	3.0	4.5	2.7	2.1	1.4	4.2	3.0
Positive summation	3.0	4.5	2.7	2.1	1.4	4.2	3.0
Arithmetic mean	3.6	3.8	3.5	3.7	2.7	3.7	3.5
Weighted mean	4.2	5.4	3.9	3.0	2.3	4.6	4.1
Median	2.7	2.9	2.9	2.5	1.5	2.6	2.9
Dispersion	56%	86%	44%	76%	93%	77%	41%

Note: Dispersion is defined as difference between highest and lowest measure in percent of lowest measure. *OFBV* is used as book value measure in the calculation of P/B ratios.

more robust variable than earnings for modeling market value of equity, and the use of P/B ratios for the valuation of unlisted FDI equity positions will *ceteris paribus* lead to more comparable market value estimates across countries than the use of P/E ratios.

4.2 Estimation of Regression Models

Since the different central tendency measures produce fairly robust results for P/B ratios, it seems reasonable to use a regression model based on company-specific P/B ratios to construct aggregate P/B ratios for the estimation of market-equivalent values for unlisted FDI equity. The advantage of this approach is the possibility of including multiple factors. No regression models on P/E ratios are estimated because of the large dispersion in the P/E central tendency measures, indicating that earnings cannot be regarded as a stable deflator for market value across companies.

Table 6 shows the results for a regression model with P/B ratios as the dependent variable. The quantitative and qualitative variables from Tables 2 and 3 have been tested, and only the significant variables have been included in the final model. Since the dependent variable has been scaled, a log transformation of trading volume ($LOGVOL$) is used. This liquidity variable as well as the stock market index variable ($INDEX$) display significant

Table 6: Regression model with P/B ratios as dependent variable

Variable	**Coefficient**	**Std. error**	***t*-value**	$P > \|t\|$	**[95% Conf.**	**interval]**
Constant	1.76	0.43	4.08	0.00	0.91	2.61
LOGVOL	0.13	0.04	2.98	0.00	0.04	0.21
INDEX	0.81	0.41	1.97	0.05	0.00	1.62
OFBV<200	0.99	0.30	3.35	0.00	0.41	1.57
DUM_IND4	−0.83	0.37	−2.23	0.03	−1.57	−0.10
Adjusted R^2	*0.04*					

Note: Companies with highest and lowest 5 percent of P/B ratios have been excluded prior to model estimation.

parameter estimates, illustrating the need to adjust valuation multiples for liquidity. Industry group dummy variables have been tested, but only the dummy variable for the industry group *financial intermediation and auxiliaries* (*DUM_IND4*) proved to be significant. The parameter estimate for this variable is negative, which means that companies belonging to this industry group *ceteris paribus* have lower P/B ratios than other companies. This finding may be explained by financial companies' tendency to revalue their assets and liabilities often, thus bringing OFBV more in line with market value and reducing the need for a P/B adjustment.

Finally, another dummy variable (*OFBV<200*) is included, distinguishing companies with OFBV below EUR 200 million from the rest. The variable has a significantly positive parameter estimate, i.e. higher P/B ratios for small companies than for large companies.[12] The relatively low valuation of large companies compared to small companies may be explained by the existence of a conglomerate discount (Berger and Ofek, 1995).

Trading volume is assumed to be insignificant for unlisted equity, and this parameter is consequently dropped in the application of the model. Thus, there will be four different P/B ratio estimates: *(i)* companies in the industry group *financial intermediation and auxiliaries* with OFBV below EUR 200 million (1.92); *(ii)* companies in other industry groups with OFBV below EUR 200 million (2.75); *(iii)* companies in the industry group financial intermediation and auxiliaries with OFBV of at least EUR 200 million (0.93); and *(iv)* companies in other industry groups with OFBV of at least EUR 200 million (1.76). On basis of the regression results, it is possible to construct P/B ratios that can be applied to unlisted equity. To find the market-equivalent value of an unlisted FDI enterprise, the P/B ratio estimate for its peer group is multiplied with the company's OFBV.

It is important to keep in mind that the model has a very low coefficient of determination,

[12]Different thresholds have been tested, and the threshold of EUR 200 million provided the most significant results.

as measured by the adjusted R^2. The P/B ratios vary significantly, and there is much unexplained variation in the model. However, if there is no systematic bias between listed and unlisted equity not already included in the model, it will yield reliable market value approximations on an aggregate level because of the law of large numbers.

5 Impact on the Danish IIP

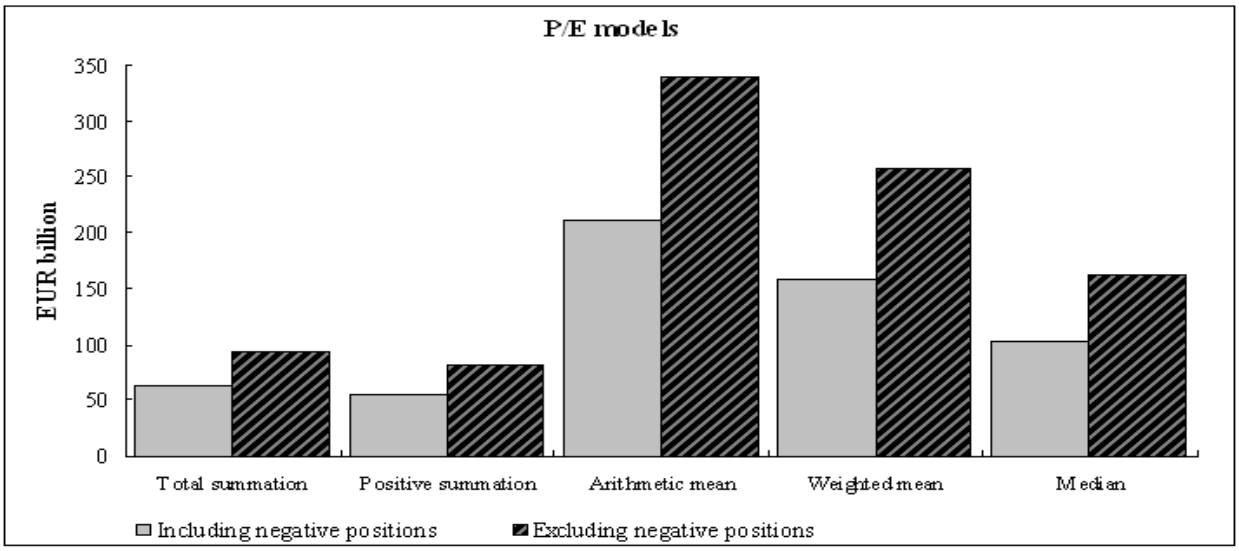
The Danish IIP is highly sensitive to both the choice of valuation method and estimation technique for unlisted FDI equity. Depending on this choice, the Danish external wealth can change from a net liability position of EUR 2 billion to a net asset position of EUR 52 billion. While these results are specific for Denmark, it is very likely that many countries are equally or more sensitive to differences in methods and techniques, for instance if they have large FDI positions. Denmark can be seen as a fairly representative case country with an open financial account, significant FDI asset and liability positions and data availability. According to UNCTAD (2009), Denmark had the 20th highest inward FDI position at end-2008.

Generally, the P/E models are less robust than the P/B models. P/E central tendency measures generate market-equivalent values of total unlisted FDI equity liabilities ranging from EUR 54 billion to EUR 340 billion, see Figure 1, the difference corresponding to 131 percent of the Danish GDP. Besides the choice of estimation technique, the treatment of negative positions is an important source for the variation in the unlisted FDI positions; 37 percent of the Danish enterprises displayed negative earnings in 2006. The treatment of negative positions play such a vital role for the P/E models because the negative earnings of unlisted companies are not dwarfed by the earnings of a few large-cap companies as seen for listed companies. The exclusion of negative positions leads to total FDI equity estimates that are more than 50 percent larger than estimates including negative positions. As mentioned in Section 2.2, the *BPM6* allows the inclusion of negative FDI equity positions, but country practices differ.

For the P/B models, the FDI estimates are considerably more stable, see Figure 2. Total market value estimates of unlisted FDI equity liabilities vary from EUR 101 billion to EUR 186 billion, the discrepancy corresponding to 39 percent of the Danish GDP. The difference of 84 percent between the highest and lowest estimates is still high, but much smaller than the difference of 530 percent observed for the P/E models.

OFBV is included in Figure 2 for illustrative purposes. In principle, it could be seen as a special case of the P/B model where the ratio by definition equals 1, which is exactly what makes it an absolute valuation model rather than a relative valuation model as the

Figure 1: Value of unlisted FDI equity liabilities in the Danish IIP at end-2006 (P/E models)



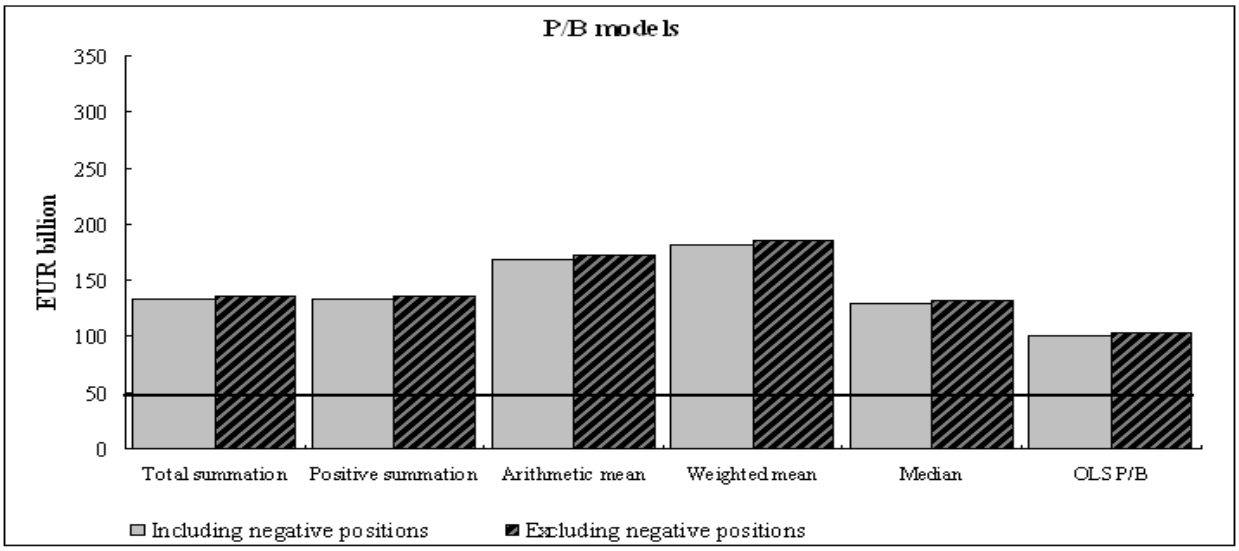
Note: Estimates for financial institutions and insurance companies are not incorporated in calculations since these companies are not included in the Bureau van Dijk ODIN Database.

P/B models. The application of the P/B models consistently generates higher FDI estimates than OFBV (Method E), most likely because accounting standards only capture intangibles to a limited extent; OFBV may consequently underestimate market values. Therefore, while OFBV promotes cross-country comparability, it does not necessarily lead to reliable market value approximations.

As was the case for the P/E models, the estimation techniques based on means produce the highest FDI estimates for the P/B models. The arithmetic mean is upwardly biased because it is affected by the skewness in the distribution of P/B ratios while the weighted mean is upwardly biased because of the significant influence of a few large companies included in major stock market indexes. Even though almost 15 percent of the unlisted FDI enterprises display negative OFBV, it only makes a small difference whether negative FDI equity positions are included in the application of the P/B models. The simple reason is that there is a limit to how negative OFBV can get before the company is forced to close down or restore the equity capital by authorities or creditors in order to stay in business. Consequently, the negative OFBV are relatively small compared to the positive OFBV.

The empirical results in this study suggest that book value, as measured by OFBV, is a better predictor than earnings for the modeling of market-equivalent values because of the comparatively low variation in P/B ratios. In other words, P/B ratios are more robust, are better valuation indicators, and thus produce more reliable market value estimates than the earnings multiples. Since P/B ratios, on average, are higher than 1, the use of unadjusted

Figure 2: Value of unlisted FDI equity liabilities in the Danish IIP at end-2006 (P/B models)



Note: The horizontal line indicates the sum of OFBV including negative positions. Estimates for financial institutions and insurance companies are not incorporated in calculations since these companies are not included in the Bureau van Dijk ODIN Database.

OFBV would underestimate the market-equivalent value of unlisted FDI equity. The favored model in the case of Denmark is the regression model on P/B ratios because this model, contrary to the central tendency measures, allows the direct inclusion of liquidity and size variables.

Naturally, the application of different valuation models will not just affect the FDI estimates, but the total Danish IIP. For simplicity, the IIP effects are only shown in detail for the favored model, i.e. the P/B regression model. Since the models are only estimated for FDI equity liabilities, it is assumed that the adjustment of FDI equity assets is proportional to the adjustment of FDI equity liabilities. The application of the P/B regression model results in a significant improvement of Denmark's overall external financial position, which changes from a net liability position of EUR 2 billion to a net asset position of EUR 8 billion, see Table 7. Denmark's total external assets would increase by 14 percent while liabilities would increase by 12 percent compared to the published figures, which for unlisted FDI equity are based on OFBV valuation. The asymmetric effect on total assets and liabilities can be ascribed to the fact that Denmark has a positive net position in FDI equity.

The potential impact of the choice of valuation method and estimation technique is even larger than shown in Table 7. For instance, the Danish net liability position of EUR 2 billion would change to a net asset position of EUR 52 billion if the compiler used the arithmetic mean measure for P/E ratios instead of OFBV (Method E) and excluded negative positions.

Table 7: Danish IIP at end-2006 depending on valuation method for unlisted FDI equity

Valuation method	**Financial instrument**	**Assets**		**Liabilities**		**Net assets**	
OFBV	FDI equity	79		67		12	
(Published data)	All other	374		388		-15	
	Total	453		455		-2	
P/B	FDI equity	142	(79%)	119	(79%)	22	(+10)
(Market-equivalent value)	All other	374	(0%)	388	(0%)	-15	(+0)
	Total	515	(14%)	508	(12%)	8	(+10)

Note: Amounts in EUR billion. The total adjustment of FDI equity assets is assumed to be proportional to the adjustment of FDI equity liabilities; no market-value adjustments are made for financial institutions and insurance companies.

Conversely, the net liability position would only change marginally from EUR 2 billion to EUR 1 billion if the compiler used the valuation model based on the positive summation measure for P/E ratios.

While it is crudely assumed above that the adjustments to assets are proportional to the liabilities adjustments, the large effects on the FDI positions clearly illustrate that moving from OFBV to other market value approximations can have a significant impact on IIP data and the net financial position of a country. The net effect is likely larger for countries with large net FDI positions, which is typically the case for emerging markets, or for countries that observe considerable differences between P/B ratios for FDI equity assets and liabilities. The latter situation could occur if the local GAAP in a country required companies to revalue their assets and liabilities more often than companies in other countries, thereby reducing the need for adjustments of the FDI equity liabilities compared to the assets.

6 Conclusions and Recommendations

In response to the increase in the use of the balance sheet approach for macroeconomic analysis and the practical difficulties associated with approximating market-equivalent values for FDI equity, the *BPM6* has introduced specific valuation guidelines. While the inclusion of the valuation guidelines in the *BPM6* serves an important purpose[13], our empirical study shows the need to reduce the number of recommended methods and, equally important, the room for interpretation within each method to enhance cross-country consistency. The analysis based on Danish data shows that OFBV is a more robust variable than earnings for

[13]The *BPM5* recommended the use of market values, but did not provide guidelines on how to estimate the market value of unlisted FDI equity

modeling market value of equity.

The analysis demonstrates a clear risk that cross-country asymmetries can occur due the choices of valuation method and estimation technique. One way to achieve the goals of *(i)* reduced asymmetries and *(ii)* better market value approximations is to establish a set-up that allows IIP compilers to share their experiences and valuation models with each other. For instance, if every country developed models for the valuation of unlisted FDI equity liabilities and shared them with other IIP compilers, much progress could be made on the two goals. First, it is conceivable cross-country asymmetries would be reduced if most compilers use the same model to value FDI enterprises resident in a given country. Second, it can be argued that the quality of the estimates would be improved if the valuation models were to be estimated by compilers with extensive knowledge about the specific country.

To promote consistency in estimates of bilateral FDI positions, the IMF recommends the use of OFBV as the valuation principle for unlisted FDI equity in the Coordinated Direct Investment Survey (CDIS), which is currently being implemented by the Statistics Department of the IMF. This symmetric valuation principle could give IIP compilers a valuable tool to detect asymmetries in coverage. In addition, the recommendation to use OFBV as valuation principle is in line with this study's conclusion that P/B ratios should be used to value unlisted FDI equity. If P/B models are estimated for all countries, the CDIS will be able to provide the necessary input data to approximate market-equivalent values for unlisted FDI equity positions in all participating IMF member states based on a consistent valuation principle. Such an initiative would indeed be a valuable contribution to the analysis of the external wealth of nations.

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Forecasting FDI Equity Income for the Danish Balance of Payments*

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Abstract

Late and significant revisions are often observed in foreign direct investment (FDI) equity income in many countries, hampering the quality of preliminary balance of payments statistics. We test a range of models on Danish data and find that forecasts for FDI equity income based on a combination of past profitability and consensus data for changes in expected private consumption growth outperform forecasts solely based on historical profitability. When the refined models are applied to the Danish balance of payments, the largest improvements are observed for outward and inward FDI separately. Revisions of net FDI equity income only decrease marginally because the significant revisions in gross terms resulting from the historical models have a tendency to (partly) cancel out each other on a net basis.

JEL Classification Numbers: *C53, C82, E01*

Keywords: *Forecasting, balance of payments, FDI, investment income, macroeconomic statistical methodology*

*The views expressed in this paper are those of the authors and do not necessarily represent the views of Danmarks Nationalbank. The authors are grateful to Niels Haldrup (CREATES, Aarhus University) for inspiration and practical advice regarding the choice of model specification. They thank Piet Philip Christiansen for collecting a vast number of financial data for the purpose of the analysis. The paper also benefits from constructive suggestions from participants at the joint Eurostat/ECB FDI Workshop in November 2009. Finally, the authors highly appreciate the helpful comments received on earlier drafts of the paper from Allan Sall Tang Andersen, Bent Christiansen, Robert Evans, Niels Lynggård Hansen, Ulrich Kaiser, Nikolaj Malchow-Møller, Niki Saabye, and two anonymous referees. Any remaining errors are the responsibility of the authors alone. The paper is forthcoming in the *Review of Income and Wealth.*

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1 Introduction

The outcome of the annual revision of the Danish balance of payments is published in October every year. As in many other countries, the largest revisions in the current account can frequently be attributed to foreign direct investment (FDI) equity income in the previous year, see Figure 1. The gross revisions are particularly large, but net FDI equity income is often revised significantly as well, directly affecting the current account balance. Large revisions of preliminary statistics cast doubt on the data and hamper the analytical usefulness of these statistics.

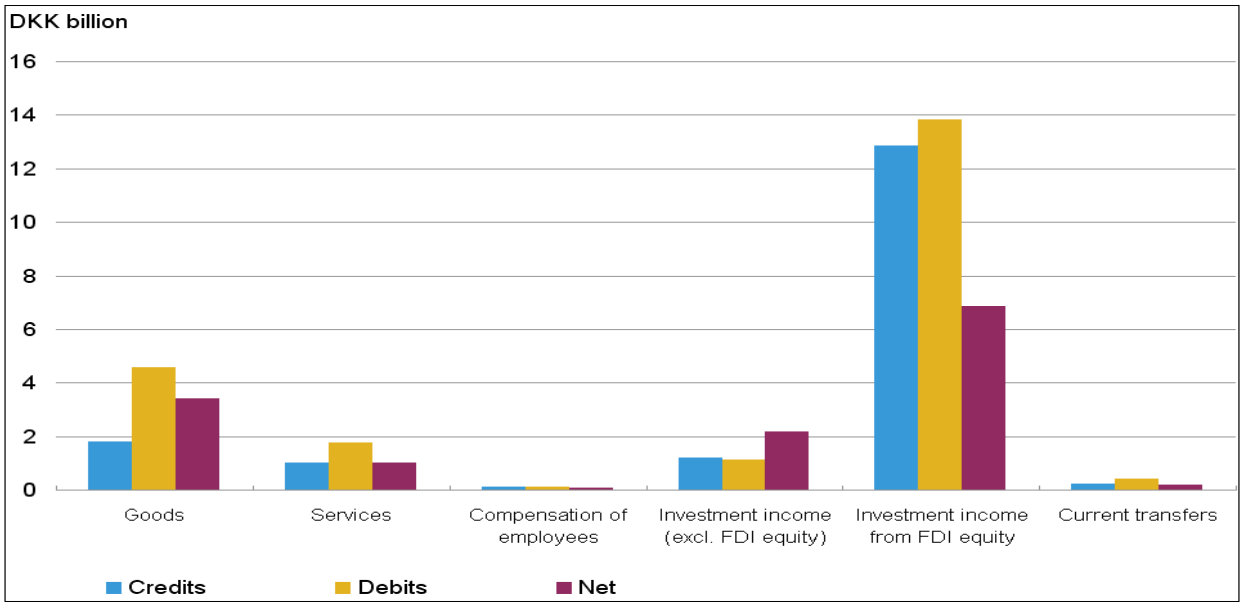
The late and significant revisions in FDI equity income have become common since the Fifth Edition of the IMF Balance of Payments Manual *(BPM5)* (IMF, 1993) introduced the estimation of reinvested earnings on FDI equity. Whereas most other data used for compilation of the preliminary monthly balance of payments are collected from reporters in time to be included in the first assessment, actual data for total FDI equity income, and thereby reinvested earnings, are normally obtained from the reporting companies' annual financial statements. These statements are only available with a considerable time lag, and therefore FDI equity income needs to be forecasted for the preliminary balance of payments. Box 2.5 of the Fourth Edition of the OECD Benchmark Definition of Foreign Direct Investment (*BD4*) (OECD, 2008) recognizes that this practice leads to large revisions across countries.

A survey conducted by the ECB and Eurostat in 2009 confirms that most EU countries only receive annual income statements from the reporting companies. This is also the case in Denmark where only listed companies are obliged to publish quarterly financial statements, but since most FDI enterprises are not listed, companies are only required to report their total profits annually. Even in the minority of countries where companies report quarterly income statements, there is still a need to forecast FDI equity income for the monthly balance of payments.

The ECB/Eurostat survey also reveals that the majority of countries base their preliminary FDI equity income estimates purely on historical information. Following this practice, the forecast model for FDI equity income used in the Danish balance of payments until December 2009 was based on a 3-year moving average for the profitability of FDI enterprises. Some countries use a combination of historical information and income growth indicators, but so far, no best practice seems to be in place.

The purpose of this study is to test refined forecast models that include a range of indicators in addition to past performance to correct for turning points in the general economic conditions. To our knowledge, this study is the first one to systematically estimate various return on equity (*ROE*) correction models on a large number of financial and macroeconomic

Figure 1: Average absolute current account revisions for 2006-08



Note: Every year in October, preliminary Danish current account figures for the previous year are revised. The figure shows the average of these revisions in absolute terms broken down by the main current account components.
Source: Authors' calculations based on official balance of payments publications from Statistics Denmark.

indicators, including consensus forecasts, and to methodologically evaluate these. We find consensus data for changes in expected private consumption growth to be the strongest predictor for the development in profitability. The refined models based on expected private consumption growth changes outperform the 3-year moving average models as well as simple models solely based on performance in the latest available period. On average, the revisions of outward and inward FDI equity income are significantly reduced, whereas the impact on net revisions is smaller.

The remainder of this paper is organized as follows. Section 2 explains how FDI equity income should be recorded in the balance of payments according to the international macroeconomic statistical manuals. In Section 3, the specifications of the refined forecast models are introduced, and the results of the empirical modeling are presented in Section 4. Comparisons between the refined models and the simpler models are made in Section 5 to quantify the impact of implementing a new forecast method for the preliminary Danish balance of payments. Section 6 concludes the paper.

2 Recording FDI Equity Income

According to the international macroeconomic statistical manuals in the area of FDI[1], income on equity between companies in an FDI relationship is recorded in the balance of payments in the following way:

$$INC_t = RIE_t + D_t, \tag{1}$$

where INC_t denotes FDI equity income in year t, RIE_t reinvested earnings in year t, and D_t dividends payable in year t. In a balance of payments context, FDI equity income is ideally compiled according to the current operating performance concept (COPC), which focuses on the net operating surplus and excludes all valuation changes such as exchange rate changes and realized gains/losses from the disposal of financial assets/liabilities. It also excludes writing-off of intangible assets (including goodwill) due to unusual events, writing-off of research and development expenditures capitalized in a prior period, provisions for losses on long-term contracts, etc. (*BPM6*, paragraph 11.43; *BD4*, paragraph 208). In practical terms, reinvested earnings are calculated as a residual item and are included as imputed transactions in both the income and financial accounts of the balance of payments.[2] Reinvested earnings may be negative in case of high dividends or negative net operating earnings.

Typically, dividends payable will be reported throughout the year whereas information about total FDI equity income is available only after the publication of the companies' annual financial statements. In Denmark, reporting on the profitability of FDI enterprises takes place annually within five months from the end of the financial year. As the monthly balance of payments is published with a lag of 40 days, it is necessary to forecast FDI equity income until the actual data become available.

Like a number of other EU countries (Foreign Direct Investment Task Force, 2004), Denmark applies an all-inclusive concept for FDI equity income rather than the COPC. Many countries choose to apply the all-inclusive concept rather than the COPC for two reasons. First, the reporting burden has to be considered, and it is easier for companies to

[1]FDI statistics are currently compiled on basis of the Fifth Edition of the IMF Balance of Payments Manual (BPM5) and the Third Edition of the OECD Benchmark Definition of Foreign Direct Investment (BD3) (OECD, 1996). In 2008-09, however, the IMF and the OECD released new and fully consistent editions of the international standards, also known as *BPM6* (IMF, 2009) and *BD4*, which will be implemented in the coming years. The guidelines for recording FDI equity income have only changed slightly from *BPM5/BD3* to *BPM6/BD4*; we will refer to the new manuals in this study.

[2]For portfolio investment, with the exception of investment fund shares, investment income only includes dividends and not reinvested earnings (*BPM6*, paragraph 11.104). *BPM6* (paragraph 11.41) explains why equity income is defined differently for FDI than for portfolio investment: *"The rationale behind the treatment of reinvested earnings on direct investment is that, because a direct investment enterprise is, by definition, subject to control, or influence, by a direct investor or investors, the decision to retain and reinvest some of its earnings within the enterprise represents an investment decision on the part of the direct investor(s)".*

report profits according to the all-inclusive concept rather than to the COPC because the former are readily available from their annual financial statements. Second, the all-inclusive concept offers better validation possibilities than the COPC because the reported figures can be checked directly against the figures in the publicly available financial statements.

Investment income defined according to the all-inclusive concept will be more volatile than income defined according to the COPC due to the inclusion of valuation (price, exchange rate, or other) changes, in particular resulting from unusual events, and is thus likely to be more difficult to predict. Nevertheless, reporters to the Danish balance of payments are instructed to exclude extraordinary gains and losses from FDI equity income. The definition of extraordinary income and expenses in the Danish GAAP is rather restrictive and only includes income and expenses originating from events that do not fall within the ordinary activities and are therefore not expected to be recurring. Examples of such events are unexpected natural disasters and expropriation.

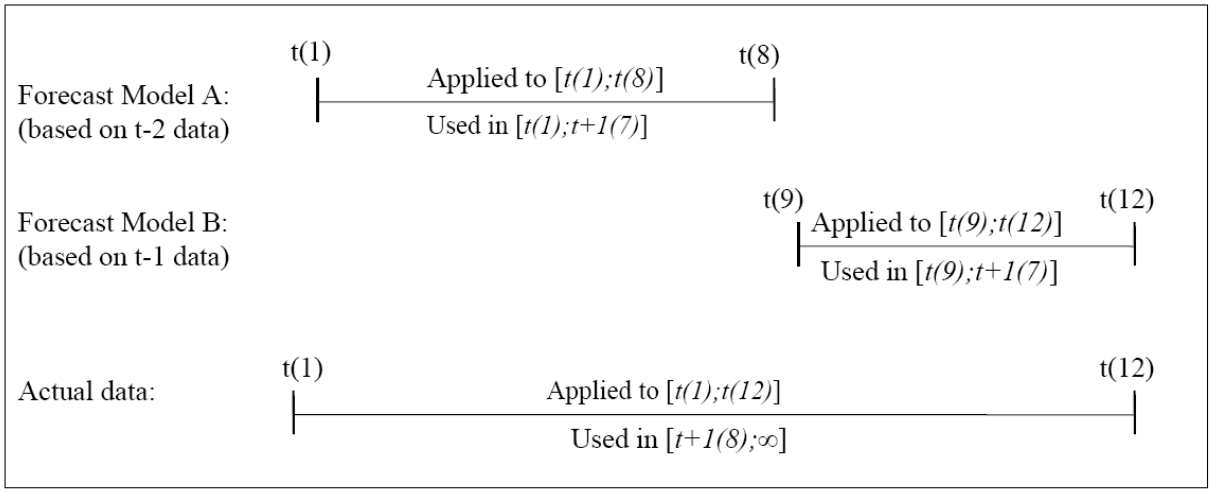
The international macroeconomic statistical manuals are generally based on the accrual principle, but since no reliable distribution indicator is available, the actual annual income for a given FDI enterprise is distributed evenly throughout the year in the Danish balance of payments.[3] Still, total FDI equity income may differ from month to month as the population of FDI enterprises continuously changes due to M&A activity.

As a result of the late availability of final accounting data on FDI enterprises' profitability, it is necessary to estimate two models that can be used to forecast FDI equity income in year t until the actual data become available, see Figure 2. Forecast Model A is based on data from year $t-2$ and is used to construct forecasts for the period $[t(1); t(8)]$, i.e. January to August. In contrast, Forecast Model B is based on data from year $t-1$ and is used to make forecasts for the period $[t(9); t(12)]$, i.e. September to December. The actual data for year t are incorporated in the annual revision in October of the following year with the first publication of $t+1(8)$ data.[4]

[3]Some countries choose to apply interpolation methods to avoid abrupt changes between data in the last months of a year and the first months of the following year.

[4]Even though the annual financial statements are available five months after the end of the financial year, the final data are not ready to be included in the published data until the detailed data validation process is finalized in October. For technical reasons, $t-1$ data can only be used in the forecast models when $t(9)$ data are published in November. The regular Danish balance of payments revision policy only allows revisions of the two previous months when the balance of payments for a given month is first published. As our analyses using the empirical models have shown that the effect of revising the two previous months is minimal in practice, we only calculate one preliminary estimate for each month. To simplify, we do not take into account the fact that the account dates of a minority of reporting companies do not follow the Gregorian calendar year.

Figure 2: Use of input data in forecast models



Source: Authors' schematization.

3 Specifications of Forecast Models

3.1 Moving Average Models

The forecast model for FDI equity income applied in the Danish balance of payments until December 2009 was exclusively based on a 3-year moving average (*MA3*) for past performance. Initial forecasts for *ROE* ratios in month m of year t were calculated at company level in the following way:

$$E\left[ROE_{t(m),j,A,MA3}\right]_{t(m)} = \frac{1}{12}\sum_{t=-4}^{-2}\left(\frac{INC_{t,j}}{0.5\left(EQ_{t-1,j}+EQ_{t,j}\right)}\right)/3, \tag{2}$$

where $INC_{t,j}$ and $EQ_{t,j}$ denote the FDI equity income and the end-of-period position, respectively, for company j in a given year. The subscript A denotes Forecast Model A, meaning that this model was used to make the preliminary estimates for January to August as illustrated in Figure 2. When actual data for year $t-1$ became available, the model was based on data for the period $[t-3; t-1]$. The positions used for the calculation of *ROE* ratios were estimated as an average of the initial and final FDI annual positions. The use of the arithmetic mean for the calculation of monthly *ROE* ratios rather than the geometric mean may have caused a slight, general upward bias in the forecasts. Since extreme *ROE* ratios are often observed at company level, estimated *ROE* observations were adjusted if they were above or below certain thresholds.

3.2 Refined Models

The refined forecast models proposed in this paper are also based on *ROE* ratios rather than on investment income directly because *ROE* ratios, unlike FDI equity income, are stationary.[5] The econometric literature (see, for instance, Granger and Newbold, 1974) has long emphasized that models estimated on non-stationary data often lead to spurious correlations, also termed nonsense correlations. Whereas both types of models are based on *ROE* ratios, the refined models differ from the moving average models in two important ways. First, in order to avoid the extreme *ROE* ratios often observed at company level, the refined models are estimated at country/industry group level for outward/inward FDI equity. The estimated *ROE* ratios can be applied to new FDI enterprises entering the population. Even though some kinds of new investment take several years to start producing equilibrium levels of income, it seems reasonable to apply the *ROE* ratios based on existing companies as most new FDI takes the form of brownfield rather than greenfield FDI.

The second and most important deviation is that the refined models follow the recommendations of the report of the EMI Sub-group 4 of the BOP Financial Flows and Stocks Task Force (1997) and include macroeconomic and financial indicators in order to reflect turning points in the economy in the estimation of *ROE* ratios. In practice, the refined models compute expected *ROE* ratios as the sum of the latest available *ROE* ratio and a correction term. As will be seen below, this specification can be regarded as a difference transformation of the data and is in line with the recommendations of Granger and Newbold (1974).

To illustrate the calculation and use of *ROE* ratios, we first introduce a simple model, in which the *ROE* ratio in a given period is assumed to be equal to the observation for the corresponding month in year $t-2$ or $t-1$, depending on data availability, to take into account seasonal patterns. Even though investment income is equally distributed throughout the year, there may be seasonal effects in the *ROE* ratios. For instance, Danish companies typically pay out dividends in March-May, which would *ceteris paribus* have a negative effect on positions and consequently lead to higher *ROE* ratios in these months.[6] The *ROE* ratio

[5] It may be argued that the *ROE* ratios in general will be upwardly biased because unlisted FDI equity positions are included in the Danish international investment position at *own funds at book value*, which may be lower than the actual market value due to the lack of registration of many intangible assets in international accounting standards (Kumah, Damgaard and Elkjær, 2009). However, the valuation principle is constant over time and will consequently only affect the scale of the *ROE* ratios, but not the forecasted investment income.

[6] As mentioned in Section 2, reinvested earnings are recorded in both the income and financial accounts. In case of high dividends, reinvested earnings have a tendency to be negative and thus lead to a decrease in positions.

for Forecast Model A in the simple version is given by:

$$E\left[ROE_{t(m),c,i,A,simple}\right]_{t(m)} = ROE_{t-2(m),c,i} = \frac{INC_{t-2(m),c,i}}{0.5\left(EQ_{t-2(m-1),c,i} + EQ_{t-2(m),c,i}\right)}, \quad (3)$$

where c and i denote country and industry groups, respectively. When $t-1$ data become available for the publication of $t(9)$ data, these data will be used instead of $t-2$ data. Forecast Model B is similar to Forecast Model A with the only exception being that it is based on $t-1$ data instead of $t-2$ data. As dividends and other flows such as capital injections/withdrawals, M&A activity, and valuation changes are reported/calculated on a monthly basis, positions including reinvested earnings can be estimated by applying the *ROE* ratios.

The simple model has the obvious weakness that it does not take business cycle changes into account. When the economy goes into a recession, last year's *ROE* ratio is likely to be upwardly biased and vice versa. Such turning points in the economy can be incorporated into the models by including a correction term. We specify a model for the correction term, which is defined as the difference between the actual *ROE* ratio and the latest available *ROE* ratio. The correction terms (CT) used in Forecast Model A for a certain country/industry group are computed for all periods available in the dataset in the following way:

$$CT_{t(m),c,i,A} = ROE_{t(m),c,i} - ROE_{t-2(m),c,i}. \quad (4)$$

The calculation of past correction terms is based on actual data for both year t and $t-2$. There will be eight observations per year for the estimation of Forecast Model A as actual data for the previous year will be available for the estimation in period $t(9)$ onwards. Conversely, there will be four observations per year for the estimation of Forecast Model B, for which the correction terms are defined as:

$$CT_{t(m),c,i,B} = ROE_{t(m),c,i} - ROE_{t-1(m),c,i}. \quad (5)$$

We have now constructed data for past correction terms, and the next step is to estimate models that will be able to predict the correction terms needed when simply applying the latest available *ROE* ratios. These models will be used as components in the refined Forecast Models A and B, respectively, and are specified in the following regression models:

$$CT_{t(m),c,i,A} = \alpha_{c,i,A} + \beta_{c,i,A} x_{t(m),c,i,A} + \varepsilon_{c,i,A} \quad (6)$$

$$CT_{t(m),c,i,B} = \alpha_{c,i,B} + \beta_{c,i,B} x_{t(m),c,i,B} + \varepsilon_{c,i,B}, \quad (7)$$

where x indexes the macroeconomic/financial variable that will be used to predict the changes in the *ROE* ratios. As the dependent variable, i.e. the correction terms, is defined as a change variable, all input variables will be differenced. Forecast Model A considers changes from year $t-2$ to t whereas Forecast Model B focuses on changes from year $t-1$ to t.

Forecast Models A and B are based on monthly rather than annual data. Since we are essentially interested in estimating 1/12 of the annual FDI equity income every month, it may be argued that the application of monthly models will inflate the number of observations and artificially lead to more significant parameter estimates. However, one could argue that this is a logical consequence of trying to forecast annual profits before the end of the year.[7] An alternative solution would have been to estimate models on actual annual data and rescale them before applying them to monthly data. On the other hand, actual data for a given year will not be available when the models have to be applied; only forecasts for the macroeconomic variables and year-to-date values for financial variables such as stock market changes are available at that point in time. These data can only be regarded as proxies for the actual annual data. If the models were to be estimated on actual annual data, we would consequently use proxies (forecast and year-to-date data) for the correction term proxies (actual annual data for changes in the general economic and financial conditions) when applying the model. In addition, "actual" data are often revised; such revisions can significantly change the results and make it even more difficult to choose the proper "actual" data to be used in the models (see, for instance, Croushore and Stark, 2001). By estimating monthly models, we use the available monthly data in the estimation as well as in the application of the models.

The parameter estimates are assumed to be time-invariant, but the estimates may change marginally when new data are added to the model. As the between-year differences in data are expected to be more significant than within-year differences, autocorrelation within a year is anticipated. Autocorrelation will lead to underestimated standard errors in a standard OLS estimation, but we adjust for this by calculating heteroscedasticity and autocorrelation consistent standard errors as proposed by Newey and West (1987). Moreover, the data have been detrended by using *ROE* ratios rather than total FDI equity income and by specifying

[7] In case of intra-year turning points in the business cycle, the consensus forecasts for the whole year are likely to change significantly. When the models are applied, such changes will be picked up by the independent variables and will hence be reflected in the forecasts, but, due to the Danish revision policy, the changes can in principle be reflected in the estimates for the two previous months, the current month, and the remaining months of the year. If drastic changes in the economic outlook occurred late in the year, the regular revision policy would thus not allow us to revise income estimates for the first part of the year. Nevertheless, the models will not overcompensate for this by deviating from the 1/12 distribution principle in the latter part of the year in an attempt to mitigate the annual revisions of the balance of payments because it would be at the expense of higher revisions of the monthly balance of payments data. Instead, in case of a significant turning point, extraordinary revisions of the first months would be the proper solution.

a difference model rather than a level model in order to remove general time trends from the data.

The correction terms used in Forecast Models A and B are estimated on all available historical data. When we are in period $[t(1); t(8)]$, actual company data will not be available for that period. Consequently, Forecast Model A computes the *ROE* ratio used to forecast FDI equity income in a given month in year t as the sum of the *ROE* ratio in the corresponding month in year $t-2$ and the expected correction term:

$$E\left[ROE_{t(m),c,i,A,refined}\right]_{t(m)} = ROE_{t-2(m),c,i} + E\left[CT_{t(m),c,i,A,refined}\right]_{t(m)}. \tag{8}$$

When we reach period $t(9)$, actual data for year $t-1$ will be available. Forecast Model B uses these data to construct forecasts for the period $[t(9); t(12)]$ in the following way:

$$E\left[ROE_{t(m),c,i,B,refined}\right]_{t(m)} = ROE_{t-1(m),c,i} + E\left[CT_{t(m),c,i,B,refined}\right]_{t(m)}. \tag{9}$$

The *ROE* ratios can be used to forecast FDI equity income as well as FDI equity positions. If the projections of positions are incorrect, the forecast for the investment income would in principle also be incorrect even if the forecasted *ROE* ratio for a given month is correct. This situation might occur late in the year if the *ROE* estimates for the first months of the year were incorrect, for instance due to imperfect early consensus forecasts for the economic developments, thus leading to incorrect position estimates. However, the possible projection errors on positions are likely to be relatively small as other financial flows are reported/estimated on a monthly basis, which means that the possible position projection errors could be attributed to reinvested earnings alone.[8]

4 Empirical Modeling of Forecast Models

4.1 Data

Our dataset comprises *(i)* company data reported to Danmarks Nationalbank for balance of payments and international investment position statistics aggregated at country/industry group level and *(ii)* macroeconomic and financial indicators reflecting general economic conditions. Company data are available for the period 1999-2008, with annual data being available for the period 1999-2004 and monthly data for the period 2005-08. We construct

[8]Positions at the end of a period are calculated as the sum of *(i)* initial positions; *(ii)* transactions (balance of payments flows); *(iii)* exchange rate changes; *(iv)* price changes; and *(v)* other changes in volume. *ROE* ratios can only feed in the forecast of reinvested earnings recorded as additional investments, i.e. only on account of *(ii)*.

Table 1: Aggregation levels used for the forecast models

Group	**Code**	**Description**	**Position**
Country group:	EU/EFTA	Countries in the EU/European Free Trade Association	323.2
(Outward FDI)	NAFTA	Countries in the North American Free Trade Agreement	36.0
	ROW	Rest of the world and not allocated	70.3
Industry group:	DK1	Manufacturing, energy, materials, and utilities	50.4
(Inward FDI)	DK2	Trade, transportation, and consumer goods	163.3
	DK3	ICT and finance	111.3

Note: The last column gives the total FDI equity position in DKK billion for each group at end-2008.

monthly data for the period 1999-2004 by distributing FDI equity income and other flows evenly throughout the year. This allows us to estimate Forecast Model A on data for the period 2001-08 since $t-2$ data are needed as input for this model. Similarly, Forecast Model B can be estimated on data for the period 2000-08. Naturally, it would have been useful to base the model estimations on a longer time series, but additional data are not available at the necessary level of detail in the case of Denmark.

According to NBER's determination of American business cycles, the dataset covers two peaks (March 2001 and December 2007) and one trough (November 2001). Bordo and Helbling (2003) find that national business cycles have become increasingly synchronized, and this conclusion validates the decision to aggregate data across countries in this study. The benefit of aggregation is that it makes the estimations less vulnerable to extreme *ROE* observations for countries, in which Danish companies have established only a few FDI enterprises. The models were initially tested on more disaggregated country/industry breakdowns, but due to the relatively small number of observations, such detailed *ROE* ratios were too dependent on individual specific company circumstances. In addition, by limiting the number of models, the burden of maintaining and applying the models in the monthly production of balance of payments statistics will be kept at a reasonable level. Whereas the models for outward FDI equity are estimated for three country groups, the models for inward FDI equity are estimated for three industry groups, see Table 1.

With regard to macroeconomic and financial indicators used for the estimation of correction terms, we include a number of possible variables in the data, see Table 2. The macroeconomic indicators are expected to have an impact on FDI enterprises' profitability in the short run. The financial indicators include developments in stock indexes and interest rates. The former are expected to reflect earnings potentials of companies whereas the latter, as a measure of financing costs, will have a direct impact on profitability.

The macroeconomic indicators used in this study are consensus forecasts from *Consensus*

Table 2: Basic indicators in the data

Indicator	**Description**	**Data**	**Type**
GDP	Gross domestic product	Consensus forecast	Growth rate
CON	Private consumption	Consensus forecast	Growth rate
INV	Investment	Consensus forecast	Growth rate
CP	Corporate profits	Consensus forecast	Growth rate
IP	Industrial production	Consensus forecast	Growth rate
MMIR	3-month money market interest rate	Actual data	Ratio
BBS	Broad-based stock index	Actual data	Level

Economics Inc. that predict the growth for the whole year since we are basically interested in forecasting 1/12 of the annual profits every month. New consensus forecasts are available every month. By including consensus forecast data in the models, we use other forecasters' predictions directly as input for our forecasting models. The variables used in Forecast Model A should in principle reflect the changes from year $t-2$ to year t while the variables used in Forecast Model B should represent changes from year $t-1$ to year t. Regarding financial indicators, we do not rely on forecasts, but only use actual data. Mose (2005) finds that consensus forecasts for financial indicators often contain very little information. In fact, he finds that the "naive" forecast of unchanged levels is more precise than consensus forecasts for bond yields and exchange rates. For this reason, we use year-to-date data for the financial indicators as a proxy for the development over the entire year. However, new data will be available every month so that updated information will be added to the independent variables throughout the year.

Changes between periods can be calculated in many different ways, and we thus construct a large number of variables based on the basic macroeconomic and financial indicators. The independent variables in the models consist of the basic indicator name and an extension, indicating how the variable is constructed, see Tables 3 and 4. For the macroeconomic indicators, we use growth variables directly as well as variables reflecting changes in growth rates. With regard to the financial indicators, we include a range of year-to-date variables, but also a number of lagged variables because financial markets often respond more quickly to new developments than does the real economy.

Since we estimate models for country groups rather than individual countries, we use weighted macroeconomic and financial indicators. For the EU/EFTA countries, the indicators are computed as the average of the national indicators for the five largest destinations for Danish FDI equity in this country group, namely Germany, Norway, Sweden, Switzerland, and the UK. The calculation of NAFTA indicators is also based on the relative size of Danish FDI equity in the specific group of countries so that the national US indicators weigh 2/3

Table 3: Construction of independent variables for Forecast Models A for reference period $t(m)$

Extension	**Model**	**Raw variable type**	**Construction of variable**	**New variable unit**
_AG1	A	Growth rate	$\left(1+E\left[x_{t/t-1}\right]_{t(m)}\right)\left(1+E\left[x_{t-1/t-2}\right]_{t-1(12)}\right)-1$	Percent
_AG2	A	Growth rate	$\left(1+E\left[x_{t/t-1}\right]_{t(m)}\right)\left(1+E\left[x_{t-1/t-2}\right]_{t-1(m)}\right)-1$	Percent
_AG3	A	Growth rate	$E\left[x_{t/t-1}\right]_{t(m)}+E\left[x_{t-1/t-2}\right]_{t-1(12)}-E\left[x_{t-2/t-3}\right]_{t-2(12)}$	Percentage points
_AG4	A	Growth rate	$E\left[x_{t/t-1}\right]_{t(m)}+E\left[x_{t-1/t-2}\right]_{t-1(m)}-E\left[x_{t-2/t-3}\right]_{t-2(m)}$	Percentage points
_AG5	A	Growth rate	$E\left[x_{t/t-1}\right]_{t(m)}-E\left[x_{t-1/t-2}\right]_{t-1(12)}-E\left[x_{t-2/t-3}\right]_{t-2(12)}$	Percentage points
_AG6	A	Growth rate	$E\left[x_{t/t-1}\right]_{t(m)}-E\left[x_{t-1/t-2}\right]_{t-1(m)}-E\left[x_{t-2/t-3}\right]_{t-2(m)}$	Percentage points
_AR1	A	Ratio	$x_{t(m)}-x_{t-2(12)}$	Percentage points
_AR2	A	Ratio	$x_{t(m)}-x_{t-2(m)}$	Percentage points
_AL1	A	Level	$\left(x_{t(m)}\right)/\left(x_{t-2(12)}\right)-1$	Percent
_AL2	A	Level	$\left(x_{t(m)}\right)/\left(x_{t-2(m)}\right)-1$	Percent
_AL3	A	Level	$\left(x_{t-1(12)}\right)/\left(x_{t-3(12)}\right)-1$	Percent
_AL4	A	Level	$\left(x_{t(m)}\right)/\left(x_{t-2(12)}\right)-\left(x_{t-2(12)}\right)/\left(x_{t-4(12)}\right)$	Percentage points
_AL5	A	Level	$\left(x_{t(m)}\right)/\left(x_{t-2(m)}\right)-\left(x_{t-2(12)}\right)/\left(x_{t-4(12)}\right)$	Percentage points
_AL6	A	Level	$\left(x_{t-1(12)}\right)/\left(x_{t-3(12)}\right)-\left(x_{t-2(12)}\right)/\left(x_{t-4(12)}\right)$	Percentage points

Note: The calculations in the table are performed for all the basic indicators (see Table 2), and the resulting variables are used in the estimation of Forecast Models A.

Table 4: Construction of independent variables for Forecast Models B for reference period $t(m)$

Extension	**Model**	**Raw variable type**	**Construction of variable**	**New variable unit**
_BG1	B	Growth rate	$E\left[x_{t/t-1}\right]_{t(m)}$	Percent
_BG2	B	Growth rate	$E\left[x_{t/t-1}\right]_{t(m)} - E\left[x_{t-1/t-2}\right]_{t-1(12)}$	Percentage points
_BG3	B	Growth rate	$E\left[x_{t/t-1}\right]_{t(m)} - E\left[x_{t-1/t-2}\right]_{t-1(m)}$	Percentage points
_BR1	B	Ratio	$x_{t(m)} - x_{t-1(12)}$	Percentage points
_BR2	B	Ratio	$x_{t(m)} - x_{t-1(m)}$	Percentage points
_BL1	B	Level	$\left(x_{t(m)}\right) / \left(x_{t-1(12)}\right) - 1$	Percent
_BL2	B	Level	$\left(x_{t(m)}\right) / \left(x_{t-1(m)}\right) - 1$	Percent
_BL3	B	Level	$\left(x_{t-1(12)}\right) / \left(x_{t-2(12)}\right) - 1$	Percent
_BL4	B	Level	$\left(x_{t(m)}\right) / \left(x_{t-1(12)}\right) - \left(x_{t-1(12)}\right) / \left(x_{t-2(12)}\right)$	Percentage points
_BL5	B	Level	$\left(x_{t(m)}\right) / \left(x_{t-1(m)}\right) - \left(x_{t-1(12)}\right) / \left(x_{t-2(12)}\right)$	Percentage points
_BL6	B	Level	$\left(x_{t-1(12)}\right) / \left(x_{t-2(12)}\right) - \left(x_{t-2(12)}\right) / \left(x_{t-3(12)}\right)$	Percentage points

Note: The calculations in the table are performed for all the basic indicators (see Table 2), and the resulting variables are used in the estimation of Forecast Models B.

and the national Canadian indicators 1/3. The ROW group consists of many countries and is rather heterogeneous. In lack of a self-evident variable, we use the EU/EFTA indicators for the ROW group. Finally, we also use the EU/EFTA indicators in the estimation of the Danish models rather than Danish data. The reason is that a large proportion of Danish FDI enterprises are export-oriented (Statistics Denmark, 2009) and are thus more exposed to the economic developments in the EU/EFTA countries than to the Danish business cycle itself. Moreover, Dam (2008) finds that Danish business cycles to a large extent are harmonized with European business cycles.[9]

Before the models are estimated, we remove certain observations from the data in order to ensure that the models are estimated for homogeneous groups of companies. First, we take out data for special purpose entities (SPEs), which in the Danish balance of payments are defined as pass-through companies with little or no economic activity in Denmark. The FDI income is balanced for these companies to ensure that they have a neutral effect on the primary income account in the balance of payments. Second, we remove a handful of special companies that have earnings patterns which cannot be explained by the developments in the general economic conditions. Examples include companies with extraordinarily lucrative patents or property rights for natural resources. These companies are defined as having annual profits in excess of DKK 1 billion and *ROE* ratios above 35 percent in at least three consecutive years including the most recent. The profits of these companies are rather stable over time so the latest observation for FDI income can be used as an approximation for the FDI income in the current period. In case of changing conditions, the estimates for the special companies can be adjusted by using information on dividend payouts and quarterly financial statements if available.

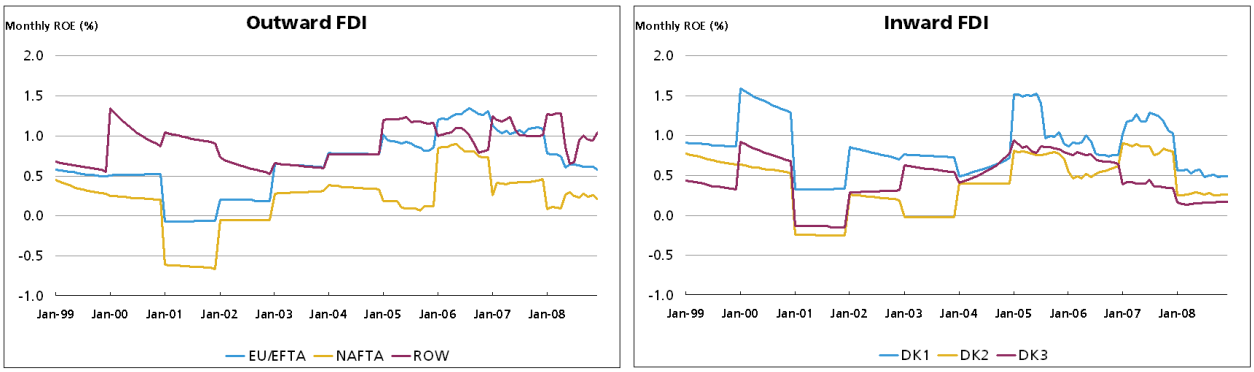
The impact of including independent variables and the sizes of the parameter estimates are expected to differ across the models. For instance, companies selling consumer goods are likely to be more sensitive to the growth in private consumption than pharmaceutical companies. Similarly, the profitability of FDI enterprises located in different countries may be impacted differently by macroeconomic and financial developments.

4.2 Estimation Results

In general terms, the evolution of *ROE* ratios for FDI equity seems to be synchronized with business cycles, see Figure 3. The ratios moved from a high level in the end of the 1990s and 2000 to a low level in connection with the trough in 2001 and increased gradually thereafter until the peak in 2007. When the downturn started by the end of 2007, it

[9]Consensus forecasts for corporate profits are only available for Canada, the UK, and the US. Hence, only UK data will be used for this variable in the EU/EFTA, ROW and industry group models.

Figure 3: Evolution of *ROE* ratios for FDI equity



Note: For the period 1999-2004, monthly data have been constructed on the basis of actual annual data while actual monthly observations are available from January 2005.

had an immediate negative effect on *ROE* ratios. These harmonized trends indicate that macroeconomic and financial data can be used in the prediction of FDI equity income.

In order to find the best predictor for the development in *ROE* ratios, i.e. the correction term, we estimate univariate versions of Equations 6 and 7 with every constructed independent variable. The results of these estimations can be found in Tables 5 and 6 and reveal that the performances of the independent variables vary across models as expected. Nevertheless, some variables perform well in most cases, for instance private consumption. Interestingly, variables based on changes in private consumption growth turn out to be better predictors for the development in *ROE* ratios than consumption growth itself. The reason is that changes in consumption growth are better than consumption growth at predicting the sharp falls in *ROE* ratios that are observed when the downturn sets in.

For Forecast Models B, the variable based on year-to-year changes in expected private consumption growth is the best indicator, whereas a variable calculated as the current year's expected consumption growth minus the sum of consumption growth in the two previous years performs best in Forecast Models A. While Forecast Models B use acceleration/deceleration in expected private consumption growth directly, Forecast Models A do this in an indirect way. The correction terms resulting from the application of Forecast Models A will be positively affected by promising outlooks for consumption in the current year compared to the past years. It makes intuitive sense that the models yield high correction terms, i.e. an upward adjustment of the historical *ROE* ratio, in case of high expected consumption growth in the current year and low growth rates in the past two years.

Overall, private consumption performs slightly better than the other macroeconomic indicators. This finding may be explained by the structure of FDI in the case of Denmark. For instance, inward FDI equity is concentrated in industries that are highly exposed to

Table 5: R^2 values for Forecast Models A depending on input variable

Variable	EU/EFTA	NAFTA	ROW	DK1	DK2	DK3	Average
GDP_AG1	0.20	0.01	0.26	0.01	0.01	0.30	0.16
GDP_AG2	0.24	0.01	0.21	0.02	0.03	0.36	0.18
GDP_AG3	0.01	0.12	0.55	0.05	0.04	0.02	0.07
GDP_AG4	0.10	0.06	0.54	0.00	0.00	0.13	0.11
GDP_AG5	0.60	0.58	0.03	0.14	0.24	0.47	0.42
GDP_AG6	0.30	0.41	0.30	0.08	0.14	0.17	0.24
CON_AG1	0.56	0.05	0.13	0.21	0.30	0.61	0.42
CON_AG2	0.56	0.08	0.11	0.20	0.35	0.56	0.43
CON_AG3	0.05	0.05	0.39	0.00	0.00	0.09	0.07
CON_AG4	0.14	0.00	0.34	0.00	0.03	0.14	0.12
CON_AG5	**0.76**	**0.61**	**0.03**	**0.25**	**0.53**	**0.40**	**0.55**
CON_AG6	0.31	0.32	0.14	0.09	0.23	0.08	0.23
INV_AG1	0.09	0.04	0.36	0.00	0.00	0.17	0.10
INV_AG2	0.08	0.01	0.22	0.00	0.00	0.17	0.08
INV_AG3	0.01	0.03	0.70	0.10	0.11	0.00	0.10
INV_AG4	0.03	0.01	0.57	0.02	0.01	0.06	0.08
INV_AG5	0.49	0.50	0.00	0.14	0.18	0.55	0.36
INV_AG6	0.23	0.30	0.37	0.15	0.13	0.25	0.22
CP_AG1	0.07	0.16	0.32	0.11	0.18	0.04	0.12
CP_AG2	0.06	0.21	0.26	0.09	0.22	0.00	0.11
CP_AG3	0.01	0.37	0.11	0.00	0.03	0.00	0.04
CP_AG4	0.01	0.22	0.30	0.00	0.00	0.02	0.04
CP_AG5	0.00	0.33	0.08	0.10	0.18	0.00	0.07
CP_AG6	0.07	0.26	0.01	0.03	0.04	0.03	0.06
IP_AG1	0.14	0.00	0.35	0.00	0.00	0.22	0.12
IP_AG2	0.17	0.01	0.28	0.00	0.01	0.27	0.14
IP_AG3	0.00	0.12	0.65	0.05	0.03	0.01	0.08
IP_AG4	0.04	0.06	0.60	0.01	0.00	0.08	0.09
IP_AG5	0.55	0.60	0.02	0.13	0.17	0.51	0.39
IP_AG6	0.37	0.44	0.26	0.12	0.18	0.26	0.29
MMIR_AR1	0.20	0.22	0.11	0.01	0.05	0.26	0.16
MMIR_AR2	0.41	0.04	0.06	0.09	0.15	0.51	0.30
BBS_AL1	0.17	0.09	0.33	0.09	0.21	0.03	0.16
BBS_AL2	0.01	0.00	0.48	0.13	0.13	0.00	0.09
BBS_AL3	0.05	0.17	0.42	0.02	0.01	0.11	0.09
BBS_AL4	0.58	0.36	0.13	0.22	0.45	0.42	0.45
BBS_AL5	0.41	0.22	0.36	0.38	0.55	0.31	0.41
BBS_AL6	0.24	0.05	0.53	0.34	0.45	0.18	0.30

Note: The table displays R^2 values resulting from estimations of Equation 6 with different independent variables. The average R^2 value is weighted by end-2008 positions.

developments in consumption, see Table 2. It may seem surprising that expected corporate profits growth does not give more explanatory power to the models than is the case because this variable represents directly what we are trying to measure. However, it may be more difficult to forecast this variable than GDP components such as private consumption and investment, which could explain the relatively poor performance by this variable. In addition, forecasts for corporate profits are only available for a few countries, meaning that the data used in the models are not necessarily representative for the country/industry groups with the exception of the NAFTA group.

Table 6: R^2 values for Forecast Models B depending on input variable

Variable	EU/EFTA	NAFTA	ROW	DK1	DK2	DK3	Average
GDP_BG1	0.00	0.12	0.08	0.07	0.05	0.01	0.03
GDP_BG2	0.38	0.52	0.01	0.25	0.27	0.22	0.30
GDP_BG3	0.36	0.51	0.02	0.25	0.26	0.20	0.28
CON_BG1	0.02	0.03	0.09	0.19	0.04	0.01	0.04
CON_BG2	**0.49**	**0.41**	**0.01**	**0.38**	**0.33**	**0.20**	**0.36**
CON_BG3	0.49	0.38	0.00	0.38	0.30	0.21	0.35
INV_BG1	0.00	0.00	0.22	0.03	0.02	0.04	0.03
INV_BG2	0.41	0.38	0.19	0.22	0.21	0.18	0.30
INV_BG3	0.34	0.38	0.26	0.23	0.20	0.13	0.27
CP_BG1	0.10	0.39	0.09	0.41	0.44	0.05	0.20
CP_BG2	0.17	0.73	0.02	0.56	0.27	0.14	0.23
CP_BG3	0.16	0.73	0.03	0.52	0.29	0.13	0.22
IP_BG1	0.00	0.11	0.13	0.05	0.03	0.01	0.03
IP_BG2	0.45	0.55	0.05	0.31	0.27	0.30	0.35
IP_BG3	0.39	0.51	0.05	0.27	0.24	0.24	0.30
MMIR_BR1	0.05	0.31	0.01	0.26	0.16	0.03	0.10
MMIR_BR2	0.03	0.28	0.01	0.22	0.14	0.01	0.07
BBS_BL1	0.35	0.08	0.18	0.17	0.15	0.05	0.22
BBS_BL2	0.36	0.10	0.20	0.26	0.20	0.08	0.25
BBS_BL3	0.00	0.06	0.11	0.03	0.03	0.00	0.02
BBS_BL4	0.27	0.16	0.01	0.04	0.03	0.05	0.14
BBS_BL5	0.36	0.20	0.02	0.11	0.07	0.10	0.20
BBS_BL6	0.20	0.07	0.03	0.11	0.20	0.21	0.17

Note: The table displays R^2 values resulting from estimations of Equation 7 with different independent variables. The average R^2 value is weighted by end-2008 positions.

The variables based on stock market developments and money-market interest rates are sound predictors, but they are outperformed by the best performing macroeconomic variables. A possible explanation for this is that the financial indicators only contain year-to-date data rather than data for the entire year as the latter are not available when the models have to be put into effect. In general, the lagged financial variables do not perform as well as the year-to-date financial variables.

We choose to apply univariate models with an identical independent variable across country/industry groups to forecast FDI equity income as the estimations of univariate models have shown that it is possible to find a variable that performs consistently well across models, namely changes in expected private consumption growth. The Ramsey (1969) RESET test has been carried out for each model, and the results generally support the chosen model specifications. Multivariate specifications have been tested, but multicollinearity is an issue in all such specifications because the independent variables to a large degree convey the same information. A high correlation between the different macroeconomic indicators was expected, but a correlation analysis also reveals that the preferred variable for Forecast Models A, *CON_AG5*, has a correlation of almost 0.9 with the second best predictor, the financial variable *BBS_AL4*. As a positive side effect, the simplicity of the chosen models makes it

Table 7: Regression models for correction terms based on data for the period 2000/01-2008

	EU/EFTA	**NAFTA**	**ROW**	**DK1**	**DK2**	**DK3**
	Forecast Models A					
Constant term	1.36	1.66	0.24	0.63	1.01	0.81
t-value	*9.09*	*6.91*	*1.25*	*1.97*	*4.07*	*3.95*
CON_AG5	0.54	0.41	0.08	0.30	0.44	0.38
t-value	*10.73*	*8.43*	*0.96*	*2.72*	*4.48*	*6.26*
R^2	0.76	0.61	0.03	0.25	0.53	0.40
	Forecast Models B					
CON_BG2	0.32	0.29	0.02	0.40	0.34	0.23
t-value	*5.91*	*3.94*	*0.29*	*2.94*	*3.37*	*1.75*
R^2	0.49	0.41	0.01	0.38	0.33	0.20

Note: Forecast Models A and B are based on Equations 6 and 7, respectively.

easy to implement them in the monthly production of the Danish balance of payments.

The final models are presented in Table 7. There are no constant terms in Forecast Models B as these were insignificant. This insignificance was anticipated as the variable based on changes in consumption growth is expected to be stationary with a mean of zero. In all models with the exception of the ROW models, the prediction power, measured by R^2, exceeds 0.20 and the independent variable is significant even when the standard errors are corrected by the Newey and West (1987) procedure. The prediction power is low for the heterogeneous ROW group, indicating that the refined ROW models cannot be expected to perform significantly better than the simple ROW models. However, due to comparatively small positions (see Table 2) and low variation in *ROE* ratios for the ROW group (see Figure 3), the revisions, and therefore the importance of these models, are expected to be smaller than for some of the other country/industry groups.

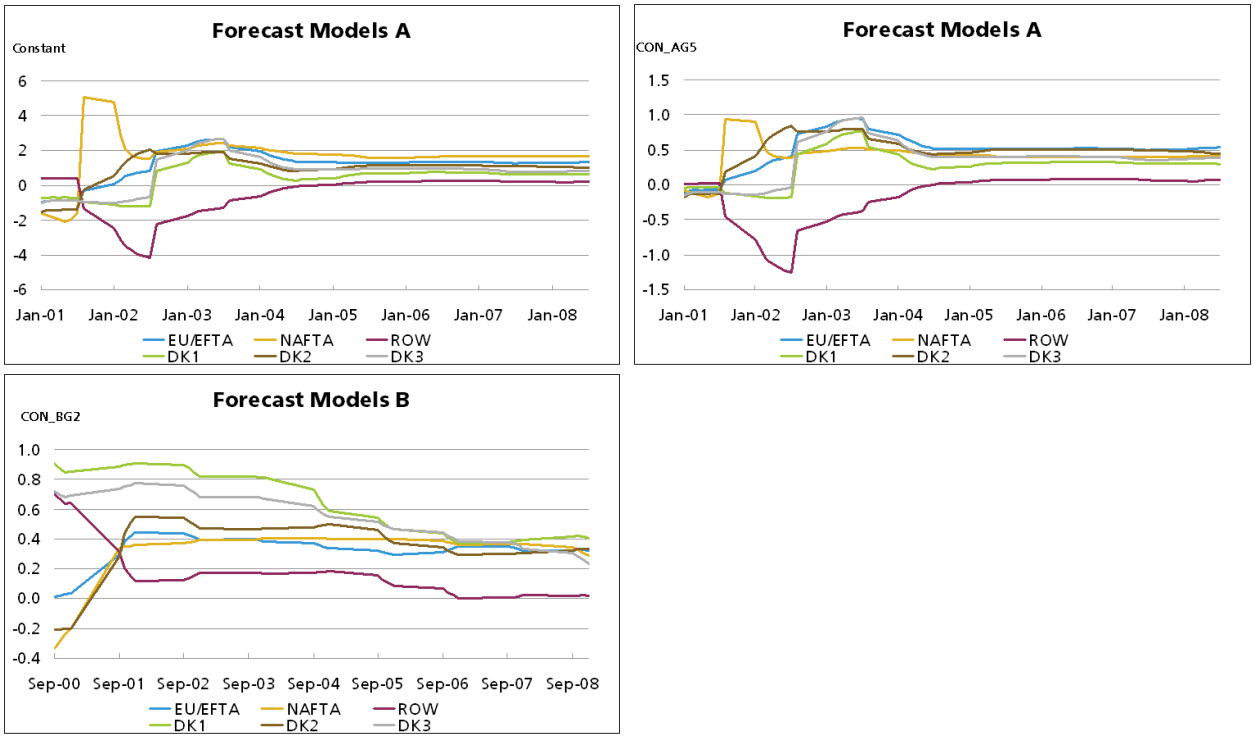
4.3 Robustness

A way to evaluate the robustness, and thereby the validity, of the models is to monitor the impact on parameter estimates when new data are included in the estimations. If the models are specified correctly and there are no structural breaks, each parameter estimate will converge to its own unique value over time. Figure 4 shows how the parameter estimates in Forecast Models A and B develop when new observations from our data are added to the models. These empirical pieces of evidence strongly suggest that convergence is taking place, thus supporting the models' robustness and choice of independent variables. The hypothesis of parameter stability is supported by the outcome of Chow (1960) tests carried out for

different data splits.

The parameter estimates seem to converge faster for Forecast Models A than for Forecast Models B. In this regard, one has to keep in mind that Forecast Models A are estimated on a larger number of observations than Forecast Models B as the former include 8 observations per year whereas the latter are based on 4 observations per year. Based on the results displayed in Figure 4, we conclude that the refined models can be used with expected changes in private consumption as the independent variable, but continued parameter estimate convergence should be monitored when re-estimating the models as new data become available.

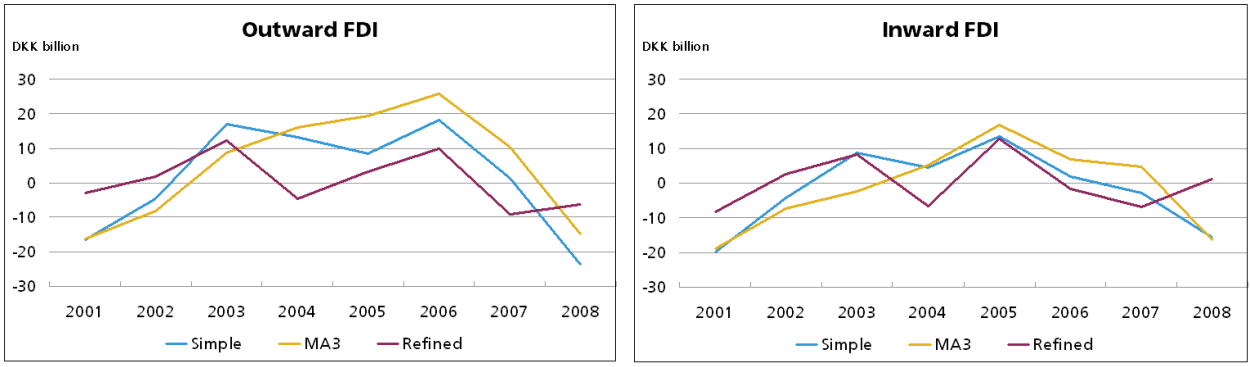
Figure 4: Developments in parameter estimates when new data are added to the models



5 Comparisons of Forecast Models

The best way to test the prediction power of a forecast model is to compare it to the alternatives. In our case, the refined forecast models can be compared to the simple forecast models solely based on the latest observation of *ROE* ratios and the 3-year moving average models. We estimate all models at the country/industry group level. If we assume that the parameter estimates of the refined models converge as illustrated in Figure 4, the models based on 2000/01-2008 data can applied for all years. Figure 5 illustrates the size of the

Figure 5: Revisions of FDI equity income



Note: As data are only available from 1999 onwards, the 3-year moving average is based on fewer observations in 2001-02.

revisions if the three different models had been applied for the period 2001-2008. On average, the refined models lead to smaller revisions for both inward and outward FDI equity income than the simple models and 3-year moving average models.

Despite the convergence in parameter estimates, in-sample tests should only be used with utmost caution. Therefore, we follow the standard recommendation (see, for instance, Fildes and Makridakis, 1995) and conduct out-of-sample tests for the period period 2006-08. As recommended in the IMF's Data Quality Assessment Framework (IMF, 2003) and the ECB Quality Report (ECB, 2009), we consider both the average and the absolute average of the revisions. The former measure contains information about possible systematic biases whereas the latter indicates the accuracy of a model. We can only conclude that a model performs well if both measures display low values.

The results in Table 8 confirm that the refined models, on average, yield considerably lower revisions for outward and inward FDI than the other models. For outward FDI, the refined models yield higher averages (measured as absolute values of non-absolute averages) than the simple models, suggesting higher bias in the refined models. However, the out-of-sample tests are only based on a 3-year period, which makes it difficult to draw strong conclusions regarding bias. An in-sample test for 2001-08 reveals that both the averages and absolute averages are smaller for the refined models than for the simple models.

We apply the Diebold and Mariano (1995) test for comparing predictive accuracy and find that the improvements in preliminary gross income estimates are statistically significant, see Table 9. However, on a net basis, the refined models only perform slightly better in terms of absolute revisions. The reason is that while the simple and 3-year moving average models lead to large errors in the forecasts, these errors often go in the same direction and cancel out each other to some extent on a net basis. The refined models, on the other hand, aim

Table 8: Out-of-sample tests for revisions in 2006, 2007, and 2008

Model	EU/EFTA	NAFTA	ROW	DK1	DK2	DK3	Net income
				2006			
Simple	15.9	2.1	0.2	0.6	0.3	1.1	16.3
MA3	22.4	2.4	1.1	0.5	4.5	1.8	19.1
Refined	7.2	2.4	−0.1	0.1	−2.4	−0.9	12.6
				2007			
Simple	1.0	0.3	0.1	−0.1	2.3	−4.8	4.0
MA3	8.7	0.4	1.3	1.6	6.5	−3.4	5.8
Refined	−10.8	0.0	−0.3	−0.8	−0.5	−7.1	−2.7
				2008			
Simple	−20.9	−2.2	−0.6	−2.6	−6.5	−6.4	−8.3
MA3	−13.7	−1.1	−0.3	−2.5	−6.6	−7.1	1.1
Refined	−5.9	−1.2	−0.4	0.0	2.6	−0.7	−9.5
				Average (absolute) 2006-2008			
Simple	−1.3 (12.6)	0.1 (1.6)	−0.1 (0.3)	−0.7 (1.1)	−1.3 (3.0)	−3.4 (4.1)	4.0 (9.5)
MA3	5.8 (14.9)	0.6 (1.3)	0.7 (0.9)	−0.1 (1.5)	1.5 (5.9)	−2.9 (4.1)	8.7 (8.7)
Refined	−3.2 (8.0)	0.4 (1.2)	−0.3 (0.3)	−0.2 (0.3)	−0.1 (1.8)	−2.3 (2.9)	0.1 (8.3)

Note: The refined models for 2006, 2007, and 2008 are based on data for 2000/01-2005, 2000/01-2006, and 2000/01-2007, respectively. The absolute average is displayed in brackets and is calculated as the average of annual revisions in absolute terms. The figures are given in DKK billion.

at forecasting credits and debits as precisely as possible with the result that credits may be overestimated and debits underestimated or vice versa. For this reason, the revisions will not necessarily have the same tendency to cancel out each other on a net basis. Still, the results show that the refined models are preferable as they clearly outperform the simple and the 3-year moving average models in gross terms and also lead to marginally better net estimates on average.

6 Conclusions

The late and large revisions observed in FDI equity income result in significant corrections of balance of payments data and violate the important statistical quality criterion of stability. Even though forecasting is always connected with uncertainty, this study has shown that it is possible to come up with a method to improve the preliminary estimates for FDI equity income in the case of Denmark.

We find that variables constructed from changes in consensus data for expected private

Table 9: Comparing predictive accuracy

Comparison	**Inward FDI**	**Outward FDI**	**Net FDI**
	In-sample tests (2001-2008)		
Refined vs. simple	−4.67**	−11.10**	−4.20**
Refined vs. MA3	−2.85**	−9.98**	−1.32
	Out-of-sample tests (2006-2008)		
Refined vs. simple	−2.15*	−4.28**	−3.70**
Refined vs. MA3	−2.47**	−4.75**	−0.34

Note: The table displays the Diebold-Mariano test statistic, S, for comparisons between predictive accuracy of monthly data. The null hypothesis of equal predictive accuracy is based on forecast errors (FE), defined as the difference between the forecasted value and the actual value, and is given by $H_0 : E[d_t] = 0$ where $d_t = |FE_{refined}| - \left|FE_{simple/MA3}\right|$. A negative test statistic indicates that the refined models have higher predictive accuracy than the simple/MA3 models. $S \overset{a}{\sim} N(0,1)$; * and ** indicate significance at the 5 and 1 percent levels, respectively.

consumption growth serve as useful indicators for the development in FDI enterprises' profitability. Forecast models using this information clearly outperform models solely based on historical profitability for outward and inward FDI, respectively. The net revisions are only slightly smaller because the large gross revisions observed in the simpler models have a tendency to (partly) cancel out each other contrary to the refined models.

As a consequence of the promising results presented in this study, the new forecasting method has been implemented in the Danish balance of payments compilation system as of January 2010. Other countries could potentially reduce the revisions by introducing similar methods for the preliminary FDI equity income estimates. As an area for future research, we recommend testing the model specifications used in this paper as well as alternative specifications on data for other countries/geographical zones in order to develop an international best practice that could be adopted by balance of payments compilers across countries.

The models are based on data for the period 1999-2008 and should be re-estimated annually to take the extra information into account. The empirical evidence presented in this paper point to quick parameter estimate convergence, but possible future changes in parameter estimates should be monitored as these may be signs of structural breaks.

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Productivity Spillovers from FDI: Ownership Structures, Domestic Firm Characteristics, and FDI Characteristics*

Jannick Damgaard†

Abstract

This paper is unique in testing the importance of the foreign ownership definition when estimating productivity spillovers from foreign direct investment (FDI) to domestic firms; a crucial aspect in countries with a widespread use of holding companies. In addition, it moves beyond the standard framework by not only analyzing aggregate productivity spillovers, but also testing the importance of both domestic firm characteristics and FDI characteristics. The empirical analysis is the first one to exploit the rich details offered by official Danish firm-level panel data. The analysis displays significant evidence of negative spillovers at the aggregate level, but the results differ widely across industries. It also reveals that not including firms under indirect foreign control in the group of foreign firms, as is done in some studies, leads to biased results. With regard to domestic firm characteristics, high export orientation and high competition mitigate some of the negative productivity spillovers. Finally, the estimations show that the negative spillovers largely stem from foreign firms (i) with low productivity, (ii) with high foreign trade orientation, and (iii) ultimately controlled by investors outside Scandinavia.

JEL Classification Numbers: *D24, F21, F23, O33*

Keywords: *Productivity, spillovers, FDI, determinants*

*The views expressed in this paper are those of the author and do not necessarily represent the views of Danmarks Nationalbank. The author is grateful to Pernille Bang and Charlotte Hansen from Statistics Denmark and to Niels Enemærke from the Danish Competition and Consumer Authority for making data access possible. The paper also benefits from constructive comments and suggestions from Robert Evans, Ulrich Kaiser, Nikolaj Malchow-Møller, and Niki Saabye. Any remaining errors are the responsibility of the author alone.

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1 Introduction

Many countries spend considerable resources on maintaining and attracting foreign direct investment (FDI). For example, Head (1998) reports that the state of Alabama gave Mercedes an incentive package worth approximately USD 230 million in 1994 for setting up a new 3,000-worker plant. Similarly, Siemens was paid GBP 50 million to locate a 1,000-worker factory in Tyneside, in Northeast England (Haskel, Pereira and Slaughter, 2007) while the Danish government investment promotion agency, *Invest in Denmark*, offers advice and services free of charge from seventeen offices worldwide to investors considering relocation, consolidation, or setting up new production facilities in Denmark. Governments often justify promotional expenses with the claim that FDI leads to increased economic competitiveness, e.g. through positive productivity spillovers to domestic firms from foreign firms[1] belonging to multinational enterprises (MNEs) (Harding and Javorcik, 2007). This paper exploits the rich details offered by official Danish firm-level data to study aspects of ownership structures, domestic firm characteristics, and FDI characteristics that have not been tested before in connection with productivity spillovers from FDI.

Since the pioneering study by Caves (1974), a large number of analyses have examined the existence of productivity spillovers. From time to time, researchers have paused to assess the current situation[2], but the empirical evidence remains mixed. Some studies support the hypothesis of positive spillovers while other studies estimate them to be insignificant or even negative. In a meta-analysis, Görg and Strobl (2001) investigate whether certain aspects of a study's design affect the results and reach the conclusion that studies based on cross-sectional data are more likely to yield positive spillovers than studies based on panel data. Lipsey and Sjöholm (2005), on the other hand, argue that the econometric method does not seem to be the crucial determinant for the mixed evidence. Instead, they suggest that differences across time and countries in domestic firms' ability to absorb the superior technology of foreign firms could be the key factor.

Even though Lipsey and Sjöholm (2005) present their explanation as an alternative to Görg and Strobl (2001), the two theories are not necessarily contradictory. For instance, it seems plausible that cross-sectional studies would have a tendency to overestimate productivity spillovers since MNEs may have a tendency to enter the most productive industries. A regular analysis based on cross-sectional data would not be able to reveal the cause-and-effect relationship between highly productive industries and foreign presence. Similarly, it

[1] In this paper, a foreign firm is defined as a firm under foreign control; a more detailed definition can be found in Section 3.

[2] Literature reviews include Blomström and Kokko (1998), Görg and Greenaway (2004), Keller (2004), Crespo and Fontoura (2007), and Smeets (2008)

is conceivable that the sign and significance of productivity spillovers would differ across studies depending on the circumstances in the host country as, for example, the absorptive capacity is likely to be different in a developed country with a highly skilled and flexible labor market than in a developing country with a rigid and low-skilled labor force. Consequently, just because one study finds negative productivity spillovers, it does not imply that one can reject all the studies that find positive spillovers or vice versa. Nevertheless, researchers should draw on the important methodological advances which have been developed in the field of estimation of productivity spillovers from FDI in the past decade and in addition, carry out sensitivity analyses to ensure that the results are robust.

This paper is unique in specifically examining whether the definition used to identify foreign firms has an impact on the estimation of productivity spillovers from FDI. In addition, it moves beyond the standard framework by not only analyzing aggregate productivity spillovers, but also testing the importance of both domestic firm and FDI characteristics. In order to test these aspects, the empirical analysis, as the first one[3], is based on official Danish firm-level panel data. The empirical estimations display considerable evidence of negative short-term productivity spillovers at the aggregate level, meaning that an increased foreign firm presence in Denmark generally hampers domestic firms' productivity in the short run.[4] At the industry level, however, both positive and negative spillovers are observed. The analysis of foreign firm definitions reveals that not including firms under indirect foreign control in the group of foreign firms, as is done in some studies, leads to biased results. It also finds that domestic firms with high export orientation and those domestic firms operating in the most competitive industries are less affected by the negative spillovers than other firms. With regard to the FDI characteristics, the estimations show that foreign firms that are ultimately owned by investors from the two other Scandinavian countries, Norway and Sweden, do not have a negative impact on domestic firms' productivity, just as limited foreign trade orientation among foreign firms mitigates the negative effects. The presence of the most productive foreign firms even has a positive effect on domestic firms' productivity.

The remainder of the paper is structured as follows. Section 2 summarizes the literature on productivity spillovers while Section 3 describes the development and the special characteristics of FDI in Denmark. In Sections 4 and 5, the estimation strategy and data are presented. Section 6 contains the econometric analysis, and Section 7 concludes the paper.

[3]Malchow-Møller, Markusen and Schjerning (2009) use official Danish firm-level data to assess wage rather than productivity effects from foreign firm presence.

[4]As official Danish statistics on foreign firms have only been produced from 2002 onwards, it is only possible to study short-term productivity spillovers in this paper.

2 Literature on Productivity Spillovers from FDI

The literature on FDI is based on the supposition that MNEs display higher productivity than domestically-oriented enterprises. The presumption of high productivity in foreign firms can explain the interest of policy makers in attracting FDI, hoping that the high performance levels will spill over to domestic firms.[5] Dunning (1993) presents his widely used OLI framework to explain why firms engage in FDI. According to his theory, a firm will expand and locate in other countries if the following three advantages exist: Ownership advantages, Locational advantages, and Internalization advantages. Ownership advantages include patents, copyrights, trademarks, superior technology, management techniques, and marketing strategies that will affect productivity in a positive way. Empirical studies for Canada (Globerman, Ries and Vertinsky, 1994), Germany (Temouri, Driffield and Higón, 2008), UK (Griffith, 1999), and the US (Doms and Jensen, 1998) support the hypothesis of higher productivity among foreign firms compared to domestic firms. A firm possessing ownership advantages can serve foreign markets through exports, licensing, or FDI; the latter option will only be chosen in case both locational and internalization advantages exist. Examples of locational advantages are low production costs, favorable regulations and tax policies, a large physical distance between home and host country, advanced infrastructure, and a skilled labor force. The main internalization advantage is to keep control over ownership advantages. In other words, MNEs try to prevent knowledge spillovers to its competitors in the host economy.

2.1 Productivity Spillover Channels

The early literature primarily focused on horizontal spillovers, i.e. productivity spillovers[6] from foreign firms to domestic firms within the same industry. The presence of foreign firms can affect the productivity of domestic firms through four main spillover channels, see Figure 1.[7] The first spillover channel is the *demonstration* effect, suggesting that domestic firms can increase their productivity by observing and imitating foreign firms' products, production processes, managerial or organizational innovations (see, e.g., Das (1987) and Wang and Blomström (1992).

[5] In addition, policy makers would be interested in employment and tax effects.

[6] This paper applies a broad definition of the term *productivity spillovers* and includes all transmission mechanisms from foreign to domestic firms whether they are pure externalities or not.

[7] While some of the productivity spillover theories have been derived in a mathematical modeling framework, the majority have not been formalized and are partly based on anecdotal evidence. This section provides a brief summary of the most important theories without going into further detail as the primary aim of this paper is to test the productivity spillover effects empirically on new data and data dimensions that have not been tested before.

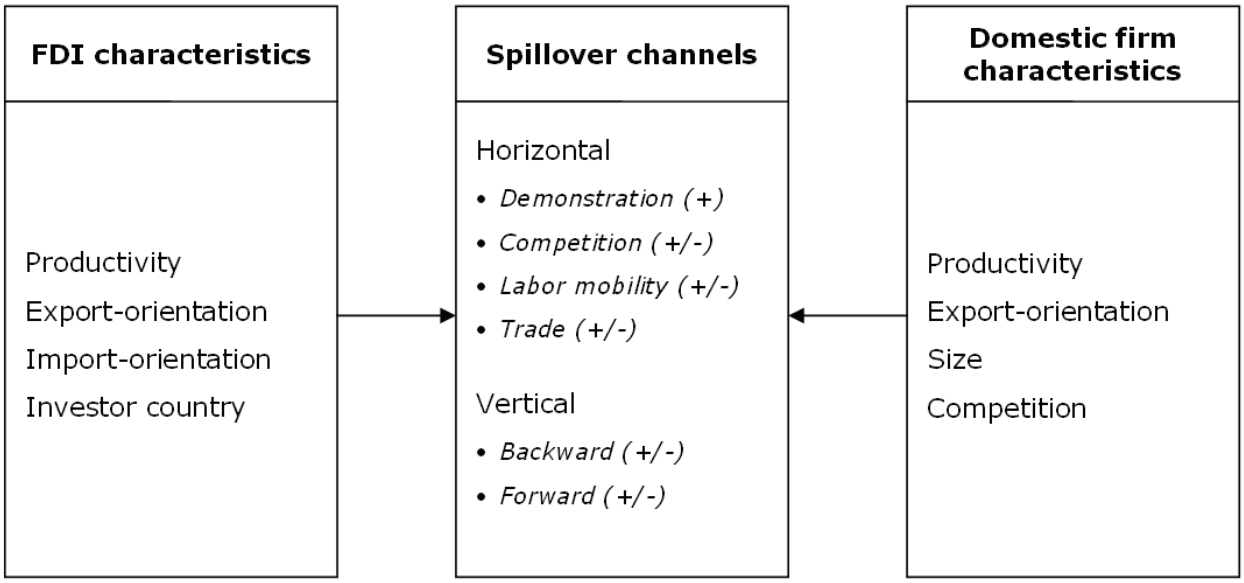
The second channel is *competition* and unlike the demonstration effect, this channel can have a positive as well as a negative impact on the productivity of domestic firms. On the one hand, the emergence of foreign firms in a country will force domestic firms to reduce X-inefficiency in order to stay competitive, thereby boosting their productivity (see, e.g., Caves, 1974; Markusen and Venables, 1999; Glass and Saggi, 2002). On the other hand, as pointed out by Aitken and Harrison (1999), foreign firms are likely to win market shares from domestic firms when entering or expanding production in a country. The domestic firms' loss of market shares will force them to reduce production and move up their given average cost curves under the assumption of increasing returns to scale, thus hampering their productivity.

Labor mobility is the third channel and is also associated with both positive and negative effects. Fosfuri, Motta and Rønde (2001) and Glass and Saggi (2002) set up models to illustrate how superior knowledge embedded in foreign firms can be transmitted to domestic firms by hiring staff who have previously worked at and received training in foreign firms. This spillover channel is not a pure externality as foreign firms typically pay a wage premium[8], and a domestic firm would normally have to match that wage premium to attract employees from foreign firms. Domestic firms will be willing to match the wage if the knowledge of an employee in a foreign firm can significantly increase its productivity. At the same time, the wage premium paid by foreign firms can potentially have a negative impact on the productivity of domestic firms because foreign firms can use the premium to poach the best-performing employees from domestic firms as suggested by Sinani and Meyer (2004) and Javorcik (2008).

The fourth and final spillover channel is *trade*, which can also have counterbalancing effects on domestic firms' productivity. On the positive side, foreign firms are generally more export-oriented than domestic firms because they have better distribution networks and knowledge about consumers' tastes in other markets. Non-exporting domestic firms may observe the behavior of and learn from foreign firms in this regard and start exporting. The result would be increased production, which would enhance productivity of domestic firms (see, e.g., Aitken, Hanson and Harrison, 1997; Greenaway, Sousa and Wakelin, 2004). An increased presence of foreign firms in an industry could, however, also have a negative impact on the productivity of domestic firms. Just as foreign firms have a tendency to display higher export shares than domestic firms, the same will be the case for import shares. If increased foreign presence in an industry is due to the crowding out of domestic firms, domestic suppliers to that industry may face lower demand because the foreign firms

[8]A possible explanation for the empirically observed wage premium is that foreign firms want to prevent employees from moving to competitors once they have received training

Figure 1: Productivity spillover channels, absorptive capacity, and FDI characteristics



Source: Author's schematization.

are more likely to use foreign suppliers, forcing the domestic suppliers to raise prices. In such a case, domestic firms in the given industry face higher input prices, which will have a negative effect on their productivity.

In the 1970s–1990s, the vast majority of empirical research on productivity spillovers focused solely on horizontal spillovers. Nevertheless, early on, Lall (1980) highlighted the role of vertical spillovers; that is spillovers from foreign firms to domestic suppliers (backward linkages) and from foreign firms to domestic buyers (forward linkages). The theories of vertical spillovers were formalized in the 1990s (see, e.g., Rodriguez-Clare, 1996; Markusen and Venables, 1999), and a number of empirical studies on vertical spillovers were published in the 2000s (see, e.g., Kugler, 2000; Schoors and Tol, 2002; Javorcik, 2004). The idea behind vertical spillovers is that whereas foreign firms will try to prevent knowledge spillovers to intra-industry competitors, they often have an incentive to share their knowledge with suppliers and buyers. For instance, if foreign firms source their inputs domestically, they may train the domestic suppliers to make sure that their products live up to certain quality standards. Similarly, foreign firms producing advanced products will promote these products to potential domestic buyers who may be able to increase productivity by using these new products in their production processes. Foreign firms may also be able to supply products at a lower price due to their ownership advantages, thereby boosting the productivity of domestic buyers. In addition, the four spillover channels mentioned above are not restricted to firms within the same industry, but are likely also to have an inter-industry impact. For example, domestic firms may benefit from imitating foreign firms in other industries, but

they may also lose their most productive employees to these firms.

2.2 Domestic Firm Characteristics

Despite a large number of empirical studies, there is no clear evidence with regard to the sign and magnitude of aggregate productivity spillovers from FDI. A plausible explanation for the varying results is that circumstances differ across countries, meaning that some of the mentioned spillover channels will work more efficiently in some countries than in others. Moreover, the aggregate results represent the net effect of all productivity spillover channels, and it is difficult to disentangle the effects. Still, some researchers have tried to dig one step deeper to investigate why some domestic firms benefit more from foreign presence than others. One approach for going into further detail is to examine domestic firm characteristics and their link with the ability to learn from foreign firms.

Productivity — In connection with domestic firm characteristics, productivity is believed to play a central role for spillovers. Findlay (1978) and Wang and Blomström (1992) posit that productivity spillovers increase with the technological gap between foreign and domestic firms because the potential for catching up via imitation is enhanced, thereby suggesting that domestic firms with low productivity will benefit most from foreign presence. Cohen and Levinthal (1989), Glass and Saggi (1998), and Kinoshita (2001) also recognize the importance of domestic firms' productivity, but they argue that some level of absorptive capacity, generated through investments in R&D or human capital, is necessary to identify the value of new information, assimilate it, and apply it to commercial ends. If a large technological gap is seen as an indicator of low absorptive capacity, productivity spillovers and the technological gap will be inversely related, meaning that domestic firms with high productivity will benefit most from foreign presence. As a result of the two contradicting theories, it is not possible to come up with a unambiguous hypothesis.

Hypothesis 1: The productivity of domestic firms has an impact on productivity spillovers from FDI; the net impact can be positive, neutral, or negative.

Export orientation — The argument has been made that export-oriented domestic firms already face significant competition on international markets (Blomström and Sjöholm, 1999). On the one hand, a high export orientation means that the importance of and interaction with the domestic market is reduced, thus limiting the spillover potential from FDI. On the other hand, export-oriented domestic firms are likely to have a higher capacity to absorb new technology and will also, as highlighted by Barrios and Strobl (2002) and Schoors and Tol (2002), be in a better position to resist the competitive pressure.

Hypothesis 2: The export orientation of domestic firms has an impact on productivity spillovers from FDI; the net impact can be positive, neutral, or negative.

Size — The size of domestic firms is also hypothesized to have an impact on their ability to take advantage of new knowledge and technology from foreign firms as domestic firms with few employees will often not have the necessary production scale to imitate the production processes of foreign firms (Crespo and Fontoura, 2007). In addition, the total staff turnover in small firms is *ceteris paribus* lower than in firms with many employees, therefore limiting the scope for spillovers through labor mobility.

Hypothesis 3: The size of domestic firms has a positive impact on productivity spillovers from FDI.

Competition — Finally, the level of competition in a domestic industry may play a role for the size and magnitude of productivity spillovers. Domestic firms operating in highly competitive industries are used to competing against a large number of firms and are likely to be in a better position to adapt to new situations and compete against foreign firms than domestic firms operating in less competitive industries. Theoretical models by Glass and Saggi (1998) and Wang and Blomström (1992) support this view.

Hypothesis 4: The competition level of the domestic industry has a positive impact on productivity spillovers from FDI.

2.3 FDI Characteristics

Another potential determinant of the sign and magnitude of productivity spillovers is the FDI characteristics, i.e. the type of FDI coming into a country.

Productivity — The productivity of foreign firms can be seen as the other side to the story of the technological gap discussed in Section 2.2. It may be argued that the largest positive spillover potential comes from the most productive foreign firms because these firms possess the most advanced technology and hence offers favorable imitation possibilities. Conversely, it could be argued that the technological gap between the most productive foreign firms and the domestic firms is too large, meaning that the spillover potential from the least productive foreign firms would actually be highest even though they may not possess the same advanced technology as the most productive foreign firms.

Hypothesis 5: The productivity of foreign firms has an impact on productivity spillovers from FDI; the net impact can be positive, neutral, or negative.

Export orientation — Foreign trade orientation of foreign firms and its relevance with regard to productivity spillovers seems to be a less explored area in the literature. On the one hand, a high export orientation among foreign firms means that domestic firms can study export behavior and will only be subject to limited foreign firm competitive pressure in the domestic market. On the other hand, they still risk losing their best-performing employees to the foreign firms and, perhaps more importantly, the possibility of imitating foreign firm behavior is severely reduced when the foreign firms only engage in the local economy to a limited extent.

Hypothesis 6: The export orientation of foreign firms has an impact on productivity spillovers from FDI; the net impact can be positive, neutral, or negative.

Import orientation — Like export orientation, the role of import orientation has received little attention in the literature. Nevertheless, Rodriguez-Clare (1996) makes an implicit reference to import orientation, arguing that backward spillovers depend on transport costs. In case of high import orientation, the scope for positive backward spillovers is hampered because it diminishes the role and use of domestic suppliers. Furthermore, foreign firms with high import shares are hypothesized to interact less with domestic firms, reducing the general spillover potential.

Hypothesis 7: The import orientation of foreign firms has a negative impact on productivity spillovers from FDI.

Investor country — Lastly, the literature mentions the investor country of the FDI as a possible spillover determinant because cultural and linguistic barriers may affect the potential for spillovers (Crespo and Fontoura, 2007). A high proportion of Danes are proficient in English, but Norwegian and Swedish are closely related to Danish, making the linguistic barrier between the Scandinavian countries small even when the native languages are spoken. Furthermore, due to the close historical roots, the cultural differences within Scandinavia are negligible compared to differences between the Danish and, for instance, American and Asian cultures. The cultures of all three Scandinavian countries are characterized by being informal with a relatively low level of authority distance. Because of the similarities, Danish firms are likely to be in a favorable position to assimilate and absorb advanced production processes from Scandinavian MNEs.

Hypothesis 8: FDI from Norway and Sweden has a positive impact on productivity spillovers compared to FDI from other countries.

3 FDI in Denmark

Denmark has a small, open economy and can be considered to be a representative OECD country in terms of *stock of inward FDI/GDP ratio*, see left-hand panel of Figure 2.[9] The Danish inward FDI position grew steadily at an average annual rate of 5.6 percent in the period from 2002 to 2008 so that the end-2008 position corresponds to 44 percent of GDP. Despite high wages and taxes, Denmark remains an attractive destination for FDI due its location as a gateway to the Nordic market, its well-educated labor force, and its highly flexible labor market. The total FDI position can be broken down by equity capital, intercompany debt, and special purpose entities (SPEs), with FDI equity capital being the largest component, see right-hand panel of Figure 2. The main recipients of FDI in Denmark are the *financial intermediation*, *trade and transport*, and *manufacturing* industries, and the largest investor country is Sweden followed by the Netherlands, Luxembourg, Great Britain, and Germany.

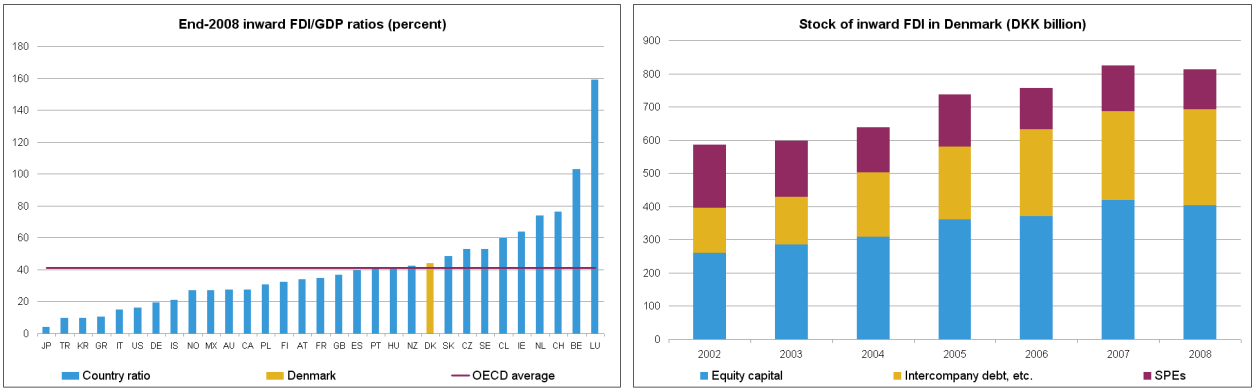
By definition, FDI statistics are financial data, measuring financial cross-border investments between entities in an FDI relationship. Such a relationship is defined according to control or significant influence; the operational threshold for significant influence is 10 percent equity ownership (OECD, 2008; IMF, 2009). Despite its status as a set of financial statistics, FDI statistics are sometimes used for real-economic analysis.[10] However, the use of FDI statistics for this purpose is associated with a number of problems. For example, SPEs are typically set up for tax reasons as empty shell companies that own equity abroad. They do not have any, or at least very limited production and employment, and thus do not impact the real economy of a country. The share of SPEs in Denmark has been reduced from 33 percent in 2002 to 15 percent of total inward FDI in 2008, but is still significant. Even if SPEs are removed from FDI statistics, it is difficult to establish a direct link between FDI positions and the production of foreign firms. One reason is that foreign capital funds' acquisitions of Danish firms in recent years have primarily been financed through bank loans, which are not recorded as FDI (Jayaswal et al., 2006). In addition, data for intercompany loans may be distorted by the establishment of cash pools in MNEs.

Another potential problem is with ownership structures. Assume that Firm A, resident

[9]The high ratios in the Benelux countries can to a large extent be explained by the widespread existence of special purpose entities (SPEs) in these countries.

[10]For instance, ECB (2008) states that *"for a host country or the foreign firms which receives the investment, [FDI] can provide a source of new technologies, capital, processes, products, organisational technologies and management skills, and as such can provide a strong impetus to economic development"*. In addition, OECD (2008) suggests that aggregate FDI data expressed as a percentage of GDP can be used as an indicator of globalization. However, due to its status as a set of financial statistics, empirical studies on productivity spillovers generally only use information about foreign ownership and base the analyses on real-economic variables such as output, value added, or employment.

Figure 2: Stock of inward FDI/GDP ratios for OECD countries and composition of Danish FDI



Source: UNCTAD (2009) and Danmarks Nationalbank.

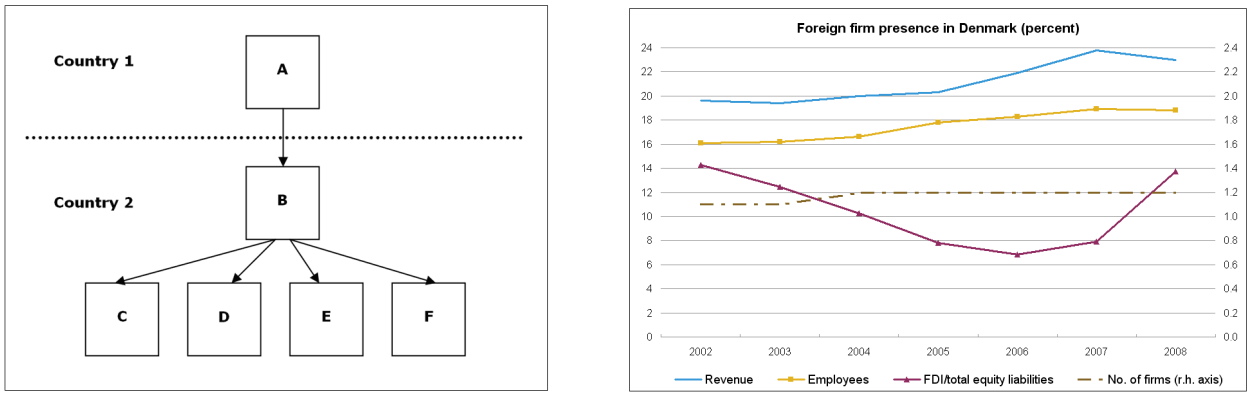
in Country 1, owns Firm B in Country 2 that in turn owns Firms C, D, E, and F in Country 2 as illustrated in the left-hand panel of Figure 3. While all firms in this case are in an FDI relationship, only the equity that Firm A holds in Firm B will be included in FDI statistics. The equity capital in Firms C, D, E, and F will be excluded as this is not direct cross-border investment, and only intercompany loans from Firm A to Firms C, D, E, and F will be recorded in FDI statistics. The ownership structure in this example is commonly used in Denmark where investments in real production facilities often take place via holding companies. For instance, when foreign investors in 2005/06 acquired TDC, the largest Danish telecommunications provider, the actual acquisition took place through the holding company Nordic Telephone Company that was set up for the purpose. Foreign AffiliaTes Statistics (FATS) have been developed to describe the real-economic activities of foreign firms.[11] It applies a slightly different definition of foreign firms than FDI statistics: *(i)* The ownership threshold is 50 percent rather than 10 percent, and *(ii)* it includes all firms controlled by a foreign investor, regardless of whether the control is direct or indirect. In other words, whereas only Firm B is a foreign firm (as defined by FDI equity) according to FDI statistics, Firms B, C, D, E, and F are all foreign firms in a FATS setting.[12]

The right-hand panel of Figure 3 illustrates the importance of foreign firms in Denmark according to the FATS definitions. While only 1.2 percent of the private firms in 2008 were classified as foreign, these firms respectively accounted for 23 and 19 percent of the total private revenue and employment. By comparison, inward FDI equity capital accounted for less than 14 percent of total Danish equity liabilities. It comes as no surprise that foreign

[11]The principles of FATS are described in detail in Eurostat (2007) while documentation on the closely related Activities of Multinational Enterprises (AMNE statistics) can be found in OECD (2008).

[12]It should be mentioned that some countries collect FDI statistics at enterprise group level rather than at firm level, thus adding to the complexity of foreign firm definitions applied in macroeconomic statistics.

Figure 3: Example of holding company structure; data for foreign firm presence in Denmark



Note: The example in the left-hand panel is the author's schematization of a typical holding company structure. The right-hand panel is based on FATS data from Statistics Denmark and FDI/financial accounts statistics from Danmarks Nationalbank.

firms' share of total production and employment is larger than the FDI equity share of total equity liabilities since, in the case of holding company structures, only the equity in the holding company and not in the underlying affiliates is recorded in FDI statistics.[13]

A number of studies have investigated whether productivity spillovers from minority FDI differ from those from majority FDI (see, e.g., Blomström and Sjöholm, 1999; Dimelis and Louri, 2002; Abraham, Konings and Slootmaekers, 2007), but this paper is the first one to examine the importance of ownership structures and the definitions used to identify foreign firms. Most empirical studies do not state whether they are restricted to direct ownership or if they also include indirect ownership. One exception is Javorcik and Spatareanu (2008) who explicitly mention that they only consider direct ownership. In contrast, this study uses the FATS definition of foreign firms including both direct and indirect foreign majority holdings as a baseline case as foreign investors will undoubtedly have an impact on a firm whether they control it directly or indirectly through a holding company. Nevertheless, an alternative foreign firm definition including only direct foreign majority holdings will be tested as well to compare the effect of using two different foreign firm definitions.

[13]Furthermore, FDI equity capital is recorded at book value in the Danish FDI statistics whereas total equity liabilities in the Danish financial accounts are estimated using price-to-book value (P/B) adjustments that usually exceed unity because accounting standards only capture intangibles to a limited extent (Kumah, Damgaard and Elkjær, 2009). The difference in valuation principles also partly explains the significant drop in the FDI equity share of total equity liabilities from 2002 to 2007 and the sudden increase in 2008. The reason is that the P/B adjustment used in the financial accounts rose considerably up to the financial crisis in 2008 where it dropped severely.

4 Estimation Strategy

The estimation strategy in this study is based on a micro panel data approach. Over the last decades, the common estimation strategy applied in the empirical studies on productivity spillovers has gradually developed from aggregate cross-sectional data analysis to firm-level panel data analysis. The main advantage of estimating spillovers on detailed panel data is that it allows for the possibility of isolating effects of unobserved differences between firms. Whereas cross-sectional data can be used to detect correlation, the temporal ordering in panel data enhances the possibilities of making causal inferences. For instance, the early studies on productivity spillovers (see, e.g., Caves, 1974; Globerman, 1979) found that high foreign presence and productivity were correlated, but based on this information, one cannot directly conclude that high foreign presence in an industry leads to high productivity. Instead, it might be that high productivity in a domestic industry attracts foreign firms. The use of panel data allows us to study the dynamics of the data and make inferences based on these.

The first step in the empirical analysis is to estimate firm-level total factor productivity based on industry-level production function estimations. Recent literature on the estimation of production functions recognizes the endogeneity issue caused by the correlation between unobservable productivity shocks and input levels, leading to biased OLS estimates.[14] To address this issue, the LP procedure, as suggested by Levinsohn and Petrin (2003), is applied. The starting point is a Cobb-Douglas production function for industry j:

$$v_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \omega_{it} + \eta_{it}, \tag{1}$$

where v_{it}, l_{it}, and k_{it} denote the logarithmic values of value added, labor, and capital, respectively, for firm i in year t.[15] The error terms in the model are represented by ω_{it} and η_{it}. Whereas η_{it} is uncorrelated with input choices, ω_{it} is a state variable that impacts the firms' input decision rules. The LP procedure estimates ω_{it} as a function of capital and intermediate input in an attempt to address the simultaneity bias. The production functions are estimated on domestic firms only as the productivity of *domestic* firms is the scope of this study. The parameter estimates from industry-specific production functions are then used to estimate total factor productivity expressed in logs (*tfp*) for a given firm in a given year in the following way:

[14] See Griliches and Mareisse (1998) for an overview of the production function estimation history.

[15] Production functions are sometimes extended to include an R&D variable, but such a variable is omitted from this analysis due to data restrictions. In addition, some studies distinguish between employees with different educational backgrounds. However, such an approach will not be used in this study as many Danish firms only have a single or very few employees, thus resulting in a large number of zero observations if the labor variable is broken down by categories.

$$\widehat{tfp_{it}} = v_{it} - \widehat{\beta}_l l_{it} - \widehat{\beta}_k k_{it}. \tag{2}$$

The second step in the estimation strategy is to create measures for the spillover variables. The measure for horizontal spillovers, *HZ*, is constructed as foreign firms' share of total industry output and is designed to capture intra-industry spillovers. If Y denotes output, and F is an indicator variable for foreign firms, *HZ* can be calculated in the following way:

$$HZ_{jt} = \sum_{i \in j} Y_{it} F_{it} \left(\sum_{i \in j} Y_{it} \right)^{-1}. \tag{3}$$

The measures for vertical spillovers are constructed by combining information from annual input-output (IO) tables with the *HZ* variable. Specifically, the measure for backward linkages, *BW*, is calculated as:

$$BW_{jt} = \sum_{k \neq j} \alpha_{jkt} HZ_{kt}, \tag{4}$$

where α_{jkt} represents the proportion of industry j's total output that is supplied to domestic industry k for intermediate consumption. To separate vertical spillovers from horizontal spillovers, intra-industry sourcing is excluded from the calculations ($k \neq j$). This measure is aimed at capturing the effect that the presence of foreign firms has on the productivity of their domestic suppliers. Similarly, the measure for forward spillovers, *FW*, can be calculated as:

$$FW_{jt} = \sum_{k \neq j} \gamma_{jkt} HZ_{kt}, \tag{5}$$

where γ_{jkt} represents the proportion of industry j's total input that is purchased from domestic industry k. This measure is aimed at capturing the effect that the presence of foreign firms has on the productivity of the domestic customers.[16]

The above measures are used to estimate the baseline model with *tfp* as the dependent variable. However, as proposed by Haskel et al. (2007), the model is estimated in first differences to eliminate the effect of unobserved firm-, industry-, and region-specific factors

[16]To illustrate how the vertical spillover measures are constructed, assume that an economy consists of three industries: agriculture (10 percent foreign presence), manufacturing (30 percent foreign presence), and services (40 percent foreign presence). If 20 percent of the manufacturing industry's output is sold to the agricultural industry and 50 percent to the services industry (the remaining 30 percent goes to private consumption and exports), the backward spillover measure for the manufacturing industry will be 0.22 (=0.2*0.1 + 0.5*0.4). Similarly, if 60 percent of the manufacturing industry's input is supplied by the agricultural industry and 25 percent by the services industry (the remaining 15 percent is imported), the forward spillover measure for the manufacturing industry will be 0.16 (=0.6*0.1 + 0.25*0.4).

such as superior management and high-quality infrastructure that are correlated with both firm productivity and foreign presence. Since there may be factors not only affecting firms' productivity levels, but also their growth potential, industry and time dummy variables, α_j and α_t, are included to capture industry-specific differences in growth potential and economy-wide productivity shocks. The exact model specification is given by:

$$\Delta\widehat{tfp_{it}} = \beta_0 + \beta_{HZ}\Delta HZ_{jt} + \beta_{BW}\Delta BW_{jt} + \beta_{FW}\Delta FW_{jt} + \beta_{COMP}\Delta COMP_{jt} + \alpha_j + \alpha_t + \varepsilon_{it}, \quad (6)$$

where *COMP* is a competition measure. The dependent variable is constructed at firm level while the regressors represent industry-level variables. Moulton (1990) demonstrates that merging micro data with aggregated variables may result in seriously downward biased standard errors. To address this issue, the standard errors are adjusted for industry-year clustering.

To test the importance of domestic firm characteristics with regard to productivity spillovers, the model is estimated on split samples. One way of making the data split would be to divide the sample into, for instance, a group of small firms and a group of large firms and estimate productivity spillovers for each group. However, size is likely to be dependent on the industry in the sense that firms are generally large in certain industries and small in other industries. As a consequence, such a data split would not allow separating the effect of size from the effect of the general industry characteristics. In an attempt to isolate the dimension effect, the data splits are made *within* industries in this study. As the competition variable is only defined at the industry level, the split for this dimension is made at the industry level. The significance of the FDI characteristics is investigated by splitting the foreign firms into groups *within* industries as well and constructing the spillover variables separately for these groups.

5 Data

The dataset used for the empirical analysis is obtained from Statistics Denmark and consists of accounting and employment information for all firms operating in Denmark in the period 2002-07. Only firms with positive values of the variables value added, number of employees (full time equivalents), fixed capital, and inputs are included in the final data. Value added and inputs are deflated to 2000-prices by using implicit price indices at the industry level calculated from the detailed Danish IO tables in fixed and current prices prior to the production function estimation. An implicit price index constructed from Statistics

Denmark's national accounts tables for fixed assets is used to deflate the fixed assets variable to 2000-prices.

The residency of the ultimate controlling investor is the official foreign firm identification used by Statistics Denmark for production of FATS, and this variable is merged to the data. Information about the residency of the immediate investor is also included to make it possible to test the effect of using different foreign firm definitions in the estimations.

Next, the data are categorized according to the 130-industry breakdown used in the Danish IO tables. Only industries with foreign presence of at least 5 percent of output in the period 2002-07 are included, reducing the number of industries in the data to 62. Firms in industries with lower foreign presence are omitted from the analysis as spillovers are likely to be small or non-existing if foreign presence is low.[17] In addition, this approach helps avoiding spurious findings that could potentially be the result of estimating a model on independent variables with very little variation because not only the levels, but also the changes in foreign firm presence are low in industries with limited foreign presence.

Finally, the Danish Competition and Consumer Authority's competition index is added to the data. The competition index is constructed at the industry level as an average of the following seven indicators: concentration, import-corrected concentration, entry rate, mobility, rate of return, wage premia, and public regulation. Productivity dispersion is normally included as an eighth indicator in the calculation of the competition index, but it has been excluded for the purpose of this paper to avoid endogeneity by using similar variables, i.e. productivity measures, on both sides of the regression equation. The competition index is defined in the range [0-2]; a high value indicates low competition and vice versa.

Table 1 displays descriptive statistics for all variables included in the analysis. While total factor productivity is firm-specific, the spillover and competition measures are defined at the industry level. The firm-specific variables are generally highly right-skewed (the mean exceeds the 75th percentile) due to the existence of many small-scale firms. Interestingly, the horizontal spillover measure based on ultimate foreign control, HZ_uci is approximately 50 percent higher than the measure based on direct foreign control, HZ_dir. This finding illustrates that by only basing the spillover measures on firms with direct foreign ownership, the presence of firms under foreign control is severely underestimated.

[17] The chosen cut-off value of 5 percent foreign presence is in a strict sense arbitrary. As an area for future research, it would be useful to study in further detail what an appropriate cut-off value could be, e.g. through a combination of quantitative and qualitative analyses.

Table 1: Summary statistics

Variable	Description	Mean	Std. dev.	25%	75%	No. of obs.
		Firm-specific variables				
V	Value added (DKK - 2000 prices)	5.77E+06	7.90E+07	6.41E+05	3.11E+06	315,518
K	Fixed assets (DKK - 2000 prices)	8.91E+06	2.05E+08	2.55E+05	2.05E+06	315,518
M	Inputs (DKK - 2000 prices)	1.44E+07	1.37E+08	7.94E+05	6.02E+06	315,518
L	Labor (no. of full time equivalents)	11.872	126.816	1.000	8.000	315,518
Δtfp		0.014	0.554	−0.159	0.196	225,732
		Industry-specific variables				
HZ	Horizontal spillover measure (ratio)	0.330	0.214	0.178	0.434	372
BW	Backward spillover measure (ratio)	0.062	0.051	0.022	0.093	372
FW	Forward spillover measure (ratio)	0.063	0.039	0.047	0.071	372
$COMP$	Competition measure (index 0-2)	0.755	0.223	0.606	0.856	372
ΔHZ		0.016	0.100	−0.020	0.032	310
ΔBW		0.002	0.010	−0.002	0.006	310
ΔFW		0.004	0.023	−0.001	0.005	310
$\Delta COMP$		−0.003	0.130	−0.063	0.050	310
HZ_uci	Horizontal spillover measure (ratio)	0.340	0.216	0.181	0.435	248
BW_uci	Backward spillover measure (ratio)	0.064	0.053	0.023	0.094	248
BW_uci	Forward spillover measure (ratio)	0.066	0.045	0.050	0.073	248
ΔHZ_uci		0.017	0.079	−0.016	0.031	186
ΔBW_uci		0.003	0.009	−0.001	0.007	186
ΔFW_uci		0.007	0.029	0.001	0.006	186
HZ_dir	Horizontal spillover measure (ratio)	0.226	0.185	0.109	0.283	248
BW_dir	Backward spillover measure (ratio)	0.042	0.041	0.013	0.064	248
FW_dir	Forward spillover measure (ratio)	0.042	0.034	0.031	0.045	248
ΔHZ_dir		0.011	0.096	−0.017	0.021	186
ΔBW_dir		0.001	0.007	−0.001	0.004	186
ΔFW_dir		0.004	0.021	−0.001	0.004	186

Note: The table displays summary statistics based on data for the period 2002-07 with the exception of variables with the extensions _uci and _dir; the latter variables are based on data for the period 2004-07 because data on direct ownership are only available for that period. The _uci variables define foreign firms as firms with a foreign ultimate controlling investor while the _dir variables instead consider the residency of the immediate investor.

6 Empirical Results

Prior to the estimation of productivity spillovers, a test is made as to whether foreign firms are more productive than domestic firms as assumed in the theoretical literature on productivity spillovers. An analysis regressing total factor productivity on a full set of industry dummies and an indicator variable for foreign firms reveals that foreign firms are indeed more productive than domestic firms in the Danish case. The result is robust to the addition of firm output to the list of regressors and clearly supports the theoretical basis for the analysis in this paper.[18]

6.1 Baseline Case and Robustness Checks

The starting point of the empirical analysis in this paper is to estimate the aggregate effects that the presence of foreign firms has on the productivity of domestic firms and to test the robustness of the findings, see Table 2. The baseline case shows that both horizontal and backward spillovers are negative while forward spillovers are insignificant in the Danish case (1). The negative horizontal spillovers may be explained by the fact that foreign firms "steal" market shares and employees from domestic firms. The negative backward spillovers are likely to be the result of higher import shares among foreign than domestic firms[19], thus leading to lower demand in the supplying domestic industries and forcing the domestic firms up their cost curve. The parameter estimate of the competition variable is also negative. In other words, an increase in the competition level in an industry (corresponding to a decrease in the competition index variable used in the regression analysis) has a positive impact on the productivity of domestic firms in that industry.

The next step is to test the robustness of the results. In their meta-analysis on FDI productivity spillovers, Görg and Strobl (2001) find that the choice of variable to capture foreign presence can affect the outcome of the analysis. In the baseline case, the foreign presence measures are based on output, but the robustness tests show that the results are robust to the use of labor/value added rather than output in the construction of the measures, illustrating that the choice of foreign presence indicator does not seem to be an issue in the Danish case ((2)-(3)).

[18]Using German firm-level data, Temouri, Driffield and Higón (2008) find that foreign firms are generally more productive than domestic firms, but their analysis also shows that there are no significant productivity differences between domestic firms belonging to German MNEs and foreign firms, highlighting the importance of the MNE dimension with regard to productivity. Unfortunately, the dataset used for this study does not allow a distinction between between domestic firms belonging to Danish MNEs and other domestic firms.

[19]An analysis regressing import shares on a full set of industry dummies and an indicator variable for foreign firms confirms that foreign firms have higher import shares than domestic firms.

A second type of robustness checks is to base the industry selection on different criteria than the 5 percent foreign presence criterion used in the baseline case ((4)-(5)). The overall picture is still negative productivity spillovers even though there are differences between the three cases. The 10 percent criterion is not used since it eliminates too many observations. The use of all industries with foreign presence is not chosen because it includes too many industries with a small variation in the spillover variables, thereby leading to very high and possibly spurious parameter estimates.

Another selection-related issue is the possibility that MNEs cherry-pick and acquire domestic firms with the highest growth potential (Görg et al., 2009). In that case, the domestic firms with the highest growth potential would leave the panel while the domestic firms with the lowest growth potential would stay in the panel, which could explain the negative spillover effects found in the estimations. To test this hypothesis, the model is estimated only on domestic firms that have not been foreign-owned at some point during the period 2002–2007. The empirical findings from the baseline model are fully robust with regard to this test (6).

It is also tested if the results are robust to the choice of estimation approach. An alternative to the first-difference estimation strategy is to estimate a fixed effect (FE) model. The FE specification eliminates the effect of unobserved firm-, industry-, and region-specific factors by replacing each observation by the difference between the observation and the variable mean. The main results are robust to this procedure, suggesting that the method used to remove unobserved effects does not affect the outcome of the analysis (7). Additionally, the model is estimated in second differences instead of first differences as productivity spillovers may take some time to set in (8). Estimating the model in longer differences has the advantage of giving more weight to persistent changes in the variables, but reduces the sample size. Nevertheless, the specification in second differences leads to similar results as the first-difference specification. Moreover, the production functions are estimated using a standard OLS approach rather than the LP approach to correct for endogeneity (9). The results are almost identical to the baseline case, but forward spillovers are also significantly negative when using the OLS approach. Nevertheless, the LP approach is preferred because it addresses endogeneity.

Table 2: Baseline Case and Robustness Checks

Regressor	**(1) Baseline**	**(2) Labor**	**(3) Value added**	**(4) 10 percent**	**(5) All**
ΔHZ	−1.351***	−1.925***	−1.908***	−0.106	−0.929***
	0.302	*0.321*	*0.309*	*0.249*	*0.276*
ΔBW	−3.516***	−4.007***	−3.961***	−3.193***	−8.854***
	0.561	*0.644*	*0.573*	*0.893*	*1.862*
ΔFW	−2.283	−2.193	−0.104	−4.896**	15.189***
	1.612	*1.354*	*1.357*	*2.000*	*4.148*
$\Delta COMP$	−0.623***	−0.605***	−0.517***	−0.674***	−0.487***
	0.209	*0.199*	*0.199*	*0.210*	*0.188*
HZ	-	-	-	-	-
BW	-	-	-	-	-
FW	-	-	-	-	-
$COMP$	-	-	-	-	-
No. of obs.	225,732	225,732	225,732	169,920	269,781
Adjusted R^2	0.018	0.020	0.020	0.009	0.037

Note: The table displays the results of estimating Equation 6 in the baseline case and with various amendments. Standard errors clustered by industry-year are reported in italics. *, **, and *** indicate significance at the 10, 5, and 1 percent levels, respectively. (1): The baseline case. (Domestic firms in industries with at least 5 percent foreign presence in terms of output are included in the estimation of Equation 6. The model is specified in first differences, and total factor productivity is estimated according to the LP method.) (2): Foreign presence variables based on number of employees (full time equivalents) rather than output. (3): Foreign presence variables based value added rather than output. (4): Only domestic firms in industries with foreign presence in terms of output of at least 10 percent rather than 5 percent are included. (5): Domestic firms in all industries with some foreign presence in terms of output are included. *(Continued on next page)*

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Regressor	**(6) Selection**	**(7) FE**	**(8) t-2**	**(9) OLS**	**(10) Levels**
ΔHZ	−1.388***	−0.821***	−1.704***	−0.729***	-
	0.308	*0.177*	*0.303*	*0.172*	
ΔBW	−3.501***	−2.387***	−3.845***	−2.368***	-
	0.559	*0.417*	*0.614*	*0.607*	
ΔFW	−1.984	0.526	−2.330	−3.414**	-
	1.630	*0.605*	*1.545*	*1.377*	
$\Delta COMP$	−0.637***	−0.936***	−0.675***	−0.846***	-
	0.211	*0.121*	*0.206*	*0.173*	
HZ	-	-	-	-	0.154**
					0.068
BW	-	-	-	-	0.542
					0.480
FW	-	-	-	-	1.195***
					0.427
$COMP$	-	-	-	-	−0.086
					0.057
No. of obs.	222,892	294,009	157,071	225,732	315,518
Adjusted R^2	0.018	0.030	0.035	0.011	0.409

Note: (6): Only domestic firms that have *not* been foreign-owned at some point during the period 2002–07 are included. (7): Equation 6 estimated as a fixed effect model rather than in first differences (the Δ variables are constructed as $x_{ijt} - \bar{x}_{ij}$ instead of as $x_{ijt} - x_{ijt-1}$). (8): Equation 6 estimated in second differences rather than in first differences (the Δ variables are constructed as $x_{ijt} - x_{ijt-2}$ instead of as $x_{ijt} - x_{ijt-1}$). (9): The production function is estimated as a simple OLS regression rather than using the LP method to correct for endogeneity (Equation 1 is estimated without ω_{it}). (10): Equation 6 estimated in levels rather than in first differences.

Finally, to illustrate the difference between the use of cross-sectional and panel data, the model specification is estimated in levels, as a pooled regression, rather than in first differences (10). As pointed out by Görg and Strobl (2001), cross-sectional models do not take into account the dynamics of the data and have a tendency to overestimate productivity spillovers. This theory is supported by the Danish data, which reveal a significantly positive relationship between levels of productivity and the horizontal/forward measures. However, this finding cannot be used to conclude that high foreign presence leads to increased productivity of domestic firms because causality can only be tested by exploiting the time dimension of the data. As shown in the first-difference estimation, increased foreign presence actually leads to lower productivity among domestic firms. Put differently, foreign firms generally choose to enter the most productive Danish industries[20], but increased foreign presence hampers the productivity of Danish firms.

6.2 Ownership Structures

The second part of the empirical analysis examines the importance of ownership structures and the foreign firm definition applied in the study, see Table 3. The baseline case from Table 2 is included in Table 3 to facilitate comparisons across models (1). Because data on immediate ownership is only available from 2004 and not from 2002 as in the baseline case, the baseline specification is applied to data for the period 2004-07 to allow for a direct comparison that will not be affected by the time period. The analysis reveals that the baseline results do not change when the model is estimated on data for a shorter period (2).

The model is now re-estimated using a different foreign firm definition so that only firms controlled directly by a foreign investor are classified as foreign as done in some studies, for instance in Javorcik and Spatareanu (2008). As shown in Table 1, this definition implies that a significant proportion of output produced by firms under ultimate foreign control is classified as Danish even though firms indirectly controlled by a foreign investor will be subject to the same demands and will benefit from access to similar foreign technology, advice, management techniques, etc. as firms under direct foreign control.

The estimation of the model solely based on direct foreign control leads to a more positive picture than is actually the case since the negative horizontal spillovers are now less significant and, more importantly, forward spillovers are significantly positive (3). Foreign firms often produce advanced products, and increased foreign firm presence eases the access to such

[20]Since level estimations should always be interpreted with care, one cannot with certainty conclude whether foreign firms choose to enter the most productive Danish industries because of their high productivity or because of other characteristics such as excess profitability or market access that may be positively correlated with productivity.

Table 3: Estimations based on different foreign firm definitions

Regressor	**(1) Baseline**	**(2) Ultimate investor**	**(3) Direct investor**
ΔHZ	−1.351***	-	-
	0.302		
ΔBW	−3.516***	-	-
	0.561		
ΔFW	−2.283	-	-
	1.612		
$\Delta COMP$	−0.623***	−1.010***	−1.458***
	0.209	*0.272*	*0.281*
ΔHZ_uci	-	−1.328***	-
		0.414	
ΔBW_uci	-	−3.100***	-
		0.652	
ΔFW_uci	-	−0.644	-
		1.739	
ΔHZ_dir	-	-	−0.696**
			0.348
ΔBW_dir	-	-	−3.751***
			0.816
ΔFW_dir	-	-	2.880**
			1.426
No. of obs.	225,732	137,648	139,255
Adjusted R^2	0.018	0.013	0.011

Note: The table displays the results of estimating Equation 6 with the following foreign firm definitions and data. (1): Foreign firms defined as firms with a non-resident ultimate controlling investor; data for the period 2002-07. (2): Foreign firms defined as firms with a non-resident ultimate controlling investor; data for the period 2004-07. (3): Foreign firms defined as firms with a non-resident direct controlling investor; data for the period 2004-07. Standard errors clustered by industry-year are reported in italics. *, **, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

products for firms operating in the domestic economy. If firms under indirect foreign control are capable of taking full advantage of the advanced products in their production processes by exploiting superior technology or advice received from their foreign ultimate investor, it may explain the positive forward spillovers since the firms under indirect foreign control are

classified as domestic firms in this specification. The lesson is that other studies that only consider direct foreign control may get biased results, particularly in countries where the use of holding companies is common.

6.3 Domestic Firm Characteristics

While the empirical analysis so far has considered productivity spillovers at the aggregate level, focus will now turn to the results at a more detailed level. Table 4 includes industry-specific results and reveals that productivity spillovers vary widely across industries. At first glance, it may seem surprising that insignificant productivity spillovers is the most common outcome when the aggregate results display negative spillovers. Nevertheless, one has to consider that there is a large variation in the number of domestic firms in each industry, and a number of the largest domestic industries display negative spillovers, thus explaining the negative results at the aggregate level. Even though the aggregate analysis displays strong evidence for negative productivity spillovers, there are a number of cases at the industry level where increased foreign firm presence has a positive effect on domestic firms' productivity.

Table 4: Parameter significance in industry-level estimations of productivity spillovers

Industry	**ΔHZ**	**ΔBW**	**ΔFW**	**No. of obs.**
Extr. of crude petroleum, natural gas etc.	.	.	.	44
Extr. of gravel, clay, stone and salt etc.	.	.	.	420
Processing etc. of fish and fish products	−	0	−	428
Processing etc. of fruit and vegetables	+	+	+	136
Mfr. of vegetable and animal oils and fats	.	.	.	25
Mfr. of starch, chocolate and sugar products	+	0	0	603
Mfr. of bread, cakes and biscuits	.	.	.	200
Mfr. of beverages	.	.	.	153
Mfr. of textiles and textile products	−	−	0	1,424
Mfr. of pulp, paper and paper products	−	0	0	535
Publishing of newspapers	.	.	.	120
Publishing activities, excluding newspapers	−	0	0	2,001
Printing activities etc.	−	−	0	3,577
Mfr. of refined petroleum products etc.	.	.	.	7
Mfr. of industrial gases and inorganic basic chemicals	.	.	.	23
Mfr. of dyes, pigments and organic basic chemicals	.	.	.	52
Mfr. of plastics and syntethic rubber	.	.	.	73
Mfr. of paints, printing ink and mastics	0	0	0	152
Mfr. of pharmaceuticals etc.	+	−	−	142
Mfr. of detergents and other chemical products	+	+	−	413

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Industry	**ΔHZ**	**ΔBW**	**ΔFW**	**No. of obs.**
Mfr. of rubber products and plastic packing goods etc.	−	0	−	806
Mfr. of builders' ware of plastic	.	.	.	258
Manufacture of other plastic products n.e.c.	+	+	−	1,080
Mfr. of glass and ceramic goods etc.	−	−	0	429
Mfr. of cement, bricks, tiles, flags etc.	.	.	.	113
Mfr. of concrete, cement, asphalt and rockwool products	0	−	0	969
Mfr. of basic ferrous metals	.	.	.	48
First processing of iron and steel	−	+	−	107
Mfr. of basic non-ferrous metals	−	0	0	72
Mfr. of construct. materials of metal etc.	−	0	+	7,581
Mfr. of hand tools, metal packaging etc.	−	+	+	2,804
Mfr. af marine engines, compressors etc.	−	−	+	837
Mfr. of other general purpose machinery	+	0	0	1,946
Mfr. of agricultural and forestry machinery	0	0	−	1,103
Mfr. of machinery for industries etc.	0	−	0	2,636
Mfr. of domestic appliances n.e.c.	0	+	0	169
Mfr. of office machinery and computers	−	+	0	174
Mfr. of other electrical machinery and apparatus	−	0	+	2,222
Mfr. of radio and communicat. equipm. etc.	0	−	0	543
Mfr. of medical and optical instrum. etc.	0	0	−	1,460
Manufacture of motor vehicles etc.	0	−	+	473
Mfr. of transport equipment excl. ships, motor vehicles etc.	−	+	+	231
Mfr. of furniture	−	0	0	2,458
Sale of motor vehicles, motorcycles etc.	−	−	0	8,311
Repair and maintenance of motor vehicles	0	−	+	11,361
Ws. and commis. trade, exc. of m. vehicles	−	−	−	40,683
Retail trade of food etc.	.	.	.	13,870
Re. sale of clothing, footwear etc.	−	−	−	11,010
Other retail sale, repair work	0	0	−	28,126
Hotels etc.	0	+	−	3,925
Restaurants etc.	0	0	−	22,597
Other scheduled passenger land transport	+	−	+	226
Air transport	0	−	0	97
Cargo handling, harbors etc.; travel agencies	−	−	0	1,701
Activities of other transport agencies	−	0	+	2,365
Post and telecommunications	0	+	−	1,028
Renting of machinery and equipment etc.	−	−	0	2,423
Computer activities exc. software consultancy and supply	0	0	−	2,275
Software consultancy and supply	+	0	0	8,013
Consulting engineers, architects etc.	0	−	−	9,237

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Industry	**ΔHZ**	**ΔBW**	**ΔFW**	**No. of obs.**
Advertising	0	+	−	4,126
Other business activities	−	−	+	15,311
Total	**62**	**62**	**62**	**225,732**
+	*15*	*13*	*13*	
0	*23*	*28*	*30*	
−	*24*	*21*	*19*	

Note: The table displays parameter significance at a 10 percent level when the model specification given in Equation 6 is applied for each of the 62 industries. +, 0, and − indicate positive, insignificant, and negative parameter estimates, respectively. For confidentiality reasons, certain results cannot be displayed at the industry level (indicated by .), but they are included in the totals/aggregates.

The next step in the analysis is to investigate the effect that certain domestic firm characteristics have on their ability to benefit from foreign firm presence, see Table 5.

Productivity — The empirical analysis based on Danish data reveals that both the group of the most and least productive domestic firms experience negative horizontal and backward spillovers and insignificant forward spillovers (1). According to Hypothesis 1, the productivity of domestic firms can have positive as well as negative effects on productivity spillovers, and the empirical results indicate that the opposing effects neutralize each other.

Just as there are two contradicting strands in the theoretical discussion on the role of domestic firm productivity with regard to productivity spillovers, the empirical evidence is mixed. Based on Romanian data, Javorcik and Spatareanu (2008) find that horizontal spillovers are insignificant for industry leaders, but negative for other domestic firms. Conversely, Griffith, Simpson and Redding (2002) show that UK firms with a large technological gap have a tendency to catch up faster than UK firms with a small technological gap.

Export orientation — Another outcome of the empirical analysis is that domestic firms with both high and low export orientation experience negative horizontal and backward spillovers, but only domestic firms with low export orientation experience negative forward spillovers (2)[21]. This finding may be explained by the fact that export-oriented firms are better at taking advantage of the products supplied by foreign firms operating in Denmark because the export-oriented firms are used to competitive pressure and finding ways to improve efficiency. Hypothesis 2 states that domestic firms' export orientation can have

[21]The 80th percentile rather than the median is used to make the export orientation split since the majority of domestic firms do not export

both positive and negative effects on productivity spillovers, and the empirical results show that the positive effect dominates the negative effect.

Barrios and Strobl (2002) and Schoors and Tol (2002) estimate productivity spillovers on Spanish and Hungarian data, respectively, and also find that export-oriented domestic firms gain more from foreign firm presence than non-export-oriented domestic firms.

Size — According to Hypothesis 3, size is believed to play a role with regard to productivity spillovers as large firms have the necessary scale to imitate advanced production technology introduced by foreign firms. The empirical analysis, however, shows that both large and small firms, in terms of number of employees, experience negative horizontal and backward spillovers and insignificant forward spillovers (3). A possible explanation for the lack of differences between large and small firms could be that even though small firms have less production scale, they are quicker at adjusting to the new situation that occurs when foreign firms increase their presence in the market. A turnaround often takes longer in larger firms.

In comparison, based on Romanian data, Merlevede and Schoors (2006) find that backward spillovers are generally positive for large firms, but often negative for small firms.

Competition — Lastly, the importance of competition is examined. The estimations show that while horizontal and backward spillovers are negative for domestic firms in both the most and least competitive industries, forward spillovers are only negative in the least competitive industries (4). These results are in line with Hypothesis 4, suggesting that there is a positive relationship between competition and foreign firm presence gains, and are similar to the ones based on domestic firms' export orientation. This similarity may be explained by the fact that both export-oriented firms and firms operating in competitive industries are used to high competition and are able to adapt to a new situation in a better way than other firms.

Smeets (2008) points out that empirical studies do not appear to have studied the effect of the host-industry competition level with regard to productivity spillovers. Nevertheless, Javorcik and Spatareanu (2008) do consider the relationship between concentration, which can be seen as a competition proxy, and productivity spillovers in the case of Romania. Contrary to the Danish case and the theoretical literature, they find that domestic firms in the most concentrated industries benefit more from foreign presence than firms in less concentrated industries.

Table 5: Domestic firm characteristics

Regressor	**(1) Productivity**		**(2) Export orientation**		**(3) Size**		**(4) Competition**	
	High	Low	High	Low	Large	Small	High	Low
ΔHZ	−1.011***	−1.614***	−1.469***	−1.346***	−1.603***	−1.036***	−2.007***	−0.678**
	0.301	*0.411*	*0.456*	*0.339*	*0.338*	*0.383*	*0.444*	*0.325*
ΔBW	−3.982***	−3.031***	−6.342***	−2.635***	−4.719***	−2.192**	−2.573***	−5.490***
	0.623	*0.859*	*0.996*	*0.613*	*0.646*	*0.863*	*0.581*	*1.076*
ΔFW	−2.650	−2.019	2.215	−3.653**	−2.941	−2.115	0.212	−5.228***
	1.966	*1.965*	*2.384*	*1.745*	*1.832*	*1.840*	*1.911*	*1.971*
$\Delta COMP$	−0.796***	−0.509***	−0.886**	−0.549***	−0.679***	−0.593***	−0.365*	−0.753**
	0.279	*0.205*	*0.349*	*0.197*	*0.310*	*0.193*	*0.185*	*0.327*
No. of obs.	112,739	112,993	39,170	186,562	110,455	115,277	150,894	74,838
Adjusted R^2	0.036	0.017	0.038	0.016	0.035	0.013	0.022	0.016

Note: The table displays the results of estimating Equation 6 in the baseline case for different groups of domestic firms. Standard errors clustered by industry-year in italics. *, **, and *** indicate significance at the 10, 5, and 1 percent levels, respectively. (1): Domestic firms with total factor productivity exceeding the median within a given industry are classified as high; the rest are classified as low. (2): Domestic firms with an export share of output exceeding the 80th percentile within a given industry are classified as high; the rest are classified as low. (3): Domestic firms with number of employees (full time equivalents) exceeding the median within a given industry are classified as large; the rest are classified as small. (4): Domestic firms in the top 50 percent of the 62 industries with regard to the Danish competition index excluding the productivity measure (reverse ordering as low competition index indicates high competition) are classified as high; the rest are classified as low.

6.4 FDI Characteristics

The final part of the empirical analysis deals with the characteristics of the foreign firms and investigates whether certain types of foreign firms generate different productivity spillovers than other types of firms, see Table 6. Such information would be valuable to policy makers when deciding what kind of FDI they should attempt to attract.

Productivity — As mentioned, the productivity of foreign firms can be seen as the other side to the story of the technological gap. The estimations show that the negative productivity spillovers stem from the presence of the least productive foreign firms (1). The most productive foreign firms display neutral horizontal and forward spillovers and positive backward spillovers. The positive backward spillovers may be explained by the most productive foreign firms' ability to train domestic suppliers, which may be a factor leading to their own success and, more importantly in this connection, leads to increased productivity of domestic suppliers. It is conceivable that the least productive foreign firms provide a limited imitation potential, which means that negative competition effect will dominate the picture. The most productive foreign firms will also win market shares from domestic firms, but the catching-up potential that they present to domestic firms offsets the negative effects. According to Hypothesis 5, the productivity of foreign firms can have opposing effects, but the empirical results show that domestic firms benefit more from the presence of the most productive foreign firms than they do from the presence of the least productive foreign firms.

Export orientation — Only the measures constructed on the basis of the most export-oriented firms are significantly negative (2). The reason may be that these firms are less in contact with domestic firms, limiting the potential for positive spillovers to take place. Even though these firms are export-oriented, they still crowd out domestic firms to some extent, which can explain the negative spillovers. Hypothesis 6 identifies both positive and negative effects from export orientation of foreign firms on productivity spillovers to domestic firms, and the empirical results demonstrate that the negative effect is the strongest. Put differently, domestic firms benefit more from the presence of the least export-oriented foreign firms than from the presence of the most export-oriented foreign firms.

Other empirical studies do not appear to have focused on the foreign trade orientation of the FDI entering a country, making a comparison to other studies impossible.

Table 6: FDI characteristics

Regressor	(1) Productivity	(2) Export orientation	(3) Import orientation	(4) Country similarities
ΔHZ_high	−0.542	−1.518***	−0.896**	−0.123
	0.401	*0.477*	*0.399*	*0.334*
ΔBW_high	3.070**	−5.439**	−6.823***	−0.998
	1.380	*2.439*	*1.990*	*2.762*
ΔFW_high	−3.465	1.481	−5.141	−1.468
	2.420	*2.227*	*3.791*	*1.968*
ΔHZ_low	−2.177***	−0.350	−1.463***	−1.605***
	0.623	*0.382*	*0.351*	*0.363*
ΔBW_low	−17.400***	−0.795	1.187	−4.257***
	3.096	*3.538*	*2.708*	*1.623*
ΔFW_low	0.621	−4.759	4.522	0.401
	6.439	*3.579*	*4.536*	*1.853*
$\Delta COMP$	−0.486***	−0.615***	−0.567***	−0.640***
	0.188	*0.215*	*0.197*	*0.211*
No. of obs.	225,732	225,732	225,732	225,732
Adjusted R^2	0.020	0.019	0.020	0.019

Note: The table displays the results of estimating Equation 6 with each of the three spillover measures broken into in two categories, depending on foreign firm characteristics within each industry. Standard errors clustered by industry-year in italics. *, **, and *** indicate significance at the 10, 5, and 1 percent levels, respectively. (1)-(3): Spillover measures with the extension _high (_low) are constructed on basis of foreign firms with total factor productivity/export share/import share equal to or above (strictly below) the median among foreign firms in a given industry. (4): Spillover measures with the extension _high (_low) are constructed on basis of foreign firms ultimately controlled by an investor from Norway or Sweden (a country outside Scandinavia).

Import orientation — With regard to import orientation, both the presence of foreign firms with high and low import orientation are associated with negative horizontal productivity spillovers, but only the presence of foreign firms with high import orientation leads to negative backward spillovers (3). The negative backward spillovers can be explained by the fact that the high import shares in the most import-oriented foreign firms lead to lower demand in the supplying industries and thus have a negative impact on the supplying firms' productivity as they will move up their cost curve. In other words, the results support Hypothesis 7 saying that domestic firms benefit more from the presence of the least than the most import-oriented foreign firms.

Investor country — Finally, the estimations show that only increased foreign presence of firms ultimately controlled by investors outside Scandinavia have a negative impact on the productivity of domestic firms whereas increased presence of firms under Norwegian or Swedish control do not affect domestic firms' productivity on a net basis (4). This result supports Hypothesis 8, stating that domestic firms benefit more from the presence of Scandinavian than other MNEs, and may be explained by the fact that the cultural and linguistic barriers within Scandinavia are relatively small, thus paving the way for positive spillovers to neutralize the negative effects. For instance, Danish firms may find it easier to imitate and adopt management techniques from Scandinavian MNEs than from MNEs with a different origin as the Scandinavian countries share a tradition for less hierarchical organizational structures than many other countries.

Other studies have also examined the nationality of the investor. For instance, Abraham, Konings and Slootmaekers (2007) find that FDI from Hong Kong, Macau, and Taiwan have a more positive effect on domestic firm productivity in China than FDI originating from other countries. Even though they hypothesize that this finding could be linked to the technological gap, smaller cultural and linguistic barriers may also play a role.

7 Conclusion

A unique contribution of this paper has been to investigate the effect of applying different foreign firm definitions. While the definition of foreign firms may, on the surface, seem like a minor technical detail, the widespread use of holding companies in many countries has made the topic an important one. It is often difficult to obtain access to official firm-level data due to confidentiality constraints, and data from commercial providers are sometimes used instead. However, such data rarely contain high-quality information on full group structures, which explains why some researchers only consider direct foreign control when

Table 7: Summary of hypotheses and empirical findings

Hypothesis		**Empirical finding**
Domestic firms characteristics:		
1:	The productivity of domestic firms has an impact on productivity spillovers from FDI; the net impact can be positive, neutral, or negative	Neutral impact
2:	The export orientation of domestic firms has an impact on productivity spillovers from FDI; the net impact can be positive, neutral, or negative	Positive impact
3:	The size of domestic firms has a positive impact on productivity spillovers from FDI	Neutral impact
4:	The competition level of the domestic industry has a positive impact on productivity spillovers from FDI	Positive impact
FDI characteristics:		
5:	The productivity of foreign firms has an impact on productivity spillovers from FDI; the net impact can be positive, neutral, or negative	Positive impact
6:	The export orientation of foreign firms has an impact on productivity spillovers from FDI; the net impact can be positive, neutral, or negative	Negative impact
7:	The import orientation of foreign firms has a negative impact on productivity spillovers from FDI	Negative impact
8:	FDI from Norway and Sweden has a positive impact on productivity spillovers compared to FDI from other countries	Positive impact

defining foreign firms. In case of holding company structures, this practice misses many firms ultimately under foreign control, and the estimations in this paper reveal that it may severely bias the results, making it impossible to neglect the issue.

The theoretical literature on productivity spillovers from FDI identifies positive as well as negative effects, and empirical studies from a number of countries show that the sign of the net effect differs across countries. This paper exploits the rich detail level offered by official Danish firm-level panel data, making it possible to test the importance of various domestic firm characteristics and FDI characteristics with regard to productivity spillovers. The analysis shows that aggregate productivity spillovers effects are negative, but the results differ widely across industries. It also finds that domestic firms with high export orientation and domestic firms operating in the most competitive industries experience less negative spillovers than other domestic firms. With regard to FDI characteristics, the estimations reveal that the negative effects largely stem from an increased presence of foreign firms (i) with low productivity, (ii) with high foreign trade orientation, and (iii) ultimately controlled by investors outside Scandinavia. The hypotheses and the empirical findings with regard to

domestic firm characteristics and FDI characteristics are summarized in Table 7.

Based on the results found in this paper, it is tempting to ask the following question: Why do Denmark and other countries spend resources on attracting FDI when empirical studies often find that FDI has a negative impact on the productivity of domestic firms? The answer to the question is that FDI is also associated with many other effects, which have not been examined here. For instance, in the case of greenfield investment, FDI may have a positive impact on both job creation and the total tax base. Moreover, only short-term productivity spillovers have been analyzed in this paper, and despite the negative short-term effects, an increased presence of foreign firms may stimulate the competitiveness of the entire economy in the medium to long run.

Nevertheless, it seems sensible to spend more resources on analyzing in further detail the whole range of effects that FDI has on the economy. This paper has contributed with an analysis of the short-term productivity effects, but it would be useful to investigate job and tax effects as well as longer-term productivity effects. As demonstrated above, such analyses can be used to identify the types of FDI that have the most positive influence on the economy. This kind of information would be extremely valuable to policymakers when defining a strategy regarding which types of FDI a country should attempt to target.

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