The Economics of Investment in the Presence of Risk and Market Frictions: Two Applications

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Contents

List of Figures

Part I

Introduction

Chapter 1

General overview and structure

> "Economics defines investment as the act of incurring an immediate cost in the expectation of future rewards. Firms that construct plants and install equipment, merchants who lay in a stock of goods for sale, and persons who spend time on vocational education are all investors in this sense. ... Viewed from this perspective, investment decisions are ubiquitous" (Dixit and Pindyck, 1994, p. 3).

The theory of investment was pioneered by Jorgenson (1963) and Tobin (1969), who proposed two alternative approaches. Since then, investment decisions have been widely analyzed in the theoretical and empirical literature. An important aspect in the context of investment decisions is risk, for "there is hardly any situation where economic decisions are made with perfect certainty" (Chavas, 2004, p. 1). Von Neumann and Morgenstern (1944) developed the expected utility theory which became the standard approach to model decision-making under uncertainty.[1] Despite its widespread use and its general acceptance, the expected utility approach has been subject to criticism, and so-called non-expected utility models have been suggested.[2] A second factor influencing investment decisions is market frictions. In the last decades, much research has been devoted to the analysis of market frictions because many real world phenomena cannot be explained under the assumption of perfect markets.[3] Information economics has shown that asymmetric information has profound effects on

[1] Concerning the meaning of the terms "risk" and "uncertainty", there is no clear consensus in the literature. Knight (1921) proposed a distinction between risk and uncertainty that depends on the ability to make probability estimates, i.e., risk is measurable but uncertainty is not. This terminology is, however, not used consistently in the literature. We follow Chavas (2004) and use the two terms interchangeably.

[2] For a comprehensive survey on non-expected utility theory, see Starmer (2000).

[3] See, e.g., Calcagnini and Saltari (2010), who provide a collection of recent contributions on the effects of market imperfections on economic decision-making.

decision-making and equilibrium outcomes in financial and other markets (Stiglitz, 2002). Additionally, investment decisions may be affected by many other market imperfections, e.g., various labor market frictions.

This dissertation contributes to the existing literature by presenting two applications of the economics of investment in the presence of risk and market frictions. The first is in the area of financial economics (Part II) and the second is in the area of international trade and labor economics (Part III). In the following, the structure and content of this dissertation are described.

Part II is devoted to asymmetric information and portfolio risk in credit markets. Particular focus lies on equilibrium credit rationing, i.e., market equilibria with excess demand for credit.[4] In Chapters 2 and 3, we motivate our analysis and review the literature on credit rationing, respectively. Chapter 4 presents our contribution which introduces non-diversifiable risk to the seminal Stiglitz and Weiss (1981) adverse selection model. We would now like to point out in what way investment, risk, and market frictions matter in our model. Firms decide whether to undertake an investment project which needs to be financed externally. Households also face an investment decision: they have to decide on their savings for future consumption. Moreover, risk plays a pivotal role in our analysis. As investment projects are risky and may fail, risk-neutral firms only apply for credit if the expected profit is non-negative. Due to correlated project payoffs, the single-name credit risks do not cancel out, and there is non-diversifiable risk. The risky return on lending is passed through to the suppliers of capital, i.e., households' return on saving is risky as well. To model households' consumption-savings decision under uncertainty, we use expected utility maximization and generalize the analysis to non-expected utility maximization. Market frictions are also relevant in our model: the credit market is characterized by asymmetric information. As lenders are unable to observe the risk of a firm's project, the loan rate is the same for each of two borrower types. There is cross-subsidization of high-risk borrowers by low-risk borrowers.

In our static partial equilibrium model, we analyze the credit market equilibrium and determine the amount and types of investment projects financed. It is shown that credit rationing is possible. We also address the role of lenders' risk aversion and the welfare implications of the equilibrium. In particular, we investigate whether there is too little or

[4] A more detailed definition is given in Section 3.2.

too much investment in equilibrium, relative to a first-best or a second-best optimum. To illustrate our theoretical results, some numerical examples are provided. In sum, we show that deviating from the common assumption of independent project payoffs leads to several interesting implications for equilibrium and welfare.

Part III deals with the employment effects of offshoring in the presence of labor market frictions. Offshoring means the relocation of production processes from the home country to a foreign country. In the case of foreign direct investment, production processes are offshored within multinational enterprises, whereas in the case of offshore outsourcing, production processes are offshored to unaffiliated suppliers.[5] Chapter 5 motivates our work, which addresses the question of whether offshoring to low-wage countries (the "South") is detrimental to employment in high-wage countries (the "North") with labor market frictions. In Chapter 6, we define the main concepts and state some general facts and consequences of offshoring. Chapter 7 reviews the literature on offshoring and its labor market effects in detail, since, to the best of our knowledge, a comprehensive literature survey that considers all the different strands of literature related to our model does not yet exist. We cover different trade models, various approaches to offshoring, and models on the labor market effects of trade and offshoring. Of main interest are models analyzing the aggregate employment effects of offshoring in the presence of labor market frictions. As the literature on this issue is still rather limited, the other contributions reviewed may act as a starting point for future research. The detailed survey gives an overview of the sizeable literature on offshoring and its labor market effects, thereby highlighting how our model contributes to the existing literature.

Chapter 8 presents our model, which is Krugman's (1979a) North-South trade model augmented to include offshoring and unemployment in the North. It is our second application of the economics of investment in the presence of risk and market frictions, which raises the question of how these aspects play into our analysis. Concerning investment, a Northern firm can move production to the South within a multinational enterprise. This foreign direct investment is associated with a fixed cost, but the production cost is lower in the South than in the North. Additionally, our model incorporates union wage setting in the North as a source of labor market frictions leading to unemployment. Risk aspects play a subordinate role in our baseline model without productivity uncertainty.[6] In the variant of the model

[5]We revert to defining terms in Section 6.1, since the terms are used differently in the literature.

[6]As we focus on equilibria with unemployment, there is employment risk in our model, i.e., each worker

with heterogeneous firms, however, risk plays a more important role. There is uncertainty about productivity in the South, and a firm only knows its expected profit as a multinational enterprise when it decides to pay the fixed cost of offshoring. A firm incurring the fixed cost of offshoring only relocates production to the South if its operating cost is lower there, i.e., if its productivity in the South is sufficiently high. This means that there is twofold uncertainty: a firm paying the fixed cost does not know the location of production and its productivity if it produces in the South.

Our static general equilibrium model endogenously determines the equilibrium number of firms that offshore production to the South and the production cost in both countries. We find that a reduction in the fixed cost of offshoring usually decreases employment in the North, while the opposite may happen at a low initial level of offshoring. The welfare effects of increased offshoring and a commitment problem of labor unions are also addressed. The variant of the model with heterogeneous firms possibly displays multiple equilibria and provides a more optimistic view of the employment effects of offshoring. In contrast to the existing literature, we extend a standard North-South trade model with two large economies. In doing so, we obtain interesting results concerning the employment effects of offshoring to low-wage countries, gains from trade, shrinking union power, and multiple equilibria.

The conclusion in Chapter 9 summarizes the main results of this dissertation and outlines some future research directions.

faces a positive probability of unemployment. The industry union has the objective to maximize expected utility of workers and bargains over the wage rate with Northern producers. It is indeterminate which workers are unemployed because the model only determines the equilibrium amount of offshoring.

Part II

Asymmetric Information and Portfolio Risk in Credit Markets

Chapter 2

Motivation

During the recent financial crisis, a temporary reduction in the availability of credit was observable. This fact can be illustrated by the Ifo Credit Constraint Indicator for German industry and trade, depicted in Figure 2.1 for the period between March 2005 and June 2011.[1] The figure shows that the share of firms indicating that credit access is restrictive increased considerably during the financial crisis beginning in 2008. In addition, it indicates the fact that restrictive credit policy is not limited to the period of the financial crisis, i.e., it is not necessarily a temporary phenomenon. While direct evidence for credit rationing is hard to come by, this data for Germany suggests that it might be an empirically relevant phenomenon.

Moreover, the financial crisis highlights the importance of information asymmetries and the portfolio risk of banks. A lesson to be learned from the crisis is that non-diversifiable risk and correlations should be more carefully considered. Our aim is not to explain the financial crisis, but to emphasize three aspects which are of interest for the analysis of credit market equilibria: credit rationing, asymmetric information, and portfolio risk. In the following, we briefly summarize existing theoretical work on credit market equilibria in order to point out how our model contributes to the literature.

In the last 30 years, theoretical research on credit markets has made significant progress. The consideration of asymmetric information represents a fundamental change. Stiglitz and Weiss (1981) and the ensuing literature showed that the credit market equilibrium

[1] The Ifo Institute for Economic Research (2011, p. 2) provides the following information: "The credit constraint indicator is based on ca. 4,000 responses of firms in industry and trade from the sectors manufacturing, construction, wholesaling and retailing. The firms are asked to respond to the following question: 'How would you assess the current willingness of banks to extend credit to businesses'? The answers to choose from are 'accommodating', 'normal' and 'restrictive'. The credit constraint is calculated from the percentages of the responses to the last of the three categories".

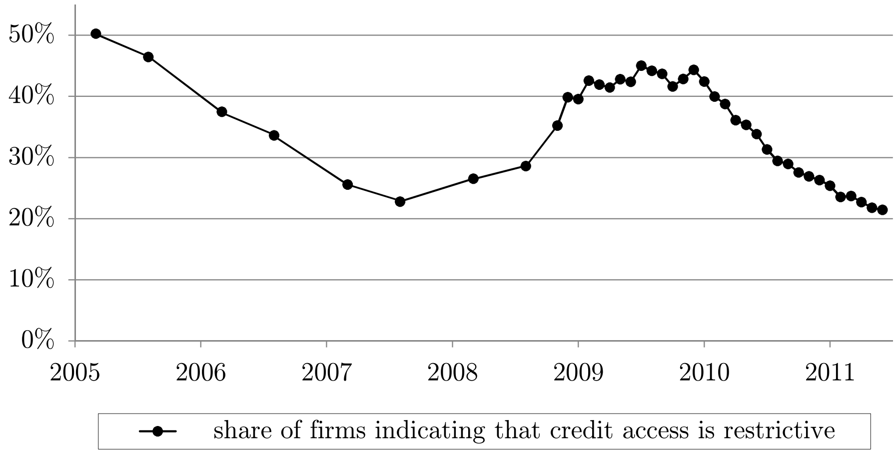

Figure 2.1: Credit Constraint Indicator for German industry and trade.
Source: Adapted from Ifo Institute for Economic Research (2011).

under asymmetric information may differ considerably from the full information outcome. In their seminal[2] contribution, Stiglitz and Weiss (1981) established, among other things, that credit rationing may arise in equilibrium due to asymmetric information. However, Coco (1997) and Arnold and Riley (2009) independently proved that credit rationing at a single equilibrium loan rate cannot occur under the Stiglitz and Weiss (1981) assumptions. Additionally, many other models have been developed that modify the Stiglitz and Weiss (1981) model and discuss the phenomenon of credit rationing. It has also been analyzed whether there is too little investment in a credit market equilibrium, relative to a socially efficient level. This is an important aspect, since credit rationing per se does not have to be inefficient.

A common feature of the credit market models with asymmetric information is the neglect of the portfolio risk of banks. The models build on the assumption that the payoffs of different risky projects are independent, and single-name credit risks cancel out due to perfect diversification.

Our analysis is motivated by the rather obvious fact that returns on risky investment projects tend to be far from independent. Direct evidence is difficult to find, but there are empirical studies suggesting that individual firms' profits are positively correlated at business cycle frequency.[3] We are interested in whether the assumption of correlated project returns

[2]According to Google Scholar, the Stiglitz and Weiss (1981) paper was cited 7,576 times (Sept. 6, 2011).
[3]In Section 4.1, we come back to this point and mention exemplary studies supporting this fact.

has a major impact on the results of credit market models with asymmetric information. For this purpose, we focus on the prominent Stiglitz and Weiss (1981) adverse selection model. We study the consequences of correlated project payoffs and, thus, of portfolio risk in the two-type version of this model. Our analysis addresses the following questions: Is credit rationing at a single equilibrium loan rate possible? Does a systematic relationship between lenders' degree of risk aversion and the credit market equilibrium exist? Is there too little or too much investment in equilibrium, relative to the first-best or the second-best optimum?

The remainder of Part II is organized as follows. Chapter 3 reviews the literature on credit rationing. It illustrates the different approaches used to explain this phenomenon and highlights the important role of the Stiglitz and Weiss (1981) model. Chapter 4 presents our model with aggregate risk.

Chapter 3

Literature review on credit rationing

3.1 Early work on credit rationing

Credit rationing is a phenomenon analyzed extensively in the financial economics literature.[1] The importance of credit rationing and the "fringe of unsatisfied borrowers" have already been emphasized by Keynes (1930).[2] In the early 1950s the so-called availability doctrine came into prominence and assigned an important role to credit rationing arguments. The doctrine, whose leading proponents are Rosa (1951), Kareken (1957), and Scott (1957), is a reaction to the then accepted view of the monetary mechanism. It suggests that monetary policy may operate to some extent through an alternative transmission channel, namely a rationing channel rather than an interest rate channel. Consequently, the funds available to banks are limited and credit is rationed.[3] Even though the availability doctrine was widely criticized, it raised interest in developing theoretical models of credit rationing. There have been several attempts to explain equilibrium credit rationing[4] in full information models, for example Hodgman (1960), Jaffee and Modigliani (1969), Cukierman (1978), and Fried and

[1] A summary of the development of the literature on credit market equilibria is given in Hillier and Ibrahimo (1993) and Freixas and Rochet (2008, Chapter 5). The structure of our literature review is guided by Hillier and Ibrahimo (1993).

[2] For Keynes' (1930) remarks on this issue, see Vol. 1, pp. 212-13, and Vol. 2, pp. 364-67.

[3] For a comprehensive discussion on the availability doctrine, see Jaffee (1971) and Clemenz (1986).

[4] While this literature was mainly concerned with equilibrium credit rationing, some models analyzed disequilibrium credit rationing. According to Baltensperger (1978), the term "equilibrium credit rationing" refers to a permanent excess demand for credit, whereas "disequilibrium credit rationing" refers to a temporary excess demand. These terms are, however, not used consistently in the literature. For example, Freixas and Rochet (2008) additionally use the term "disequilibrium credit rationing" in the context of models on institutional restrictions in which credit rationing is a permanent phenomenon.

Howitt (1980).[5] These models are not fully satisfactory because they do not really explain equilibrium credit rationing. They rather assume it or introduce ad hoc rigidities, e.g., interest rate regulations (cf. Clemenz, 1986, p. 3). Yet since the late 1970s, there has been considerable progress in providing convincing theoretical explanations for this phenomenon: various credit market models incorporate asymmetric information and show how this market friction may cause credit rationing. Before going into more detail about these models, credit rationing is defined in greater detail.[6]

3.2 Definitions of credit rationing

More precise definitions are crucial to the understanding of the different types of credit rationing addressed in the models with information asymmetries. We present some common definitions and only remark that the different models use slightly modified definitions applying to their specific framework.[7]

Freixas and Rochet (2008, p. 172) give a comprehensive definition which follows Baltensperger (1978): "Equilibrium credit rationing occurs whenever some borrower's demand for credit is turned down, even if this borrower is willing to pay all the price and non-price elements of the loan contract". The interest rate charged by the bank is a price element, whereas collateral requirements or the loan size are examples for non-price elements. Hence, if a borrower with insufficient collateral is denied credit, he is not credit rationed according to this definition. Keeton (1979) contrasts two types of credit rationing: "Type I" rationing occurs when all borrowers within a given group receive smaller loans than those demanded at the interest rate charged. Rationing of "type II" arises when borrowers within a group are randomly rationed, i.e., some borrowers of that group do not receive any funds at all, while others are fully funded. According to Jaffee and Stiglitz (1990, p. 849), type II rationing is the "purest form of credit rationing"; they establish the term "pure credit rationing" for situations in which "some individuals obtain loans, while apparently identical individuals, who are willing

[5] Hodgman (1960) derives a hump-shaped credit supply curve for each borrower, while Jaffee and Modigliani (1969) build on the assumption that banks cannot use price discrimination due to regulation. Cukierman (1978) focuses on horizontal integration of banks, i.e., banks provide other services besides credit. Fried and Howitt (1980) model credit rationing stemming from implicit contracts in credit markets. For more details, see Clemenz (1986, Chapter 1) and Hillier and Ibrahimo (1993).

[6] A brief and rather general definition was given in Chapter 1.

[7] As our model builds on the seminal contribution of Stiglitz and Weiss (1981), their definition of credit rationing is spelt out below.

to borrow at precisely the same rate, do not".[8] Another phenomenon which can emerge in equilibrium is "red-lining", "where exclusion from the loan market is not random but is systematically determined by an array of imperfect indicators of entrepreneurial quality" (De Meza and Webb, 2000, p. 217). This means some identifiable groups of borrowers may be excluded from the loan market. Several authors use the term "credit rationing" in this context (e.g., Stiglitz and Weiss, 1981), while others do not classify this as such (e.g., Freixas and Rochet, 2008).

This section illustrated the different forms of credit rationing analyzed in theoretical models and pointed out that varying definitions exist in the literature.

3.3 Asymmetric information and credit rationing

We now come back to credit market models with asymmetric information. The models incorporate different forms of asymmetric information, which may lead to the problems of adverse selection, moral hazard, or costly state verification. These three problems of asymmetric information were first identified in other markets. In their ground-breaking papers, Arrow (1963, 1968) and Akerlof (1970) showed how moral hazard arises because of hidden action in insurance markets and how adverse selection results from hidden information in the market for used cars, respectively. Townsend (1979) pioneered the analysis of costly state verification in insurance markets. Since then, it has been widely recognized that asymmetric information can have far-reaching effects on market outcomes, and the different approaches have been applied to credit market models.

In credit market models with ex ante asymmetric information, information is asymmetrically distributed between the lender and the borrower before project returns are realized. Adverse selection models consider the inability of lenders to distinguish between different types of borrowers, i.e., there is hidden information. Whereas in (ex ante) moral hazard models, lenders cannot influence the firms' choice between different projects or the firms' effort after a loan has been granted, i.e., there is hidden action. Jaffee and Russell (1976), Keeton (1979), and Stiglitz and Weiss (1981) were the first to show that ex ante asymmetric information may cause credit rationing. While Jaffee and Russell (1976) explain type I rationing in the

[8] In Section 4.3, we provide a definition of a pure rationing equilibrium for the two-type version of the Stiglitz and Weiss (1981) model with aggregate risk.

context of adverse selection and moral hazard, Keeton (1979) presents a model on moral hazard explaining type II rationing. The seminal contribution of Stiglitz and Weiss (1981) is discussed in detail below. In credit market models with ex post asymmetric information, project returns are no longer assumed to be costlessly observable for the lender. These models of costly state verification, which apply the ideas of Townsend (1979), are also called ex post moral hazard models, since borrowers have an incentive to misreport the project return. Williamson (1986, 1987) was the first to explain credit rationing in such a model.[9]
As pointed out by Hillier and Ibrahimo (1993, p. 284), all these models illustrate how information asymmetries "may create a non-monotonic relationship between bank profitability per dollar loaned and the interest rate, and how this may lead to credit rationing".[10]

After this general overview of credit market models with asymmetric information, we present the seminal contribution of Stiglitz and Weiss (1981) (henceforth SW), in which several partial equilibrium models of credit rationing with ex ante asymmetric information are analyzed. SW use the term credit rationing "for circumstances in which either a) among loan applicants who appear to be identical some receive a loan and others do not, and the rejected applicants would not receive a loan even if they offered to pay a higher interest rate; or b) there are identifiable groups of individuals in the population who, with a given supply of credit, are unable to obtain loans at any interest rate, even though with a larger supply of credit, they would" (Stiglitz and Weiss, 1981, pp. 394-95). Part a) of the definition refers to type II rationing and part b) to red-lining. In the following, we focus on the results of SW concerning type II rationing and briefly mention their moral hazard model before turning to their prominent adverse selection model.[11]
In the moral hazard model, each firm has a hidden choice between a safe and a risky project. Raising the interest rate may induce the firm to undertake the risky project, i.e., the interest rate may act as an incentive mechanism. SW show that there may be an interest rate above which the bank's expected return declines due to the moral hazard effect. In this case, an equilibrium with (type II) credit rationing may arise.[12]

[9]Adopting the model of Gale and Hellwig (1985), Williamson (1986, 1987) establishes that the standard debt contract is optimal in his setup and that financial intermediaries arise endogenously in the presence of monitoring cost.

[10]This non-monotonicity implies a certain shape of the credit supply curve which may lead to credit rationing (see the description of the Stiglitz and Weiss, 1981, model below). In contrast, regulations or other assumptions directly influence the credit supply curve in the early models with full information.

[11]Due to the assumption of indivisible projects, SW analyze rationing of type II rather than type I. For the results of the models on redlining and other aspects, see Sections III and IV of the SW paper.

[12]Another noteworthy contribution on moral hazard and credit rationing is Bester and Hellwig (1987).

However, more prominent is the adverse selection model of SW,[13] in which each borrower is endowed with a project and the payoffs of different projects differ by mean-preserving spreads.[14] By assumption, the lender cannot distinguish between different types of borrowers, and the amount of collateral and loan size are identical for all borrowers. In this setup, the interest rate a borrower is willing to pay may act as a screening device. For high interest rates, borrowers with riskier project still demand credit but those with less risky projects do not. An increase in the interest rate has the following effects: the average riskiness of the loan portfolio increases (i.e., the adverse selection effect), and the remaining borrowers pay a higher rate if they are able to repay. SW establish that there may be an interest rate above which the adverse selection effect dominates so that the bank's expected repayment declines. In the case of a globally hump-shaped return function, the credit supply curve is backward-bending, and an equilibrium with (type II) credit rationing may arise.[15] Besides, SW argue that a return function with multiple humps may give rise to a two-price equilibrium, which is characterized by excess demand and random rationing at the lower interest rate and market clearing at the higher rate.[16] Yet, they do not derive the conditions for such a return function.

The analysis of SW has some interesting implications: The "Law of Supply and Demand" is repealed, and, as a consequence, standard comparative statics analysis is no longer possible. Supply and demand are shown to be interdependent. Additionally, red-lining of some classes of borrowers may be observed. The two-price equilibrium disproves the "Law of the Single Price", and the level of investment under asymmetric information might be inefficient.[17] The ground-breaking adverse selection model of SW prompted a number of papers with different objectives. Among other things, these contributions criticize and change the assumptions, question the relevance of credit rationing, and push the analysis a step further. We cluster the models according to their focus and their main deviation from the SW model.[18]

[13]Whenever we refer to the SW model, we mean their adverse selection model.

[14]This means the different projects have the same expected return but differ in their riskiness (see Rothschild and Stiglitz, 1970).

[15]Coco (1997) and Arnold and Riley (2009) independently showed that this putative credit rationing result (at a single equilibrium loan rate) is inconsistent with the SW assumptions. Later in this section, their finding is presented in detail.

[16]For a more detailed description of a two-price equilibrium, see Stiglitz and Weiss (1981), p. 398. In Section 4.3, we provide a definition of the two-price equilibrium for the two-type version of the SW model with aggregate risk.

[17]Cf. Hillier and Ibrahimo (1993, pp. 284-88), who give a detailed description of these implications.

[18]Many of the papers reviewed below are also covered in Hillier and Ibrahimo (1993), pp. 288-99.

It has been widely criticized that SW assume the use of standard debt contracts as well as identical loan size and collateral requirement for all borrowers. SW rule out any sorting mechanism and focus solely on the role of the interest rate the bank charges. Several papers address this issue and consider different contracts which induce self-selection of borrowers. If banks offer different contracts which specify the loan rate and collateral requirement simultaneously, collateral may be used as a sorting device. Contributions adopting this approach include Wette (1983), Chan and Kanatas (1985), and Bester (1985).[19] In his noteworthy contribution, Bester (1985) shows that, if an equilibrium exists, there is no equilibrium credit rationing in a variant of the SW model with different contracts.[20] Low-risk firms choose the contract with a higher amount of collateral and a lower loan rate, while high-risk firms choose the other contract. The separating equilibrium[21] reveals the asymmetric information, and there is no reason for credit rationing. This result contrasts with the pooling equilibrium stemming from the debt contract with a fixed amount of collateral in the SW model.[22] In a related paper, Besanko and Thakor (1987b) characterize admissible debt contracts by a set of credit instruments, namely interest rate, collateral, loan size, and credit granting probability. It is shown that there is no credit rationing in equilibrium, since the lender uses a sufficiently large set of credit instruments in order to sort the borrowers. In addition, Besanko and Thakor (1987a) analyze the role of market structure (i.e., monopolistic or competitive credit markets) for credit allocation and for lenders' use of collateral as a sorting device.[23] Instead of focusing on collateral, Milde and Riley (1988) use loan size as a sorting device. In their model, banks use higher loan size at higher interest rates to induce self-selection of borrowers. This mechanism is ruled out in the SW model by the assumption that all firms have the same need for capital.

Another point of criticism is that SW do not take account of the complexity of the lender-borrower relationship. In their static setup, strategies of lenders are limited. As a response to this critique, Stiglitz and Weiss (1983) extend their model to allow for multi-period

[19] Wette (1983) shows that increases in collateral may also cause adverse selection effects when the interest rate is fixed. Chan and Kanatas (1985) establish that in a model with asymmetric valuations of the payoffs the less risky borrowers provide more collateral.

[20] Bester (1987) establishes a similar result for the case of risk-averse borrowers. He shows that credit rationing occurs only if some borrowers cannot provide enough collateral, i.e., if perfect sorting is not viable.

[21] This type of equilibrium was first analyzed in insurance markets in Rothschild and Stiglitz (1976). In this context, different contracts also specify a quantity and a price.

[22] In their response, Stiglitz and Weiss (1986) develop a model in which, among other changes, the level of collateralization is positively related to the riskiness of the borrowers. This view is supported by empirical evidence of Berger and Udell (1990). SW argue that credit rationing is still possible in such a setup.

[23] For a survey on the use of collateral in credit markets, see Coco (2000). The empirical work he reviews is inconsistent with the use of collateral as a signal of project types.

relationships between the bank and borrowers. Equilibrium credit rationing is still possible in this model, in which defaulters are denied credit in future periods. Additionally, Diamond (1989) analyzes how borrowers' reputation is formed and how the incentive effects of reputation evolve over time. Reputation may not provide better incentives at the beginning of a lending relationship, but over time, reputation will lead the borrower to choose less risky projects. The multi-period model of Bester (1994) considers the role of collateral for debt renegotiation given ex post asymmetric information. Initial contracts are more likely to be renegotiated in the presence of collateral requirements, since collateralization reduces the incentives for strategic default. Petersen and Rajan (1995) establish that competition in credit markets is an important factor for the value of lending relationships.

Furthermore, there is no explicit game-theoretic foundation for competitive equilibria in the SW model. Since it is problematic to achieve competitive equilibria under two-sided price competition (Stahl, 1988, and Yanelle, 1989, 1997), Arnold (2011) provides a detailed game-theoretic foundation for the SW model. Building on the work of Stahl (1988) and Yanelle (1989, 1997), competition in the deposit and credit market is described as a two-stage game. With double Bertrand competition, the order of the game is important: the credit subgame has to precede the deposit subgame in order to obtain the competitive equilibria as subgame-perfect Nash equilibria.[24] In an earlier contribution, Hellwig (1987) is concerned with different game-theoretic formalizations of competition in markets with adverse selection. It is illustrated that the prediction of how a competitive market works varies with the different formalizations. Hellwig (1987) elucidates the conditions for the existence of a competitive equilibrium, for credit rationing, and for the emergence of different credit contracts.[25]

While SW focus on the credit market equilibrium, a group of papers analyzes the equity market equilibrium in the presence of asymmetric information and the interaction between equity and debt financing. Cho (1986) argues that the use of equity instead of debt could avoid the inefficient allocation of capital in the SW model, since equity contracts are not associated with adverse selection effects. In contrast, Myers and Majluf (1984) and Greenwald et al. (1984) establish that rationing is also possible in equity markets. For this purpose, the authors change some assumptions, in particular asymmetric information

[24] Arnold (2011) shows that the SW assumptions may give rise to a two-price equilibrium but not to a credit rationing equilibrium (see also Arnold and Riley, 2009). We come back to this point later.

[25] General thoughts on game-theoretic aspects of credit market models can be found in Clemenz (1986, pp. 155-63).

concerns expected returns and not project risk (cf. Hellmann and Stiglitz, 2000). De Meza and Webb (1987) take this a logical step further and model the competition between the different forms of financing, equity or debt. They derive the equilibrium mode of finance and find that it is debt in their own model but equity in the SW model. This difference as well as the over- and underinvestment result mentioned below are due to changes in the model assumptions: In the SW model, the expected returns are equal across projects, and the payoffs differ by mean-preserving spreads. Concerning the information asymmetry, SW assume that lenders are uninformed about the *risk* of a borrower's project. In contrast, De Meza and Webb (1987) assume that the projects have the same return if successful but differ in the success probability; i.e., the riskiest project has the lowest expected return. In their setup, the lender is uninformed about the *expected return* of a borrower's project. These changes have far-reaching consequences. As the different projects are ranked by first-order stochastic dominance, an increase in the interest rate improves the composition of the loan portfolio in the De Meza and Webb (1987) model. Thus, there is no adverse selection, and credit rationing never occurs in equilibrium. Moreover, De Meza and Webb (1987) are the first to explicitly address the welfare properties of the market equilibrium by comparing the equilibrium level of investment with the optimum investment under full information. They show that the equilibrium in their own model is characterized by overinvestment, while there is underinvestment in the SW model irrespective of whether rationing occurs or not.[26] Hence, in both models the market equilibrium is not first-best efficient.[27] Asymmetric information concerns the expected project return in the De Meza and Webb (1987) model and project risk in the SW model. In a setup with both forms of information asymmetries, Hellmann and Stiglitz (2000) analyze the interaction between equity and debt finance. They find that there may be credit and/or equity rationing in equilibrium. The adverse selection which results in rationing outcomes may be caused by competition between the equity and credit market.

As pointed out by De Meza and Webb (1987), asymmetric information may cause inefficient levels of investment, and, thus, there may be a case for government interventions. In general, under- and overinvestment can be mitigated by an interest rate subsidy and an

[26] With the aim to clarify the different results of these two models, Bernhardt (2000) analyzes a setup in which lenders and borrowers are symmetrically uninformed. He argues that the over- and underinvestment result depends on the kind of uncertainty about production technology, i.e., how the stochastic component enters payoffs.

[27] In Section 4.8.1, we prove the underinvestment result for the SW model with uncorrelated payoffs, thereby showing that the first-best and second-best optima coincide.

interest rate tax, respectively.[28] In this context, we mention the contribution of Mankiw (1986). Using a hidden-type model, he shows that credit allocation is inefficient and can be improved by interventions. Moreover, he highlights that the government should act as lender of last resort due to the possibility of financial fragility. Policy implications are discussed in several other papers, but the recommendations drawn from this class of models should be treated with caution for the following reasons: All of these models are rather simple, and their implications are sensitive to changes in the underlying assumptions.[29] As these contributions use only partial equilibrium models, they do not consider the effects of government interventions on the economy as a whole.

This last aspect leads us to another group of papers which is concerned with macroeconomic consequences of asymmetric information in capital markets. Greenwald and Stiglitz (1987) give a rather general overview of possible consequences for the macroeconomy. Additionally, business cycle theorists incorporate the results from research on imperfect capital markets into general equilibrium models. Bernanke and Gertler (1989, 1990) use a model with ex post and ex ante asymmetric information, respectively.[30] Greenwald and Stiglitz (1993) also analyze the influence of capital market imperfections on the business cycle and take into account the fact that asymmetric information may lead to a collapse of the equity market. Suarez and Sussman (2004) use a dynamic extension of the moral hazard model in SW in order to analyze endogenous cycles. In their simple model, the business cycle is generated solely by financial imperfections. These different contributions illustrate the idea that financial factors (i.e., the way of financing projects, the access to financial markets, and contractual arrangements) play a crucial role for business cycles and the macroeconomy in general.[31] A line of research which is more concerned with long-run macroeconomic development is the finance and growth literature.[32] The central idea is that the functioning of financial markets and the financial structure may have a substantial influence on economic growth and the overall development of the economy. For instance, Bencivenga and Smith

[28] Note that the emergence of credit rationing per se does not imply a socially inefficient level of investment or a role for government interventions. De Meza and Webb (1992) show that credit rationing need not be inefficient, since it may also prevail in capital markets with symmetric information.

[29] For example, De Meza and Webb (2000) show that credit rationing may be associated with overinvestment in a model of simultaneous adverse selection and (ex ante) moral hazard. In contrast, credit rationing is associated with underinvestment in the SW model.

[30] In a simple neoclassical model of business cycles, Bernanke and Gertler (1989) analyze the relationship between borrowers' net worth, agency costs of financing investments, and business fluctuations. They show how shocks are propagated via capital market imperfections. Bernanke and Gertler (1990) examine financial fragility in a general equilibrium model, in which agency costs play a major role.

[31] For a more detailed discussion on this issue, see Reichlin (2004).

[32] Among others, Levine (2005) provides a survey of the theoretical and empirical work in this field.

(1993) address the profound consequences of credit rationing in an endogenous growth model with adverse selection in the credit market. They show that, among other things, government investment subsidies can be growth-reducing.
We already mentioned some contributions that provide arguments against the relevance of equilibrium credit rationing, e.g., Bester (1985), who points out the role of collateral as a sorting device. In addition, Riley (1987, p. 226) concludes "that the extent of rationing implied by the SW model is not likely to be very important empirically". He builds on the assumption that banks can group borrowers into different risk classes and highlights that credit rationing can occur only in one marginal class. More recent contributions that question the relevance of credit rationing focus on the option to wait. Lensink and Sterken (2001, 2002) modify the SW model such that a firm has the possibility to delay its project. They assume that waiting projects never default, i.e., the uncertainty involved in an investment is resolved in the future. Since firms with riskier projects have a greater return from waiting, they are the first to delay their projects as the interest rate rises. Consequently, banks have no reason to ration credit. De Meza and Webb (2006) build on this model, but the option to wait has a different implication in their setup. By delaying a project, a firm accumulates financial assets and reduces the size of the loan needed. Given the assumption that banks condition the interest rate on the loan size, less risky firms delay their projects, and there is no random rationing. The authors mention scaling down the project or decreasing consumption as other options to reduce the size of the loan needed, in turn, avoiding credit rationing. Besides the adverse selection model, De Meza and Webb (2006) study a model with moral hazard, in which equilibrium credit rationing only occurs if a delay deteriorates the indivisible project sufficiently.

The theoretical models mentioned so far emphasize the problems of asymmetric information that may arise in capital markets and the far-reaching consequences they might have. As pointed out by Stiglitz (2002, p. 461), the main insight gained by research on asymmetric information is that "even a small amount of information imperfection could have a profound effect on the nature of the equilibrium". The information-based models are an important contribution to economic theory, and this is particularly true for the literature on credit rationing. Credit market models with asymmetric information considerably improved our understanding of this phenomenon, but the literature review illustrates that the relevance of equilibrium credit rationing is disputed. Several models explain how equilibrium credit rationing may be caused by asymmetric information, while other models question this result. The equilibrium outcomes of the different models depend heavily on the underlying assumptions.

Since there is no consensus on the relevance of credit rationing in the theoretical literature, empirical evidence on credit rationing would be valuable. The scarceness of microeconomic data on contract details of commercial bank loans, however, limits empirical testing of the theories of credit rationing.[33] Due to this fact, some empirical investigations focus on macroeconomic variables as proxies for credit rationing. For example, the stickiness of commercial loan rates, measured by the speed with which the commercial loan rate adjusts to changes in open market rates, is used as evidence for credit rationing. Using this approach, Jaffee (1971) and Slovin and Sushka (1983) find different degrees of loan stickiness and come to opposing conclusions concerning the empirical relevance of credit rationing.[34] As there are many other reasons for sticky loan rates, this method is rather controversial. In a more recent contribution, Gu et al. (2008) use a new technique and analyze the US credit market at the aggregate level. They detect that credit is not rationed for very high or very low levels of inflation but for intermediate levels. Unfortunately, there is little direct testing of the empirical relevance of credit rationing. A notable exception is the study of Berger and Udell (1992), which uses individual loan data for more than a million commercial loans in the US from 1977 to 1988. Berger and Udell (1992) find evidence for the stickiness of loan rates but show that most of the stickiness does not stem from credit rationing. Their findings suggest that "information-based equilibrium credit rationing ... [is no] important macroeconomic phenomenon" (Berger and Udell, 1992, p. 1076). However, this evidence only applies to a specific micro data set and cannot be generalized. Up to now, the empirical relevance of credit rationing is still obscure. There is surely a need for better microeconomic data and further research.

This overview shows that there is a sizeable theoretical literature on the phenomenon of credit rationing and, in particular, illustrates the important role of the SW model. A

[33] Petrick (2005) gives an overview of the various methods for measuring credit rationing, which all turn out to be quite data demanding.

[34] Other studies using macroeconomic data are by King (1986) and Sofianos et al. (1990). King (1986) obtains mixed results concerning the empirical relevance of credit rationing, while Sofianos et al. (1990) find evidence for the credit rationing hypothesis using time series for uncommitted loans. Since alternative interpretations may apply, these results should be treated with caution (cf. Berger and Udell, 1992).

widely cited result of SW is that pure credit rationing may only arise if the bank's return function is globally hump-shaped. As pointed out independently by Coco (1997) and Arnold and Riley (2009), however, pure credit rationing at a single equilibrium loan rate cannot occur in the SW model, since the return function cannot be globally hump-shaped under the SW assumptions. It is shown that the return on lending is maximum at the highest possible loan rate (i.e., the loan rate at which the riskiest borrowers drop out of the market). Consequently, non-monotonicity of the return function cannot result in a pure rationing equilibrium, but it may give rise to a two-price equilibrium in the SW model.[35] In a two-price equilibrium, only the less risky borrowers are rationed, since the riskier borrowers who do not get credit at the lower interest rate still demand credit at the higher rate. Even though there is rationing in a two-price equilibrium, the term "credit rationing equilibrium" is used only for credit rationing at a single equilibrium interest rate.
The papers of Coco (1997) and Arnold and Riley (2009) demonstrate that the theory of equilibrium credit rationing under asymmetric information, which was established primarily in the 1980s, is still in need of clarification and encourage further research in this field.

All models presented in this literature survey assume that the payoffs of different projects are independent. In the next chapter, we present our model introducing non-diversifiable risk in the SW model. It is shown that correlation of project payoffs has a major effect on the results of the model; among other things, a pure rationing equilibrium may arise.

[35] Arnold (2011) suggests a modification of the model for which the return function may be globally hump-shaped and pure credit rationing may arise: it has to be assumed that projects which are riskier in terms of second-order stochastic dominance also have a lower expected return.

Chapter 4

A credit market model with asymmetric information and portfolio risk

This chapter is based on joint work with Lutz Arnold and Johannes Reeder. It presents an extended version of Arnold et al. (2010) which also contains elements of Reeder and Trepl (2009).

4.1 Introduction

Models of adverse selection or moral hazard in the credit market show why lenders tend to finance investment projects which are too risky from their point of view. The reason why lenders dislike risky projects is that, when standard credit contracts are used, they generate lower expected repayment. Due to the common assumption of independence of the payoffs on different projects and the law of large numbers for large economies (Uhlig, 1996), the repayments on a well-diversified credit portfolio are safe, however (an implication that tends to irritate scholars with a background in portfolio theory): uncorrelated single-name credit risks cancel out and do not create any portfolio risk for the lender. A notable case in point is the seminal SW adverse selection model, in which an increase in the interest rate raises the average riskiness of the pool of active borrowers, but nonetheless the return on lending remains safe.

We introduce non-diversifiable risk to the SW model (with two borrower types), so that an increase in the average riskiness of the borrower pool causes higher portfolio risk, which has to be borne by lenders. This has several interesting implications for equilibrium and welfare. Most importantly, it opens up the possibility of equilibrium credit rationing. As mentioned in Chapters 2 and 3, Coco (1997) and Arnold and Riley (2009) independently showed that there cannot be pure rationing at a single interest rate in the SW model. The reason is that it would be profitable to serve rationed risky borrowers at their maximum acceptable interest rate. This strategy of "picking risky borrowers" might be unattractive to risk-averse lenders when the project payoffs are correlated, since it gives rise to a highly risky credit portfolio. Thus, a profitable deviation from the strategies that lead to rationing may not exist, restoring the possibility of equilibrium credit rationing.

A two-price equilibrium entails higher average project risks and, hence, higher portfolio risk than a rationing equilibrium, at a given level of investment. This is because market clearing at the higher interest rate implies that all risky projects are financed. As a consequence, whether a two-price equilibrium or a rationing equilibrium arises depends systematically on lenders' degree of relative risk aversion. To address this issue, we use the constant relative risk aversion (CRRA) version of the Ordinal Certainty Equivalent (OCE) utility function proposed by Selden (1978), which allows to disentangle changes in risk aversion from changes in the preference for consumption smoothing over time. We show that starting from a two-price equilibrium, a rationing equilibrium arises when (everything else equal) the degree of relative risk aversion grows sufficiently large. Thus, stronger risk aversion tends to make the emergence of a rationing equilibrium more likely.

A two-price equilibrium is, in a specific sense, more inefficient than a rationing equilibrium: consider a parameter change that leads to a switch from a rationing equilibrium to a two-price equilibrium. The level of investment is continuous in model parameters, so it changes only slightly. However, the riskiness of the pool of active borrowers deteriorates discontinuously, since all risky firms get finance in a two-price equilibrium. As a consequence, borrowers have to pay higher risk premia, so aggregate profit and total welfare jump downward. One way to avoid this inefficiency of a two-price equilibrium is to impose a usury law that prohibits interest rates above the equilibrium rate with pure rationing. Analogous results are derived by Coco (1997, Section 3) in a model with independent returns in which projects differ by both riskiness and mean return.[1]

[1] See also Coco and De Meza (2009).

Following De Meza and Webb (1987), next we address the question of whether there is too little or too much investment in equilibrium, relative to a first-best or a second-best optimum. Contrary to the common result that equilibrium is generally characterized by underinvestment,[2] we find that equilibrium overinvestment may arise in a two-price equilibrium or in a rationing equilibrium, viz., when firms are endowed with a large amount of collateral and little weight is put on their expected utility in the optimum solution. Under these conditions, optimum saving is low, and may thus fall short of equilibrium investment, because households' consumption can be satisfied by reallocating the firms' collateral to them.[3]

As stated in Chapter 2, the motivation for the analysis is the observation that returns on risky investment projects are correlated, so that someone has to bear the additional risk when firms carry out riskier investment projects. While direct evidence of correlation between individual firms' returns on investment is hard to come by, there are numerous country studies showing that economy-wide and industry factors explain much of the variance in firm earnings (e.g., Brealey, 1971, for the US), that firm-level profitability is strongly affected by aggregate demand shocks (e.g., Machin and Van Reenen, 1993, for the UK), and that macroeconomic shocks have a profound impact on business failures (e.g., Gaffeo and Santoro, 2009, for Italy). Generally, the fact that aggregate corporate profits are strongly procyclical means that individual firms' profits are positively correlated at business cycle frequency. These observations suggest that there is significant correlation between the returns on individual firms' risky endeavors. One might object that, even so, independence would be a convenient assumption if it reduced complexity without having a major impact on the results. However, the summary of the results above shows that the introduction of non-diversifiable risk leads to much richer model implications, as different types of non-market clearing equilibria emerge depending on lenders' risk attitudes, with interesting welfare implications. Azariadis and Smith (1998), among others, investigate a business cycle model with credit rationing. While they use "the most extreme (and simplest) version" (Azariadis and Smith, 1998, footnote 6, p. 521) of a model that gives rise to differential repayment probabilities in order to focus on business cycle dynamics, the emphasis of our static model, following SW, is on the causes

[2]The standard underinvestment result for the SW model with uncorrelated payoffs is proved in Appendix 4.8.1. Note that in other credit market models with uncorrelated payoffs, credit rationing may be associated with overinvestment; for instance, in the De Meza and Webb (2000) model with simultaneous adverse selection and (ex ante) moral hazard (cf. footnote 29 in Chapter 3).

[3]This relates to variants of the SW model concerned with optimal risk sharing, such as Bester (1987) (see also the survey in Coco, 2000). These models usually assume risk-averse borrowers and independent project risks (i.e., no risk for lenders) and highlight the welfare loss due to the use of collateral as a sorting device: since a borrower's marginal utility is higher when his project fails, he should not put up any collateral in a first-best optimum.

and determinants of repayment probabilities. Asea and Blomberg (1998), among others, use data on lending standards to estimate a model with regime switching between lax and tight. The above citation of business cycle facts is just meant to back up the rather obvious fact that project risks tend to be far from independent and should not be taken to suggest that we attempt to make a contribution to aggregate dynamics.

We proceed as follows. Section 4.2 presents the model with CRRA preferences. In Section 4.3, we demonstrate that pure credit rationing can arise. Section 4.4 introduces OCE preferences and analyzes the impact of the degree of risk aversion on the type of equilibrium. Section 4.5 highlights the inefficiency of a two-price equilibrium. In Section 4.6, we address the question of equilibrium underinvestment. Section 4.7 concludes.

4.2 Model setup

There are two time periods $t = 1, 2$. There is one homogeneous (perishable) good, which can be used for consumption or investment. There is a continuum of measure M (> 0) of identical risk-averse consumers, each endowed with y (> 0) units of the homogeneous good in the first period and nothing in the second period. So to consume in period 2, they have to save in period 1. The consumers' preferences are represented by the CRRA utility function

$$E[u(c_1, c_2)] = \frac{c_1^{1-\theta}}{1-\theta} + \delta E\left(\frac{c_2^{1-\theta}}{1-\theta}\right), \quad 0 < \delta,\, \theta < 1, \tag{4.1}$$

where c_t is period-t consumption of the homogeneous good $(t = 1, 2)$. θ measures the inverse of the intertemporal elasticity of substitution in consumption *and* the degree of relative risk aversion. The assumption that $1/\theta$ is greater than one ensures that capital supply is upward-sloping, so that the analysis is comparable to the existing literature.[4] In the model with OCE preferences, we will maintain the assumption that the intertemporal elasticity of substitution exceeds unity but allow for arbitrary positive degrees of relative risk aversion.

There are a continuum of measure N_S (> 0) of safe firms and a continuum of measure N_R (> 0) of risky firms, each endowed with collateral C (> 0) and the ability to turn B $(> C)$ units of the homogeneous good invested in the first period into a random second-period output of the homogeneous good. Safe firms' projects succeed with probability p_S and risky

[4] $1/\theta > 1$ implies that the substitution effect outweighs the income effect in the consumption-savings decision.

firms' projects with probability p_R $(0 < p_R < p_S < 1)$.[5] In case of success, they yield R_S or R_R, respectively. If a project fails, the payoff is zero. The projects are equally profitable on average: $p_S R_S = p_R R_R$ $(\equiv \bar{R} > B)$. Standard debt is the only financial instrument.[6] Firms' collateral C cannot be traded in the capital market.[7] Firm owners are risk-neutral and apply for capital if the expected return on their investment (taking care of the possibility that they lose their collateral) is non-negative. There is asymmetric information: lenders are unable to observe whether a firm owns a safe or a risky project.[8]

The novel assumption is that the projects' payoffs are not independent. There are three states of nature $s \in \{R, S, F\}$. In state R, which occurs with probability p_R, all projects succeed; in state S, which occurs with probability $p_S - p_R$, only the safe projects succeed; in state F (i.e., with probability $1 - p_S$), all projects fail. Thus, the returns of any two risky projects as well as of any two safe projects are perfectly correlated: if one risky project succeeds, all risky projects succeed; if one safe project succeeds, all safe projects succeed; and the risky projects never succeed unless the safe projects do.[9] As a consequence of non-diversifiable risk, and contrary to the SW model, the single-name risks do not cancel out, so lenders face positive portfolio risk. For instance, in state F, all borrowers are unable to repay, so lenders merely receive the posted collateral. We checked the robustness of our results by making different assumptions about the dependence of project returns. Among other things, we analyzed the model under the alternative assumptions that there is positive but imperfect correlation and that the returns on safe projects are mutually independent.[10] The sets of parameters for which, e.g., rationing or overinvestment occur change, but the essence of our results remains unaffected.

[5] Note that "safe" means relatively safe, since $p_S < 1$.

[6] Standard debt is the optimal mode of finance in related models, e.g., when lenders can observe whether a project has succeeded or not but not its payoff in case of success (see Besanko and Thakor, 1987b).

[7] We maintain this assumption, even though it is not innocuous in the welfare analysis (cf. footnote 31), for the sake of comparability with the literature.

[8] Lenders only know the distribution of types in the economy. In our model, ex ante asymmetric information appears in the guise of hidden information, since firms have either a risky or a safe project. Moreover, we assume that payoffs are observable ex post.

[9] This means that, besides perfect intra-type correlation, we also consider inter-type correlation in that the risky projects can only succeed if the safe projects do.

[10] Reeder and Trepl (2009) use the assumption that the returns on safe projects are mutually independent. In comparison to the above mentioned correlation structure, this alternative assumption does not change the analysis for high interest rates at which only risky firms demand credit. For low interest rates, however, it implies lower aggregate risk and, thus, higher capital supply. In Reeder and Trepl (2009, Section 4.1), we also propose a way to model imperfect correlation. In brief, we introduce a random variable $\tilde{q}$ with support $[0, 1]$ to capture the degree of dependency and assume that households take the consumption-savings decision after $\tilde{q}$ has been realized. Thus, $\tilde{q}$ can be interpreted as an aggregate shock which determines capital risk. The cases of independent payoffs and perfect correlation between risky firms are the two extreme realizations of $\tilde{q}$, i.e., $q = 0$ and $q = 1$. It is shown that the main results do not rely on the extreme assumption of perfect correlation between risky firms, and analogous arguments apply for the above mentioned correlation structure.

We assume that the revenue from lending is passed through completely to the suppliers of capital.[11] One interpretation is that loans are made and deposits are taken by intermediaries without operating cost and without equity.[12] Alternatively, one may think of collateralized corporate bonds held by funds (so that the different types of firms are represented proportionally in each household's portfolio). A more complete model would introduce banks with positive equity, which serves as a buffer against losses on loans, so that deposits are safe and bank owners carry the non-diversifiable risk that does not remain in the firm sector. The main point, which the present model captures in the simplest possible fashion, is that the realization of investment projects creates non-diversifiable risks that someone has to bear and that these risks have a profound impact on the nature and efficiency of equilibrium in the credit market.[13]

4.3 Restoring credit rationing

This section demonstrates that, unlike in the SW model (cf. Coco, 1997, and Arnold and Riley, 2009), credit rationing may occur in the presence of portfolio risk.

Let r denote the interest rate (because of asymmetric information, lenders cannot set type-specific interest rates), $\lambda \equiv N_S/(N_S + N_R)$ the proportion of safe borrowers, and $p \equiv \lambda p_S + (1-\lambda)p_R$ the average success probability among all firms. Firms of risk type $i \in \{S, R\}$ apply for capital if the expected profit $\pi_i(r) = p_i[R_i - (1+r)B] + (1-p_i)(-C)$ is non-negative, i.e., if $r \leq r_i$, where

$$r_i \equiv \frac{1}{B}\left(\frac{\bar{R} - C}{p_i} + C\right) - 1, \quad i \in \{S, R\}$$

($r_i > 0$ for $i \in \{S, R\}$).[14]

[11] Due to this assumption, we use the terms "lenders" and "households" interchangeably in our model.

[12] Since we abstract from the cost of intermediation, the raison d'être of banks is not analyzed. Additionally, we abstract from equity which would raise questions about the banks' risk attitude and behavior in the market.

[13] It will be seen that for well-collateralized credit, firm owners bear significantly more risk than suppliers of credit (see footnotes 14 and 21).

[14] The variances of safe firms' profit and their repayment to lenders are $p_S(1-p_S)[R_S - (1+r)B + C]^2$ and $p_S(1-p_S)[(1+r)B - C]^2$, respectively. At $r = r_S$, the ratio of the variances is $[C/(\bar{R} - C)]^2$ and exceeds unity if $C > \bar{R}/2$, i.e., if collateral does not fall short of half of the expected project payoff. Similarly, the ratio of the variances of risky firms' profit and repayment at $r = r_S$

$$\left(\frac{\frac{p_S - p_R}{p_R}\bar{R} + C}{\bar{R} - C}\right)^2$$

exceeds unity under the weaker condition $C > [1 - p_S/(2p_R)]\bar{R}$. This confirms the assertion that for well-collateralized credit, firm owners bear the bulk of the risk created by their investments at an equilibrium with interest rate r_S, even though the return on lending is not safe either. If expected profit is a modest percentage

The demand for capital is

$$D(r) = \begin{cases} (N_S + N_R)B; & r \le r_S \\ N_R B; & r_S < r \le r_R \\ 0; & r_R < r \end{cases}. \tag{4.2}$$

The average success probability in the pool of credit applicants is p for $r \le r_S$ and p_R for $r_S < r \le r_R$.[15] Denote the (random) return on lending at rate r as $i(r)$. This function will be determined below. Since the revenue from lending is passed through completely, the consumers solve

$$\max_s : \frac{(y-s)^{1-\theta}}{1-\theta} + \delta E\left(\frac{\{[1+i(r)]s\}^{1-\theta}}{1-\theta}\right)$$

by choosing an appropriate level of savings s. Let

$$\hat{R}(r) \equiv E\left\{[1+i(r)]^{1-\theta}\right\}. \tag{4.3}$$

Optimal saving is

$$s = \frac{y}{1+\delta^{-\frac{1}{\theta}}\hat{R}(r)^{-\frac{1}{\theta}}} \equiv s^*(r) \tag{4.4}$$

($0 < s^*(r) < y$), and the indirect utility function is

$$u(y - s^*(r)) + \delta E\left\{u([1+i(r)]s^*(r))\right\} = \frac{y^{1-\theta}}{1-\theta}\left[1+\delta^{\frac{1}{\theta}}\hat{R}(r)^{\frac{1}{\theta}}\right]^{\theta} \equiv v(r). \tag{4.5}$$

From (4.4), the total supply of capital by a measure M of consumers facing the stochastic return profile $i(r)$ (yet to be determined) is

$$S(r, M) = s^*(r)M. \tag{4.6}$$

For the sake of brevity, we focus attention on model specifications such that

$$N_R B < S(r_S, M) < (N_S + N_R)B. \tag{4.7}$$

That is, the supply of capital at interest rate r_S is sufficient to carry out the risky projects but not all projects. This assumption rules out single-price market clearing equilibria (with

of expected project payoff and, hence, of expected repayment, a comparison in terms of coefficients of variation reinforces this conclusion.

[15] This illustrates the fact that there is adverse selection for $r > r_S$, i.e., only the risky firms demand credit.

or without adverse selection) and, thus, allows us to focus on the two most interesting types of equilibria: pure credit rationing equilibrium and two-price equilibrium. A pure rationing equilibrium prevails when there is positive excess demand for capital but there is no interest rate that implies a more favorable return distribution for the consumers. Let X denote the quantity of capital channeled from lenders to borrowers.[16]

Definition 4.1: (r_1, X) *is a* pure rationing equilibrium (PRE) *if*

↪ $X = S(r_1, M) < D(r_1)$,

↪ *there is no* r *such that* $v(r) > v(r_1)$.

A two-price equilibrium entails that credit is given at two different interest rates r_1 and r_2 $(> r_1)$, with positive excess demand at the lower rate r_1 and equality of supply and residual demand at the higher rate r_2. To qualify as an equilibrium, the two interest rates have to provide consumers with the same level of indirect utility. Moreover, interest rates at which there is positive residual demand (i.e., $r < r_2$) must be no more favorable to consumers than r_1 and r_2. Let M_1 (> 0) and $M_2 = M - M_1$ (> 0) denote the measures of consumers giving credit and X_1 and X_2 the quantities of capital channeled from lenders to borrowers at r_1 and r_2, respectively. Denote the residual demand at r_2 as $\tilde{D}_2$.[17]

Definition 4.2: $(r_1, r_2, M_1, M_2, X_1, X_2)$ *with* $r_2 > r_1$ *is a* two-price equilibrium (TPE) *if*

↪ $v(r_1) = v(r_2)$,

↪ $X_1 = S(r_1, M_1) < D(r_1)$,

↪ $X_2 = S(r_2, M_2) = \tilde{D}_2$,

↪ *there is no* $r < r_2$ *such that* $v(r) > v(r_2)$.

In the original SW model, pure credit rationing cannot arise in equilibrium; if there is excess demand at r_S but not at r_R, as stipulated in (4.7), the equilibrium is a TPE (see Coco, 1997, Arnold and Riley, 2009, and Appendix 4.8.1). Our first main result states that, given the presence of aggregate risk and risk-averse suppliers of capital, a PRE *can* arise. A PRE exists whenever there is not a TPE (except in the measure-zero event $v(r_R) = v(r_S)$):

[16] As already mentioned in Chapter 3, borrowers are randomly rationed in the SW model due to the assumption of indivisible projects (type II credit rationing).

[17] In a two-price equilibrium, there is random rationing at the lower interest rate r_1. Since all risky firms get credit either at r_1 or at r_2, only safe firms are rationed.

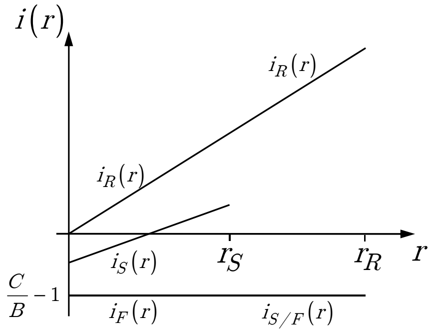

Figure 4.1: Return function.

Proposition 4.1: *Let (4.7) hold. (a) If $v(r_R) < v(r_S)$, there is a PRE and not a TPE. (b) If $v(r_R) > v(r_S)$, there is a TPE and not a PRE. (c) If $v(r_R) = v(r_S)$, there are a TPE and a PRE.*

Proof: The crucial observation is that $S(r, M)$ (for given M) and $v(r)$ move in the same direction as r changes. This follows immediately from (4.4)-(4.6): r affects $S(r, M)$ and $v(r)$ only via $\hat{R}(r)$, and both functions increase when $\hat{R}(r)$ rises. From (4.3),

$$\hat{R}'(r) = (1-\theta)E\left\{[1+i(r)]^{-\theta} i'(r)\right\} \tag{4.8}$$

whenever $i'(r)$ exists. Let $i_s(r)$ denote the return on lending in state s:[18]

$$\begin{pmatrix} i_R(r) \\ i_S(r) \\ i_F(r) \end{pmatrix} = \begin{pmatrix} r \\ \lambda r + (1-\lambda)\left(\frac{C}{B}-1\right) \\ \frac{C}{B}-1 \end{pmatrix}, \quad r \leq r_S, \tag{4.9}$$

and

$$\begin{pmatrix} i_R(r) \\ i_{S/F}(r) \end{pmatrix} = \begin{pmatrix} r \\ \frac{C}{B}-1 \end{pmatrix}, \quad r_S < r \leq r_R \tag{4.10}$$

(see Figure 4.1). Both for $r < r_S$ and for $r_S < r < r_R$, we have $i_s'(r) \geq 0$ in all states and strict inequality for some state s.[19] It follows from (4.8) that $\hat{R}'(r) > 0$ and, therefore,

[18] A subscript s/s' on a function or variable indicates that it applies in states s and s'.

[19] The expected return is $E[i(r)] = pr + (1-p)(C/B-1)$ for $r \leq r_S$ and $E[i(r)] = p_R r + (1-p_R)(C/B-1)$ for $r_S < r \leq r_R$ (the same formulas apply for the safe return on lending in the case of independent project payoffs, see Appendix 4.8.1). Evaluating $E[i(r)]$ at r_S and r_R and using $p < p_S$ and $\bar{R} > C$ yields $E[i(r_S)] = p\bar{R}/(p_S B) + (1-p/p_S)C/B - 1 < \bar{R}/B - 1 = E[i(r_R)]$. Hence, $E[i(r)]$ attains its global maximum at r_R (see also Coco, 1997, and Arnold and Riley, 2009). Intuitively, there are both risky and safe firms active at r_S, and the risky firms make strictly positive expected profits. At r_R, only risky firms are active, and their expected profits are zero.

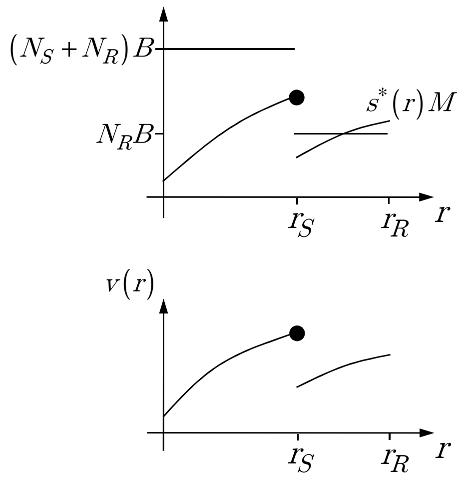

Figure 4.2: Pure rationing equilibrium (PRE).

$(s^*)'(r) > 0$, $\partial S(r,M)/\partial r > 0$, and $v'(r) > 0$ for $r < r_S$ and for $r_S < r < r_R$. For $r > r_S$, let $\Delta(r)$ denote the difference between $\hat{R}(r)$ and $\hat{R}(r_S)$:

$$\Delta(r) \equiv \hat{R}(r) - \hat{R}(r_S), \quad r > r_S. \tag{4.11}$$

Using (4.3), (4.9), and (4.10), one obtains

$$\begin{aligned} \Delta(r) \quad = \quad & -(p_S - p_R)\left\{\left[\lambda(1+r_S) + (1-\lambda)\frac{C}{B}\right]^{1-\theta} - \left(\frac{C}{B}\right)^{1-\theta}\right\} \\ & + p_R\left[(1+r)^{1-\theta} - (1+r_S)^{1-\theta}\right]. \end{aligned} \tag{4.12}$$

Consider $\Delta(r_S + \varepsilon)$ with $\varepsilon > 0$ and $\varepsilon \to 0$. As the last term in square brackets goes to zero, while the term in braces does not (since $r_S > 0 > C/B - 1$), we have $\lim_{\varepsilon > 0, \varepsilon \to 0} \Delta(r_S + \varepsilon) < 0$. That is, $\hat{R}(r)$ and, hence, $s^*(r)$, $S(r,M)$, and $v(r)$ jump downward at r_S. Thus, both $S(r,M)$ (for given M) and $v(r)$ attain their respective global maxima on the interval $[0, r_R]$ either at r_S or at r_R. The two constellations consistent with (4.7) are illustrated in Figures 4.2 and 4.3 (evidently, parameter combinations giving rise to either case exist, as will be illustrated by means of example below).

(a) In Figure 4.2, $S(r,M)$ and $v(r)$ attain their (unique) respective maxima at r_S. (r_S, $S(r_S,M)$) is a PRE. Since $v(r_S) > v(r_1)$ and $r_S < r_2$ whenever $v(r_1) = v(r_2)$ for two interest rates r_1 and r_2, a TPE does not exist.

(b) In Figure 4.3, $S(r,M)$ and $v(r)$ attain their (unique) respective maxima at r_R. In this case, a PRE does not exist. For whenever there is positive excess demand at r ($< r_R$), the

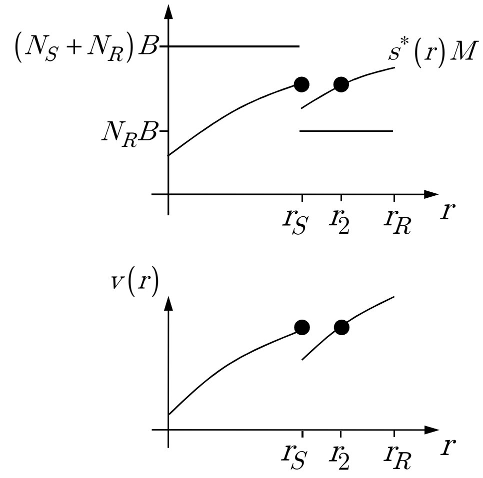

Figure 4.3: Two-price equilibrium (TPE).

second condition in the definition of a PRE is violated: $v(r_R) > v(r)$. Let $r_1 = r_S$. There exists an interest rate $r_2 > r_1$ such that $v(r_2) = v(r_1)$. Let X_1 and X_2 be determined by

$$X_1 = \frac{N_S + N_R}{N_S}\left[S(r_1, M) - N_R B\right] = S(r_1, M) - X_2 \tag{4.13}$$

and $M_1 = X_1/s^*(r_1)$ (> 0) and $M_2 = X_2/s^*(r_2)$ (> 0). From (4.5), $v(r_2) = v(r_1)$ implies $\hat{R}(r_2) = \hat{R}(r_1)$. From (4.4), it follows that $s^*(r_2) = s^*(r_1)$. Using (4.6) and (4.13), it follows from the definitions of M_1 and M_2 that $M_1 + M_2 = M$. The residual demand at r_2 is

$$\tilde{D}_2 = \left[1 - \frac{X_1}{(N_S + N_R)B}\right] N_R B. \tag{4.14}$$

It is straightforward to check that $(r_1, r_2, M_1, M_2, X_1, X_2)$, thus defined, is a TPE: by construction, $v(r_1) = v(r_2)$; from (4.6) and $M_1 = X_1/s^*(r_1)$, $X_1 = S(r_1, M_1)$; from $M_1 < M$, $\partial S(r, M)/\partial M > 0$, $r_1 = r_S$, and (4.7), $S(r_1, M_1) < D(r_1)$; from (4.6) and $M_2 = X_2/s^*(r_2)$, $X_2 = S(r_2, M_2)$; from (4.13) and (4.14) together with (4.6) and $M_2 = X_2/s^*(r_2)$, $S(r_2, M_2) = \tilde{D}_2$ $(= -(N_R/N_S)S(r_1, M) + (N_S + N_R)(N_R/N_S)B)$; by construction, $v(r) \leq v(r_2)$ for all $r < r_2$.

(c) The proofs that $(r_S, S(r_S, M))$ is a PRE in case (a) and $(r_1, r_2, M_1, M_2, X_1, X_2)$ is a TPE in case (b) also go through when $v(r_S) = v(r_R)$. ||

The multiplicity of equilibria in case (c) is not by itself remarkable, as $v(r_S) = v(r_R)$ is a measure-zero event.[20] We will come back to this case, however, when we compare welfare

[20] One could avoid this multiplicity by making the inequality in the second condition of Definition 4.1 weak.

levels in the two types of equilibria. For now, the important point is that aggregate risk makes the emergence of a PRE possible.[21]

As a numerical example, let the model parameters be given by:

y	M	θ	δ	B	p_S	p_R	$\bar{R}$	C	N_S	N_R
10	3,000	0.5	0.95	100	0.9	0.8	110	80	100	100

Safe and risky firms apply for credit up to interest rates $r_S = 13.33\%$ and $r_R = 17.5\%$, respectively. At r_S, each consumer supplies $s(r_S) = 4.9369$ units of capital, so the total supply of capital is 14,810.6541 ($= S(r_S, M)$). Since it is higher than 10,000 ($= N_R B$) and lower than 20,000 ($= (N_S + N_R)B$), condition (4.7) is satisfied. As $\Delta(r_R) = 0.0066 > 0$, the equilibrium is a TPE. The consumers' indirect utility is $v(r_S) = 8.8883$. A measure 96.2131 of randomly selected firms receive a loan at 13.33% interest, and the 51.8935 risky firms rationed at this interest receive a loan at 15.71% interest.[22]

4.4 Risk aversion and rationing

In a PRE, since rationing is necessarily random, the proportion of realized projects which are risky is equal to the proportion of risky firms in the total population of firms (i.e., $1-\lambda$). The presence of rationing means that some risky firms do not get funds. In a TPE, by contrast, all risky projects are carried out, which makes the return profile less attractive from the risk-averse lenders' point of view. This suggests that a PRE is more likely to emerge as the lenders' degree of relative risk aversion rises. The present section gives a precise statement of this proposition.

Within the framework used so far we encounter the familiar problem that both relative risk aversion and the preference for intertemporal consumption smoothing are parameterized by the same parameter θ.[23] So in order to appropriately address the question of which type of equilibrium emerges under what degree of risk aversion, we generalize the analysis by following Selden's (1978) OCE approach.[24] Let $\hat{c}_2$ be the certainty equivalent (CE) of

[21]Since r_S is the single equilibrium interest rate in a PRE, the considerations of who bears how much risk in footnote 14 apply. In a TPE, the same considerations apply for safe firms and for risky firms which get credit at r_S. For risky firms that receive credit at r_2, the ratio of the variances of profit and repayment is $([(1-\lambda)(p_S - p_R)C - p_S\bar{R}]/\{[p_R + \lambda(p_S - p_R)]C\})^2$ and exceeds unity if $C > \{p_S/[(1-2\lambda)(p_S - p_R) - p_R]\}\bar{R}$.

[22]Numerical examples for a PRE are provided in Sections 4.4 and 4.5.

[23]In Reeder and Trepl (2009, Section 2.5), it is shown (for the alternative correlation structure) that a critical θ above which a PRE arises does not necessarily exist in the expected utility framework.

[24]Selden's (1978) work prompted, among others, the widely cited paper by Epstein and Zin (1989) with an infinite horizon.

period-2 consumption corresponding to the period utility function introduced in (4.1):

$$\frac{\hat{c}_2^{1-\theta}}{1-\theta} = E\left(\frac{c_2^{1-\theta}}{1-\theta}\right), \quad \theta > 0, \quad \theta \neq 1 \tag{4.15}$$

(we now allow for $\theta > 1$).[25] Households' utility is given by

$$u(c_1, \hat{c}_2) = \frac{c_1^{1-\eta}}{1-\eta} + \delta \frac{\hat{c}_2^{1-\eta}}{1-\eta}, \quad 0 < \eta < 1. \tag{4.16}$$

$1/\eta$ is the (intertemporal) elasticity of substitution between c_1 and $\hat{c}_2$.[26] The model analyzed above is the special case with $\eta = \theta$.[27]

$\hat{R}(r)^{1/(1-\theta)}$ defined in (4.3) is the CE of $1 + i(r)$. Using this definition and $c_2 = [1 + i(r)]s$, the CE defined in (4.15) can be expressed as:

$$\hat{c}_2 = s\hat{R}(r)^{\frac{1}{1-\theta}}.$$

Households solve

$$\max_s : \frac{(y-s)^{1-\eta}}{1-\eta} + \delta \frac{\left[s\hat{R}(r)^{\frac{1}{1-\theta}}\right]^{1-\eta}}{1-\eta}.$$

The solution is

$$s = \frac{y}{1 + \delta^{-\frac{1}{\eta}} \hat{R}(r)^{-\frac{1}{1-\theta}\frac{1-\eta}{\eta}}} \equiv s^*(r), \tag{4.17}$$

and indirect utility is

$$v(r) \equiv \frac{y^{1-\eta}}{1-\eta}\left[1 + \delta^{\frac{1}{\eta}} \hat{R}(r)^{\frac{1}{1-\theta}\frac{1-\eta}{\eta}}\right]^{\eta}. \tag{4.18}$$

Given the novel definitions of $s^*(r)$ and $v(r)$, define capital supply (cf. (4.6)) and the two types of equilibria as before. Our first task is to generalize Proposition 4.1:

Proposition 4.2: *The assertion of Proposition 4.1 also holds true in the OCE framework.*

[25]For the sake of brevity, we omit the case of logarithmic utility (i.e., $\theta = 1$), which has to be treated separately.

[26]Note that the optimization problem as a whole is a non-expected utility approach, since the objective function is generally not linear in probabilities.

[27]The empirical literature suggests that there is no unanimous relationship between risk aversion and the intertemporal elasticity of substitution. In particular, the hypothesis of an inverse relationship as implied by the expected utility setup is rejected. There is, however, dissent regarding the plausible magnitudes of η and θ. Attanasio and Weber (1989) estimate values of $\eta < 1$ and $\theta > 1$. While this empirical study supports our analysis, there are other studies with values of $\eta > 1$, e.g., Hall (1987) and Epstein and Zin (1991).

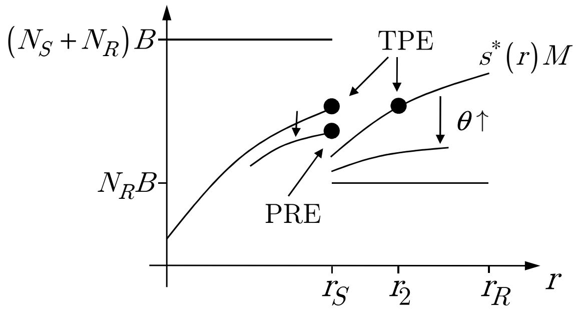

Figure 4.4: Switch from a TPE to a PRE.

Proof: The crucial observation is that, as before, changes in the interest rate move $S(r, M)$ and $v(r)$ in the same direction, as is evident from (4.17) and (4.18). From (4.3),

$$\frac{d\left[\hat{R}(r)^{\frac{1}{1-\theta}}\right]}{dr} = \hat{R}(r)^{\frac{\theta}{1-\theta}} E\left\{[1 + i(r)]^{-\theta} i'(r)\right\}.$$

Equations (4.9) and (4.10) hold true without modification. So for all $r < r_S$ and $r_S < r < r_R$, we have $d[\hat{R}(r)^{1/(1-\theta)}]/dr > 0$ and a fortiori $(s^*)'(r) > 0$ (from (4.17)), $\partial S(r, M)/\partial r > 0$ (from (4.6)), and $v'(r) > 0$ (from (4.18)). Since (4.3), (4.9), and (4.10) are unchanged, $\Delta(r)$ defined in (4.11) satisfies (4.12). For $\theta < 1$, the arguments put forward in the proof of Proposition 4.1 prove $\hat{R}(r_S + \varepsilon) < \hat{R}(r_S)$ for ε positive and small. Hence, $\hat{R}(r_S + \varepsilon)^{1/(1-\theta)} < \hat{R}(r_S)^{1/(1-\theta)}$. From (4.6), (4.17), and (4.18), it follows that $S(r, M)$ and $v(r)$ jump downward as r rises above r_S. For $\theta > 1$, the term in braces in (4.12) is negative, so $\lim_{\varepsilon > 0, \varepsilon \to 0} \Delta(r_S + \varepsilon) > 0$, i.e., $\hat{R}(r_S + \varepsilon) > \hat{R}(r_S)$ for ε positive and small. As before, this implies $\hat{R}(r_S + \varepsilon)^{1/(1-\theta)} < \hat{R}(r_S)^{1/(1-\theta)}$, so that, in this case also, $S(r, M)$ and $v(r)$ display downward discontinuities at r_S. This proves that both $S(r, M)$ and $v(r)$ attain their respective maxima either at r_S or at r_R. Under the maintained assumption (4.7), the remainder of the proof runs parallel to the proof of Proposition 4.1. ||

We are now in a position to give a precise statement of the proposition that higher risk aversion makes the emergence of a PRE more likely:

Proposition 4.3: *Starting from a TPE, as the degree of relative risk aversion θ rises and (4.7) remains satisfied, a PRE emerges.*

Proof: The proof consists of two steps. (a) Increases in θ reduce $s^*(r)$. (b) For θ large enough, $s^*(r)$ and $v(r)$ attain their maxima at r_S. Thus, starting from a TPE, as risk aversion becomes stronger, the capital supply schedule shifts downward, and at some point the maximum will occur at r_S and a PRE emerges, provided that (4.7) is still valid (see Figure 4.4).

(a) From (4.17), as noted by Basu and Ghosh (1993, p. 121), a decrease in the CE $\hat{R}(r)^{1/(1-\theta)}$ reduces $s^*(r)$. So we have to prove that an increase in θ reduces $\hat{R}(r)^{1/(1-\theta)}$ or, equivalently, $\ln[\hat{R}(r)^{1/(1-\theta)}]$. From (4.3) (suppressing the argument of the functions $\hat{R}(r)$ and $i(r)$),

$$\begin{aligned} \frac{\partial \left[\ln\left(\hat{R}^{\frac{1}{1-\theta}}\right)\right]}{\partial\theta} &= \frac{1}{(1-\theta)^2}\frac{1}{E\left[(1+i)^{1-\theta}\right]} \\ &\cdot\left(E\left[(1+i)^{1-\theta}\right]\ln\left\{E[\,(1+i)^{1-\theta}\,]\right\} - E\left\{(1+i)^{1-\theta}\ln\left[(1+i)^{1-\theta}\right]\right\}\right). \end{aligned}$$

Since $(1+i)^{1-\theta}\ln[(1+i)^{1-\theta}]$ is a strictly convex function of the random variable $(1+i)^{1-\theta}$, the derivative is negative by virtue of Jensen's inequality.

(b) From (4.12),

$$\begin{aligned} \Delta(r_R) &= \left(\frac{C}{B}\right)^{1-\theta}\left\{-(p_S-p_R)\left[\left(\lambda\frac{1+r_S}{\frac{C}{B}}+1-\lambda\right)^{1-\theta}-1\right]\right. \\ &\quad\left. +\,p_R\left[\left(\frac{1+r_R}{\frac{C}{B}}\right)^{1-\theta}-\left(\frac{1+r_S}{\frac{C}{B}}\right)^{1-\theta}\right]\right\}. \end{aligned}$$

Since $C/B < 1+r_S < 1+r_R$, as θ grows large (in particular larger than one), the power terms inside the braces become arbitrarily small, so $\Delta(r_R) > 0$. From (4.11), $\hat{R}(r_R) > \hat{R}(r_S)$ and $\hat{R}(r_R)^{1/(1-\theta)} < \hat{R}(r_S)^{1/(1-\theta)}$. From (4.17), it follows that $s^*(r)$ attains its maximum at r_S. ||

The example considered below shows that there exist model specifications such that a switch from a TPE to a PRE occurs. More generally, the following condition is sufficient to ensure that (4.7) remains valid as θ rises:

$$N_R B < \frac{y}{1+\delta^{-\frac{1}{\eta}}\left(\frac{C}{B}\right)^{-\frac{1-\eta}{\eta}}}M. \tag{4.19}$$

$i(r_S) \geq C/B - 1$ in all states of nature with strict inequality in some state of nature. Hence, $\hat{R}(r_S)^{1/(1-\theta)} > C/B$. From (4.6) and (4.17), $S(r_S, M)$ exceeds the term on the right-hand side of (4.19) for all θ, so $N_R B < S(r_S, M)$. The validity of the second inequality in (4.7) follows from the fact that it is satisfied in the TPE and $S(r_S, M)$ becomes smaller as θ increases (step (a) in the proof of Proposition 4.3).

In the numerical example introduced at the end of the preceding section (which implicitly assumes $\theta = \eta = 0.5$), the critical value for θ, above which the equilibrium is a PRE, is 2.5435. If, for instance, $\theta = 3$, we have $\Delta(r_R) = 0.0058$. The single equilibrium interest rate is $r_S = 13.33\%$, indirect utility is $v(r_S) = 8.8516$. The supply of capital is 14,684.1058, so 53.1589 (or 26.58%) of the borrowers are rationed.

Another way of analyzing the impact of portfolio risk on the nature of equilibrium is to compare the model with correlated payoffs to the (identically parameterized) model with independent payoffs. Since rationing cannot arise in the model with uncorrelated risks, it follows immediately from Propositions 4.1 and 4.2 that the introduction of correlated risks (holding everything else equal) potentially causes rationing. Details are in Appendix 4.8.1.

4.5 Inefficiency of a two-price equilibrium

From a welfare point of view, a TPE is particularly unattractive. For even leaving aside the question of whether total investment is at its optimal level, it is precisely the risky projects, disliked by the risk-averse lenders, which have a one-hundred percent chance of being financed. In the present section, we show that, as a consequence, a change in a model parameter that gives rise to a switch from a TPE to a PRE has a discontinuous positive impact on welfare. Coco (1997, pp. 12-13) arrives at the same conclusion under the assumption that riskier projects have lower expected (uncorrelated) returns[28] and concludes that a usury law that prevents lenders from attracting risky borrowers at high interest rates raises welfare. This conclusion naturally carries over to our setup with non-diversifiable risk and risk-averse lenders.[29]

Proposition 4.4: *A parameter change that leads to a switch from a TPE to a PRE has a continuous effect on household utility but leads to a discontinuous increase in aggregate profit.*

Proof: The proof consists of two steps. We consider first (a) the knife-edge case $v(r_S) = v(r_R)$, in which both a PRE and a TPE exist, and then (b) a small change in a parameter that leads to a switch from a TPE to a PRE.

(a) Consider the model with OCE preferences and suppose parameters are such that $v(r_S) =$

[28] He assumes large differences in projects' risk and only minor differences in expected returns so that less risky firms drop out of the market first, i.e., there is adverse selection.

[29] The effects of usury laws in the presence of moral hazard are analyzed in Coco and De Meza (2009).

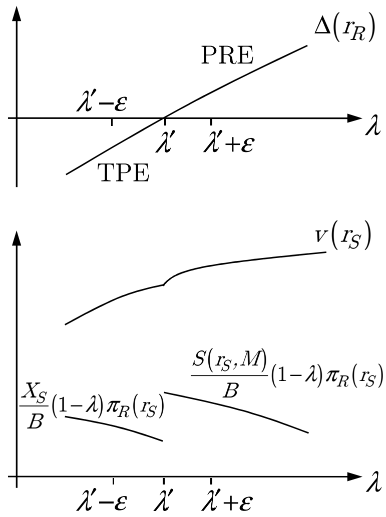

Figure 4.5: Welfare effect of a switch from a TPE to a PRE ($\theta > 1$).

$v(r_R)$, i.e., $\Delta(r_R) = 0$. From part (c) of Proposition 4.1 and Proposition 4.2, $(r_S, S(r_S, M))$ is a PRE, and there is also a TPE with $r_2 = r_R$. Households' indirect utility is $v(r_S)$ in both equilibria. The mass of projects carried out in equilibrium $S(r_S, M)/B$ is also the same in both equilibria. But while in the PRE the loan rate is r_S for all borrowers who get funds, some borrowers have to pay the interest rate r_R in the TPE. This is the price firms have to pay in order to make households finance riskier projects. Total expected firm profit in the TPE is

$$\frac{X_S}{B}(1-\lambda)\pi_R(r_S)$$

(where use is made of $\pi_S(r_S) = 0$ and $\pi_R(r_2) = \pi_R(r_R) = 0$). This compares with aggregate profit

$$\frac{S(r_S, M)}{B}(1-\lambda)\pi_R(r_S)$$

in a PRE (where use is made of $\pi_S(r_S) = 0$). Since $X_S < S(r_S, M)$, expected profit is strictly less in the TPE.

(b) If $\theta > 1$, a switch from a TPE to a PRE occurs when $\Delta(r_R)$ changes from negative to positive, and vice versa for $\theta < 1$. Consider model parameters $(B, C, p_S, p_R, \lambda) = (B', C', p'_S, p'_R, \lambda')$ such that $\Delta(r_R) = 0$. Consider a change in a parameter a ($\in \{B, C, p_S, p_R, \lambda\}$) that has a first-order effect on $\Delta(r_R)$ (i.e., $d\Delta(r_R)/da \neq 0$ for $(B, C, p_S, p_R, \lambda) = (B', C', p'_S, p'_R, \lambda')$). Without loss of generality, let $d\Delta(r_R)/da > 0$ (if the reverse inequality holds true, consider parameter $-a$).

For instance, let $a = \lambda$ and $\theta > 1$: from (4.12), $d\Delta(r)/d\lambda > 0$ for $\theta > 1$ (see Figure 4.5). For

$\theta > 1$, when the parameter rises from $a' - \varepsilon$ to $a' + \varepsilon$ (ε positive and small), $\Delta(r_R)$ turns from negative to positive and a PRE replaces a TPE, and vice versa for $\theta < 1$. From the analysis in the preceding section, it is clear that this is the only way a change in a parameter can bring about a switch from a TPE to a PRE. From (4.3), (4.9), and (4.18), $v(r_S)$ is a continuous function of model parameters. From step (a), aggregate profit jumps upward. ||

As pointed out by Coco (1997), the special inefficiency of a TPE can be avoided by imposing an upper bound $\bar{r}$ on the set of admissible interest rates:

Proposition 4.5: *If the equilibrium is a TPE, imposing an interest rate ceiling* $\bar{r} \in (r_S, r_2)$ *raises welfare.*

Proof: Define a PRE with an interest ceiling as in Definition 4.1 except that we add the condition $r_1 \leq \bar{r}$. The condition $r \leq \bar{r}$ rules out the existence of a TPE, for $v(r_S)$ exceeds $v(r)$ for any admissible pair of interest rates which yield the same expected utility. $(r_S, S(r_S, M))$ is a PRE with interest ceiling, since $v(r) < v(r_S)$ for all $r \leq \bar{r}$, $r \neq r_S$. ||

To illustrate the assertions of Propositions 4.4 and 4.5, we modify our running example such that θ is close to the critical value above which a PRE emerges:

y	M	η	θ	δ	B	p_S	p_R	$\bar{R}$	C	N_S	N_R
10	3,000	0.5	2.55	0.95	100	0.9	0.8	110	80	99	101

We also changed the numbers of safe and risky firms slightly, but will return to the original values in a second. At interest rate $r_S = 13.33\%$, each household saves $s^*(r_S) = 4.9029$, so the supply of capital is 14,708.7000. As demand drops from 20,000 to 10,100 at r_S, condition (4.7) is satisfied. The critical value for θ, above which there is a PRE, is 2.5720, so the equilibrium is a TPE with $r_2 = 17.47\%$ (which can also be inferred from $\Delta(r_R) = -0.0002$ and $\theta > 1$). Indirect utility and aggregate profit are $v(r_S) = v(r_2) = 8.8587$ and 157.8703, respectively. Now, let $N_S = N_R = 100$, holding all other parameters fixed, so that λ rises from 49.5% to 50%. Since θ is now above the critical value 2.5435 ($\Delta(r_R) = 6 \cdot 10^{-5}$ is positive), a PRE emerges. Indirect utility rises only slightly (to $v(r_S) = 8.8591$), but aggregate profit soars by more than 50% to 245.1701.[30] In the former case, with 99 safe and 101 risky firms, consider

[30] One might object that the rise in welfare is not surprising, since this parameter change (viz., a higher proportion of safe firms) is good for the economy. To illustrate that the parameter change need not be good for the economy, we use an example in which p_R falls and welfare rises due to a switch from a TPE to a PRE. The example from Section 4.3 is modified such that $N_S = 180$, $N_R = 20$, and $p_R = 0.76$. The critical value for

the imposition of an interest rate ceiling $\bar{r}$ between 13.34% and 17.46%. The equilibrium becomes a PRE with 13.33% interest. Borrower expected utility is ($v(r_S)$ =) 8.8587, as in the TPE without the interest ceiling. But aggregate firm profit rises from 157.8703 to ($(X/B)(1-\lambda)\pi_R(r_S)$ =) 247.5964.

4.6 Optimum investment

A TPE is "more inefficient" than a PRE, but even a PRE entails inefficient risk sharing. This is because firms' collateral is a potential hedge against households' period-2 consumption risk, but is not used completely in order to insure consumers in equilibrium, as firms which do not invest or whose projects succeed keep their collateral.[31] This section characterizes the optimal solution of the model, with efficient risk sharing, and addresses the question of whether the market brings forth too little or too much investment.

For the sake of simplicity, we return to the expected utility setup. In the main text, we maintain the assumption that information is asymmetric: when n projects are carried out, λn turn out to be safe and $(1-\lambda)n$ risky. We assume that the firms' collateral can only be consumed in the second period. The constrained-efficient solution maximizes household expected utility for a given level β of each firm owners' expected utility by a suitable choice of investment and state-contingent consumption levels. We show that underinvestment occurs, as one might expect, for high levels of β and for low values of collateral. However, since decreases in β reduce the need to invest in order to achieve the firm owners' given level of expected utility and increases in collateral expand the pool of resources available for period-2 consumption, equilibrium overinvestment can arise for low values of β and large values of collateral. (The first-best case, in which the planner can distinguish safe from risky projects, is analyzed in Appendix 4.8.2.)

Suppose all firm owners receive the same levels of consumption in period 2, irrespective of whether their project is realized or not. Let α_s denote the firm owners' consumption level in state $s \in \{R, S, F\}$. Since firm owners are risk-neutral, we can assume without loss of generality that their expected utility equals expected consumption, so the constraint that

θ, above which a PRE emerges, is 0.5034, so the equilibrium is a TPE. Indirect utility and aggregate profit are $v(r_S) = v(r_2) = 8.9134$ and 66.8871, respectively. Now, let $p_R = 0.75$, holding all other parameters fixed. A PRE emerges, since θ is now above the critical value of 0.4981. Whereas indirect utility falls only slightly (to $v(r_S) = 8.9128$), aggregate profit increases by more than 10% to 74.4686.

[31] That is why the case in which firms' collateral can be traded would require a separate analysis.

they receive a given level β (≥ 0) of expected utility becomes

$$p_R\alpha_R + (p_S - p_R)\alpha_S + (1 - p_S)\alpha_F = \beta. \tag{4.20}$$

In equilibrium, a firm owner's expected consumption is $C + \pi_i(r)$ if he takes a loan at interest rate r and carries out his investment project (of type i) and C otherwise. So if, for instance, β equals the sum of collateral and expected equilibrium profit per firm owner, then the firm owners are as well-off in the constrained optimum as in the market equilibrium. Let $m \equiv (N_S + N_R)/M$ denote the "number" of firms per household and c_{2s} period-2 household consumption in state s. Then,

$$\begin{pmatrix} c_{2R} \\ c_{2S} \\ c_{2F} \end{pmatrix} = \begin{pmatrix} m(C - \alpha_R) + \frac{\lambda R_S + (1-\lambda) R_R}{B} s \\ m(C - \alpha_S) + \frac{\lambda R_S}{B} s \\ m(C - \alpha_F) \end{pmatrix}. \tag{4.21}$$

The level of investment per household s is bounded above by the minimum of mB and y, i.e., either by the amount of investment opportunities or by disposable income. For the sake of brevity, we restrict attention on the case in which My is sufficiently large to finance all investment projects:

$$mB \leq y.$$

The maximum attainable expected utility for firm owners is then $\beta = C + \bar{R}$ (achieved with $s = mB$ and $c_{2s} = 0$ for $s \in \{R, S, F\}$).

Definition 4.3: *Given* $\beta \in [0, C + \bar{R}]$, $(c_1, s, c_{2R}, c_{2S}, c_{2F}, \alpha_R, \alpha_S, \alpha_F)$ *is a* constrained optimum (CO) *if it maximizes (4.1) subject to the constraints* $s \leq mB$, $c_1 = y - s$, *(4.20), (4.21), and non-negativity of each component.*

Since (4.1) is continuous and the set of vectors which satisfy the constraints is non-empty and compact, a CO exists. Due to the fact that households are risk-averse and firm owners are risk-neutral, household consumption is equalized across all states in which firm owners' consumption is positive in a CO.[32] For future reference, notice that period-2 household consumption is the same when all projects succeed or only the safe projects succeed (i.e., $c_{2R} = c_{2S}$)

[32] If households consume different quantities in two states s and s', say, their marginal rate of substitution differs from $p_s/p_{s'}$, which is the firm owners' marginal rate of substitution. So if the firm owners' consumption is positive in both states, there is scope for a mutually beneficial reallocation of resources.

if

$$\alpha_R - \alpha_S = \frac{(1-\lambda)R_R}{mB}s. \tag{4.22}$$

Similarly, $c_{2S} = c_{2F}$ if

$$\alpha_S - \alpha_F = \frac{\lambda R_S}{mB}s. \tag{4.23}$$

We have to distinguish three different cases, arising dependent on the choice of investment s.

(a) For

$$\max\left\{0, mB\frac{\beta - C}{\bar{R}}\right\} \leq s \leq mB\frac{\beta}{\bar{R}}, \tag{4.24}$$

s is sufficiently low and the share of investment returns in total wealth is sufficiently small so that it is possible to equalize households' period-2 consumption across all three states. Solving (4.20), (4.22), and (4.23) for the α_s's and substituting into (4.21) gives:

$$\begin{pmatrix} \alpha_R \\ \alpha_S \\ \alpha_F \end{pmatrix} = \begin{pmatrix} \beta + \frac{\lambda R_S + (1-\lambda)R_R - \bar{R}}{mB}s \\ \beta + \frac{\lambda R_S - \bar{R}}{mB}s \\ \beta - \frac{\bar{R}}{mB}s \end{pmatrix}$$

and

$$c_{2R/S/F} = m(C - \beta) + \frac{\bar{R}}{B}s \tag{4.25}$$

(firm owners' and consumers' state-contingent consumption levels in this and the following two cases are illustrated in the upper two panels of Figure 4.6). If $0 \leq s < mB(\beta - C)/\bar{R}$, i.e., the first inequality in (4.24) is violated, then the returns on investment are insufficient so as to satisfy (4.20). When the second inequality in (4.24) is violated, the non-negativity $\alpha_F \geq 0$ does not hold, i.e., the firm owners' risk bearing capacity in the state when all projects fail is exhausted.

(b) Second, consider investment levels

$$mB\frac{\beta}{\bar{R}} \leq s \leq mB\frac{\beta}{(1-\lambda)\bar{R}}. \tag{4.26}$$

In this case, it is possible to equalize household consumption in states R and S but not in F.

[33] This figure depicts the case $0 < mB(\beta - C)/\bar{R}$, i.e., $\beta > C$.

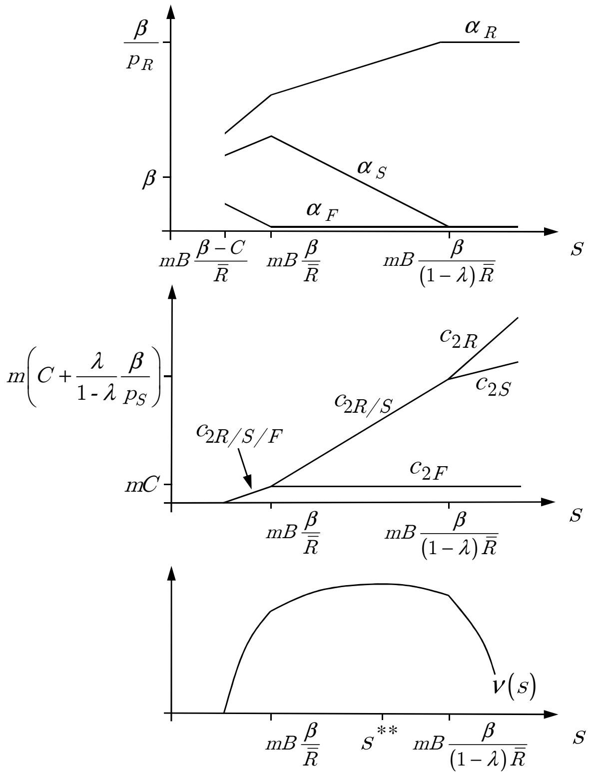

Figure 4.6: Consumption levels with optimal risk sharing under asymmetric information.[33]

From (4.20)-(4.22) and $\alpha_F = 0$, we obtain:

$$\begin{pmatrix} \alpha_R \\ \alpha_S \\ \alpha_F \end{pmatrix} = \begin{pmatrix} \frac{1}{p_S}\left[\beta + \frac{(1-\lambda)p_S(R_R - R_S)}{mB}s\right] \\ \frac{1}{p_S}\left[\beta - \frac{(1-\lambda)\bar{R}}{mB}s\right] \\ 0 \end{pmatrix}$$

and

$$\begin{pmatrix} c_{2R/S} \\ c_{2F} \end{pmatrix} = \begin{pmatrix} m\left(C - \frac{\beta}{p_S}\right) + \frac{R_S}{B}s \\ mC \end{pmatrix}. \tag{4.27}$$

(c) Finally, for

$$mB\frac{\beta}{(1-\lambda)\bar{R}} \leq s, \tag{4.28}$$

c_{2R} exceeds c_{2S} and c_{2F} even if R is the only state in which firm owners consume:

$$\begin{pmatrix} \alpha_R \\ \alpha_{S/F} \end{pmatrix} = \begin{pmatrix} \frac{\beta}{p_R} \\ 0 \end{pmatrix}$$

and

$$\begin{pmatrix} c_{2R} \\ c_{2S} \\ c_{2F} \end{pmatrix} = \begin{pmatrix} m\left(C - \frac{\beta}{p_R}\right) + \frac{\lambda R_S + (1-\lambda) R_R}{B} s \\ mC + \frac{\lambda R_S}{B} s \\ mC \end{pmatrix}. \tag{4.29}$$

Substituting $c_1 = y - s$ and c_{2s} from (4.25), (4.27), and (4.29) into (4.1) gives households' expected utility as a function $\nu(s)$ of s alone. The level of investment in a CO is $s^{**} = \arg\max_s \nu(s)\,\text{s.t.:}\, 0 \leq s \leq mB$. The function $\nu(s)$ is strictly concave (see the lower panel of Figure 4.6). This follows from the fact that if two $(c_1, s, c_{2R}, c_{2S}, c_{2F}, \alpha_R, \alpha_S, \alpha_F)$ satisfy the constraints in Definition 4.3, then a convex combination also satisfies these constraints (because of linearity of the constraints) and yields higher expected utility (because of strict concavity of the function in (4.1) in $(c_1, c_{2R}, c_{2S}, c_{2F})$). $\nu(s)$ is continuous and it is differentiable in the interior of the intervals in (4.24), (4.26), and (4.28):

$$\nu'(s) = \begin{cases} \frac{\delta \bar{R}}{B}\left[m(C-\beta) + \frac{\bar{R}}{B} s\right]^{-\theta} - (y-s)^{-\theta}; & \max\left\{0, mB\frac{\beta - C}{\bar{R}}\right\} < s < mB\frac{\beta}{\bar{R}} \\ \frac{\delta \bar{R}}{B}\left[m\left(C - \frac{\beta}{p_S}\right) + \frac{R_S}{B} s\right]^{-\theta} - (y-s)^{-\theta}; & mB\frac{\beta}{\bar{R}} < s < mB\frac{\beta}{(1-\lambda)\bar{R}} \\ \frac{\delta p_R[\lambda R_S + (1-\lambda) R_R]}{B}\left[m\left(C - \frac{\beta}{p_R}\right) + \frac{\lambda R_S + (1-\lambda) R_R}{B} s\right]^{-\theta} & \\ +\frac{\delta (p_S - p_R)\lambda R_S}{B}\left(mC + \frac{\lambda R_S}{B} s\right)^{-\theta} - (y-s)^{-\theta}; & mB\frac{\beta}{(1-\lambda)\bar{R}} < s \end{cases}. \tag{4.30}$$

It has kinks at $mB\beta/\bar{R}$ and at $mB\beta/[(1-\lambda)\bar{R}]$. There are four possible types of solutions to $s^{**} = \arg\max_s \nu(s)\,\text{s.t.:}\, 0 \leq s \leq mB$. For $\nu'(mB) \geq 0$, all projects are realized in the CO: $s^{**} = mB$. For $\nu'(0) \leq 0$, it is optimal not to invest at all: $s^{**} = 0$. If $\nu'(s^{**}) = 0$ for some s^{**} that satisfies one of the inequalities on the right-hand side of (4.30), then it is optimal to invest s^{**}. The final possibility is that $\nu(s)$ attains its maximum at one of the kinks, i.e., at $s^{**} = mB\beta/\bar{R}$ or $mB\beta/[(1-\lambda)\bar{R}]$. By virtue of the theorem of the maximum, s^{**} is a continuous function of β and C. In a CO with $\nu'(s^{**}) = 0$, investment s^{**} increases when β rises or C falls. This follows from the strict concavity of $\nu(s)$ and the fact that an increase in β or a decrease in C raises $\nu'(s)$ (see (4.30)). Optimum investment s^{**} also increases with β when it occurs at a kink of $\nu(s)$.

Depending on the model parameters β, $\bar{R}$, and λ, some or all of cases (a)-(c) arise for admissible investment levels $0 \leq s \leq mB$.[34]

[34] In Appendix 4.8.2, it is shown that the state-contingent consumption levels c_{2s} ($s \in \{R, S, F\}$) are identical in the second-best and first-best solutions if the investment levels are small enough (i.e., smaller than the minimum of $mB\beta/[(1-\lambda)\bar{R}]$ and $mB(\beta + \lambda\bar{R})/\bar{R}$). A simple sufficient condition is that $\beta \geq (1-\lambda)\bar{R}$. That is, for $\bar{R} \leq \beta$ and $(1-\lambda)\bar{R} \leq \beta < \bar{R}$, the second-best and first-best household consumption and utility levels coincide.

$\bar{\mathbf{R}} \leq \boldsymbol{\beta}$:

In this case, $s \leq mB \leq mB\beta/\bar{R}$. From (4.24), only case (a) can arise. It is optimal to carry out all projects (i.e., $s^{**} = mB$) if ($\nu'(mB) \geq 0$, i.e.)

$$\beta \geq \bar{R} + C - \left(\frac{y}{m} - B\right)\left(\frac{\delta \bar{R}}{B}\right)^{\frac{1}{\theta}}.$$

Otherwise optimum investment satisfies the first-order condition $\nu'(s^{**}) = 0$, i.e.,

$$s^{**} = \frac{y - \left(\frac{\delta \bar{R}}{B}\right)^{-\frac{1}{\theta}} m(C - \beta)}{1 + \delta^{-\frac{1}{\theta}} \left(\frac{\bar{R}}{B}\right)^{-\frac{1-\theta}{\theta}}}. \tag{4.31}$$

Since $\beta \geq \bar{R}$ and $\bar{R} > C$, we have $\beta > C$. So, as noted in the discussion of case (a) above, $s^{**} > 0$.

$(\mathbf{1} - \boldsymbol{\lambda})\bar{\mathbf{R}} \leq \boldsymbol{\beta} < \bar{\mathbf{R}}$:

For s small enough, case (a) applies. For $s = mB$, (4.26) holds with strict inequalities, i.e., case (b) applies. From (4.30), it is optimal to finance all projects if

$$\beta \geq \bar{R} + p_S \left[C - \left(\frac{y}{m} - B\right)\left(\frac{\delta \bar{R}}{B}\right)^{\frac{1}{\theta}}\right].$$

If the right-hand side of this inequality is non-positive for $C = 0$, then it is optimal to realize all projects (i.e., $s^{**} = mB$) for C low enough, irrespective of β. If the right-hand side is positive for $C = 0$, $s^{**} = mB$ becomes optimal once β is large enough. If $\beta \geq C$, zero investment is ruled out on the same grounds as before. If, on the other hand, $\beta < C$, $s^{**} = 0$ is optimal (i.e., $\nu'(0) \leq 0$) if

$$\beta \leq C - \frac{y}{m}\left(\frac{\delta \bar{R}}{B}\right)^{\frac{1}{\theta}}. \tag{4.32}$$

$\boldsymbol{\beta} < (\mathbf{1} - \boldsymbol{\lambda})\bar{\mathbf{R}}$:

Each of the cases (a)-(c) arises for some $s \leq mB$. It is optimal to realize all projects if $\nu'(mB) \geq 0$, where now the last lines on the right-hand side of (4.30) are relevant. As in the preceding case, $s^{**} > 0$ for $\beta \geq C$, while $s^{**} = 0$ if (4.32) holds for $\beta < C$.

The results are summarized in Figure 4.7 (where $s^{**} < mB$ for $\beta = 0$)[35] and in:

[35] Alternatively, it may be the case that $s^{**} = mB$ for $\beta = 0$ and low levels of C.

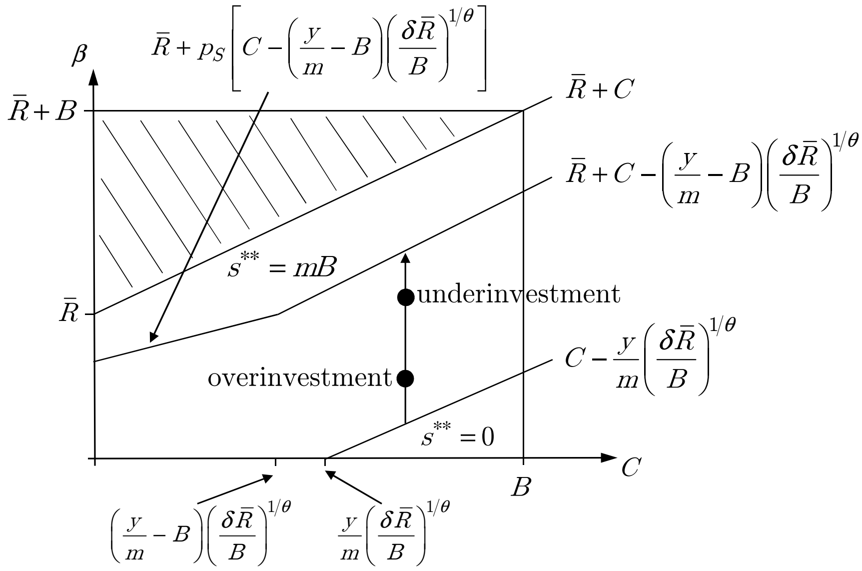

Figure 4.7: Optimum investment with asymmetric information.

Proposition 4.6: *For $\beta = 0$, $s^{**} > 0$ or $s^{**} = 0$, depending on whether $C < (y/m)(\delta\bar{R}/B)^{1/\theta}$ or $C \geq (y/m)(\delta\bar{R}/B)^{1/\theta}$, respectively. In the latter case, $s^{**} > 0$ for $\beta > C - (y/m)(\delta\bar{R}/B)^{1/\theta}$. s^{**} is non-decreasing in β. $s^{**} = mB$ for $\beta \geq \bar{R}+C-(y/m-B)(\delta\bar{R}/B)^{1/\theta}$.*

In words, consumers respond to a reduction in their period-2 consumption possibilities brought about by an increase in the firm owners' expected utility β with higher investment s^{**}. Increases in collateral C relax the constraint that firm owners receive a given level of expected utility, so optimum investment s^{**} decreases.

Having characterized both the credit market equilibrium and the CO, we can now address the question of whether there is too little or too much investment in equilibrium.[36]

Proposition 4.7: *In a PRE or a TPE, (a) for C small enough, there is underinvestment relative to the CO for all β; (b) for C large enough, there is overinvestment for sufficiently low values of β and underinvestment for sufficiently high values of β.*

Proof: (a) Suppose $\beta = C = 0$. From (4.28), case (c) applies for all investment levels. As noted above, $\beta \geq C$ implies that the CO entails $s^{**} > 0$. From (4.30), s^{**} satisfies

$$s^{**} = \frac{y}{1 + \delta^{-\frac{1}{\theta}}\left\{p_R\left[\frac{\lambda R_S+(1-\lambda)R_R}{B}\right]^{1-\theta} + (p_S - p_R)\left(\frac{\lambda R_S}{B}\right)^{1-\theta}\right\}^{-\frac{1}{\theta}}}.$$

[36]Note that variations in β do not affect the credit market equilibrium but variations in C do.

The term in braces exceeds

$$p_R\left(\frac{R_S}{B}\right)^{1-\theta}+(p_S-p_R)\left(\frac{\lambda R_S}{B}\right)^{1-\theta}=\hat{R}(r_S). \tag{4.33}$$

So, from (4.4), $s^{**} > s^*(r_S)$ for $\beta = C = 0$. $C = 0$ is not admissible in the equilibrium analysis (in the absence of collateral, firms would have nothing to lose from taking a credit). But both optimum investment s^{**} and $s^*(r_S)$ are continuous functions of C (for $s^*(r_S)$, this follows from the definition of r_S, (4.3), (4.4), and (4.9)). Therefore, there is underinvestment (i.e., $s^{**} > s^*(r_S)$) for $\beta = 0$ and C sufficiently small. The fact that s^{**} is non-decreasing in β and $s^*(r_S)$ ($< mB$) is independent of β implies underinvestment for all β.
(b) The fact that $s^{**} = 0$ for $\beta = 0$ and $C \geq (y/m)(\delta\bar{R}/B)^{1/\theta}$ (from Proposition 4.6) and $s^*(r_S) > (1-\lambda)mB > 0$ (from (4.7)) implies that there is overinvestment for $\beta = 0$ and C large enough. Underinvestment occurs as β becomes sufficiently large so that $s^{**} = mB$ (see Figure 4.7). ||

From (4.4), for each C (and other model parameters except y), there exists y such that (4.7) is satisfied. So, from Proposition 4.1, for each $C > 0$ and $\beta \geq 0$, there exist parameterizations of the model such that a PRE or a TPE exists. This proves that parameter combinations exist such that overinvestment arises in a PRE or a TPE.
The standard underinvestment result[37] holds true if firms have little collateral and a sufficiently high weight in the planning solution. However, if there is abundant collateral a large portion of which can be reallocated to the consumers in the CO, then there is equilibrium overinvestment.[38] To illustrate this, let us return to our running example:

y	M	θ	δ	B	p_S	p_R	$\bar{R}$	C	N_S	N_R	β
10	3,000	0.5	0.95	100	0.9	0.8	110	80	100	100	81.1737

As mentioned at the end of Section 4.3, there is a TPE with $s^*(r_S) = 4.9369$ and $v(r_S) = 8.8883$. Total expected firm profit $(X_1/B)(1-\lambda)\pi_R(r_S)$ is 234.7463, so expected profit per

[37]Appendix 4.8.1 proves the standard underinvestment result for the SW model with uncorrelated payoffs. Following De Meza and Webb (1987), it is assumed that $\beta = C$, and the first-best and second-best solutions coincide. One might ask whether there are parameter constellations such that for $\beta = C$ there is overinvestment in the model with correlated risks and underinvestment in the model with uncorrelated risks. We provide the following example: $y = 10$, $M = 3{,}000$, $\theta = \eta = 0.8$, $\delta = 0.95$, $B = 100$, $p_S = 0.3$, $p_R = 0.2$, $\bar{R} = 150$, $N_S = 150$, $N_R = 50$, and $C = \beta = 80$. In the model with correlated risks, there is a PRE with $s^*(r_S) = 4.9664$, while optimum investment is $s^{**} = 4.4197$ (in the second-best and first-best case). In contrast, with uncorrelated risks, there is a TPE with $\check{s}^*(r_S) = 5.0683$, and optimum investment is $\check{s}^{**} = mB = 6.6667$.
[38]Compared to the first-best case, the market equilibrium may also be characterized by underinvestment or overinvestment. See Appendix 4.8.2.

firm owner is 1.1737. This motivates our choice of β, which equals the value of the collateral plus expected profit per capita. Optimal investment is $s^{**} = 5.0123$, which is the solution to $\nu'(s^{**}) = 0$ in case (b). There is underinvestment: the "number" of projects financed in the credit market equilibrium (i.e., $3{,}000 \cdot 4.9369/100 = 148.1065$) falls short of the optimum "number" (i.e., $3{,}000 \cdot 5.0143/100 = 150.3701$). Indirect utility is $(\nu(s^{**}) =)$ 8.8962. The credit market equilibrium is doubly inefficient: there is too little investment, and too large a proportion of the investment capital is dedicated to risky projects. Proposition 4.7 suggests that overinvestment tends to arise when β falls. In fact, when $\beta = 75$ (holding everything else equal), we have $s^{**} = 4.8147 < 4.9369 = s^*(r_S)$ (maximum utility rises to 9.0621).

4.7 Conclusion

Our model deviates from the common assumption in models of the credit market with asymmetric information that single-name credit risks cancel out and do not create any portfolio risk. The introduction of portfolio risk in the SW model raises several interesting questions and yields several interesting results. A credit market equilibrium with pure credit rationing becomes possible. Comparative statics analysis shows that an increase in risk aversion turns a two-price equilibrium into a rationing equilibrium. A two-price equilibrium is more inefficient than a rationing equilibrium, and a usury law that rules out the higher of the two interest rates raises welfare. Compared to the optimal allocation of resources, the credit market equilibrium is characterized by either underinvestment or overinvestment, where the latter tends to occur when collateral is high and firm owners get little consumption. The implications of the model are thus much richer than the standard SW model's, in which a non-market clearing equilibrium is generally a TPE and there is too little investment in equilibrium.

The most promising route for future research seems to be the introduction of bank capital. In the model considered here, there are no intermediaries with positive equity that could serve as a buffer against loan losses. Introducing bank capital would help make the model more complete, as one could distinguish the portions of the banks' credit risk borne by the bank owners (the major part or all) and by the depositors (little or none at all), respectively. Another possible extension of the model would introduce lenders with heterogeneous risk attitudes, which would raise the question of the optimal allocation of risks across differently risk-averse agents. Risky collateral would shed further light on optimal risk sharing. These, and possibly further, issues can only be meaningfully addressed in a model with portfolio risk, and we are confident that our results will hold true with a small amount of bank capital, a small second group of consumers with different risk attitude, or uncertain collateral with a small variance.

In this chapter, we analyzed how aggregate risk affects the credit market equilibrium in a model with asymmetric information. In our setup with correlated project payoffs, lenders' risk aversion plays a crucial role for the credit market outcome. If risk aversion increases, fewer investment projects are financed and the average riskiness of the projects financed possibly falls. While Part II of this dissertation (Chapters 2 to 4) was devoted to this first application of the economics of investment in the presence of risk and market frictions, Part III (Chapters 5 to 8) deals with the second application, viz., the employment effects of offshoring in the presence of labor market frictions.

4.8 Appendix

4.8.1 Uncorrelated payoffs

This appendix compares the model with non-diversifiable risk to the standard SW model, in which single-name risks cancel out completely. We show that the introduction of correlation between project payoffs possibly causes the emergence of pure credit rationing and that it tends to reduce equilibrium investment. We also prove the standard equilibrium underinvestment result for the SW model.

Call the model with non-diversifiable risk described in Sections 4.2 and 4.4 model "C". Let "U" be the identically parameterized (SW) model that is obtained by replacing correlated with uncorrelated payoffs. In model U, the (due to Uhlig's, 1996, law of large numbers) safe return on lending is $\check{i}(r) = pr + (1-p)(C/B-1)$ for $r \leq r_S$ and $\check{i}(r) = p_R r + (1-p_R)(C/B-1)$ for $r_S < r \leq r_R$.[39] Since consumers do not face any risk, the expected utility and OCE approaches yield the same results for U. Let $\check{R}(r) = [1+\check{i}(r)]^{1-\theta}$. Optimal saving $\check{s}^*(r)$ is given by

$$\check{s}^*(r) = \frac{y}{1 + \delta^{-\frac{1}{\eta}} \check{R}(r)^{-\frac{1}{1-\theta}\frac{1-\eta}{\eta}}} \tag{4.34}$$

[39] As mentioned in footnote 19, the same formulas apply for the expected return of the model with correlated risk. Evaluating $\check{i}(r)$ at r_S and r_R and using $p < p_S$ and $\bar{R} > C$ yields $\check{i}(r_S) < \check{i}(r_R)$. This fact is pointed out by Coco (1997) and Arnold and Riley (2009).

(cf. (4.17)). Let

$$N_R B < \check{s}^*(r_S)M < (N_S + N_R)B \tag{4.35}$$

(cf. (4.7)).

The following proposition states that the introduction of portfolio risk possibly causes the emergence of credit rationing:

Proposition 4.A.1: *(a) There exist parameters such that U does not have a PRE but C does. (b) The reverse is not true.*

Proof: The return function $\check{i}(r)$ attains its unique global maximum $\check{i}(r_R) = \bar{R}/B - 1$ at r_R. Given (4.35), similar arguments as in the proofs of Proposition 4.1 and 4.2 prove that there is a TPE and not a PRE. So U does not possess a PRE. (a) Jointly with Proposition 4.2, this proves the former part of the proposition. (b) The fact that U does not possess a PRE also contradicts the supposition that C does not have a PRE but U does. ||

Another way to compare models U and C is to ask which one brings forth higher investment. The following proposition states that the introduction of portfolio risk reduces equilibrium investment:

Proposition 4.A.2: *Equilibrium investment is lower in C than in U.*

Proof: From (4.9) and (4.10), $E[i(r)] = \check{i}(r)$ for all $r \leq r_R$. Using $\check{R}(r) = [1 + \check{i}(r)]^{1-\theta}$, it follows that

$$\check{R}(r) = \{1 + E[i(r)]\}^{1-\theta} .$$

Jensen's inequality implies $\hat{R}(r) < \check{R}(r)$ if $\theta < 1$ and $\hat{R}(r) > \check{R}(r)$ if $\theta > 1$. In either case, from (4.17) and (4.34), we have $s^*(r) < \check{s}^*(r)$ (given $\eta < 1$). That is, the presence of risk reduces optimal saving (cf. Basu and Ghosh, 1993, Proposition 1, pp. 121-22). Since (4.7) holds, the equilibrium of C is a TPE or a PRE, and equilibrium investment is $S(r_S, M) = s^*(r_S)M$. Since (4.35) holds, the equilibrium of U is a TPE, and equilibrium investment is $\check{s}^*(r_S)M$. The validity of the assertion follows from $s^*(r) < \check{s}^*(r)$. ||

De Meza and Webb (1987, Proposition 5A, pp. 287-88) argue that the equilibrium of the SW model is characterized by underinvestment (irrespective of whether the credit market clears or not). They assume that, in the optimum, the proceeds of the investment projects accrue to the consumers, but the collateral remains with the firm owners, i.e., using the notation of Section 4.6, $\beta = C$. Since diversification eliminates project-specific risks, safe and risky projects are equally good under these assumptions, whether there is asymmetric information or not does not matter, the first-best and second-best optima coincide. The following proposition generalizes the De Meza and Webb (1987) result:

Proposition 4.A.3: *In an equilibrium of U with $s^*(r) < mB$ and $r < r_R$, there is underinvestment for $\beta \geq C$.*

Proof: Consider the optimal solution for model U. Given independent project risks, the safe rate of return is $\bar{R}/B - 1$. Since consumers do not face any risk, we can use the notation of the model with expected utility (i.e., $\eta = \theta$). Period-2 consumption c_2 is then given by the right-hand side of (4.25). If optimum investment is mB, the condition $s^*(r) < mB$ of the proposition implies that there is underinvestment. So we can focus on an interior optimum. Optimum investment $\check{s}^{**}$ is then given by the right-hand side of (4.31), so

$$\check{s}^{**} \geq \frac{y}{1 + \delta^{-\frac{1}{\theta}} \left(\frac{\bar{R}}{B}\right)^{-\frac{1-\theta}{\theta}}} \tag{4.36}$$

for $\beta \geq C$. In an equilibrium of U, as shown in the proof of Proposition 4.A.1, we have $\check{i}(r) < \bar{R}/B - 1$ for $r < r_R$. Hence, $\check{R}(r) < (\bar{R}/B)^{1-\theta}$. From (4.34) with $\eta = \theta$ and (4.36), $\check{s}^{**} > \check{s}^*(r)$. ||

If $s^*(r) = mB$ in equilibrium, underinvestment evidently cannot arise. Optimum investment is then also equal to mB. The condition $r < r_R$ rules out the special case in which the supply of funds at the projects' expected rate of return $\bar{R}/B - 1$ is merely sufficient to finance N_R projects. Equilibrium and optimum again coincide in this case.

4.8.2 First-best optimum

This appendix analyzes the first-best optimum that can be achieved when, contrary to what has been assumed in Section 4.6, it is possible to distinguish safe and risky projects.

Clearly, for $Ms \leq N_S B$, the first-best solution entails that only safe projects are realized.

For $Ms > N_S B$, all N_S safe projects as well as $Ms/B - N_S$ risky projects are realized. So

$$\begin{pmatrix} c_{2R/S} \\ c_{2F} \end{pmatrix} = \begin{pmatrix} m(C - \gamma_S) + \frac{R_S}{B} s \\ m(C - \gamma_F) \end{pmatrix}$$

for $s \leq mB\lambda$ and

$$\begin{pmatrix} c_{2R} \\ c_{2S} \\ c_{2F} \end{pmatrix} = \begin{pmatrix} m(C - \delta_R) - \lambda m(R_R - R_S) + \frac{R_R}{B} s \\ m(C - \delta_S) + \lambda m R_S \\ m(C - \delta_F) \end{pmatrix}$$

for $mB\lambda < s$, where the γ's and δ's are the firm owners' consumption levels in the respective cases and states of nature. The constraint that they receive expected utility β reads:

$$p_S \gamma_S + (1 - p_S)\gamma_F = \beta$$

for $s \leq mB\lambda$ and

$$p_R \delta_R + (p_S - p_R)\delta_S + (1 - p_S)\delta_F = \beta$$

for $mB\lambda < s$. For the sake of brevity, we confine attention to cases where β is not too large:[40]

$$\beta < \lambda \bar{R}. \tag{4.37}$$

Similarly as in Section 4.6, we obtain four different cases:

(a) First, let

$$\max\left\{0, mB\frac{\beta - C}{\bar{R}}\right\} \leq s \leq mB\frac{\beta}{\bar{R}}.$$

The second inequality and (4.37) jointly imply $s \leq mB\lambda$. c_2 is equalized across all states:

$$\begin{pmatrix} \gamma_S \\ \gamma_F \end{pmatrix} = \begin{pmatrix} \beta + \frac{1}{m}\frac{R_S - \bar{R}}{B} s \\ \beta - \frac{1}{m}\frac{\bar{R}}{B} s \end{pmatrix},$$

and c_{2s} is given by (4.25). Firm owners' and consumers' state-contingent consumption levels in this and the following three cases are illustrated in Figure 4.8.

[40]This condition is inessential for the determination of optimum investment (cf. footnote 42 below).
[41]This figure depicts the case $0 < mB(\beta - C)/\bar{R}$, i.e., $\beta > C$.

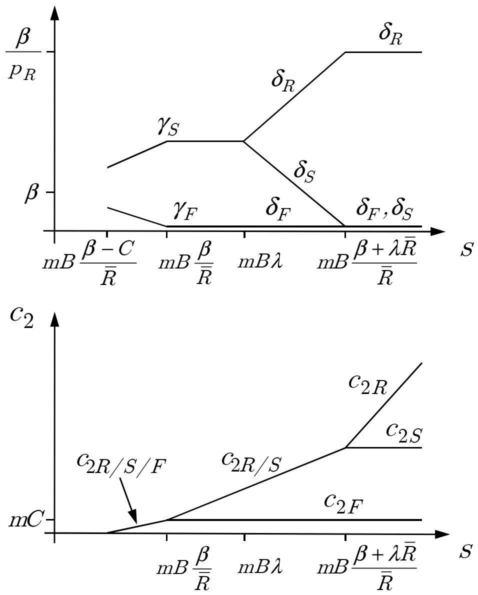

Figure 4.8: Consumption levels with optimal risk sharing under symmetric information.[41]

(b) For

$$mB\frac{\beta}{\bar{R}} < s \leq mB\lambda, \tag{4.38}$$

still only safe projects are realized, but the non-negativity constraint on γ_F is binding:

$$\begin{pmatrix} \gamma_S \\ \gamma_F \end{pmatrix} = \begin{pmatrix} \frac{\beta}{p_S} \\ 0 \end{pmatrix},$$

and c_{2s} is given by (4.27).

(c) For

$$mB\lambda < s \leq mB\frac{\beta + \lambda\bar{R}}{\bar{R}},$$

some risky projects are carried out:

$$\begin{pmatrix} \delta_R \\ \delta_S \\ \delta_F \end{pmatrix} = \begin{pmatrix} \frac{\beta}{p_S} - \lambda(R_R - R_S) + \frac{1}{m}\frac{R_R - R_S}{B}s \\ \frac{1}{p_S}\left(\beta + \lambda\bar{R} - \frac{1}{m}\frac{\bar{R}}{B}s\right) \\ 0 \end{pmatrix},$$

and (4.27) gives period-2 consumption.

(d) For

$$mB\frac{\beta + \lambda\bar{R}}{\bar{R}} < s,$$

firm owners consume only in the state when the risky projects succeed:

$$\begin{pmatrix} \delta_R \\ \delta_{S/F} \end{pmatrix} = \begin{pmatrix} \frac{\beta}{p_R} \\ 0 \end{pmatrix}.$$

Household consumption is given by

$$\begin{pmatrix} c_{2R} \\ c_{2S} \\ c_{2F} \end{pmatrix} = \begin{pmatrix} m\left(C - \frac{\beta}{p_R}\right) - \lambda m(R_R - R_S) + \frac{R_R}{B} s \\ mC + \lambda m R_S \\ mC \end{pmatrix}. \tag{4.39}$$

Consider the expected utility setup. Substituting the state-contingent consumption levels c_{2s} into (4.1) yields expected utility as a function $\nu(s)$ of investment s alone.[42] This allows us to conduct the welfare analysis parallel to the second-best case. One noteworthy implication is that the state-contingent consumption levels c_{2s} ($s \in \{R, S, F\}$) are identical in the second-best and first-best solutions for investment levels s up to the minimum of $mB\beta/[(1-\lambda)\bar{R}]$ and $mB(\beta + \lambda\bar{R})/\bar{R}$. So if the second-best and first-best investment levels are small enough, the second-best and first-best household consumption and utility levels coincide. This is because the fact that the projects are more risky on average in the second-best solution does not matter for consumer welfare as long as the firm owners' risk bearing capacity is sufficient so as to absorb the additional risk. A simple sufficient condition is that $\beta \geq (1-\lambda)\bar{R}$, for in this case, $s \leq mB \leq \min\{mB\beta/[(1-\lambda)\bar{R}], mB(\beta + \lambda\bar{R})/\bar{R}\}$. For the sake of brevity, we merely prove that there is equilibrium underinvestment for low levels of collateral and firm owner expected utility and illustrate the possibility of overinvestment by means of the running example.

Proposition 4.A.4: *In a PRE or TPE, for C and β small enough and $s^*(r_S) < mB\lambda$, there is underinvestment.*

Proof: Let $\tilde{s}^{**}$ denote optimum investment. We can focus on the case $\tilde{s}^{**} < mB\lambda$, since otherwise the assertion of the proposition trivially holds true. Given $\beta = 0$, case (b) applies

[42] The reason for condition (4.37) being inessential is that the same function $\nu(s)$ also gives utility if the inequality sign in (4.37) is reversed. If $\beta > \lambda\bar{R}$, c_{2s} is also given by (4.25) for $\max\{0, mB(\beta - C)/\bar{R}\} \leq s \leq mB\beta/\bar{R}$, by (4.27) for $mB\beta/\bar{R} < s \leq mB(\beta + \lambda\bar{R})/\bar{R}$, and by (4.39) for $mB(\beta + \lambda\bar{R})/\bar{R} < s$. As some risky projects are financed for $\lambda mB < s \leq mB\beta/\bar{R}$, the γ's and δ's do not remain the same.

(cf. (4.38)). Using (4.27) and $\beta = C = 0$, we obtain optimal investment:

$$\tilde{s}^{**} = \frac{y}{1 + \delta^{-\frac{1}{\theta}} p_S^{-\frac{1}{\theta}} \left(\frac{R_S}{B}\right)^{-\frac{1-\theta}{\theta}}}.$$

From (4.4) and (4.33), it follows that $\tilde{s}^{**} > s^*(r_S)$. $C = 0$ is not admissible in the equilibrium analysis. But both optimum investment s^{**} and $s^*(r_S)$ are continuous functions of β and C (this follows from the theorem of the maximum for $\tilde{s}^{**}$ and from the definition of r_S, (4.3), (4.4), and (4.9) for $s^*(r_S)$). As a consequence, $\tilde{s}^{**} > s^*(r_S)$ holds true for β and C sufficiently close to zero. ||

To illustrate the fact that the second-best solution does not necessarily imply a welfare loss compared to the first-best optimum and the possibility of overinvestment relative to the first-best outcome, we return to the example at the end of Section 4.6, except that we now set $\beta = 50$, so that (4.37) is satisfied. The CO displays overinvestment: $s^{**} = 4.0145 < 4.9369 = s^*(r_S)$. Indirect utility $\nu(s^{**}) = 9.7036$ exceeds the equilibrium value by 9.17%. The first-best optimum is characterized by the same amount of investment (and, therefore, overinvestment) and the same level of indirect utility. This is because $s^{**} = 4.0145 < 6.06 = \min\{mB\beta/[(1-\lambda)\bar{R}],\, mB(\beta + \lambda\bar{R})/\bar{R}\}$.

Part III

Employment Effects of Offshoring in the Presence of Labor Market Frictions

Chapter 5

Motivation

The recent decades have seen a rapid increase in international trade and foreign direct investment (FDI). Helpman (2006, p. 589) highlights that trade and FDI "have been among the fastest growing economic activities around the world". This fact is shown in Figure 5.1, which compares the growth in world FDI outflows, in world goods exports, and in world GDP between 1975 and 2009. Since the late 1980s, GDP growth has fallen far short of FDI growth and has also been lower than goods exports growth. Both FDI and goods exports have increased considerably, but FDI has expanded much faster. Additionally, the figure presents the growth in FDI outflows from seven developed countries.[2] The share of outflows of these seven countries accounted for more than 60% of the total until 2000 and for more than 45% in the period 2000-2009. This indicates that the developed countries were the main driver of FDI growth until 2000 and still play a pivotal role.[3] Moreover, the rise in FDI and final good trade was accompanied by a fast expansion of trade in intermediate inputs and services.[4] As pointed out by Bottini et al. (2007), initially mainly manufacturing inputs were traded, but more recently trade in services has increased considerably due to improvements in communication technologies.

These trends in the data are associated with the rapidly expanding business practice of offshoring. Production processes can be offshored within multinational enterprises (MNEs), i.e., via FDI, or to unaffiliated suppliers. If not all production processes are conducted in the same country, offshoring involves trade in intermediate inputs or services.

[1] All variables are in constant 2000 US dollars and purchasing power parity. Developed countries include Canada, France, Germany, Italy, Japan, the UK, and the US.

[2] We use the G8 countries with the exception of Russia due to data limitations.

[3] For more information on this issue and the business practice of offshoring, see Crinò (2009).

[4] Empirical evidence for this trend is provided, for instance, by Hummels et al. (2001), Yeats (2001), and Amiti and Wei (2005a).

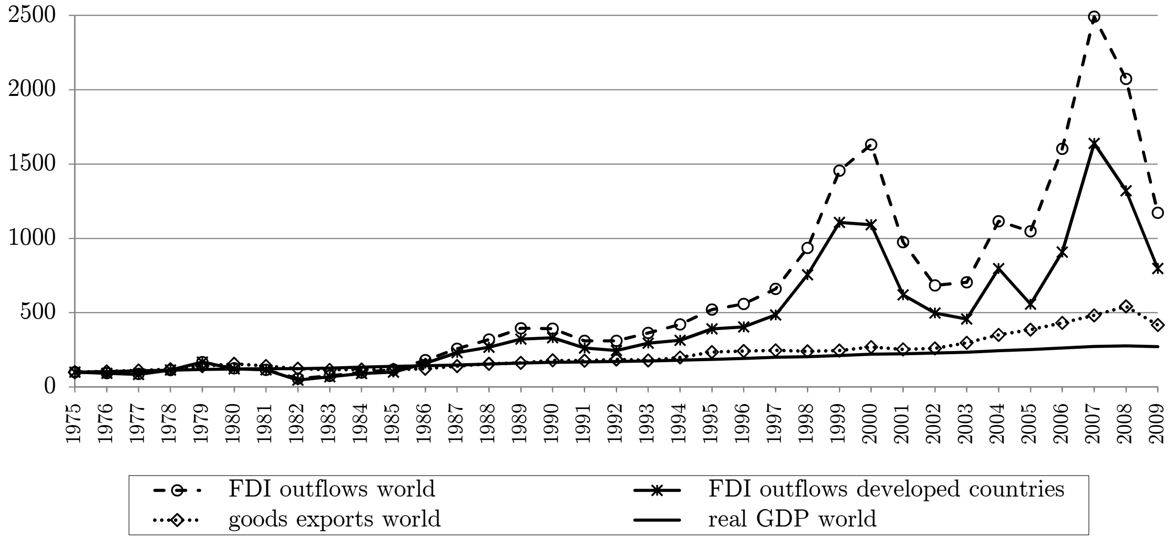

Figure 5.1: Growth in FDI outflows and goods exports compared to GDP growth. World and seven developed countries, 1975 = 100.
Source: UNCTAD (Foreign Direct Investment Database) and World Bank (World Development Indicators).[1] Adapted from Crinò (2009).

While, in general, the host countries for offshoring are both industrialized and emerging economies, we are primarily concerned with production relocation from industrialized countries to emerging economies. The enormous wage differential constitutes the main explanation for the steady increase in offshoring of manufacturing and services to emerging countries (cf., for instance, Amiti and Wei, 2005a). General reasons contributing to this trend are, among other things, the reduction of trade barriers, decreasing transportation and communication cost, substantial progress in information technology, and improvements in institutions of the target country.

The consequences of the proceeding international integration are very complex and affect the involved economies in various ways. One question became particularly important for politicians, the media, and the public: is offshoring to low-wage countries detrimental to employment in high-wage countries? In many industrialized countries, the debate over offshoring centers on its labor market repercussions, and the fear of low-wage competition is widespread. Anecdotal evidence for negative employment repercussions is indeed easy to find, but whether offshoring lowers or raises aggregate employment in the home country is very controversial. For instance, Greg Mankiw, when he was Head of the President's Council of Economic Advisers in the US, commented that offshoring is only "the latest manifestation of the gains from trade that economists have talked about at least since Adam Smith" and "a good thing" (Mankiw and Swagel, 2006, p. 1032). This statement was attacked sharply, since it is not evident that there are aggregate welfare gains for each country involved. In addition, aggregate welfare gains do not rule out that some agents may lose from offshoring. According to the predominant view in the public debate, the employees in the home country are the "losers" of offshoring.

The fear of negative employment repercussions is present not only in the US but even more in Western Europe. There are two main reasons why this concern is greater in Western Europe. First, the US labor market is quite flexible, whereas several Western European labor markets are characterized by rigidities and the presence of labor unions. In many Western European countries, the labor unions still play an important role in wage setting due to a coverage of collective bargaining of around or above 70%.[5] In the presence of strong unions, wages tend to be higher and more rigid, therefore the negative employment effects are expected to be larger. Second, the opening up of the formerly communist Central and Eastern European countries (CEECs) during the 1990s and the subsequent eastern enlargement of the European Union (EU) intensified low-wage competition for Western European countries. The geographic and cultural vicinity make the CEECs a favorite target for offshoring of Western European firms.[6] According to the survey by Kinkel and Maloca (2009), 40% of German manufacturing firms that were active in offshoring between 2007 and 2009 relocated production to the new EU member states, 27% to China, 16% to other Asian countries, and 12% to other Eastern European countries. As there is a substantial wage gap between Western European countries and the CEECs,[7] employees in highly unionized Western European countries fear massive job losses caused by production relocation to the CEECs.

In general, various factors including country-specific labor market institutions influence the nature and the magnitude of the employment effect of offshoring in the home country. Despite the relevance of this issue, the academic literature, both theoretical and empirical,

[5] Cf. OECD (2004, p. 145). The estimates for the year 2000 are 68% for Germany, above 95% for Austria, above 90% for France, and above 80% for Italy. While collective bargaining coverage is very high in these countries, union density is much smaller (25% in Germany, 37% in Austria, 10% in France, and 35% in Italy).

[6] See Neureiter and Nunnenkamp (2010) for more details on this issue.

[7] A factor that is likely to contribute, among other things, to this wage gap is the difference in labor market institutions, with collective bargaining coverage being notably lower in the CEECs. Before 1990, the CEECs had total coverage. However, union coverage decreased markedly during the 1990s (cf. Baranowska and Gebel, 2008, pp. 10-11). Estimates for 2002 show that, with the exception of the UK and Slovenia, collective bargaining coverage is higher in the old EU member states compared to the new member states. For instance, the coverage is 42% in Hungary, 35% in the Czech Republic and Poland, and around 20% in the Baltic countries (cf. Van Gyes et al., 2007, p. 14).

is far from providing detailed insights on the employment repercussions of offshoring in the presence of labor market frictions. It is not yet clear whether the employees in the home country are the "losers" of offshoring.

The theoretical literature has examined the relationship between offshoring to low-wage countries and aggregate unemployment only to a rather limited extent. Yet, there is a vast literature on the phenomenon of offshoring as well as on other labor market effects of production relocation. For quite a long time, the theory of trade and offshoring mainly used full employment models and focused on the wage differential between high- and low-skilled workers. There was an "apparent disconnect between the public and academic views of the impact of trade on labor market outcomes" (Davidson and Matusz, 2010, p. 2). Economists predominantly talked about wages, while the public talked about jobs. Recently, the public opinion has been taken more seriously,[8] and more theoretical research is devoted to labor market frictions. Trade models with imperfect labor markets allow for analyzing the effects of offshoring on wage levels, unemployment, aggregate welfare, and its distribution. Some progress has been made in this respect, but the number of trade models with offshoring and imperfect labor markets is still very limited. In addition, existing models of production relocation to a low-wage country and unemployment assume that the high-wage country is a small open economy, i.e., the production cost in the low-wage country is exogenously given. As these models abstract from important repercussions on the domestic labor market, there is a need for future research considering general equilibrium models of offshoring and unemployment with two large economies.

In the empirical literature, the results regarding the aggregate employment effects of offshoring are inconclusive and limited.[9] The findings should be interpreted with caution and further research is needed for several reasons: First, the effect of offshoring is difficult to disentangle from that of technological change. Second, most studies are firm-level studies which deliver an incomplete picture of the effect on economy-wide employment. Third, it has not yet been established how country-specific labor market institutions influence the strength of the employment effect. Therefore, it is not possible to deduce general principles from country studies. Fourth, the measurement of offshoring may crucially influence the results. In sum, the impact of offshoring on economy-wide employment is very difficult to identify empirically.

[8] See Section 8.1 for more information on this issue.

[9] There is, however, a sizeable literature on the effect of offshoring on the wage differential between skill groups and the relative skilled labor demand.

These main facts about the academic literature show that further research is needed to shed more light on the following questions: What is the aggregate employment effect of offshoring to low-wage countries (the "South")? How do certain labor market frictions in the high-wage country (the "North") influence the magnitude of the employment effect? Through which channels does offshoring affect employment in the high-wage country? These are the questions which motivate our analysis. We present Krugman's (1979a) North-South trade model augmented to include offshoring to the South and union wage setting in the North. This framework captures one important characteristic of many Western European labor markets and allows for analyzing the effects of offshoring on production cost in both countries and unemployment in the North. Hence, this model also takes into account the host country effects and endogenously determines the cost differential which motivates offshoring. As extensions, a second factor of production and firm heterogeneity are considered.

Our study builds upon several streams of literature presented in detail in Chapter 7. In the next chapter, we first define the main concepts and state some general facts and consequences of offshoring. This step is essential for a better understanding of the different approaches used in the literature.

Chapter 6

Offshoring: Definitions, facts and consequences

Trade theorists have studied international production processes of firms since the 1960s by using a variety of terms which refer to the same or related phenomena: "offshore sourcing", "(international) outsourcing", "delocalization", "intra-product specialization", "international fragmentation of production", "vertical specialization", "slicing up the value chain", "kaleidoscope comparative advantage", "global production sharing", "disintegration of production", "multi-stage production", "offshoring", "trade in tasks", "FDI", "multinational activity" and many more.[1] This non-exhaustive list illustrates that it is necessary to define the main terms which are widely used in the current literature. Since the definitions vary, we also point out confusing use of terms.

6.1 Definitions of offshoring and related concepts

"Offshoring" and "outsourcing" are two widely used terms. Some people treat them as synonyms, but this is misleading as they refer to two distinct business decisions: location (domestic or abroad) and ownership (in-house or external) choice for production processes.[2] This two-dimensionality is illustrated in Figure 6.1. If production processes are located domestically, they can be conducted in-house or by an external supplier, and international

[1] See Feenstra (1998, pp. 31-32), Hummels et al. (2001, p. 76), and Bottini et al. (2007, p. 3) for information on the authors using the respective terms.

[2] The term "production processes" includes both manufacturing and service activities.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">location</td></tr>
<tr><td>domestic</td><td>abroad</td></tr>
<tr><td rowspan="2">ownership</td><td>in-house</td><td>domestic internal production
→ domestic integration</td><td>production by foreign affiliate
→ FDI</td></tr>
<tr><td>external</td><td>domestic production by unaffiliated supplier
→ domestic outsourcing</td><td>production by foreign unaffiliated supplier
→ offshore outsourcing</td></tr>
</table>

➡ **outsourcing**

⬇ **offshoring**

Figure 6.1: Definition of offshoring and outsourcing.
Source: Adapted from Bottini et al. (2007) and Kirkegaard (2008).

trade is not involved. If production processes are relocated abroad,[3] they can be carried out by an affiliate or by an unaffiliated supplier. These two modes of offshoring are associated with intra-firm trade and arm's length trade, respectively.[4] Following the widespread terminology in the recent literature, the bold terms in Figure 6.1 represent the terminology we adopt across the paper: "offshoring" includes both "FDI" and "offshore outsourcing", whereas "outsourcing" includes "domestic outsouring" and "offshore outsouring".[5] Thus, the two concepts overlap as both include "offshore outsourcing", and the fourth organizational form, "domestic integration", is not comprised in either concept.

Unfortunately, this clear terminology is not universally adopted in the literature. Some papers use the term "international outsourcing" for both modes of "offshoring", an example being Amiti and Wei (2005a). Moreover, the business literature restricts the term "offshoring" to production relocation within MNEs, which we call "FDI".[6] Following the widespread terminology in the industrial organization and trade literature, we use the term with the broader meaning.

Concerning the term "outsourcing", some authors take narrower definitions than the standard one we follow. For instance, Bhagwati et al. (2004) restrict the term to comprise

[3]In this context, "abroad" means a country different from where a firm's headquarter is located.
[4]As long as headquarter services are needed for final good production, at least trade in these services is involved.
[5]See, for example, Helpman (2006) and Grossman and Rossi-Hansberg (2008). These and many other authors use the terms "offshoring" and "outsourcing" as we do. The terminology for the four organizational forms varies slightly between different sources. "FDI" is, for instance, also called "vertical FDI" and "production transfer within MNEs". Terms used instead of "offshore outsourcing" are, for instance, "international outsourcing" and "arm's length contract".
[6]An example that adopts this approach is Kirkegaard (2008).

only offshore outsourcing of services. Additionally, Markusen (2005) interestingly points out that there exists a long-standing literature which labels the business practice of outsourcing with the inverse term "internalization".

A term which should be briefly mentioned in the context of offshoring is "inshoring". According to Trefler (2005) and Bottini et al. (2007), "inshoring" refers to the same process, i.e., the cross-border relocation of production, but from the point of view of the target country. Some authors label it "insourcing" instead.[7] However, "insourcing" is a rather confusing term, since it has also been used for trade-unrelated issues, namely for domestic internal production and domestic outsourcing from the point of view of the receiving firm.

Having distinguished offshoring from outsourcing, we now classify offshoring on the basis of the type of relocated activity. "Material offshoring" refers to the relocation of manufacturing activities, such as assembly or intermediate input production, while "service offshoring" describes the relocation of service activities, e.g., call-centers, after-sale services, or accounting.[8]

As a next step, we take a closer look at the activities of MNEs by discussing the traditional division of FDI into horizontal and vertical FDI. The term "horizontal FDI" is generally used for "subsidiaries that serve the local market in the host country" (Helpman, 2006, p. 596). Thus, this kind of FDI is driven by market-seeking motives. "Vertical FDI", in contrast, refers to "subsidiaries that add value to products that are not destined (necessarily) for the host country market" (Helpman, 2006, p. 596).[9] Cost-saving motives underlie this sourcing strategy.[10]

As we define the term "offshoring" very broadly, it encompasses both forms of FDI. In contrast, Kirkegaard (2005, p. 4) states that "not all FDI is offshoring", since his narrower definition excludes horizontal FDI. This perception is adopted, for example, by Bottini et al. (2007) and Crinò (2009). Another issue to add is that, in practice, the above mentioned traditional categories of FDI lose importance because of the growing complexity of MNEs' sourcing and integration strategies (cf. Lipsey, 2002, and Helpman, 2006).

[7] For instance, Amiti and Wei (2005a) use this term for international outsourcing in the opposite direction.

[8] These definitions are widely used. See, for instance, Bottini et al. (2007) and Crinò (2009).

[9] As pointed out by Bottini et al. (2007), the value added may take the form of specific intermediate goods, final goods, or services.

[10] Cost-saving motives refer to the saving of production cost and not to the saving of trade cost for a final good, which may be associated with horizontal FDI.

To refer to the phenomenon of offshoring, the term "international fragmentation" is used especially by one stream of literature. As pointed out by Grossman and Rossi-Hansberg (2008, p. 1980), the focus of this literature lies on the modeling of the "breakdown of technology for producing some good into discrete parts that can be separated in space". Other frequently used terms focusing on global production systems are "slicing up the value chain", "global value chain", and the like.[11]

Due to technological development ever smaller slices of the value chain are tradable. This fact is addressed by the new concept of "trade in tasks". As a crucial novelty, Grossman and Rossi-Hansberg (2008, p. 1978) "conceptualize production in terms of the many tasks that must be performed by each factor of production".

Lastly, it should be briefly mentioned that some studies use very general terms like "globalization" or "economic integration". Subsuming various aspects, these terms refer to the phenomenon of offshoring as well as trade liberalization for final goods and other aspects.

To sum up, the terminology used in the literature is sometimes confusing. Therefore, we stick to our definitions throughout the literature survey in order to clarify the issues. In the following, some general facts and consequences of offshoring are stated.

6.2 Facts and consequences of offshoring

The motivations for offshoring may vary considerably depending on the sector, the mode of offshoring, the type of relocated activity, and the target country. To give an impression of the main reasons for offshoring, the OECD (2007) refers to a 2003 survey from the consulting firm A. T. Kearney. The survey results show that for large firms cost reduction is the main reason for offshoring, followed by proximity to clients, increase in sales, improvement of productivity, and access to foreign markets. Trefler (2005) states that an alternative motivation is the improvement of access to skilled workforces. Additionally, he refers to a survey from Accenture in 2004 concerning the importance of different factors in choosing an offshore outsourcing provider for services. In this survey, cost reduction is only the third most important factor behind service providers' expertise and service providers' flexibility. These different results illustrate the fact that the ranking of motivations depends on the above mentioned circumstances.

[11] Hummels et al. (2001) use the very general term "vertical specialization" to refer to the global chain of value-adding stages.

In Chapter 5, we have already pointed out some factors which are favorable to offshoring, namely the reduction of trade barriers, the decrease in transportation and communication cost, technological change, and improved institutions in the host country. There is, however, also a long list of factors which are unfavorable to offshoring: low quality of goods and services, delay in delivery, management problems, unexpectedly high cost, lack of protection of intellectual property rights, problems of contract enforcement, restrictions on establishment, and the like.[12] The list of factors which are unfavorable to offshoring also sheds some light on factors leading to "backshoring", i.e., moving production back home. Firms may decide to re-relocate their production processes due to the risk associated with offshoring.[13] In addition, there are various factors which favor offshore outsourcing relative to FDI. One prime example is the improvement of the contracting environment.[14]

After this brief outline of the motivations for offshoring and the factors influencing offshoring decisions, we proceed with the following question: what are the effects of offshoring on the domestic economy? As pointed out by the OECD (2007), possible positive effects are, among others, growth in consumers' income, improved competitiveness and productivity of enterprises, export growth, control of inflation, and better returns on capital. In contrast, possible negative effects are falling real wages of certain categories of workers, deterioration in the terms of trade, possible decline in capacity for innovation, loss of tax revenues, regional effects, and many others. This very general exposition illustrates that offshoring influences the domestic economy in various ways. We are particularly interested in the effects on domestic employment. The public debate focuses on potential negative employment effects that arise if offshoring firms substitute foreign for domestic labor. Alternatively, domestic and foreign labor may act as complements in firms' production processes. Besides this direct employment effect, offshoring may increase the productivity of domestic firms, and this productivity effect may in turn lead to job creation. The effect on domestic wages, which crucially depends on country-specific labor market institutions, also influences the employment effect. In the presence of labor unions, offshoring may influence the bargaining power of firms in the wage setting process. Additionally, the above mentioned positive and negative effects on the domestic economy may have repercussions

[12] Cf. Markusen (2005, p. 20) and OECD (2007, p. 38) for a more detailed discussion of these issues.

[13] Kinkel and Maloca (2009) provide survey data on the backshoring activity of German manufacturing firms. We revert to this study in Section 8.7.

[14] A summary of the factors which are analyzed in theoretical models is provided by Spencer (2005, p. 1131).

on the labor market. Hence, the nature and the magnitude of the overall employment effect of offshoring are not easy to determine. These rather general thoughts on the labor market effects of production relocation give a first impression of the complexity of this issue. To reduce complexity, the theoretical studies use different approaches to abstract from some repercussions and highlight various links between offshoring and employment.

In this chapter, we presented definitions as well as general facts and consequences of offshoring. This step is conducive to better understanding the academic literature. Several strands of literature that address the phenomenon of offshoring exist, and the literature on the labor market effects of offshoring and trade has started to grow in recent years. As the analyzed scenarios and the results differ considerably between the numerous contributions, a close look at the respective modeling approaches is needed. Therefore, we review in detail the state of the art of the literature on offshoring and its labor market effects in the next chapter. This survey, which is still selective due to the enormous amount of literature, shows the differences and similarities of the various models as well as promising avenues for further research. To the best of our knowledge, a survey that brings together all the different bodies of literature we consider does not exist. Pflüger et al. (2010) also review the literature on the labor market effects of trade and FDI, though their focus differs. They too consider some basic models on trade and offshoring, but with respect to the labor market effects they primarily concentrate on agglomeration models of the "new economic geography" and empirical evidence on Germany. Other more selective surveys are mentioned when reviewing the respective branches of literature.

Chapter 7

Literature review on offshoring and its labor market effects

This chapter is organized as follows. In Section 7.1, we consider the development of trade theory, since the theories on offshoring build on different models of final good trade. Section 7.2 reviews various streams of literature that deal with offshoring. This comprises models on horizontal FDI, complex integration strategies of MNEs, firms' sourcing strategies, international fragmentation, task trade, and technology transfers by offshoring.[1] Since the main purpose is to review the theoretical literature on offshoring, we mention only a few empirical studies that motivate or support theory. In the subsequent sections, we present models that analyze the labor market effects of trade and offshoring. Section 7.3 deals with models on offshoring without labor market frictions, while Section 7.4 is devoted to models of trade and labor market frictions, which may act as a good starting point for further research on offshoring. In Section 7.5, we proceed by reviewing existing work on labor market effects of offshoring in the presence of labor market frictions, with particular focus on studies considering union wage setting as a source of frictions. Section 7.6 states the main results of the empirical literature on labor market effects of production relocation. Finally, Section 7.7 summarizes the survey and points out avenues for further research. Thereby, it also illustrates how our analysis contributes to the literature.

[1] To stay focused, we abstract from other approaches to offshoring whose focus differs considerably from ours. For example, we exclude studies on the role of agglomeration economies for FDI decisions (see Pflüger et al., 2010, pp. 11-14) as well as studies on the role of tax policy in attracting FDI (see Markusen and Maskus, 2001, p. 18).

7.1 Development of trade theory

Trade theory consists of a portfolio of models that have evolved over time. In the following, we primarily concentrate on trade models on which the theories of offshoring are based. We begin with traditional trade theory that focuses on the comparative advantage of countries. One source of comparative advantage is differences in technologies, an approach originated by David Ricardo in the nineteenth century. A simple Ricardian model consists of two countries, two goods, and one factor of production. Due to constant but different unit factor requirements, the relative cost of producing the two goods is different in the two countries. Therefore, countries specialize in the production of their comparative advantage good, which yields a simple structure of trade flows. The other source of comparative advantage used in traditional trade theory is differences in factor endowments. This approach is attributed to Eli Heckscher and Bertil Ohlin, two authors whose contributions date back to the first half of the twentieth century. In the simplest case, the Heckscher-Ohlin model consists of two countries, two goods, and two factors of production ($2\times2\times2$). The key assumptions of this model are that goods differ in factor intensities, countries differ in factor endowments, and technologies are the same across countries. These assumptions determine the pattern of comparative advantage and of trade.[2] Additionally, the Heckscher-Ohlin model allows for the analysis of aggregate welfare and distributional effects. A third model of traditional trade theory is the Ricardo-Viner model (or the specific factor model), which assumes sector-specific factors. It is mentioned briefly, since a few contributions on offshoring build on this model. In general, traditional trade theory assumes that each industry produces a homogeneous good and, hence, only explains inter-industry trade.

The empirical evidence of large flows of trade within industries led to a further development of the theory of trade around 1980. It was Paul Krugman who pioneered intra-industry trade theory, also called the "new trade theory". His widely cited contribution is Krugman (1980), which is a special case of Krugman (1979b). The main ingredients of this theory are the possibility of product differentiation, economies of scale, and monopolistic competition. In addition, consumer preferences are characterized by love of variety. Due to these features, each of the otherwise identical firms produces a single variety of a good, and intra-industry trade arises in this one-factor model. The wage rates in the two symmetric countries are the same. In contrast to traditional trade theory, welfare gains do not accrue from dif-

[2] Concerning the implied pattern and magnitude of trade, the Heckscher-Ohlin model is often rejected empirically (Trefler, 1995).

fering opportunity cost of production but from increased scale of production and greater product diversity.[3]

The theory of so-called North-South trade modified the intra-industry trade model (or "North-North trade" model) to allow for wage differentials between countries. This theory explains both the pattern of trade and the wage differential between developed countries (the "North") and less developed countries (the "South"). Krugman (1979a) introduced exogenous differences in technology,[4] which are in line with the product cycle hypothesis described in an influential article by Vernon (1966). According to this stylized hypothesis, a typical manufactured product is innovated in developed countries and initially produced there. When the production process becomes more standardized, technology is transferred to less developed countries characterized by lower wages.[5] Krugman (1979a) was the first to formally model this phenomenon in a trade context. He applies an exogenous rate of new product innovation in the North and an exogenous rate of technology transfer to the South. Since Krugman (1979a, p. 259) uses the term "imitation lag", it becomes apparent that he thinks of technology transfer via imitation. In this setup, the North exports new goods and imports old goods. Wages are higher in the North due to technological superiority, i.e., the ability to produce certain goods the South cannot produce. Our own study presented in Chapter 8 builds on this model.

The theory of Krugman (1979a) was further developed by Grossman and Helpman (1991a), who endogenized the rates of innovation and imitation. They embed the North-South trade model in an endogenous growth framework and model innovation as an increase in the number of producible varieties. In contrast, Grossman and Helpman (1991b) regard innovation as quality improvements of the existing varieties. In these North-South models, imitation by Southern firms is the only channel of technology transfer. Some contributions on offshoring modify this assumption, for there are in general various ways of technology transfer.

A further seminal contribution to the trade literature is the model of Helpman and Krugman (1985), which integrates traditional and intra-industry trade theory. By introducing monopolistic competition, product differentiation, and economies of scale

[3]This is the case in Krugman (1979b), whereas the welfare gains accrue only from greater product diversity in the less complex Krugman (1980) model.

[4]These differences are not the same as in the Ricardian model. It is assumed that all goods are produced with the same cost function.

[5]In addition, Vernon (1966) specifies the mode of production in the South, which changes along the product cycle. This aspect is not addressed by Krugman (1979a) but by Antràs (2005) (see Section 7.2.2).

into a Heckscher-Ohlin framework, it accounts for both inter- and intra-industry trade flows. As stated by Helpman (1999), it is possible to extend this framework in such a way that it embodies, for example, factor price inequality, differences in technology, and trade cost. This integrated model is convenient for studies that combine theory and empirics.

All trade models mentioned so far are based on the analysis of a representative firm, at least within each industry. These models provide valuable insights concerning different possible patterns of trade and sources of aggregate welfare gains. However, in the 1990s, new findings on trade within industries emerged which could not be explained by the existing models. Using new firm-level data, empirical studies showed that, within an industry, only a fraction of firms export and that firm characteristics, such as productivity and size, differ considerably between exporters and non-exporters.[6] Motivated by these findings, richer models featuring firm heterogeneity were developed. Melitz (2003), the initiator of this "new new trade theory", embeds productivity differences at the firm level into the Krugman (1980) model on intra-industry trade. Potential firms, which face uncertainty regarding their productivity, pay a fixed and irreversible cost to enter the domestic industry. Once the entry cost is paid, each firm draws its productivity from some distribution. As in Krugman (1980), all firms pay the same wage. In his dynamic industry model with North-North trade, Melitz (2003) shows that only the most productive firms enter the export market due to an additional fixed cost of exporting. Less productive firms serve only the domestic market, while the least productive firms are forced to exit the industry. Trade liberalization results in inter-firm reallocations towards more productive firms and thereby implies a rise in aggregate productivity. This is a source of gains from trade which has not been analyzed in previous trade models. The Melitz (2003) model has become a new workhorse in trade theory and stimulated a growing literature on the impact of firm heterogeneity on various trade-related issues including offshoring.

Baldwin and Forslid (2010) study different aspects of trade liberalization using the Melitz (2003) framework. Interestingly, trade liberalization may lead to an anti-variety effect, i.e., a fall in the number of available product varieties,[7] but nonetheless it leads to welfare gains. A modified version of the Melitz (2003) model is presented by Melitz and Ottaviano (2008). They dispense with constant elasticity of substitution preferences and use a linear demand

[6] Cf. Helpman (2006, p. 592), who also mentions some examples of empirical studies.
[7] This effect stands in contrast to the results of standard intra-industry models like Krugman (1980).

system which brings forth variable markups. Therefore, market size and trade influence the toughness of competition in the market. The authors derive predictions concerning the impact of trade liberalization on productivity and price distributions.

In a noteworthy contribution, Bernard et al. (2007) integrate heterogeneous firms into a trade model à la Helpman and Krugman (1985) with imperfect competition and endowment-driven comparative advantage. This rich model explains three patterns of trade simultaneously: countries' exports are higher in comparative advantage industries, there exists two-way trade within industries, and only a fraction of firms export within each industry. In this setup, trade liberalization leads to reallocations both within and across industries and countries. The rise in aggregate productivity may lead to gains for all factors.[8]

This new class of trade models with heterogeneous productivities provides new insights into the causes and consequences of trade. In addition to productivity heterogeneity, a second firm characteristic has recently been analyzed, namely the number of products a firm manufactures and exports. To stay focused, we cover these multi-product models only briefly. Empirical studies showed that exporting firms typically export multiple products. However, in most trade theories, firm boundaries and the number of products per firm are indeterminate, or single-product firms are assumed. Motivated by these facts, models with heterogeneous firms producing multiple products evolved. For instance, Eckel and Neary (2010) show that trade liberalization influences the scale and the scope of multi-product firms. Among other things, firms may drop marginal high-cost products and focus on their core competencies.[9]

By reviewing the main developments of the trade literature,[10] we illustrated the differences between the various models. Of particular importance is that the assumption of full employment is a common ground of all these trade models. Since we focus on aggregate employment effects, we revert to this point later on. To sum up, the trade literature traditionally focused on industries and countries. In addition, the newer models point out the role of individual firm characteristics, such as firm productivity and number of products, and foster a better understanding of the microfoundations of trade.

[8] This is an anti-Stolper-Samuelson result, for it is not necessarily the case that the abundant factor gains from trade liberalization, while the scare factor loses.

[9] Bernard et al. (2007) and Eckel and Neary (2010) provide further information on trade models with multi-product firms.

[10] More comprehensive surveys on the development of the trade literature can be found, for instance, in Markusen (2005), Bernard et al. (2007), and Helpman (2010).

As the reviewed trade models focus on final goods and exporting as the only means to serve foreign markets, they do not consider the possibility of production offshoring and the choice between different sourcing strategies. Yet, splitting the production process across countries and firms is a widespread business practice. The international organization of production affects the pattern of trade in final goods as well as in intermediate inputs and services. Due to this fact, the analysis of offshoring decisions helps to explain the trends in the data. In the following, we discuss various approaches to offshoring, which build on different trade models and on other sub-areas of economic theory.

7.2 Different approaches to offshoring

In this section, we review various strands of literature analyzing the phenomenon of offshoring. The models are grouped by topic rather than chronologically, while the categories are not mutually exclusive. First, we present the main contributions on horizontal FDI and complex integration strategies of MNEs. We proceed by discussing the literature on firms' sourcing strategies for intermediate inputs. Subsequently, the models of international fragmentation and task trade are surveyed. Lastly, we review the literature on offshoring as a means of technology transfer. The selected models cover a broad range of topics, and the modeling approaches vary considerably. The aim of this overview is to illustrate how different forms of offshoring are modeled and which questions can be addressed in the different setups.

7.2.1 Horizontal FDI and complex integration strategies

As the topic covered in this section is not the primary focus of this dissertation, only two main contributions are mentioned. The first is on horizontal FDI, while the second considers complex integration strategies of MNEs. Up to now, these models have hardly been used to address the labor market effects of offshoring. Only the first model is incorporated in a contribution mentioned in Section 7.5.

Helpman et al. (2004) extend the Melitz (2003) model, in which exporting is the only way to serve foreign markets, to additionally allow for horizontal FDI. Serving the foreign market through subsidiary sales is associated with a fixed cost that arises from giving up the concentration of production, while avoiding trade cost. This proximity-concentration tradeoff[11] is the main determinant of Helpman et al.'s (2004) heterogeneous firm model. The authors show that the least productive firms are forced to leave the industry, low productive firms only serve the domestic market, and high-productivity firms also serve foreign markets. Among the latter, the relatively less productive firms export and the more productive engage in horizontal FDI. This sorting pattern is in line with their own estimates and other empirical studies.[12] Using a Pareto distribution, they find that the ratio of subsidiary sales to exports is higher in sectors with greater productivity dispersion.[13] The approach of Helpman et al. (2004) highlights the effects of within-industry heterogeneity on the firm's decision to serve foreign markets via FDI or exporting. This model and the trade models mentioned above focus on final goods and abstract from the sourcing decision for intermediate inputs.

As already mentioned in Section 6.1, MNEs are increasingly engaged in both horizontal and vertical FDI. Such complex integration strategies are, for instance, analyzed by Grossman et al. (2006).[14] They build on Yeaple (2003) and Melitz (2003) concerning the modeling of the two types of FDI and the heterogeneous productivity of firms, respectively. In a framework with two symmetric Northern countries and one Southern country, each Northern firm must provide headquarter services at home, but relocation of production is possible. These firms can perform the production of components and assembly of the final good either in the home country or in the other Northern country or in the South. Grossman et al. (2006) derive the equilibrium choice of integration strategies for the heterogeneous firms. They analyze how this choice depends on the fixed cost for foreign affiliates, the trade cost for intermediate and final goods, and the relative size of the consumer market in the South. The model predicts an array of integration strategies and highlights a complementarity between the two types of FDI. It combines cost-saving and market-seeking motives, while abstracting from the outsourcing decision.

In the next section, the firms' choice concerning the sourcing strategies for intermediate inputs is analyzed. Both the outsourcing and the offshoring decision are addressed. To clarify the differences between the modeling approaches, it should be pointed out that all approaches

[11]Empirical evidence for this kind of tradeoff is given by Brainard (1997). An early example of an FDI model that focuses on the proximity-concentration tradeoff is Markusen (1984). Markusen (2004) provides a summary of the literature on horizontal MNEs.

[12]Girma et al. (2005) conduct an empirical study on the UK and find that the productivity distribution of MNEs dominates that of exporters, which in turn dominates that of domestic firms. Additionally, Arnold and Hussinger (2005) analyze the export behavior of German manufacturing firms. They detect a causal link between high productivity and the presence in foreign markets.

[13]Greater productivity dispersion is modeled by a lower shape parameter of the Pareto distribution.

[14]A second model that combines the two types of FDI is the so-called knowledge-capital model (see Markusen, 2004, for more information).

to offshoring reviewed in the remainder of Section 7.2 do not consider horizontal FDI, i.e., market-seeking motives.

7.2.2 Sourcing strategies of firms

The recent decades have seen new trends in trade and investment patterns, and the organizational change of firms has been key to this development (cf. Helpman, 2006, p. 589). One important aspect concerning the organizational form is the sourcing strategy for intermediate inputs. To address the issues of location and ownership choice, trade models are enriched by concepts of industrial organization theory and contract theory. The concepts which are integrated include relationship-specific investments, search and matching, and incomplete contracts. The models of this relatively new branch of literature highlight different tradeoffs explaining the circumstances under which a firm decides to engage in outsourcing and/or offshoring of intermediate inputs. Moreover, the implications for the industry structure are analyzed.

As this is a lively area of research, we do not review all contributions in detail and focus primarily on the models of incomplete contracts. More detailed surveys of this literature are provided by Spencer (2005) and Helpman (2006).

All the incomplete contract models mentioned below "build on a common assumption, namely that some inputs are highly specific to a final product and that their supply is not fully contractible" (Helpman, 2006, p. 591). This assumption can be used in different incomplete contract settings in order to analyze various aspects associated with sourcing strategies.

The first category of models studies organizational choice by focusing on matching between buyers and suppliers of specialized inputs and the resulting thick market effects.[15] Since the consideration of the simultaneous ownership and location decision turns out to be rather complex, a series of papers by Grossman and Helpman (2002, 2003, and 2005) focuses on the decision between two of the four possible forms (cf. Figure 6.1). In Grossman and Helpman (2002), the choice of ownership is addressed in a purely domestic context. Nevertheless we mention this model, as it is further developed in the ensuing papers. The make-or-buy decision is governed by the tradeoff between the cost of a larger and less

[15] We do not review Spencer and Qiu (2001) and Qiu and Spencer (2002). These early contributions on incomplete contracts have a narrow focus on specific organizations and use only a partial equilibrium approach. See Spencer (2005) for a detailed review of these papers.

specialized organization under vertical integration and the cost associated with the search for a partner and incomplete contracting under outsourcing.[16] The underlying theory of the firm is the so-called transaction cost approach,[17] which implies that the cost associated with hold-up problems stemming from incomplete contracting only exists under outsourcing. Concerning the industry equilibrium, which results from firms' organizational choices, Grossman and Helpman (2002) show that some sectors solely consist of vertically integrated firms, whereas others solely consist of disintegrated firms.

While Grossman and Helpman (2002) analyze the ownership decision in a closed economy, Grossman and Helpman (2003) study the decision between FDI and offshore outsourcing of specialized inputs to the South in a related setup. They establish that the prevalence of offshore outsourcing relative to FDI rises under the following conditions: the productivity advantage of specialized suppliers increases, the industry size of final good producers rises, the degree of contract incompleteness falls, or the relative wage of the South decreases. However, Grossman and Helpman (2003) use exogenous wages and do not consider the location decision between North and South.

Their third paper on different sourcing strategies is the only one which uses a general equilibrium model of monopolistic competition and North-South trade. With respect to the sourcing options considered, it complements the other two papers and addresses the location choice for outsourcing activities. Grossman and Helpman (2005) do not allow for in-house production of specialized inputs and assume that final good producers enter only in the North while input suppliers enter in both countries. Outsourcing involves costly search for a partner and incomplete contracting. The authors analyze the equilibrium of this trade model, thereby emphasizing its determinants. The scale of offshore outsourcing relative to domestic outsourcing depends on the differences across countries in market thickness, cost of customizing inputs, contracting environment, and search cost.

The second group of papers on organizational choice under incomplete contracts combines the property rights theory of the firm with different trade models. The so-called contractual input intensity is emphasized as a main determinant of the firm's sourcing strategy. In contrast to the traditional factor intensity, this measure concerns the control of intermediate inputs. Since intermediate inputs that are controlled by affiliated or unaffiliated

[16] A related paper, which also uses a simple model focusing on matching, is McLaren (2000). In contrast to Grossman and Helpman (2002), it embeds bidding rather than incomplete contracting under outsourcing.

[17] More information on the transaction cost approach is provided by Spencer (2005, p. 1110).

suppliers suffer more from contractual problems than intermediate inputs under direct control of the final good producer (e.g., headquarter services), the term contractual input intensity is used for the relative requirement of the two categories of intermediate inputs (cf. Helpman, 2006, p. 609). Using this modeling approach, the different papers address the effect of contractual input intensity on trade patterns (Antràs, 2003), product cycles (Antràs, 2005), and the impact of within-industry heterogeneity (Antràs and Helpman, 2004).

Antràs (2003) further develops the work of Grossman and Helpman (2002, 2003) on the choice of ownership. He uses a two-sector trade model in the spirit of Helpman and Krugman (1985), changes the modeling of contract incompleteness, and embeds another theory of the firm, namely the property rights theory.[18] This theory, which was developed by Grossman and Hart (1986) and Hart and Moore (1990), implies that the hold-up problem resulting from sunk, relationship-specific investments and incomplete contracts is also present within MNEs.[19] Nash bargaining[20] over the surplus created by the relationship thus takes place under integration and outsourcing, but the distribution of the surplus depends on the ownership structure. On the one hand, integration within MNEs provides property rights which improve the bargaining position of the final good producer, while on the other hand, it reduces the supplier's incentives to supply components. In this model, the supplier, who is either inside or outside the firm, controls one intermediate input and the other is controlled by the final good producer. As already mentioned above, a main determinant of the decision between integration and outsourcing is the relative intensity of these two intermediate inputs. Antràs (2003) analyzes the integrated equilibrium of this trade model in order to show that offshoring within MNEs and, thus, intra-firm trade in inputs prevails in the sector with a higher relative intensity of the input controlled by the final good producer. The other sector is characterized by offshore outsourcing and arm's length trade. To combine theoretical results with empirical support, Antràs (2003) assumes that the intermediate input controlled by the final good producer is capital intensive, while the other input is labor intensive. In this case, the model predicts the following two patterns of US import data: Across industries, the higher the capital intensity of an industry, the larger the share of intra-firm imports in total imports. Across countries, the higher the capital-labor ratio of the exporting country, the larger the share of intra-firm imports in total imports.

[18]For detailed information on the property rights theory, see, for instance, Spencer (2005, p. 1114).

[19]As pointed out by Trefler (2005), the transaction cost approach used by Grossman and Helpman (2002, 2003) assumes that FDI magically removes hold-up problems within the firm. Antràs (2003) addresses this issue by applying the property rights approach.

[20]See Binmore et al. (1986) for detailed information on the Nash bargaining solution.

A variant of this model is used to describe product cycles in Antràs (2005). In a dynamic model of North-South trade, goods continuously standardize along their life cycle. This is modeled by a continuous fall in their headquarter intensity. In addition to the ownership choice, a Northern firm has to decide whether to offshore the manufacturing stage of production. To limit the extent of offshoring, it is assumed that contract incompleteness is present only for international contracts. As a consequence, the tradeoff between lower cost in the South and the distortions stemming from incomplete contracting determine the firm's organizational choice. Initially, goods are manufactured in the North, and as the goods become more standardized, the manufacturing stage is offshored to the South. Production is first offshored within firm boundaries and only later on to independent supplier. Thus, this incomplete contract model features a product cycle that specifies the different modes of production transfer in line with Vernon's (1966) formulation.[21]

In their prominent model on organizational choice, Antràs and Helpman (2004) highlight the impact of within-industry heterogeneity. They embed heterogeneous productivities of the Melitz (2003) type in a one-factor North-South trade model featuring relationship-specific investments, contractual input intensity, and property rights. Compared to related work, they abstract from differences in factor proportions (in contrast to Antràs, 2003) and use a static setting (in contrast to Antràs, 2005). It is assumed that producers of final good varieties need two customized inputs, namely headquarter services and intermediate inputs. These firms are located in the North, where they also produce the headquarter services. The production of the intermediate inputs, which is subject to incomplete contracts, can be both outsourced and offshored. Nash bargaining between suppliers of intermediate inputs and final good producers is modeled as in Antràs (2003). The supply of labor faced by the producers of final good varieties is perfectly elastic in both countries. Across the differentiated good sectors, the importance of headquarter services varies. In this setup, each Northern firm decides between the four possible organizational forms, which involve different fixed cost. By assumption, the fixed cost is higher for sourcing in the South and, given the location, higher for integration. Additionally, the variable cost is lower in the South, and integration gives the final good producer a larger share of the revenue but lowers the supplier's incentives. The heterogeneous firms choose a sourcing strategy for the intermediate inputs depending on

[21] This model differs from the above mentioned contributions of Krugman (1979a) and Grossman and Helpman (1991a,b) in that the product cycle is driven by voluntary offshoring rather than imitation of Southern firms. As these earlier articles on product cycles focus on the effects on trade flows and relative wages, imitation is used as a simple form of production transfer.

productivity and sectoral characteristics, e.g., headquarter intensity. This model is the first in which different organizational forms coexist within an industry. In particular, Antràs and Helpman (2004) show that all four forms may coexist in a headquarter-intensive sector: with increasing productivity the firms choose to exit the market, outsource domestically, integrate domestically, outsource abroad, and engage in FDI. The last form, offshoring within MNEs, is associated with the highest organizational cost and is most likely if both productivity and headquarter intensity are high. The authors analyze in detail the determinants for the relative prevalence of the different organizational forms. Empirical support for the above mentioned sorting pattern is provided, for instance, by Tomiura (2007).[22] The Antràs and Helpman (2004) model, which is widely cited in the literature, delivers interesting results. With regard to our research questions, however, we remark the following: Since the focus of Antràs and Helpman (2004) is on the endogenous organizational choice, they restrict the general equilibrium structure to a minimum. Most importantly, the Northern and Southern wage rates are fixed and cannot be influenced by organizational choice.[23] Hence, this model is not designed to address general equilibrium effects of organizational choice on employment, aggregate welfare, or distribution of income.[24]

To analyze complementarities between outsourcing and offshoring, Grossman et al. (2005) develop a variant of the Antràs and Helpman (2004) model, in which the fixed cost for integration is lower than for outsourcing. One key finding is that, in the case of zero transportation cost, the smaller the fixed cost for outsourcing in an industry, the higher the fraction of both outsourcing firms and offshoring firms.

While the above mentioned papers on organizational choice under incomplete contracts have a lot of common ground, we proceed by reviewing related papers that use different approaches.

Grossman and Helpman (2004) embed the incentive system approach of Holmstrom and Milgrom (1994) into a model of heterogeneous firms and North-South trade. It is assumed that the nature of contracts between principals and employees or suppliers is constrained.

[22] Using firm-level data on all manufacturing industries in Japan, he finds the following ranking: Firms active in FDI tend to be more productive than firms outsourcing abroad and exporters. The latter two are in turn more productive than domestic firms. Nunn and Trefler (2008) also support the predictions of Antràs and Helpman (2004) by examining US intra-firm and arm's-length import data.

[23] As Antràs and Helpman (2004) introduce a homogeneous good in addition to the differentiated goods and preferences which are quasilinear in the homogeneous good, the wage rates in the North and the South are determined by the respective fixed labor productivities in the production of the homogeneous good.

[24] See also Spencer (2005) and Grossman and Rossi-Hansberg (2008) for a discussion of this class of models.

In this effort-based model, there is a tradeoff between higher-powered incentives under outsourcing and greater monitoring under vertical integration. Grossman and Helpman (2004) mainly analyze the sorting of the heterogeneous firms into different organizational forms. They find that the least and most productive firms choose offshore outsourcing. Among the firms with intermediate productivity, the less productive choose FDI and the more productive domestic integration. Thus, their sorting pattern differs considerably from Antràs and Helpman (2004).[25]

In their noteworthy paper, Feenstra and Hanson (2005) use a simple incomplete contract model of offshoring and test it with data on firms engaged in export-processing in China. Their model is based on the property rights approach but is general enough to allow for implications of the incentive system approach. It encompasses four alternative organizational forms: the same or different parties can have the ownership of the plant and the control of the input purchases. The organizational choice depends on model parameters, and the theoretical predictions are supported by the data. In accordance with the property rights approach, the most prevalent form is foreign ownership of the plant and control over inputs by the local management. Moreover, this pattern is particularly common in provinces with thick export markets and low contracting cost.[26]

Another model on organizational choice with a somewhat different focus is Marin and Verdier (2010). It embeds the Aghion and Tirole (1997) theory of delegating authority[27] in a trade model of the Melitz and Ottaviano (2008) type in order to investigate the link between trade and varying levels of decentralization across firms and countries. This model is also tested empirically with data on the internal organization of Austrian and German firms.

The final contribution we mention in this section is by Nunn (2007), who builds on the work of Levchenko (2004). Instead of focusing on the inability to write complete contracts, he analyzes the institutional differences across countries that influence the quality of contract enforcement and, thereby, the pattern of trade. The impact of the quality of contract enforcement is expected to be particularly pronounced for industries that require considerable relationship-specific investments, i.e., contract-intensive industries. Nunn (2007) confirms his theoretical insights by a detailed empirical analysis. He finds that countries with good contract enforcing institutions export relatively more in contract-intensive industries.

[25] Detailed information on the incentive system approach and the model of Grossman and Helpman (2004) can be found in Spencer (2005).

[26] See Spencer (2005) for more information on the modeling approach of Feenstra and Hanson (2005).

[27] This theory of the firm extends the property rights approach (see Spencer, 2005, for more details).

Hence, the institutional environment turns out to be an important source of comparative advantage. Although this study focuses on the effects of contract enforcement for specialized inputs on final good trade flows, it suggests that the extent of offshoring as well as the relative prevalence of offshore outsourcing and FDI are also influenced by the quality of contracting institutions. This aspect is analyzed by Antràs and Helpman (2006), who generalize the Antràs and Helpman (2004) model in order to allow for varying degrees of contract incompleteness across inputs and countries. One of their main findings is that better contracting institutions in the South lead to more offshoring, while they may lower or raise the prevalence of FDI relative to offshore outsourcing.

To sum up, there is a vast body of literature on firms' sourcing strategies for intermediate inputs. Motivated by new trends in the data, this literature enhances the understanding of the various factors influencing the location and ownership choice of individual firms. Moreover, it highlights how these firm-level decisions influence the industry structure and the trade flows of intermediate and final goods.

As the other approaches to offshoring do not focus on the choice between different modes of offshoring, it should be emphasized that the models on firms' sourcing strategies analyze different factors that favor offshore outsourcing relative to FDI. Concerning this aspect, we additionally mention an empirical study, which supports and supplements the theoretical insights of this section. Using survey data on Austrian and German firms that offshore to Eastern Europe, Marin (2006) finds that lower trade cost, reduced level of corruption, and improved contracting environment in the host country favor offshore outsourcing relative to FDI. The opposite result is obtained for low organizational cost of hierarchies and large hold-up cost.

We can expect to see more work in this lively area of research on organizational choice, which also serves as a starting point for several related topics.[28] Since we are concerned with the labor market effects of offshoring, we note that the models on firms' sourcing strategies are not designed to analyze labor market and welfare effects. Due to the complexity of the models, the general equilibrium structure is often restricted to a minimum. Up

[28] Two examples are the contributions by Antràs et al. (2006) and Antràs et al. (2009). In a model of firms' hierarchies, Antràs et al. (2006) examine the effects of the formation of cross-country teams through offshoring. They show that offshoring results in better matching between Northern managers and Southern workers and in increasing wage inequality in the South. Antràs et al. (2009), in contrast, combine the literature on MNE activity with the macroeconomic literature on capital flows. It is analyzed how costly financial contracting and weak investor protection influence MNE activity and FDI flows. Their theoretical findings are supported by firm-level data.

to now, labor market effects have not yet been analyzed in frameworks that build on this class of models, but future research might investigate the labor market effects of these complex sourcing strategies. We proceed by reviewing the literature on international fragmentation of production processes. Instead of focusing on the determinants of organizational choice, this literature mainly concentrates on distributional and welfare effects of offshoring.

7.2.3 Literature on international fragmentation

A sizeable literature has developed that uses the term international fragmentation when referring to the phenomenon of offshoring. This strand of literature usually considers multinational firms, as the ownership choice for offshored activities is not addressed. Concerning the modeling of the production process, the following is assumed: the production process of a good can be split into separate activities, and some exogenous development allows that these production activities are carried out in different countries. Without going into depth on these exogenous developments, this literature focuses on the interesting effects of international fragmentation on factor rewards, production, trade flows, and welfare. The various contributions use general equilibrium models building on traditional trade theory in order to address cost-saving motives of offshoring. Many models are based on the Heckscher-Ohlin framework and emphasize factor-proportion arguments, while others are inspired by the Ricardian model or the Ricardo-Viner model.[29] Noteworthy contributions that we do not cover in detail are Arndt (1997), Jones (2000), Jones and Kierzkowski (1990, 2001), Deardorff (2001a,b), and Kohler (2004a,b).[30] Some of these authors use verbal and diagrammatic analysis, while others analyze mathematical models. To reduce complexity, it is predominantly assumed that fragmentation takes place in only one sector and one direction (cf. Baldwin and Robert-Nicoud, 2007). Concerning activities moved abroad, the early models focus primarily on the offshoring of activities that are low-skilled labor intensive. As pointed out by Grossman and Rossi-Hansberg (2008), this literature shows the analogy of fragmentation and technological progress in the same industry. The different modeling approaches deliver interesting insights, but the effects of fragmentation depend heavily on modeling details, such as the industry in which fragmentation occurs, the relative

[29] For more information on this issue, see Kohler (2008, pp. 3-4).

[30] Brief reviews of these models are provided by Baldwin and Robert-Nicoud (2007) and Kohler (2007). Markusen (2004) presents the development of the theory of multinational firms and lists Helpman (1984) as an early contribution using a simple factor-proportions explanation for MNE activity. In the Helpman (1984) model, MNEs only exist if factor endowments differ strongly enough.

factor intensities of the fragmented activities, and the like. Due to this fact, we review the literature on international fragmentation rather selectively. Another reason is that the models on task trade further develop this approach. In the following, we present three contributions that were motivated by the public debate about offshoring of white-collar services and skill-intensive activities. This also gives an impression of the related modeling approach concerning offshoring of activities that are low-skilled labor intensive.

Markusen (2005) studies a variety of model structures in which the relative intensity of skilled and unskilled labor and sometimes also of a third factor (know-how) play a key role. The first framework is a 2×2×2 Heckscher-Ohlin model with fragmentation occurring in one sector. Non-factor price equalization is achieved by assuming that the countries' endowments lie in different diversification cones.[31] Numerical simulations are required to study the impact of fragmentation. Markusen (2005) assumes that production fragmentation occurs only in the skill-intensive sector and that the offshored activity is of middle skill intensity. In this setting, the relative demand for skilled labor and the skill premium tend to increase in both countries due to offshoring,[32] but this direct effect may be reversed by the terms of trade effect. The other models "vary in terms of the number of factors, the substitutability of factors in various sectors, and the factor-intensity of the offshored process and offshoring sector" (Baldwin and Robert-Nicoud, 2007, p. 4). Running simulations for the different models, Markusen (2005) examines the effects of offshoring on each factor and aggregate welfare. The simulations demonstrate various scenarios, including one in which all factors gain and one in which all factors lose. The paper's aim is to present several plausible and empirically relevant alternatives to model the offshoring of white-collar services. As the theoretical outcome depends on the focus of the selected model, it is hard to draw robust conclusions.

To examine offshoring of white-collar services, Markusen and Strand (2007) develop a general equilibrium model similar to the first model in Markusen (2005). However, they assume that two types of international fragmentation become possible for one of the two goods: services can be separated from final good production and, additionally, can be split into headquarter and production activity. Simulations show that the possibility of both types of fragmentation tends to be beneficial for a small, skilled-labor abundant economy.

[31] This is the case if the endowments differ enough so that the two countries specialize in different goods in equilibrium.

[32] This happens in both countries, since the transferred activities are not skill intensive from the North's point of view but from the South's. In this context, the North is a high-skilled abundant country, while the South is low-skilled abundant.

The authors also discuss the factor price consequences and extend the model by dividing skilled labor into two types.
Deardorff (2005), who examines skilled-labor offshoring, uses a variant of the Heckscher-Ohlin model enriched with differences in technology. He illustrates that wages of unskilled workers in the developed North can fall below wages of their counterparts in the developing South as a consequence of offshoring, but it is also possible that skilled and unskilled workers in the North gain.

To sum up, models of international fragmentation allow for analyzing the effects of offshoring on aggregate welfare as well as on labor demand and factor rewards for different skill groups. Due to the complexity of these models, offshoring is only considered for one sector rather than the whole economy. Since the various models address different scenarios of offshoring, their results differ considerably and hinge on modeling details. Hence, it is not easy to derive general conclusions. The description of Markusen's (2005) first model illustrates how cost-saving offshoring can be studied based on a Heckscher-Ohlin framework with non-factor price equalization. In this model, the interplay between factor endowments and skill intensity takes center stage.
In contrast to the above mentioned literature on sourcing strategies, the models on international fragmentation address labor market effects of offshoring, namely the wage and demand effects for different skill groups. However, aggregate employment effects are not analyzed, since these models adopt the standard assumption of full employment. Contributions that change this assumption are reviewed in Section 7.5. We now proceed by presenting the related literature on task trade. This literature evolved because a model like the above mentioned 2×2×2 Heckscher-Ohlin model with international fragmentation is not well-suited to analyze the fact that ever finer slices of the value chain are traded.

7.2.4 Theory of task trade

As already mentioned in Section 6.1, Grossman and Rossi-Hansberg (2008) model the production process as a continuum of tasks. To clarify their contribution to the literature, we present related previous work and include the noteworthy contribution of Feenstra and Hanson (1996a) in this context. Compared to the above mentioned literature, the theory of task trade is in general more similar in spirit to the international fragmentation literature than to the literature on firms' sourcing strategies. Kohler (2004b) is an example of a related international fragmentation model. In his setup, there is a continuum of fragmented activities, each of which requires capital and labor. In contrast to Grossman and Rossi-Hansberg (2008), fragmentation is possible in only one sector, and the cost of trading fragmented activities is uniform.

Another strand of literature, which is related to both the fragmentation and the task trade literature, addresses offshoring in models with tradable intermediate inputs. Our review of this class of models is restricted to the influential work of Feenstra and Hanson (1996a).[33] These authors analyze the contribution of offshoring to the decline in relative wages of unskilled workers. It is assumed that the production of a single good requires both capital and a continuum of intermediate inputs that differ in their relative intensity of skilled and unskilled labor.[34] In an equilibrium without factor price equalization, the South produces a range of inputs up to some critical ratio of skilled to unskilled labor, while the skill-abundant North produces the remaining inputs. As all intermediate inputs are traded costlessly in this model, the range of inputs produced abroad is determined by the countries' factor endowments. An increase in the relative capital stock of the South leads to a shift of production activities to the South and, thus, to a rise in the relative wage of skilled workers in both countries. The reason is that the range of intermediate inputs produced in the South extends in such a way that the average skill intensity of inputs produced in each country rises. The theory is supported by an empirical analysis with respect to the impact of offshoring on relative wages of unskilled US workers during the 1980s. In comparison to the Feenstra and Hanson (1996a) approach, the main novelty of the paper by Grossman and Rossi-Hansberg (2008) is the introduction of heterogeneous cost for trading inputs.[35]

Having highlighted the main differences compared to the previous literature, we now present more details on the seminal work of Grossman and Rossi-Hansberg (2008). In their model, some tasks must be performed by low-skilled workers (L-tasks) and others by high-skilled workers (H-tasks). The production of each of two final goods requires a continuum of L-tasks and a continuum of H-tasks, but the factor intensities may differ between the two goods. Additionally, the cost for trading tasks is heterogeneous in order to capture the fact that different tasks vary in terms of tradability, i.e., suitability for offshoring.[36] Cost-saving

[33] Feenstra and Hanson's (1996a) model is further developed in the literature, one example being the work of Barba Navaretti and Venables (2004) on multinational firms.

[34] The modeling approach of Feenstra and Hanson (1996a) is similar to the Heckscher-Ohlin model with a continuum of goods.

[35] This review of previous work draws on Grossman and Rossi-Hansberg (2008, pp. 1979-80).

[36] See Grossman and Rossi-Hansberg (2008, footnote 2, p. 1978) for contributions that characterize tasks that are well-suited for offshoring.

motives determine the geographic organization of firms, with the extent of offshoring being continuous.[37] Studying the impact of falling offshoring cost on factor prices, Grossman and Rossi-Hansberg (2008) emphasize a productivity effect of increased task trade and show its analogy to factor-augmenting technological progress. This productivity effect benefits the factor whose tasks are easier to offshore. For instance, this means that offshoring of L-tasks is associated with rising wages for domestic low-skilled workers. The authors highlight that, due to this productivity effect, a fall in the offshoring cost may lead to shared gains for all domestic factors if the relative price effect or its impact on factor prices is not too large. This result contrasts with the standard factor-proportions theory, according to which falling cost of trading final goods leads to a distributional conflict. Grossman and Rossi-Hansberg (2008) offer a tractable model of offshoring that can be used to address its impact on prices, resource allocation, welfare, and other purposes. They extend the conventional Heckscher-Ohlin model and illustrate the important role of heterogeneous cost for trading tasks.[38] According to the authors, the drawbacks of their theory are restrictive assumptions concerning the specific production technology and the transportation cost for partially processed goods. Nevertheless, the Grossman and Rossi-Hansberg (2008) model is widely used in the literature. Section 7.5 reviews some contributions on the employment effects of offshoring that build on this model but refrain from the full employment assumption.

In the following, we present the literature considering offshoring as a means of technology transfer in a growth context. This literature differs considerably from the aforementioned models, with the exception of Antràs (2005).

7.2.5 Technology transfer by offshoring

This section deals with the approach to offshoring taken by the growth literature on product cycles which builds on the work of Grossman and Helpman (1991a,b). These authors model imitation as the only channel through which technological knowledge can be diffused internationally. However, FDI and offshore outsourcing are other important channels of technology transfer to the South. Both modes of offshoring are considered in the ensuing literature, and we begin by presenting the literature on FDI.[39]

[37] In contrast to the literature on sourcing strategies, there is no distinction between offshore outsourcing and FDI.

[38] Grossman and Rossi-Hansberg (2010) develop a related model for task trade between countries with similar relative factor endowments. In this model, country size may differ between the two countries.

[39] Antràs (2005) is related to this literature insofar as he analyzes product cycles and models voluntary offshoring instead of imitation. Since he focuses on incomplete contracts and changes some crucial assumptions,

Helpman (1993) is mainly concerned with the enforcement of intellectual property rights (IPR) in a product variety model of innovation and imitation, but he also considers a "crude theory of foreign direct investment" (Helpman, 1993, p. 1276). He emphasizes the important relationship between the extent of FDI and IPR protection, and this issue is further developed by Lai (1998). To contrast imitation and FDI as means of technology transfer to the South, Lai (1998) uses a dynamic North-South trade model that builds on the product cycle model of Grossman and Helpman (1991a) and Helpman (1993). Concerning the technology transfer via FDI, he assumes that Northern firms may transfer production to the South via FDI and that Southern firms can only imitate the products of MNEs. In contrast to other models, there is no fixed cost of offshoring. In each period, a firm's decision to offshore production is driven by the tradeoff between lower wages in the South and the probability that its product will be imitated after multinationalization. The equilibrium values are such that, at any time, Northern firms are indifferent between offshoring and continuing production in the North, i.e., the expected present discounted values of profits are the same. Thus, the instantaneous profit of MNEs is larger than that of Northern producers. Lai (1998) determines the extent of FDI in the steady state and analyzes the effect of stronger IPR protection, which is modeled as a fall in the exogenous imitation rate. He finds that stronger IPR protection in the South increases the rate of innovation, the rate of technology transfer, and Southern relative wage. It is demonstrated that the opposite effects arise if technology is transferred to the South via imitation (as in Grossman and Helpman, 1991a) rather than FDI. Glass and Saggi (2002) analyze the two channels of technology transfer simultaneously and assume that Southern firms can more easily imitate the products of MNEs relative to the products of Northern firms. Building on the quality ladder framework of Grossman and Helpman (1991b), they model stronger IPR protection by an increase in the cost of imitation. They find that stronger IPR protection lowers FDI and innovation, a result contrasting with Lai (1998). These models on FDI are reexamined and extended by, among others, Glass and Wu (2007) and Mondal and Gupta (2008a).

We now turn to a contribution on offshore outsourcing. Glass and Saggi (2001) build on the quality ladder model of Grossman and Helpman (1991b) but assume that Northern firms, which assemble the final good using Northern labor, can purchase basic stages of production from Southern firms. Hence, offshore outsourcing replaces imitation as the channel of production transfer to the South. In analogy to innovation, offshore outsourcing

his model is included in a different section.

is associated with a fixed cost and uncertain rewards. This incorporates the fact that "a firm might never find a feasible adaptation of its production process" (Glass and Saggi, 2001, p. 72). Once a firm is successful in innovation, it chooses the price of its good and the intensity of adaptation. In their dynamic setup, Glass and Saggi (2001) identify five forces that potentially explain higher offshore outsourcing along with a lower relative wage of the North and a higher rate of innovation. These forces include falling cost of adapting technologies for the South and a larger fraction of production stages that can be offshored.
To sum up, this strand of literature builds on North-South growth models with product varieties and quality ladders. The focus differs from most of the aforementioned models. On the one hand, the effects of stronger IPR protection in the South on FDI and growth are analyzed. On the other hand, the causes for offshore outsourcing and its wage and growth effects are studied. These dynamic North-South models, which are driven by differences in technology, deliver interesting insights on the issue of offshoring, but they do not address employment issues. To the best of our knowledge, labor market frictions have not yet been considered in such North-South growth models with offshoring.

In Section 7.2, we reviewed different approaches analyzing offshoring in the context of trade theory. Apparently, the research questions as well as the theoretical frameworks differ considerably between the various contributions on offshoring. In the next three sections, we present models that address labor market effects. Section 7.3 deals with labor market effects of offshoring in frictionless labor markets, while Section 7.4 reviews trade models with labor market frictions. These models may act as a starting point for future research on the employment effects of offshoring. Section 7.5 presents existing work related to our research focus, viz., offshoring models with labor market frictions.

7.3 Labor market effects of offshoring in frictionless labor markets

As this section deals with full employment frameworks, it should be pointed out that all models of Section 7.2 use such frameworks. We have already mentioned the labor market effects that some of these contributions on offshoring address, and, therefore, we only briefly summarize their results. The models on international fragmentation and task trade (Sections

7.2.3 and 7.2.4) mainly analyze the effects on labor demand and wages for different skill groups in the domestic economy. They shed some light on this issue, but no consensus has yet emerged. The results depend on different factors, including the skill intensity of the offshored activity and the sectors in which offshoring occurs. In the following, we add a few other papers concerned with the extensively studied aspect of relative labor demand and wages.

In their survey on trade and wages, Feenstra and Hanson (2001) emphasize that trade in intermediate inputs is a potentially important explanation for the rising wage gap between skilled and unskilled workers in developed countries. Additionally, they state that the wage and employment effects of trade in intermediate inputs can be much greater than the effects of trade in final goods. Building on the model of Feenstra and Hanson (1996a), they show that trade in inputs has the same effects as skill-biased technological change and, thus, raises the relative demand and wages for the high-skilled.

Sayek and Şener (2006) use a dynamic product cycle model with two skill groups in order to analyze the effects on the domestic skill premium. They assume that production can be shifted to the South via offshore outsourcing[40] or imitation. One key result is that a larger fraction of outsourced production leads to a rise in the Northern skill premium.

A contribution that studies the welfare and wage effects of service offshore outsourcing is Bhagwati et al. (2004). Three models building on traditional trade theory suggest that service offshore outsourcing generally benefits the economy as a whole. However, the distributional effects are less unanimous: it may be that some workers lose while others gain or that all workers are better off. The latter is also emphasized, for instance, by Grossman and Rossi-Hansberg (2008).

To sum up, much research on the labor market effects of offshoring has focused on its contribution to the increase in the skill premium observed in many industrialized countries. Several studies suggest that offshoring tends to increase the wage differential, while others point to the possibility that this need not always be the case.[41]

Offshoring may also affect the elasticity of labor demand. A contribution addressing this fact is Senses (2010), whose theoretical underpinning builds on the model of Feenstra and Hanson (1996a). If the demand for labor used in production is elastic, an increase in

[40] Offshore outsourcing is modeled in the spirit of Glass and Saggi (2001).

[41] There is also much empirical work on this issue, which is reviewed in Section 7.6.

offshoring lowers the share of production workers and, thereby, increases the conditional labor demand elasticities. This effect on the elasticity of labor demand is consistent with the Rodrik (1997) hypothesis. Although Senses (2010) is mainly an empirical investigation, we briefly present this theoretical mechanism because it is also used in other contributions (e.g., Koskela and Stenbacka, 2009).

Karabay and McLaren (2010) study the impact of offshoring on the volatility of wages and workers' welfare. They contrast the effects of trade in final goods with those of offshoring in a 2×2×2 trade model, in which risk is allocated through long-run employment relationships. It is shown that the welfare of rich country workers is lowered by trade in final goods but raised by offshoring. Moreover, trade in final goods reduces wage volatility, while offshoring leads to increasing wage volatility.

In this section, we surveyed some labor market effects of offshoring analyzed in full employment models. However, we are particularly interested in the aggregate employment effects for economies with labor market frictions. Therefore, we proceed by reviewing contributions that study the labor market effects of trade in models with labor market frictions. Afterwards, we present models that also consider offshoring in such frameworks.

7.4 Labor market effects of trade under labor market frictions

The first part of this literature review illustrated the fact that full employment models are widely used to treat the effects of trade in final goods and offshoring. Davidson and Matusz (2010, p. 15) point out that "by and large the importance of labor market structure and labor market institutions has not [...] received the attention that it deserves". Early exceptions that analyze trade in final goods and unemployment include Brecher (1974) on minimum wages, Matusz (1986) on implicit contracts, Copeland (1989) on efficiency wages, Agell and Lundborg (1995) on fair wages, Davidson et al. (1988) on search and matching, and Grossman (1984) on unionized labor markets. In recent years, however, the interest in this topic has resurged, and several trade papers with labor market imperfections and unemployment have been published.

Most of the recent contributions incorporate search unemployment. Davidson and Matusz (2010) provide a comprehensive summary of their seminal research. In a series of papers starting with Davidson et al. (1988), they study various effects of search induced unemployment in trade models.[42] In the following, we review two recent contributions on search unemployment and trade introducing heterogeneous firms of the Melitz (2003) type. Trade liberalization leads to inter-firm reallocations towards more productive firms in the Melitz (2003) model (see Section 7.1). Jobs are lost at some firms and new jobs are created at other firms, but there is no aggregate employment effect. Yet, this changes if labor market frictions are considered.

Helpman and Itskhoki (2010) analyze the effects of labor market frictions and trade cost on welfare, trade flows, productivity, and unemployment. Using a static model[43] with two countries and two sectors, they embed search and matching frictions of the Diamond-Mortensen-Pissarides type[44] and individual wage bargaining[45] into both sectors. In addition to a homogeneous good sector, there is a differentiated good sector with heterogeneous firms of the Melitz (2003) type, which pay the same wage. This setup implies that trade liberalization affects the productivity distribution in the differentiated good sector. Labor market frictions, which can vary across sectors, are the only difference between the two countries. Changes in these frictions (e.g., higher efficiency of matching or lower cost of hiring) affect the trading partner. Helpman and Itskhoki (2010) show that labor market frictions act as a source of comparative advantage and that both countries gain from trade. Concerning trade liberalization, they find the following: a fall in trade cost may raise or reduce a country's aggregate unemployment, depending on whether its relative labor market frictions in the differentiated good sector are low or high.[46]

The second contribution presented in the context of search frictions and heterogeneous firms is by Felbermayr et al. (2011). In contrast to Helpman and Itskhoki (2010), these authors use a generalized version of the Melitz (2003) trade model with symmetric countries. Concerning the labor market, they integrate the same type of search and matching frictions as well as individual bargaining. In their one-sector model, labor market frictions do not affect average productivity. One key result is that trade liberalization leads to lower unemployment

[42] Building on this work, Moore and Ranjan (2005) analyze the impact of trade liberalization on unemployment. They find that both trade liberalization and skill-biased technological change lead to rising wage inequality, but their impact on unemployment may be quite different.

[43] The static analysis is consistent with the steady state of a dynamic model (Helpman and Itskhoki, 2009).

[44] A detailed description of this approach is provided by Pissarides (2000).

[45] It is assumed that the wage is bargained between a worker and his firm because the search and matching frictions lead to bilateral monopoly power.

[46] In related models, Helpman et al. (2010a,b) study the impact of trade liberalization on unemployment and wage inequality within industries. Helpman and Itskhoki (2010) and Helpman et al. (2010a,b) illustrate that labor market frictions may act as a source of comparative advantage. A detailed review of this approach is provided by Helpman (2010).

and higher real wages if, and only if, it improves average productivity. To examine under which circumstances trade liberalization and average productivity are positively linked, they calibrate the model towards US data. Interestingly, they find that different trade liberalization scenarios all reduce unemployment.[47] As a robustness check, they consider firm-level collective bargaining[48] instead of individual bargaining, and their main results still hold.

In recent years, search frictions have been widely used to incorporate unemployment in trade models, but other noteworthy approaches also exist. Egger and Kreickemeier (2009) include the fair wage approach of Akerlof and Yellen (1990) in a trade model with heterogeneous firms. Whether workers consider a wage fair depends on the productivity of the firm they work for. In this setup, trade liberalization leads to increasing within-group wage inequality and higher unemployment. Hence, their result concerning the effect on unemployment contrasts with Felbermayr et al. (2011).[49]

Like Egger and Kreickemeier (2009), Davis and Harrigan (2011) consider the labor market effects of trade liberalization in a Melitz (2003) type trade model. However, they incorporate the efficiency wage model of Shapiro and Stiglitz (1984). One key result is that trade liberalization may destroy a large fraction of good jobs which pay above average wage, although the impact on aggregate employment is very small in their model.

To analyze the link between trade and unemployment, the literature mainly uses setups that do not consider economic growth and dynamic trade patterns. An exception constitute dynamic North-South trade models of the product cycle with labor market frictions. Arnold (2002) studies the impact of imitation on Northern frictional unemployment in a model based on Helpman (1993). He shows that labor market flexibility, modeled by the outflow rate of unemployment, crucially affects the growth effects of North-South trade. In contrast, Mondal and Gupta (2008b) introduce efficiency wages for low-skilled Southern workers into the Grossman and Helpman (1991a) model. They find that stronger IPR protection either lowers or raises the level of unemployment in the South, depending on the North-South wage differential. While the focus of these two contributions differs from the other papers in this section, the contribution by Grieben and Şener (2009) also deals with the labor market effects

[47] In a closely related model, Janiak (2006) shows that trade liberalization increases equilibrium unemployment, but he imposes rather restrictive and implausible assumptions.

[48] Concerning the modeling of firm-level collective bargaining, they apply the efficient bargaining approach, in which the two parties bargain over both wages and employment. See Cahuc and Zylberberg (2004, Chapter 7, Section 3.2) for more information on this approach.

[49] Another trade paper with unemployment due to fair wages is Kreickemeier and Nelson (2006). It examines the impact of global and national technological change on relative wages and unemployment levels.

of trade liberalization. Concerning the modeling of production activity, trade, and growth, Grieben and Şener (2009) deviate from the standard North-South endogenous growth models in several ways. In addition, they assume that the Northern labor market is characterized by firm-level collective bargaining as well as a minimum wage. The labor union's objective is to maximize the expected wage in excess of the given minimum wage. In this model, unilateral Northern trade liberalization leads to increasing Northern unemployment and lower per-capita welfare in both countries, whereas unilateral Southern trade liberalization leads to the opposite effects. Grieben and Şener (2009) consider union wage setting as a source of labor market frictions in a trade context. In the next section on offshoring, we treat this source of labor market frictions more extensively.

To sum up, this section illustrates that there is a small but growing literature on final good trade and unemployment. Among other things, the models analyze the general equilibrium effects of trade liberalization on unemployment, and further research on offshoring and unemployment may be inspired by this work. The next section reviews the existing literature on offshoring and labor market frictions.

7.5 Labor market effects of offshoring under labor market frictions

First, we present contributions that analyze the labor market effects of offshoring in trade models with either fair wages or search frictions. Afterwards, existing work on offshoring and unionized labor markets is reviewed in detail. Due to the focus of our own study, we are especially concerned with the impact of offshoring on aggregate unemployment.

7.5.1 Fair wages and search frictions

Applying the fair wage approach to efficiency wages, Egger and Kreickemeier (2008) study the impact of offshoring on the domestic skill premium and unemployment of the unskilled workers in a small open economy. They use a standard model of international fragmentation with three sectors and two inputs, namely skilled and unskilled labor, and assume that the two inputs are mobile across sectors. Production can be fragmented only in the sector with middle skill intensity. Skilled workers are fully employed in equilibrium, but the fairness constraint is binding for unskilled workers, which leads to unemployment for this group of workers. The authors demonstrate how the relative wage and employment effects of international fragmentation can be explained by the interaction of relative factor endowments, the skill intensity of the domestically produced component, preferences towards wage equality, and the level of unemployment benefits. In particular, it is shown that international fragmentation increases unemployment of unskilled workers if unskilled labor is sufficiently abundant relative to skilled labor.

Instead of focusing on fair wages, it is more common to introduce search and matching frictions. In the following, we present four contributions on offshoring that build on job search models. Sethupathy (2009) investigates the effects of offshoring on firm-level domestic wages and employment. His two-sector model displays heterogeneous firms with endogenous markups (Melitz and Ottaviano, 2008) in the differentiated good sector and a productivity effect in line with Grossman and Rossi-Hansberg (2008). Search frictions and individual bargaining are present only in the differentiated good sector. The homogeneous good sector absorbs any residual labor, and offshoring is not possible in this sector. For firms in the differentiated good sector, this model predicts the following: Since offshoring firms increase their productivity and profitability, they raise the wages paid to domestic workers. In contrast, non-offshoring firms lose profitability and lower their wages. The effect on domestic employment is ambiguous at offshoring firms and negative at non-offshoring firms. These theoretical predictions are tested with data on US multinationals (see Section 7.6).

Kohler and Wrona (2010) follow Grossman and Rossi-Hansberg (2008) by modeling offshoring as trade in a continuum of tasks. In contrast to Sethupathy (2009), they focus on aggregate employment effects of offshoring and rule out reallocation of labor across sectors. They assume that workers are specific to a single sector, in which offshoring occurs.[50] In this single-sector economy, the labor market is characterized by search frictions and individual bargaining. Concerning offshoring, Kohler and Wrona (2010) incorporate the simplifying assumption of a given foreign wage rate that is low enough so that the domestic economy imports tasks. They find that increased offshoring of tasks does not necessarily lead to net job destruction in this small open economy. More precisely, enhanced technology of offshoring has the following consequences: jobs are lost at the extensive margin because ever more tasks are offshored, and jobs are created at the intensive margin because labor cost saving results in a productivity effect and higher employment for the entire set of tasks. The authors derive conditions for

[50]This assumption of factor specificity is associated with a short-run perspective on offshoring. Cf. Kohler (2008, p. 3).

domestic net job creation and highlight that steady improvements in the offshoring technology may have a non-monotonic effect on employment. The main determinants of the shape of this relationship are the slope and the convexity of the offshoring cost function for the different tasks. One key finding is that, for certain industry characteristics, improvements in the offshoring technology cause wage cuts and job losses for low levels of offshoring but wage gains and job creation above a critical level of offshoring. For alternative industry characteristics, increased offshoring leads to a steady decrease in employment. This employment reducing effect is also obtained in a related work by Keuschnigg and Ribi (2009).[51]

Mitra and Ranjan (2010) study the impact of offshoring on both sectoral and economy-wide unemployment, whereby they highlight the role of intersectoral labor mobility. Their two-sector model exhibits search frictions and individual bargaining in the labor market. In one sector, firms use labor to produce two inputs, which are then assembled into a good, and offshoring of production is possible for only one of the two inputs.[52] The other sector uses only domestic labor in the production of its good. The two goods are then combined to produce the final consumption good, which is exported in the case of offshoring in order to pay for the imports of the input produced abroad. As in Kohler and Wrona (2010), it is assumed that the wage in the other country is fixed. Due to this small open economy assumption, these models abstract from repercussions on the domestic labor market that would arise in the case of two large open economies.[53] Analyzing the steady state of this model, Mitra and Ranjan (2010) find that offshoring leads to a higher wage and lower unemployment in each sector if intersectoral labor mobility is perfect. This reduction in sectoral unemployment is driven by the complementarity between the offshored and the domestically produced input which leads to a positive productivity effect of offshoring.[54] Since this productivity effect outweighs the negative relative price effect in the offshoring sector, both sectors experience lower unemployment. In the case that offshoring results in a labor movement towards the sector with lower or equal search cost, economy-wide unemployment decreases unambiguously as well. These findings refer to the case of perfect intersectoral labor mobility. If instead intersectoral

[51] Keuschnigg and Ribi (2009) also use a job search model to analyze the effects of offshoring, but they mainly focus on welfare policy, i.e., redistribution and social insurance. In their model with two skill groups, only the low-skilled workers are subject to unemployment, and offshoring raises unemployment among the low-skilled.

[52] With regard to the modeling of offshoring possibilities, the paper by Mitra and Ranjan (2010) is related to international fragmentation models.

[53] In the case of two large open economies, offshoring shifts, among other things, the foreign wage rate and this shift feeds back on domestic production and employment decisions.

[54] By relying on a positive productivity effect of offshoring, Mitra and Ranjan (2010) follow the seminal work of Grossman and Rossi-Hansberg (2008) (but they use a different framework and refrain from the full employment assumption).

labor mobility is imperfect, unemployment in the offshoring sector may increase, while unemployment in the non-offshoring sector definitely falls. As a result, the impact on aggregate employment is ambiguous. Additionally, the presence of imperfect labor mobility may give rise to a mixed equilibrium in which only a fraction of firms in the offshoring sector move production abroad. For this type of equilibrium, unemployment unambiguously increases in the offshoring sector.[55]

In a related job search model, Ranjan (2010) analyzes the labor market effects of offshoring in the presence of firm-level collective bargaining.[56] He adopts the right-to-manage (RTM) approach:[57] wages are bargained between a firm and a labor union in the first stage, and the firm chooses domestic employment in the second stage. Since the amount of offshoring is also determined in the second stage, the threat point of the firm can be positive. The goods market is characterized by a single good that is produced under diminishing returns of labor. In contrast to Mitra and Ranjan (2010), Ranjan (2010) models the offshored input and domestic labor as perfect substitutes. He abstracts from a productivity effect of offshoring due to his focus on the role of collective bargaining in shaping the labor market effects. Concerning offshoring, he assumes that the supply curve of the offshored input is upward sloping, i.e., some inputs are costlier to offshore.[58] As this is a draft paper, the analytical results for the steady state are very limited up to now, but numerical examples illustrate some interesting aspects: while the wage is monotonically increasing in the cost of offshoring (due to higher wage claims' of workers), the relationship between the cost of offshoring and unemployment is non-monotonic. If the offshoring cost is initially very high and then begins to fall steadily, unemployment first decreases before it increases. Two effects countervail: firms hire more domestic labor due to a lower wage, and they increasingly substitute offshored inputs for domestic labor. Ranjan (2010) emphasizes the result that offshoring may reduce both the wage and unemployment.[59]

[55] In a contribution preceding the paper by Mitra and Ranjan (2010), Davidson et al. (2008) investigate how offshoring of high-tech jobs affects the wages of low- and high-skilled workers and overall welfare. In this job search model, firms endogenously choose different technologies, and workers differ in skill levels. The authors briefly address unemployment, but their key result is that offshoring leads to a falling skill premium.

[56] Most job search models assume individual wage bargaining between a worker and his firm. Exceptions that consider firm-level collective bargaining include Felbermayr et al. (2011), who mention this form of bargaining only in the appendix of their trade paper, and Ranjan (2010). It is assumed that the workers a firm hires are represented by a labor union.

[57] The RTM approach assumes that the two parties bargain over wages, while the firm then unilaterally determines employment. For details on this approach, see Cahuc and Zylberberg (2004, Chapter 7, Section 3.1).

[58] This is a reduced form version of Grossman and Rossi-Hansberg (2008).

[59] Additionally, Ranjan (2010) contrasts his findings for collective firm-level bargaining with the results obtained in his model under the widely used assumption of individual bargaining. He argues that the non-

In recent years, several small open economy models that consider fair wages or search and matching frictions in order to address the effect of offshoring on economy-wide unemployment have appeared. Models that focus on search frictions include wage bargaining to determine wages. Most contributions assume individual wage bargaining, while Ranjan (2010), for instance, postulates labor market institutions and studies the case of firm-level collective bargaining in the presence of search frictions. Concerning the role of labor market institutions, there is another strand of literature that does not take search frictions into account. In these models, union wage setting is the source of labor market frictions, and it induces unemployment. The next section is devoted to these contributions on offshoring and unionized labor markets, whose modeling approach differs considerably from job search models.

7.5.2 Union wage setting

A considerable amount of literature on offshoring and unionized labor markets exists, but the work on the effects of offshoring on aggregate unemployment is still limited. As our own analysis focuses on union wage setting as the source of labor market frictions, we also cover several studies on offshoring and unionized labor markets analyzing aspects other than aggregate unemployment. These contributions are presented first.

Bughin and Vannini (1995) use an oligopoly model to investigate how a unionized labor market in the host country alters the choice of an MNE between FDI and exporting.[60] In contrast, Zhao (1998) examines the labor market effects of offshoring and the role of FDI for the bargaining position of the firms.[61] There are two identical countries, each of which is characterized by a unionized sector and a non-unionized sector that absorbs all workers not employed in the unionized sector. Collective bargaining at the industry level is simultaneous and independent between the two countries. Zhao (1998) applies the efficient bargaining approach, according to which the two parties bargain over both wages and employment.[62] In each country, there is a monopoly firm that produces the good of the unionized sector. It is assumed that these firms can undertake symmetric intra-industry FDI without a fixed

monotonicity of unemployment does not arise in the case of individual bargaining. This result may, however, be due to either the different level of bargaining or the change in the time structure.

[60] In a related work, Leahy and Montagna (2000) address the question of how different degrees of wage setting centralization impact the incentives of an MNE for FDI. In a recent contribution that builds on the framework of Bughin and Vannini (1995), Rocha-Akis and Schöb (2011) include a redistributive welfare state and examine welfare policy in the presence of unionized labor markets and offshoring.

[61] Zhao (1998) extends the analysis of Zhao (1995) so as to analyze the effect of FDI on wages and sectoral employment.

[62] As already mentioned in footnote 48, see Cahuc and Zylberberg (2004, Chapter 7, Section 3.2) for more information on this approach.

cost. Since each MNE bargains in the home and the host country, the two MNEs partially cooperate against the labor union in each country. Zhao (1998) highlights that FDI leads to strategic interaction and alters a firm's threat point in the bargain. The cost-saving effect of FDI is ruled out by the assumption of identical countries. In this model, FDI always lowers the bargained wage. Additionally, if the union does not care more about wages than employment, FDI reduces employment in the unionized sector and the competitive wage in the non-unionized sector. The author states that these effects are weaker under firm-level collective bargaining.[63]

In a related framework, Skaksen and Sørensen (2001) derive conditions under which labor unions appreciate FDI. They use an industrial organization model, in which a single monopolistic firm decides to be a local firm or an MNE with some production abroad. There is collective wage bargaining between this firm and the labor union at home. If the firm decides to engage in FDI in the first stage, it simultaneously bargains over wages with the foreign labor union. It is implicitly assumed that labor union members not employed by this firm get a job elsewhere and earn the competitive wage that prevails in this country. In this setup, FDI lowers the demand elasticity for domestic labor.[64] As a consequence, the union may achieve a higher wage, which outweighs a potential employment loss in this industry. Local workers tend to gain from FDI if the degree of complementarity between the MNE activities at home and abroad is high. In contrast, they tend to lose in case of a high degree of substitution.

There are several other contributions that analyze different aspects concerning offshoring and unionized labor markets without considering aggregate unemployment. To stay focused, we just mention some selected papers and do not describe the different frameworks they build upon. Gaston (2002) studies how offshoring possibilities influence the nature of collective bargaining in light of the fact that they worsen the bargaining position of unions. Additionally, Naylor and Santoni (2003) consider an FDI game between two unionized firms and investigate the impact of union bargaining power on the decision for FDI. In contrast, Lommerud et al. (2003) address the question of how trade liberalization alters both domestic wage bargaining and the incentives for FDI. In a related paper, Collie and Vandenbussche (2005) analyze the optimal domestic trade policy in the presence of FDI and a unionized

[63] In this model, firm-level collective bargaining means that, in the presence of FDI, there are two independent and simultaneous wage bargaining games in each country.

[64] This contrasts with the Rodrik (1997) hypothesis, according to which globalization increases the demand elasticity and, thus, lowers the workers' bargaining power.

labor market. Elberfeld et al. (2005) investigate the impact of FDI on welfare and labor demand in the home country, while Lommerud et al. (2009) examine the incentives for offshoring in the presence of strong unions. The last contribution mentioned in this context is Bognetti and Santoni (2010). This study, which is closely related to Skaksen and Sørensen (2001), addresses the effect of offshoring to a low-wage country on the union's welfare.

Since we are particularly interested in the effect of offshoring on unemployment, we proceed with contributions that analyze this issue. To guide their empirical analysis, Egger and Egger (2003) consider a simple one-sector model of a small open economy, in which firms may offshore part of their intermediate input production to a foreign country that is rich in low-skilled labor. In the case of offshoring, a firm uses low-skilled labor abroad and only high-skilled labor at home. It is assumed that the domestic market for low-skilled labor is unionized. In this model, a decline in trade barriers stimulates offshoring and, thereby, leads to unemployment of domestic low-skilled workers. However, Egger and Egger (2003) do not model the wage bargaining process explicitly and simply postulate that low-skilled employment decreases in the domestic wage differential between high- and low-skilled labor. In contrast, Eckel and Egger (2009) use a trade model with two symmetric countries and two-way horizontal FDI. They investigate the relationship between firm-level collective bargaining and the mode to serve the foreign market in a setup with heterogeneous firms. Each country consists of a homogeneous good sector and a differentiated good sector, and the homogeneous good, which requires only capital, acts as a numéraire. The modeling of the differentiated good sector combines aspects of Helpman et al. (2004) with the RTM approach to firm-level wage bargaining. In the two identical countries, the sequence of events is as follows: First, each firm in the differentiated good sector decides to serve the foreign market as an exporter or an MNE and incurs the fixed capital cost that differs for these two options. Second, firm-level wage bargaining takes place. An MNE negotiates with two independent unions at the plant level. Third, the firms determine employment, produce their respective varieties with labor input, and sell them in both countries. In this model, the firm's decision between exporting and FDI depends on the proximity-concentration tradeoff. Additionally, the presence of unions makes FDI more attractive, since it increases a firm's disagreement profit and, thereby, strengthens its bargaining position. Concerning the labor market effects, Eckel and Egger (2009) find that the unemployment rate tends to be lower under economic integration than in autarky. This is due to a wage reducing effect of FDI, i.e., MNEs pay lower wages than exporters. Real income of the average worker rises under economic integration, while workers in MNEs may lose. The authors argue that the reduction in unions' bargaining power in both countries may have a particularly positive employment effect in the case of strong unions, while this kind of deregulation is less effective in the presence of weak unions.

The approaches of Egger and Egger (2003) and Eckel and Egger (2009) differ from ours. To analyze the effect of offshoring on aggregate unemployment, we consider a high-wage country with a unionized labor market that may move production to a low-wage country. In the following, we review contributions that consider this offshoring scenario.

Skaksen (2004) studies the effects of both potential, but non-realized, and realized offshore outsourcing on domestic wages and aggregate employment.[65] He assumes that wage bargaining takes place prior to the firm's decision on the level of offshore outsourcing and domestic employment. Due to this timing structure, he only considers offshore outsourcing, which is more flexible than establishing an own plant via FDI. In this small open economy model, a single final good is produced by combining two intermediate activities, one of which can be perfectly substituted by offshore outsourcing. Labor is the only factor of production, and the domestic market for labor is unionized. The cost of buying the intermediate activity abroad is exogenous and assumed to be sufficiently low so that a domestic firm would never export this activity. Skaksen (2004) analyzes the bargaining game between a representative firm and a labor union. He finds that potential, but non-realized, offshore outsourcing acts as a threat in the wage bargaining game and strengthens the firm's bargaining position.[66] Consequently, a marginal fall in the cost of offshore outsourcing results in a lower negotiated wage rate and higher employment in this case. Aggregate welfare rises and the firm gains, while the labor union loses. If instead realized offshore outsourcing is analyzed, the results differ considerably: A marginal fall in the cost of offshore outsourcing raises the wage rate and reduces employment. The labor union gains, but the firm loses and aggregate welfare falls. This paper highlights the differential impact of non-realized and realized offshore outsourcing on the wage bargaining game in the home country.

Using a related small open economy model, Koskela and Stenbacka (2009) also examine the effects of offshore outsourcing on domestic wages and employment.[67] In contrast to

[65] This model is related to some of the above mentioned models, especially to Skaksen and Sørensen's (2001).

[66] This effect would not arise when applying the efficient bargaining approach instead of the RTM approach.

[67] Koskela and Stenbacka (2009) state that their model can alternatively be interpreted as one of FDI rather than offshore outsourcing.

Skaksen (2004), the offshoring decision precedes wage bargaining, and firms choose their domestic labor demand after the wage bargain.[68] The authors point out that such a time structure is relevant if offshore outsourcing is a long-term decision requiring significant sunk investments for establishing a network of foreign suppliers. Therefore, they assume a fixed cost of offshore outsourcing, which is convex in the amount of offshored labor. In final good production, domestic and offshored labor are modeled as perfect substitutes with a productivity differential. The wage in the foreign country, which is not endogenous, is assumed to be sufficiently low. In this setup, offshore outsourcing increases the wage elasticity of domestic labor demand (see Senses, 2010), which in turn leads to a wage reducing effect. In addition, offshore outsourcing mitigates the firm's profit reducing effect of higher domestic wages. For a sufficiently strong labor union, the first effect dominates and offshore outsourcing lowers the negotiated wage and aggregate unemployment in the home country. The opposite effects arise in the case of a weak labor union. Koskela and Stenbacka (2009) remark that, in the presence of a sufficiently strong union, the fraction of production that should be optimally offshored increases in the bargaining power of the union. This paper stresses that the effect of offshore outsourcing on unemployment depends critically on the relative bargaining power of the labor union.[69] The models of Skaksen (2004) and Koskela and Stenbacka (2009) deliver interesting insights, but the production cost in the low-wage country is given exogenously due to the small open economy assumption. Thus, these models abstract from repercussions on the domestic labor market which arise if two large open economies are involved in offshoring.

To sum up, the modeling approaches and the aspects analyzed differ considerably between the contributions on offshoring and unionized labor markets. For instance, some models consider two identical countries with labor unions and two-way FDI, while others study offshoring from a high-wage country with a unionized labor market to a low-wage country. There are only a few contributions addressing the effect of offshoring on aggregate unemployment.

[68] The terms "ex ante wage bargaining" and "ex post wage bargaining" can be used for the time structure in Skaksen (2004) and Koskela and Stenbacka (2009), respectively.

[69] In a closely related paper, Koskela and Stenbacka (2010) study the effects of offshore outsourcing and wage solidarity on the labor demand for high- and low-skilled workers, the skill premium, and aggregate unemployment. They consider a monopoly union and find that offshore outsourcing reduces domestic unemployment if the fraction of high-skilled workers is sufficiently low. Two other related papers are by Koskela and König (2008) and Koskela and Schöb (2010). Koskela and König (2008) add flexible and committed profit sharing to a model that examines the relationship between wage bargaining, offshore outsourcing, and aggregate unemployment. In contrast, Koskela and Schöb (2010) analyze the impact of alternative labor tax reforms on domestic employment in the presence of offshore outsourcing and a unionized domestic labor market.

In Section 7.5, we presented models analyzing the labor market effects of offshoring in the presence of labor market frictions. In these models, unemployment is caused by fair wages, search frictions, or union wage setting. This section illustrates that research on offshoring and aggregate unemployment is growing but still limited. We observe that all models on offshoring to a low-wage country consider small open economies and, thus, abstract from repercussions on domestic employment and the effects on the host country. Due to this fact, there is a need for further theoretical research on the aggregate employment effect of offshoring. We revert to this issue in more detail in Section 7.7. First, however, empirical results on the labor market effects of offshoring are reviewed.

7.6 Empirical evidence on the labor market effects of offshoring

The theoretical literature sheds some light on the labor market effects of offshoring, but the impact of offshoring on aggregate employment and the role of country-specific labor market characteristics are not yet fully understood. In this section, we present the insights gained by empirical studies on the labor market effects of offshoring. A comprehensive survey of the sizeable amount of empirical literature is carried out by Crinò (2009), while Bottini et al. (2007) provide a more selective survey. Since our focus lies on theoretical work, we do not discuss the different empirical methodologies and concentrate on the main results concerning the domestic labor market effects of offshoring.[70] In particular, we present studies on Western European countries with rigid labor markets.[71]

A widely discussed issue is the impact of material offshoring[72] on wage inequality between skilled and unskilled workers and relative skilled employment. On the one hand, in most industrialized countries with flexible labor markets both of these variables rose sharply

[70]For a review on the host country effects of offshoring, see Bottini et al. (2007, pp. 29-31 and 35-36). The related empirical literature on the labor market effects of trade is also not covered in this section. Two examples that examine the relationship between trade liberalization and aggregate employment are Dutt et al. (2009) and Felbermayr et al. (2011). The link between job turnover and trade is, for instance, studied by Davidson and Matusz (2010, Chapters 7 and 8).

[71]Our summary draws on the surveys of Bottini et al. (2007) and Crinò (2009) and additionally presents studies related to our research focus.

[72]The studies build on different proxies for material offshoring. Mostly used are the shares of imported intermediates in output, value added, and input purchases. These measures include offshore outsourcing and vertical FDI but not horizontal FDI.

during the 1980s and the first half of the 1990s. In sum, the empirical studies on these countries show that material offshoring substantially contributed to the rising skill-biased inequality. For instance, Hijzen et al. (2005) and Hijzen (2007) conduct studies on the UK, Head and Ries (2002) on Japan, and Feenstra and Hanson (1996b) on the US. A summary of empirical studies on the US, Japan, Mexico, and Hongkong is provided in the survey of Feenstra and Hanson (2001).[73] On the other hand, in European countries with lower wage flexibility the increase in wage inequality was less dramatic, but relative skilled employment and unemployment of the unskilled rose considerably. In countries like Germany, Austria, and Italy material offshoring to the CEECs has increased rapidly since 1990 (cf. Crinò, 2009). The question whether offshoring to the CEECs contributed to the rise in the relative skilled labor demand in these highly unionized countries is examined in several industry-level studies. For Austria, Egger and Egger (2003, 2005) find that offshoring to the CEECs significantly increased relative skilled labor demand and that the consideration of inter-industry spillovers magnifies this labor market effect. For Italy, the results of Helg and Tajoli (2005) indicate that material offshoring towards the CEECs had a considerable impact on the rise in relative skilled labor demand. However, for Germany, they do not find a significant effect with their broad measure of offshoring. In contrast, Geishecker (2006) shows that material offshoring to the CEECs significantly contributed to the rising relative skilled labor demand in Germany.[74] To sum up, these studies on the skill-biased inequality suggest that material offshoring tends to harm the domestic low-skilled workers relative to the high-skilled. Depending on the labor market characteristics of the home country, offshoring primarily lowers their relative wage or their relative labor demand. One difficulty encountered by these empirical studies is to isolate the effect of offshoring, since a similar effect arises from skill-biased technological change, which is another important determinant of rising inequality.

Moreover, material offshoring "seems to make employment more volatile, by raising the elasticity of labor demand and the risk of job losses" (Crinò, 2009, p. 197). Senses (2010) analyzes the effect of material offshoring on the elasticity of labor demand (see also Section 7.3). Testing her theoretical prediction with plant-level data for the US manufacturing sector, she finds that an increase in offshoring is associated with an increase in labor demand

[73] See Bottini et al. (2007, pp. 31-35) and Crinò (2009, pp. 202-10) for more information on these studies.

[74] Additionally, Geishecker and Görg (2008) study the real wage effect of offshoring for Germany and find that material offshoring exerted a negative effect only on low-skilled workers. In contrast to Geishecker (2006), Becker et al. (2009) analyze the effect of world-wide production relocation within MNEs on relative skilled labor demand and detect a much smaller impact.

elasticities for production workers. The effect of material offshoring on short-run employment dynamics is addressed, for instance, in a study by Egger et al. (2007) on Austria. They show that material offshoring lowers the probability to remain employed in the manufacturing sector and the probability to change into this sector. For Denmark, Munch (2005) finds that material offshoring raises the individual probability of job displacement only modestly. For Germany, however, a significant effect is detected by Geishecker (2008).[75] The varying results may stem from, among other things, country-specific labor market institutions. To clarify the magnitude of the effect on individual employment volatility, further research is needed.

Union wage setting is not explicitly considered in the majority of empirical studies. One of the few exceptions is the study by Braun and Scheffel (2007), analyzing the effect of material offshoring on the union wage premium in German manufacturing industries. The authors show that more offshoring reduces the union wage premium of low-skilled workers, while they do not find evidence of a negative wage effect for low-skilled workers not covered by collective bargaining agreements. For low-skilled workers, the study supports the hypothesis that offshoring lowers the bargaining power of labor unions and the negotiated wage (see, e.g., Gaston, 2002).[76] In a study on five Western European countries, Dumont et al. (2006) also provide empirical evidence that offshoring lowers union bargaining power.[77] The analysis of these effects is essential in order to better understand the wage and employment effects of offshoring.

Since we are most interested in the effect on the aggregate employment level, we continue by presenting studies that shed some light on this issue. First of all, we want to clarify that the contribution of offshoring on unemployment is very difficult to identify empirically. As most of the studies work with firm-level data, their statements concerning the aggregate employment level are only vague indications. The reason is that there may be adverse effects of production relocation beyond the boundary of the offshoring firms. Thus, firm-level

[75]In a related paper, Bachmann and Braun (2008) study the effect of offshoring on overall job stability in the manufacturing and the service sector. They show that the effects differ significantly across age and skill groups. In addition, Becker and Muendler (2008) find that the probability of job displacement is lower in German MNEs that offshore production than in local German firms. Buch and Lipponer (2010) also do not find evidence for higher employment volatility in German MNEs.

[76]In footnote 74 we mentioned the finding of Geishecker and Görg (2008), namely material offshoring lowers the real wages of low-skilled workers in Germany. The Braun and Scheffel (2007) result suggests that this effect works via the change in the union wage premium.

[77]In Section 8.5, we cover this study in more detail.

studies may markedly underestimate the impact on economy-wide employment. With aggregate data, however, the effect of offshoring is very difficult to isolate. In addition, data scarcity and methodological problems complicate the empirical analysis of this issue (cf. Neureiter and Nunnenkamp, 2010). Although the firm-level studies do not consider all direct and indirect effects on economy-wide employment, they illuminate some effects on domestic employment.

Concerning service offshoring, the literature suggests that it has at most a small negative impact on the aggregate level of employment.[78] The effect of service offshoring is predominantly studied for the US and the UK. For instance, Amiti and Wei (2005a,b) find no support for a substantial negative effect of service offshoring on aggregate industry employment in the US and the UK, but service offshoring tends to change the sectoral composition of jobs.[79]

After a brief look at service offshoring, we now present the main contributions concerning the employment effects of production relocation within MNEs. The following studies use MNE data including both vertical and horizontal FDI.[80] They analyze how world-wide activity of MNEs affects employment at the parent firm[81] and contrast the effects for affiliates in low- and high-wage countries. Horizontal, market-seeking FDI is generally associated with affiliates in other high-wage countries, while vertical, cost-saving FDI is mainly linked with low-wage countries. Crinò (2009, p. 234) summarizes the results of different country studies as follows: "MNEs tend to substitute domestic and foreign labor in response to changes in relative wages across countries. Substitutability is weak, however, and mainly driven by horizontal, market-seeking FDI". Exemplary studies that support this statement are Braconier and Ekholm (2000) on Sweden, Harrison and McMillan (2006) on the US, and Konings and Murphy (2006) on 12 European countries.[82] After this rather general summary, we narrow the focus and present studies on Western European countries that examine the labor market effects of production relocation to low-wage countries, in particular to the CEECs. Konings

[78]See Bottini et al. (2007, p. 26) and Crinò (2009, p. 220) for more information.

[79]Furthermore, Crinò (2008, 2010) obtains the following result by analyzing the US and nine Western European countries: service offshoring tends to shift relative employment in favor of high-skilled white-collar workers.

[80]The proxies of the above mentioned studies on material offshoring include the relocation of input production via offshore outsouring and FDI. Only the latter of the two is included in the MNE data, which additionally comprises horizontal FDI.

[81]Concerning the employment effect at the parent firm, a basic argument is that an MNE shifts production abroad via FDI and, thus, employs less domestic labor. But as the relationship is more complex, the employment effects predicted by theory are ambiguous. One important aspect is whether domestic and foreign labor are substitutes or complements in the MNE's production function (cf. Crinò, 2009).

[82]Blomström et al. (1997) conduct an early study on Sweden and the US, which analyzes the effect of multinational activity on domestic employment.

and Murphy (2006) find no evidence of substitution between Western European MNEs and their affiliates in the CEECs. This result is supported by Barba Navaretti et al. (2010), who state that offshoring production to low-wage countries by Italian and French multinationals does not exert a negative effect on their domestic employment. In contrast, Cuyvers et al. (2005) conclude that affiliate production in the CEECs negatively affects employment in the EU manufacturing sectors. In most cases, the authors find this negative effect both at the investing firm and sectoral level. Since the employment repercussions in neighboring countries of the CEECs may differ from average results on the EU, we take a closer look at Germany and Austria. Becker et al. (2005) find evidence that lower wages in the CEECs tend to reduce domestic employment in German MNEs, but the substitutability relationship is stronger for affiliates in other Western European countries. These findings are confirmed by a recent study from Muendler and Becker (2010) analyzing the employment effects at the extensive and intensive margin.[83] Using survey data on Austrian and German firms, Marin (2004) detects that FDI in the CEECs is associated with surprisingly low job losses in the parent firms of the two countries. She argues that low-wage jobs of affiliates in the CEECs help the Austrian and German MNEs to stay competitive. Temouri and Driffield (2009) use a data set on German MNEs, in which a large portion of FDI in low-wage countries is FDI in the CEECs. Their results suggest that FDI in low-wage countries does not lead to lower employment or lower average wages in the parent firms of both the service and the manufacturing sector. To sum up, the reported results regarding the employment effects of FDI in the CEECs are inconclusive. The bulk of firm-level studies suggest a rather limited effect on domestic employment. One may expect that there is a substitutability relationship for the neighboring countries of the CEECs, but only some studies support this expectation. As already mentioned above, one shortcoming of these firm-level studies is that they may markedly underestimate the impact on economy-wide employment. Moreover, these studies consider both horizontal and vertical FDI in the CEECs, which may have opposing effects on the employment level. To get a clearer and more complete picture of the employment repercussions, further research is needed.

On the one hand, jobs created abroad may destroy jobs at home. On the other hand, the offshoring of jobs may exert a positive effect on productivity in the home country, and this

[83] For production relocation to the CEECs, their study suggests that the employment adjustment happens mainly at the extensive margin, i.e., when MNEs enter the foreign market.

productivity effect may in turn lead to job creation (cf. Bottini et al., 2007). In the following, we briefly list studies that emphasize the relationship between offshoring and productivity. For the case of service offshoring, Amiti and Wei (2005b) report a significant positive impact on productivity in the US. Sethupathy (2009) tests his theoretical model (see Section 7.5.1) with firm-level data on US multinationals and offshoring to Mexico. He finds that wages at the offshoring firms are higher than at non-offshoring firms and rationalizes the higher wages by a productivity and rent-sharing effect.[84] For Germany, Jäckle and Wamser (2010) identify a positive productivity effect for firms that turn multinational. Marin (2004) also emphasizes the productivity gain for Austrian and German MNEs associated with FDI in the CEECs. Analyzing the productivity effect for Irish manufacturing firms, Görg et al. (2008) detect a positive effect for exporters and MNEs. In general, this productivity effect may also lead to domestic firm selection processes. Due to this fact, the net impact of offshoring on economy-wide employment is difficult to identify, and country-specific labor market characteristics have to be taken into account.

In this brief and necessarily selective overview, we stated some broad conclusions one may draw from the empirical literature. When interpreting the results, the above mentioned difficulties associated with empirical research in this field should be kept in mind. The findings suggest that material offshoring harms low-skilled workers and makes employment more volatile. Concerning the effect of offshoring on the level of employment, the results are inconclusive. Most existing studies suggest that offshoring has only a limited effect on domestic employment, but the topic remains controversial. Nevertheless, the studies illuminate direct and indirect effects on employment. The heterogeneous results may stem from measurement problems concerning offshoring, different data sources, varying methodologies, limited data availability, or country-specific labor market characteristics. The findings also depend on the modes of offshoring covered in the studies. For instance, Neureiter and Nunnenkamp (2010) consider both modes of offshoring, i.e., offshore outsourcing and FDI, and finds that cost-saving motives are associated with more job losses than market-seeking motives.[85] Opposing results are obtained by the majority of the above mentioned FDI studies. Moreover, firm-level studies provide an incomplete picture of the effects on economy-wide employment and may underestimate the overall effect. There is a

[84] Concerning employment, he finds no evidence of higher employment losses in offshoring firms relative to non-offshoring firms.

[85] They use a recent Eurostat firm-level survey for a sample of ten European countries.

need for further empirical research, which clarifies these issues and examines the channels highlighted in recent theoretical models. Given our research focus, we want to emphasize one question that should be addressed: how do country-specific labor market institutions influence the magnitude of the employment effect? Other avenues for further empirical research are pointed out by Crinò (2009, p. 235) and Pflüger et al. (2010, pp. 19-23).[86]

7.7 Conclusion

This comprehensive literature survey covered existing theoretical work on trade and offshoring as well as on the labor market effects of these economic activities. Since the main aspects have already been summarized in each section of the survey, we will simply point out several important issues in this conclusion. Concerning the phenomenon of offshoring, the analyzed scenarios and the modeling approaches differ considerably between the various contributions. A close look at the differences and similarities of the models enhances our understanding of the heterogeneous results. To illustrate the wide array of models, we mention a few key differences: skill-specific versus economy-wide (or industry-specific) offshoring, two-way offshoring between identical countries versus production relocation from North to South, and cost-saving versus market-seeking offshoring. Moreover, some studies focus on the determinants of offshoring in general or of different organizational forms, while others analyze the effects of offshoring on domestic wages, the skill-bias, trade flows, employment, welfare, and many other aspects. There is a sizeable amount of literature on offshoring, but there is not much theoretical work on the effect of offshoring on aggregate employment. Existing studies either use North-North models or North-South models with the industrialized North being a small open economy. In the latter case, the models abstract from repercussions on the domestic labor market and host country effects. The studies provide some insights on the employment effects of offshoring, but the results vary considerably depending on the modeling details. It is still not fully understood how various factors including different labor market characteristics determine the nature and the magnitude of the employment effect. Besides the theoretical literature, we briefly reviewed the main results of empirical work on the labor market effects. The majority of empirical studies suggest that the effects of offshoring on domestic employment are rather limited.

[86]Among other things, they mention empirical research concerning task trade, the productivity effect of offshoring, within-group wage and employment inequalities, spatial aspects, and the extensive margin.

There is, however, considerable controversy, and the existing studies have many limitations. As some avenues for future theoretical and empirical research have already been indicated in the respective sections of the survey, we only highlight selected topics where further theoretical research is needed. First, the labor market implications of the complex sourcing strategies covered in Section 7.2.2 have not yet been addressed. Second, the effects of cost-saving offshoring on the host country are merely analyzed. Third, there is a need for further research on the aggregate employment effects of offshoring in the presence of labor market frictions. Future models should consider the general equilibrium effects that arise in a trade framework with two large open economies and offshoring. The detailed review of the different models in Sections 7.1 to 7.5 illustrates possible starting points for future work. It is important to improve our understanding of the aggregate employment effects of offshoring, as policy makers and the public are very concerned about this issue.

The analysis presented in the next chapter is motivated by the case of highly unionized Western European countries that offshore production to low-wage countries. Therefore, we use a standard North-South trade model enriched with offshoring and union wage setting in the North which allows to analyze the effects of offshoring on the production cost in both countries and unemployment in the North. To the best of our knowledge, we are the first to address the employment effects of offshoring in such a setup. The numerous contributions related to our model have been covered in detail in this survey. Additionally, Section 8.1 provides a short overview of the most important related models in order to emphasize the main issues.

Chapter 8

A North-South trade model with offshoring and unemployment

This chapter is based on joint work with Lutz Arnold. It presents an extended version of Arnold and Trepl (2011).

8.1 Introduction

Emerging economies export goods to high-wage countries because of lower production cost due to lower wages. Offshoring production to emerging markets costs jobs in high-wage countries if wages do not edge down. So offshoring does not benefit all agents in the high-wage country. While most non-economists regard these statements as self-evident, many, if not most, economists disagree. There are two possible explanations for this "apparent disconnect between the public and academic views of the impact of trade on labor market outcomes" (Davidson and Matusz, 2010, p. 2; see also Amiti and Wei, 2005a, and Mankiw and Swagel, 2006). One possible explanation is that the public is badly informed about what is actually going on in the global economy and/or gets the driving forces wrong. In fact, when the debate about offshoring, wages, and jobs resurfaced in the mid-1990s, economists (e.g., Freeman, 1995, and Krugman, 1995) pointed out that the public tends to overestimate the extent and, therefore, the significance of trade with low-wage countries and offshoring and that unemployment is largely determined by labor market institutions, rather than international trade. The alternative explanation for the divergence between the public and academic views of the employment effects of offshoring is that the optimistic academic view is based on inadequate models of low-wage competition, offshoring, and unemployment. Some prominent economists, notably Blinder (2006) and Krugman (2008) (with a "guilty conscience", as he said famously when he presented his paper at the Brookings institution), conceded that we should not discard this second possibility prematurely.

We present a model in which an emerging economy exports goods to a high-wage country because of lower production cost due to lower wages, and offshoring production to the emerging market costs jobs in the high-wage country, since wages do not edge down. As a result, offshoring does not benefit all agents in the high-wage country and may even make them all worse-off. The model is Krugman's (1979a) North-South trade model augmented to include offshoring and union wage setting (the standard explanation for persistent unemployment in European high-wage countries, cf. Nickell et al., 2005).[1] Our main finding is that a decrease in the cost of offshoring usually has a negative effect on employment, thus supporting skeptical opinions on the labor market effects of globalization. The employment effects of further offshoring can be positive when there is little offshoring initially. This finding is consistent with concerns about the employment effects of offshoring that have been growing as the globalization process intensifies.

The model yields further interesting results. First, a welfare analysis shows that if additional offshoring raises employment, then it constitutes a Pareto improvement: workers in the North and in the South as well as firm owners gain. Otherwise, offshoring benefits workers in the South, but hurts their Northern counterparts. The impact on firm owners' real income depends on the effect on the scale of their firms. If this effect is negative, all agents in the North lose. An extension of the model with two factors of production gives rise to a similarly pessimistic assessment of the employment and welfare effects of offshoring. Second, the model provides an equilibrium explanation for shrinking union power: Northern workers have an incentive to appoint a "pragmatic union leader", with low bargaining power or with preferences biased toward higher employment. This is because they face a commitment problem: given that offshoring production is a longer-term decision than wage setting, workers have to look for a way to make the announcement that they will not fight for high wages once firms have decided to keep production at home credible. We construct a general equilibrium at which the commitment problem vanishes when a sufficiently large portion of industry unions appoint a pragmatic union leader. Third, we show that the extension of the model with heterogeneous firms (following Melitz, 2003) yields the possibility of multiple equilibria: if Northern unions

[1] See also Chapter 5, where further information on this issue is provided.

anticipate a low real wage in the South, they set a high real wage, and offshoring activity is intensive; conversely, if they anticipate a high real wage in the South, they set a lower real wage, and there is little offshoring. So coordinated shifts in the unions' wage policy have an impact on offshoring and employment. The model with firm heterogeneity justifies a more optimistic assessment of the labor market effects of offshoring than the model with homogeneous firms: the marginal impact of the wage rate set in the North on firms' decision to offshore production moderates unions' wage claims, thereby fostering employment.[2]

The distinguishing feature of our model is that offshoring and unemployment are investigated in a setup in which the labor cost in both the high-wage country and the low-wage country is endogenously determined. In particular, offshoring (motivated by factor price differentials) feeds back on factor prices in both countries and on unemployment in the North. The model thus encompasses (in a static environment) the experience of export-oriented emerging economies, which struggle with a dwindling cost advantage in the course of their development process. China is a noteworthy current example:

> "'China has become a victim of its own success,' sighs Peter Tan, president and managing director of Flextronics in Asia. He finds it especially hard to hire and retain technical staff, ranging from finance directors to managers versed in international production techniques such as 'six sigma' and 'lean manufacturing'. There are not enough qualified workers to go around, causing rampant poaching and extremely fast wage inflation. 'China is definitely not the cheapest place to produce any more,' he says" (The Economist, 2007).

This is reminiscent of Japan in the 1990s and the maturing of other emerging economies. The cost advantage of several CEECs, which are currently a favorite target for offshoring of Western European firms, will also dwindle in the future.

Our model is related to several voluminous strands of the international economics literature, which have been covered in detail in Chapter 7. In the following, we summarize the most important related papers, thereby highlighting the aspects of interest for our analysis. One class of papers analyzes the impact of *offshoring* on wage setting, trade flows, and the organization of firms without simultaneously considering aggregate unemployment. Zhao (1998) shows how firms can make use of FDI in order to improve their position in wage bargaining

[2] An increase in the mass of goods producible in the South without a fixed cost has similar effects on employment and welfare as a decrease in the cost of offshoring (see footnotes 16 and 18). A setup without costly offshoring would not be suited to analyze the case for a pragmatic union leader or multiplicity of equilibria in the presence of productivity uncertainty, however.

in a two-country North-North model. By contrast, offshoring makes the demand curve for domestic labor less elastic, thereby raising the unions' wage claims and decreasing industry employment in Skaksen and Sørensen (2001). Helpman et al. (2004) show that the most productive firms, and only these firms, use FDI rather than exports to serve foreign markets in a general equilibrium North-North trade model based on Melitz (2003). Going one step further, Antràs and Helpman (2004) consider a North-South model with incomplete contracts, in which firms decide whether to produce in-house or outsource and, in either case, in which country. They show how, depending on firm characteristics, firms sort into the four different possible organizational forms. Grossman and Rossi-Hansberg (2008) show how trade in tasks raises aggregate productivity when different tasks in the value chain can be offshored at different cost. A second class of international trade models incorporates *unemployment* but not offshoring. Recent contributions include Helpman and Itskhoki (2010) and Felbermayr et al. (2011). The former authors show that differences in search frictions in the labor market act as a source of comparative advantage when countries are identical in other respects. The latter authors introduce search frictions in the labor market to the Melitz (2003) model. Trade liberalization can raise productivity to such an extent that both employment and real wages go up. Finally, there are models which encompass both *offshoring and unemployment*. Like our model, these papers focus on the effect of (changes in the cost of) offshoring on equilibrium employment. Skaksen (2004) considers a unionized small open economy, in which wage setting precedes the offshoring decision. A decrease in the cost of offshoring possibly reduces unemployment, as the non-realized threat of offshoring moderates unions' wage claims. Egger and Kreickemeier (2008) show that an increase in international fragmentation raises unemployment among low-skilled workers caused by efficiency wages in a small open economy if unskilled labor is sufficiently abundant relative to skilled labor. Koskela and Stenbacka (2009) consider a small open economy similar to Skaksen's (2004), in which the offshoring decision precedes wage bargaining, however. Additional offshoring raises the elasticity of labor demand, thereby reducing the domestic wage and unemployment if the unions' bargaining power is sufficiently high. Eckel and Egger (2009) analyze a North-North trade model with heterogeneous firms, two-way FDI, and wage bargaining. Unemployment tends to be lower with FDI than in autarky, as FDI strengthens firms' bargaining position. Kohler and Wrona (2010) argue that in a small open economy with search unemployment and trade in tasks the Grossman and Rossi-Hansberg (2008) productivity effect can be strong enough so that on net offshoring decreases unemployment in spite of job destruction in the offshored tasks. In Ranjan's (2010) search model, a reduction in the cost of offshoring possibly reduces equilibrium unemployment by moderating workers' claims in the wage bargain with firms. In a related model with a positive productivity effect of offshoring, Mitra and Ranjan (2010) show that offshoring may lead to a higher wage and lower economy-wide unemployment. As already mentioned in Chapter 7, the papers on offshoring and unemployment consider either North-North models with factor price equalization or small open economies. In the former case, offshoring is driven by factors other than exploiting lower production cost. In the latter case, somewhat paradoxically, the industrialized North is the small economy relative to the emerging South, whose production cost is exogenously given. The main contribution of our model is to address the issues raised by Skaksen (2004), Koskela and Stenbacka (2009), and others in Krugman's (1979a) North-South setup, in which factor prices everywhere and, therefore, the cost differential that drives offshoring are determined endogenously.[3]

The remainder of Chapter 8 is organized as follows. Section 8.2 introduces the model with one factor of production and without firm heterogeneity. In Section 8.3, we prove existence of a free trade equilibrium. Section 8.4 characterizes the employment and welfare effects of changes in the cost of offshoring, while Section 8.5 makes the case for a pragmatic union leader. In Section 8.6, a second factor of production is introduced. Sections 8.7 and 8.8 deal with firm heterogeneity. In Section 8.9, we sum up our main findings and suggest an avenue for future research.

8.2 Model setup

This section describes the model. It is understood that each endogenous variable is an element of $\mathbb{R}_+$. We will make some additional assumptions about the magnitudes of the model parameters below.

The world economy is made up of two countries, North and South. There are a continuum of measure $\bar{L}^N$ (> 0) of workers in the North and a continuum of measure $\bar{L}^S$ (> 0) of workers

[3] In addition to the models cited above, there are North-South endogenous growth models based on Grossman and Helpman (1991a,b) and Helpman (1993), which study offshoring or unemployment. Lai (1998) shows that stronger IPR protection raises growth if relocation of production is due to FDI, whereas the contrary holds true for imitation. Glass and Saggi (2001) demonstrate that a decrease in the labor requirement for offshoring boosts both offshoring activity and growth. Other North-South endogenous growth models focus on the impact of labor market imperfections on innovation and growth. Arnold (2002) shows that the more rigid the labor market, the more negative the impact of imitation on unemployment in the North. Imitation also has a negative effect on growth in Mondal and Gupta's (2008b) model with efficiency wages and unemployment in the South and in Grieben and Şener's (2009) model with collective bargaining in the North.

in the South. Each worker is endowed with one unit of labor. In addition, there are firm owners, who do not supply labor, in the North. In the baseline model, labor is the only factor of production. Later on, we introduce a second factor, skilled labor, in the North.

There is a continuum of measure one of industries i, indexed along the unit interval. Each industry produces varieties j of a differentiated good indexed along the interval $[0, n]$. The mass of varieties per industry n (> 0) is given, i.e., there is no product innovation. Each agent's preferences are described by the Dixit and Stiglitz (1977) utility function

$$\left[\int_0^1 \int_0^n x(i,j)^\alpha dj\ di\right]^{\frac{\beta}{\alpha}}, \tag{8.1}$$

where $x(i, j)$ is consumption of variety j of the good produced in industry i $(0 < \alpha < 1$ and $\beta > 0)$. Any two varieties are equally good substitutes for each other, irrespective of whether they are produced in the same industry or in different industries.[4] Agents are either risk-averse $(\beta < 1)$ or risk-neutral $(\beta = 1)$. The virtue of having "a large number" of industries, rather than a single industry, is that this allows us to consider industry unions which are "large in the small but small in the large" (Neary, 2003): their wage setting does not affect aggregate income and the aggregate price level. Since the industries are all alike, we suppress the industry index i in what follows.[5]

For each variety j of each good i, there is a single producer in the North. This producer is able to produce "his" variety using a^N (> 0) units of labor per unit of output. For a subset of measure n^S of the n varieties producible in the North, there are also competitive producers in the South with the ability to produce the varieties with input coefficient a^S $(0 \leq n^S < n$ and $a^S > 0)$. In order to express that the South is less productive than the North, one can assume $a^S > a^N$, but this is inessential to the analysis. In addition, the production of the remaining $n - n^S$ varieties can be moved to the South within MNEs.[6] To do so, the Northern producer of a variety has to incur a fixed cost.[7] We assume that the fixed cost consists of f^M (> 0) units of labor in the South. One may think (informally) of the cost of setting up a plant, establishing a network of suppliers, training workers, etc. The assumption that (for now)

[4] We can focus on one representative industry, since all industries are identical. Variables referring to quantities in this industry equal economy-wide aggregates.

[5] Up to Section 8.4 the model can alternatively be interpreted as one with a single industry and wage bargaining at the firm level. The equations which describe an equilibrium are the same.

[6] That is, offshorers move *all* their production to the South. This way of modeling offshoring is a special case of Glass and Saggi (2001), where firms can offshore an exogenous fraction of the labor services required to produce varieties of a differentiated good. The analysis can be generalized in the obvious way at the cost of additional complexity of the algebra.

[7] Northern and Southern labor are perfect substitutes, once the fixed cost of offshoring has been paid.

the organization of offshoring production does not involve labor input in the North appears acceptable on the grounds that, in practice, the number of production workers affected by the offshoring decision is much larger and, therefore, decisive for the general equilibrium effects of offshoring. This is confirmed by the model with skilled labor in Section 8.6, in which offshoring also requires a fixed amount of skilled labor in the North.[8] We make two alternative assumptions about the input coefficients in Southern plants of MNEs. We start with the simple case of no uncertainty: the input coefficient a^S is the same for each firm that spends the fixed offshoring cost. Later on, following the new new trade theory with heterogeneous firms originating from Melitz (2003), we assume that the productivities are random. This is meant to capture the fact that even established companies face substantial uncertainty when they move production to emerging economies. Up to Section 8.4 we confine attention to symmetric equilibria, with the same level of offshoring activity and the same wage rate in each industry. Let n^M denote the measure of varieties offshored to the South for any i. Let w^N and w^S denote the wage rates in the North and in the South, respectively. Suppose the South has a cost advantage, in that $w^N a^N > w^S a^S$. Then in each industry $n - n^S - n^M$ varieties are supplied by a monopolist producing in the North, n^S varieties are produced under perfect competition in the South, and n^M varieties are supplied monopolistically by an MNE producing in the South.[9] We argue below (at the end of Section 8.3) that the model can also be interpreted as one of offshore outsourcing.

In each industry i, there is a single union, which represents $\bar{L}^N$ workers. The industry union bargains over the wage rate with the firms in this sector producing in the North. Firms have the RTM; they choose employment after the wage rate is set. In the version of the model without uncertainty about the input coefficient in Southern plants considered up to Section 8.6, wage bargaining takes place *after* the offshoring decision (see Figure 8.1). This ordering of events is meant to capture the fact that offshoring production is a longer-term decision than wage setting.[10] If employment L^N falls short of $\bar{L}^N$ in sector i, each worker faces the same

[8] The assumption is also implicit in the small open economy models of Skaksen (2004) and Koskela and Stenbacka (2009), in which the cost function for offshoring is independent of the price of domestic labor. Introducing Northern labor as an input in the offshoring process in the one-factor model would raise subtle questions with regard to the wage setting process (cf. footnote 20).

[9] There is no trade cost, no trade in intermediate inputs, and no distinction between services and manufacturers. The motive for offshoring is saving production cost rather than serving foreign markets.

[10] Concerning collective wage bargaining, there are different modeling options. First, both the RTM approach and the efficient bargaining approach are used in the context of offshoring (see footnotes 48 and 57 in Chapter 7; for the controversy, see Skaksen, 2004, and Ranjan, 2010). We decide to use the RTM approach, since it seems to be a more appropriate description of reality. Second, wages may be bargained at the firm level or at the industry level. In order to be able to analyze the commitment problem and the case of heterogeneous firms, we choose industry-level bargaining (see footnote 5 for a firm-level interpretation). Third, there are

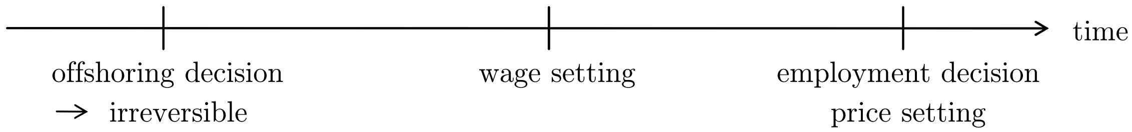

Figure 8.1: Timing of events with homogeneous firms.

probability $L^N/\bar{L}^N$ of employment.[11] Unemployed workers have zero income and reservation utility b (> 0). So expected utility is the sum of $L^N/\bar{L}^N$ times the maximized value of (8.1) and $(1 - L^N/\bar{L}^N)b$.[12] Firms which have decided to offshore production are not party to the wage bargain, so the threat point of the firms involved in the bargain is zero. Wages and employment maximize the Nash product subject to the constraint that employment is determined by the labor demand of the local firms. The firms' weight in the Nash bargain is denoted γ ($0 \leq \gamma < 1$). $\gamma = 0$ is the monopoly union special case. The distribution of productivities and the timing of events in the version of the model with uncertainty about the input coefficient in Southern plants are explained in detail in Section 8.7.

8.3 Equilibrium with homogeneous firms

In this section, we show that, under suitable parameter assumptions, the model without uncertainty about the input coefficient for production in the South possesses a unique symmetric equilibrium with a cost advantage for the South and unemployment.

Let $p(i, j)$ denote the price of variety j of good i. $p(i, j)$, $x(i, j)$ ($i \in [0, 1]$, $j \in [0, n]$), w^N, w^S, and n^M are a *symmetric equilibrium with a cost advantage for the South and unem-*

different options concerning the ordering of events which in general depends on the flexibility of offshoring. In our model, offshoring within MNEs is associated with a long-term investment, i.e., a fixed cost that has to be incurred before wage setting. The sequence of wage bargaining and the offshoring decision of firms which have incurred the fixed cost differs between the baseline model and the extension with productivity uncertainty. While offshoring is irreversible in the baseline model, paying the fixed cost gives firms the option to offshore in the extension with productivity uncertainty (see Sections 8.7 and 8.8).

[11] In labor economics, it is common to assume that workers who do not get a job in one unionized sector face a positive probability of getting a job in another unionized sector. Our assumption that "[E]ach worker is typically tied to one industry" (Parlour and Walden, 2011, p. 394) is also employed in the literature on hedging uncertain labor income. We believe that it is appropriate in our context, with the threat of job losses due to offshoring.

[12] In the presence of unemployment benefits tied to wages, the reservation utility depends on the wage level. Similarly, the value of being unemployed depends on economy-wide unemployment (i.e., the probability of finding a job) and on the wage earned once back in work in a dynamic matching setup (such as Felbermayr et al., 2011, Mitra and Ranjan, 2010, and Ranjan, 2010). If there is a competitive sector that absorbs the workers who do not get jobs in the unionized sector, the competitive wage in this sector determines the reservation utility (as in Zhao, 1998). These effects are absent in our model. For details, see Layard et al. (2005, Section 2.2).

ployment (or *equilibrium* for short) if the following conditions are satisfied: operating cost is higher in the North than in the South ($w^N a^N > w^S a^S$); Northern producers without Southern competitors (i.e., firms producing in the North and MNEs) maximize monopoly profit; Southern producers supply varieties at price equal to unit cost; the measure of MNEs is n^M in each industry; it does not pay to move the production of further varieties abroad, i.e., either $n^M > 0$ and the fixed cost of setting up an MNE is equal to the difference between an MNE's operating profit and a Northern producer's operating profit, or $n^M = 0$ and the fixed cost is no less than the operating profit differential; for each employed worker and firm owner, consumption of the varieties of the differentiated goods maximizes utility subject to the budget constraint; demand equals supply for each variety of each good; the wage rate and employment maximize the Nash product subject to the constraint that employment is determined via firms' labor demand; there is excess supply of labor in the North; the labor market in the South clears.[13]

Let $P = [\int_0^1 \int_0^n p(i,j)^{1-\varepsilon} dj\ di]^{1/(1-\varepsilon)}$ (where $\varepsilon = 1/(1-\alpha)$) and I denote the price index and world income, respectively. From (8.1), the world-wide demand for variety j of good i is

$$x(i,j) = \left[\frac{p(i,j)}{P}\right]^{-\varepsilon} \frac{I}{P}. \tag{8.2}$$

Firms producing in the North set $p(i,j) = w^N a^N/\alpha$, MNEs set $p(i,j) = w^S a^S/\alpha$, and the price of goods produced by Southern producers is $w^S a^S$. From (8.2),

$$x^N = \left(\frac{w^N a^N}{w^S a^S}\right)^{-\varepsilon} x^M, \quad x^S = \alpha^{-\varepsilon} x^M, \tag{8.3}$$

where x^N, x^M, and x^S are the outputs of monopolists producing in the North, MNEs, and Southern firms, respectively.

From the definition of the price index and the pricing rules,

$$\left(\frac{w^N a^N}{P}\right)^{\varepsilon-1} = \alpha^{\varepsilon-1}\left(n - n^S - n^M\right) + \left(n^S + \alpha^{\varepsilon-1} n^M\right)\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon-1}. \tag{8.4}$$

The operating profit differential is $(w^S a^S x^M - w^N a^N x^N)/(\varepsilon - 1)$. The fixed cost of setting up a subsidiary is $w^S f^M$. Using (8.3), the condition that it does not pay to move further

[13] Our model considers union wage setting in the North and a frictionless labor market in the South. As we have referred to the case of highly unionized Western European countries and offshoring to the CEECs in Chapter 5, this simplifying assumption can be motivated by the fact that collective bargaining coverage is notably lower in the CEECs (see footnotes 5 and 7 in Chapter 5).

varieties abroad becomes

$$(\varepsilon-1)f^M \geq \left[1-\left(\frac{w^N a^N}{w^S a^S}\right)^{1-\varepsilon}\right]\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon} a^S x^N, \quad n^M \geq 0, \tag{8.5}$$

with at most one strict inequality.

Consider the wage bargain between the industry union and the producers of varieties in an industry with $n-n^S-n^M>0$. From (8.2) and the markup pricing rule, the demand for labor per firm $L^d : \{\mathbb{R}_+\backslash\{0\}\}\times\mathbb{R}_+\to\mathbb{R}_+$ is given by $L^d(w^N/P,\, I/P)=a^N[(w^N a^N)/(\alpha P)]^{-\varepsilon} I/P$. This can be used to rewrite a firm's real profit (i.e., firm profit deflated by the price index P) as $(w^N/P)L^d(w^N/P,\, I/P)/(\varepsilon-1)$. The Nash product is

$$\left\{\frac{(n-n^S-n^M)L^d\left(\frac{w^N}{P},\frac{I}{P}\right)}{\bar{L}^N}\left[\left(\frac{w^N}{P}\right)^{\beta}-b\right]\right\}^{1-\gamma}\left[\frac{\frac{w^N}{P}L^d\left(\frac{w^N}{P},\frac{I}{P}\right)}{\varepsilon-1}\right]^{\gamma}.$$

An employed Northern worker's indirect utility is $(w^N/P)^{\beta}$ (from (8.2)). So the term in braces is a worker's expected utility gain compared to his reservation utility b (i.e., his threat point). Firms which bargain in the North have not incurred the fixed cost of offshoring, so their threat point is zero, and the final term in square brackets is a representative firm's real profit. The wage rate w^N and employment L^N maximize the Nash product subject to $(n-n^S-n^M)L^d(w^N/P,\, I/P)\leq \bar{L}^N$. We focus on an equilibrium in which the constraint is not binding, i.e., unemployment prevails. We will spell out the parameter condition necessary for this case to arise below. Then,

$$\frac{w^N}{P}=\left\{\left[1-\frac{\beta(1-\gamma)}{\varepsilon-\gamma}\right]^{-1}b\right\}^{\frac{1}{\beta}}=\frac{\omega^N}{a^N}. \tag{8.6}$$

We call the real wage rate in (8.6) the RTM wage. Given constant wage elasticity, shift parameters of the labor demand function do not affect the RTM wage (cf. Cahuc and Zylberberg, 2004, p. 395). In particular, this means that the wage rate does not go down when the amount of offshoring (i.e., n^M) rises. Firms which have sunk the offshoring cost have no incentive to adopt the RTM wage and produce in the North, since production is cheaper in the South. This lends support to the assumption that they are not party to the wage bargain in the first place. ω^N measures the Northern real wage w^N/P relative to its labor productivity $1/a^N$. Labor market clearing in the South requires $\bar{L}^S=a^S(n^S x^S+n^M x^M)+n^M f^M$

or, using (8.3),

$$\bar{L}^S = \left(\alpha^{-\varepsilon} n^S + n^M\right) \left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon} a^S x^N + n^M f^M. \tag{8.7}$$

The price setting equation (8.4), the arbitrage condition (8.5), the wage setting rule for the North (8.6), and the labor market clearing condition for the South (8.7) jointly determine the real wage rate in the North w^N/P, the measure of varieties produced in MNEs n^M, the relative production cost $(w^N a^N)/(w^S a^S)$, and the output of firms producing in the North x^N.[14] From (8.4) and (8.6),

$$\frac{w^N a^N}{w^S a^S} = \left[\frac{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S - n^M)}{n^S + \alpha^{\varepsilon-1} n^M}\right]^{\frac{1}{\varepsilon-1}} = f(n^M), \tag{8.8}$$

where $f : [0,\, n - n^S] \to \mathbb{R}_+$ if $n^S > 0$ and $f : (0, n - n^S] \to \mathbb{R}_+$ if $n^S = 0$. Letting $f(0) = \infty$ if $n^S = 0$, it is understood that $f(0) > a$ holds for all $a \in \mathbb{R}$ and $f(0) < a$ is violated for all $a \in \mathbb{R}$. We assume that

$$(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S) - n^S > 0, \tag{8.9}$$

so that $f(0) > 1$. Equation (8.8) combines price and wage setting. From (8.6), the Northern real wage is constant. From (8.4), for given $(w^N a^N)/(w^S a^S) > 1$, an increase in n^M raises the real wage in the North w^N/P, as the production of varieties moves to the relatively cheaper location. So the relative production cost $(w^N a^N)/(w^S a^S)$ has to fall in order to restore the original real wage rate. Hence, $f(n^M)$ is monotonically decreasing.

Suppose $f^M < (\alpha^{\varepsilon} \bar{L}^S)/[(\varepsilon - 1)n^S]$. Then, from (8.5) and (8.7),

$$\frac{w^N a^N}{w^S a^S} \leq \left[1 - (\varepsilon - 1)\frac{\alpha^{-\varepsilon} n^S + n^M}{\frac{\bar{L}^S}{f^M} - n^M}\right]^{\frac{1}{1-\varepsilon}} = g(n^M, f^M),\ n^M \geq 0, \tag{8.10}$$

with at most one strict inequality. g maps $\{(n^M,\, f^M) \in \mathbb{R}^2_+ |\ n^M < [\bar{L}^S/f^M - (\varepsilon-1)\alpha^{-\varepsilon} n^S]/\varepsilon\}$ (i.e., those $(n^M,\, f^M)$ for which the term in square brackets in (8.10) is positive) on $\mathbb{R}_+$. Equation (8.10) combines the condition that further offshoring is not profitable and labor market clearing in the South. Suppose $n^M > 0$. From (8.7), an increase in the measure of MNEs n^M requires a decrease in the scale of each MNE x^M $(= [(w^N a^N)/(w^S a^S)]^{\varepsilon} x^N)$. From (8.5), the relative production cost $(w^N a^N)/(w^S a^S)$ has to rise in order to compensate for the ensuing decrease in the operating profit differential. Therefore, $g(n^M, f^M)$ is monotonically

[14] The North does not possess an autarky equilibrium. For $n^S = n^M = 0$, (8.4) becomes $w^N a^N/P = \alpha n^{1/(\varepsilon-1)}$. There is in general no joint solution to this equation and (8.6); the unions' wage setting behavior and the firms' price setting behavior are incompatible with each other.

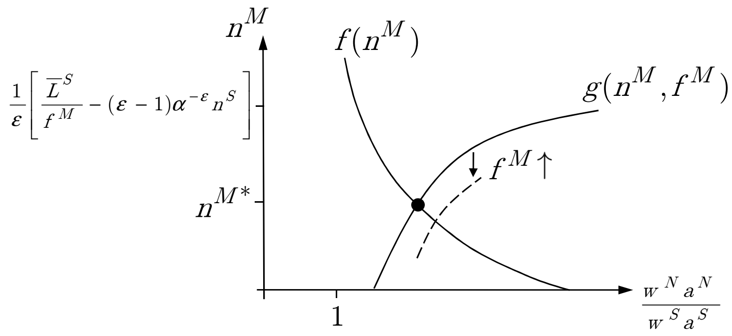

Figure 8.2: Equilibrium with homogeneous firms.

increasing in n^M. For $f^M \geq (\alpha^\varepsilon \bar{L}^S)/[(\varepsilon - 1)n^S]$, from (8.5) and (8.7), the fixed cost of entry exceeds the operating profit differential for all $n^M \geq 0$, so $n^M = 0$.

w^N/P is given by (8.6). Once n^M and $(w^N a^N)/(w^S a^S)$ are determined via (8.8) and (8.10), w^S/P is given by $(w^S/w^N)(w^N/P)$, goods prices $p(i,j)/P$ are given by the markup pricing rules for monopolistically supplied goods and average cost for goods sold competitively, and outputs $x(i,j)$ are pinned down by (8.3) and (8.7) ($i \in [0,1]$, $j \in [0,n]$) (of course, absolute prices are indeterminate). So in order to find an equilibrium, it suffices to find n^M and $(w^N a^N)/(w^S a^S)$ which satisfy (8.8) and (8.10). This is illustrated in Figure 8.2. $f(n^M)$ falls from $f(0) > 1$ to unity as n^M grows large. $g(n^M, f^M)$ rises from $g(0, f^M) = [1 - (\varepsilon - 1)\alpha^{-\varepsilon} n^S/(\bar{L}^S/f^M)]^{1/(1-\varepsilon)} > 1$ to infinity as n^M rises towards $[\bar{L}^S/f^M - (\varepsilon - 1)\alpha^{-\varepsilon} n^S]/\varepsilon$. If $f(0) \geq g(0, f^M)$, there is a unique $n^{M*} \geq 0$ such that $f(n^{M*}) = g(n^{M*}, f^M)$. From (8.8) and (8.10), $f(0) \geq g(0, f^M)$ if, and only if,

$$f^M \leq \frac{\alpha^\varepsilon \bar{L}^S}{(\varepsilon - 1)n^S}\left[1 - \frac{n^S}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S)}\right] = \bar{f}^M \tag{8.11}$$

($\bar{f}^M > 0$ due to (8.9) and $\bar{f}^M = \infty$ for $n^S = 0$), and n^{M*} is then determined by

$$\frac{f^M}{\bar{L}^S - n^{M*} f^M} = \frac{1}{\varepsilon - 1}\frac{1}{\alpha^{-\varepsilon} n^S + n^{M*}}\frac{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S) - n^S}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S - n^{M*})}. \tag{8.12}$$

For $n^S > 0$ and $f^M > \bar{f}^M$, the equilibrium is characterized by $n^M = 0$ $(= n^{M*})$ and $(w^N a^N)/(w^S a^S) = f(0) < g(0)$. For $n^S = 0$, n^{M*} converges to zero as f^M grows large.

We have to make sure that there is unemployment and that n^{M*} does not exceed either $\bar{L}^S/f^M$ or $n - n^S$. Using $L^N = (n - n^S - n^M)a^N x^N$, (8.3), (8.7), and (8.8), employment in the North can be rewritten as

$$\begin{aligned} L^N &= (n-n^S-n^M)a^N \frac{\bar{L}^S - n^M f^M}{a^S(\alpha^{-\varepsilon} n^S + n^M)} \left[\frac{n^S + \alpha^{\varepsilon-1} n^M}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n-n^S-n^M)}\right]^{\frac{1}{\alpha}} \\ &= \Psi(n^M, f^M). \end{aligned} \tag{8.13}$$

Ψ maps $\{(n^M, f^M) \in \mathbb{R}_+^2 |\ n_M \leq \min\{n - n^S,\ \bar{L}^S/f^M\},\ n^M > 0 \text{ if } n^S = 0\}$ on $\mathbb{R}_+$. Unemployment prevails if $\bar{L}^N$ is sufficiently large so that $\Psi(n^{M*}, f^M) < \bar{L}^N$. From the definition of g,

$$n^{M*} < \frac{1}{\varepsilon}\left[\frac{\bar{L}^S}{f^M} - (\varepsilon-1)\alpha^{-\varepsilon} n^S\right] < \frac{\bar{L}^S}{f^M}.$$

(cf. Figure 8.2), so the condition $n^{M*} < \bar{L}^S/f^M$ is automatically satisfied. To check the condition $n^{M*} \leq n - n^S$, set $n^{M*} = n - n^S$ in (8.12). The right-hand side is positive, finite, and independent of f^M, and the left-hand side increases continuously from zero to infinity as f^M rises from zero to $\bar{L}^S/(n-n^S)$. Hence, there is $\underline{f}^M$ such that $n^{M*} = n - n^S$ for $f^M = \underline{f}^M$. Differentiating (8.12) totally gives

$$\begin{aligned} \frac{dn^{M*}}{df^M} &= -\frac{\bar{L}^S}{f^M\left(\bar{L}^S - n^{M*} f^M\right)}\left[\frac{f^M}{\bar{L}^S - n^{M*} f^M}\right. \\ &\quad \left. + \frac{1}{\alpha^{-\varepsilon} n^S + n^{M*}} + \frac{\alpha^{\varepsilon-1}}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n-n^S-n^{M*})}\right]^{-1} < 0 \end{aligned} \tag{8.14}$$

(cf. Figure 8.2). So $n^{M*} < n - n^S$ for $f^M > \underline{f}^M$. This proves:

Proposition 8.1: *Suppose (8.9) holds, $f^M \geq \underline{f}^M$, and $\Psi(n^{M*}, f^M) < \bar{L}^N$. Then a unique symmetric equilibrium with a cost advantage for the South and unemployment exists.*

The model has an alternative interpretation as one of offshore outsourcing. Consider an equilibrium with $n^{M*} > 0$, in which the operating profit differential $(w^S a^S x^M - w^N a^N x^N)/(\varepsilon - 1)$ is equal to the fixed cost of setting up a subsidiary $w^S f^M$. Suppose offshore outsourcing requires the same fixed amount of Southern labor f^M as offshoring within an MNE. Suppose further the monopolist for a given variety and a Southern producer can write a contract that ensures the delivery of x^M units of the variety at price $w^S a^S$ and prohibits the sale of output to any other party (alternatively, one can think of an intermediate input that is transformed one-to-one into final output by the Northern monopolist). Prices and quantities are the same as with offshoring within an MNE.[15]

[15]This reinterpretation of the model abstracts from the differences between different organizational forms of

8.4 Employment and welfare effects of offshoring

This section investigates the employment and welfare effects of changes in the labor requirement for offshoring f^M. A decrease in f^M tends to reduce employment. An exception to this rule prevails if there is little international economic activity initially: if the mass of goods producible in the South without a fixed cost n^S is small, then employment rises as f^M falls below the level $\bar{f}^M$ at which offshoring becomes profitable. Similar results are obtained by Skaksen (2004) and Ranjan (2010). If employment rises, the reduction in f^M yields a Pareto improvement: Northern workers' expected utility, Southern workers' utility, and firm owners' real profits rise. However, when employment falls, a decrease in the offshoring cost benefits Southern workers at the expense of their Northern counterparts. Firm owners' utility and utilitarian world-wide social welfare possibly fall.

Consider an increase in f^M. As shown in (8.14) and illustrated in Figure 8.2, the mass of goods produced in MNEs in the South n^{M*} falls, which is conducive to employment. At the same time relative production cost $(w^N a^N)/(w^S a^S)$ rises (see (8.8) and Figure 8.2), and this effect tends to reduce the scale x^N of each active firm (see (8.5)). So the effect of an increase in f^M on employment is ambiguous. From the analysis in the preceding section, the relationship between the equilibrium measure of MNEs n^{M*} and the cost of offshoring in terms of Southern labor f^M is described by a continuous function $\Phi : [\underline{f}^M, \infty) \to \mathbb{R}_+$, which satisfies $\Phi(f^M) < \bar{L}^S/f^M$ and is monotonically decreasing for $f^M < \bar{f}^M$. For $n^S > 0$, $\bar{f}^M$ is finite and $n^{M*} = 0$ is constant for $f^M > \bar{f}^M$.

Consider the composite function $\Gamma(f^M) = \Psi(\Phi(f^M),\, f^M) : [\underline{f}^M, \infty) \to \mathbb{R}_+$. Γ relates equilibrium employment to the labor requirement for offshoring (see Figure 8.3). We assume that $\bar{L}^N$ is large enough so that there is unemployment (i.e., $\Gamma(f^M) < \bar{L}^N$) for all admissible f^M. From $\Psi(n - n^S, f^M) = 0$ and $\Phi(\underline{f}^M) = n - n^S$, it follows that $\Gamma(\underline{f}^M) = 0$. That is, employment in the North is zero when all firms move production to the South. $\Gamma(f^M) > 0$ for $f^M > \underline{f}^M$. The interesting question is whether $\Gamma(f^M)$ increases monotonically with f^M or possibly has a downward-sloping segment. The answer is provided by the following result:

production, which is at the heart of Antràs and Helpman's (2004) incomplete contracts model. They assume that an MNE entails a higher fixed cost than an offshore outsouring agreement but is advantageous in that it gives the Northern firm a stronger bargaining position, since it avoids being threatened with not being delivered outsourced essential specialized inputs (see also Helpman, 2006). As our model is not a model of the boundary of the firm, it is open to two alternative interpretations.

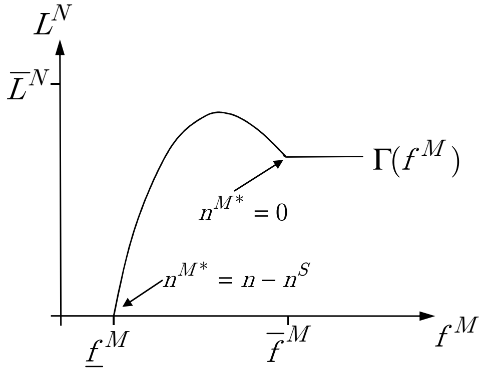

Figure 8.3: Employment effects of offshoring.

Proposition 8.2: *Let $n^S > 0$. Suppose $\Gamma(f^M) < \bar{L}^N$ for $f^M \in [\underline{f}^M, \infty)$. Then $\Gamma'(f^M) < 0$ for f^M sufficiently close to $\bar{f}^M$ if, and only if,*

$$n^S < \frac{n}{1 + \varepsilon\alpha^{2-\varepsilon}} \tag{8.15}$$

and

$$\alpha^2 \varepsilon n^S \left[1 + \frac{(1+\alpha^2\varepsilon)\alpha^{-\varepsilon} n^S}{n - n^S - \varepsilon\alpha^{2-\varepsilon} n^S}\right] < (\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S) - n^S. \tag{8.16}$$

Proof: Log-differentiating Γ, using (8.13), gives

$$\begin{aligned}\frac{d\ln\Gamma(f^M)}{df^M} &= -\frac{n^{M*}}{\bar{L}^S - n^{M*} f^M} + \Phi'(f^M)\Bigg[-\frac{1}{n - n^S - n^{M*}} - \frac{f^M}{\bar{L}^S - n^{M*} f^M} \\ &\quad -\frac{1}{\alpha^{-\varepsilon} n^S + n^{M*}} + \frac{\alpha^{\varepsilon-2}}{n^S + \alpha^{\varepsilon-1} n^{M*}} - \frac{\alpha^{\varepsilon-2}}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S - n^{M*})}\Bigg],\end{aligned} \tag{8.17}$$

where $n^{M*} = \Phi(f^M)$. Evaluating this derivative at $\bar{f}^M$ (interpreting $\Phi'(\bar{f}^M)$ as the left-hand derivative), using $\Phi(\bar{f}^M) = 0$ and (8.11), we have

$$\begin{aligned}\frac{d\ln\Gamma(\bar{f}^M)}{df^M} &= \Phi'(\bar{f}^M)\Bigg\{-\frac{1}{n - n^S} - \frac{\alpha^\varepsilon}{(\varepsilon-1)n^S} + \frac{\alpha^\varepsilon}{(\varepsilon-1)\left[(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S)\right]} \\ &\quad -\frac{\alpha^\varepsilon}{n^S} + \frac{\alpha^{\varepsilon-2}}{n^S} - \frac{\alpha^{\varepsilon-2}}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S)}\Bigg\}.\end{aligned}$$

The term in braces is positive if, and only if, the conditions of the proposition are satisfied. Given $\Phi'(\bar{f}^M) < 0$, this proves the proposition. ||

In the case $n^S = 0$, $\Gamma'(f^M) < 0$ holds provided that f^M is large enough. This follows from the observation that, from (8.13), $L^N \to 0$ as $n^M \to 0$. Thus, when there is very little offshoring initially, an increase in the offshoring activity possibly comes along with rising employment. However, as the labor requirement for offshoring falls and further production goes abroad, the employment effect certainly turns negative and, given that there is no positive lower bound on employment, significantly so (see Figure 8.3). The conditions for positive employment effects of further offshoring in the proposition are quite strong. For instance, for $\alpha = 0.8$, (8.15) is violated unless the fraction of goods Southern firms are able to produce n^S/n falls short of 9.3%. Moreover, numerical experimentation shows that if (8.15) and (8.16) are satisfied, the range of f^M-values for which $\Gamma'(f^M) < 0$ tends to be small. So positive employment effects of reductions in the fixed cost of offshoring appear to be the exception rather than the rule.[16]

Next, consider the impact of offshoring on agents' welfare. The indirect utility Northern workers obtain from spending the RTM wage in (8.6) is independent of f^M and exceeds the reservation utility. So their equilibrium expected utility is a function of employment alone, and the derivative with respect to f^M has the same sign as $\Gamma'(f^M)$. The real wage in the South $w^S/P = (w^S/w^N)(w^N/P)$ is a decreasing function of the relative production cost $(w^N a^N)/(w^S a^S)$ alone. Since the equilibrium value of $(w^N a^N)/(w^S a^S)$ is an increasing function of f^M, a decrease in f^M unambiguously raises Southern workers' utility for $f^M < \bar{f}^M$. From markup pricing and $L^N = (n - n^S - n^M)a^N x^N$, real profit of a firm producing in the North is $[1/(\varepsilon-1)](w^N/P)L^N/(n-n^S-n^M)$. Since the real wage is fixed, equilibrium real profit is determined by scale alone. Let $h(f^M) = \Gamma(f^M)/[n - n^S - \Phi(f^M)] : [\underline{f}^M, \infty) \to \mathbb{R}_+$. h gives the equilibrium value of $L^N/(n - n^S - n^M)$. The derivative of equilibrium real profit with respect to f^M has the same sign as

$$\frac{d \ln h(f^M)}{df^M} = \frac{d \ln \Gamma(f^M)}{df^M} + \frac{\Phi'(f^M)}{n - n^S - \Phi(f^M)}. \tag{8.18}$$

The same holds true for an MNE's profit, for the non-profitability of further offshoring implies that they make the same profit as Northern producers if plants in the South are set up in the first place.[17]

[16]The employment effects of an increase in n^S (i.e., the mass of goods producible in the South without a fixed cost) are similar to the effects of a decrease in f^M (i.e., the fixed cost of producing further goods in the South). Ignoring costly offshoring, employment in the North is $\Psi(0,0)$. Employment is small for n^S close to zero (recall that an equilibrium does not exist for $n^S = 0$) and for $n^S = n$ and positive in between. So the impact of an increase in n^S on employment is positive if there is little international trade initially, but turns negative at a higher level of n^S.

[17]Since Southern firms make zero profit, we do not have to analyze the effect of f^M on their profit.

Proposition 8.3: *A marginal change in f^M causes a Pareto improvement if, and only if, $df^M < 0$ and $\Gamma'(f^M) < 0$.*

Proof: Since Southern workers' utility is a decreasing function of f^M, only a decrease in the offshoring cost $df^M < 0$ can bring about a Pareto improvement. A decrease in f^M raises Northern workers' expected utility exactly if $\Gamma'(f^M) < 0$. From (8.18) and $\Phi'(f^M) < 0$, $\Gamma'(f^M) < 0$ implies $h'(f^M) < 0$, so the decrease in f^M also raises firms' real profit. ||

Southern workers benefit because the technology transfer within MNEs raises the purchasing power of the wages they earn, Northern workers gain because their probability of getting a job rises, and firm profits soar because both the increase in employment in the North and the increase in the measure of MNEs raise the scale of each firm that stays in the North. From Proposition 8.2, this situation arises when f^M falls below the level at which Northern firms start to operate plants in the South and n^S is sufficiently small.

Whenever $\Gamma'(f^M) > 0$, a decrease in f^M benefits Southern workers but harms their Northern counterparts. The firm owners' interests can coincide with either side. To see this, we first consider a case in which their interests are aligned with those of Southern workers. Substituting from (8.12) into (8.17) and then into (8.18) yields

$$\begin{aligned} h'(f^M) \quad = \quad & -\frac{n^{M*}}{\bar{L}^S - n^{M*} f^M} + \Phi'(f^M)\Bigg[-\frac{1}{\varepsilon - 1}\frac{1}{\alpha^{-\varepsilon} n^S + n^{M*}}\frac{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S) - n^S}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S - n^{M*})} \\ & - \frac{1}{\alpha^{-\varepsilon} n^S + n^{M*}} + \frac{\alpha^{\varepsilon-2}}{n^S + \alpha^{\varepsilon-1} n^{M*}} - \frac{\alpha^{\varepsilon-2}}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S - n^{M*})}\Bigg]. \end{aligned} \tag{8.19}$$

The term in square brackets is positive if, and only if,

$$\alpha^2 \varepsilon n^S \left(1 + \frac{\alpha^{\varepsilon-1} n^{M*}}{n^S}\right)^2 < (\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S) - n^S. \tag{8.20}$$

Proposition 8.4: *Suppose $\Gamma'(f^M) > 0$ and (8.20) holds for $n^{M*} = n - n^S$. Then a marginal decrease in f^M raises firm owners' real profit.*

Proof: If (8.20) holds for $n^{M*} = n - n^S$, then it holds for all $n^{M*} \leq n - n^S$. From (8.19), $h'(f^M) < 0$ for all $f^M < \bar{f}^M$. ||

The condition of the proposition ensures that the net effect of lower employment and more offshoring on the scale of producers staying in the North is positive. As a consequence, Southern workers and Northern firms gain from easier access to Southern production plants, at the expense of Northern workers.

Finally, we consider a case in which easier offshoring is detrimental to both workers and firm owners in the North:

Proposition 8.5: *Suppose (8.20) is violated for $n^{M*} = 0$. Then for f^M sufficiently close to $\bar{f}^M$, a marginal decrease in f^M reduces workers' expected utility and firm owners' real profit in the North.*

Proof: The fact that (8.20) is violated for $n^{M*} = 0$ implies that (8.16) is also violated, so $\Gamma'(\bar{f}^M) > 0$. For f^M close to $\bar{f}^M$, n^{M*} and, hence, the first term in the sum on the right-hand side of (8.19) are close to zero. If (8.20) is violated, the term in square brackets on the right-hand side of (8.19) is negative, so $h'(f^M) > 0$. ||

Unemployment soars, and this reduces the scale and profit of Northern firms. So there are losers but no winners from additional offshoring in the North.[18]

Turning to world-wide social welfare, suppose agents are risk-neutral (i.e., let $\beta = 1$), and define social welfare as the sum of all agents' individual (indirect expected) utilities. $\beta = 1$ implies that each agent's indirect utility can be set equal to his real income (i.e., income deflated by the price index P). Hence, social welfare is I/P. Using (8.2), markup pricing, (8.6), and $L^N = (n - n^S - n^M)a^N x^N$, this can be written as

$$\frac{I}{P} = \left(\frac{\omega^N}{\alpha}\right)^{\varepsilon} \frac{L^N}{n - n^S - n^M},$$

and the derivative of social welfare with respect to f^M has the same sign as $h'(f^M)$. From the analysis above we immediately obtain:

Proposition 8.6: *Let $\beta = 1$. Consider $df^M < 0$. Social welfare rises if $\Gamma'(f^M) < 0$. Social welfare rises if $\Gamma'(f^M) > 0$ and (8.20) holds for $n^{M*} = n - n^S$. For f^M sufficiently close to $\bar{f}^M$, social welfare falls if (8.20) is violated for $n^{M*} = 0$.*

[18] Again, the effects of an increase in the mass of goods producible in the South without a fixed cost n^S are similar, when costly offshoring is ignored (cf. footnote 16). The derivative of Northern workers' expected utility with respect to n^S has the same sign as the derivative of $L^N = \Psi(0,0)$ with respect to n^S. The same holds true for firms' aggregate real profit $(w^N/P)L^N/(\varepsilon - 1)$. Finally, an increase in n^S raises $(w^S a^S)/(w^N a^N)$, so that Southern workers' real wage $(w^S/w^N)(w^N/P)$ rises. Hence, an increase in n^S constitutes a Pareto improvement if L^N rises, while both Northern workers and firm owners lose if employment falls.

The final part of the proposition strengthens the message of Proposition 8.5 further: not only does everyone in the North lose from additional offshoring, but the losses are so large that the aggregate world-wide social welfare (ignoring distributional considerations) goes down despite rising worker utility in the South.

8.5 The case for a pragmatic union leader

Offshoring is often cited as a prime cause of shrinking union power (and, therefore, lower wages, especially for low-skilled workers). Dumont et al. (2006) present direct empirical evidence corroborating this claim. They explain (estimates of) union bargaining power in 12 industries in five high-income EU countries using several measures of internationalization. They find that the number of employees in foreign affiliates in the CEECs relative to the domestic industry has a significant negative effect on union bargaining power. The present section derives an equilibrium explanation for shrinking union power from our model.[19]

The starting point is the observation that Northern unions face a serious commitment problem in an equilibrium with positive offshoring activity (i.e., with $n^{M*} > 0$). Suppose a single industry union could commit to agree to a wage rate $\omega^N/a^N + dw^N/P$ marginally below the RTM wage ω^N/a^N ($dw^N/P < 0$). This would cause a negligible loss in the indirect utility of an employed worker. At the same time, it would render the operating profit differential between an MNE and a Northern producer in that industry strictly smaller than the fixed cost of offshoring, so that all firms in the industry would leave production at home, and the demand for labor would surge from $(n - n^S - n^{M*})L^d(\omega^N/a^N,\, I/P)$ to $(n - n^S)L^d(\omega^N/a^N + dw^N/P,\, I/P)$. If there were a way to make such a commitment, unions would strive to use it. In parallel to Rogoff's (1985) case for a "conservative central banker", unions may appoint a "pragmatic union leader" (PUL) in order to commit to wage restraint. In the following, we show that an equilibrium might exist in which some unions set the RTM wage and others employ a PUL in order to commit to a lower real wage rate. That is, union bargaining power decreases endogenously in some industries.

Suppose each industry union can appoint a non-combative union leader, who commits credibly to accept a wage rate in his industry $\tilde{w}^N/P$ equal to a given fraction δ of the RTM wage

[19] The effect of offshoring on union bargaining power is also addressed, for instance, by Rodrik (1997) and Gaston (2002).

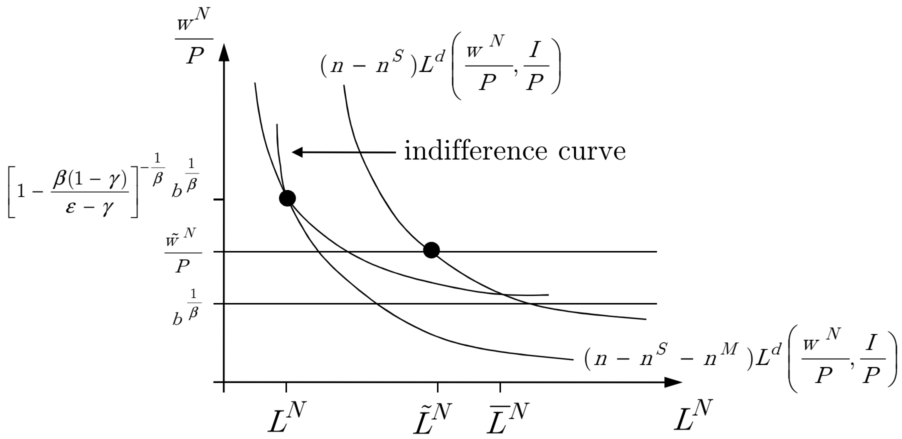

Figure 8.4: Employment with or without commitment.

in (8.6):

$$\frac{\tilde{w}^N}{P} = \delta\frac{\omega^N}{a^N}, \tag{8.21}$$

where $[1-\beta(1-\gamma)/(\varepsilon-\gamma)]^{1/\beta} \leq \delta \leq 1$ (the former inequality ensures that the wage is no less than the reservation wage $b^{1/\beta}$). One interpretation is that the union appoints a weak union leader, with bargaining power $1-\tilde{\gamma} \in [0, 1-\gamma]$. For each δ, there is $\tilde{\gamma}$ such that $\tilde{w}^N/P = \{b/[1-\beta(1-\tilde{\gamma})/(\varepsilon-\tilde{\gamma})]\}^{1/\beta}$ satisfies (8.21). A different possible interpretation (analogous to a central banker with stronger inflation aversion than the public) is that the PUL maximizes union members' expected utility, but uses a lower reservation utility for the unemployed $\tilde{b}$ in doing so (where $[1-\beta(1-\gamma)/(\varepsilon-\gamma)]b \leq \tilde{b} \leq b$). Letting $\delta = (\tilde{b}/b)^{1/\beta}$, the validity of (8.21) then follows from (8.6). As in Rogoff (1985), the commitment entails no physical cost. However, the lower δ, the greater the degree of wage restraint implied by the commitment solution.

Let $\tilde{x}^N$ denote the output of a firm in an industry with commitment. From (8.2) and (8.21), $\tilde{x}^N/x^N = \delta^{-\varepsilon}$. Employment in the industry is $\tilde{L}^N = (n-n^S)a^N\tilde{x}^N$. We assume that $\tilde{L}^N < \bar{L}^N$ (see Figure 8.4). The necessary parameter condition is derived later on. Using $L^N = (n-n^S-n^M)a^N x^N$, it follows that

$$\frac{\tilde{L}^N}{L^N} = \frac{n-n^S}{n-n^S-n^M}\delta^{-\varepsilon}. \tag{8.22}$$

Let μ denote the (endogenous) proportion of industries with a PUL. The definition of an equilibrium with PULs is similar as in Section 8.3: μ is included in the list of variables that constitute an equilibrium, and, as an additional condition, expected utility with commitment

$(\tilde{L}^N/\bar{L}^N)(\tilde{w}^N/P)^\beta + (1 - \tilde{L}^N/\bar{L}^N)b$ is greater than expected utility without commitment $(L^N/\bar{L}^N)(w^N/P)^\beta + (1 - L^N/\bar{L}^N)b$ and $\mu = 1$, or else the expected utilities are the same and $\mu \in (0,1)$. Using (8.22), this additional condition can be written as

$$\frac{n^M}{n - n^S} \geq 1 - \delta^{-\varepsilon}\left[1 - \frac{\varepsilon - \gamma}{\beta(1-\gamma)}\left(1 - \delta^\beta\right)\right], \quad \mu \leq 1, \tag{8.23}$$

with at most one strict inequality. There is $\tilde{\delta}$ in the interval $([1-\beta(1-\gamma)/(\varepsilon-\gamma)]^{1/\beta}, 1)$ such that the right-hand side of the first inequality in (8.23) is positive for $[1-\beta(1-\gamma)/(\varepsilon-\gamma)]^{1/\beta} \leq \delta < \tilde{\delta}$ and non-positive for $\tilde{\delta} \leq \delta \leq 1$.

For $\tilde{\delta} \leq \delta \leq 1$, the first inequality in (8.23) is strict for all $n^M \geq 0$. That is, the cost of commitment is low enough so that it pays to appoint a PUL irrespective of the amount of offshoring. Each industry union makes use of the commitment device. The analysis in Section 8.3 goes through, except that the real wage in (8.6) is lower by factor δ. (If $n^{M*} > 0$, the commitment problem is still present, however: the appointment of a slightly *more* PUL would mean that the measure of firms which go abroad jumps to zero at the cost of a small loss in wages.)

Let $\delta < \tilde{\delta}$, so that the right-hand side of the first inequality in (8.23) is positive. As in Section 8.3, let n^{M*} be the equilibrium measure of MNEs in the absence of the possibility of commitment. If $n^M = n^{M*}$ violates the first inequality in (8.23) or satisfies it with equality, then the job losses due to offshoring are small enough so that it does not pay to commit to wage moderation, and the analysis in Section 8.3 goes through without modification. The interesting case is that in which the first inequality in (8.23) is strict for $n^M = n^{M*}$. In this case, there possibly exists an equilibrium with RTM wages in some sectors and PULs in others:

Proposition 8.7: *Suppose the conditions of Proposition 8.1 are satisfied, and the first inequality in (8.23) is strict for $n^M = n^{M*}$. Suppose further $\delta < \tilde{\delta}$ and*

$$f^M > \frac{\alpha^\varepsilon \bar{L}^S}{(\varepsilon - 1)n^S}\left[1 - \frac{n^S}{(\omega^N)^{\varepsilon-1} - \left(\frac{\alpha}{\delta}\right)^{\varepsilon-1}(n - n^S)}\right]. \tag{8.24}$$

Then for $\bar{L}^N$ large enough, there is an equilibrium with $\mu \in (0,1)$.

Proof: See Appendix 8.10.1. ||

Proposition 8.7 provides an equilibrium explanation for shrinking union power; a subset of the unions endogenously chooses to cut down its union power as a way to commit to wage restraint. The unions' commitment problem is solved, in that no union has an incentive to decrease its bargaining power further (as there is no offshoring in the industries with a PUL). Since in the standard RTM model (for a closed economy with perfectly competitive goods markets) a decrease in their bargaining power harms unions, it is the interaction of wage setting with offshoring that creates scope for shrinking union power as an equilibrium phenomenon.

8.6 Headquarter services

In the model considered so far the fixed cost of offshoring consists of labor input in the South (for setting up a plant, establishing a network of suppliers, training workers, etc.) only. This ignores that a large part of the planning process for setting up a foreign subsidiary is carried out in the headquarter. Furthermore, the success or failure of offshoring in practice is often determined by issues that relate to the cooperation between parent and subsidiary (e.g., bridging cultural gaps, ensuring stability of production chains, quality controls, etc.) and, therefore, require inputs both in the headquarter and in the subsidiary. So, as a robustness check, the present section assumes that the fixed cost of offshoring consists of labor inputs both in the North and in the South. The analysis confirms the pessimistic assessment of the employment and welfare effects of offshoring based on the one-factor model without headquarter services.

Suppose, in addition to the $\bar{L}^N$ (unskilled) workers, there are $\bar{H}^N$ (> 0) skilled workers in the North, each supplying one unit of skilled labor (while unskilled labor is the only factor of production in the South). Setting up a subsidiary in the South requires the input of f^N (≥ 0) units of skilled labor in the North and f^M (≥ 0) units of labor in the South ($f^N > 0$ if $f^M = 0$). We assume that

$$n - n^S < \frac{\bar{L}^S}{f^M} < \frac{\bar{H}^N}{f^N}. \tag{8.25}$$

That is, there are enough labor in the South and enough skilled labor in the North to pay the fixed cost of offshoring all varieties. The production function for varieties of differentiated goods in the North is $x(i,j) = Ah(i,j)^\zeta l(i,j)^{1-\zeta}$ ($0 < \zeta < 1$, $A = \{[\zeta/(1-\zeta)]^{1-\zeta} + [(1-\zeta)/\zeta]^\zeta\}$), where $h(i,j)$ and $l(i,j)$ are the inputs of skilled and unskilled labor, respectively.

The wage rate for skilled labor is denoted v^N. The definition of an equilibrium is the same as in Section 8.3 except that v^N is included in the list of variables and the market clearing condition for skilled labor in the North is included in the set of conditions.[20]

The price of each variety produced in the North $(v^N)^\zeta(w^N)^{1-\zeta}/\alpha$ is the usual markup on unit cost. The price setting equation becomes

$$\left(\frac{w^N}{P}\right)^{\varepsilon-1} = \alpha^{\varepsilon-1}\left(n - n^S - n^M\right)\left(\frac{w^N}{v^N}\right)^{\zeta(\varepsilon-1)} + \left(n^S + \alpha^{\varepsilon-1}n^M\right)\left(\frac{w^N}{w^S a^S}\right)^{\varepsilon-1} \tag{8.26}$$

(cf. (8.4)). The condition that it does not pay to move further varieties abroad is

$$(\varepsilon-1)\left(f^M + \frac{w^N}{w^S a^S}a^S f^N\right) \geq \left[1 - \left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon}\left(\frac{v^N}{w^N}\right)^{\zeta(1-\varepsilon)}\right]\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon} a^S x^N, \quad n^M \geq 0, \tag{8.27}$$

with at most one strict inequality (cf. (8.5)). The Nash product for the wage bargain in industry i is

$$\left\{\frac{(n - n^S - n^M)\hat{L}^d\left(\frac{w^N}{P}, \frac{v^N}{P}, \frac{I}{P}\right)}{\bar{L}^N}\left[\left(\frac{w^N}{P}\right)^{\beta} - b\right]\right\}^{1-\gamma}\left[\frac{A}{\varepsilon-1}\left(\frac{\zeta}{1-\zeta}\right)^{\zeta}\frac{w^N}{P}\hat{L}^d\left(\frac{w^N}{P}, \frac{v^N}{P}, \frac{I}{P}\right)\right]^{\gamma},$$

where

$$\hat{L}^d\left(\frac{w^N}{P}, \frac{v^N}{P}, \frac{I}{P}\right) = \frac{1}{A}\left(\frac{1-\zeta}{\zeta}\frac{v^N}{w^N}\right)^{\zeta}\left[\frac{(v^N)^\zeta(w^N)^{1-\zeta}}{\alpha P}\right]^{-\varepsilon}\frac{I}{P}$$

is the demand for unskilled labor per Northern firm (for the sake of convenience, here and in what follows, we do not specify domain and range of functions). The constant wage elasticity of labor demand is $\varepsilon - \zeta(\varepsilon - 1)$. The union and the employers in each industry take the economy-wide wage rate for skilled labor v^N as given. Maximization of the Nash product subject to the labor demand equation yields

$$\frac{w^N}{P} = \left[\frac{b}{1 - \frac{\beta(1-\gamma)}{\varepsilon-\gamma-\zeta(\varepsilon-1)}}\right]^{\frac{1}{\beta}} = \hat{\omega}^N \tag{8.28}$$

if there is unemployment (cf. (8.6)). Market clearing for skilled labor implies

$$\bar{H}^N = (n - n^S - n^M)B(a^N)^\varepsilon\left(\frac{v^N}{w^N}\right)^{-1-\zeta(\varepsilon-1)} x^N + n^M f^N, \tag{8.29}$$

where $B = (1/A)[\zeta/(1-\zeta)]^{1-\zeta}$.

[20] The assumption that manufacturing is the only use of unskilled labor (as headquarter services in the North are provided by a different factor, whose price is determined via perfect competition) allows us to sidestep the question of how union wage setting in manufacturing interacts with the wage for, and the employment probability of, unskilled labor in different tasks.

The labor market clearing condition for the South (8.7), the price setting equation (8.26), the arbitrage condition (8.27), the wage setting rule for unskilled labor in the North (8.28), and the labor market clearing condition for skilled labor in the North (8.29) jointly determine the equilibrium values of w^N/P, v^N/w^N, n^M, $w^N/(w^S a^S)$, and x^N.

From (8.26) and (8.28),

$$\frac{v^N}{w^N} = \left[\frac{(\hat{\omega}^N)^{\varepsilon-1} - (n^S + \alpha^{\varepsilon-1} n^M) \left(\frac{w^N}{w^S a^S}\right)^{\varepsilon-1}}{\alpha^{\varepsilon-1}(n - n^S - n^M)} \right]^{\frac{1}{\zeta(1-\varepsilon)}} . \tag{8.30}$$

From (8.7), (8.29), and (8.30),

$$\begin{aligned} \frac{\bar{H}^N - n^M f^N}{\bar{L}^S - n^M f^M} &= \frac{B}{a^S} \frac{(n - n^S - n^M)^{-\frac{1}{\zeta(\varepsilon-1)}}}{\alpha^{-\varepsilon} n^S + n^M} \left(\frac{w^N}{w^S a^S} \right)^{-\varepsilon} \\ &\quad \cdot \left[\frac{(\hat{\omega}^N)^{\varepsilon-1} - (n^S + \alpha^{\varepsilon-1} n^M) \left(\frac{w^N}{w^S a^S}\right)^{\varepsilon-1}}{\alpha^{\varepsilon-1}} \right]^{\frac{1+\zeta(\varepsilon-1)}{\zeta(1-\varepsilon)}} . \end{aligned} \tag{8.31}$$

From (8.7), (8.27), and (8.30),

$$\begin{aligned} \alpha^{\varepsilon-1}(n - n^S) + n^S - (\hat{\omega}^N)^{\varepsilon-1} \left(\frac{w^N}{w^S a^S} \right)^{1-\varepsilon} &\leq (\varepsilon - 1) \frac{f^M + \frac{w^N}{w^S a^S} a^S f^N}{\bar{L}^S - n^M f^M} \\ &\quad \cdot \alpha^{\varepsilon-1}(n - n^S - n^M)(\alpha^{-\varepsilon} n^S + n^M), \\ &\quad n^M \geq 0, \end{aligned} \tag{8.32}$$

with at most one strict inequality. From (8.30), the South has a cost advantage (i.e., $w^S a^S < (v^N)^\zeta (w^N)^{1-\zeta}$) exactly if

$$\frac{w^N}{w^S a^S} > \frac{\hat{\omega}^N}{[n^S + \alpha^{\varepsilon-1}(n - n^S)]^{\frac{1}{\varepsilon-1}}} = \hat{\nu}^N. \tag{8.33}$$

The following inequality ensures that this condition is satisfied in equilibrium:

$$\frac{B}{a^S} \frac{(n - n^S)^{-\frac{1}{\zeta(\varepsilon-1)}}}{\alpha^{-\varepsilon} n^S} (\hat{\nu}^N)^{-\varepsilon} \left[\frac{(\hat{\omega}^N)^{\varepsilon-1} - n^S (\hat{\nu}^N)^{\varepsilon-1}}{\alpha^{\varepsilon-1}} \right]^{\frac{1+\zeta(\varepsilon-1)}{\zeta(\varepsilon-1)}} > \frac{\bar{H}^N}{\bar{L}^S}. \tag{8.34}$$

For $\zeta = 0$, (8.34) boils down to the corresponding condition (8.9) in Section 8.3. An equilibrium exists if, given f^M and f^N, there exists $(n^M, (w^N/(w^S a^S))$ with $0 \leq n^M < n - n^S$ and $w^N/(w^S a^S) > \hat{\nu}^N$ that satisfies (8.31) and (8.32).

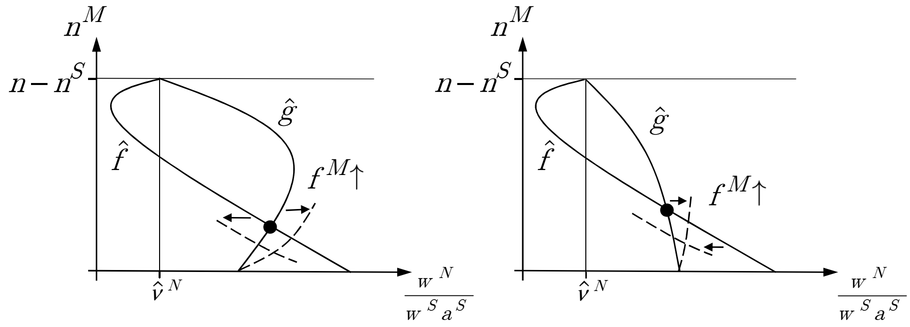

Figure 8.5: Equilibrium with headquarter services.

Proposition 8.8: *Suppose (8.25) and (8.34) hold and $\bar{L}^N$ is sufficiently large. Then a symmetric equilibrium with a cost advantage for the South and unemployment exists.*

Proof: See Appendix 8.10.2. ||

The determination of the equilibrium values of $w^N/(w^S a^S)$ and n^M via (8.31) and (8.32) is illustrated in Figure 8.5. Equation (8.31) has a unique solution $w^N/(w^S a^S) = \hat{f}(n^M, f^M, f^N)$. $\hat{f}(n^M, f^M, f^N)$ starts at $\hat{f}(0, f^M, f^N) > \hat{\nu}^N$ and goes to $\hat{\nu}^N$ with infinite slope as $n^M \to n - n^S$. A solution to equation (8.32) holding with equality may or may not exist. If so, solutions come in pairs, and the smaller solution $\hat{g}(n^M, f^M, f^N)$ satisfies $\hat{g}(n^M, f^M, f^N) > \hat{\nu}^N$ for all n^M. In the main text, we assume that $\hat{g}(n^M, f^M, f^N)$ exists for all n^M and that $\hat{f}$ and $\hat{g}$ intersect at some positive n^M, with $\partial \hat{f}/\partial n^M < \partial \hat{g}/\partial n^M$ at the point of intersection. For $\bar{L}^N$ sufficiently large, the intersection represents a symmetric equilibrium with a cost advantage for the South, unemployment, and offshoring.

Having established existence of equilibrium, we address the comparative statics effects of changes in the labor requirement for offshoring on the amount of offshoring, employment, and the wages of skilled and unskilled workers in the North. Broadly speaking, the results reinforce the pessimistic conclusions drawn from the one-factor model: a decrease in the cost of offshoring raises Southern workers' utility, but this gain comes at the expense of unskilled Northern workers' expected utility and possibly skilled workers' expected utility as well. While general analytical results are hard to come by, the model is tractable enough so that we can substantiate these claims analytically for the case of low offshoring cost. Since changes in f^M are easier to deal with than changes in f^N, we focus on the former. Throughout, it is understood that variables refer to equilibrium values.

Proposition 8.9: *Suppose* $n^M > 0$ *and* $\partial\hat{f}/\partial n^M < \partial\hat{g}/\partial n^M$. *Then* $dn^M/df^M < 0$ *and* $d(w^N/(w^S a^S))/df^M > 0$.

Proof: See Appendix 8.10.2. ||

An increase in f^M shifts $\hat{f}$ to the left and $\hat{g}$ to the right. For $\hat{g}$ downward-sloping at the equilibrium point, the comparative statics effects are obvious from the right panel of Figure 8.5. For the opposite case, the proof requires some tedious algebra.
Numerical analysis shows that generally $dL^N/df^M > 0$. That is, employment falls when the labor requirement for offshoring in the South f^M falls. This is easy to see for a small offshoring cost:

Proposition 8.10: $dL^N/df^M > 0$ *for* f^M *and* f^N *small enough.*

Proof: See Appendix 8.10.2. ||

Starting from a low level of offshoring, the welfare effects of a decrease in the labor requirement for offshoring in the South are similar as in the one-factor model. The fact that the relative wage $w^N/(w^S a^S)$ and employment fall implies that Southern workers' utility w^S/P goes up, but Northern unskilled workers' expected utility goes down, and the same holds true for the skilled workers:

Proposition 8.11: *For* f^M *and* f^N *small enough, a decrease in* f^M *raises Southern workers' utility but reduces both unskilled Northern workers' expected utility and skilled workers' utility.*

Proof: See Appendix 8.10.2. ||

Evidently, the commitment problem analyzed in Section 8.5 remains present in the two-factor model: each industry union would commit to agree to a wage rate $\hat{\omega}^N + dw^N/P$ $(dw^N/P < 0)$ marginally below the RTM wage $\hat{\omega}^N$ in (8.28) if it could, since this would completely eliminate the incentive to offshore at the cost of a negligible loss in the indirect utility of an employed worker.

8.7 Heterogeneous firms

So far we have neglected the uncertainties surrounding the establishment of a plant in an emerging economy. Productivity uncertainty appears particularly relevant with regard to offshoring to low-wage emerging markets. The recent experience of German manufacturers provides a good example (see Kinkel and Maloca, 2009). German firms were especially active in offshoring since the mid-1990s: in each of the two-year periods between 1995 and 2005, about 15-25% of the German manufacturing firms relocated (further) production abroad. The main target region was Central and Eastern Europe, the dominant motive cost reduction, and the preferred mode offshoring within MNEs (rather than offshore outsourcing). In 2007-09, this proportion fell to 9% (though it was still 45% for firms with 1,000 or more employees and 24% for the medium-sized manufacturers with 250 to below 1,000 employees). At the same time, 3% of all manufacturing firms re-relocated production to Germany. That is, there was one firm moving production back to Germany per three offshorers. The main motive for moving production back home was disappointment with the quality of production processes and the scope for handling them.

Following the new new trade theory initiated by Melitz (2003), the present section introduces uncertainty about the input coefficient in the South to the model of Section 8.2. A novel feature of the model is that uncertainty concerns only production abroad, while productivity in the North is certain (whereas the new new trade theory assumes that productivities are identical at different locations). Given that the typical product cycle involves offshoring of mature products (Vernon, 1966), this seems to be an appropriate representation of the firms' offshoring decision. The central result in this section is that the interaction of firms' risky offshoring decision and unions' wage setting behavior provides a natural explanation for multiple equilibria. The implications of the model for aggregate employment are the object of the subsequent section.

We return to the assumption that labor is the only factor of production and offshoring requires labor input in the South only, and we focus on the monopoly union special case of RTM wage setting. Firms which pay the fixed cost of offshoring $w^S f^M$ acquire the ability to produce in the South. The productivity of Southern subsidiaries is uncertain when the fixed cost is paid. Following Helpman et al. (2004) and Baldwin and Forslid (2010), each firm independently draws a productivity level in the South from the Pareto distribution, i.e., the probability of

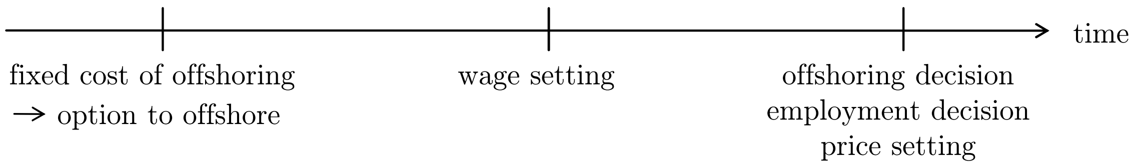

Figure 8.6: Timing of events with heterogeneous firms.

drawing an input coefficient $a' \leq a$ is $H(a) = a^{\lambda}$ for $0 \leq a \leq 1$ (where $\lambda > \varepsilon - 1$).[21] After firms have spent the fixed cost of offshoring, the monopoly unions set wages. The realizations of the input coefficients are still not known, so each union sets a uniform wage rate for its industry (firm-level wages cannot be made contingent on the firms' productivity in Southern subsidiaries realized later). After wages are determined, firms which have incurred the fixed cost observe productivity in their Southern subsidiary and decide whether to offshore or not, and all firms decide on their labor demand. Thus, in contrast to ex ante (relative to offshoring) wage setting as in Skaksen (2004) and ex post wage setting as in Koskela and Stenbacka (2009) (and in the model with homogeneous firms in Sections 8.3 and 8.4), wages are set in between the firms' decisions to set up capacity in the South and to utilize it (see Figure 8.6).[22] Bergin et al.'s (2009) observation that variation in the number of existing subsidiaries that actually operate explains a sizeable portion of output volatility in MNEs provides neat evidence for the practical relevance of this timing structure. We comment on the impact of the difference in the timing of events compared to the model with homogeneous firms at the beginning of Section 8.8.

Let n^M denote the mass of firms in industry i which incur the fixed cost of offshoring (which possibly exceeds the mass of firms which actually offshore production). Equilibrium is defined similarly as in the model with homogeneous firms, with the following modifications: either $n^M > 0$ and the fixed cost of setting up an MNE is equal to the *expected* difference between an MNE's operating profit and a Northern producer's operating profit, or $n^M = 0$ and the fixed cost is no less than the *expected* operating profit differential; firms which have incurred the fixed cost of offshoring relocate production to the South if, and only if, operating cost is lower there; if a firm has incurred the fixed cost but does not offshore, its profit in the North is no less than the fixed cost of offshoring.[23]

[21] The productivity level in the South $(1/a)$ is Pareto distributed, i.e., the probability of drawing a productivity level $(1/a') \leq (1/a)$ is $G(1/a) = 1 - a^{\lambda}$ for $1 \leq (1/a) < \infty$. It follows that the input coefficients are distributed as spelt out above.

[22] As in the baseline model, setting up capacity in the South is a longer-term decision than wage setting, i.e., the fixed cost of offshoring has to be incurred before wage setting (cf. footnote 10).

[23] If we dropped the final condition, we would have to allow for bankruptcy or introduce an insurance

An MNE with input coefficient a in the South sets the markup price $w^N a^N/\alpha$ or $w^S a/\alpha$, depending on whether it produces in the North or in the South, respectively. From (8.2), its operating profit if it produces in the South is $w^S a[(w^S a)/(w^N a^N)]^{-\varepsilon} x^N/(\varepsilon - 1)$. An MNE offshores production if, and only if, this is greater than operating profit in the North $w^N a^N x^N/(\varepsilon - 1)$, i.e.,

$$a < \frac{w^N a^N}{w^S}. \tag{8.35}$$

The main novelty that is due to firm heterogeneity is that the union's objective function becomes non-concave, which implies that the optimum wage w^N/P is a discontinuous and non-monotonic function of the prevailing wage rate in the South w^S/P. The monopoly union maximizes workers' expected utility gain compared to the reservation utility b subject to the industry labor demand curve. Using (8.35), the mass of firms that produce in the North is $n - n^S - \max\{(w^N a^N)/w^S)^\lambda, 1\}\, n^M$. Labor demand per firm is given by the function $L^d(w^N/P, I/P)$ defined in Section 8.3. Substituting L^d and omitting the factor $(a^N)^{1-\varepsilon}\alpha^\varepsilon(I/P)/\bar{L}^N$, which it takes as given, the union's objective function becomes

$$\left[n - n^S - \max\left\{\left(\frac{w^N a^N}{w^S}\right)^\lambda, 1\right\} n^M\right]\left[\left(\frac{w^N}{P}\right)^\beta - b\right]\left(\frac{w^N}{P}\right)^{-\varepsilon}. \tag{8.36}$$

An increase in w^N/P has a twofold negative effect on employment. For one thing, it reduces labor demand per firm in the North (the intensive margin). For another, for $w^N/P < (w^S/P)/a^N$ (i.e., $w^N a^N < w^S$), it decreases the mass of firms operating in the North (the extensive margin). Consistent with the Rodrik (1997) hypothesis, offshoring thus increases the wage elasticity of labor demand. The function in (8.36) is depicted in Figure 8.7 for given n^M. The max term equals one for $w^N/P \geq (w^S/P)/a^N$. For $w^S/P \leq a^N b^{1/\beta}$, this condition is satisfied for all $w^N/P \geq b^{1/\beta}$. From Section 8.3, we know that the monopoly union sets $w^N/P = \omega^N/a^N$ then, where ω^N is defined by (8.6) with $\gamma = 0$. For $w^S/P > a^N b^{1/\beta}$, we have $w^N a^N/w^S < 1$ for w^N/P in the interval $(b^{1/\beta}, (w^S/P)/a^N)$. For w^S/P close enough to $a^N b^{1/\beta}$, ω^N/a^N is still the optimum wage rate. On the other hand, for $w^S/P = \omega^N$ $(> a^N b^{1/\beta})$, the left-hand derivative of the function in (8.36) is negative at $w^N/P = \omega^N/a^N$, so it attains a local maximum at some $w^N/P < \omega^N/a^N$. It follows that there is a real wage rate in the South $w^S/P = \breve{\omega}^S(n^M)$ such that (8.36) has two maxima (with the same level

mechanism that redistributes income from "lucky" firms that draw a low input coefficient to "unlucky" high-a firms (we must not assume that firm owners also have wage income, since the wage setting process assumes that the workers involved have no income if they do not work).

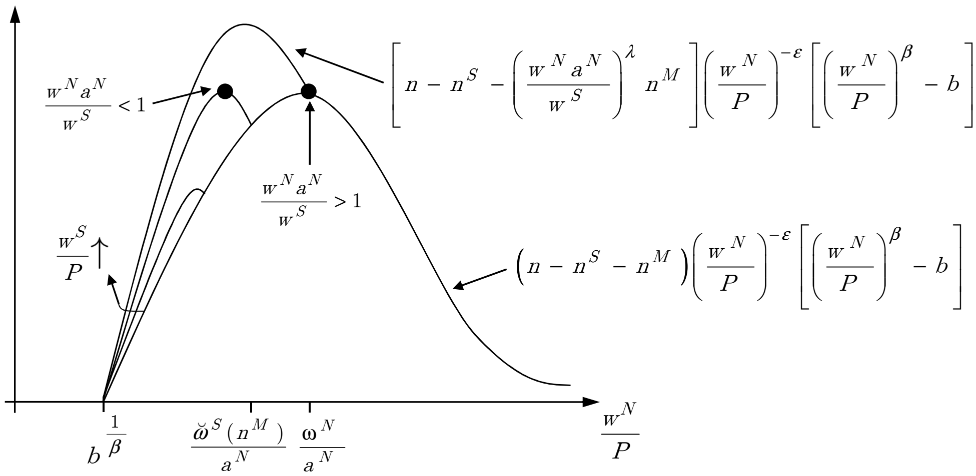

Figure 8.7: Wage setting with heterogeneous firms.

of expected utility), one at a wage rate $w^N/P < \breve{\omega}^S(n^M)/a^N$ (so that $w^N a^N/w^S < 1$) and the other one at a wage rate $w^N/P > \breve{\omega}^S(n^M)/a^N$ (so that $w^N a^N/w^S > 1$). The monopoly wage is ω^N/a^N for w^S/P up to $\breve{\omega}^S(n^M)$ and is implicitly determined by

$$\frac{w^N}{P} = \left[1 - \frac{\beta}{\frac{\lambda n^M}{(n-n^S)\left(\frac{w^N a^N}{w^S}\right)^{-\lambda} - n^M} + \varepsilon}\right]^{-\frac{1}{\beta}} b^{\frac{1}{\beta}} = \frac{\breve{\omega}^N\left(\frac{w^N a^N}{w^S a^S},\, n^M\right)}{a^N} \tag{8.37}$$

for $w^S/P > \breve{\omega}^S(n^M)$. $\breve{\omega}^N((w^N a^N)/(w^S a^S), n^M)$ is decreasing in its first argument, so if a solution w^N/P exists, then it is unique. Moreover, since $\breve{\omega}^N((w^N a^N)/(w^S a^S),\, n^M)$ rises when w^S/P rises, the optimum wage w^N/P is an increasing function of w^S/P for $w^S/P > \breve{\omega}^S(n^M)$. This relation between the union wage in the North and labor cost in the South is similar as in Skaksen (2004).

Proposition 8.12: *There are functions $\breve{\omega}^N((w^N a^N)/(w^S a^S),\, n^M)$ ($< \omega^N$ and decreasing in both arguments), $\underline{\nu}(n^M)$, and $\bar{\nu}(n^M)$ (with $\underline{\nu}(n^M) = \bar{\nu}(n^M) = 1/a^S$ for $n^M = 0$ and $\underline{\nu}(n^M) < 1/a^S < \bar{\nu}(n^M)$ for $n^M > 0$) such that*

$$\frac{w^N}{P} = \begin{cases} \frac{\breve{\omega}^N\left(\frac{w^N a^N}{w^S a^S}, n^M\right)}{a^N}, & \frac{w^N a^N}{w^S a^S} \le \underline{\nu}(n^M) \\ \frac{\omega^N}{a^N}, & \frac{w^N a^N}{w^S a^S} \ge \bar{\nu}(n^M) \end{cases}. \tag{8.38}$$

Proof: See Appendix 8.10.3. ||

Low levels of relative production cost $(w^N a^N)/(w^S a^S)$ $(\leq \underline{\nu}(n^M))$ go along with a real wage that falls short of the monopoly wage ω^N/a^N defined in Section 8.3. Relative production cost $(w^N a^N)/(w^S a^S)$ in the interval $(\underline{\nu}(n^M),\ \bar{\nu}(n^M))$ is incompatible with the unions' wage setting behavior. What will prove crucial to multiplicity of equilibria is the non-monotonicity of the dependence of the Northern real wage on relative production cost: w^N/P is non-increasing in $(w^N a^N)/(w^S a^S)$ both for $(w^N a^N)/(w^S a^S) \leq \underline{\nu}(n^M)$ and for $(w^N a^N)/(w^S a^S) \geq \bar{\nu}(n^M)$; but as $(w^N a^N)/(w^S a^S)$ jumps upward from $\underline{\nu}(n^M)$ to $\bar{\nu}(n^M)$, w^N/P jumps upward.

The remainder of the equilibrium analysis is straightforward. From the definition of the price index and the markup pricing rules,

$$\left(\frac{w^N a^N}{P}\right)^{\varepsilon-1} = \begin{cases} \left[n - n^S - \left(\frac{w^N a^N}{w^S}\right)^{\lambda} n^M\right] \alpha^{\varepsilon-1} & \\ +n^M \frac{\lambda\alpha^{\varepsilon-1}}{\lambda+1-\varepsilon} \left(\frac{w^N a^N}{w^S}\right)^{\lambda} + n^S \left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon-1}, & \frac{w^N a^N}{w^S a^S} \leq \frac{1}{a^S} \\ (n - n^S - n^M)\alpha^{\varepsilon-1} & \\ +n^M \frac{\lambda\alpha^{\varepsilon-1}}{\lambda+1-\varepsilon} \left(\frac{w^N a^N}{w^S}\right)^{\varepsilon-1} + n^S \left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon-1}, & \frac{w^N a^N}{w^S a^S} \geq \frac{1}{a^S} \end{cases}. \tag{8.39}$$

The condition that further offshoring is not profitable reads:

$$\begin{aligned} \frac{1}{\varepsilon-1} w^N a^N x^N \quad &\geq \quad H\left(\frac{w^N a^N}{w^S}\right) E\left[\frac{1}{\varepsilon-1} w^S a \left(\frac{w^S a}{w^N a^N}\right)^{-\varepsilon} x^N \,\middle|\, a \leq \frac{w^N a^N}{w^S}\right] \\ &+ \left[1 - H\left(\frac{w^N a^N}{w^S}\right)\right] \frac{1}{\varepsilon-1} w^N a^N x^N - w^S f^M, \quad n^M \geq 0, \end{aligned}$$

with at most one strict inequality. Simplifying terms yields

$$f^M \geq \begin{cases} \frac{x^N}{\lambda+1-\varepsilon} \left(\frac{w^N a^N}{w^S}\right)^{\lambda+1}, & \frac{w^N a^N}{w^S a^S} \leq \frac{1}{a^S} \\ \frac{x^N}{\lambda+1-\varepsilon} \frac{\lambda\left(\frac{w^N a^N}{w^S}\right)^{\varepsilon} - (\lambda+1-\varepsilon)\frac{w^N a^N}{w^S}}{\varepsilon-1}, & \frac{w^N a^N}{w^S a^S} \geq \frac{1}{a^S} \end{cases}, \quad n^M \geq 0, \tag{8.40}$$

with at most one strict inequality. The condition that firm profit in the North $w^N a^N x^N/(\varepsilon-1)$ is sufficient to cover the fixed cost $w^S f^M$ for firms that do not offshore is

$$\left(\frac{w^N a^N}{w^S}\right)^{\lambda} \leq \frac{\lambda}{\varepsilon-1} - 1$$

if $n^M > 0$ and $w^N a^N/w^S < 1$. The labor market clearing condition for the South becomes

$$\bar{L}^S = \begin{cases} n^M \frac{\lambda}{\lambda+1-\varepsilon} \left(\frac{w^N a^N}{w^S}\right)^{\lambda+1} x^N + n^S a^S \alpha^{-\varepsilon} \left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon} x^N + n^M f^M, & \frac{w^N a^N}{w^S a^S} \leq \frac{1}{a^S} \\ n^M \frac{\lambda}{\lambda+1-\varepsilon} \left(\frac{w^N a^N}{w^S}\right)^{\varepsilon} x^N + n^S a^S \alpha^{-\varepsilon} \left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon} x^N + n^M f^M, & \frac{w^N a^N}{w^S a^S} \geq \frac{1}{a^S} \end{cases}. \tag{8.41}$$

Equations (8.38)-(8.41) jointly determine w^N/P, n^M, $(w^N a^N)/(w^S a^S)$, and x^N. From (8.38) and (8.39),

$$\frac{w^N a^N}{w^S a^S} = \begin{cases} \left\{ \dfrac{\breve{\omega}^N\left(\frac{w^N a^N}{w^S a^S}, n^M\right)^{\varepsilon-1} - \alpha^{\varepsilon-1}\left[n - n^S + \frac{\varepsilon-1}{\lambda+1-\varepsilon}\left(\frac{w^N a^N}{w^S}\right)^{\lambda} n^M\right]}{n^S} \right\}^{\frac{1}{\varepsilon-1}}, & \frac{w^N a^N}{w^S a^S} \leq \underline{\nu}(n^M) \\ \left[\dfrac{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S - n^M)}{n^S + \frac{\lambda}{\lambda+1-\varepsilon}(a^S)^{\varepsilon-1}\alpha^{\varepsilon-1} n^M}\right]^{\frac{1}{\varepsilon-1}}, & \frac{w^N a^N}{w^S a^S} \geq \bar{\nu}(n^M) \end{cases}. \tag{8.42}$$

Let $\breve{f}(n^M)$ denote the mapping that assigns solutions $(w^N a^N)/(w^S a^S)$ to this equality to n^M. For $(w^N a^N)/(w^S a^S) \geq \bar{\nu}(n^M)$, this is simply the right-hand side of the equation. A crucial property of the mapping $\breve{f}$ is that, as we will see below, it is possibly multi-valued for a certain range of n^M-values. From (8.40) and (8.41),

$$\begin{aligned} \frac{w^N a^N}{w^S a^S} &\leq \begin{cases} \left[\dfrac{(\lambda+1-\varepsilon)(a^S)^{-\lambda}\alpha^{-\varepsilon} n^S}{\frac{\bar{L}^S}{f^M} - (1+\lambda) n^M}\right]^{\frac{1}{\lambda+1-\varepsilon}}, & \frac{w^N a^N}{w^S a^S} \leq \frac{1}{a^S} \\ \left[\frac{\lambda}{\lambda+1-\varepsilon}(a^S)^{\varepsilon-1} - (\varepsilon-1)\dfrac{\alpha^{-\varepsilon} n^S + \frac{\lambda}{\lambda+1-\varepsilon}(a^S)^{\varepsilon-1} n^M}{\frac{\bar{L}^S}{f^M} - n^M}\right]^{\frac{1}{1-\varepsilon}}, & \frac{w^N a^N}{w^S a^S} \geq \frac{1}{a^S} \end{cases} \\ &= \breve{g}(n^M, f^M), \quad n^M \geq 0, \end{aligned} \tag{8.43}$$

with at most one strict inequality. The function $\breve{g}$ is increasing in n^M, increasing in f^M, and continuous. For $(w^N a^N)/(w^S a^S) \geq \bar{\nu}(n^M)$, the only difference between the functions $\breve{f}$ and $\breve{g}$ and their counterparts f and g defined in (8.8) and (8.10), respectively, is the presence of the term $[\lambda/(\lambda+1-\varepsilon)](a^S)^{\varepsilon-1}$.[24]

If the curves representing $\breve{f}$ and $\breve{g}$ do not intersect either at $(w^N a^N)/(w^S a^S) \leq \underline{\nu}(n^M)$ or at $(w^N a^N)/(w^S a^S) \geq \bar{\nu}(n^M)$, a symmetric equilibrium does not exist. If there is a unique intersection with $(w^N a^N)/(w^S a^S) \leq \underline{\nu}(n^M)$ or $(w^N a^N)/(w^S a^S) \geq \bar{\nu}(n^M)$, there is a unique equilibrium. The main result in this section is that multiple equilibria can occur, and that this is not a theoretical curiosity that depends on the curvature of the functions which determine equilibrium, but a natural consequence of the unions' wage setting behavior.

Proposition 8.13: *There are parameters such that two symmetric equilibria with a cost advantage for the South and unemployment exist.*

[24] As $\lambda \to \infty$, this term goes to unity, and at the same time $E(a) = \lambda/(\lambda+1) \to 1$ and $\sigma_a^2 = \lambda/[(\lambda+1)^2(\lambda+2)] \to 0$. Accordingly, for $(w^N a^N)/(w^S a^S) \geq \bar{\nu}(n^M)$, the model "converges" to the model with certainty and input coefficient $a^S = 1$ as $\lambda \to \infty$.

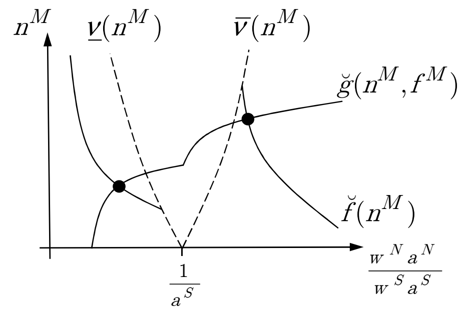

Figure 8.8: Multiple equilibria.

Proof: Let $\bar{L}^N = 30$, $\bar{L}^S = 40$, $\alpha = 0.5$, $a^N = 0.3$, $a^S = 0.7143$, $n = 5$, $n^S = 0.1$, $f^M = 8$, $b = 2.5$, $\beta = 0.5$, and $\lambda = 2.5$. $\breve{f}$ and $\breve{g}$ intersect twice, at $((w^N a^N)/(w^S a^S), n^M) = (1.2797, 1.1539)$ (so that $1 < (w^N a^N)/(w^S a^S) < \underline{\nu}(n^M) = 1.3279$) and at $((w^N a^N)/(w^S a^S), n^M) = (1.6754, 1.4394)$ (so that $(w^N a^N)/(w^S a^S) > \bar{\nu}(n^M) = 1.5679$). In the former equilibrium, the real wage in the South is $w^S/P = 3.1565$. The two local maxima of the union's objective function occur at $w^N/P = 9.6174$ and $w^N/P = \omega^N/a^N = 11.1111$ with values 0.0259 and 0.0253, respectively. That is, the global maximum is at $w^N/P = 9.6174$. A proportion $((w^N a^N/w^S)^\lambda =)$ 0.7988 of the firms which have spent the fixed cost of offshoring go abroad. The condition that the owners of those firms that incur the fixed cost of offshoring but do not go abroad have non-negative income is satisfied: $(w^N a^N/w^S)^\lambda = 0.7988 \leq 1.5 = \lambda/(\varepsilon - 1) - 1$. In the latter equilibrium, the real wage in the South is $w^S/P = 2.7854$. The two local maxima of the union's objective function occur at $w^N/P = 9.0570$ and $w^N/P = \omega^N = 11.1111$ with values 0.0220 and 0.0234, respectively. The global maximum is at $w^N/P = 11.1111$. Aggregate employment is 19.6160 in the former equilibrium and 6.9781 in the latter. ||

The example in the proof is constructed such that there is a range of n^M-values in which $\breve{f}$ assigns two values of $(w^N a^N)/(w^S a^S)$ to each n^M and $\breve{g}$ intersects $\breve{f}$ twice (see Figure 8.8). The reason why $\breve{f}$ is possibly multi-valued is that the relation between $(w^N a^N)/(w^S a^S)$ and the wage rate w^N/P is non-monotonic. The function $\breve{f}$ is derived from the wage setting equation (8.38) and the price setting equation (8.39). According to the price setting equation (8.39), for given n^M, an increase in the relative production cost in the North $(w^N a^N)/(w^S a^S)$ causes an increase in the Northern real wage. If the wage setting process gave rise to a non-increasing relation between $(w^N a^N)/(w^S a^S)$ and w^N/P (as in the model with homogeneous firms), there could not be multiple values of $(w^N a^N)/(w^S a^S)$ consistent with firms' price setting and unions' wage setting behavior for given n^M. But as noted above, w^N/P jumps

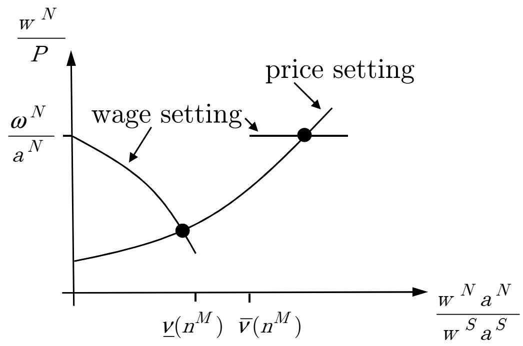

Figure 8.9: Wage setting and price setting.

upward as $(w^N a^N)/(w^S a^S)$ jumps upward from $\underline{\nu}(n^M)$ to $\bar{\nu}(n^M)$ (see Figure 8.9). That is why both a low level and a high level of relative production cost $(w^N a^N)/(w^S a^S)$ are compatible with agents' price and wage setting behavior. For the low value of $(w^N a^N)/(w^S a^S)$ $(< \underline{\nu}(n^M))$, the real wage in the South $(w^S/P > \breve{\omega}^S(n^M))$ is high, so unions in the North have an incentive to set wages low enough such that not all firms that have paid the fixed cost of offshoring go abroad. They take the negative impact of a marginal decrease in w^N/P on offshoring intensity into account and set $w^N/P < \omega^N/a^N$. For $(w^N a^N)/(w^S a^S)$ $(> \bar{\nu}(n^M))$ high, the real wage rate in the South w^S/P $(< \breve{\omega}^S(n^M))$ is so low that keeping firms that have paid the fixed cost of offshoring at home requires a degree of wage moderation which is unattractive from the unions' point of view, so they set $w^N/P = \omega^N/a^N$.

If two equilibria exist, the equilibrium with higher offshoring activity is characterized by the lower real wage in the South. Since there is full employment in the South and profits made by Southern subsidiaries of MNEs accrue to firm owners in the North, Southern agents prefer the equilibrium with less offshoring, in which the South exports a narrower range of goods. So the model should not be taken as an explanation for divergent economic performance of developing countries with different levels of industrialization (see, e.g., Murphy et al., 1989). Rather, it points to the role of wage policy in equilibrium selection: unions in the North have to accept a low real wage in order to keep jobs at home.

The commitment problem discussed in Section 8.5 remains present with firm heterogeneity. In a symmetric equilibrium with offshoring, the expected operating profit differential between an MNE and a Northern producer is equal to the fixed cost of offshoring. If a union could commit to set the wage rate w^N/P slightly below the equilibrium level (i.e., $\breve{\omega}^N((w^N a^N)/(w^S a^S), n^M)/a^N$ if $(w^N a^N)/(w^S a^S) < \underline{\nu}(n^M)$ and ω^N/a^N if $(w^N a^N)/(w^S a^S) >$ $\bar{\nu}(n^M)$), then no firm in the industry would pay the fixed cost of offshoring, so employment and expected utility would surge. So each single union has an incentive to appoint a PUL, who has lower bargaining power or attaches a lower reservation utility to being unemployed.

8.8 Employment with heterogeneous firms

This section deals with equilibrium employment in the model introduced in the previous section. The upshot of the analysis is that the model justifies a more optimistic assessment of the labor market effects of offshoring than the model with homogeneous firms analyzed in Sections 8.3 and 8.4. The reason is that, as in Skaksen (2004), the presence of potential, but non-realized, offshoring has a moderating effect on the unions' wage claims, since the wage has an impact on firms' decision to offshore.

The model with heterogeneous firms differs from the model with homogeneous firms in two respects. For one thing, productivity in Southern subsidiaries is uncertain. For another, firms which have paid the fixed cost of offshoring decide whether to move production abroad only after unions have set the wage rate; i.e., paying the fixed cost in the first stage gives firms the *option* to offshore, whereas offshoring is *irreversible* in the model with homogeneous firms. Different labor market outcomes can in principle be due to either of these two differences. However, in Proposition 8.A.1 in Appendix 8.10.4, we rule out the option to offshore *per se* as an explanation for differences in equilibrium employment: in the model with homogeneous firms *and the option to offshore*, if an equilibrium exists (which is not implied by existence of equilibrium with irreversible offshoring), it displays the same level of employment as the equilibrium of the model with irreversible offshoring. Thus, it is the assumption of firm heterogeneity which raises the possibility that the firms' option to offshore feeds back on unions' wage setting behavior.[25]

Consider the model with heterogeneous firms. Let $\breve{((w^N a^N)/(w^S a^S))}$, $\breve{n}^M$, and $\breve{L}^N$ denote the equilibrium values of relative production cost, the mass of producers which incur the fixed cost of offshoring, and aggregate employment in the North. For the sake of comparability, set $a^S = E(a) = \lambda/(\lambda+1)$, so that the expected input coefficient coincides with the certain input coefficient in the model with irreversible offshoring. For simplicity, set $n^S = 0$. A change in the wage rate unions set has a marginal impact on offshoring intensity if, and only

[25] Together with Proposition 8.1, this rules out multiplicity of equilibria in the model with homogeneous firms and the option to offshore. So the possible multiplicity of equilibria stated in Proposition 8.13 is also a consequence of firm heterogeneity.

if, $(w^N a^N)/(w^S a^S) < \underline{\nu}(n^M)$. Our main result in this section is that employment is higher than with homogeneous firms and irreversible offshoring in this case under fairly general conditions:

Proposition 8.14: *Let $n^S = 0$. Suppose the model with homogeneous firms and $a^S = \lambda/(1+\lambda)$ has an equilibrium with $n^{M*} > 0$, and the model with heterogeneous firms has an equilibrium with $((w^{\breve{N}} a^N)/(w^S a^S)) < \underline{\nu}(\breve{n}^M)$ and $\breve{n}^M > 0$. Then $\breve{L}^N > L^{N*}$ if $\breve{n}^M \leq n^{M*}$. If $\breve{n}^M \leq n/2$ and $((w^{\breve{N}} a^N)/(w^S a^S)) \leq ((w^N a^N)/(w^S a^S))^*$, then $\breve{L}^N > L^{N*}$ also holds for $\breve{n}^M > n^{M*}$.*

Proof: See Appendix 8.10.5.[26] ||

Given that offshoring is an all-or-nothing decision (so that $n^M > n/2$ would mean that firms incur the fixed cost necessary to offshore more than half of the domestic products) and that an equilibrium in which offshoring responds to wage policy is located to the left of $\underline{\nu}(n^M)$ in Figure 8.8 (so that the relative production cost tends to be low), the conditions of the proposition imposed in the case $\breve{n}^M > n^{M*}$ appear rather weak. The proposition states that productivity uncertainty is conducive to high employment, since, as in Skaksen (2004), it means that unions have to take into account the impact of wage increases on realized offshoring.

Proposition 8.14 compares employment in equilibria with or without uncertainty for a given labor requirement for offshoring f^M. Another question (addressed in Section 8.4 for the case of homogeneous firms) is how equilibrium employment responds to changes in f^M in the model with uncertainty. Generally, employment can increase or decrease (locally) when f^M rises and can be higher or lower than the employment level that arises when f^M is large enough so that there is no offshoring in equilibrium. In the example in the proof of Proposition

[26] We also illustrate Proposition 8.14 by means of examples. First, consider the case $\breve{n}^M \leq n^{M*}$. Let $\bar{L}^N = 30$, $\bar{L}^S = 35$, $\alpha = 0.5$, $a^N = 0.3$, $a^S = 0.6364$, $n = 5$, $n^S = 0$, $f^M = 8$, $b = 2.5$, $\beta = 0.5$, and $\lambda = 1.75$. The model with homogeneous firms has an equilibrium with $n^{M*} = 1.5066$, $((w^N a^N)/(w^S a^S))^* = 2.1063$, and $L^{N*} = 5.6544$. For the model with heterogeneous firms, the following equilibrium values are obtained: $\breve{n}^M = 1.5909$ (and a proportion 0.5052 of the firms which have spent the fixed cost of offshoring go abroad), $((w^{\breve{N}} a^N)/(w^S a^S)) = 1.0638 < \underline{\nu}(\breve{n}^M) = 1.5772$, and $\breve{L}^N = 22.0834$. Hence, $\breve{L}^N$ is larger than L^{N*}. Second, consider the case $\breve{n}^M > n^{M*}$, $\breve{n}^M \leq n/2$, and $((w^{\breve{N}} a^N)/(w^S a^S)) \leq ((w^N a^N)/(w^S a^S))^*$. Let $\bar{L}^N = 30$, $\bar{L}^S = 40$, $\alpha = 0.5$, $a^N = 0.95$, $a^S = 0.8333$, $n = 5$, $n^S = 0$, $f^M = 3$, $b = 1.4$, $\beta = 0.5$, and $\lambda = 5$. The model with homogeneous firms has an equilibrium with $n^{M*} = 3.3021$, $((w^N a^N)/(w^S a^S))^* = 1.4907$, and $L^{N*} = 7.9377$. The equilibrium of the model with heterogeneous firms is: $\breve{n}^M = 2.2222 \leq n/2$ (and a proportion 0.4313 of these firms actually offshore production), $((w^{\breve{N}} a^N)/(w^S a^S)) = 1.0142 < \underline{\nu}(\breve{n}^M) = 1.1954$ (and $\leq ((w^N a^N)/(w^S a^S))^* = 1.4907$), and $\breve{L}^N = 126.3848 > L^{N*}$. (In both examples, the condition that the owners of those firms which incur the fixed cost but do not offshore have non-negative income is satisfied.)

8.13, n^M falls to zero for $f^M = 108$. Employment, at 2.6442, is then lower than in either of the two equilibria which exist for $f^M = 8$. Numerical experimentation suggests that, as one would expect, employment is generally higher than without offshoring in equilibria with $((w^{\breve{N}}a^N)/(w^S a^S)) < \underline{\nu}(\breve{n}^M)$.

8.9 Conclusion

Popular concerns about adverse employment effects of offshoring production to low-wage countries are not hard to reconcile with standard economic theory. Incorporating an offshoring decision and standard RTM union wage setting into the standard Krugman (1979a) North-South trade model yields a model in which negative effects of decreases in the cost of offshoring are the rule rather than the exception. The popular concerns cannot be discarded on the grounds that they are incompatible with basic principles of economics. The model casts doubt on the presence of gains from trade with low-wage countries for countries with a strongly unionized labor market[27] and explains shrinking union power as an equilibrium phenomenon.

A more optimistic view of the employment effects of offshoring can be justified by a model with heterogeneous firms, in which unions can prevent the relocation of production to a foreign subsidiary by moderating their wage claims. This model possibly gives rise to multiple equilibria, which differ in terms of wage policies and employment levels.

Our baseline one-factor model is flexible enough to incorporate the possibility of commitment to a PUL, a second factor of production, or firm heterogeneity. So there is probably scope for other extensions and modifications. The most promising direction for future research seems to be the integration of a value chain with different tasks and trade in tasks as in Grossman and Rossi-Hansberg (2008). In such a setup one could investigate the impact of the joint distribution of the offshoring cost and reductions in the production cost across the stages of the value chain on wage setting and employment.

In this chapter, our analysis considering union wage setting and offshoring to low-wage countries illustrated the factors which determine the decision to relocate production abroad via FDI as well as the impact of offshoring on domestic employment and production cost in both countries. In the variant of the model with heterogeneous firms, we showed how

[27] This result contrasts with the statement of Greg Mankiw mentioned in Chapter 5.

productivity uncertainty influences the results. Part III of this dissertation was devoted to this second application of the economics of investment in the presence of risk and market frictions. Chapter 9 provides some concluding remarks on this dissertation.

8.10 Appendix

8.10.1 Proof of Proposition 8.7

Proof: The condition for non-profitability of further offshoring in industries with the RTM wage (8.6) is unchanged. The fact that the wage is lower implies that there is no offshoring in industries with a PUL. The price setting equation and the condition for labor market clearing in the South become

$$\begin{aligned}\left(\frac{w^N a^N}{P}\right)^{\varepsilon-1} &= (1-\mu)\left[\alpha^{\varepsilon-1}\left(n-n^S-n^M\right)+\left(n^S+\alpha^{\varepsilon-1}n^M\right)\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon-1}\right] \\ &\quad +\mu\left[\left(\frac{\alpha}{\delta}\right)^{\varepsilon-1}\left(n-n^S\right)+n^S\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon-1}\right] \qquad (8.44)\end{aligned}$$

and

$$\bar{L}^S = \left[\alpha^{-\varepsilon}n^S+(1-\mu)n^M\right]\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon} a^S x^N+(1-\mu)n^M f^M, \qquad (8.45)$$

respectively. Equations (8.5), (8.6), (8.23), (8.44), and (8.45) determine w^N/P, n^M, $(w^N a^N)/(w^S a^S)$, x^N, and μ. Equation (8.21) then pins down $\tilde{w}^N/P$. From (8.6) and (8.44),

$$\frac{w^N a^N}{w^S a^S} = \left[\frac{(\omega^N)^{\varepsilon-1}-\alpha^{\varepsilon-1}\left(1-\mu+\frac{\mu}{\delta^{\varepsilon-1}}\right)\left(n-n^S\right)+(1-\mu)\alpha^{\varepsilon-1}n^M}{n^S+(1-\mu)\alpha^{\varepsilon-1}n^M}\right]^{\frac{1}{\varepsilon-1}} = \tilde{f}(n^M,\mu), \qquad (8.46)$$

where $\tilde{f}:[0,\, n-n^S]\times[0,1]\to\mathbb{R}$. From (8.5) and (8.45),

$$\frac{w^N a^N}{w^S a^S} \leq \left[1-(\varepsilon-1)\frac{\alpha^{-\varepsilon}n^S+(1-\mu)n^M}{\frac{\bar{L}^S}{f^M}-(1-\mu)n^M}\right]^{\frac{1}{1-\varepsilon}} = \tilde{g}(n^M,f^M,\mu), \quad n^M\geq 0, \qquad (8.47)$$

with at most one strict inequality, where $\tilde{g}$ maps $\{(n^M,f^M,\mu)\in\mathbb{R}^2_+\times[0,1]\,|\,(1-\mu)n^M < [\bar{L}^S/f^M-(\varepsilon-1)\alpha^{-\varepsilon}n^S]/\varepsilon\}$ on $\mathbb{R}_+$. Let the measure of firms which offshore in industries with the RTM wage $\tilde{n}^{M*}$ be determined by (8.23) holding with equality. The assumption that n^{M*} satisfies the first inequality in (8.23) implies $n^{M*}>0$ and $0<\tilde{n}^{M*}<n^{M*}$. The question is: does there exist $\tilde{\mu}\in(0,1)$ such that $\tilde{f}(\tilde{n}^{M*},\tilde{\mu})=\tilde{g}(\tilde{n}^{M*},f^M,\tilde{\mu})$?

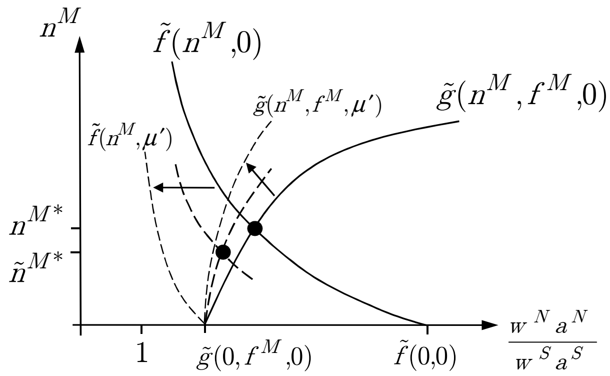

Figure 8.10: Equilibrium with $\tilde{\mu} \in (0,1)$.

The fact that $n^{M*} > 0$ implies $\tilde{f}(0,0) = f(0) > g(0,f^M) = \tilde{g}(0,f^M,0)$. From (8.24), (8.46), and (8.47), we have $\tilde{f}(0,1) < \tilde{g}(0,f^M,1)$. So $\tilde{f}(0,\mu') = \tilde{g}(0,f^M,\mu')$ for some $\mu' \in (0,1)$. For given f^M, let $\varphi : [0,\mu'] \to \mathbb{R}_+$ be defined by $\tilde{f}(\varphi(\mu),\mu) = \tilde{g}(\varphi(\mu),f^M,\mu)$. φ is a continuous real-valued function. By construction, $\varphi(0) = n^{M*}$ and $\varphi(\mu') = 0$. Hence, there is $\tilde{\mu} \in (0,\mu')$ such that $\varphi(\tilde{\mu}) = \tilde{n}^{M*}$, i.e., $\tilde{f}(\tilde{n}^{M*},\tilde{\mu}) = \tilde{g}(\tilde{n}^{M*},f^M,\tilde{\mu})$ (cf. Figure 8.10).
The fact that $n^{M*} > 0$ implies $f^M < \bar{f}^M$. This does not contradict (8.24), since the right-hand side of (8.24) is less than $\bar{f}^M$. $\tilde{n}^{M*} < n^{M*}$ implies the validity of $(1-\mu)\tilde{n}^{M*} < \bar{L}^S/f^M$ and $\tilde{n}^{M*} < n - n^S$. The condition for unemployment in industries with a PUL is:

$$(n-n^S)\delta^{-\varepsilon}a^N \frac{\bar{L}^S - (1-\mu')\tilde{n}^{M*}f^M}{a^S\left[\alpha^{-\varepsilon}n^S + (1-\mu')\tilde{n}^{M*}\right]}\left[\frac{n^S + \alpha^{\varepsilon-1}\tilde{n}^{M*}}{(\omega^N)^{\varepsilon-1} - \left(1-\mu' + \frac{\mu'}{\delta^{\varepsilon-1}}\right)(n-n^S)}\right] < \bar{L}^N.$$

Since $\tilde{n}^{M*}$ and μ' are independent of $\bar{L}^N$, the condition is satisfied for $\bar{L}^N$ large enough. Employment is lower in industries with RTM wages, so unemployment prevails there too. ||

8.10.2 Proofs of Propositions 8.8 to 8.11

Proof of Proposition 8.8: Rewrite (8.31) as

$$\begin{aligned}
0 &= \frac{B(n-n^S-n^M)^{-\frac{1}{\zeta(\varepsilon-1)}}}{a^S(\alpha^{-\varepsilon}n^S+n^M)}\left(\frac{w^N}{w^Sa^S}\right)^{-\varepsilon}\left[\frac{(\hat{\omega}^N)^{\varepsilon-1} - (n^S+\alpha^{\varepsilon-1}n^M)\left(\frac{w^N}{w^Sa^S}\right)^{\varepsilon-1}}{\alpha^{\varepsilon-1}}\right]^{\frac{1+\zeta(\varepsilon-1)}{\zeta(\varepsilon-1)}} \\
&\quad -\frac{\bar{H}^N - n^Mf^N}{\bar{L}^S - n^Mf^M} \\
&= \hat{F}\left(n^M, \frac{w^N}{w^Sa^S}, f^N, f^M\right). \qquad (8.48)
\end{aligned}$$

Rewrite (8.32) as

$$\begin{aligned} 0 \quad &\geq \quad \alpha^{\varepsilon-1}(n-n^S)+n^S-(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} \\ &\quad -(\varepsilon-1)\frac{f^M+\frac{w^N}{w^S a^S}a^S f^N}{\bar{L}^S-n^M f^M}\alpha^{\varepsilon-1}(n-n^S-n^M)(\alpha^{-\varepsilon}n^S+n^M) \\ &= \quad \hat{G}\left(n^M,\frac{w^N}{w^S a^S},f^N,f^M\right), \quad n^M\geq 0, \end{aligned} \tag{8.49}$$

with at most one strict inequality.

Here and in what follows, we do not specify domain and range of functions, omit arguments when convenient, and do not label equilibrium values explicitly. We use subscripts n and w to indicate partial derivatives with respect to n^M and $w^N/(w^S a^S)$, respectively. Denote the function in the first line of (8.48) as $\check{F}$. $\check{F}_w<0$ for $w^N/(w^S a^S)<\hat{\omega}^N/(n^S+\alpha^{\varepsilon-1}n^M)^{1/(\varepsilon-1)}$. From (8.25), $\bar{H}^N-n^M f^N>0$ and $\bar{L}^S-n^M f^M>0$ for $n^M\in[0,n-n^S)$. So there is a unique $w^N/(w^S a^S)<\hat{\omega}^N/(n^S+\alpha^{\varepsilon-1}n^M)^{1/(\varepsilon-1)}$ that solves $\hat{F}(n^M,w^N/(w^S a^S),f^N,f^M)=0$ for $n^M\in[0,n-n^S)$ (see the left panel of Figure 8.11).[28] Define $\hat{f}(n^M,f^M,f^N)$ as this $w^N/(w^S a^S)$. From (8.34), $\check{F}(0,\hat{\nu}^N,f^N,f^M)>\bar{H}^N/\bar{L}^S$ and, therefore, $\hat{f}(0,f^M,f^N)>\hat{\nu}^N$. From (8.48), $\hat{f}(n-n^S,f^M,f^N)=\hat{\nu}^N$. Differentiating $\hat{F}$ partially yields

$$\begin{aligned} \hat{F}_n \quad &= \quad -\check{F}\Bigg[-\frac{1}{\zeta(\varepsilon-1)}\frac{1}{n-n^S-n^M}+\frac{1}{\alpha^{-\varepsilon}n^S+n^M} \\ &\quad +\frac{1+\zeta(\varepsilon-1)}{\zeta(\varepsilon-1)}\frac{\alpha^{\varepsilon-1}}{(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon}-(n^S+\alpha^{\varepsilon-1}n^M)}\Bigg] \\ &\quad -\frac{f^M\bar{H}^N-f^N\bar{L}^S}{(\bar{L}^S-n^M f^M)^2} \end{aligned} \tag{8.50}$$

and

$$\hat{F}_w=-\check{F}\left(\frac{w^N}{w^S a^S}\right)^{-1}\left[\varepsilon+\frac{1+\zeta(\varepsilon-1)}{\zeta}\frac{n^S+\alpha^{\varepsilon-1}n^M}{(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon}-(n^S+\alpha^{\varepsilon-1}n^M)}\right].$$

So $\hat{f}_n(n-n^S,f^M,f^N)=-\hat{F}_n(n-n^S,\hat{\nu}^N,f^N,f^M)/\hat{F}_w(n-n^S,\hat{\nu}^N,f^N,f^M)=\infty$. In sum, $\hat{f}(n^M,f^M,f^N)$ starts at $\hat{f}(0,f^M,f^N)>\hat{\nu}^N$ and goes to $\hat{\nu}^N$ with infinite slope as $n^M\to n-n^S$ (see Figure 8.5 in the main text).

[28] According to (8.30), $w^N/(w^S a^S)$ has to be smaller than $\hat{\omega}^N/(n^S+\alpha^{\varepsilon-1}n^M)^{1/(\varepsilon-1)}$ in an equilibrium. For the sake of completeness, we add that for $w^N/(w^S a^S)>\hat{\omega}^N/(n^S+\alpha^{\varepsilon-1}n^M)^{1/(\varepsilon-1)}$, $\hat{F}$ may rise or fall. In the left panel of Figure 8.11, we only draw the first case which corresponds to $(\zeta(\varepsilon-1)+1)/\zeta(\varepsilon-1)$ being an even number.

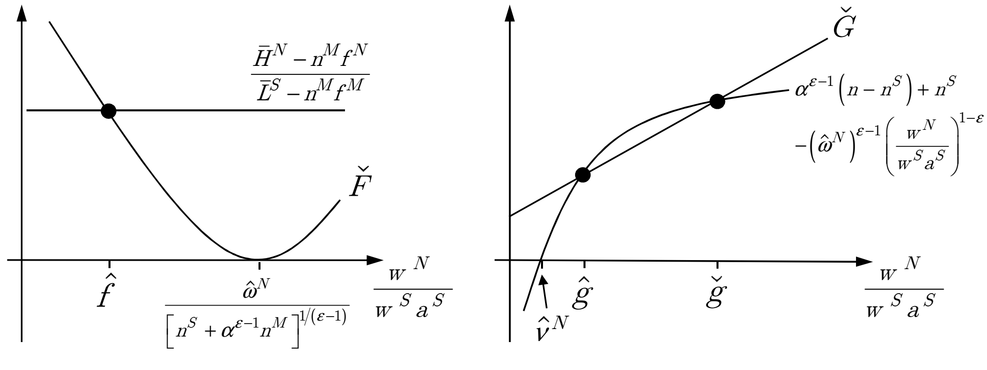

Figure 8.11: Determination of $\hat{f}$, $\hat{g}$, and $\check{g}$.

Define the function following the minus sign in the second line of (8.49) as $\check{G}$. As illustrated in the right panel of Figure 8.11, solutions $w^N/(w^S a^S)$ to (8.49) come in pairs. For (n^M, f^M, f^N) such that a solution exists, define $\hat{g}(n^M, f^M, f^N)$ as the smaller solution and $\check{g}(n^M, f^M, f^N)$ as the larger solution. As can be seen from Figure 8.11, $\hat{g}(n^M, f^M, f^N) > \hat{\nu}^N$ for all $n^M < n - n^S$. From (8.49), $\check{G}(n - n^S, w^N/(w^S a^S), f^M, f^N) = 0$, so $\hat{g}(n - n^S, f^M, f^N) = \hat{\nu}^N$. Differentiating $\hat{G}$ partially yields

$$\hat{G}_n = \check{G}\left(\frac{1}{n - n^S - n^M} - \frac{1}{\alpha^{-\varepsilon} n^S + n^M} - \frac{f^M}{\bar{L}^S - n^M f^M}\right) \tag{8.51}$$

and

$$\hat{G}_w = (\varepsilon - 1)(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{-\varepsilon} - \check{G}\frac{a^S f^N}{f^M + \frac{w^N}{w^S a^S} a^S f^N}.$$

Since $\check{G} > 0$, $\hat{G}_n > 0$ for n^M close enough to $n - n^S$. Since $\check{G}(n - n^S, w^N/(w^S a^S), f^M, f^N) = 0$, $\hat{G}_w > 0$ for n^M close enough to $n - n^S$. Hence, $\hat{g}_n(n - n^S, f^M, f^N) = -\hat{G}_n(n - n^S, \hat{\nu}^N, f^N, f^M)/\hat{G}_w(n - n^S, \hat{\nu}^N, f^N, f^M) < 0$.

For given n^M, if $\hat{g}(n^M, f^M, f^N)$ exists, then (8.49) holds exactly if $w^N/(w^S a^S) \leq \hat{g}(n^M, f^M, f^N)$. If $\hat{g}$ does not exist, then (8.49) holds. If $\hat{f}(n^M, f^M, f^N) = \hat{g}(n^M, f^M, f^N)$ or $\hat{f}(n^M, f^M, f^N) = \check{g}(n^M, f^M, f^N)$ for some $n^M > 0$, then n^M and $w^N/(w^S a^S) = \hat{f}(n^M, f^M, f^N)$ constitute an equilibrium with offshoring. The fact that $\check{g}(n^M, f^M, f^N) \geq \hat{g}(n^M, f^M, f^N) > \hat{\nu}^N$ implies that condition (8.33) is satisfied. If $\hat{g}(0, f^M, f^N)$ exists and $\hat{f}(0, f^M, f^N) < \hat{g}(0, f^M, f^N)$ or if $\hat{g}(0, f^M, f^N)$ does not exist, then $n^M = 0$ and $w^N/(w^S a^S) = \hat{f}(0, f^M, f^N)$ constitute an equilibrium without offshoring. $\hat{f}(0, f^M, f^N) > \hat{\nu}^N$ implies that (8.33) is satisfied.

Suppose $\hat{g}(0, f^M, f^N)$ exists and $\hat{f}(0, f^M, f^N) > \hat{g}(0, f^M, f^N)$. If $\hat{g}$ exists for all n^M, then $\hat{f}$ and $\hat{g}$ intersect for some $n^M > 0$ and an equilibrium with offshoring exists (see Figure 8.5

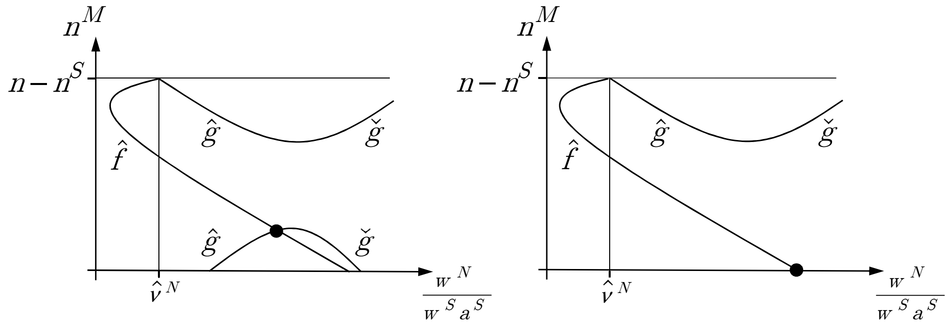

Figure 8.12: Existence of equilibrium with two factors of production.

in the main text). If $\hat{g}$ does not exist for all n^M, then $\hat{g}$ and $\check{g}$ converge for some $n^M > 0$ (corresponding to a tangency point in the right panel of Figure 8.11), so $\hat{f}$ intersects either $\hat{g}$ or $\check{g}$ and an equilibrium with $n^M > 0$ exists (see the left panel of Figure 8.12). If $\hat{g}(0, f^M, f^N)$ exists and $\hat{f}(0, f^M, f^N) \leq \hat{g}(0, f^M, f^N)$ or $\hat{g}(0, f^M, f^N)$ does not exist, then an equilibrium with $n^M = 0$ exists (see the right panel of Figure 8.12).

From cost minimization, employment in the North is $L^N = [(1-\zeta)/\zeta](v^N/w^N)(\bar{H}^N - n^M f^N)$. Using (8.30), this can be rewritten as

$$L^N = \frac{1-\zeta}{\zeta}\left[\frac{(\hat{\omega}^N)^{\varepsilon-1} - (n^S + \alpha^{\varepsilon-1} n^M)\left(\frac{w^N}{w^S a^S}\right)^{\varepsilon-1}}{\alpha^{\varepsilon-1}(n - n^S - n^M)}\right]^{\frac{1}{\zeta(1-\varepsilon)}} (\bar{H}^N - n^M f^N). \tag{8.52}$$

Since the equilibrium values of n^M and $w^N/(w^S a^S)$ are independent of $\bar{L}^N$, there is unemployment for $\bar{L}^N$ sufficiently large. ||

Proof of Proposition 8.9: From (8.48) and (8.49),

$$\hat{F}_f = -\frac{n^M(\bar{H}^N - n^M f^N)}{(\bar{L}^S - n^M f^M)^2} \tag{8.53}$$

and

$$\hat{G}_f = -\check{G}\left(\frac{1}{f^M + \frac{w^N}{w^S a^S} a^S f^N} + \frac{n^M}{\bar{L}^S - n^M f^M}\right), \tag{8.54}$$

where subscript f denotes partial differentiation with respect to f^M. So

$$\hat{F}_w < 0,\ \hat{F}_n < 0,\ \hat{F}_f < 0,\ \hat{G}_w > 0,\ \hat{G}_f < 0,\ \frac{\hat{F}_n}{\hat{F}_w} > \frac{\hat{G}_n}{\hat{G}_w} \tag{8.55}$$

in equilibrium. The final inequality states that $\hat{f}_n < \hat{g}_n$. From (8.48) and (8.49),

$$\frac{dn^M}{df^M} = \frac{\hat{F}_w \hat{G}_f - \hat{F}_f \hat{G}_w}{\hat{F}_n \hat{G}_w - \hat{F}_w \hat{G}_n}, \quad \frac{d\left(\frac{w^N}{w^S a^S}\right)}{df^M} = \frac{\hat{F}_f \hat{G}_n - \hat{F}_n \hat{G}_f}{\hat{F}_n \hat{G}_w - \hat{F}_w \hat{G}_n}.$$

From (8.55), an increase in the labor requirement for offshoring in the South reduces the equilibrium amount of offshoring: $dn^M/df^M < 0$.

The wage gap between North and South for unskilled labor increases (i.e., $d(w^N/(w^S a^S))/df^M > 0$) if, and only if,

$$\hat{F}_f \hat{G}_n < \hat{F}_n \hat{G}_f.$$

From (8.55), this condition is satisfied if $\hat{G}_n \geq 0$. In the opposite case, inserting (8.50), (8.51), (8.53), and (8.54), dividing by $\check{G}$ (> 0), using $\check{F} = (\bar{H}^N - n^M f^M)/(\bar{L}^S - n^M f^M)$, multiplying by $(\bar{L}^S - n^M f^M)^2/(\bar{H}^N - n^M f^M)$ (> 0), and simplifying terms yields

$$\begin{aligned}
-\frac{n^M[\bar{L}^S - (n - n^S) f^M]}{(n - n^S - n^M)(\bar{L}^S - n^M f^M)} \quad < \quad & \left(\frac{\bar{L}^S - n^M f^M}{f^M + \frac{w^N}{w^S a^S} a^S f^N} + n^M\right) \\
& \cdot \left\{ \frac{1}{\zeta(\varepsilon - 1)} \left[-\frac{1}{n - n^S - n^M} \right.\right. \\
& \left. + \frac{\alpha^{\varepsilon-1}}{(\hat{\omega}^N)^{\varepsilon-1} \left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S + \alpha^{\varepsilon-1} n^M)} \right] \\
& + \frac{\alpha^{\varepsilon-1}}{(\hat{\omega}^N)^{\varepsilon-1} \left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S + \alpha^{\varepsilon-1} n^M)} \\
& \left. + f^M f^N \frac{\frac{\bar{H}^N}{f^N} - \frac{\bar{L}^S}{f^M}}{(\bar{H}^N - n^M f^N)(\bar{L}^S - n^M f^M)} \right\} \\
& + \frac{\bar{L}^S - n^M f^M}{f^M + \frac{w^N}{w^S a^S} a^S f^N} \frac{1}{\alpha^{-\varepsilon} n^S + n^M}.
\end{aligned}$$

The fact that $w^N/(w^S a^S) > \hat{\nu}^N$ implies that the term in square brackets in the second and third lines is positive. So the validity of the inequality follows from condition (8.25). $||$

Proof of Proposition 8.10: Log-differentiate (8.52) to obtain

$$\begin{aligned} \frac{d\ln L^N}{df^M} = & \left[-\frac{f^N}{\bar{H}^N - n^M f^N} - \frac{1}{\zeta(\varepsilon-1)}\frac{1}{n-n^S-n^M}\right. \\ & \left. +\frac{1}{\zeta(\varepsilon-1)}\frac{\alpha^{\varepsilon-1}}{(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S + \alpha^{\varepsilon-1}n^M)}\right]\frac{dn^M}{df^M} \\ & +\frac{1}{\zeta}\frac{(n^S+\alpha^{\varepsilon-1}n^M)\left(\frac{w^N}{w^S a^S}\right)^{-1}}{(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S + \alpha^{\varepsilon-1}n^M)}\frac{d\left(\frac{w^N}{w^S a^S}\right)}{df^M}. \end{aligned} \tag{8.56}$$

From (8.56), $dL^N/df^M > 0$ exactly if

$$\begin{aligned} 0 < & \left\{-\left[\frac{\zeta(\varepsilon-1)f^N}{\bar{H}^N - n^M f^N} + \frac{1}{n-n^S-n^M}\right]\right. \\ & \left.\cdot\left[(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S+\alpha^{\varepsilon-1}n^M)\right] + \alpha^{\varepsilon-1}\right\}\frac{dn^M}{df^M} \\ & +(\varepsilon-1)(n^S+\alpha^{\varepsilon-1}n^M)\left(\frac{w^N}{w^S a^S}\right)^{-1}\frac{d\left(\frac{w^N}{w^S a^S}\right)}{df^M}. \end{aligned} \tag{8.57}$$

From (8.49),

$$\alpha^{\varepsilon-1} - \frac{(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S+\alpha^{\varepsilon-1}n^M)}{n-n^S-n^M} \leq (\varepsilon-1)\frac{f^M + \frac{w^N}{w^S a^S}a^S f^N}{\bar{L}^S - n^M f^N}(\alpha^{-1}n^S + \alpha^{\varepsilon-1}n^M).$$

So for $f^M \to 0$ and $f^N \to 0$, the (potentially negative) term in braces in (8.57) goes to zero, and the assertion follows from $d(w^N/(w^S a^S))/df^M > 0$ (cf. Proposition 8.9). ||

Proof of Proposition 8.11: Southern workers' utility is $w^S/P = (w^S/w^N)(w^N/P)$. The real wage for unskilled labor in the North w^N/P is fixed via (8.28). From Proposition 8.9, $d(w^N/(w^S a^S))/df^M > 0$. So w^S/P rises as f^M falls.

As their real wage is fixed, unskilled Northern workers' expected utility falls whenever employment falls. From Proposition 8.10, this happens for f^M and f^N small enough.

The real wage of skilled workers in the North $v^N/P = (v^N/w^N)(w^N/P)$ falls whenever v^N/w^N falls. From (8.30), v^N/w^N is given by the power term in (8.52), so

$$\frac{d\ln\left(\frac{v^N}{w^N}\right)}{df^M} = \frac{d\ln L^N}{df^M} + \frac{f^N}{\bar{H}^N - n^M f^N}.$$

The fact that L^N decreases as f^M falls for f^M and f^N small enough implies that v^N/w^N and, hence, v^N/P also fall for f^M and f^N small enough. ||

8.10.3 Proof of Proposition 8.12

Proof: The upper right panel of Figure 8.13 depicts the dependence of the monopoly union wage in the North on the real wage in the South. The upper left panel of Figure 8.13 illustrates the dependence of $(w^N a^N)/(w^S a^S)$ on w^S/P. For $w^S/P < \breve{\omega}^S(n^M)$, w^N/P is constant, so $(w^N a^N)/(w^S a^S)$ falls as w^S/P rises. At $w^S/P = \breve{\omega}^S(n^M)$, $(w^N a^N)/(w^S a^S)$ jumps downward, from above $1/a^S$ to below $1/a^S$. For $w^S/P > \breve{\omega}^S(n^M)$, from (8.37), $(w^N a^N)/(w^S a^S)$ and w^N/P are inversely related. Since w^N/P is an increasing function of w^S/P, $(w^N a^N)/(w^S a^S)$ is a decreasing function of w^S/P.

Consider the inverse of the mapping of w^S/P on $(w^N a^N)/(w^S a^S)$ depicted in the upper left panel of Figure 8.13. Let $\underline{\nu}(n^M)$ be implicitly determined by

$$\underline{\nu}(n^M) = \frac{\breve{\omega}^N(\underline{\nu}(n^M), n^M)}{\breve{\omega}^S(n^M)a^S},$$

and

$$\bar{\nu}(n^M) = \frac{\omega^N}{\breve{\omega}^S(n^M)a^S}.$$

Notice that $\underline{\nu}(n^M) \leq 1/a^S \leq \bar{\nu}(n^M)$. For $(w^N a^N)/(w^S a^S) \leq \underline{\nu}(n^M)$, there is w^S/P which induces the monopoly union to set $w^N/P = \breve{\omega}^N((w^N a^N)/(w^S a^S), n^M)/a^N$. For $(w^N a^N)/(w^S a^S) \geq \bar{\nu}(n^M)$, there is w^S/P such that $w^N/P = \omega^N/a^N$. For $(w^N a^N)/(w^S a^S) \in (\underline{\nu}(n^M), \bar{\nu}(n^M))$, there is no pair $(w^S/P, w^N/P)$ consistent with the monopoly union's maximizing decision. For $(w^N a^N)/(w^S a^S) < \underline{\nu}(n^M)$, when $(w^N a^N)/(w^S a^S)$ increases, w^S/P and, hence, w^N/P fall (and $w^N/P = \breve{\omega}^N(0, n^M)/a^N = \omega^N/a^N$ for $(w^N a^N)/(w^S a^S) = 0$). So the wage rate w^N/P set by the monopoly union is a non-increasing function of $(w^N a^N)/(w^S a^S)$ in each of the intervals $(0, \underline{\nu}(n^M))$ and $(\bar{\nu}(n^M), \infty)$; but as $(w^N a^N)/(w^S a^S)$ jumps upward from $\underline{\nu}(n^M)$ to $\bar{\nu}(n^M)$, the monopoly real wage jumps upward from $\breve{\omega}^N(\underline{\nu}(n^M), n^M)$ to ω^N/a^N.

An increase in n^M reduces the value of the union's objective function (8.36) for all $w^N/P > b^{1/\beta}$. From the envelope theorem, the derivative of the maximum value of the union's objective function with respect to n^M is proportional to $\max\{(w^N a^N/w^S)^\lambda, 1\}$. Starting from a situation such that $w^S/P = \breve{\omega}^S(n^M)$ (so that (8.36) has two maxima), let n^M rise. Since the value of the maximum with $w^N/P > (w^S/P)/a^N$ (i.e., $\max\{(w^N a^N/w^S)^\lambda, 1\} = 1$) reacts

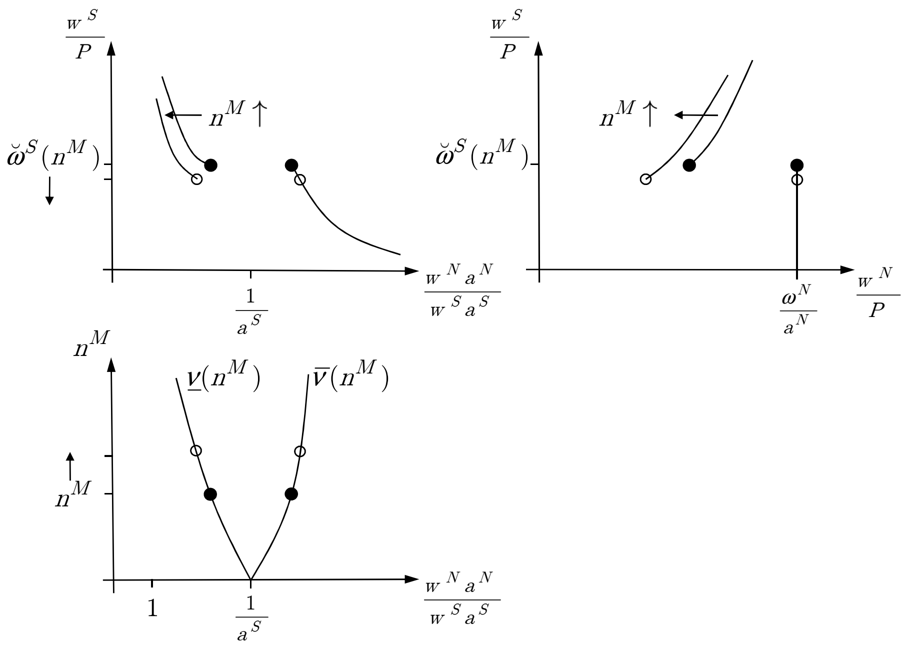

Figure 8.13: Admissible $((w^N a^N)/(w^S a^S), n^M)$ pairs.

stronger to the increase in n^M, the maximum with $w^N/P < (w^S/P)/a^N$ now has a higher value. Since the objective function decreases when w^S/P falls for $w^N/P < (w^S/P)/a^N$ and is independent of w^S/P for $w^N/P > (w^S/P)/a^N$, w^S/P has to fall in order to restore two maxima again, i.e., $\breve{\omega}^S(n^M)$ is a decreasing function. $\breve{\omega}^N((w^N a^N)/(w^S a^S), n^M)$ is decreasing in its second argument. So for any $w^S/P > \breve{\omega}^S(n^M)$, the optimum wage rate w^N/P and, consequently, $(w^N a^N)/(w^S a^S)$ fall as n^M rises (i.e., the relevant portions of the graphs in the upper panels of Figure 8.13 shift to the left). For the inverse of the mapping from w^S/P to $(w^N a^N)/(w^S a^S)$, this means that the bounds of the interval of non-admissible $(w^N a^N)/(w^S a^S)$-values $(\underline{\nu}(n^M), \bar{\nu}(n^M))$ change (the upper bound rises, the lower bound may rise or fall).[29] For n^M and, hence, $\max\{(w^N a^N/w^S)^\lambda, 1\}\, n^M$ close to zero, the difference between the two optimum wages w^N/P for $w^S/P = \breve{\omega}^S(n^M)$ is small, so $\underline{\nu}(n^M)$ and $\bar{\nu}(n^M)$ are close to $1/a^S$ (see the bottom panel of Figure 8.13). ||

[29] An increase in n^M leads to a rise in $\bar{\nu}(n^M) = \omega^N/\breve{\omega}^S(n^M)a^S$, since $\breve{\omega}^S(n^M)$ is a decreasing function of n^M and ω^N is independent of n^M. $\underline{\nu}(n^M)$, which is implicitly determined by $\underline{\nu}(n^M) = \breve{\omega}^N(\underline{\nu}(n^M), n^M)/\breve{\omega}^S(n^M)a^S$, may rise or fall due to opposing effects.

8.10.4 Proposition 8.A.1

Proposition 8.A.1: *Suppose productivity in Southern plants of MNEs is certain and firms have the option to offshore. Then an equilibrium with $n^M > 0$ coincides with the equilibrium of the (identically parameterized) model with irreversible offshoring. The set of parameters for which equilibrium exists is smaller than in the model with irreversible offshoring.*

Proof: Firms which have spent the fixed cost of offshoring move production to the South exactly if production is more expensive in the North, i.e., if $w^N a^N > w^S a^S$. So the unions' objective function is (omitting variables taken as given by the monopoly union)

$$\left(n - n^S - \mathbf{1}_{\frac{w^N a^N}{w^S a^S} > 1} n^M\right) \left[\left(\frac{w^N}{P}\right)^\beta - b\right] \left(\frac{w^N}{P}\right)^{-\varepsilon}, \tag{8.58}$$

where $\mathbf{1}$ is the indicator function. Unions set $w^N/P = \omega^N/a^N$ or $w^N/P = (w^S a^S)/(a^N P)$ (so that $w^N a^N = w^S a^S$ and the potential offshorers stay at home), depending on which real wage yields the higher value of the objective function. But $w^N a^N > w^S a^S$ in an equilibrium with $n^M > 0$, since no firm would spend the fixed cost of offshoring if the operating profit differential between producing in a Southern subsidiary and in the North were non-positive. So there cannot be an equilibrium with $n^M > 0$ and $w^N/P \neq \omega^N/a^N$. As a consequence, the same conditions as in the model with irreversible offshoring determine equilibrium prices and quantities. An additional condition for existence is that the objective function (8.58) takes on a higher value at ω^N/a^N than at $(w^S a^S)/(a^N P)$. ||

8.10.5 Proof of Proposition 8.14

Proof: In the model with homogeneous firms, if (8.5) holds, equilibrium employment in the North satisfies

$$L^N = (n - n^M) \frac{a^N}{a^S} \frac{(\varepsilon - 1) f^M}{\frac{w^N a^N}{w^S a^S} \left[\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon - 1} - 1\right]}. \tag{8.59}$$

With firm heterogeneity, employment satisfies $L^N = [n - (w^N a^N / w^S)^\lambda n^M] a^N x^N$. If (8.40) holds and $w^N a^N / w^S < 1$, then

$$\begin{aligned} L^N &= \left[n - \left(\frac{w^N a^N}{w^S} \right)^{\lambda} n^M \right] a^N \frac{(\lambda + 1 - \varepsilon) f^M}{\left(\frac{w^N a^N}{w^S} \right)^{1+\lambda}} \\ &> (n - n^M) a^N \frac{(\lambda + 1 - \varepsilon) f^M}{\left(\frac{w^N a^N}{w^S} \right)^{1+\lambda}}. \end{aligned} \tag{8.60}$$

As in the model with homogeneous firms, employment is proportional to the mass of firms active in the North and to the scale of each firm, and firm scale is a monotonically decreasing function of relative production cost $(w^N a^N)/(w^S a^S)$ alone. Given $n^S = 0$, (8.43) alone determines the mass of firms which incur the fixed cost of offshoring if $(\breve{w^N a^N})/(w^S a^S) \leq \underline{\nu}(\breve{n}^M)$:

$$\breve{n}^M = \frac{1}{1+\lambda} \frac{\bar{L}^S}{f^M}. \tag{8.61}$$

Let

$$\breve{\nu} = \left(\frac{\lambda}{\lambda + 1 - \varepsilon} \right)^{\frac{1}{\varepsilon - 1}}.$$

Further, let

$$L^{N\prime} = (n - \breve{n}^M) \frac{a^N}{a^S} \frac{(\lambda + 1 - \varepsilon) f^M}{\breve{\nu}}$$

denote the value of (8.59) evaluated at $((\breve{w^N a^N})/(w^S a^S),\, n^M) = (\breve{\nu},\, \breve{n}^M)$. The first assertion of the proposition follows from the fact that $\breve{L}^N > L^{N\prime}$ and $L^{N\prime} > L^{N*}$ if $\breve{n}^M \leq n^{M*}$. From (8.60) and $(\breve{w^N a^N}/w^S) < 1$,

$$\breve{L}^N > (n - \breve{n}^M) a^N (\lambda + 1 - \varepsilon) f^M.$$

The validity of $\breve{L}^N > L^{N\prime}$ follows from the fact that

$$a^S \breve{\nu} = \frac{\lambda}{1+\lambda} \left(\frac{\lambda}{\lambda + 1 - \varepsilon} \right)^{\frac{1}{\varepsilon - 1}} > 1$$

for $\lambda > \varepsilon - 1$ (the expression on the left-hand side is decreasing in λ and converges to unity as $\lambda \to \infty$). From (8.10), $g(\breve{n}^M,\, f^M) = \breve{\nu}$. From $\breve{n}^M \leq n^{M*}$ and the fact that g is increasing in n^M, it follows that $((w^N a^N)/(w^S a^S))^* \geq \breve{\nu}$ (cf. Figure 8.14). Since the right-hand side of (8.59) is a decreasing function of both $(w^N a^N)/(w^S a^S)$ and n^M (whenever g is positive-valued), it follows that $L^{N\prime} > L^{N*}$.[30]

[30] Analogously, from the fact that $\breve{g}$ is an increasing function of n^M and (8.60), it follows that if two equilibria

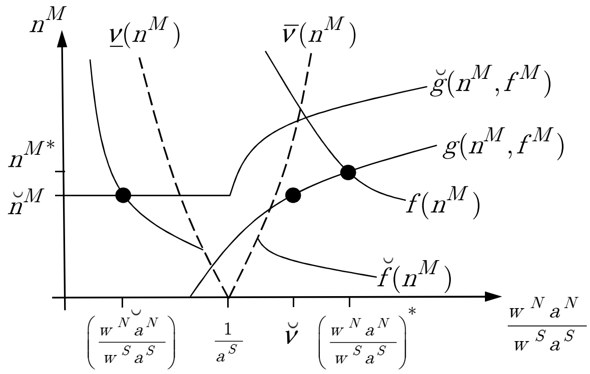

Figure 8.14: Employment with and without uncertainty.

Turning to the case $\breve{n}^M < n/2$, $(w^N a^N)\breve{}/(w^S a^S) < ((w^N a^N)/(w^S a^S))^*$, and $\breve{n}^M > n^{M*}$, from (8.8), (8.59), and $\breve{\omega}^N((w^N a^N)\breve{}/(w^S a^S), \breve{n}^M) < \omega^N$, equilibrium employment in the model with homogeneous firms satisfies

$$L^{N*} < (n - n^{M*})\frac{a^N}{a^S}\frac{(\varepsilon-1)f^M}{\left(\frac{w^N a^N}{w^S a^S}\right)^* \frac{\breve{\omega}^N\left(\breve{\left(\frac{w^N a^N}{w^S a^S}\right)}, \breve{n}^M\right)^{\varepsilon-1} - \alpha^{\varepsilon-1}n}{\alpha^{\varepsilon-1}n^{M*}}}.$$

Given $n^S = 0$, for $(w^N a^N)/(w^S a^S) \leq \underline{\nu}(n^M)$, (8.42) becomes

$$\frac{\varepsilon-1}{\lambda+1-\varepsilon}\left(\frac{w^N a^N}{w^S}\right)^\lambda = \frac{\breve{\omega}^N\left(\frac{w^N a^N}{w^S a^S}, n^M\right) - \alpha^{\varepsilon-1}n}{\alpha^{\varepsilon-1}n^M}.$$

Hence,

$$L^{N*} < (n - n^{M*})a^N \frac{(\lambda+1-\varepsilon)f^M}{\left(\frac{w^N a^N}{w^S}\right)^* \breve{\left(\frac{w^N a^N}{w^S}\right)}^\lambda}\frac{n^{M*}}{\breve{n}^M}.$$

From (8.60), $\breve{L}^N > L^{N*}$ is implied by

$$\frac{(n - \breve{n}^M)\breve{n}^M}{\breve{\left(\frac{w^N a^N}{w^S}\right)}} > \frac{(n - n^{M*})n^{M*}}{\left(\frac{w^N a^N}{w^S}\right)^*}.$$

$n^{M*} < \breve{n}^M \leq n/2$ implies that the numerator on the left-hand side is greater than the numerator on the right-hand side. So the validity of the inequality follows from $((w^N a^N)\breve{}/(w^S a^S)) \leq ((w^N a^N)/(w^S a^S))^*$. ||

with $n^M > 0$ exist in the model with firm heterogeneity, employment is higher in the equilibrium with little offshoring (n^M low) and a low wage differential ($(w^N a^N)/(w^S a^S)$ low).

Part IV

Conclusion

Chapter 9

Summary and future research

This dissertation presents two applications of the economics of investment in the presence of risk and market frictions. The first application addresses the role of aggregate risk in credit markets with asymmetric information, while the second analyzes the employment effects of offshoring in a model with union wage setting. We were motivated to study these topics due to their relevance and insufficient consideration in economic theory so far. In the following, we summarize our main results and outline some future research directions.

In Part II, we introduced non-diversifiable risk in the seminal Stiglitz and Weiss (1981) adverse selection model. Portfolio risk rises if the average riskiness of the projects financed increases, and lenders have to bear this risk. This opens up the possibility of a credit rationing equilibrium. In contrast, a rationing equilibrium cannot arise in the original Stiglitz and Weiss (1981) model, as shown independently by Coco (1997) and Arnold and Riley (2009). In our model, lenders' degree of risk aversion plays a crucial role. In order to conduct comparative statics analysis with respect to this parameter, we generalized the model by using a non-expected utility framework that separates risk aversion from the preference for intertemporal consumption smoothing. It is shown that there is a switch from a two-price equilibrium to a pure rationing equilibrium when the degree of risk aversion grows sufficiently large. Comparing the two types of equilibrium from a welfare point of view, the two-price equilibrium is more inefficient. The imposition of a usury law may thus raise welfare if it rules out the higher interest rate of a two-price equilibrium. Additionally, we derived optimal investment in a first-best and a second-best solution. Relative to both optima, the credit market equilibrium may be characterized by underinvestment or overinvestment. Hence, credit rationing does not necessarily imply too little investment. Overinvestment can arise if collateral is high and firm owners get little consumption in the optimum. This contrasts with the standard underinvestment result for the original Stiglitz and Weiss (1981) model.

In sum, the introduction of non-diversifiable risk has profound effects on equilibrium and welfare. We modified a standard theoretical model in order to illustrate the fact that the common assumption of independent project payoffs not only reduces complexity in credit market models with asymmetric information but also significantly influences the equilibrium outcome and the welfare implications.

This aspect points to an avenue for future research. Although the information-based models considerably improved our understanding of equilibrium credit rationing, they have the shortcoming that they abstract from portfolio risk. As non-diversifiable risk plays a major role in financial markets, it would be desirable that this kind of risk is also considered in credit market models. We suggest further development of the theory in this direction, and our analysis demonstrates a possibility of integrating portfolio risk in existing credit market models with asymmetric information. More generally, correlations and non-diversifiable risk matter in many areas, but they have not always received sufficient attention in the theoretical literature.[1] Therefore, other fields of financial economics should as well put more emphasis on these aspects.

In Part III, we first provided a comprehensive literature survey on offshoring and its labor market effects, bringing together the different strands of literature. Concerning the phenomenon of offshoring, the analyzed scenarios differ considerably between the numerous contributions. Some main differences are: skill-specific versus economy-wide (or industry-specific) offshoring, two-way offshoring between identical countries versus production relocation from North to South, and cost-saving versus market-seeking offshoring. While several studies focus on the determinants of offshoring and organizational choice, others consider the impact of offshoring on wages, the skill-bias, trade flows, employment, welfare, and many other aspects. As most papers use full employment models, the literature on the aggregate employment effect of offshoring is still limited. To incorporate unemployment, the models consider search frictions, fair wages, and union wage setting. Up to now, it is not

[1] Of course, there are exceptions which also analyze the role of correlations. Katzur and Lensink (2010), for example, consider correlated project payoffs in the context of group lending in microfinance.

fully understood which factors determine the nature and the magnitude of the employment effect. In particular, the impact of different labor market characteristics on the employment effect has not been sufficiently analyzed. The empirical literature does not resolve these issues either, since the findings are inconclusive and the studies have serious limitations. Concerning the employment effect of offshoring to low-wage countries, existing models assume that the North is a small open economy relative to the emerging South, i.e., the production cost in the South is exogenously given. This assumption simplifies the analysis but is somewhat paradoxical. Due to this fact, we analyzed a model with two large economies that also takes into account the effect of offshoring on the South and its repercussions on employment in the North. The model is Krugman's (1979a) North-South trade model extended to include offshoring and union wage setting in the North. Our baseline model supports popular concerns about negative employment effects of offshoring. A reduction in the cost of offshoring usually lowers employment; it may only have a positive effect when there is little offshoring initially. Concerning the welfare effects of additional offshoring, we find that Southern workers always gain from offshoring, but Northern workers and firm owners may gain or lose. If both employment and the scale of Northern firms fall, all agents in the North lose. Thus, a high-wage country with a highly unionized labor market does not necessarily benefit from offshoring to a low-wage country. This pessimistic assessment of the employment and welfare effects is corroborated by the extension of the model with two factors of production. In addition, our model explains shrinking union power as an equilibrium phenomenon. As labor unions face a commitment problem, they may appoint a "pragmatic union leader", who will not fight for high wages after firms have decided to produce in the North. We also analyzed a variant of the model with heterogeneous firms, in which unions may prevent firms from offshoring by lowering their wage claims. First, this model possibly displays multiple equilibria implying different wage policies and employment levels. Second, it justifies a more optimistic assessment of the employment effect, since potential, but non-realized, offshoring has a moderating effect on unions' wage claims.

Building on a standard North-South trade model, we illustrated the complex relationship between offshoring to a low-wage country and domestic employment. Due to our focus on Western European countries with unionized labor markets, we incorporated union wage setting as a source of labor market frictions in our model.

In general, it can be expected to see much more work in this lively area of research concerning offshoring and its labor market effects. International integration intensifies, and the widespread business practice of offshoring has profound effects on the involved economies, which should be addressed in theoretical models. As the fear of low-wage competition is present in many industrialized countries, there is a need for further research to improve the understanding of the employment effects of offshoring. We suggest studying various offshoring scenarios in general equilibrium models with two large economies. Moreover, dynamic aspects and the impact of different labor market characteristics should be further considered. Due to the fact that for quite a long time the theory of trade and offshoring has predominantly used full employment models, there are many questions left to study in the context of offshoring and labor market frictions.

Bibliography

Agell, J. and P. Lundborg (1995). Fair Wages in the Open Economy. *Economica 62(247)*, 335–51.

Aghion, P. and J. Tirole (1997). Formal and Real Authority in Organizations. *Journal of Political Economy 105(1)*, 1–29.

Akerlof, G. A. (1970). The Market for "Lemons": Quality Uncertainty and the Market Mechanism. *Quarterly Journal of Economics 84(3)*, 488–500.

Akerlof, G. A. and J. L. Yellen (1990). The Fair Wage-Effort Hypothesis and Unemployment. *Quarterly Journal of Economics 105(2)*, 255–83.

Amiti, M. and S.-J. Wei (2005a). Fear of service outsourcing: is it justified? *Economic Policy 20(42)*, 308–47.

Amiti, M. and S.-J. Wei (2005b). Service Offshoring, Productivity and Employment: Evidence from the US. *CEPR Discussion Paper 5475.*

Antràs, P. (2003). Firms, Contracts, and Trade Structure. *Quarterly Journal of Economics 118(4)*, 1375–418.

Antràs, P. (2005). Incomplete Contracts and the Product Cycle. *American Economic Review 95(4)*, 1054–73.

Antràs, P., M. A. Desai, and C. F. Foley (2009). Multinational Firms, FDI Flows, and Imperfect Capital Markets. *Quarterly Journal of Economics 124(3)*, 1171–219.

Antràs, P., L. Garicano, and E. Rossi-Hansberg (2006). Offshoring in a Knowledge Economy. *Quarterly Journal of Economics 121(1)*, 31–77.

Antràs, P. and E. Helpman (2004). Global Sourcing. *Journal of Political Economy 112(3)*, 552–80.

Antràs, P. and E. Helpman (2006). Contractual Frictions and Global Sourcing. *NBER Working Paper 12747.*

Arndt, S. W. (1997). Globalization and the open economy. *North American Journal of Economics and Finance 8(1)*, 71–79.

Arnold, J. M. and K. Hussinger (2005). Export Behavior and Firm Productivity in German Manufacturing: A Firm-Level Analysis. *Review of World Economics 141(2)*, 219–43.

Arnold, L. G. (2002). On the growth effects of North-South trade: the role of labor market flexibility. *Journal of International Economics 58(2)*, 451–66.

Arnold, L. G. (2011). A Game-Theoretic Foundation for Competitive Equilibria in the Stiglitz-Weiss Model. *Manuscript, University of Regensburg (forthcoming German Economic Review).*

Arnold, L. G., J. J. Reeder, and S. Trepl (2010). Single-Name Credit Risk, Portfolio Risk, and Credit Rationing. *University of Regensburg Working Papers in Business, Economics and Management Information Systems 448.*

Arnold, L. G. and J. G. Riley (2009). On the Possibility of Credit Rationing in the Stiglitz-Weiss Model. *American Economic Review 99(5)*, 2012–21.

Arnold, L. G. and S. Trepl (2011). Taking Public Opinion Seriously: A General Equilibrium Model of Low-Wage Competition, Offshoring, and Unemployment. *BGPE Discussion Paper 101.*

Arrow, K. J. (1963). Uncertainty and the Welfare Economics of Medical Care. *American Economic Review 53(5)*, 941–73.

Arrow, K. J. (1968). The Economics of Moral Hazard: Further Comment. *American Economic Review 58(3)*, 537–39.

Asea, P. K. and B. Blomberg (1998). Lending cycles. *Journal of Econometrics 83(1-2)*, 89–128.

Attanasio, O. P. and G. Weber (1989). Intertemporal Substitution, Risk Aversion and the Euler Equation for Consumption. *Economic Journal 99(395)*, 59–73.

Azariadis, C. and B. Smith (1998). Financial Intermediation and Regime Switching in Business Cycles. *American Economic Review 88(3)*, 516–36.

Bachmann, R. and S. Braun (2008). The Impact of International Outsourcing on Labour Market Dynamics in Germany. *Ruhr Economic Paper 53*.

Baldwin, R. E. and R. Forslid (2010). Trade Liberalization with Heterogeneous Firms. *Review of Development Economics 14(2)*, 161–76.

Baldwin, R. E. and F. Robert-Nicoud (2007). Offshoring: General Equilibrium Effects on Wages, Production and Trade. *NBER Working Paper 12991*.

Baltensperger, E. (1978). Credit Rationing: Issues and Questions. *Journal of Money, Credit and Banking 10(2)*, 170–83.

Baranowska, A. and M. Gebel (2008). Temporary Employment in Central- and Eastern Europe: Individual Risk Patterns and Institutional Context. *Mannheimer Zentrum für Europäische Sozialforschung, Working Paper 106*.

Barba Navaretti, G., D. Castellani, and A.-C. Disdier (2010). How does investing in cheap labour countries affect performance at home? Firm-level evidence from France and Italy. *Oxford Economic Papers 62(2)*, 234–60.

Barba Navaretti, G. and A. Venables (2004). *Multinational Firms in the World Economy*. Princeton University Press.

Basu, P. and S. Ghosh (1993). Optimal Saving under General Changes in Uncertainty: A Nonexpected Utility Maximizing Approach. *Southern Economic Journal 60(1)*, 119–27.

Becker, S. O., K. Ekholm, R. Jäckle, and M.-A. Muendler (2005). Location Choice and Employment Decisions: A Comparison of German and Swedish Multinationals. *Review of World Economics 141(4)*, 693–731.

Becker, S. O., K. Ekholm, and M.-A. Muendler (2009). Offshoring and the Onshore Composition of Occupations, Tasks and Skills. *Stirling Economics Discussion Paper 2009-18*.

Becker, S. O. and M.-A. Muendler (2008). The Effect of FDI on Job Security. *B.E. Journal of Economic Analysis & Policy (Advances) 8(1)*, Article 8.

Bencivenga, V. R. and B. D. Smith (1993). Some consequences of credit rationing in an endogenous growth model. *Journal of Economic Dynamics and Control 17(1-2)*, 97–122.

Berger, A. N. and G. F. Udell (1990). Collateral, Loan Quality, and Bank Risk. *Journal of Monetary Economics 25(1)*, 21–42.

Berger, A. N. and G. F. Udell (1992). Some Evidence on the Empirical Significance of Credit Rationing. *Journal of Political Economy 100(5)*, 1047–77.

Bergin, P. R., R. C. Feenstra, and G. H. Hanson (2009). Offshoring and Volatility: Evidence from Mexico's Maquiladora Industry. *American Economic Review 99(4)*, 1664–71.

Bernanke, B. and M. Gertler (1989). Agency Costs, Net Worth, and Business Fluctuations. *American Economic Review 79(1)*, 14–31.

Bernanke, B. and M. Gertler (1990). Financial Fragility and Economic Performance. *Quarterly Journal of Economics 105(1)*, 87–114.

Bernard, A. B., J. B. Jensen, S. J. Redding, and P. K. Schott (2007). Firms in International Trade. *Journal of Economic Perspectives 21(3)*, 105–30.

Bernard, A. B., S. J. Redding, and P. K. Schott (2007). Comparative Advantage and Heterogeneous Firms. *Review of Economic Studies 74(1)*, 31–66.

Bernhardt, D. (2000). Credit Rationing? *American Economic Review 90(1)*, 235–39.

Besanko, D. and A. V. Thakor (1987a). Collateral and Rationing: Sorting Equilibria in Monopolistic and Competitive Credit Markets. *International Economic Review 28(3)*, 671–89.

Besanko, D. and A. V. Thakor (1987b). Competitive Equilibrium in the Credit Market under Asymmetric Information. *Journal of Economic Theory 42(1)*, 167–82.

Bester, H. (1985). Screening vs. Rationing in Credit Markets with Imperfect Information. *American Economic Review 75(4)*, 850–55.

Bester, H. (1987). The role of collateral in credit markets with imperfect information. *European Economic Review 31(4)*, 887–99.

Bester, H. (1994). The Role of Collateral in a Model of Debt Renegotiation. *Journal of Money, Credit and Banking 26(1)*, 72–86.

Bester, H. and M. F. Hellwig (1987). Moral Hazard and Equilibrium Credit Rationing: An Overview of the Issues. In G. Bamberg and K. Spremann (Eds.), *Agency Theory, Information, and Incentives*, pp. 135–66. Springer-Verlag.

Bhagwati, J., A. Panagariya, and T. N. Srinivasan (2004). The Muddles over Outsourcing. *Journal of Economic Perspectives 18(4)*, 93–114.

Binmore, K., A. Rubinstein, and A. Wolinsky (1986). The Nash bargaining solution in economic modelling. *RAND Journal of Economics 17(2)*, 176–88.

Blinder, A. S. (2006). Offshoring: The Next Industrial Revolution? *Foreign Affairs 85(2)*, 113–28.

Blomström, M., G. Fors, and R. E. Lipsey (1997). Foreign Direct Investment and Employment: Home Country Experience in the United States and Sweden. *Economic Journal 107(445)*, 1787–97.

Bognetti, G. and M. Santoni (2010). Can domestic unions gain from offshoring? *Journal of Economics 100(1)*, 51–67.

Bottini, N., C. Ernst, and M. Luebker (2007). Offshoring and the labour market: What are the issues? *Economic and Labour Market Paper 2007-11.*

Braconier, H. and K. Ekholm (2000). Swedish Multinationals and Competition from High- and Low-Wage Locations. *Review of International Economics 8(3)*, 448–61.

Brainard, S. L. (1997). An Empirical Assessment of the Proximity-Concentration Trade-off between Multinational Sales and Trade. *American Economic Review 87(4)*, 520–44.

Braun, S. and J. Scheffel (2007). Does International Outsourcing Depress Union Wages. *SFB 649 Discussion Paper 33.*

Brealey, R. (1971). Some Implications of the Comovement of American Company Earnings. *Applied Economics 3(3)*, 183–96.

Brecher, R. A. (1974). Minimum Wage Rates and the Pure Theory of International Trade. *Quarterly Journal of Economics 88(1)*, 98–116.

Buch, C. M. and A. Lipponer (2010). Volatile multinationals? Evidence from the labor demand of German firms. *Labour Economics 17(2)*, 345–53.

Bughin, J. and S. Vannini (1995). Strategic direct investment under unionized oligopoly. *International Journal of Industrial Organization 13(1)*, 127–45.

Cahuc, P. and A. Zylberberg (2004). *Labor economics.* MIT Press.

Calcagnini, G. and E. Saltari (2010). *The Economics of Imperfect Markets.* Physica-Verlag.

Chan, Y.-S. and G. Kanatas (1985). Asymmetric Valuations and the Role of Collateral in Loan Agreements. *Journal of Money, Credit and Banking 17(1)*, 84–95.

Chavas, J.-P. (2004). *Risk Analysis in Theory and Practice.* Elsevier Academic Press.

Cho, Y. J. (1986). Inefficiencies from Financial Liberalization in the Absence of Well-Functioning Equity Markets. *Journal of Money, Credit and Banking 18(2)*, 191–99.

Clemenz, G. (1986). *Credit Markets with Asymmetric Information.* Springer-Verlag.

Coco, G. (1997). Credit rationing and the welfare gain from usury laws. *University of Exeter Discussion Paper in Economics 97/15*.

Coco, G. (2000). On the Use of Collateral. *Journal of Economic Surveys 14(2)*, 191–214.

Coco, G. and D. De Meza (2009). In Defense of Usury Laws. *Journal of Money, Credit and Banking 41(8)*, 1691–703.

Collie, D. and H. Vandenbussche (2005). Can Import Tariffs Deter Outward FDI? *Open Economies Review 16(4)*, 341–62.

Copeland, B. R. (1989). Efficiency wages in a Ricardian model of international trade. *Journal of International Economics 27(3-4)*, 221–44.

Crinò, R. (2008). Service offshoring and productivity in Western Europe. *Economics Bulletin 6(35)*, 1–8.

Crinò, R. (2009). Offshoring, Multinationals and Labour Market: A Review of the Empirical Literature. *Journal of Economic Surveys 23(2)*, 197–249.

Crinò, R. (2010). Service Offshoring and White-Collar Employment. *Review of Economic Studies 77(2)*, 595–632.

Cukierman, A. (1978). The Horizontal Integration of the Banking Firm, Credit Rationing and Monetary Policy. *Review of Economic Studies 45(1)*, 165–78.

Cuyvers, L., M. Dumont, G. Rayp, and K. Stevens (2005). Home Employment Effects of EU Firms' Activities in Central and Eastern European Countries. *Open Economies Review 16(2)*, 153–74.

Davidson, C., L. Martin, and S. J. Matusz (1988). The Structure of Simple General Equilibrium Models with Frictional Unemployment. *Journal of Political Economy 96(6)*, 1267–93.

Davidson, C. and S. J. Matusz (2010). *International Trade with Equilibrium Unemployment.* Princeton University Press.

Davidson, C., S. J. Matusz, and A. Shevchenko (2008). Outsourcing Peter to Pay Paul: High-Skill Expectations and Low-Skill Wages with Imperfect Labor Markets. *Macroeconomic Dynamics 12(4)*, 463–79.

Davis, D. R. and J. Harrigan (2011). Good jobs, bad jobs, and trade liberalization. *Journal of International Economics 84(1)*, 26–36.

De Meza, D. and D. C. Webb (1987). Too Much Investment: A Problem of Asymmetric Information. *Quarterly Journal of Economics 102(2)*, 281–92.

De Meza, D. and D. C. Webb (1992). Efficient credit rationing. *European Economic Review 36(6)*, 1277–90.

De Meza, D. and D. C. Webb (2000). Does credit rationing imply insufficient lending? *Journal of Public Economics 78(3)*, 215–34.

De Meza, D. and D. C. Webb (2006). Credit Rationing: Something's Gotta Give. *Economica 73(292)*, 563–78.

Deardorff, A. V. (2001a). Fragmentation across cones. In S. W. Arndt and H. Kierzkowski (Eds.), *Fragmentation: New Production Patterns in the World Economy*, pp. 35–51. Oxford University Press.

Deardorff, A. V. (2001b). Fragmentation in simple trade models. *North American Journal of Economics and Finance 12(2)*, 121–37.

Deardorff, A. V. (2005). A trade theorist's take on skilled-labor outsourcing. *International Review of Economics & Finance 14(3)*, 259–71.

Diamond, D. W. (1989). Reputation Acquisition in Debt Markets. *Journal of Political Economy 97(4)*, 828–62.

Dixit, A. K. and R. S. Pindyck (1994). *Investment under Uncertainty.* Princeton University Press.

Dixit, A. K. and J. E. Stiglitz (1977). Monopolistic Competition and Optimum Product Diversity. *American Economic Review 67(3)*, 297–308.

Dumont, M., G. Rayp, and P. Willemé (2006). Does internationalization affect union bargaining power? An empirical study for five EU countries. *Oxford Economic Papers 58(1)*, 77–102.

Dutt, P., D. Mitra, and P. Ranjan (2009). International trade and unemployment: Theory and cross-national evidence. *Journal of International Economics 78(1)*, 32–44.

Eckel, C. and H. Egger (2009). Wage bargaining and multinational firms. *Journal of International Economics 77(2)*, 206–14.

Eckel, C. and J. P. Neary (2010). Multi-Product Firms and Flexible Manufacturing in the Global Economy. *Review of Economic Studies 77(1)*, 188–217.

Egger, H. and P. Egger (2003). Outsourcing and skill-specific employment in a small economy: Austria after the fall of the Iron Curtain. *Oxford Economic Papers 55(4)*, 625–43.

Egger, H. and P. Egger (2005). Labor market effects of outsourcing under industrial interdependence. *International Review of Economics & Finance 14(3)*, 349–63.

Egger, H. and U. Kreickemeier (2008). International fragmentation: Boon or bane for domestic employment? *European Economic Review 52(1)*, 116–32.

Egger, H. and U. Kreickemeier (2009). Firm Heterogeneity and the Labor Market Effects of Trade Liberalization. *International Economic Review 50(1)*, 187–216.

Egger, P., M. Pfaffermayr, and A. Weber (2007). Sectoral adjustment of employment to shifts in outsourcing and trade: evidence from a dynamic fixed effects multinomial logit model. *Journal of Applied Econometrics 22(3)*, 559–80.

Elberfeld, W., G. Götz, and F. Stähler (2005). Vertical Foreign Direct Investment, Welfare, and Employment. *B.E. Journal of Economic Analysis & Policy 5(1)*, Article 3.

Epstein, L. G. and S. E. Zin (1989). Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: A Theoretical Framework. *Econometrica 57(4)*, 937–69.

Epstein, L. G. and S. E. Zin (1991). Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: An Empirical Analysis. *Journal of Political Economy 99(2)*, 263–86.

Feenstra, R. C. (1998). Integration of Trade and Disintegration of Production in the Global Economy. *Journal of Economic Perspectives 12(4)*, 31–50.

Feenstra, R. C. and G. H. Hanson (1996a). Foreign Investment, Outsourcing and Relative Wages. In R. C. Feenstra, G. M. Grossman, and D. A. Irwin (Eds.), *The Political Economy of Trade Policy*, pp. 89–128. MIT Press.

Feenstra, R. C. and G. H. Hanson (1996b). Globalization, Outsourcing, and Wage Inequality. *American Economic Review 86(2)*, 240–45.

Feenstra, R. C. and G. H. Hanson (2001). Global Production Sharing and Rising Inequality: A Survey of Trade and Wages. *NBER Working Paper 8372*.

Feenstra, R. C. and G. H. Hanson (2005). Ownership and Control in Outsourcing to China: Estimating the Property-Rights Theory of the Firm. *Quarterly Journal of Economics 120(2)*, 729–61.

Felbermayr, G., J. Prat, and H.-J. Schmerer (2011). Globalization and labor market outcomes: Wage bargaining, search frictions, and firm heterogeneity. *Journal of Economic Theory 146(1)*, 39–73.

Freeman, R. B. (1995). Are Your Wages Set in Beijing? *Journal of Economic Perspectives 9(3)*, 15–32.

Freixas, X. and J.-C. Rochet (2008). *Microeconomics of Banking*. MIT Press.

Fried, J. and P. Howitt (1980). Credit Rationing and Implicit Contract Theory. *Journal of Money, Credit and Banking 12(3)*, 471–87.

Gaffeo, E. and E. Santoro (2009). Business failures, macroeconomic risk and the effect of recessions on long-run growth: A panel cointegration approach. *Journal of Economics and Business 61(6)*, 435–52.

Gale, D. and M. F. Hellwig (1985). Incentive-Compatible Debt Contracts: The One-Period Problem. *Review of Economic Studies 52(4)*, 647–63.

Gaston, N. (2002). The Effects of Globalisation on Unions and the Nature of Collective Bargaining. *Journal of Economic Integration 17(2)*, 377–96.

Geishecker, I. (2006). Does Outsourcing to Central and Eastern Europe Really Threaten Manual Workers' Jobs in Germany? *World Economy 29(5)*, 559–83.

Geishecker, I. (2008). The impact of international outsourcing on individual employment security: A micro-level analysis. *Labour Economics 15(3)*, 291–314.

Geishecker, I. and H. Görg (2008). Winners and losers: a micro-level analysis of international outsourcing and wages. *Canadian Journal of Economics 41(1)*, 243–70.

Girma, S., R. Kneller, and M. Pisu (2005). Exports versus FDI: An Empirical Test. *Review of World Economics 141(2)*, 193–218.

Glass, A. J. and K. Saggi (2001). Innovation and wage effects of international outsourcing. *European Economic Review 45(1)*, 67–86.

Glass, A. J. and K. Saggi (2002). Intellectual property rights and foreign direct investment. *Journal of International Economics 56(2)*, 387–410.

Glass, A. J. and X. Wu (2007). Intellectual property rights and quality improvement. *Journal of Development Economics 82(2)*, 393–415.

Görg, H., A. Hanley, and E. Strobl (2008). Productivity effects of international outsourcing: evidence from plant-level data. *Canadian Journal of Economics 41(2)*, 670–88.

Greenwald, B. C. and J. E. Stiglitz (1987). Keynesian, New Keynesian, and New Classical Economies. *Oxford Economic Papers 39(1)*, 119–32.

Greenwald, B. C. and J. E. Stiglitz (1993). Financial Market Imperfections and Business Cycles. *Quarterly Journal of Economics 108(1)*, 77–114.

Greenwald, B. C., J. E. Stiglitz, and A. Weiss (1984). Informational Imperfections in the Capital Market and Macroeconomic Fluctuations. *American Economic Review 74(2)*, 194–99.

Grieben, W.-H. and F. Şener (2009). Labor Unions, Globalization, and Mercantilism. *CESifo Working Paper 2889*.

Grossman, G. M. (1984). International competition and the unionized sector. *Canadian Journal of Economics 17(3)*, 541–56.

Grossman, G. M. and E. Helpman (1991a). Endogenous Product Cycles. *Economic Journal 101(408)*, 1214–29.

Grossman, G. M. and E. Helpman (1991b). Quality Ladders and Product Cycles. *Quarterly Journal of Economics 106(2)*, 557–86.

Grossman, G. M. and E. Helpman (2002). Integration Versus Outsourcing in Industry Equilibrium. *Quarterly Journal of Economics 117(1)*, 85–120.

Grossman, G. M. and E. Helpman (2003). Outsourcing versus FDI in industry equilibrium. *Journal of the European Economic Association 1(2-3)*, 317–27.

Grossman, G. M. and E. Helpman (2004). Managerial incentives and the international organization of production. *Journal of International Economics 63(2)*, 237–62.

Grossman, G. M. and E. Helpman (2005). Outsourcing in a Global Economy. *Review of Economic Studies 72(1)*, 135–59.

Grossman, G. M., E. Helpman, and A. Szeidl (2005). Complementarities between Outsourcing and Foreign Sourcing. *American Economic Review 95(2)*, 19–24.

Grossman, G. M., E. Helpman, and A. Szeidl (2006). Optimal integration strategies for the multinational firm. *Journal of International Economics 70(1)*, 216–38.

Grossman, G. M. and E. Rossi-Hansberg (2008). Trading Tasks: A Simple Theory of Offshoring. *American Economic Review 98(5)*, 1978–97.

Grossman, G. M. and E. Rossi-Hansberg (2010). Task Trade between Similar Countries. *Manuscript, Princeton University*. `http://www.princeton.edu/~grossman/TTSC070610.pdf` (01.09.2011).

Grossman, S. J. and O. D. Hart (1986). The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. *Journal of Political Economy 94(4)*, 691–719.

Gu, J., P. Hernandez-Verme, and Q. Li (2008). An Empirical Evaluation of the Presence of Credit Rationing in the U.S. Credit Markets. *Manuscript, Texas A&M University*. http://www.docstoc.com/docs/52280579/An-EmpiricalEvaluation-of-the-Presence-of-Credit-Rationing-in (01.09.2011).

Hall, R. E. (1987). Consumption. *NBER Working Paper 2265*.

Harrison, A. E. and M. S. McMillan (2006). Outsourcing Jobs? Multinationals and US Employment. *NBER Working Paper 12372*.

Hart, O. and J. Moore (1990). Property Rights and the Nature of the Firm. *Journal of Political Economy 98(6)*, 1119–58.

Head, K. and J. Ries (2002). Offshore production and skill upgrading by Japanese manufacturing firms. *Journal of International Economics 58(1)*, 81–105.

Helg, R. and L. Tajoli (2005). Patterns of international fragmentation of production and the relative demand for labor. *North American Journal of Economics and Finance 16(2)*, 233–54.

Hellmann, T. and J. E. Stiglitz (2000). Credit and equity rationing in markets with adverse selection. *European Economic Review 44(2)*, 281–304.

Hellwig, M. F. (1987). Some recent developments in the theory of competition in markets with adverse selection. *European Economic Review 31(1-2)*, 319–25.

Helpman, E. (1984). A Simple Theory of International Trade with Multinational Corporations. *Journal of Political Economy 92(3)*, 451–71.

Helpman, E. (1993). Innovation, Imitation, and Intellectual Property Rights. *Econometrica 61(6)*, 1247–80.

Helpman, E. (1999). The Structure of Foreign Trade. *Journal of Economic Perspectives 13(2)*, 121–44.

Helpman, E. (2006). Trade, FDI, and the Organization of Firms. *Journal of Economic Literature 44(3)*, 589–630.

Helpman, E. (2010). Labor Market Frictions as a Source of Comparative Advantage, with Implications for Unemployment and Inequality. *NBER Working Paper 15764*.

Helpman, E. and O. Itskhoki (2009). Labor Market Rigidities, Trade and Unemployment: A Dynamic Model. *Manuscript, Harvard University*. http://www.economics.harvard.edu/files/faculty/30_LaborMarketRigidities_Dynamic_2.pdf (01.09.2011).

Helpman, E. and O. Itskhoki (2010). Labour Market Rigidities, Trade and Unemployment. *Review of Economic Studies 77(3)*, 1100–37.

Helpman, E., O. Itskhoki, and S. Redding (2010a). Inequality and Unemployment in a Global Economy. *Econometrica 78(4)*, 1239–83.

Helpman, E., O. Itskhoki, and S. Redding (2010b). Unequal effects of trade on workers with different abilities. *Journal of the European Economic Association 8(2-3)*, 421–33.

Helpman, E. and P. R. Krugman (1985). *Market Structure and Foreign Trade.* MIT Press.

Helpman, E., M. J. Melitz, and S. R. Yeaple (2004). Export versus FDI with Heterogeneous Firms. *American Economic Review 94(1)*, 300–16.

Hijzen, A. (2007). International Outsourcing, Technological Change, and Wage Inequality. *Review of International Economics 15(1)*, 188–205.

Hijzen, A., H. Görg, and R. C. Hine (2005). International Outsourcing and the Skill Structure of Labour Demand in the United Kingdom. *Economic Journal 115(506)*, 860–78.

Hillier, B. and M. V. Ibrahimo (1993). Asymmetric Information and Models of Credit Rationing. *Bulletin of Economic Research 45(4)*, 271–304.

Hodgman, D. R. (1960). Credit Risk and Credit Rationing. *Quarterly Journal of Economics 74(2)*, 258–78.

Holmstrom, B. and P. Milgrom (1994). The Firm as an Incentive System. *American Economic Review 84(4)*, 972–91.

Hummels, D., J. Ishii, and K.-M. Yi (2001). The nature and growth of vertical specialization in world trade. *Journal of International Economics 54(1)*, 75–96.

Ifo Institute for Economic Research (2011). Credit Constraint Indicator - From the Ifo Business Survey for June 2011. http://www.cesifo-group.de/portal/page/portal/ifoHome/a-winfo/d1index/18INDEXKREDKL (01.09.2011).

Jäckle, R. and G. Wamser (2010). Going Multinational: What are the Effects on Home-Market Performance? *German Economic Review 11(2)*, 188–207.

Jaffee, D. M. (1971). *Credit Rationing and the Commercial Loan Market: An Econometric Study of the Structure of the Commercial Loan Market.* John Wiley & Sons, Inc.

Jaffee, D. M. and F. Modigliani (1969). A Theory and Test of Credit Rationing. *American Economic Review 59(5)*, 850–72.

Jaffee, D. M. and T. Russell (1976). Imperfect Information, Uncertainty, and Credit Rationing. *Quarterly Journal of Economics 90(4)*, 651–66.

Jaffee, D. M. and J. E. Stiglitz (1990). Credit rationing. In B. M. Friedman and F. H. Hahn (Eds.), *Handbook of Monetary Economics, Volume 2*, pp. 837–88. Elsevier Academic Press.

Janiak, A. (2006). Does Trade Liberalization Lead to Unemployment? Theory and Some Evidence. *Manuscript, Universite Libre de Bruxelles*. `http://www.pse.ens.fr/t2m/t2m_ajaniak.pdf` (01.09.2011).

Jones, R. W. (2000). *Globalization and the theory of input trade.* MIT Press.

Jones, R. W. and H. Kierzkowski (1990). The Role of Services in Production and International Trade: A Theoretical Framework. In R. W. Jones and A. Krueger (Eds.), *The Political Economy of International Trade: Essays in Honor of Robert E. Baldwin*, pp. 31–48. Blackwell.

Jones, R. W. and H. Kierzkowski (2001). Globalization and the Consequences of International Fragmentation. In G. A. Calvo, R. Dornbusch, and M. Obstfeld (Eds.), *Money, Capital Mobility and Trade: Essays in Honor of Robert A. Mundell*, pp. 365–83. MIT Press.

Jorgenson, D. W. (1963). Capital Theory and Investment Behavior. *American Economic Review 53(2)*, 247–59.

Karabay, B. and J. McLaren (2010). Trade, offshoring, and the invisible handshake. *Journal of International Economics 82(1)*, 26–34.

Kareken, J. H. (1957). Lenders' Preferences, Credit Rationing, and the Effectiveness of Monetary Policy. *Review of Economics and Statistics 39(3)*, 292–302.

Katzur, T. and R. Lensink (2010). The Role of Joint Liability Contracts and Guarantor Contracts in Microfinance. *Manuscript, University of Groningen*. `http://www.aeaweb.org/aea/2011conference/program/retrieve.php?pdfid=323` (01.09.2011).

Keeton, W. R. (1979). *Equilibrium Credit Rationing.* Garland Publishing, Inc.

Keuschnigg, C. and E. Ribi (2009). Outsourcing, unemployment and welfare policy. *Journal of International Economics 78(1)*, 168–76.

Keynes, J. M. (1930). *The Pure Theory of Money, Volumes I and II.* Harcourt, Brace.

King, S. R. (1986). Monetary Transmission: Through Bank Loans or Bank Liabilities? *Journal of Money, Credit and Banking 18(3)*, 290–303.

Kinkel, S. and S. Maloca (2009). Produktionsverlagerung und Rückverlagerung in Zeiten der Krise: Entwicklungen und Treiber von Produktionsverlagerungen und Rückverlagerungen im deutschen Verarbeitenden Gewerbe. *Modernisierung der Produktion. Mitteilungen aus der ISI-Erhebung 52*. `www.isi.fraunhofer.de/isi-de/i/download/pi-mitteilungen/pi52.pdf` (01.09.2011).

Kirkegaard, J. F. (2005). Outsourcing and Offshoring: Pushing the European Model Over the Hill, Rather Than Off the Cliff! *Institute for International Economics Working Paper 05-1.*

Kirkegaard, J. F. (2008). Offshoring, Outsourcing, and Production Relocation - Labor Market Effects in the OECD Countries and Developing Asia. *Singapore Economic Review 53(3)*, 371–418.

Knight, F. H. (1921). *Risk, uncertainty and profit.* Houghton Mifflin.

Kohler, W. (2004a). Aspects of International Fragmentation. *Review of International Economics 12(5)*, 793–816.

Kohler, W. (2004b). International Outsourcing and Factor Prices with Multistage Production. *Economic Journal 114(494)*, 166–85.

Kohler, W. (2007). The Bazaar Effect, Unbundling of Comparative Advantage, and Migration. *CESifo Working Paper 1932.*

Kohler, W. (2008). Offshoring: Why Do Stories Differ? *CESifo Working Paper 2231.*

Kohler, W. and J. Wrona (2010). Offshoring Tasks, yet Creating Jobs? *CESifo Working Paper 3019*.

Konings, J. and A. P. Murphy (2006). Do Multinational Enterprises Relocate Employment to Low-Wage Regions? Evidence from European Multinationals. *Review of World Economics 142(2)*, 267–86.

Koskela, E. and J. König (2008). Flexible Outsourcing, Profit Sharing and Equilibrium Unemployment. *CESifo Working Paper 2382*.

Koskela, E. and R. Schöb (2010). Outsourcing of Unionized Firms and the Impact of Labor Market Policy Reforms. *Review of International Economics 18(4)*, 682–95.

Koskela, E. and R. Stenbacka (2009). Equilibrium unemployment with outsourcing under labour market imperfections. *Labour Economics 16(3)*, 284–90.

Koskela, E. and R. Stenbacka (2010). Equilibrium unemployment with outsourcing and wage solidarity under labour market imperfections. *European Economic Review 54(3)*, 376–92.

Kreickemeier, U. and D. Nelson (2006). Fair wages, unemployment and technological change in a global economy. *Journal of International Economics 70(2)*, 451–69.

Krugman, P. R. (1979a). A Model of Innovation, Technology Transfer, and the World Distribution of Income. *Journal of Political Economy 87(2)*, 253–66.

Krugman, P. R. (1979b). Increasing returns, monopolistic competition, and international trade. *Journal of International Economics 9(4)*, 469–79.

Krugman, P. R. (1980). Scale Economies, Product Differentiation, and the Pattern of Trade. *American Economic Review 70(5)*, 950–59.

Krugman, P. R. (1995). Growing World Trade: Causes and Consequences. *Brookings Papers on Economic Activity*, 327–77.

Krugman, P. R. (2008). Trade and Wages, Reconsidered. *Brookings Papers on Economic Activity*, 103–54.

Lai, E. L.-C. (1998). International intellectual property rights protection and the rate of product innovation. *Journal of Development Economics 55(1)*, 133–53.

Layard, R., S. Nickell, and R. Jackman (2005). *Unemployment: Macroeconomic Performance and the Labour Market.* Oxford University Press.

Leahy, D. and C. Montagna (2000). Unionisation and Foreign Direct Investment: Challenging Conventional Wisdom? *Economic Journal 110(462)*, 80–92.

Lensink, R. and E. Sterken (2001). Asymmetric information, option to wait to invest and the optimal level of investment. *Journal of Public Economics 79(2)*, 365–74.

Lensink, R. and E. Sterken (2002). The Option to Wait to Invest and Equilibrium Credit Rationing. *Journal of Money, Credit and Banking 34(1)*, 221–25.

Levchenko, A. A. (2004). Institutional Quality and International Trade. *IMF Working Paper 04/231.*

Levine, R. (2005). Finance and Growth: Theory and Evidence. In P. Aghion and S. N. Durlauf (Eds.), *Handbook of Economic Growth, 1A*, pp. 865–934. Oxford University Press.

Lipsey, R. E. (2002). Home and Host Country Effects of FDI. *NBER Working Paper 9293.*

Lommerud, K. E., F. Meland, and L. Sørgard (2003). Unionised Oligopoly, Trade Liberalisation and Location Choice. *Economic Journal 113(490)*, 782–800.

Lommerud, K. E., F. Meland, and O. R. Straume (2009). Can deunionization lead to international outsourcing? *Journal of International Economics 77(1)*, 109–19.

Machin, S. and J. Van Reenen (1993). Profit Margins and the Business Cycle: Evidence from UK Manufacturing Firms. *Journal of Industrial Economics 41(1)*, 29–50.

Mankiw, N. G. (1986). The Allocation of Credit and Financial Collapse. *Quarterly Journal of Economics 101(3)*, 455–70.

Mankiw, N. G. and P. Swagel (2006). The Politics and Economics of Offshore Outsourcing. *Journal of Monetary Economics 53(5)*, 1027–56.

Marin, D. (2004). A Nation of Poets and Thinkers - Less so with Eastern Enlargement? Austria and Germany. *CEPR Discussion Paper 4358.*

Marin, D. (2006). A new international division of labor in Europe: Outsourcing and offshoring to Eastern Europe. *Journal of the European Economic Association 4(2-3)*, 612–22.

Marin, D. and T. Verdier (2010). Corporate Hierarchies and International Trade: Theory and Evidence. *Manuscript, University of Munich*. `http://www.iwb.vwl.uni-muenchen.de/forschung/veroffentlichungen/ver___marin/material/powermarkup37-marin.pdf` (01.09.2011).

Markusen, J. R. (1984). Multinationals, multi-plant economies, and the gains from trade. *Journal of International Economics 16(3-4)*, 205–26.

Markusen, J. R. (2004). *Multinational Firms and the Theory of International Trade*. MIT Press.

Markusen, J. R. (2005). Modeling the Offshoring of White-Collar Services: From Comparative Advantage to the New Theories of Trade and Foreign Direct Investment. In *Brookings Trade Forum*, pp. 1–23. Brookings Institution Press.

Markusen, J. R. and K. E. Maskus (2001). General-Equilibrium Approaches to the Multinational Firm: A Review of Theory and Evidence. *NBER Working Paper 8334*.

Markusen, J. R. and B. Strand (2007). Trade in Business Services in General Equilibrium. *NBER Working Paper 12816*.

Matusz, S. J. (1986). Implicit Contracts, Unemployment and International Trade. *Economic Journal 96(382)*, 307–22.

McLaren, J. (2000). "Globalization" and Vertical Structure. *American Economic Review 90(5)*, 1239–54.

Melitz, M. J. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica 71(6)*, 1695–725.

Melitz, M. J. and G. I. Ottaviano (2008). Market Size, Trade, and Productivity. *Review of Economic Studies 75(1)*, 295–316.

Milde, H. and J. G. Riley (1988). Signaling in Credit Markets. *Quarterly Journal of Economics 103(1)*, 101–29.

Mitra, D. and P. Ranjan (2010). Offshoring and unemployment: The role of search frictions labor mobility. *Journal of International Economics 81(2)*, 219–29.

Mondal, D. and M. R. Gupta (2008a). Innovation, imitation and multinationalisation in a North–South model: a theoretical note. *Journal of Economics 94(1)*, 31–62.

Mondal, D. and M. R. Gupta (2008b). Intellectual property rights protection and unemployment in a North South model: A theoretical analysis. *Economic Modelling 25(3)*, 463–84.

Moore, M. P. and P. Ranjan (2005). Globalisation vs Skill-Biased Technological Change: Implications for Unemployment and Wage Inequality. *Economic Journal 115(503)*, 391–422.

Muendler, M.-A. and S. O. Becker (2010). Margins of Multinational Labor Substitution. *American Economic Review 100(5)*, 1999–2030.

Munch, J. R. (2005). International Outsourcing and Individual Job Separations. *University of Copenhagen Discussion Paper 05-11.*

Murphy, K. M., A. Shleifer, and R. W. Vishny (1989). Industrialization and the Big Push. *Journal of Political Economy 97(5)*, 1003–26.

Myers, S. C. and N. S. Majluf (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics 13(2)*, 187–221.

Naylor, R. and M. Santoni (2003). Foreign direct investment and wage bargaining. *Journal of International Trade & Economic Development 12(1)*, 1–18.

Neary, J. P. (2003). Globalization and market structure. *Journal of the European Economic Association 1(2-3)*, 245–71.

Neureiter, M. and P. Nunnenkamp (2010). Outsourcing Motives, Location Choice and Labour Market Implications: An Empirical Analysis for European Countries. *Kyklos 63(2)*, 206–30.

Nickell, S., L. Nunziata, and W. Ochel (2005). Unemployment in the OECD Since the 1960s. What Do We Know? *Economic Journal 115(500)*, 1–27.

Nunn, N. (2007). Relationship-Specificity, Incomplete Contracts, and the Pattern of Trade. *Quarterly Journal of Economics 122(2)*, 569–600.

Nunn, N. and D. Trefler (2008). The Boundaries of the Multinational Firm: An Empirical Analysis. In E. Helpman, D. Marin, and T. Verdier (Eds.), *The Organization of Firms in a Global Economy*, pp. 55–83. Harvard University Press.

OECD (2004). *OECD Employment Outlook 2004*. OECD Publishing.

OECD (2007). *Offshoring and Employment: Trends and Impacts*. OECD Publishing.

Parlour, C. A. and J. Walden (2011). General Equilibrium Returns to Human and Investment Capital under Moral Hazard. *Review of Economic Studies 78(1)*, 394–428.

Petersen, M. A. and R. G. Rajan (1995). The Effect of Credit Market Competition on Lending Relationships. *Quarterly Journal of Economics 110(2)*, 407–43.

Petrick, M. (2005). Empirical Measurement of Credit Rationing in Agriculture: A Methodological Survey. *Agricultural Economics 33(2)*, 191–203.

Pflüger, M., U. Blien, J. Möller, and M. Moritz (2010). Labor Market Effects of Trade and FDI: Recent Advances and Research Gaps. *IZA Discussion Paper 5385*.

Pissarides, C. A. (2000). *Equilibrium unemployment theory*. MIT Press.

Qiu, L. D. and B. J. Spencer (2002). Keiretsu and relationship-specific investment: implications for market-opening trade policy. *Journal of International Economics 58(1)*, 49–79.

Ranjan, P. (2010). Offshoring and Labor Market Outcomes in the Presence of Collective Bargaining. *Manuscript, University of California*. `http://www.economics.uci.edu/~pranjan/papers/unions_offshoring_draft1.pdf` (01.09.2011).

Reeder, J. J. and S. Trepl (2009). Dependent Revenues, Capital Risk and Credit Rationing. *BGPE Discussion Paper 78*.

Reichlin, P. (2004). Credit Markets, Intermediation, and the Macroeconomy: A Discussion. In S. Bhattacharya, A. Boot, and A. Thakor (Eds.), *Credit Markets, Intermediation, and the Macroeconomy*, pp. 856–91. Oxford University Press.

Riley, J. G. (1987). Credit Rationing: A Further Remark. *American Economic Review 77(1)*, 224–27.

Rocha-Akis, S. and R. Schöb (2011). Welfare Policy in the Presence of Unionised Labour and Internationally Mobile Firms. *Scandinavian Journal of Economics 113(1)*, 93–119.

Rodrik, D. (1997). *Has globalization gone too far?* Peterson Institute for International Economics.

Rogoff, K. (1985). The Optimal Degree of Commitment to an Intermediate Monetary Target. *Quarterly Journal of Economics 100(4)*, 1169–89.

Rosa, R. V. (1951). Interest Rates and the Central Bank. In *Money, Trade, and Economic Growth: In Honor of John Henry Williams*, pp. 270–95. Macmillan Company.

Rothschild, M. and J. E. Stiglitz (1970). Increasing Risk: I. A Definition. *Journal of Economic Theory 2(3)*, 225–43.

Rothschild, M. and J. E. Stiglitz (1976). Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information. *Quarterly Journal of Economics 90(4)*, 629–49.

Sayek, S. and F. Şener (2006). Outsourcing and Wage Inequality in a Dynamic Product Cycle Model. *Review of Development Economics 10(1)*, 1–19.

Scott, I. O. (1957). The Availability Doctrine: Theoretical Underpinnings. *Review of Economic Studies 25(1)*, 41–48.

Selden, L. (1978). A New Representation of Preferences over "Certain × Uncertain" Consumption Pairs: The "Ordinal Certainty Equivalent" Hypothesis. *Econometrica 46(5)*, 1045–60.

Senses, M. Z. (2010). The effects of offshoring on the elasticity of labor demand. *Journal of International Economics 81(1)*, 89–98.

Sethupathy, G. (2009). Offshoring, Wages, and Employment: Theory and Evidence. *Manuscript, Columbia University*. `http://www.sais-jhu.edu/bin/k/k/Sethupathy_Offshoring_February_2010.pdf` (01.09.2011).

Shapiro, C. and J. E. Stiglitz (1984). Equilibrium Unemployment as a Worker Discipline Device. *American Economic Review 74(3)*, 433–44.

Skaksen, J. R. (2004). International outsourcing when labour markets are unionized. *Canadian Journal of Economics 37(1)*, 78–94.

Skaksen, M. Y. and J. R. Sørensen (2001). Should trade unions appreciate foreign direct investment. *Journal of International Economics 55(2)*, 379–90.

Slovin, M. B. and M. E. Sushka (1983). A Model of the Commercial Loan Rate. *Journal of Finance 38(5)*, 1583–96.

Sofianos, G., P. Wachtel, and A. Melnik (1990). Loan Commitments and Monetary Policy. *Journal of Banking & Finance 14(4)*, 677–89.

Spencer, B. J. (2005). International outsourcing and incomplete contracts. *Canadian Journal of Economics 38(4)*, 1107–35.

Spencer, B. J. and L. D. Qiu (2001). Keiretsu and Relationship-Specific Investment: A Barrier To Trade? *International Economic Review 42(4)*, 871–901.

Stahl, D. O. (1988). Bertrand Competition for Inputs and Walrasian Outcomes. *American Economic Review 78(1)*, 189–201.

Starmer, C. (2000). Developments in Non-Expected Utility Theory: The Hunt for a Descriptive Theory of Choice under Risk. *Journal of Economic Literature 38(2)*, 332–82.

Stiglitz, J. E. (2002). Information and the Change in the Paradigm in Economics. *American Economic Review 92(3)*, 460–501.

Stiglitz, J. E. and A. Weiss (1981). Credit Rationing in Markets with Imperfect Information. *American Economic Review 71(3)*, 393–410.

Stiglitz, J. E. and A. Weiss (1983). Incentive Effects of Terminations: Applications to the Credit and Labor Markets. *American Economic Review 73(5)*, 912–27.

Stiglitz, J. E. and A. Weiss (1986). Credit rationing and collateral. In J. Edwards, J. Franks, C. Mayer, and S. Schaefer (Eds.), *Recent developments in corporate finance*, pp. 101–30. Cambridge University Press.

Suarez, J. and O. Sussman (2004). Endogenous Cycles in a Stiglitz-Weiss Economy. In S. Bhattacharya, A. Boot, and A. Thakor (Eds.), *Credit Markets, Intermediation, and the Macroeconomy*, pp. 833–55. Oxford University Press.

Temouri, Y. and N. L. Driffield (2009). Does German Foreign Direct Investment Lead to Job Losses at Home? *Applied Economics Quarterly 55(3)*, 243–63.

The Economist (2007). The problem with Made in China. January 11. http://www.economist.com/node/8515811 (01.09.2011).

Tobin, J. (1969). A General Equilibrium Approach To Monetary Theory. *Journal of Money, Credit and Banking 1(1)*, 15–29.

Tomiura, E. (2007). Foreign outsourcing, exporting, and FDI: A productivity comparison at the firm level. *Journal of International Economics 72(1)*, 113–27.

Townsend, R. M. (1979). Optimal Contracts and Competitive Markets with Costly State Verification. *Journal of Economic Theory 21(2)*, 265–93.

Trefler, D. (1995). The Case of the Missing Trade and Other Mysteries. *American Economic Review 85(5)*, 1029–46.

Trefler, D. (2005). Offshoring: Threats and Opportunities. *Paper Prepared for the Brookings Trade Forum 2005*. http://emlab.berkeley.edu/users/webfac/cbrown/e153_sp06/2005btftrefler.pdf (01.09.2011).

Uhlig, H. (1996). A law of large numbers for large economies. *Economic Theory 8(1)*, 41–50.

Van Gyes, G., T. Vandenbrande, S. Lehndorff, G. Schilling, S. Schief, and H. Kohl (2007). Industrial relations in EU Member States 2000-2004. www.eurofound.europa.eu/pubdocs/2007/15/en/1/ef0715en.pdf (01.09.2011).

Vernon, R. (1966). International Investment and International Trade in the Product Cycle. *Quarterly Journal of Economics 80(2)*, 190–207.

Von Neumann, J. and O. Morgenstern (1944). *Theory of Games and Economic Behavior*. Princeton University Press.

Wette, H. C. (1983). Collateral in Credit Rationing in Markets with Imperfect Information: Note. *American Economic Review 73(3)*, 442–45.

Williamson, S. D. (1986). Costly Monitoring, Financial Intermediation, and Equilibrium Credit Rationing. *Journal of Monetary Economics 18(2)*, 159–79.

Williamson, S. D. (1987). Costly Monitoring, Loan Contracts, and Equilibrium Credit Rationing. *Quarterly Journal of Economics 102(1)*, 135–45.

Yanelle, M.-O. (1989). The Strategic Analysis of Intermediation. *European Economic Review 33(2-3)*, 294–301.

Yanelle, M.-O. (1997). Banking Competition and Market Efficiency. *Review of Economic Studies 64(2)*, 215–39.

Yeaple, S. R. (2003). The complex integration strategies of multinationals and cross country dependencies in the structure of foreign direct investment. *Journal of International Economics 60(2)*, 293–314.

Yeats, A. (2001). Just How Big is Global Production Sharing? In S. W. Arndt and H. Kierzkowski (Eds.), *Fragmentation: New Production Patterns in the World Economy*, pp. 108–143. Oxford University Press.

Zhao, L. (1995). Cross-hauling direct foreign investment and unionized oligopoly. *European Economic Review 39(6)*, 1237–53.

Zhao, L. (1998). The impact of foreign direct investment on wages and employment. *Oxford Economic Papers 50(2)*, 284–301.