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Chapter 1

Introduction

"Temporary agency employment", "temporary help work", or just "agency work": terms like this wander through the news and headlines for many years and the discussion about this controversial issue in labor market politics does not break off. There are people protesting against it and labor unions are fighting against it. Sometimes, it even seems that temporary agency employment gets stylized to the decline of the world of work itself. This thesis provides a contribution to shed light on different aspects of temporary agency employment and helps to assess advantages and disadvantages from an academic perspective.

Temporary agency employment is a three-sided, atypical employment relationship in which a worker is employed at a so-called temporary employment agency that acts as an intermediary between a worker and a firm which uses the worker in its production. The worker has an employment contract with the agency but is, by means of commercial contract, hired out to a client firm that uses the worker in its production. The advantage for the firm is that it can flexibly release the worker back to the agency when there is no need for the task any longer. This characteristic contractual relationship distinguishes temporary agency employment from other forms of temporary employment like fixed-term employment.

Worldwide, about forty-three million people work in the temporary agency sector. Compared to overall employment, this seems to be an insignificant number and it amounts to "only" 1.7% of the global working population (WEC, 2017). However, it equals the amount of employed workers in Europe's largest economy, Germany. Furthermore, in countries like Germany the amount of workers employed in temporary agency employment has tremendously increased in recent years, more than sevenfold since 1990 (Jahn & Weber, 2016a). Other countries, mostly European, show similar patterns. Overall, temporary agency employment is unequally distributed and some countries use temporary agency employment more intensive than others. The U.K. (3.8%), Australia (3.7%), the Netherlands (3.0%), and Germany (2.4%) use temporary agency employment above average. Italy (1.2%), Denmark (0.8%), or Greece (0.1%) almost avoid deploying temporary agency employment (WEC, 2017).

Crimmann et al. (2009) use the German IAB establishment panel to analyze in which sectors temporary agency employment is used at all and, if so, in which intensity it occurs. The authors show that it is most intensively used in the manufacturing sector, while firms in the service sector almost do without this form of employment. Furthermore, an important finding is that the bigger the firm, the more likely the use of temporary agency employment. In the manufacturing sector every other firm with more than 250 employees uses temporary agency work. In firms producing industrial goods or capital equipment, about 5% of the workers are borrowed from an agency. Next to other management reasons that are discussed below, temporary agency employment is subjected to the business cycle and more intensively used in booms.

The reasons for engaging in temporary agency employment are diverse and both sides, employers and employees, may have incentives to choose this form of employment. For employers, the first and most obvious motive is saving costs and increasing profits (see e.g. Jahn & Weber, 2016a). Due to the fact that there is no legal relationship between the worker and the firm, most instruments of employment protection do not apply to temporary agency work. Moreover, the costs for temporary agency workers are much easier to calculate and to keep track of than for regular workers. The borrowing fee includes all risks that an employer usually has to take into account when hiring a worker, e.g. pension costs or costs of absenteeism. Second, by using temporary agency workers firms can easily adjust the workforce in production peaks or balance workforce fluctuations (see Houseman, 2001; Ono & Sullivan, 2013).[1] Third, if the task is limited to a short time and there is no permanent use of the job, another advantage of temporary agency employment is the lack of training time and costs (Crimmann et al., 2009). Last, adjusting the work force by terminating the assignment of temporary agency workers in recessions is less costly for firms in terms of publicity and reputation than adjusting the regular workforce, especially if there is a strong employee representation which is the likelier the bigger the firm is.

Empirical studies verify that there are substantial wage gaps of up to 25% between temporary agency workers and regularly employed workers (see e.g. Jahn & Pozzoli, 2013) and that labor turnover is five times higher than for regular employment (Haller & Jahn, 2014). Nevertheless, there are incentives for workers to engage in temporary agency employment. Some workers, like students and young professionals, particularly choose this form of employment to gain diversified professional experience in a short time and, hence, to increase their attractiveness for potential employers (Crimmann et al., 2009). Furthermore, employees see temporary agency employment as a stepping stone to regular employment, to gain employability, and to earn money while maintaining freedom and independence by not being stuck to a specific employer (CIETT/Ecorys-NEI, 2002; Nunez & Livanos, 2015).

While countries like the U.S. have a rather long tradition of using temporary agency employment, European labor markets are traditionally less flexible. This inflexibility led to typically high unemployment rates and a high share of structural unemployment. Furthermore, in most countries this is combined with strong and supportive welfare states and social security systems. This is supported by strong labor unions and employee representations. The coverage rate of collective bargaining in the European Union is, even when it has declined over the years, still about 60% on average (Eurofound, 2015). Thus, labor unions play a central role in the wage determination. Temporary agency

[1] Baumgarten & Kvasnicka (2017) use German data to show that firms that use temporary agency employment in their production managed the financial crisis of 2008/09 much better in terms of business performance and keeping the regularly employed workforce stable than firms that do not use this form of employment.

employment provides an alternative production possibility for the firms which becomes more attractive, the cheaper it is relative to regular employment. Therefore, labor unions clearly fight against temporary agency employment.

The institutional frameworks and legal regulations of temporary agency employment are diverse and differ substantially across different countries. The UK, Austria, Denmark, and Sweden have almost no restrictions in the use of temporary agency employment. Other countries limit its use by time or sector restrictions. Two other important forms of restriction are the synchronization and the re-employment ban. While the former means that the contract between the worker and the agency has to exceed the assignment period to a firm by a specific duration, the latter states that it is not allowed to lend the same worker to the same client firm twice. Clauwaert (2000), Arrowsmith (2006), and Voss et al. (2013) give overviews of the legal framework of temporary agency employment in the European Union. However, as the high unemployment rates in the European countries are the facing challenge in current labor market politics, there was ongoing deregulation of temporary agency employment in the recent decades. Next to other suitable policy instruments, e.g. reducing employment protection or paying wage subsidies for employers who hire long-term unemployed, the deregulation of temporary agency employment is one of the core instruments to make labor markets more flexible. An outstanding example for a labor market reform that also included a radical deregulation in the temporary agency work sector is the so-called "Agenda 2010", the labor market reform of the former German social-democratic chancellor Gerhard Schröder. Regarding temporary agency employment, the main deregulating changes in this reform have been the abolition of the maximum period of assignment and the removal of the synchronization and re-employment ban (Antoni & Jahn, 2006). This reform, including the deregulation of temporary agency employment, led to a rapid increase in employment in that sector – the absolute number of temporary agency workers doubled sine then –, while the fraction of long-term unemployed in Germany substantially declined; from 1.72 million in 2007 to 1.05 million in 2011 (Bundesagentur für Arbeit, 2012).[2]

[2]Similar to Germany, there have been changes in regulations regarding temporary agency work in almost all European countries (see Eurofound, 2008, p. 12, Table 5 for an overview of the most important

With increasing importance of temporary agency employment in the political and public discussion, it also gained more attention in academic research. Autor (2001, 2003) provides a first theoretical contribution in the modeling of temporary agency employment by investigating the role of employment agencies in the screening process for regular employment and by discussing why firms hesitate to fully substitute their workforce by temporary agency workers even if they seem to be less expensive at first sight. Another important theoretical contribution is provided by Neugart & Storrie (2006). The authors suggest the increase in temporary agency employment to be caused by the improved matching efficiency induced by temporary employment agencies that work as intermediaries in the labor market matching of workers and firms. However, most of the research in this field focuses on the empirical investigation of temporary agency employment. The main issues that are addressed are the strategic use of temporary agency employment in the production (see, e.g., Vidal & Tigges, 2009; Holst et al., 2010; Nielen & Schiersch, 2014), its effect on the employment structure (see, e.g., Jahn & Bentzen, 2012; Jahn & Weber, 2016b), the wage differential between regularly and temporary employed workers (see, e.g., Garz, 2013; Goldschmidt & Schmieder, 2017), and the question if workers can use temporary agency employment as a stepping stone to regular employment (for recent contributions see, e.g., Jahn & Rosholm, 2013, 2014; Givord & Wilner, 2015; Krekeler, 2016).[3] Furthermore, due to the bad image of temporary agency employment, more recently the job satisfaction of agency workers gains attention in research. Petilliot (2016) and Busk et al. (2017) show that legal deregulation of temporary agency employment leads to a decline in job satisfaction due to decreasing wages and increased job insecurity.

The present work enters the theoretical discussion of the effects of temporary agency employment by picking up three different problems that have not been analyzed yet. Furthermore, it combines research on temporary agency employment with existing literature on labor unions to address the issues of European labor markets more properly. The additional contribution to the existing literature splits up into three parts. Chapter 2 discusses the optimal economic behavior of firms and labor unions that face the potential

changes).

[3] See also Autor & Houseman (2005, 2010); Amuedo-Dorantes et al. (2008); Kvasnicka (2009).

of using temporary agency employment in the bargaining process. Chapter 3 examines the macroeconomic effects of the deregulation of temporary agency work on wages, employment, the employment structure, and the position of labor unions in the economy. Finally, Chapter 4 studies how the technological choice of firms in the economy changes due to the deregulation of temporary agency employment.

Chapter 2 (joint work with Thomas Beißinger) focuses on the question of the optimal economic behavior of the bargaining parties when firms threaten labor unions in the bargaining process with the use of temporary agency employment in their production. Based on the work of Skaksen (2004) and Koskela & Schöb (2010), who use theoretical models to analyze the impact of offshoring on collectively bargained wages, Chapter 2 provides a monopoly union model to examine how and to what extend firms can strategically use the threat of temporary agency employment to dampen the wage claims of the labor unions. Furthermore, the model suggests how labor unions should optimally behave and respond to these threats. Focusing on the cost-reducing motive behind the use of temporary agency employment – i.e. assuming that the decision about hiring temporary agency workers is purely based on the comparison of the costs for different types of labor –, it is shown that labor unions may find it optimal to accept lower wages to prevent firms from using temporary agency workers. There are three cases that can be distinguished and formally analyzed to describe the optimal behavior of firms and unions: most obvious, when regular employment is less expensive than temporary agency employment, there is no need for the union to adjust its wage claims. If, however, temporary agency workers are less expensive than regular workers, the labor union may have an incentive to adjust its wage claims downwards to the same level. It should adjust its wage claims downwards as long as the decline in the utility of the labor union from adjusting the wage claims is less than the loss that results when the firm indeed used temporary agency employment. Finally, if the resulting utility of the labor union from a downward adjustment of the wage claims leads to an even lower utility level than when unions refuses to adjust, unions should not oppose firms' use of temporary agency employment, even if this leads to a loss in regular employment. Distinguishing these three cases, the optimal strategy of both bargaining parties and the optimal behavior in the negotiations can be revealed and formally be analyzed. The model enables to assess the different possible strategies of the bargaining parties and to compare the resulting gains and losses in the negotiations. It provides a significant contribution to the existing literature for different reasons. First, as empirical research may tend to use data on firms that use temporary agency work and compare this with firms that do not use this type of employment, the sole comparison of both types of firms neglects that the actual influence of temporary agency work may be unobservable when firms successfully threaten with its use in the negotiations. Furthermore, if firms decide to employ agency workers, the model suggests that labor unions increase their wage claims for the remaining regular workers to a level that even exceeds the claims of the labor union if there is no threat at all. Drawing the conclusion that a high wage level in a firm is the reason for using temporary agency employment in the production may, therefore, be wrong. An intensive use of temporary agency workers in high-wage firms may be the cause and not the consequence of the high wage level in those firms.

While Chapter 2 focuses on the optimal individual behavior of firms and labor unions and is in large parts limited to the partial equilibrium perspective, Chapter 3 (joint work with Dario Cords) concentrates on the macroeconomic determinants. As stated above, there have been continuous deregulation efforts regarding temporary agency employment in almost all European countries aiming at an increasing flexibility in the European labor markets within the last few decades. To describe and to analyze the effects of the deregulation on the macroeconomic determinants like wages, unemployment, and the employment structure, Chapter 3 uses a general equilibrium matching model à la Mortensen & Pissarides (1994) and Pissarides (2000). In particular, it builds up on the work of Delacroix (2006), Ebell & Haefke (2006), Bauer & Lingens (2013), and Krusell & Rudanko (2016), who provide first theoretical models of labor unions in the matching framework, and Neugart & Storrie (2006) and Baumann et al. (2011), who give important contributions to the combination of the matching framework and temporary agency employment. The model that is developed in Chapter 3 provides the first theoretical contribution that combines labor unions and temporary agency employment in the matching framework. Large firms produce differentiated goods employing regular workers that are organized in labor unions and, optionally, use temporary agency work for parts of the production to substitute regular workers. Furthermore, the model depicts the characteristic labor market flows from temporary agency employment to regular employment, which is modeled as on-the-job search. The model shows that the deregulation of temporary agency work leads to a reduction in overall unemployment. Surprisingly, this favors regular employment due to lower wages that arise from the impact that the more attractive production alternative temporary agency employment has on the position of the labor unions in the wage bargaining. However, the most interesting finding is that there is a hump-shaped relationship between the degree of institutional deregulation of temporary agency work and its rate of employment. This is explained by the fact that there are voluntary, non-institutional regulations in the form of agreements between firms and employee representations that become more important, the less regulated temporary agency employment is. They have a counter-effect on the costs of temporary agency work that are lowered by the deregulation. The model contributes to the discussion of temporary agency employment by combining labor unions and temporary agency work in the matching framework. Moreover, it suggests that one of the main arguments of the opponents of this form of employment is not plausible. Different to what opponents suggest, the model shows that ongoing deregulation and flexibility in this sector does not inevitably leads to a steady increase in precarious employment. This finding is in line with the fact that, even if there is some volatility in the penetration rate of temporary agency work, it stays relatively stable at a rate of approximately 2% of overall employment in most industrialized countries.

Chapter 4 picks up another aspect of the deregulation of temporary agency employment. As the technological orientation of an economy is not fixed, the ongoing deregulation raises the question of how the technology choice of firms in an economy changes due to the availability of the cheaper and, therefore, more attractive production alternative of temporary agency work. As in Chapter 3, the model in Chapter 4 uses the matching framework of Mortensen & Pissarides (1994) and Pissarides (2000) and in particular builds up on the work of Albrecht & Vroman (2002) and Dolado et al. (2009). In their influential contribution, Albrecht & Vroman examine the technology choice of firms in presence of worker heterogeneity. Dolado et al. enrich this framework by introducing on-the-job search. The model that is developed in this thesis reveals how the decision of firms with which technology to enter the market and to produce with changes with deregulation of temporary agency work. It builds a setting with two types of jobs that differ in their productivity and workers that randomly match with temporary agency or regular job vacancies. Workers produce the same good, independent on which job they are employed in, but the technology and productivity differs. Temporary agency work is less expensive to hire for firms than regular workers as direct labor costs are lower and there is no employment protection. However, job destruction and labor turnover is higher in temporary agency employment. The model suggests that the legal deregulation of temporary agency employment deteriorates the technology level used in the economy, leads to a more intensive use of the less advanced technology, and increases its employment. Regular workers are shown to suffer from declining wages while the labor income of temporary agency workers increases. Furthermore, it is shown that technological progress of the technology used in the production with temporary agency workers even strengthens the effects of the legal deregulation. However, Chapter 4 also provides an advice for economic policy by suggesting that subsidies or other forms of support for directed investments in technological progress of more advanced technologies may be suitable to dampen the macroeconomic effects of the deregulation of temporary agency employment.

Finally, following the detailed description and analysis of the different models, Chapter 5 provides a short discussion and concludes the thesis.

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Chapter 2

The Impact of Temporary Agency Work on Labor Union Wage Setting: A Theoretical Analysis*

2.1 Introduction

Usually, labor unions put up strong resistance to the employment of temporary agency workers and the perceived weakening of pay and labor standards.[1] However, as pointed out by Böheim & Zweimüller (2013), in a given firm it is not necessarily clear *a priori* whether the labor union will oppose the employment of temporary agency workers. The reason is that cost savings and increases in profits could enable labor unions to extract higher rents in firms that employ agency workers. The theoretical analysis in this chapter sheds more light on the question whether labor unions may profit from the introduction of temporary agency work or not. In more general terms, it will be analyzed how labor unions react to the firms' option to employ temporary agency workers and how this change in labor unions' wage-setting behavior affects firms' profits, unions' rents, and employment.

*This chapter is the result of joint work with Thomas Beissinger and has appeared as Beissinger & Baudy (2015).

[1]See, e.g., Heery (2004) for the UK, Coe et al. (2009) for Australia, and Olsen & Kalleberg (2004) for Norway and the US.

As far as we know, this is the first theoretical paper dealing with the impact of temporary agency work on labor union wage setting.

Temporary agency work constitutes a tripartite relationship, in which a temporary agency worker is employed by the temporary work agency and, by means of a commercial contract, is hired out to perform work assignments at a client firm. In return, the client firm has to pay a fee to the temporary work agency. In the following, temporary agency workers are referred to as temporary workers or agency workers. During the past few decades the share of agency workers in the total workforce has significantly increased in almost all OECD countries. Though the great recession starting in 2007 led to a cyclical decline in temporary agency work, in many countries the agency work penetration rate seems to resume its upwards trend. For example, in Germany the absolute number of individuals employed in temporary work agencies increased by more than seven times during the last twenty years, see Jahn & Weber (2016). Similarly, the agency work penetration rate significantly increased in the European Union (with a peak in 2007), Japan, or the U.S. (see CIETT, 2013).

Various motives are behind the use of temporary agency employment (see, e.g., Holst et al., 2010). Some motives have to do with the firm's necessity to react to a changing environment under uncertainty. In this case, temporary agency work is used as a "flexibility buffer". For example, the demand for temporary workers may be induced by the needs to adjust for workforce fluctuations and staff absences or to deal with greater uncertainty about future output levels (see Houseman, 2001 and Ono & Sullivan, 2013). Other motives are more of a strategic nature and have to do with the potential of using temporary agency employment to cut wage costs and increase profits. This strategic motive is well documented in the empirical literature (see, e.g., Mitlacher, 2007 and Jahn & Weber, 2016). The focus of the present model is on this cost-reduction motive behind the use of temporary agency employment and how this affects the "effective" wage bargaining power of labor unions.

One of the results will be that the option to use agency workers may affect wage setting also in those firms that do not employ temporary agency workers. This is an important result for at least two reasons. First, empirical studies may come to wrong conclusions if they try to identify the wage effects of temporary agency work by comparing wage levels for regular workers in firms with and without temporary agency work. Second, though the share of agency workers in the total workforce is only about two percent in many OECD countries, the impact of temporary agency work on the wage-setting process may be much larger.

From a methodological point of view, the theoretical model developed in this chapter is related to papers discussing the impact of international outsourcing on labor union wage setting. For example, in Koskela & Schöb (2010) and Skaksen (2004) the firms' option to outsource some part of production dampens wage claims of labor unions. Lommerud et al. (2006) analyze how international mergers might restrain the market power of unions in oligopoly markets. In those papers, the outsourcing or merging option imposes a threat to the bargaining power of labor unions, whereas in our paper the "effective" bargaining power of labor unions is eroded by the possibility to replace regular workers by temporary agency workers.

The remainder of the chapter is organized as follows. Section 2.2 outlines the theoretical framework and explains the components of the theoretical model. Section 2.3 derives the labor demand functions for regular workers for two employment regimes. In one regime only regular workers are used, whereas in the other regime agency workers are employed as well. Section 2.4 analyzes the wage-setting behavior of labor unions when firms have the option to also employ agency workers. It is shown that three wage-setting regimes can be distinguished. Section 2.5 compares the levels of wages, employment, labor unions' utilities and firm's profits for the three wage-setting regimes. Whereas the analysis in the main text focuses on a closed economy, Section 2.6 shows that the results also hold in a small open economy. Section 2.7 contains a summary and some conclusions.

2.2 Outline of the Model

The model analyzes the impact of temporary agency work on labor union wage setting using two modeling frameworks: the main variant focuses on the partial equilibrium in a closed economy with monopolistic competition in goods markets, whereas Section 2.6

explains how the main model equations have to be modified in order to describe the general equilibrium in a small open economy where goods prices are determined by world markets.

The following outline of the model is based on the modeling framework for the closed economy. There are two types of agents in the economy: Besides workers, who supply labor and do not own capital, there are also capitalists, who own the firms and do not supply labor. There also exist two types of firms in the economy: Productive firms produce final goods by using regular workers and possibly also temporary agency workers in production. Temporary work agencies lend temporary workers to productive firms. Between productive firms monopolistic competition prevails in the goods market. Because of barriers to market entry (that are, for simplicity, not explicitly modeled) the number of productive firms is given and monopoly rents are earned in the goods market. Firm-level labor unions determine wages on behalf of employed regular workers and try to appropriate some share of the rents for their members. Agency workers, however, are not covered by labor unions' wage agreements.

The model belongs to the class of so-called "right-to-manage" models, in which firms retain the right to choose the employment level. In contrast, in an "efficient bargaining" model firms and labor unions bargain over both, wages and employment. Whereas in the first class of models the equilibrium lies on the labor demand curve, in the latter case the bargaining outcome lies on a contract curve which usually is different from the labor demand curve. Since the implications of these model classes may be quite different, the decision to base the analysis on the right-to-manage model is justified in detail in Appendix 2.A.1. The model consists of the following core elements:

i) Productive firms. The final good is produced using two segments (or rather intermediate goods). The first segment can solely be produced by regular workers, whereas the second can be produced by regular workers or, optionally, by temporary workers. Such a production technology models the fact that temporary workers are mainly used for doing simple tasks in the production process, whereas more important parts of the production are done by regular workers. Formally, the technology of the representative productive firm is described by the production function

$$Y = S_1^{\alpha} S_2^{\beta} \qquad \alpha + \beta \leq 1, \tag{2.1}$$

where S_1 denotes the segment that can be solely produced by regular workers L_1, whereas segment S_2 can be produced by regular workers L_2 and/or by temporary workers $\tilde{L}_2$. It is assumed that

$$S_1 = L_1 \tag{2.2}$$

$$S_2 = L_2 + \delta \tilde{L}_2 \qquad 0 < \delta \leq 1. \tag{2.3}$$

Temporary workers might be less productive than regular workers, in which case $\delta < 1$ holds. Thus, $\delta \tilde{L}_2$ as well as L_1 and L_2 may be interpreted as labor in "efficiency units", where in the latter cases productivity is normalized to one. Total regular employment is $L = L_1 + L_2$. Notice that, apart from possibly being less productive than regular workers, temporary workers are assumed to be perfect substitutes for regular workers in some areas of production. For example, regularly employed assemblymen or warehouse workers may be (perfectly) substituted by temporary agency workers if the latter group can be employed at lower costs.[2]

The goods demand function for the productive firm is

$$Y = p^{-\eta} Q \qquad \eta > 1, \tag{2.4}$$

with p denoting the firm's price relative to the aggregate price level and η denoting the price elasticity of the demand for goods (in absolute values).[3] Q is the share of aggregate demand (being equal to aggregate output) that would accrue to the single firm if $p = 1$. Since the focus of the first model variant is on a partial equilibrium model, Q is normalized to one. If a productive firm wants to employ a temporary worker, a fee $\tilde{x}$ must be paid to the temporary work agency. Real profits of the productive firm are

$$\Pi = pY - w(L_1 + L_2) - x\delta \tilde{L}_2, \tag{2.5}$$

[2] This assumption is also in line with Jahn & Weber (2016) showing that regular jobs are substantially substituted by temporary jobs.

[3] This isoelastic goods demand function of the Blanchard & Kiyotaki (1987) type is often used in the literature and can be derived from Dixit & Stiglitz (1977) preferences.

where w denotes the gross real wage rate for regular workers and x denotes the real fee per temporary worker in "efficiency units", i.e.

$$x \equiv \frac{\tilde{x}}{\delta}. \tag{2.6}$$

In other words, x denotes the costs of producing one unit of S_2 if temporary workers are used for production. Firms compare these costs with the costs w of producing one unit of S_2 using regular workers.

ii) Temporary work agencies. It is assumed that temporary workers are just on the books of the temporary work agency when they are "idle", i.e. agency workers only receive a payment by the temporary work agency when they are assigned to a job at a client firm. This assumption captures quite well the institutional framework for temporary agency work in the UK, and to some extent the Netherlands or France, to name only some examples. In other countries, such as Germany and Sweden, temporary workers get an employment contract and obtain wage payments by the temporary work agency even when they are not assigned to a client firm.[4] However, as pointed out by Kvasnicka (2003), hirings by temporary work agencies occur primarily on-call as a reaction to current client demand to avoid the risk of initial prolonged unproductive employment of workers. In other words, the first assignment of a worker at a client firm almost always coincides with the moment the worker is hired by the temporary work agency, whereas activities such as screening take place prior to hiring. Our assumption therefore seems to be appropriate for the analysis of temporary work in a static model as it is considered in this paper.

It is assumed that the profits of a temporary work agency are equal to $(\tilde{x} - \omega - s)\tilde{L}_2$, where ω denotes the gross real wage rate of the temporary worker and s denotes real screening and search costs implied by the hiring of the temporary worker. Parameter s may also be related to the degree of regulation of temporary agency work. For example, in Germany a temporary worker was only allowed to work for a limited duration at the same client firm before the implementation of the Hartz reforms. Hence, in case the client firm

[4] The latter case has been analyzed in the matching models of Neugart & Storrie (2006) and Baumann et al. (2011). Alternatively, Neugart & Storrie (2006) also analyzed a model variant where workers are just on the books of the temporary work agency, which did not affect their main results (see their footnote 8).

intended to employ a temporary agency worker for a longer duration, the temporary work agency had to find a new temporary worker for the same job, implying higher screening and hiring costs.

Moreover, it is assumed that there is free market entry reflecting the fact that the establishment of a temporary work agency does not imply large irreversible investments as is the case for most productive firms. Since in equilibrium zero profits prevail, it must hold that[5]

$$\tilde{x} = \omega + s. \tag{2.7}$$

iii) Temporary workers. In 2008, the European Council introduced the Temporary Agency Work Directive (2008/104/EC) to close the wage gap between temporary agency workers and regular workers. However, Article 5 of this directive allows for derogations of the principle of equal pay to uphold collective labor agreements that may establish other working and employment conditions for temporary workers. As a consequence, in many European countries collective agreements were drawn up for temporary agency workers to circumvent the equal pay obligation. A wage penalty for temporary workers also results if firms refuse to pay bonuses or payments made to regular workers that are not mandated by collective agreements, or if they classify temporary agency workers into inappropriate pay grades (Garz, 2013).

To capture the fact that in many countries temporary workers have a very low effective bargaining power, we follow the matching models of Neugart & Storrie (2006) and Baumann et al. (2011) by assuming that agencies are able to set the wage ω equal to the reservation wage of workers.[6] The temporary work agency therefore offers a wage making its workers at the margin indifferent to either being hired by the agency or staying

[5]The assumption of free market entry is not appropriate for countries in which the establishment of a temporary work agency is restricted by government regulation. In that case eq. (2.7) should be interpreted as a simple shortcut to capture the fact that the fee $\tilde{x}$ claimed by the temporary work agency is positively related to screening costs s and the wage rate ω of a temporary worker.

[6]The fact that temporary workers often have a very low bargaining power is also pointed out in Eurofound (2008). According to this study, research findings also suggest that agency workers may have limited knowledge of their rights or the means to apply them.

unemployed. From these matching models it is known that the payment of temporary workers may be lower than, equal to, or greater than unemployment benefits depending on whether temporary workers find regular jobs more likely than unemployed workers or not (see eqs. (16) and (17) in Baumann et al., 2011). It is assumed that the temporary work agency offers a gross real wage ω so that the net real wage ω_n equals net unemployment benefits b_n. Implicitly, it is therefore assumed that the job finding probability is the same for unemployed and temporary workers. Net wages and benefits are defined as $\omega_n \equiv (1-\tau_w)\omega$ and $b_n \equiv (1-\tau_b)b$, where τ_w and τ_b denote the tax rates for wages and benefits, respectively. Hence, it is taken into account that in many countries unemployment benefits are also subject to income taxation. As in Beissinger & Egger (2004), we consider a situation in which $(1-\tau_b) = \phi(1-\tau_w)$, with $\phi \geq 1$. The government often imposes a lower tax burden on unemployment benefits implying $\phi > 1$, whereas if taxes on wages and unemployment benefits are the same, $\phi = 1$. The assumption $\omega_n = b_n$ then implies

$$\omega = \phi b \qquad \text{with} \quad \phi \geq 1. \tag{2.8}$$

iv) Labor unions. It is assumed that all employed regular workers are union members. Firm-level labor unions determine the wage for regular workers by maximizing the rent accruing to their members.[7] The rent of a single union member equals the differential between the net wage at the respective firm and the net income obtained as outside option.[8] For the determination of the outside option it must be taken into account that a regular worker being dismissed by the firm under consideration may either end up as a unemployed worker or finds a job as a temporary worker. However, because of eq. (2.8), the net wage of a temporary worker equals net unemployment benefits. As a consequence, the outside option of a regular worker simply amounts to net unemployment benefits.

[7] The chapter considers a monopoly union model instead of a Nash bargaining model in order to keep the analysis as simple as possible. It is well known from the literature that a Nash bargaining model does not change the qualitative results derived from a monopoly union model.

[8] In Strifler & Beissinger (2016) unions not only take the outside option into account, but also care about an internal reference related to the firm (e.g. profits per worker). However, such an analysis is beyond the scope of this paper.

The utility function of the representative union is the rent of a single worker times the number of regular workers at the firm under consideration, i.e. $U = L(w_n - b_n)$, where $w_n \equiv (1-\tau_w)w$ denotes the net real wage of regular workers.[9] Because $(1-\tau_b) = \phi(1-\tau_w)$ the labor union utility function can be rewritten as

$$U = L\,(1-\tau_w)\,(w - \phi b), \qquad \text{with} \quad \phi \geq 1. \tag{2.9}$$

v) Government budget constraint. In the partial equilibrium version of the model it would not be necessary to take explicit account of taxes and the government budget constraint. However, in the general equilibrium version the government budget constraint "closes" the model and shows how tax receipts are used to finance unemployment benefits. In the case of a balanced budget

$$\tau_w w(L_1 + L_2) + \tau_w \omega \tilde{L}_2 = (1-\tau_b)\,b\,[1 - L_1 - L_2 - \tilde{L}_2]. \tag{2.10}$$

The government may determine the level of net unemployment benefits by choosing τ_b and b. From the condition for a balanced budget then tax rate τ_w follows.

vi) Solution of the model. In the model, the agents' decisions are taken in two stages. In the first stage, the labor union determines the wage level for regular workers and the temporary work agency determines the fee it claims for the employment of an agency worker at a client firm. Because of the zero profit condition for temporary work agencies in eq. (2.7), the earnings equation (2.8) for agency workers, and eq. (2.6), the fee for an agency worker (in efficiency units) simply is $x = (\phi b + s)/\delta$. In the second stage, the firm decides on whether to use temporary workers or not and also determines the employment levels of regular workers and (possibly) temporary workers. This is taken into account by the labor union in the determination of the wage level. In order to obtain a subgame perfect equilibrium, the two-stage game must be solved by backward induction. Notice

[9] As is explained in Appendix A.1 in Strifler & Beissinger (2016), other well-known specifications of the union utility function, such as the expected utility function, are not fully consistent with a general equilibrium model. Since our model can also be interpreted as the general equilibrium in a small open economy, we assume rent-maximizing unions in our model.

that the firm's decision to employ temporary workers can be made quite "spontaneously" and can be easily reversed, since it does not require irreversible investment decisions. Hence, it is quite natural to assume that labor union wages are determined before the firm decides on the use of temporary agency workers and not the other way around.

2.3 The Determination of Labor Demand

In stage 2, each productive firm chooses the number of regular and temporary workers. The fee x to be paid to the temporary employment agency for a temporary worker (in efficiency units) and the wage rate w for a regular worker are already determined (from stage 1). Inserting eqs. (2.1) to (2.4) into eq. (2.5), the profit maximization problem of the representative firm is[10]

$$\max_{L_1, L_2, \tilde{L}_2} \pi = L_1^{\alpha\kappa}(L_2 + \delta\tilde{L}_2)^{\beta\kappa} - w(L_1 + L_2) - x\delta\tilde{L}_2 \quad \text{s.t.} \quad L_2 \geq 0, \tilde{L}_2 \geq 0, \tag{2.11}$$

where the parameter κ is defined as $\kappa \equiv (\eta - 1)/\eta$, with $0 < \kappa < 1$. The lower κ, the higher the monopoly power of firms. The first-order conditions are

$$\begin{aligned}
\frac{\partial \pi}{\partial L_1} &= \alpha\kappa L_1^{\alpha\kappa-1}(L_2 + \delta\tilde{L}_2)^{\beta\kappa} - w = 0, \\
\frac{\partial \pi}{\partial L_2} &= \beta\kappa L_1^{\alpha\kappa}(L_2 + \delta\tilde{L}_2)^{\beta\kappa-1} - w \leq 0, \qquad L_2 \geq 0, \qquad \frac{\partial \pi}{\partial L_2} L_2 = 0, \\
\frac{\partial \pi}{\partial \tilde{L}_2} &= \beta\kappa L_1^{\alpha\kappa}(L_2 + \delta\tilde{L}_2)^{\beta\kappa-1} - x \leq 0, \qquad \tilde{L}_2 \geq 0, \qquad \frac{\partial \pi}{\partial \tilde{L}_2} \tilde{L}_2 = 0.
\end{aligned}$$

It follows from the first-order conditions that three cases can be distinguished depending on whether the wage rate w for regular workers is lower than, equal to, or higher than the costs x of temporary workers.

Case I: $w < x$.

If $w < x$, it is cheaper to employ only regular workers, hence $L_2 > 0$ and $\tilde{L}_2 = 0$. From

[10] Because of eq. (2.1), both segments are essential for production. The corresponding labor input conditions $L_1 > 0$ and $L_2 + \tilde{L}_2 > 0$ are not explicitly taken into account in eq. (2.11).

the first-order conditions the following labor demand functions are obtained

$$L_1 = L_1(w) = A_1 \cdot w^{-1/[1-\kappa(\alpha+\beta)]}, \tag{2.12}$$

$$L_2 = L_2(w) = A_2 \cdot w^{-1/[1-\kappa(\alpha+\beta)]}, \tag{2.13}$$

with

$$A_1 \equiv \left[(\alpha\kappa)^{1-\beta\kappa} \cdot (\beta\kappa)^{\beta\kappa}\right]^{1/[1-\kappa(\alpha+\beta)]} \quad \text{and} \quad A_2 \equiv \left[(\alpha\kappa)^{\alpha\kappa} \cdot (\beta\kappa)^{1-\alpha\kappa}\right]^{1/[1-\kappa(\alpha+\beta)]}. \tag{2.14}$$

Therefore, total labor demand L for regular workers is given by

$$L = L_r(w) = (A_1 + A_2)\, w^{-1/[1-\kappa(\alpha+\beta)]}, \tag{2.15}$$

where the index r denotes the situation in which only regular workers are employed. The wage elasticity of labor demand (in absolute values), denoted as ε_r, is

$$\varepsilon_r = \frac{1}{1-\kappa(\alpha+\beta)}. \tag{2.16}$$

Case II: $w = x$.

This situation describes the borderline case in which the firm is indifferent between employing regular workers and temporary workers in the production of S_2. The number of regular workers in the production of S_2 could therefore vary between 0 and $L_2(x)$, where $L_2(x)$ denotes the labor demand function $L_2(w)$ from eq. (2.13) evaluated at $w = x$. For ease of exposition it is assumed that the firm only employs regular workers if $w = x$.[11] Hence, in case II the same labor demand demand function for regular workers as in eq. (2.15) (evaluated at $w = x$) results, i.e.

$$L = L_r(x) = (A_1 + A_2)\, x^{-1/[1-\kappa(\alpha+\beta)]}. \tag{2.17}$$

Case III: $w > x$.

In this case, profits are maximized by using only temporary workers in the production of S_2, hence $L_2 = 0$ and $\tilde{L}_2 > 0$. The labor demand functions are

$$\begin{aligned} L_1 &= L_1(w,x) = A_1 \left[w^{-(1-\beta\kappa)}\, x^{-\beta\kappa}\right]^{1/[1-\kappa(\alpha+\beta)]} \\ \tilde{L}_2 &= \tilde{L}_2(w,x) = (1/\delta) A_2 \left[w^{-\alpha\kappa}\, x^{-(1-\alpha\kappa)}\right]^{1/[1-\kappa(\alpha+\beta)]}, \end{aligned} \tag{2.18}$$

[11] This behavior would result if the labor union claimed a wage w that is marginally lower than x.

with A_1 and A_2 being defined as in case I, see eq. (2.14). Total labor demand for regular workers in case III equals L_1, i.e.

$$L = L_t(w, x) = A_1 \left[w^{-(1-\beta\kappa)}\, x^{-\beta\kappa}\right]^{1/[1-\kappa(\alpha+\beta)]}, \tag{2.19}$$

where the index t denotes the situation in which only temporary workers are employed in the production of S_2. In this case, the demand for regular workers also depends on the fee for temporary workers because of the complementarities in production between segments S_1 and S_2. For example, if the number of temporary workers in the production of S_2 is reduced because these workers become more expensive, the demand for regular workers in the production of S_1 is reduced as well. The wage elasticity of labor demand for regular workers (in absolute values) now becomes

$$\varepsilon_t = \frac{(1-\beta\kappa)}{1-\kappa(\alpha+\beta)}. \tag{2.20}$$

Notice that both labor demand elasticities, ε_r and ε_t, are constant and greater than one. Moreover, notice that $\varepsilon_t < \varepsilon_r$ holds. If temporary workers are employed as well, the labor demand elasticity for regular workers gets smaller (in absolute values) because of the decline in the share of regular employment in total costs.

2.4 Union Wage Determination for Regular Workers

In stage 1, labor unions choose the wage that maximizes the economic rent for employed regular members, defined in eq. (2.9), taking into account that employment is determined by firms in stage 2. Whether firms use temporary agency workers or not depends on the size of the fee for temporary workers relative to the wage that has to be paid to regular workers. Segment S_2 is produced by regular workers if $w \leq x$, whereas it is produced by temporary workers if $w > x$. Since labor unions determine the wage w for regular workers, their actions also affect the employment level chosen by firms.

In the following analysis it will turn out that there exist three wage-setting regimes, denoted as regimes R, X, and T, respectively. In regime R, the representative labor union claims the wage w_R, defined as the monopoly wage if the labor demand function is $L_r(w)$, and the corresponding firm chooses the employment level $L_r(w_R)$. In regime X, the labor union finds it optimal to set a wage $w_X = x$ that equals the fee for temporary workers and the employment level is $L_r(x)$. In regime T, the labor union claims the wage w_T, defined as the monopoly wage if the labor demand function is $L_t(w, x)$, and the firm chooses the employment level $L_t(w_T, x)$. Which regime prevails depends on the fee x for temporary workers relative to two threshold values $\underline{x}$ and $\overline{x}$, with $\underline{x} < \overline{x}$, as depicted in Figure 2.1. If $x \geq \overline{x}$, the labor union will choose the wage-setting regime R. For $x < \underline{x}$, the regime T will be chosen, whereas for intermediate values of the fee, $\underline{x} \leq x < \overline{x}$, the wage-setting regime X will be implemented.[12]

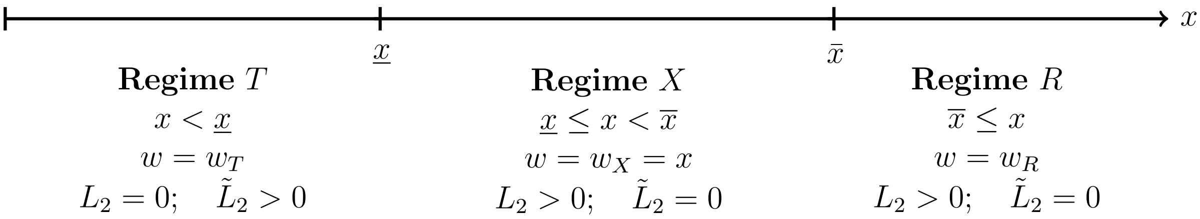

Figure 2.1: Three Wage-Setting Regimes for Regular Workers Depending on the Size of the Fee for Temporary Agency Workers

Before moving on to prove these statements, the monopoly wages and corresponding employment and utility levels for the regimes R and T are derived. As shown in Appendix 2.A.2, in these regimes each union sets the wage for regular workers as a mark-up over unemployment benefits, with the mark-up depending negatively on the wage elasticity of labor demand for regular workers. As has been shown in Section 2.3, the labor demand elasticities differ depending on whether the firm uses only regular workers or also temporary workers in production. In regime R, the rent-maximizing wage for regular

[12] Notice that in the wage-setting regimes R and X only regular workers are employed, i.e. the firm chooses the employment level according to the $L_r(w)$ function. The indices r and t just distinguish the labor demand functions and have a different meaning than the indices for the wage-setting regimes R, X, and T.

workers claimed by the labor union is

$$w_R = \frac{1}{(\alpha + \beta)\kappa}\, \phi b, \tag{2.21}$$

leading to the employment level $L_r(w_R)$ determined by eq. (2.15). The labor union then achieves the utility level

$$V_R = L_r(w_R)\,(1 - \tau_w)\,(w_R - \phi b). \tag{2.22}$$

In regime T, the rent-maximizing wage for regular workers becomes

$$w_T = \frac{1 - \beta\kappa}{\alpha\kappa}\, \phi b, \tag{2.23}$$

leading to the employment level $L_t(w_T, x)$ determined by eq. (2.19). Interestingly, it turns out that $w_T > w_R$. If the firm uses temporary agency work, the union's wage claim for the remaining regular workers is higher than the rent-maximizing wage if only regular workers are employed. The reason is that the labor demand elasticity for regular workers is lower (in absolute values) if also temporary workers are employed. In regime T, the labor union achieves the economic rent

$$V_T(x) = L_t(w_T, x)\,(1 - \tau_w)\,(w_T - \phi b). \tag{2.24}$$

As can be seen from this equation, the monopoly rent in regime T is a function of the fee for temporary workers. While w_T is constant, labor demand $L_t(\cdot)$ for regular workers negatively depends on the fee x. As a consequence, V_T also negatively depends on x.

An intuition for the determination of the threshold values $\underline{x}$ and $\overline{x}$ and the separation of the different wage-setting regimes is most easily obtained by looking at Figure 2.2 that describes the labor market for regular workers. The curve $L_r(w)$ represents labor demand in case only regular workers are employed in the production of both segments, whereas $L_t(w, x)$ is the labor demand curve (for regular workers) if temporary workers are used for the production of the S_2-segment. Notice that a decline in x leads to a rightward shift of the L_t-curve.

If $x \geq w_R$, i.e. the fee for temporary workers is higher than or equal to the wage w_R, the labor union chooses the wage $w = w_R$ that maximizes its economic rent if only regular workers are employed, and the firm decides to employ only regular workers (point A). The upper threshold for x therefore is

$$\overline{x} \equiv w_R = \frac{1}{(\alpha+\beta)\kappa}\,\phi b. \tag{2.25}$$

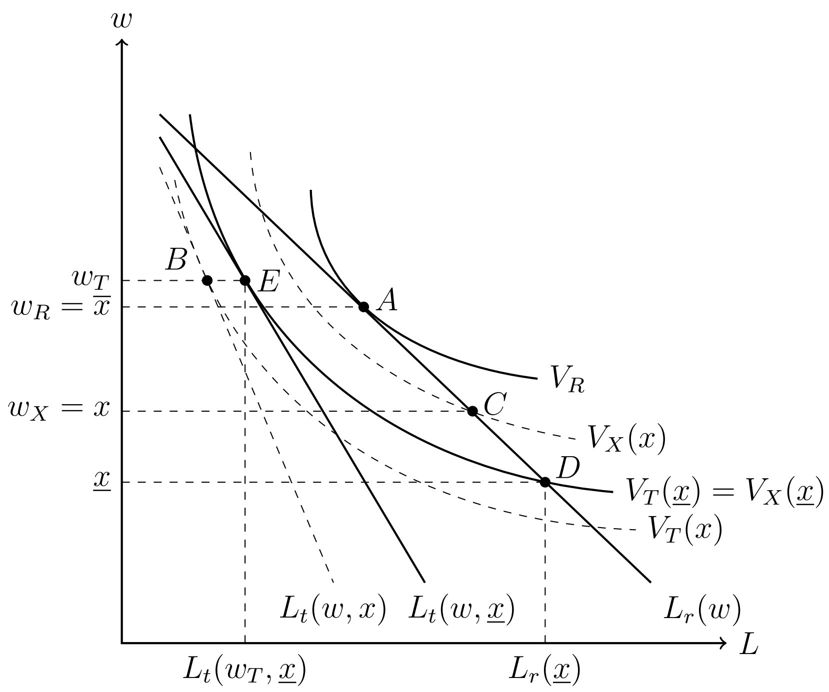

Figure 2.2: The Determination of the Threshold Values $\underline{x}$ and $\overline{x}$

Now suppose that the fee x for temporary workers is somewhat below $\overline{x}$. If the labor union still claimed the wage w_R, the firm would decide to employ temporary workers for the production of S_2, because $x < w_R$. In Figure 2.2, the corresponding labor demand curve (for regular workers) is depicted as the dashed line $L_t(w, x)$. If the labor union chooses a wage rate $w > x$, the firm chooses employment according to this $L_t(w, x)$-curve. Along this curve, the rent-maximizing wage is given by w_T, leading to the employment level $L_t(w_T, x)$ (point B). As is evident from the figure, in this situation the labor union would be better off by instead choosing a wage $w_X = x$ that makes the firm to employ only regular workers (point C). The reason is that the corresponding economic rent

$$V_X(x) = L_r(x)(1-\tau_w)(x-\phi b) \tag{2.26}$$

is higher than the utility level $V_T(x)$ corresponding to the indifference curve tangent to the $L_t(w,x)$-curve in point B.

If the fee for temporary workers further declines, the $L_t(w,x)$-curve and the indifference curve representing the maximum level of economic rent in regime T shift to the right due to the complementarities in production mentioned in Section 2.3. Simultaneously, with decreasing x the economic rent achievable in regime X declines and the corresponding indifference curve shifts to the left. As depicted in Figure 2.2, there has to exist a lower threshold $\underline{x}$ defined as the wage level for regular workers that renders the labor union indifferent between the situation in which only regular workers are used (point D) and the situation in which temporary workers replace regular workers in the production of segment S_2 (point E). The labor demand curve in the latter situation is given by $L_t(w,\underline{x})$. Hence, $\underline{x}$ is implicitly defined by the condition

$$V_T(\underline{x}) = V_X(\underline{x}). \tag{2.27}$$

If $x < \underline{x}$, the $L_t(w,x)$-curve lies to the right of the $L_t(w,\underline{x})$-curve. Hence, it no longer pays off for the labor union to prevent the employment of temporary workers because in this case $V_X(x) < V_T(x)$.

The graphical analysis using Figure 2.2 suggests that a lower threshold $\underline{x} < \overline{x}$ exists, where $\overline{x} = w_R$. Since the graphical results depend on the position of the $L_t(w,x)$-curves relative to the $L_r(w)$-curve, it has to be shown that the graphical intuition is correct. The formal proof, outlined in more detail in Appendix 2.A.3, is based on the following reasoning:

1. To determine the upper threshold $\overline{x}$, it is shown that for all values of the fee x with $x \geq w_R$ it is optimal for the labor union to claim the wage $w = w_R$. The alternative strategy of choosing a wage $w > x$, thereby inducing the firm to employ temporary workers for the production of segment S_2, is not in the interest of the labor union.[13] This is demonstrated by noting that for $x = w_R$ it holds that $V_R > V_T(w_R)$. In other words, the wage-employment combination $(w_R, L_r(w_R))$ leads to a higher economic rent than the

[13]Note that for fees $x > w_R$ it can never be optimal to choose a wage w with $w_R < w < x$, because w_R is the rent-maximizing wage if only regular workers are employed.

combination $(w_T, L_t(w_T, x = w_R))$. Moreover, because $\partial V_T(x)/\partial x < 0$, it must also hold that $V_R > V_T(x)$ for all $x > w_R$. It can be concluded that for $x \geq w_R$, the R-regime prevails in which it is the best strategy for the labor union to claim the wage w_R, and for the firm to employ only regular workers.

2. It has already been noted in step 1 that $V_R > V_T(w_R)$. Because of eqs. (2.22) and (2.26), it also holds that $V_R = V_X(w_R)$. It can therefore be concluded that $V_X(w_R) - V_T(w_R) > 0$. Moreover, it can be shown that $\partial[V_X(x) - V_T(x)]/\partial x > 0$ for $x \leq w_R$. In other words, the difference between the economic rents in regimes X and T declines with a decline in x. However, at least for marginal declines in x, it still holds that $V_X(x) > V_T(x)$. This means that if x (marginally) declines below w_R, it is better to set the wage equal to the fee of temporary workers (X-regime) in order to prevent temporary agency employment (T-regime). From steps 1 and 2 it follows that $\overline{x} = w_R$ indeed constitutes the upper threshold for the fee x. For $x \geq \overline{x}$ the R-regime prevails, whereas for (at least marginally) lower values than $\overline{x}$ the X-regime is chosen.

3. Since $V_X(w_R) - V_T(w_R) > 0$ and $\partial[V_X(x) - V_T(x)]/\partial x > 0$ for $x \leq w_R$, with declining x eventually a level $\underline{x}$ is reached where $V_X(\underline{x}) = V_T(\underline{x})$. If $\underline{x}$ were lower than the lowest admissible value of fee x, denoted $x_{\min}$ and defined as $x_{\min} = \phi b$, regime T would never occur.[14] However, it is shown that $x_{\min} < \underline{x}$ and $V_X(x) - V_T(x) < 0$ for all x with $x_{\min} \leq x < \underline{x}$. Hence, $\underline{x}$ constitutes the lower threshold separating regimes X and T.

2.5 Comparison of the Different Wage-Setting Regimes

This section compares the levels of wages, employment, labor union's utilities, and firm's profits for the three wage-setting regimes defined in Section 2.4. Starting with the comparison of the wage levels, it immediately follows from the discussion in Section 2.4 that

$$w_T > w_R > w_X, \tag{2.28}$$

[14] As has been outlined in Section 2, $x = (\phi\, b + s)/\delta$. The minimum value for x is obtained for $\delta = 1$ and $s = 0$, leading to $x_{\min} = \phi b$.

where w_X represents all wages $w_X = x$ for $x \in [\underline{x}, \overline{x})$. The first inequality is due the lower wage elasticity of labor demand for regular workers in regime T in comparison to regime R. Hence, in the employment regime with temporary workers, the optimal wage w_T is higher than the monopoly wage w_R when only regular workers are employed. The second inequality results from the union's incentive to undercut the wage w_R to prevent temporary agency employment if $\underline{x} \leq x < \overline{x}$.

Regarding the labor union's utility, it follows from the determination of the threshold values $\underline{x}$ and $\overline{x}$ in Section 2.4 that

$$V_R > V_X(x) > V_T(x) \qquad \text{for } x > \underline{x}. \tag{2.29}$$

From that discussion it is also evident that $V_T(x) > V_X(x)$ if $x < \underline{x}$ and that $V_T(x)$ increases with declining x. An interesting question left to answer is whether for values of x with $x_{\min} < x < \underline{x}$ it could be possible that $V_T(x) > V_R$. This would mean that labor unions profit from the employment of (relatively cheap) temporary workers because of higher economic rents. However, in Appendix 2.A.4 it is shown that, at least in our model, this result cannot occur. Instead, we conclude that

$$V_R > V_T(x) \qquad \text{for } x \geq x_{\min} = \phi\, b. \tag{2.30}$$

Hence, labor unions are always harmed by the employment of temporary workers.

Since in regimes R and X the same labor demand function is relevant and $w_X < w_R$, it immediately follows that employment in regime X is higher than employment in regime R. Moreover, it also holds that employment in regime R is higher than employment in regime T. If this were not the case, we would get a situation in which both wages and employment of regular workers are higher in regime T than in regime R. This, however, would contradict the inequality in eq. (2.30). Therefore,

$$L_r(w_X) > L_r(w_R) > L_t(w_T, x), \tag{2.31}$$

where w_X again refers to wages $w_X = x$ in the interval $x \in [\underline{x}, \overline{x})$ that are chosen in regime X. Note that the second inequality not only holds for $x \in [x_{\min}, \underline{x})$, but for all $x \geq x_{\min}$. In Appendix 2.A.5 it is explicitly shown that inequality (2.31) holds.

Finally, the firm's profits in the different regimes are considered (for details see Appendix 2.A.5). It can easily be derived that $\pi_X(x) > \pi_T(x)$ and $\pi_X(x) > \pi_R$ for all $x \geq x_{\min}$. However, whether profits in regime T exceed profits in regime R or vice versa, depends on the values of the exogenous parameters α, β, and κ. In Appendix 2.A.5 it is shown that there exists a value $x > x_{\min}$, denoted x_{indiff}, for which $\pi_R = \pi_T(x_{\text{indiff}})$. The location of x_{indiff} depends on the parameter values of α, β, and κ. If $x_{\text{indiff}} \in [\underline{x}, \overline{x})$, profits in regime T are higher than in regime R, i.e. it then holds that $\pi_T(x) > \pi_R$ for $x \in [x_{\min}, \underline{x})$. It can be shown that the probability for this situation is the higher, the smaller κ and the higher β relative to α. In other words, the larger the share of segment S_2 in production and the higher its share in total labor costs, the higher is the incentive of firms to hire temporary agency workers in the production of that segment to reduce labor costs and increase profits. However, if $x_{\text{indiff}} \in [x_{\min}, \underline{x})$, there is a range of fees for temporary workers $(x_{\text{indiff}}, \underline{x})$ for which $\pi_T(x) < \pi_R$. It may seem puzzling that firms would employ temporary workers in such a situation though this implies lower profits than in the regime where only regular workers are employed (at the monopoly wage w_R). The explanation is as follows: According to our analysis, the labor union finds it no longer profitable to prevent temporary agency employment if $x < \underline{x}$. The labor union therefore demands a wage w_T for the remaining regular workers and the firm finds it optimal to replace regular workers in segment S_2 by temporary workers. Both, the firm and the labor union, would be better off if the firm would only employ regular workers in both segments at the monopoly wage w_R. However, if the labor union claims the wage w_R, the firm still has the incentive to deviate from such an agreement and to replace the regular workers in segment S_2 by temporary workers, since $x < \underline{x} < w_R$. In such a case, the labor union would be even worse off than in a situation in which it claims the higher wage w_T for the remaining regular workers.

2.6 A Model Variant for a Small Open Economy

The model outlined above also describes the general equilibrium for a small open economy. In a small open economy goods prices are determined in world markets. Since the representative firm faces an infinitely elastic demand curve at world prices, the parameter κ introduced in eq. (2.11) equals 1. To obtain well defined labor demand functions it must be assumed that $\alpha + \beta < 1$ in eq. (2.1). Instead of eqs. (2.16) and (2.20), the labor demand elasticities now become

$$\varepsilon_r = \frac{1}{1-(\alpha+\beta)} \qquad \text{and} \qquad \varepsilon_t = \frac{1-\beta}{1-(\alpha+\beta)}.$$

With these labor demand elasticities, the monopoly wages in regimes R and T can be computed as

$$w_R = \frac{1}{\alpha+\beta}\,\phi b \qquad \text{and} \qquad w_T = \frac{1-\beta}{\alpha}\,\phi b, \tag{2.32}$$

where again $w_T > w_R$ holds. The rest of the analysis remains unchanged, i.e. there exist again the three regimes R, X, and T separated by the threshold values $\underline{x}$ and $\overline{x}$ as outlined in the closed economy version of the model. Therefore, our conclusions also hold in a general equilibrium setting for a small open economy.

2.7 Summary and Conclusions

This chapter develops a theoretical model to analyze how the firms' option to employ temporary agency workers affects the wage-setting behavior of labor unions. In the model, the motive behind employing temporary agency workers is the reduction in costs when the fee for temporary workers is lower than the wage for regular workers. The theoretical predictions are derived using two modeling frameworks: the partial equilibrium in a closed economy with monopolistic competition in goods markets and the general equilibrium in a small open economy where goods prices are determined by world markets. For simplicity, in the model monopoly unions are assumed that by their very nature have the highest wage-setting power.

It is shown that, depending on the fee for temporary workers, unions may try to prevent the implementation of temporary agency work by deviating from the monopoly wage and accepting lower wages. In this case, firms are able to use the option to replace regular workers by temporary workers as a threat against unions, thereby lowering wage demands and increasing profits. Unions then only claim wages that are equal to the fee the firm would have to pay for temporary workers. As a consequence, the firms' option to use agency workers may affect wage setting also in those firms that do not employ temporary agency workers. This is an important result for at least two reasons. First, empirical studies may come to wrong conclusions if they try to identify the wage effects of temporary agency work by comparing wage levels for regular workers in firms with and without temporary agency work. Second, though the share of agency workers in the total workforce is relatively small in many OECD countries, the impact of temporary agency work on the wage-setting process may be much larger.

It is also shown that if the fee for temporary workers is below a specific lower threshold, it is no longer the optimal strategy for labor unions to prevent the employment of temporary agency workers. Interestingly, since firms reduce the number of regular workers, it now is the best strategy for labor unions to claim wages that are even higher than the wage demands when the firms' threat to replace regular workers is not credible. Hence, according to our model, the intensive use of temporary agency workers in high-wage firms may be the cause and not the consequence of the high wage level in those firms.

In the literature it is sometimes argued that the use of temporary agency work may also benefit labor unions because they would be able to appropriate higher economic rents. It would then be in the interest of unions not to resist the employment of agency workers. However, at least in the present model, labor unions are always harmed by the firms' option to employ temporary workers.

2.A Appendix

2.A.1 Right-to-Manage Versus Efficient Bargaining

Empirical studies lack a clear answer about whether the right-to-manage model or the efficient bargaining model is more relevant. If managers are asked about the issues covered in bargains with labor unions, the answers seem to unambiguously back up the right-to-manage model (Booth, 1995). This can be most clearly seen in the U.S., where many collective agreements explicitly stipulate that employers retain the right to determine the level of employment. Even in countries where such a stipulation is not explicitly found in employment contracts, one gets the impression that labor unions typically do not bargain over employment.

Some economists argued that bargaining over employment implicitly occurs through firm-union agreements on "manning" levels (by which capital-to-labor or labor-to-output ratios are meant).[15] However, it is not clear why agreements on manning levels should be interpreted as contracts which implicitly determine the employment level. The reason is that, for instance, a fixed capital-labor ratio does not prevent firms from adjusting both capital and employment, or changing the number of shifts per machine (Layard et al., 1991, p. 96).

It is sometimes claimed that empirical studies which do not rely on survey data but focus on market outcomes would support the hypothesis that efficient bargains do, at least implicitly, occur (see, for example, Brown & Ashenfelter, 1986). However, Booth (1995, chap. 5) convincingly argues that the tests applied in these studies in order to distinguish between the right-to-manage model and the efficient bargaining model are flawed and therefore not credible. Empirical studies trying to identify the appropriate bargaining model from observed market outcomes are confronted with almost unsurmountable difficulties. In principle, each study has to make assumptions about labor unions' preferences, technologies, other labor market imperfections, and the market structure. The empirical tests then are joint tests of these assumptions. For example, the shape of the contract curve depends on the preferences of union members and may even coincide with the labor

[15]For this discussion see, e.g., McDonald & Solow (1981), Johnson (1990) and Clark (1990).

demand curve.[16] Hence, even if one focuses on the efficient bargaining model, different results are possible depending on labor union's preferences. The critique goes farther than that, since empirical studies have failed to significantly improve our knowledge about labor unions' preferences (see, for example, Pencavel, 1991).

The fact that efficient bargains are not observed more frequently may be due to the fact that something important is missing in theoretical considerations which claim the superiority of wage-employment bargains. For instance, efficient bargains may not be enforceable. Since the bargaining outcome usually lies off the labor demand curve, the firm has an incentive to cheat and may try to increase profits at the bargained wage level by choosing employment according to its labor demand curve. If labor unions are unable to enforce the labor contract, they may prefer higher wages and lower employment as predicted by the right-to-manage model.[17] For all these reasons, we consider the right-to-manage model to be a plausible framework for studying the impact of labor unions on labor market outcomes.

2.A.2 Utility Maximization of the Labor Union

In the wage-setting regimes R and T, the representative labor union chooses the optimal wage w_R and w_T by maximizing its objective function (2.9) subject to the labor demand function $L_r(w)$ or $L_t(w, x)$ defined in eqs. (2.15) and (2.19), respectively. From the first-order condition it follows that

$$-\frac{\partial L_r}{\partial w}\frac{w_R}{L_r} = \frac{w_R}{w_R - \phi\, b} \quad \text{and} \quad -\frac{\partial L_t}{\partial w}\frac{w_T}{L_t} = \frac{w_T}{w_T - \phi\, b}$$

for the R-regime and T-regime, respectively. Therefore,

$$w_R = \frac{\varepsilon_r}{\varepsilon_r - 1}\phi\, b \quad \text{and} \quad w_T = \frac{\varepsilon_t}{\varepsilon_t - 1}\phi\, b,$$

[16] See, for example, the "insider model" of Carruth & Oswald (1987) and the "seniority wage model" of Oswald (1993).

[17] If uncertainty and asymmetric information with respect to the future level of the firm's goods demand are taken into account, the scope of incentive-compatible contracts may be severely limited due to the costs of information gathering and the problems associated with moral hazard.

where ε_r and ε_t are defined in eqs. (2.16) and (2.20), respectively. If the tax rate for unemployment benefits is lower than that for wages, $\phi > 1$ holds, whereas $\phi = 1$ if the tax rate for unemployment benefits and wages is the same. In the case of the R-regime, the second-order condition for a utility maximum is

$$(1-\tau_w)\left[(w_R - \phi\, b)\cdot \left.\frac{\partial^2 L_r}{\partial w^2}\right|_{w=w_R} + 2\cdot \left.\frac{\partial L_r}{\partial w}\right|_{w=w_R}\right] < 0.$$

Since

$$\left.\frac{\partial L_r}{\partial w}\right|_{w=w_R} = -\varepsilon_r \cdot \frac{L_r(w_R)}{w_R}, \qquad \text{and} \qquad \left.\frac{\partial^2 L_r}{\partial w^2}\right|_{w=w_R} = \frac{\varepsilon_r}{w_R^2}\cdot L_r(w_R)\cdot(1+\varepsilon_r),$$

it can be shown that the second-order condition for a the utility maximum holds because

$$-L_r \cdot \frac{\varepsilon_r}{w_R^2}\cdot \phi\, b < 0.$$

A similar reasoning applies to the second-order condition in the T-regime.

2.A.3 Determination of the Wage-Setting Regimes

This appendix provides the details for the proof outlined in Section 2.4.

1. It is first shown that $V_R > V_T(w_R)$. Inserting the labor demand function $L_r(\cdot)$ from eq. (2.15) into the expression for V_R in eq. (2.22), one obtains

$$V_R = (A_1 + A_2)\, w_R^{\frac{-1}{1-\kappa(\alpha+\beta)}}(1-\tau_w)(w_R - \phi b).$$

Similarly, inserting $L_t(\cdot)$ from eq. (2.19) into the expression for V_T in eq. (2.24) for $x = w_R$ leads to

$$V_T(w_T) = A_1[w_T^{-(1-\beta\kappa)} w_R^{-\beta\kappa}]^{\frac{1}{1-\kappa(\alpha+\beta)}}(1-\tau_w)(w_T - \phi b).$$

Hence, for $V_R > V_T(w_R)$ it must hold that

$$\frac{A_1}{A_1 + A_2}\cdot\frac{w_T - \phi b}{w_R - \phi b} < \left[\frac{w_R^{-1}}{w_T^{-(1-\beta\kappa)} w_R^{-\beta\kappa}}\right]^{\frac{1}{1-\kappa(\alpha+\beta)}}. \tag{2.33}$$

Because of the definition of A_1 and A_2 in eq. (2.14) and the definitions of w_R and w_T in eqs. (2.21) and (2.23), the LHS of this inequality is

$$\frac{A_1}{A_1 + A_2}\cdot\frac{w_T - \phi b}{w_R - \phi b} = \frac{\alpha}{\alpha+\beta}\cdot\frac{\alpha+\beta}{\alpha} = 1. \tag{2.34}$$

Hence, inequality (2.33) becomes

$$1 < \left[\frac{w_T}{w_R}\right]^{\frac{1-\beta\kappa}{1-\kappa(\alpha+\beta)}},$$

leading to $w_T > w_R$. Since the last inequality is true, also $V_R > V_T(w_R)$ holds.

As next step the derivative of $V_T(x)$ is computed. One obtains

$$\frac{\partial V_T(x)}{\partial x} = -\frac{\beta\kappa}{1-\kappa(\alpha+\beta)} \frac{V_T(x)}{x} < 0.$$

If these results are taken together, it can be concluded that for all fees $x \geq w_R$, the R-regime prevails in which it is the best strategy for the labor union to claim the wage w_R, and for the firm to employ only regular workers.

2. Using eqs. (2.24) and (2.26) for V_T and V_X, respectively, and taking account of the labor demand functions (2.17) and (2.19), the difference in the rents achievable in regimes X and T is

$$\begin{aligned} V_X(x) - V_T(x) = (1-\tau_w)\cdot& \\ &\left[(A_1+A_2)\, x^{-\frac{1}{1-\kappa(\alpha+\beta)}}\,(x-\phi b) - A_1\left[x^{-\beta\kappa} w_T^{-(1-\beta\kappa)}\right]^{\frac{1}{1-\kappa(\alpha+\beta)}}(w_T-\phi b)\right], \end{aligned}$$

and its derivative with respect to fee x is

$$\begin{aligned} \frac{\partial[V_X(x)-V_T(x)]}{\partial x} = (1-\tau_w)\cdot& \\ &\left[(A_1+A_2)x^{-\frac{1}{1-\kappa(\alpha+\beta)}} \underbrace{\left(1-\frac{1}{1-\kappa(\alpha+\beta)}\frac{x-\phi b}{x}\right)}_{\equiv C}\right. \\ &\left. + \frac{\beta\kappa}{1-\kappa(\alpha+\beta)} A_1 \left(x^{-\beta\kappa} w_T^{-(1-\beta\kappa)}\right)^{\frac{1}{1-\kappa(\alpha+\beta)}} x^{-1}(w_T-\phi b)\right] \end{aligned}$$

The term C is positive if

$$x < \frac{1}{\kappa(\alpha+\beta)}\,\phi b = w_R,$$

and it is zero if $x = w_R$. Hence, $x \leq w_R$ is sufficient for $\partial[V_X(x) - V_T(x)]/\partial x > 0$ to hold.

As has been explained in Section 2.4, it follows from points 1 and 2 that $\overline{x} = w_R$ indeed constitutes the upper threshold for the fee x. For $x \geq \overline{x}$ the R-regime prevails, whereas for (at least marginally) lower values than $\overline{x}$, the X-regime is chosen.

3. Since $V_X(w_R) - V_T(w_R) > 0$ and $\partial[V_X(x) - V_T(x)]/\partial x > 0$ for $x \leq w_R$, with declining x eventually a level $\underline{x}$ is reached where $V_X(\underline{x}) = V_T(\underline{x})$, implying

$$(A_1 + A_2)\underline{x}^{\frac{-1}{1-\kappa(\alpha+\beta)}}(\underline{x} - \phi\, b) = A_1\left[w_T^{-(1-\beta\kappa)}\underline{x}^{-\beta\kappa}\right]^{\frac{1}{1-\kappa(\alpha+\beta)}}(w_T - \phi\, b).$$

Rearrangement leads to the following expression which implicitly defines $\underline{x}$:

$$\frac{\alpha}{\alpha+\beta}\left(\frac{w_T}{\underline{x}}\right)^{\frac{-(1-\beta\kappa)}{1-\kappa(\alpha+\beta)}} = \frac{\underline{x} - \phi\, b}{w_T - \phi\, b}.$$

Theoretically, it may be possible that $\underline{x}$ is lower than the lowest admissible value of fee x, denoted $x_{\min}$, where $x_{\min} = \phi b$. This would mean regime T never to occur. However, it can be shown that for $x_{\min}$ the difference in the utilities in regimes X and T is negative:

$$\begin{aligned} V_X(x_{\min}) - V_T(x_{\min}) &= L_r(x_{\min})(1-\tau_w)(\phi\, b - \phi\, b) - L_t(x_{\min})(1-\tau_w)(w_T - \phi\, b) \\ &= -L_t(x_{\min})(1-\tau_w)(w_T - \phi\, b) < 0. \end{aligned}$$

As $\partial[V_X(x) - V_T(x)]/\partial x > 0$ and $V_X(\underline{x}) - V_T(\underline{x}) = 0$, it holds that $x_{\min} < \underline{x}$. Hence, regime T is a possible outcome of the model and $\underline{x}$ constitutes the lower threshold separating regimes X and T.

2.A.4 Proof for $V_R > V_T(x)$ for $x > x_{\min}$

Since $V_T(x)$ increases with declining x, it could be the case that for very low x the inequality $V_T(x) > V_R$ holds. In terms of Figure 2.2 this would mean that for a very low fee x the $L_T(x)$-curve may lie far enough to the right that the corresponding economic rent in regime T is higher than the economic rent achievable in regime R. However, it can be shown that in our model such a case cannot occur. To do so, it has to be shown that the highest achievable economic rent in regime T is lower than the rent achievable in regime R. Since $\partial V_T(x)/\partial x < 0$, the highest value of V_T is obtained at $V_T(x_{\min})$, where $x_{\min} = \phi\, b$. In the following, we will show that

$$V_T(x_{min}) < V_R \tag{2.35}$$

holds. Taking account of the definition of the utility functions in eqs. (2.22) and (2.24) and the labor demand functions in eqs. (2.15) and (2.19), this condition is met if

$$\frac{A_1}{A_1 + A_2} \cdot \frac{w_T - \phi b}{w_R - \phi b} < \left[\frac{w_T^{(1-\beta\kappa)}(\phi\, b)^{\beta\kappa}}{w_R}\right]^{\frac{1}{1-\kappa(\alpha+\beta)}}. \tag{2.36}$$

Because of eq. (2.34), the LHS of this inequality is equal to one. Taking account of the definitions of w_R and w_T in eqs. (2.21) and (2.23), rearrangement of inequality (2.36) leads to

$$\kappa(\alpha+\beta)\left(\frac{1-\beta\kappa}{\alpha\kappa}\right)^{(1-\beta\kappa)} > 1. \tag{2.37}$$

To show that this inequality is fulfilled, we set $\alpha+\beta=z$ with $z \leq 1$. In the following, the cases $z=1$ and $z<1$ are considered separately.

Case 1: $z=1$. Since in this case $\alpha = 1-\beta$, the LHS of inequality (2.37) becomes

$$f := \kappa\left(\frac{1-\beta\kappa}{(1-\beta)\kappa}\right)^{1-\beta\kappa} \tag{2.38}$$

It must be shown that f is greater than one for all admissible values of β and κ. Because of the sign of the partial derivatives,[18]

$$\frac{\partial f}{\partial \beta} = \kappa^2\left(\frac{1-\beta\kappa}{(1-\beta)\kappa}\right)^{1-\beta\kappa}\left[\frac{1-\beta\kappa}{(1-\beta)\kappa} - \ln\left(\frac{1-\beta\kappa}{(1-\beta)\kappa}\right) - 1\right] > 0,$$
$$\frac{\partial f}{\partial \kappa} = -\left(\frac{1-\beta\kappa}{(1-\beta)\kappa}\right)^{1-\beta\kappa}\left[1+\beta\kappa\ln\left(\frac{1-\beta\kappa}{(1-\beta)\kappa}\right)\right] < 0,$$

the lowest admissible values of β and the highest admissible values of κ must be considered. Since it holds that $\lim_{\kappa\to 1} f = 1$ and $\lim_{\beta\to 0} f = 1$, f is indeed greater than one for all admissible values of κ and β. Hence, $V_R > V_T(x)$ for all admissible values of the fee for temporary workers ($x \geq x_{\min}$) in the case $\alpha+\beta=1$.

Case 2: $z<1$. Since in this case $\alpha = z-\beta$, the LHS of inequality (2.37) becomes

$$h := z\,\kappa\left(\frac{1-\beta\kappa}{(z-\beta)\kappa}\right)^{1-\beta\kappa} \tag{2.39}$$

[18] For the first derivative to be positive, the term in corner brackets has to be positive. In general it holds that $y-\ln(y)>1$ for expression y being positive and unequal to one. As expression $(1-\beta\kappa)/((1-\beta)\kappa)>1$, the term in brackets is indeed positive.

It must be shown that h is greater than one for all admissible values of β and κ. Because of the sign of the partial derivatives,

$$\frac{\partial h}{\partial \kappa} = -\kappa z \beta \left(\frac{1-\beta\kappa}{(z-\beta)\kappa}\right)^{1-\beta\kappa} \ln\left(\frac{1-\beta\kappa}{(z-\beta)\kappa}\right) < 0,$$
$$\frac{\partial h}{\partial \beta} = z\kappa^2 \left(\frac{1-\beta\kappa}{(z-\beta)\kappa}\right)^{1-\beta\kappa} \left[\frac{1-\beta\kappa}{(z-\beta)\kappa} - \ln\left(\frac{1-\beta\kappa}{(z-\beta)\kappa}\right) - 1\right] > 0,$$

the lowest admissible values of β and the highest admissible values of κ must be considered. It holds that

$$\lim_{\kappa\to 1} h = z\left(\frac{1-\beta}{z-\beta}\right)^{1-\beta}.$$

In order to check whether this expression is still greater than one if β gets very small, we compute

$$\lim_{\beta\to 0}\left(\lim_{\kappa\to 1} h\right) = \frac{1}{z}\cdot z = 1.$$

Therefore, h is indeed greater than one for all admissible values of κ and β. Hence, $V_R > V_T(x)$ for all admissible values of the fee for temporary workers ($x \geq x_{\min}$) in the case $\alpha + \beta < 1$.

Taken together, $V_R > V_T(x)$ for all admissible parameter values and $x \geq x_{\min}$.

2.A.5 Comparison of Labor Demand and Profits in the Different Regimes

As has been explained in Section 2.5, employment in regime X is greater than employment in regime R because $w_X < w_R$. It is now shown that employment in regime R is greater than employment in regime T. Using eqs. (2.15), (2.19), (2.21), and (2.23), it turns out that employment in regime R is greater than that in regime T if

$$\left(\frac{\alpha}{\alpha+\beta}\right)^{1-\kappa(\alpha+\beta)} < \kappa(\alpha+\beta)\left(\frac{1-\beta\kappa}{\alpha\kappa}\right)^{(1-\beta\kappa)}. \tag{2.40}$$

The RHS of this inequality is greater than one because of inequality (2.37). Since the LHS is smaller than one, the condition is met.

Using eqs. (2.11), (2.12), (2.13), (2.17), (2.18), and (2.19), maximum profits in the different regimes are

$$\pi_R = [A_1^{\alpha\kappa} A_2^{\beta\kappa} - (A_1 + A_2)] \cdot w_R^{-\frac{\kappa(\alpha+\beta)}{1-\kappa(\alpha+\beta)}} \tag{2.41}$$

$$\pi_T(x) = [A_1^{\alpha\kappa} A_2^{\beta\kappa} - (A_1 + A_2)] \cdot [w_T^{-\alpha\kappa} x^{-\beta\kappa}]^{\frac{1}{1-\kappa(\alpha+\beta)}} \tag{2.42}$$

$$\pi_X(x) = [A_1^{\alpha\kappa} A_2^{\beta\kappa} - (A_1 + A_2)] \cdot x^{-\frac{\kappa(\alpha+\beta)}{1-\kappa(\alpha+\beta)}} \tag{2.43}$$

It is easy to verify that $\pi_X(x) > \pi_T(x)$ and $\pi_X(x) > \pi_R$ for all $x \in [x_{\min}, \overline{x}]$ as for this range of x it holds that $w_T > x$ and $w_R > x$, respectively. However, it is left to show whether in regime T firms earn higher profits than in regime R. Using eqs. (2.41) and (2.42), the value of x that renders the firm indifferent between both regimes, i.e. for which $\pi_R = \pi_T(x_{\text{indiff}})$, is

$$x_{\text{indiff}} = w_R \left(\frac{w_R}{w_T}\right)^{\frac{\alpha}{\beta}} \tag{2.44}$$

Obviously $x_{\text{indiff}} < w_R$, because $w_R/w_T < 1$. Furthermore, it can be shown that x_{indiff} is greater than $x_{\min}$. For this, using eq. (2.44) and $x_{\min} = \phi\, b$, it has to hold that

$$\kappa(\alpha+\beta)\left[\kappa(\alpha+\beta)\frac{1-\beta\kappa}{\alpha\kappa}\right]^{\frac{\alpha}{\beta}} < 1. \tag{2.45}$$

Setting $\alpha + \beta = z$ with $z \leq 1$, the LHS of inequality (2.45) becomes

$$l := z\,\kappa\left(z\frac{1-\beta\kappa}{z-\beta}\right)^{\frac{z-\beta}{\beta}}. \tag{2.46}$$

It must be shown that l is smaller than one for all admissible values of β and κ. The partial derivatives of l are

$$\frac{\partial l}{\partial \kappa} = z\left(z\frac{1-\beta\kappa}{z-\beta}\right)^{\frac{z-\beta}{\beta}} \cdot \left[1 - \frac{\kappa(z-\beta)}{1-\beta\kappa}\right] > 0$$

and

$$\frac{\partial l}{\partial \beta} = z\,\kappa\left(z\frac{1-\beta\kappa}{z-\beta}\right)^{\frac{z-\beta}{\beta}} \cdot \left[-\frac{z}{\beta^2}\ln\left(\frac{(1-\beta\kappa)z}{z-\beta}\right) + \frac{(1-\beta\kappa)-\kappa(z-\beta)}{\beta(1-\beta\kappa)}\right].$$

It will turn out that l decreases in β. For this to be the case, the expression in corner brackets has to be negative, or, alternatively written,

$$\ln\left(\frac{(1-\beta\kappa)z}{z-\beta}\right) - \frac{\beta(1-\beta\kappa)-\beta\kappa(z-\beta)}{(1-\beta\kappa)z} > 0.$$

Expanding the second term of the LHS, the inequality can be written as

$$\ln\left(\frac{(1-\beta\kappa)z}{z-\beta}\right)+\frac{z-\beta}{(1-\beta\kappa)z}>1,$$

which is fulfilled because $(\ln y + 1/y) > 1$ for $y \neq 1$.

As l increases in κ and decreases in β, the highest admissible value of κ and the lowest admissible value of β must be considered to make sure that inequality (2.45) is fulfilled. Since the limits are[19]

$$\lim_{\kappa\to 1} l = z\left(z\,\frac{1-\beta}{z-\beta}\right)^{\frac{z-\beta}{\beta}} < 1 \quad \text{and} \quad \lim_{\beta\to 0} l = \frac{e\,\kappa\,z}{e^{\kappa\,z}} < 1, \tag{2.47}$$

function l is indeed smaller than one for all admissible values of κ and β and, hence, x_{indiff} is greater than $x_{\min}$.

It is still left to show where x_{indiff} is located compared to $\underline{x}$, i.e. whether x_{indiff} is smaller than, equal to, or greater than $\underline{x}$. This question cannot be answered by just comparing x_{indiff} and $\underline{x}$ directly, because $\underline{x}$ is only implicitly defined. However, Section 2.4 discussed that for $x \in [x_{\min}, \underline{x})$ the economic rent $V_T(x)$ exceeds $V_X(x)$ whereas for $x \in [\underline{x}, \overline{x})$ the opposite holds. This information can be used to identify the location of x_{indiff}. If for $V_T(x)$ and $V_X(x)$ evaluated at x_{indiff} the economic rent in regime T exceeds the rent in regime X, x_{indiff} lies in the interval $[x_{\min}, \underline{x})$. In the opposite case x_{indiff} lies in the interval $[\underline{x}, \overline{x})$. With the definitions of V_T and V_X in eqs. (2.24) and (2.26) and the corresponding labor demand functions (2.17) and (2.19), the utility levels are

$$V_X(x_{\text{indiff}}) = (A_1 + A_2)\left[\left(\frac{w_R}{w_T}\right)^{\frac{\alpha}{\beta}} w_R\right]^{-\frac{1}{1-\kappa(\alpha+\beta)}} (1-\tau_w)\left[\left(\frac{w_R}{w_T}\right)^{\frac{\alpha}{\beta}} w_R - \phi b\right] \tag{2.48}$$

$$V_T(x_{\text{indiff}}) = A_1\left[w_T^{1-\beta\kappa}\left(\frac{w_R}{w_T}\right)^{\alpha\kappa} w_R^{\beta\kappa}\right]^{-\frac{1}{1-\kappa(\alpha+\beta)}} (1-\tau_w)\,[w_T - \phi b] \tag{2.49}$$

Using these equations, it turns out that $x_{\text{indiff}} \in [\underline{x}, \overline{x})$ or rather $V_X(x_{\text{indiff}}) > V_T(x_{\text{indiff}})$ if

$$\left[\frac{\left(\frac{w_R}{w_T}\right)^{\frac{\alpha}{\beta}} w_R}{w_T^{(1-\beta\kappa)}\left(\frac{w_R}{w_T}\right)^{\alpha\kappa} w_R^{\beta\kappa}}\right]^{-\frac{1}{1-\kappa(\alpha+\beta)}} > \frac{A_1}{A_1+A_2}\cdot\frac{w_T-\phi b}{\left(\frac{w_R}{w_T}\right)^{\frac{\alpha}{\beta}} w_R - \phi b}. \tag{2.50}$$

[19]Note that for $z = 1$, $\lim_{\kappa\to 1} l = 1$. For $z < 1$, $\lim_{\kappa\to 1} l \le 1$ as $\lim_{\beta\to 0}(\lim_{\kappa\to 1} l) = e\,z/e^z \le 1$.

Because of eq. (2.34) it holds that $A_1/(A_1 + A_2) = \alpha/(\alpha + \beta)$ and $w_T - \phi b = (w_R - \phi b) \cdot (\alpha + \beta)/\alpha$. Therefore, eq. (2.50) becomes

$$\left(\frac{w_T}{w_R}\right)^{\frac{[1-\kappa(\alpha+\beta)]\beta\kappa+\alpha\kappa}{[1-\kappa(\alpha+\beta)]\beta\kappa}} > \frac{w_R - \phi b}{\left(\frac{w_R}{w_T}\right)^{\frac{\alpha\kappa}{\beta\kappa}} w_R - \phi b}. \tag{2.51}$$

However, calibration of inequality (2.51) shows that there are combinations of admissible parameter values possible for which this inequality is violated. This means that for some admissible combinations of α, β, and κ it holds that $x_{\text{indiff}} < \underline{x}$, whereas for other parameter combinations $x_{\text{indiff}} > \underline{x}$. Setting $\alpha + \beta = z$ with $z \leq 1$, it turns out that the smaller κ and the higher β compared to α, the higher is the probability that $x_{\text{indiff}} \in [\underline{x}, \overline{x})$.

Whether firms benefit from using temporary agency employment compared to using regular workers only, depends on the location of x_{indiff}. For $x \in [x_{\min}, \underline{x})$, labor unions claim wage w_T and regime T occurs. If, additionally, $x_{\text{indiff}} \in [\underline{x}, \overline{x})$, then the firm's profit in regime T unambiguously exceeds the profit achievable in regime R. If, however, $x_{\text{indiff}} \in [x_{\min}, \underline{x})$, there is a range of fees for temporary workers $(x_{\text{indiff}}, \underline{x})$ for which $\pi_T(x) < \pi_R$.

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Chapter 3

Deregulation of Temporary Agency Employment in a Unionized Economy: Does This Really Lead to a Substitution of Regular Employment?*

3.1 Introduction

During the last two decades, the use of temporary agency work increased tremendously in almost all OECD countries. In Germany, for example, the number of temporary agency workers increased sevenfold (Jahn & Weber, 2016). With a share of temporary agency employment on overall employment of just about 2% in most industrialized countries, temporary agency employment may seem to be rather small and, therefore, to be a minor labor market issue at first sight. However, the deregulation of temporary agency employment is an important, frequently used and highly discussed labor market policy issue in Europe. There has been ongoing institutional deregulation of temporary agency

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employment aiming at increasing flexibility of the countries' labor markets. For instance, in Germany the deregulation of temporary agency employment was part of the labor market reform "Agenda 2010" of the former social-democratic chancellor Gerhard Schröder in 2003. The aim of increasing the attractiveness of temporary agency employment was, next to other labor market instruments, to reduce unemployment and to increase the international competitiveness of the German economy. The political idea behind the deregulation of temporary agency employment is to bring more people to work that are not able to find a job in the regular labor market, e.g. long-term unemployed. By using temporary workers in the production, firms may "test" the workers and, afterwards, convert their employment relationship to regular employment. From the firm's perspective, there are various motives for using temporary agency workers in the production process (see, e.g., Holst et al., 2010). One of them is that using temporary agency workers in the production allows to easily adjust the workforce to uncertainty about future output levels, workforce fluctuations, worker absence etc. since temporary agency workers are not covered by employment protection (see Houseman, 2001; Ono & Sullivan, 2013). Another argument for replacing regular by temporary workers is that the use of the latter may lead to cost savings and increasing profits (see, e.g., Jahn & Weber, 2016).

In most European countries, wages are determined by collective bargaining agreements between firms and labor unions. The use of temporary agency employment may lead to a substitution of part of the regular workforce that is represented by the unions. Thus, labor unions have to take the behavior of the employment agencies into account in the negotiation process. Otherwise, the increasing attractiveness for firms to use temporary agency work may induce a substantial replacement of regular employment and, hence, deteriorate the labor unions' position in the economy.

Despite the important role of labor unions in almost all European economies, up to now there has been limited attention on the investigation of temporary agency employment on labor union's behavior. Beissinger & Baudy (2015) give a first theoretical contribution analyzing the firm's strategic use of potential temporary agency employment in the wage-setting process to dampen labor union's wage claims. However, the model neglects the general equilibrium effects of increasing temporary agency employment. Therefore, it is not able to cope with the main argument of opponents of temporary agency work that the ongoing transition to more flexible labor markets leads to a change in the employment structure towards more precarious employment and a decrease in union coverage. Thus, it is left to analyze the effects of temporary agency work on overall employment and the employment structure in the economy in a dynamic setup.

To close this gap, the present chapter analyzes the general equilibrium effects of temporary agency employment in a frictional labor market à la Mortensen & Pissarides (1994) and Pissarides (2000). It is assumed that there are large firms producing differentiated goods with labor being the only production factor. Workers can either be hired directly by the firms or, alternatively, the firm may borrow workers from temporary employment agencies. Both types of work are modeled as perfect substitutes. Regular workers are organized in firm-level labor unions. Agencies are small (one worker) and bargain individually with the firm over the fee a firm has to pay for using temporary workers in its production. This model framework enables to reveal the employment structure in the economy and its adjustment to shocks like institutional changes in the regulation of temporary work agencies. Furthermore, it is possible to analyze how union coverage evolves in the economy and to examine the flows in the different labor market states. Legal (de)regulation is modeled by regulatory costs arising from institutional barriers like limitations regarding the maximum period of assignment of temporary workers, re-employment bans, synchronization bans or equal pay obligations for regular and temporary agency workers. Higher legal regulation leads to increasing regulatory costs.

The main result of the model is that there is a hump-shaped relationship between temporary agency employment used in the production and its degree of legal deregulation. At first sight, this may be counterintuitive as it means that progressive legal deregulation does not inevitably lead to an increase in temporary agency employment but it may even decline. Furthermore, regular employment monotonically increases in the deregulation of temporary employment. Thus, there is no reduction in the degree of union coverage but, on the contrary, it even increases. Unions and single workers both suffer from temporary agency employment due to declining wage rates and labor union utility. The findings reject the main argument of opponents of temporary agency employment and support the policy makers' idea that legal deregulation of temporary agency employment increases the flexibility of the European labor markets and brings people to work who may not find regular employment. The model supports the deregulation efforts of temporary agency employment in order to increase the employment level.

The structure of the chapter is as follows. Section 3.2 gives a brief discussion of related literature on labor unions and temporary agency employment. Section 3.3 describes the outline of the model and its components in more detail before the model is solved in Section 3.4. Section 3.5 defines the equilibrium. In Section 3.6, the model is calibrated and its predictions considering the employment structure in the economy are presented. Section 3.7 examines the key insights of the model, i.e. the changes in the wage setting and the employment structure triggered by legal deregulation of the temporary employment sector. Finally, Section 3.8 summarizes the results and concludes.

3.2 Related Literature

The behavior of labor unions has already been widely discussed in the literature (for an overview see Booth, 1995; Boeri et al., 2001; Addison & Schnabel, 2003). However, little attention was paid on modeling unionized labor markets in the framework of search and matching for a long time. A first contribution to labor unions in the matching framework is given by Delacroix (2006). He introduces a multisectorial model with a varying degree of union coverage and monopolistic competition in the goods market and investigates the union's reaction to changes in the unemployment insurance. Based on this framework, Ebell & Haefke (2006) study the effect of a product market deregulation on the formation of labor unions by endogenizing the choice of the bargaining institution. Bauer & Lingens (2013) investigate the efficiency in search models with large firms and collectively bargained wages, while Krusell & Rudanko (2016) analyze the intertemporal effect of unions' commitment to future wages. In another recent contribution, Ranjan (2013) examines the general equilibrium effects of decreasing offshoring costs in a unionized economy. He identifies a non-monotonic relationship of unemployment and offshoring costs in the domestic, offshoring country. Decreasing costs of offshoring increase unemployment first, but a further reduction leads to a decrease in unemployment afterwards.

Theoretical work on temporary agency employment is rather limited. The very first theoretical contributions are given by Autor (2001, 2003). While his first paper investigates the role of employment agencies in the screening for regular jobs, the latter describes that firms relinquish to substitute the whole workforce by temporary agency employment due to distinct capital investments related to specific workers. The first contribution to temporary agency employment in the framework of search and matching is provided by Neugart & Storrie (2006). The authors analyze the increase of temporary agency employment based on an improved matching efficiency that is induced by temporary work agencies acting as intermediaries in the matching process of workers and firms. Baumann et al. (2011) use the same framework and enrich the model setup by endogenous job destruction. However, the majority of research on temporary agency employment is based on its empirical investigation and focuses on its strategic use in the production (see, e.g., Vidal & Tigges, 2009; Holst et al., 2010), its effect on the employment structure (Jahn & Bentzen, 2012; Haller & Jahn, 2014), the wage differential of temporary agency work (Garz, 2013) and the question if temporary agency employment may be used as a stepping stone to regular employment (e.g. Amuedo-Dorantes et al., 2008; Kvasnicka, 2009; Autor & Houseman, 2005, 2010; Jahn & Rosholm, 2013, 2014).

3.3 Outline of the Model

3.3.1 Labor Market Flows

All workers are assumed to be identical. Following Neugart & Storrie (2006), the workforce is segmented into four different groups. As in the standard matching literature, workers are either unemployed (U) or directly employed at a firm (regular employment, R). Furthermore, workers can be employed at temporary employment agencies. Temporary employment agencies hire workers and have them in their pool (unassigned temporary work, T) with the aim to lend the workers to firms that use the workers in their production (assigned temporary work, A). Unemployed workers may either find a regular job or become unassigned temporary workers. Once in the pool of the temporary employment agency, the job in state T may either be destroyed to unemployment with an exogenous rate δ or the temporary agency worker becomes assigned to a firm. Moreover, temporary agency workers (assigned and unassigned) search on-the-job for regular employment. It is assumed that the effectiveness of search is higher for temporary workers compared to that of unemployed workers. This is reflected by parameters γ_T and γ_A for unassigned and assigned temporary workers, respectively. Assigned temporary workers may find regular jobs or their current position is destroyed with the exogenous rate χ, meaning that they fall back to state T just being in the pool of the temporary employment agency. Employment of regular workers is destroyed to unemployment with the exogenous rate δ which coincides with the job destruction rate of unassigned temporary jobs. It is assumed that $\chi > \delta$. The reason is that due to its flexibility and a lack of employment protection instruments, temporary agency employment is more affected by exogenous shocks than regular jobs.

Workers accept the first suitable job offer they get whatever type it is and matching of firms and workers/agencies is formally described by the matching function

$$M_i = M(V_i, S_i). \tag{3.1}$$

The matching function exhibits constant returns to scale, is increasing in both arguments, at least twice differentiable, and satisfies the Inada conditions. M_i denotes the instantaneous flow of hires for the different employment states $i = T, A, R$. The number of vacancies posted in state i is denoted by V_i. The number of job-searchers in the respective state is given by S_i. Firms post vacancies for regular and assigned temporary jobs, while temporary employment agencies only post vacancies for unassigned temporary workers. Vacancies posted in state i are filled with the rate $M(V_i, S_i)/V_i \equiv m(\theta_i)$, while the workers' finding rate for a job in state i is $M(V_i, S_i)/S_i \equiv \theta_i m(\theta_i)$. Variable $\theta_i \equiv V_i/S_i$ reflects the labor market tightness in state i. The number of job-searchers differs across the states and, thus, labor market tightness θ_i has to be stated for each "submarket" separately. Unemployed workers search for both, regular and temporary employment, while temporary workers are allowed to search for regular employment on-the-job. Thus, there is an overlap in the groups searching for different types of jobs. The total number of job-searchers for unassigned temporary agency employment equals the number of unemployed workers,

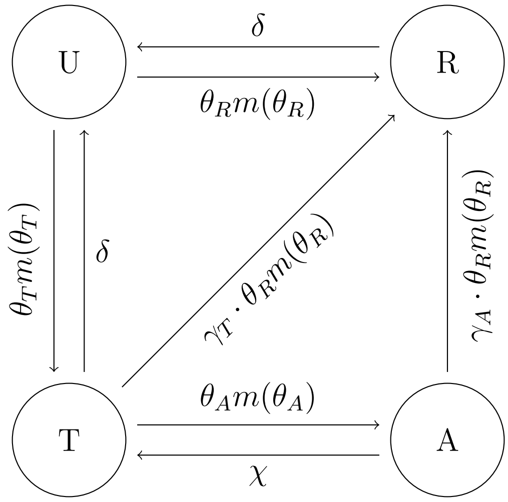


Figure 3.1: Labor Market Flows

$S_T = U$. Unassigned temporary workers look for assignments, $S_A = L_T$. L_i denotes the amount of employed workers in the respective state. Moreover, all workers in states U, T, and A search for regular jobs, i.e. $S_R = U + \gamma_T \cdot L_T + \gamma_A \cdot L_A$. As temporary workers' search effectiveness differs from the search effectiveness of unemployed workers, $\gamma_T \cdot L_T$ and $\gamma_A \cdot L_A$ describe the *effective* number of unassigned and assigned temporary workers looking for regular employment, respectively.[1] Using the information about vacancies and job-searchers in each submarket, it can be concluded that unemployed workers find jobs in regular employment with rate $\theta_R m(\theta_R)$, while unassigned and assigned temporary workers find regular jobs with probabilities $\gamma_T \theta_R m(\theta_R)$ and $\gamma_A \theta_R m(\theta_R)$, respectively. Unemployed workers find unassigned temporary jobs with probability $\theta_T m(\theta_T)$ and, once in the pool of the agency, become assigned with probability $\theta_A m(\theta_A)$. Figure 3.1 depicts the labor market flows.

Using the information about the flows into and out of the different labor market states, the instantaneous flows are represented by

$$\dot{L_T} = m(\theta_T) \cdot V_T + \chi \cdot L_A - \theta_A m(\theta_A) \cdot L_T - \gamma_T \theta_R m(\theta_R) \cdot L_T - \delta \cdot L_T \tag{3.2}$$

$$\dot{L_A} = m(\theta_A) \cdot V_A - \chi \cdot L_A - \gamma_A \theta_R m(\theta_R) \cdot L_A \tag{3.3}$$

[1] Total labor force N is normalized to unity. Hence, $U + L_T + L_A + L_R = 1$, with U, L_T, L_A, and L_R denoting the unemployment and employment rates, respectively.

$$\dot{L_R} = m(\theta_R) \cdot V_R - \delta \cdot L_R. \tag{3.4}$$

In the steady state, the in- and outflows for the different states coincide, i.e. $\dot{L_T} = \dot{L_A} = \dot{L_R} = 0$. Thus, the flows can be rewritten to[2]

$$[\delta + \theta_A m(\theta_A) + \gamma_T \theta_R m(\theta_R)] \cdot L_T = m(\theta_T) \cdot V_T + \chi \cdot L_A \tag{3.5}$$

$$[\chi + \gamma_A \theta_R m(\theta_R)] \cdot L_A = m(\theta_A) \cdot V_A \tag{3.6}$$

$$\delta \cdot L_R = m(\theta_R) \cdot V_R. \tag{3.7}$$

Similar to the employment flows, the flows into and out of unemployment are

$$\dot{U} = \delta \cdot L_R + \delta \cdot L_T - \theta_T m(\theta_T) \cdot U - \theta_R m(\theta_R) \cdot U. \tag{3.8}$$

As the change in unemployment is zero in steady state, i.e. $\dot{U} = 0$, the equilibrium unemployment rate is formally represented by

$$U = \frac{\delta(L_R + L_T)}{\theta_T m(\theta_T) + \theta_R m(\theta_R)}. \tag{3.9}$$

Note that equilibrium unemployment does not directly depend on the labor market tightness in state A. The amount of assigned temporary workers only influences the structure of employment, but not its rate. There is no direct channel from assigned temporary work to unemployment or vice versa.

3.3.2 Goods Market

Households act as consumers in the goods market and, at the same time, as workers in the labor market. Consumers are risk neutral in the aggregate consumption good and have Dixit & Stiglitz (1977) preferences over a continuum of differentiated goods. The goods demand function can be derived from the following optimization problem that the households are facing:

$$\max_{c_{j,k}} \left(\int c_{j,k}^{\frac{\eta-1}{\eta}} \, dj \right)^{\frac{\eta}{\eta-1}} \quad \text{with} \quad j = 0, ..., n \quad \text{and} \quad \eta > 1, \tag{3.10}$$

[2]The flow equations given here represent the firm's perspective. They can easily be converted to the respective flow equations from the workers side of view. To do so, the respective job-searchers of each state and the condition that the total labor force equals the sum of the workers of each state have to be used. Appendix 3.A.1 provides the respective equations.

subject to the resource constraint

$$I_k = \int c_{j,k} \cdot \left(\frac{P_j}{P}\right) \cdot dj, \tag{3.11}$$

where j denotes the differentiated good and k denotes the household. Further, $c_{j,k}$ denotes household k's consumption of good j, while I_k is the real income of household k. Parameter η gives the elasticity of substitution across the differentiated goods, while $p_j = P_j/P$ is the firm's price relative to the aggregate price level. The solution to the aforementioned maximization problem and, thus, aggregate demand for good j is given by

$$Y_j \equiv \int c_{j,k} \cdot dk = p_j^{-\eta} \cdot I, \tag{3.12}$$

with $I \equiv \int I_k \cdot dk$ being aggregate real income and $P \equiv (\int P_j^{1-\eta})^{\frac{1}{1-\eta}}$ denoting the price index.

3.3.3 Firms

In contrast to the basic matching model of Mortensen & Pissarides (1994) and Pissarides (2000), the model in this chapter is dealing with large firms that employ multiple workers. Each firm j produces a single, differentiated final good. There are two reasons for using large firms instead of one-worker firms. First, in models of monopolistic competition the optimal firm size and its output level are determined endogenously. Hence, restricting the firm size to one worker conflicts with monopolistic goods market competition (for more details see Ebell & Haefke, 2006). Second, assuming firm-level labor unions representing more than one worker, it is natural to assume bargaining with large firms. Considering the production technology of the firm, final goods are produced by using labor as the only input factor. Workers can either be employed directly at the respective firm (regular workers), or they are borrowed from temporary work agencies (assigned temporary workers). The amount of regular workers employed at firm j is denoted by $L_{j,R}$, while $L_{j,A}$ gives the amount of temporary agency workers used in the production. The firm's production technology is described by

$$Y_j = \tau \cdot [L_{j,R} + L_{j,A}]^{\rho} \quad \text{with} \quad \rho \in (0,1), \tag{3.13}$$

where τ denotes an efficiency parameter and ρ captures decreasing returns to scale in the production. Using this type of production technology reflects the idea that regular workers and temporary agency workers are perfect substitutes. This is a reasonable assumption because temporary agency employment is used in almost all branches and in particular in blue-collar, low-skilled jobs, to replace regular workers doing simple tasks. The reason to replace regular workers doing simple tasks is all about lowering costs.

The instantaneous profit of a firm is given by[3]

$$\pi_j = p_j(Y_j)\, Y_j - w_R\, L_{j,R} - \varepsilon x\, L_{j,A}^{\sigma} - h\,(V_{j,A} + V_{j,R}), \tag{3.14}$$

with $p_j(Y_j)$ representing the firm's inverse goods demand function that can be derived from eq. (3.12). Variable w_R denotes the wage rate of regular workers. The fee the firm has to pay to the temporary work agency is depicted by x, while h denotes the costs of posting a vacancy in state A and R. Parameter ε describes regulatory costs or rather institutional barriers associated with firm's use of temporary employment, e.g. employment protection, the maximum period of assignment, synchronization ban and re-employment ban. Next to institutional regulations, there are often voluntary firm-level agreements between employers and employee representations regulating the use of temporary agency employment. For instance, such agreements limit the share of temporary agency workers on all employees within a firm or specify a maximum duration of assignment undercutting the legal time limit. Furthermore, they may include commitments for transferring temporary workers to regular contracts after a specific assignment period or expand the rights of the employees representative committee with increasing temporary agency employment used within the firm.[4] Such non-institutional firm-level costs of temporary agency work are convexly increasing in the number of employed temporary workers, as many of these regulations apply only if the amount of temporary agency workers in the firm exceeds specific levels. In principle, it holds that the stronger the employee representation in a

[3] Appendix 3.A.2 shows that this profit function is strictly concave and, hence, a profit maximum exists.

[4] An overview of such voluntary firm-level agreements used in Germany are provided by R. Krause (2012).

firm, the more agreements apply with an increasing amount of temporary agency workers. The convexity of the costs is reflected by parameter $\sigma > 1$.[5] $V_{j,R}$ and $V_{j,A}$ denote the number of vacancies firm j posts for regular and temporary workers, respectively.

3.3.4 Workers

The expected value of regular employment is given by

$$r\Psi_R = w_R + \delta \cdot (\Psi_U - \Psi_R). \tag{3.15}$$

Wage rate w_R reflects the instantaneous inflow of being regularly employed, while the second term depicts the loss from becoming unemployed weighted by its probability of occurrence δ. The expected value of being unemployed is given by

$$r\Psi_U = z + \theta_T m(\theta_T) \cdot (\Psi_T - \Psi_U) + \theta_R m(\theta_R) \cdot (\Psi_R - \Psi_U). \tag{3.16}$$

Parameter z denotes the net income of being unemployed. The last two terms at the right-hand-side (RHS) describe the expected gain from possible changes in the labor market state. Similarly, the present discounted value of being in the pool of the temporary work agency is

$$r\Psi_T = w_T + \delta \cdot (\Psi_U - \Psi_T) + \theta_A m(\theta_A) \cdot (\Psi_A - \Psi_T) + \gamma_T \cdot \theta_R m(\theta_R) \cdot (\Psi_R - \Psi_T). \tag{3.17}$$

Variable w_T denotes the payment that temporary agency workers receive for being in the pool of the temporary work agency.[6] By searching on-the-job they may improve their position in the labor market and find regular employment with probability $\gamma_T \theta_R m(\theta_R)$. The worker's expected value of assigned temporary agency employment is

$$r\Psi_A = w_A + \chi \cdot (\Psi_T - \Psi_A) + \gamma_A \cdot \theta_R m(\theta_R) \cdot (\Psi_R - \Psi_A), \tag{3.18}$$

[5] This type of convex costs is also used by Koskela & Schöb (2010) and Ranjan (2013). They argue that the costs of offshoring are convex. Such costs are similar to the costs of temporary agency employment as offshoring is also used as a potential cost-saving production alternative for firms.

[6] This labor market setup fits well to Central European countries such as France, Germany, the Netherlands, and Sweden (Arrowsmith, 2006). In those countries temporary workers even receive a wage when they are just on the books of the temporary work agency.

with w_A denoting the wage that temporary workers receive being assigned to a firm. For simplicity reasons it is assumed that the agency sets w_T and w_A in a way that makes the worker at the margin indifferent between being unemployed, being in the pool of temporary employment agencies, or being assigned to a client firm, such that

$$\Psi_U = \Psi_T = \Psi_A. \tag{3.19}$$

Even if this assumption seems quite strong at first sight, it is reasonable. It reflects the fact that temporary agency workers usually have a rather weak bargaining position as they are not organized in labor unions (see, e.g., Storrie, 2002; Dolado et al., 2000; Neugart & Storrie, 2006). Furthermore, workers may accept a rather low utility out of being employed at a temporary employment agency. They use temporary employment as a stepping stone to regular employment. The probability of finding a regular job while being employed at a temporary employment agency is higher compared to finding a regular job out of being unemployed. Moreover, eq. (3.19) simplifies the model significantly. Applying this assumption, the value functions (3.15) to (3.18) simplify to

$$r\Psi_R = w_R + \delta \cdot (\Psi_U - \Psi_R) \tag{3.20}$$

$$r\Psi_T = w_T + \gamma_T \, \theta_R m(\theta_R) \, (\Psi_R - \Psi_T) \tag{3.21}$$

$$r\Psi_A = w_A + \gamma_A \, \theta_R m(\theta_R) \, (\Psi_R - \Psi_A) \tag{3.22}$$

$$r\Psi_U = z + \theta_R m(\theta_R) \, (\Psi_R - \Psi_U). \tag{3.23}$$

3.3.5 Labor Unions

It is assumed that all regularly employed workers are members of a labor union. Firm specific, symmetric labor unions determine the wage rate for regular workers by maximizing the rent of its members. The rent of a union member equals the difference between the expected value of regular employment and the outside option, which is the value of being unemployed. Thus, the rent of a union member is given by $\Psi_R - \Psi_U$. As the union bargains for all regular workers that are employed at firm j, the utility of the respective labor union is formally represented by

$$U_j = [\Psi_R - \Psi_U] \cdot L_{j,R}. \tag{3.24}$$

3.3.6 Temporary Employment Agencies

Temporary employment agencies pay a wage rate w_A to temporary workers that are assigned to a client firm and a wage rate w_T to unassigned temporary workers that are only in the pool of the agency. For each assigned temporary worker, the agency receives a fee x from the firm the worker is lend to.

In contrast to firms, it is considered to have one-worker agencies. Each agency offers a single vacancy that can be filled by an unemployed worker. In case of a successful match, the unemployed worker switches to the worker pool of the agency and waits for assignment at a client firm. The agency's expected profit of posting a vacancy is

$$r\Omega_V = -\tilde{h} + m(\theta_T)[\Omega_T - \Omega_V], \tag{3.25}$$

where $\tilde{h}$ denotes the cost of a vacancy.[7] The expected profit of having a worker on hold, Ω_T, is

$$r\Omega_T = -w_T + \theta_A m(\theta_A)[\Omega_A - \Omega_T] + \gamma_T \theta_R m(\theta_R)[\Omega_V - \Omega_T] + \delta[\Omega_V - \Omega_T]. \tag{3.26}$$

Even in case of a filled vacancy, eq. (3.26), there is no positive flow income but, on the contrary, the agency has to pay w_T. Having a vacancy filled is only worthwhile for the agency due to the potential assignment of the worker to a client firm. This is reflected by the second term at the right-hand-side. In general, the last three terms denote the expected gains/losses due to changes in the different labor market states. Finally, the agency's expected profit of assigning a worker to a client firm is given by

$$r\Omega_A = x - w_A + \gamma_A \theta_R m(\theta_R)[\Omega_V - \Omega_A] + \chi[\Omega_T - \Omega_A], \tag{3.27}$$

where $x - w_A$ denotes the flow profit in this state. Using eqs. (3.25) to (3.27), the agency's job creation can formally be described as

$$\frac{\tilde{h}}{m(\theta_T)} = \frac{\theta_A m(\theta_A)(x - w_A) - w_T[r + \chi + \gamma_A \theta_R m(\theta_R)]}{[r + \theta_A m(\theta_A) + \gamma_T \theta_R m(\theta_R) + \delta] \cdot [r + \chi + \gamma_A \theta_R m(\theta_R)] - \chi \theta_A m(\theta_A)}. \tag{3.28}$$

[7] Agency's vacancy costs $\tilde{h}$ differ from the firm's vacancy costs h with $h > \tilde{h}$. This reflects the fact that the firms' screening process of potential employees is more intensive, since they are more interested in long-term employment relationships and stronger rules of employment protection apply, while agencies are able to quit the employment relationship easier.

3.4 Solution of the Model

Recalling the assumption that the values of being unemployed, being in the pool of the temporary agency employment agency, and being assigned to a client firm coincide, the wage rates of assigned and unassigned temporary workers can be derived using the workers' asset functions. The bargaining problems between firms and unions and firms and agencies are interrelated due to the substitutability of regular and temporary employment in the firms' production technology. Hence, the whole bargaining game consists of two stages involving three bargaining parties: Firms, unions, and temporary employment agencies.

1. In the first stage, there are two simultaneous bargaining games. On the one hand, the firm bargains with the agency over the fee the firm has to pay to the agency to use temporary agency workers in the production process. As we are dealing with one-worker agencies, the bargaining problem is of the type individual bargaining. On the other hand, the labor union determines the wage rate of regular workers. As the union is responsible for all regular workers in a firm, the bargaining problem is a collective one. For both bargaining games the model uses the so-called right-to-manage model. The negotiation games are further specified in the respective subsections.

2. In the second stage, the firm uses its "right to manage" to set the respective employment levels for regular and temporary workers.

In order to obtain a subgame perfect Nash equilibrium for the whole bargaining game, the two stages have to be solved by backward induction.

3.4.1 Wage Determination for Agency Workers

Workers are indifferent between being unemployed or in either state of temporary agency employment. This is given by eq. (3.19). Thus, the wage rates that temporary agency workers receive can easily be computed by combining the asset functions being temporarily employed and being unemployed. Using eqs. (3.20), (3.21), and (3.23), the wage for unassigned temporary workers turns out to be

$$w_T = z + (w_R - z) \cdot \Gamma_T(\theta_R) \quad \text{where} \quad \Gamma_T(\theta_R) = \left[\frac{(1-\gamma_T)\theta_R m(\theta_R)}{r+\delta+\theta_R m(\theta_R)}\right]. \tag{3.29}$$

Similarly, using eqs. (3.20), (3.22), and (3.23), the wage for assigned temporary workers can be computed as

$$w_A = z + (w_R - z) \cdot \Gamma_A(\theta_R) \quad \text{where} \quad \Gamma_A(\theta_R) = \left[\frac{(1-\gamma_A)\theta_R m(\theta_R)}{r+\delta+\theta_R m(\theta_R)}\right]. \tag{3.30}$$

Wages are set as a mark-up over net unemployment income. The mark-up is denoted by $\Gamma_l(\theta_R)$ with $l = A, T$. As the wage rate for regular workers is larger than the net income of being unemployed, it is easy to see that the mark-up is only positive if the search effectiveness parameters γ_T and γ_A are smaller than unity. Parameters γ_T and γ_A being equal to unity means that the search effectiveness of temporary workers coincides with that of unemployed workers. In this case, the wage rates of both types of temporary workers simplify to the net unemployment income, i.e. $w_T = w_A = z$. It seems plausible to assume that the search effectiveness of unassigned and assigned temporary workers is larger than the search effectiveness of an unemployed worker. In this case, the resulting wage rates are smaller than the net income of being unemployed. At first sight, this sounds counterintuitive. However, it reveals the idea that unassigned and assigned temporary workers temporarily accept a lower wage because they hope to find a regular job with larger probability compared to looking for regular employment while being unemployed. This is in line with the idea that temporary agency work is a stepping stone into regular employment.

3.4.2 Firm's Labor Demand

The firm's intertemporal profit maximization problem is given by

$$\max_{\substack{V_{j,R}(s),V_{j,A}(s)\\ L_{j,R}(s),L_{j,A}(s)}} \int_t^\infty e^{-r(s-t)}\Big\{p(Y_j)\,Y_j - w_R(s)\,L_{j,R}(s) - \varepsilon x(s)\,L^\sigma_{j,A}(s) - h\,[V_{j,A}(s)+V_{j,R}(s)]\Big\}ds, \tag{3.31}$$

subject to the laws of motion for assigned temporary and regular workers, eqs. (3.3) and (3.4), and the goods demand and production function, given by eqs. (3.12) and

(3.13), respectively. Thus, the current-value Hamiltonian that solves this intertemporal maximization problem can formally be stated as

$$\begin{aligned} H = &\tau^{\kappa}(L_{j,R} + L_{j,A})^{\rho\kappa} I^{1-\kappa} - w_R\, L_{j,R} - \varepsilon x\, L_{j,A}^{\sigma} - h\,(V_{j,A} + V_{j,R}) \\ &+ \lambda_1[m(\theta_R)V_{j,R} - \delta L_{j,R}] + \lambda_2[m(\theta_A)V_{j,A} - \chi L_{j,A} - \gamma_A\theta_R m(\theta_R)L_{j,A}], \end{aligned} \tag{3.32}$$

with eqs. (3.3) and (3.4) denoting the equations of motion for the state variables $L_{j,R}$ and $L_{j,A}$, and $\lambda_1 \equiv \mu_1 e^{-r(s-t)}$ and $\lambda_2 \equiv \mu_2 e^{-r(s-t)}$ being the current-value Lagrange multipliers. Variables $V_{j,A}$ and $V_{j,R}$ are the control variables of the intertemporal maximization problem. Parameter $\kappa \equiv (\eta - 1)/\eta$, with $\kappa \in (0, 1)$, reflects the firm's monopoly power in the goods market. The lower κ, the higher the firm's monopoly power. The relevant first-order conditions of the intertemporal maximization problem are

$$\frac{\partial H}{\partial V_{j,R}} = -h + \lambda_1 m(\theta_R) = 0 \tag{3.33}$$

$$\frac{\partial H}{\partial V_{j,A}} = -h + \lambda_2 m(\theta_A) = 0 \tag{3.34}$$

$$\frac{\partial H}{\partial L_{j,R}} = \rho\kappa\tau^{\kappa}(L_{j,R} + L_{j,A})^{\rho\kappa-1} I^{1-\kappa} - w_R - \delta\lambda_1 = r\lambda_1 - \dot{\lambda}_1 \tag{3.35}$$

$$\frac{\partial H}{\partial L_{j,A}} = \rho\kappa\tau^{\kappa}(L_{j,R} + L_{j,A})^{\rho\kappa-1} I^{1-\kappa} - \sigma\varepsilon x L_{j,A}^{\sigma-1} - \lambda_2[\chi + \gamma_A\theta_R m(\theta_R)] = r\lambda_2 - \dot{\lambda}_2. \tag{3.36}$$

In the steady state it has to hold that $\dot{\lambda}_1 = \dot{\lambda}_2 = 0$ and $\dot{L}_{j,R} = \dot{L}_{j,A} = 0$. By substituting eqs. (3.33) and (3.34) in eqs. (3.35) and (3.36), respectively, the first-order conditions turn out to be

$$\rho\kappa\tau^{\kappa}(L_{j,R} + L_{j,A})^{\rho\kappa-1} I^{1-\kappa} - w_R = (r + \delta)\frac{h}{m(\theta_R)} \tag{3.37}$$

$$\rho\kappa\tau^{\kappa}(L_{j,R} + L_{j,A})^{\rho\kappa-1} I^{1-\kappa} - \sigma\varepsilon x L_{j,A}^{\sigma-1} = [r + \chi + \gamma_A\theta_R m(\theta_R)]\frac{h}{m(\theta_A)}. \tag{3.38}$$

Eqs. (3.37) and (3.38) determine the firm's labor demand for regular and assigned temporary workers. Theoretically, it may be possible that firms only produce with one type of labor. Appendix 3.A.3 discusses the conditions for such corner solutions to appear. However, in the following it is assumed that parameters are such that regular and temporary employment are both positive, i.e. there is an interior solution.[8]

[8] This rather restrictive assumption is based on Ranjan (2013, p. 176) who uses a similar assumption concerning the two production factors domestic labor and foreign produced input, which are perfect substitutes in production.

It can be easily shown that[9]

$$\frac{dL_{j,R}}{dw_R} < 0, \frac{dL_{j,R}}{dx} > 0, \frac{dL_{j,A}}{dx} < 0 \text{ and } \frac{dL_{j,A}}{dw_R} > 0.$$

3.4.3 Wage Determination for Regular Workers

The wage rate for regular workers is determined by collective bargaining. Since the union represents all regular employed workers in a firm, it has a very strong bargaining position. Thus, it is assumed that wages are determined by a special variant of the right-to-manage model, namely the monopoly union model. This simplifies the formal analysis of the model. Having monopoly power, the union has the exclusive right to set the wage rate of regular workers. In response, the firm sets the corresponding employment level. Thus, the union has to take account of the firm's labor demand for regular workers that decreases in the wage of regular workers as well as the labor demand for assigned temporary workers that increases in the wage of regular workers.

The monopoly union maximizes its objective function, eq. (3.24), subject to the total labor demand of the firm, given by eqs. (3.37) and (3.38). Using eqs. (3.20) and (3.23), the rent of a single worker can be stated as

$$\Psi_R - \Psi_U = \frac{w_R - z}{r + \delta + \theta_R m(\theta_R)}. \tag{3.39}$$

The union's maximization problem can formally be stated by the following Lagrangian function:

$$\begin{aligned} \mathscr{L} = & \frac{w_R - z}{r + \delta + \theta_R m(\theta_R)} \cdot L_{j,R} + \xi_1 \left[\frac{r+\delta}{m(\theta_R)} h - \rho\kappa\tau^{\kappa} (L_{j,R} + L_{j,A})^{\rho\kappa - 1} I^{1-\kappa} + w_R \right] \\ & + \xi_2 \left[\frac{r + \chi + \gamma_A \theta_R m(\theta_R)}{m(\theta_A)} h - w_R - \frac{r+\delta}{m(\theta_R)} h + \sigma\varepsilon x L_{j,A}^{\sigma-1} \right]. \end{aligned} \tag{3.40}$$

The first-order conditions are

$$\frac{\partial \mathscr{L}}{\partial L_{j,R}} = \frac{w_R - z}{r + \delta + \theta_R m(\theta_R)} - \xi_1 \cdot \rho\kappa(\rho\kappa - 1)\tau^{\kappa}(L_{j,R} + L_{j,A})^{\rho\kappa-2} I^{1-\kappa} = 0 \tag{3.41}$$

$$\frac{\partial \mathscr{L}}{\partial L_{j,A}} = -\xi_1 \cdot \rho\kappa(\rho\kappa - 1)\tau^{\kappa}(L_{j,R} + L_{j,A})^{\rho\kappa-2} I^{1-\kappa} + \xi_2 \cdot (\sigma - 1)\sigma\varepsilon x L_{j,A}^{\sigma-2} = 0 \tag{3.42}$$

$$\frac{\partial \mathscr{L}}{\partial w_R} = \frac{L_{j,R}}{r + \delta + \theta_R m(\theta_R)} + \xi_1 - \xi_2 = 0. \tag{3.43}$$

[9] Appendix 3.A.4 provides the detailed calculations.

Combining eqs. (3.41) to (3.43), the wage rate for regular workers is given by

$$w_R = z + L_{j,R}\left[\frac{(\rho\kappa-1)\rho\kappa\tau^{\kappa}(L_{j,R}+L_{j,A})^{\rho\kappa-2}I^{1-\kappa}\cdot(\sigma-1)\sigma\varepsilon x L_{j,A}^{\sigma-2}}{(\rho\kappa-1)\rho\kappa\tau^{\kappa}(L_{j,R}+L_{j,A})^{\rho\kappa-2}I^{1-\kappa}-(\sigma-1)\sigma\varepsilon x L_{j,A}^{\sigma-2}}\right]. \tag{3.44}$$

Evaluation of the RHS of eqs. (3.44) reveals that the term in corner brackets is positive. Thus, the union sets the wage rate for regular workers as a mark-up over the net income of being unemployed.

3.4.4 Determination of the Fee for Firm's Use of Temporary Employment

The fee for using a temporary worker in the production is determined by bargaining between firms and temporary work agencies. As each agency employs only one worker, the bargaining problem is similar to individual bargaining. In contrast to the monopoly union model which is used for the determination of the union's wage claims, firms and agencies bargain directly over the fee. This reflects the fact that, compared to the labor union, a single agency is less powerful in the negotiation. Furthermore, firms that hire more than one agency worker have to bargain with several temporary employment agencies separately.

The firm treats each additional assigned temporary worker as a marginal worker. Thus, the rent of the firm in the Nash product equals the contribution of an additional assigned temporary worker that is formally represented by the partial derivative of the firms profit with respect to $L_{j,A}$. As it has to be taken into account that the labor demand of regular and assigned temporary workers are mutually best responses, the firm's profit is evaluated at the optimal labor demand for regular workers, $L^*_{j,R}$. Thus, the generalized Nash-bargaining problem between the firm and the agency can be stated as

$$\max_x \left[\Omega_A - \Omega_T\right]^{\beta}\cdot\left[\frac{\partial\pi(L^*_{j,R})}{\partial L_{j,A}}\right]^{1-\beta} \quad \text{with} \quad \beta\in(0,1), \tag{3.45}$$

where β denotes the agency's bargaining power. The agency's rent, $\Omega_A - \Omega_T$, can be computed using eqs. (3.25) to (3.27) and the free entry condition, $\Omega_V = 0$. It is formally given by

$$\Omega_A - \Omega_T = \frac{x - w_A + w_T + \frac{\tilde{h}}{m(\theta_T)}\cdot[\gamma_T\theta_R m(\theta_R) + \delta - \gamma_A\theta_R m(\theta_R)]}{r + \chi + \theta_A m(\theta_A) + \gamma_A\theta_R m(\theta_R)}. \tag{3.46}$$

Taking into account that the number of regular workers is chosen to maximize the firm's profit, the marginal contribution of an additional assigned temporary agency worker for the firm is given by

$$\frac{\partial \pi(L^*_{j,R})}{\partial L_{j,A}} = w_R - \sigma \varepsilon x L^{\sigma-1}_{j,A}. \tag{3.47}$$

Thus, the first-order condition of the bargaining problem in eq. (3.45) is

$$\beta \cdot \left(w_R - \sigma \varepsilon x L^{\sigma-1}_{j,A}\right) = (1-\beta) \cdot \left[x - w_A + w_T + \frac{\tilde{h}}{m(\theta_T)} \cdot \left[\gamma_T \theta_R m(\theta_R) + \delta - \gamma_A \theta_R m(\theta_R)\right]\right] \cdot \sigma \varepsilon L^{\sigma-1}_{j,A}. \tag{3.48}$$

After some rearrangement, the optimal fee for temporary workers can be obtained as

$$x = \beta \frac{w_R}{\sigma \varepsilon L^{\sigma-1}_{j,A}} + (1-\beta) \left[\left(w_A + \frac{\tilde{h}}{m(\theta_T)} \gamma_A \theta_R m(\theta_R) \right) - \left(w_T + \frac{\tilde{h}}{m(\theta_T)} [\gamma_T \theta_R m(\theta_R) + \delta] \right) \right]. \tag{3.49}$$

In the case that the whole bargaining power is on the side of the agency (i.e. $\beta = 1$), the fee would equal the first term on the RHS. Thus, the agency would set the fee in order to equate the unit costs of regular and assigned temporary employment. In the case that the whole bargaining power is on the firm's side (i.e. $\beta = 0$), the fee would equal the term in corner brackets. It would therefore hold, that the firm's fee is exactly the difference between the agency's total costs of an assigned temporary job and the agency's total costs of an unassigned temporary worker. As the bargaining power is shared between the firm and the agency, the optimal fee is the weighted sum of the aforementioned described terms.

3.5 Steady-State Equilibrium

The key endogenous variables θ_i, w_i, x, L_i and U for $i = T, A, R$ are determined by the flow equations (3.5) to (3.7) and (3.9), the labor demand equations (3.28), (3.37) and (3.38), the equations for workers wage rates (3.29), (3.30) and (3.44), and the fee that firms have to pay for using temporary agency employment in the production, eq. (3.49). Furthermore, in equilibrium the resource constraint, that aggregate demand and aggregate production coincide, has to hold. Hence,

$$Y \equiv \int_0^n Y_j \left(\frac{P_j}{P} \right) dj \tag{3.50}$$

is fulfilled. Due to symmetry of the firms in equilibrium, the firm's price coincides with the aggregate price level, hence, $p_i = 1$, and eq. (3.50) simplifies to $Y = n\,Y_j$.

3.6 Calibration

To describe the model equilibrium and to show the effects of the legal deregulation, the model is calibrated using values that result in an overall unemployment rate that is similar to what is observed for industrialized countries. The matching function that is used in the following is of Cobb-Douglas type and formally represented by

$$M = \zeta \cdot V_i^{1-\alpha} \cdot S_i^{\alpha}. \tag{3.51}$$

Parameter α indexes the matching elasticity and ζ is a scale parameter denoting the efficiency of the matching process. Following Petrongolo & Pissarides (2001), the matching elasticity is set to $\alpha = 0.5$. The scale parameter of the matching function is $\zeta = 0.3$ (M. U. Krause & Uhlig, 2012).

As described in the outline of the model, unions are modeled to embody the full wage-setting power in the determination of regular workers' wages. In contrast to that, it is assumed that in firm-agency bargaining over the firm's fee for using temporary agency employment, agencies have a rather low bargaining power, set to $\beta = 0.2$. This is mainly based on two reasons. First, contrary to unions who embody specific human capital and clearly differ from each other, firms may be rather indifferent between the agencies to bargain with since the workers that are represented by temporary work agencies perform more or less simple tasks. Second, the agencies' relatively low bargaining power reflects the existing imbalance in the size of firms using temporary agency employment and its supplier. Even if limiting the size of the agency in the present model to one worker is rather restrictive, empirical studies support this imbalance in the size of the bargaining parties. For instance, while the workforce of almost all German firms using temporary agency employment comprises more than 50 employees (Crimmann et al., 2009), 82% of the temporary employment agencies have less than 20 employees (Bundesagentur für Arbeit, 2016a).

Reflecting the idea of temporary agency work being a stepping stone to regular employment, it is assumed that the search effectiveness of temporary agency workers is larger compared to that of unemployed workers. Furthermore, the search effectiveness of assigned temporary workers even exceeds that of unassigned temporary workers. Albeit not under their contract, assigned temporary workers already work for regular firms and therefore have a higher chance to find regular employment compared to unassigned temporary workers. This idea is captured by the parameterization of $\gamma_A = 1.2$ and $\gamma_T = 1.15$.

For simplicity reasons it is assumed that any type of job is destroyed with exogenous rate $\delta = \chi = 0.02$ (M. U. Krause & Uhlig, 2012).[10] The net income of being unemployed is assumed to be related to the wage rate of regular workers with a standard value of the replacement ratio of 60%. The interest rate is $r = 0.05$, goods demand elasticity is chosen equal to $\eta = 2.5$, resulting in $\kappa = 0.6$, and the production function parameter is $\rho = 0.9$. Parameter σ, assuring convexity of the cost function of assigned temporary agency employment and reflecting firm-level costs of voluntary restrictions of temporary employment, is chosen to be $\sigma = 1.2$. This ensures that the cost function is not too convex.[11] The size of the labor force, N, and the scale parameter of the production function, τ, are normalized to unity. For simplicity reasons it is assumed that the costs of posting a job at a regular firm and a temporary employment agency coincide and are equal to $h = \tilde{h} = 0.058$. Parameter ε can be considered as regulatory costs of temporary agency employment compared to regulatory costs of regular employment, which are normalized to unity. For the calibration in this Section, regulatory costs of temporary agency employment are assumed to be slightly higher than for regular workers, $\varepsilon = 1.1$. This reflects still existing legal regulations, such as the maximum period of assignment or the equal

[10] According to Haller & Jahn (2014), labor turnover in temporary agency jobs is five times higher than in regular employment. In the present model, this labor turnover is described by the combination of a higher rate of exogenous job destruction and successful on-the-job search of agency workers. However, as a higher value for the rate of job destruction does not qualitatively change the results of Sections 3.6 and 3.7, it is for simplicity reasons assumed that δ and χ coincide.

[11] If the costs are too convex, there is no interior solution and the firms only use regular employment in the production. This is theoretically possible, but not realistic as the average rate of temporary agency employment in industrialized countries is about 2%.

Table 3.1: Calibration parameter values for Germany

Parameter	Description	Value
α	Matching elasticity	0.5
β	Bargaining power of the agency	0.2
γ_A	Search effectiveness of assigned temporary workers	1.2
γ_T	Search effectiveness of unassigned temporary workers	1.15
δ, χ	Job destruction rate	0.02
ε	Regulatory costs of temporary workers	0.5-1.4
ζ	Matching efficiency	0.3
η	Goods demand elasticity	2.5
ρ	Production function parameter	0.9
σ	Non-institutional, firm-level costs of using temporary workers	1.2
τ	Efficiency of the production technology	1
$h, \tilde{h}$	Costs of posting a vacancy	0.058
N	Size of the labor force	1
r	Interest rate	0.05
z	Net income of being unemployed	$0.6 \cdot w_R$

pay obligation for regular and temporary workers. In Section 3.7, ε varies, taking values in the domain 0.5 to 1.4. The reason for ε varying in a rather wide range is as follows: regulatory costs of temporary agency employment may be smaller than for regular employment ($\varepsilon < 1$), because there is either no or rather a weak employment protection. On the other hand, they may be higher ($\varepsilon > 1$), e.g. due to the synchronization ban and re-employment ban. Table 3.1 provides the full list of parameter values used in the calibration.

The parameter values chosen fit well with the employment structure observable in Germany. Temporary employment in almost all OECD countries is around 2% (CIETT, 2013). The currently observed overall unemployment rate in Germany is about 6.5% (Bundesagentur für Arbeit, 2016b). The model predicts an unemployment rate of 6.7%, almost coinciding with the current value observed for Germany. Temporary employment (assigned and unassigned temporary work) equals 2.7%, while the rate of regular employment is 90.6%.

3.7 Decrease in Regulatory Costs For Using Temporary Agency Workers

As indicated in Section 3.1, in recent decades there have been continuous deregulation efforts regarding temporary agency work aiming at more flexible European labor markets. This section takes a closer look at the effects of such a deregulation, which is modeled as a reduction in regulatory costs ε. Calibrating the model using the values stated in Section 3.6 and a varying degree of $\varepsilon \in (0.4, 1.5)$, the effects of a legal deregulation on the workers' wage rates and the firm's fee for using temporary agency employment, depicted in Figure 3.2, can be summarized in the following proposition:

Proposition 3.1. *Workers' wage rates decrease with increasing deregulation, while the firm's fee for using temporary agency employment increases in the degree of deregulation.*

Furthermore, Figure 3.3 depicts the steady-state employment rates for the different values of ε and can be summarized as follows:

Proposition 3.2. *The legal deregulation of temporary agency employment leads to a monotonic reduction in unemployment as it lowers firm's production costs and, thus, induces a higher overall labor demand. At the same time, it increases regular employment and, hence, the degree of employment covered by labor union bargaining. Unassigned temporary employment also increases monotonically. However, there is a hump-shaped relationship between regulatory costs and temporary agency employment used in the firm's production.*

The firm's decision of using regular or temporary agency employment in the production is based on the marginal costs of the respective worker. Due to the substitutability of both types of workers, marginal costs of regular and temporary workers have to coincide in equilibrium and, furthermore, have to be balanced with marginal revenue. The optimality conditions of the firm's intertemporal optimization problem, eq. (3.37) for regular workers and eq. (3.38) for temporary agency workers, can be rearranged such that the left-hand-sides (LHS) equal the firm's marginal revenue. The RHS denotes the marginal costs of the respective type of worker:

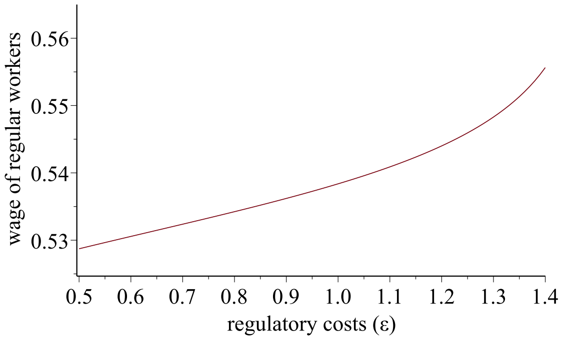
$$\rho\kappa\tau^{\kappa}(L_{j,R}+L_{j,A})^{\rho\kappa-1}I^{1-\kappa}=w_R+(r+\delta)\frac{h}{m(\theta_R)} \tag{3.52}$$

$$\rho\kappa\tau^{\kappa}(L_{j,R}+L_{j,A})^{\rho\kappa-1}I^{1-\kappa}=\sigma\varepsilon x L_{j,A}^{\sigma-1}+[r+\chi+\gamma_A\theta_R m(\theta_R)]\frac{h}{m(\theta_A)}. \tag{3.53}$$

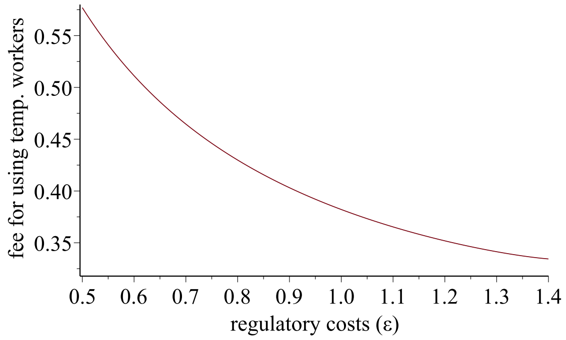
The marginal costs of both groups of workers consist of two parts each. The first term of the respective marginal cost function reflects the unit costs of an additional worker, while the second term represents the costs of posting a vacancy that are taken into account in the intertemporal maximization problem.

Recall that the wage rate for regular workers, the fee, and the employment rates are determined in two stages. In the first stage, labor unions set the wage rate w_R and, at the same time, agencies and firms bargain over the fee x. In the second stage, firms respond by choosing the optimal employment levels of the respective type of worker based on the determined wage rate and the fee. While unions take the employment responses for regular and temporary agency employment into account, the one-worker agency neglects the effects of its own behavior on the employment level of assigned temporary workers.

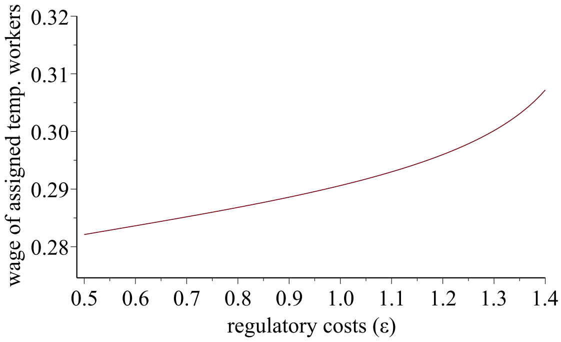
A reduction in regulatory costs leads ceteris paribus to a decrease in the unit costs of temporary agency workers which, in principle, increases the firm's demand for this type of workers. The resulting increase in assigned temporary agency employment L_A decreases the firm's marginal revenue. Due to the substitutability of regular and temporary workers, unions have to reduce their wage claims as a reaction to the legal deregulation to prevent a substitution of regular employment by temporary workers. This can also be seen from eq. (3.44). The resulting reduction in labor union's wage claims maintains the attractiveness of using regular employment compared to temporary agency employment. Furthermore, the decrease in unit costs increases the firm's labor demand for regular workers. The increase in regular employment cushions the firm's increasing demand for temporary agency employment initialized by the shock in ε. To state it differently, legal deregulation leads to an overall increase in firms' labor demand, which is not fully served by temporary agency employment but (partly) substituted by an increase in regular employment. Figure 3.2a shows that w_R decreases monotonically, but with decreasing rate. Furthermore, Figure 3.3a shows that L_R increases monotonically, but with decreasing rate.



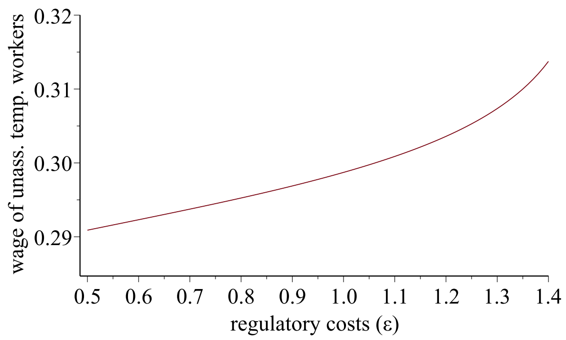
(a) wage rate of regular workers



(b) fee for using temp. workers



(c) wage rate of assigned temp. workers



(d) wage rate of unassigned temp. workers

Figure 3.2: Reaction of Fee and Wages to Changing Regulatory Costs of Temporary Agency Employment

The concavity of regular employment stems from the convex costs of temporary agency employment. The higher the rate of assigned temporary employment, the larger its impact on the marginal costs of temporary workers. As the union considers the employment effects for both types of labor input in the wage determination, it anticipates that the less regulated and, ceteris paribus, the higher assigned temporary agency employment, the higher its impact on the marginal costs of assigned temporary workers. Thus, the substitution of regular employment by temporary agency workers declines in L_A as its impact on the marginal costs of temporary agency employment increases. The resulting changes in the wage claims and the employment rate of regular workers are, therefore, weaker.

As stated above, the reduction in regulatory costs directly affects the marginal costs of

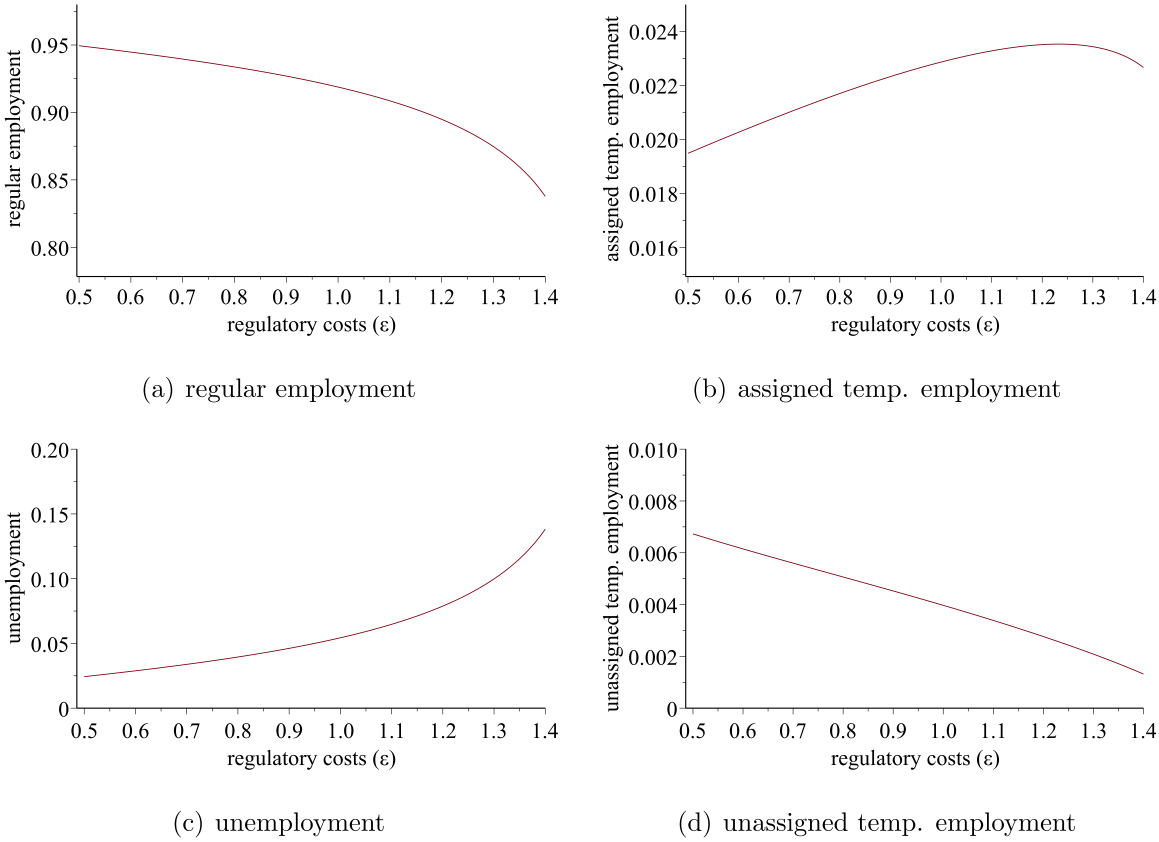


Figure 3.3: Employment Reaction to Changing Regulatory Costs of Temporary Agency Employment

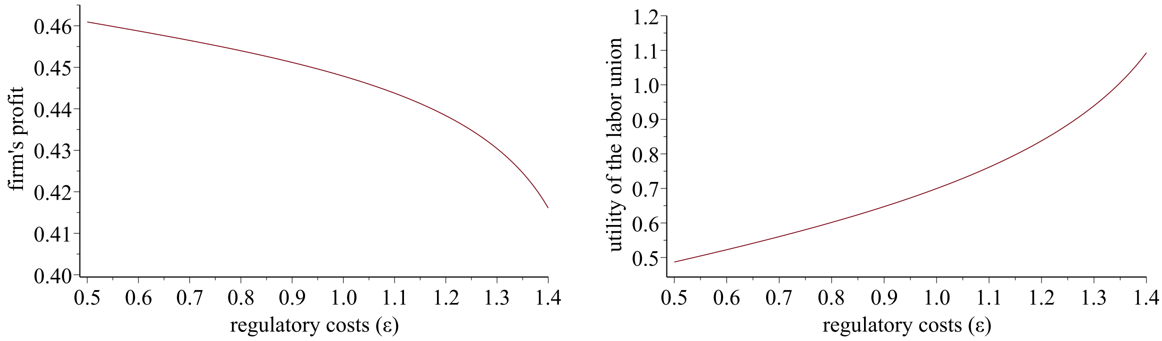
temporary workers, LHS of eq. (3.53), and ceteris paribus increases the labor demand for this production factor. Although, as can be seen directly from eq. (3.49), the decrease in regulatory costs encourages the agencies to increase the fee x and, by this, the agencies' profit. This increase cushions the reduction in marginal costs as it opposes the effect initialized by the shock in regulatory costs. As agencies and firms bargain individually and agencies are small (one worker), the agency does not take into account that the firm responses by adjusting the amount of temporary agency work due to changes in the fee x. Even if the employment response of temporary employment may still be positive overall, the increase in the fee x dampens the firm's increasing labor demand for this employment type induced by legal deregulation.

Furthermore, as the agency considers the firm's demand for regular employment in the determination of the fee x, it anticipates that the lower the legal regulation, the lower the firm's adjustment of regular employment to changes in regulatory costs. The agency assumes that with decreasing ε its scope to adjust x upwards increases. Thus, the fee x increases convexly in decreasing legal regulation of temporary agency work. This is depicted in Figure 3.2b. However, the agency does not take into account that the less regulated temporary agency work and, ceteris paribus, the higher the demand for temporary agency workers, the higher its impact on the convex unit costs of this production factor, see RHS of eq. (3.53). These two reasons, the increase in x and L_A's increasing impact on marginal costs, finally lead to the marginal costs of temporary agency employment being higher than the firm's marginal revenue and, furthermore, the marginal costs of regular employment. Thus, firms react to the agencies behavior with a reduction in temporary agency employment in order to balance marginal revenue and marginal costs, eq. (3.53). Overall, the aforementioned mechanisms lead to the hump-shaped relationship of temporary agency employment and regulatory costs, as shown in Figure 3.3b.[12]

Using the argumentation above, the steady-state changes of the wage rates of temporary agency workers can be explained. The wage rates of temporary workers, given in eqs. (3.29) and (3.30), positively depend on the wage rate of regular workers. The higher the wage rate of regular workers, the higher the mark-up on unemployment income and, thus, the higher the wage rate of temporary agency workers. Hence, the behavior of the wages qualitatively coincide with that of regular workers' wages. This is depicted in Figures 3.2c and 3.2d.

Furthermore, Figure 3.3c gives the steady-state unemployment rate for varying values of ε. Even if the composition of the firm's increased labor demand is a priori unclear, it is obvious that legal deregulation leads to an overall increase in total employment as it decreases the costs of both inputs, regular and temporary workers. Thus, based on the depicted development of the employment rates of regular and assigned temporary workers,

[12]Next to the effects on unit costs, the agency's and union's behavior also affects the second part of the marginal costs, the vacancy costs that are taken into account in the intertemporal maximization problem. For simplicity reasons, these effects are not considered in more detail in the argumentation provided above.



(a) firm's profit

(b) utility of the labor union

Figure 3.4: Evolution of Firm's Profits and Union's Utility due to Changing Regulatory Costs of Temporary Agency Employment

legal deregulation of temporary agency employment leads to a monotonic decrease in overall unemployment.

Figure 3.3d shows that unassigned temporary agency employment monotonically increases in legal deregulation. Having in mind that there is a hump-shaped relationship of assigned temporary employment and regulatory costs, this may be counterintuitive at first sight. The reason is that legal deregulation leads to an increase in the fee x, which increases the expected profit of the agency, eq. (3.27). More agencies enter the market leading to an increase in employment of unassigned temporary workers. Thus, legal deregulation of temporary agency employment drives agencies to hoard idle labor waiting for an assignment in a client firm.

Finally, we take a closer look at the firm's profit and the union's utility due to changing regulatory costs. This is depicted in Figure 3.4. Legal deregulation of temporary agency employment leads to a more profitable production alternative for firms and dampens union's wage claims. Furthermore, it decreases the costs of using temporary agency employment in the production. Thus, it is intuitive that the firm's profit monotonically increases in the degree of legal deregulation, as depicted in Figure 3.4a. Even if regular employment increases monotonically in legal deregulation, the wage rate for regular workers and, hence, the rent of a single worker, decreases. The increase in regular employment does not balance the loss in individual workers' rent. Thus, the utility of the labor union decreases in legal deregulation, see Figure 3.4b. Even if the rate of regular employment and, as a consequence, the degree of union coverage in the economy increases, unions suffer by declining wages caused by temporary agency employment.

3.8 Summary and Conclusions

This chapter develops a theoretical model to analyze the general equilibrium effects of the legal deregulation of temporary agency employment on negotiated wages and the employment structure in a unionized economy. Large firms produce differentiated goods using labor as the only production factor. Workers can either be hired directly by the firm (regular workers) or by temporary employment agencies that lend the workers to the firms for the production process. Both types of work are perfect substitutes. Regular workers are represented by firm-level labor unions, which are assumed to be monopoly unions. Temporary employment agencies are small (one worker) and bargain individually with the firm over the fee that the agency receives from the firm for borrowing a worker. In response to the determined fee and the claimed wage, the firm chooses the respective employment levels used in its production.

While there already exist contributions on labor unions and temporary employment agencies in the literature, the present model is the first that combines temporary agency employment and the wage-setting behavior of labor unions in a frictional labor market to discuss the agency's impact on regular employment and the overall employment structure in the economy.

The most striking result is that the model predicts that legal deregulation of temporary agency employment does not lead to a steady increase in this employment type implying that there is no substitution of regular employment. Instead, there exists a hump-shaped relationship between temporary agency employment and its degree of legal deregulation. Whereas deregulation out of a high degree of regulation leads to an increase in temporary agency employment, its rate decreases the more extensive legal deregulation is. Thus, deregulation efforts of the temporary agency employment sector that occurred in most European countries in recent decades, do not inevitable lead to a strengthening of this sector, but may even lead to a declining rate of temporary agency employment in the economy. At the same time, the rate of regular employment increases monotonically and overall employment benefits from the deregulation.

The reason for the hump-shaped pattern of temporary agency employment and the steady increase in regular employment is the cost structure of temporary agency employment. There are often voluntary, non-institutional firm-level agreements restricting the degree of temporary agency employment used in the production. Thus, the costs of temporary agency employment increase convexly. The higher the rate of temporary agency employment induced by legal deregulation, the higher the impact of the non-institutional firm-level agreements on marginal costs. Because agencies are rather small compared to the large firms they bargain with, they do not consider the consequences of the convex cost structure in their negotiations. Combined with the fact that more attractive temporary agency employment forces the labor unions to reduce their wage claims for regular employed workers to prevent employment losses and maintain the competitiveness with temporary agency employment, temporary agency employment may even decrease in the degree of legal deregulation, while regular employment increases monotonically.

Nevertheless, even if legal deregulation does not lead to a decline in the coverage of collectively bargained wages in the economy, it leads to a reduction in workers' wage rates and a reduction in labor union's utility.

These findings reject the main argument of opponents of temporary agency employment that its legal deregulation leads to a substitution of regular employment and to a higher share of precarious employment. Hence, the policy makers' idea, that legal deregulation of temporary agency employment increases the flexibility of the European labor markets and brings people to work who may not find regular employment, seems to be verified. Thus, legal deregulation of temporary agency employment aiming at an increasing employment level may be continued.

3.A Appendix

3.A.1 Steady State Employment Flows

Using the steady-state conditions for each labor market state, the respective job-searchers and the condition that $U + L_T + L_A + L_R = 1$, the steady-state flows from the perspective of the firm can be rewritten to obtain the respective flow equations for the different employment rates

$$L_T = \frac{\theta_T m(\theta_T) \cdot (1 - L_R) + [\chi - \theta_T m(\theta_T)] \cdot L_A}{\delta + \theta_T m(\theta_T) + \theta_A m(\theta_A) + \gamma_T \theta_R m(\theta_R)} \tag{3.54}$$

$$L_A = \frac{\theta_A m(\theta_A) L_T}{\chi + \gamma_A \theta_R m(\theta_R)} \tag{3.55}$$

$$L_R = \frac{[1 - L_T(1 - \gamma_T) - L_A(1 - \gamma_A)] \cdot \theta_R m(\theta_R)}{\delta + \theta_R m(\theta_R)}. \tag{3.56}$$

The numerators denote the flows into and out of the respective labor market states. Division by the respective denominator weights the flows by the average retention period of a job in the respective state.

3.A.2 Concavity of the Firm's Instantaneous Profit Function

Using eqs. (3.12) and (3.13), the instantaneous profit of the firm, eq. (3.14), can be written as

$$\pi_j = \tau^\kappa (L_{j,R} + L_{j,A})^{\rho\kappa} I^{1-\kappa} - w_{j,R}\, L_{j,R} - \varepsilon x\, L_{j,A}^{\sigma} - h\,(V_{j,A} + V_{j,R}), \tag{3.57}$$

with $\kappa = (\eta - 1)/\eta$. The lower κ, the higher the firm's monopoly power in the goods market. The second order conditions are

$$\frac{\partial^2 \pi}{\partial L_{j,R}^2} = \rho\kappa(\rho\kappa - 1)\tau^\kappa (L_{j,R} + L_{j,A})^{\rho\kappa - 2} I^{1-\kappa} < 0 \tag{3.58}$$

$$\frac{\partial^2 \pi}{\partial L_{j,A}^2} = \rho\kappa(\rho\kappa - 1)\tau^\kappa (L_{j,R} + L_{j,A})^{\rho\kappa - 2} I^{1-\kappa} - \sigma(\sigma - 1)\varepsilon x L_{j,A}^{\sigma-2} < 0 \tag{3.59}$$

$$\frac{\partial^2 \pi}{\partial L_{j,R} \partial L_{j,A}} = \rho\kappa(\rho\kappa - 1)\tau^\kappa (L_{j,R} + L_{j,A})^{\rho\kappa - 2} I^{1-\kappa} < 0. \tag{3.60}$$

While the necessary condition for a profit maximum is that the first-order conditions are equal to zero, the sufficient condition for a profit maximum is

$$\frac{\partial^2 \pi}{\partial L_{j,R}^2}\frac{\partial^2 \pi}{\partial L_{j,A}^2} - \left(\frac{\partial^2 \pi}{\partial L_{j,R}\partial L_{j,A}}\right)^2 > 0. \tag{3.61}$$

This can be seen to hold for $\kappa \in (0,1)$ and $\sigma > 1$:

$$\rho\kappa(\rho\kappa - 1)\tau^{\kappa}(L_{j,R} + L_{j,A})^{\rho\kappa-2} I^{1-\kappa} \cdot [-\sigma(\sigma-1)\varepsilon x L_{j,A}^{\sigma-2}] > 0. \tag{3.62}$$

3.A.3 Corner Solutions in Firm's Production

The decision of the firm, which type of labor input to use in the production, directly depends on the marginal costs of each labor input. If the costs of an additional temporary worker undercut (exceed) the marginal costs of a regular worker, the firm will only produce with temporary workers (regular workers). Evaluating eqs. (3.37) and (3.38) at $L_A > 0$ and $L_R = 0$, it turns out that the firm will produce by solely using temporary workers in the entire production, if

$$\tau^{\kappa} L_{j,R}^{\rho\kappa} I^{1-\kappa} = \sigma x \varepsilon L_A^{\sigma-1} + [r + \chi + \gamma_A \theta_R m(\theta_R)]\frac{h}{m(\theta_A)} < w_R + (r+\delta)\frac{h}{m(\theta_R)}.$$

On the contrary, evaluating eqs. (3.37) and (3.38) at $L_R > 0$ and $L_A = 0$, it follows that the final good will be produced by solely using regular employment, if

$$\tau^{\kappa} L_{j,R}^{\rho\kappa} I^{1-\kappa} = w_R + (r+\delta)\frac{h}{m(\theta_R)} < [r + \chi + \gamma_A \theta_R m(\theta_R)]\frac{h}{m(\theta_A)}.$$

Choosing the cost function of temporary employment to be convex (but not too convex) ensures to rule out the first case, since temporary employment becomes too expensive at a certain level of production. On the other hand, a convex cost function implies that temporary workers are relatively cheap at a low level of production, making the second case less likely. Thus, the probability to obtain an interior solution crucially depends on the convexity of the cost function of temporary employment.

3.A.4 Derivatives of Firm's Labor Demand

Using eqs. (3.37) and (3.38), respectively, it turns out that the labor demand decreases with respect to its own costs, i.e. formally

$$\frac{dL_{j,R}}{dw_R} = \frac{1}{\rho\kappa(\rho\kappa - 1)\tau^{\kappa}(L_{j,R} + L_{j,A})^{\rho\kappa-2} I^{1-\kappa}} < 0 \tag{3.63}$$

and

$$\frac{dL_{j,A}}{dx} = \frac{\sigma L_{j,A}^{\sigma-1}}{\rho\kappa(\rho\kappa - 1)\tau^{\kappa}(L_{j,R} + L_{j,A})^{\rho\kappa-2} I^{1-\kappa} - \sigma(\sigma - 1)\varepsilon x L_{j,A}^{\sigma-2}} < 0. \tag{3.64}$$

Taking eqs. (3.63) and (3.64) into account, it can be shown that the labor demand of regular (temporary) workers increases in the fee x (wage of regular workers)

$$\frac{dL_{j,R}}{dx} = -\frac{dL_{j,A}}{dx} > 0 \tag{3.65}$$

$$\frac{dL_{j,A}}{dw_R} = \frac{\rho\kappa(\rho\kappa - 1)\tau^{\kappa}(L_{j,R} + L_{j,A})^{\rho\kappa-2} I^{1-\kappa} \cdot \frac{dL_{j,R}}{dw_R}}{\sigma(\sigma - 1)\varepsilon x L_{j,A}^{\sigma-2} - \rho\kappa(\rho\kappa - 1)\tau^{\kappa}(L_{j,R} + L_{j,A})^{\rho\kappa-2} I^{1-\kappa}} > 0. \tag{3.66}$$

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Chapter 4

Temporary Work Agencies and Technology: How Deregulation of Temporary Agency Work Influences the Technological Orientation of the Economy

4.1 Introduction

Forty million people around the world are employed in so-called temporary agency employment (CIETT, 2015), a tripartite employment relationship in which workers are employed at temporary work agencies that lend them to client firms that use the workers in the production process without having a direct employment relationship with the respective employee. This huge number almost equals the total size of employment in Germany, Europe's largest economy, with about 43.5 million workers (Bundesagentur für Arbeit, 2017b). At the same time, temporary agency employment was – and in some countries still is – highly regulated and in public discussion temporary agency employment is accused of being precarious employment that offers low income but no sustainable perspective for workers employed at the agencies. Indeed, there is a substantial wage gap up to 25% between regularly and temporarily employed workers (see, e.g., Jahn & Pozzoli, 2013) and labor turnover in agency employment is almost five times higher than that of regular employment (Haller & Jahn, 2014). Nevertheless, workers and firms both have incentives to engage in temporary agency employment. According to CIETT/Ecorys-NEI (2002), temporary agency workers report their main reasons for engaging in temporary agency employment to be using temporary agency employment as a stepping stone to regular employment, to gain work experience and employability, and to earn money while maintaining freedom and independence. For employers, there exist various reasons for using temporary agency employment (see, e.g., Holst et al., 2010). Next to the motive of saving costs and increase profits (Jahn & Weber, 2016b), temporary workers may be used to adjust the workforce in production peaks, worker absence, or workforce fluctuation (see Houseman, 2001; Ono & Sullivan, 2013). As temporary agency workers are not covered by employment protection legislation, their use can be adjusted very flexible.

Legal regulation of temporary agency employment differs substantially across different countries. Some countries have almost no restrictions in the use of temporary agency employment, such as Austria, Denmark, the UK, and Sweden. Other countries limit the use of temporary agency employment by restricting the length of the assignment of a worker (e.g. Germany), or by allowing temporary agency employment only for specific reasons. Furthermore, temporary agency employment may be limited to specific sectors. Clauwaert (2000) and Arrowsmith (2006) give detailed overviews of the legal framework of temporary agency work in the European Union. In more recent years, there have been substantial legal deregulations in most European countries.[1] In Germany, the deregulation was part of the labor market reform "Agenda 2010." The main deregulations were the elimination of the maximum period of assignment and the synchronization and re-employment ban (see, e.g., Vitols, 2004; Antoni & Jahn, 2009).

In recent years, public discussion about temporary agency employment also found its way into economic research. While Autor (2001, 2003) gives a first contribution to the theoretical investigation, Neugart & Storrie (2006) discuss how an improved matching efficiency in temporary agency jobs led to the substantial increase in temporary agency

[1] See Eurofound (2009), p. 12, Table 5, for the main regulatory changes since 2004.

employment in the recent decades. The models of Chapter 2 and Chapter 3 continue the discussion of the role of temporary agency employment but especially focus on its effect on the role and behavior of labor unions. While the former discusses firms' strategic use of temporary agency employment in the wage negotiations in order to dampen the wage claims of labor unions, the latter analyzes the general equilibrium effects of temporary agency employment on overall employment and the employment structure in a unionized economy. This chapter sets a different focus. It analyzes how deregulation of the production alternative of temporary agency employment affects the firms choice of different technology levels and, hence, the technological orientation and organization of the whole economy. Furthermore, it investigates how technological progress of the more intensively used technology affects the economy and demonstrates which kind of economic policy is suitable to dampen or even balance the effects caused by legal deregulation of the agency work sector. The referred research questions are analyzed in a matching model according to Mortensen & Pissarides (1994) and Pissarides (2000). In particular, the model is based on the framework of Albrecht & Vroman (2002), who investigate the technology choice of firms under worker heterogeneity, and Dolado et al. (2009), who extend the framework of Albrecht & Vroman to on-the-job search.

One of the model's core findings is that firms react to the legal deregulation of temporary agency work by choosing to produce with technologies that use this type of employment more intensively. This form of employment is mainly used for simple tasks that are produced with a less advanced technology. Thus, firms shift to production with the basic, less advanced technology. As firms usually invest in technologies that they use intensively and that increase their profits, deregulation of temporary agency work may increase the firms incentive to invest in research and development in the technology that is used in temporary agency production. Therefore, the paper also analyzes the macroeconomic effects of technological progress of temporary agency production and shows that investments in this technology strengthen the effects induced by the legal deregulation. Furthermore, it also shows that specific investments in the technological progress of more advanced technologies may balance or at least dampen the effects of the deregulation. Thus, it may be a beneficial economic policy to give incentives for investments in these technologies.

The remainder of the chapter is organized as follows. Section 4.2 provides a brief overview of related literature. Section 4.3 gives a detailed description of the model framework and Section 4.4 discusses the induced changes by legal deregulation and technological progress on the technology choice of firms, the employment structure, and workers' wages. Section 4.5 summarizes the results and concludes.

4.2 Related Literature

This chapter combines and extends two fields of research: temporary agency employment and endogenous technology choice of firms. Recently, there has been substantial research interest in temporary agency employment. However, most of the research concentrates on the empirical investigation of the following key issues: the strategic use of temporary agency work in the production (e.g. Vidal & Tigges, 2009; Holst et al., 2010), its effect on the employment structure (Haller & Jahn, 2014; Jahn & Weber, 2016a), the wage differential of temporary agency work (Garz, 2013), and the idea of temporary agency employment being a stepping stone to regular employment (Amuedo-Dorantes et al., 2008; Autor & Houseman, 2010; Jahn & Rosholm, 2014). However, the more important for the present paper are the few theoretical contributions on temporary agency work. Autor (2001, 2003) investigates the role of employment agencies in the screening for regular employment and, in the latter contribution, describes that firms hesitate to substitute the whole workforce by temporary agency workers because there are distinct capital investments related to specific workers that would be lost with the use of the more volatile temporary agency employment. The most important theoretical contribution is provided by Neugart & Storrie (2006). Their model is the first that combines temporary agency work and the matching model. The authors explain the increase in temporary employment in recent years to be caused by an increased matching efficiency that was induced by temporary employment agencies, which act as an intermediary in the matching between firms and workers. Baumann et al. (2011) extend this framework by enriching the model setup by endogenous job destruction. Beissinger & Baudy (2015) give another contribution by analyzing the firm's strategic use of potential temporary agency work in the wage-setting process to dampen the labor union's wage claims. However, the model neglects the general equilibrium effects. This is captured by Chapter 3 of this thesis. The authors combine labor unions and temporary work agencies in the matching framework and develop a model with large firms and in which both types of employment are perfect substitutes. However, they assume homogeneous firms and do not take into account that cheaper or rather more attractive temporary agency employment may change the technological orientation of the economy.

The second field of literature that is related to the present chapter is research on the endogenous technology choice of firms. Acemoglu (1999) shows that for a heterogeneous workforce, firms provide skill-specific jobs if the productivity difference between the two skill levels is big enough or if the proportion of high-skilled workers in the economy is high enough. Mortensen & Pissarides (1999) use a model with endogenous technology choice and heterogeneity on both sides of the market to study the effects of a skill-biased technological change in the different systems of unemployment insurance and firing taxes in Europe and the US.[2] Another influential contribution, which the present model refers to, is Albrecht & Vroman (2002). The authors model an economy with heterogeneity on both sides of the labor market and analyze how a change in the skill composition of the workers in the economy changes the endogenously determined technology choice of firms. This framework serves as a base for extensive follow-up work. Davidson et al. (2008) extend this framework to an open economy investigating the effects of international offshoring on the technological orientation of the economy. Dolado et al. (2009) also use the framework of Albrecht & Vroman and extend it by on-the-job search. Furthermore, Liu et al. (2017) and Cords (2017) analyze the effects of immigration on the host country enriching the basic model of Albrecht & Vroman appropriately.

[2] Another contribution is given by McKenna (1996). However, he does not endogenize the technology choice of firms but the education decision of workers in a two-sector matching model and examines how workers adjust their education decision to the availability of skill-demanding jobs.

4.3 The Model

4.3.1 Basic Assumptions

The model is in continuous time. There is a unit mass of homogeneous workers who live infinitely, are risk neutral, and discount the future at a common rate $r > 0$. Workers are in one of three labor market states: they are either unemployed and looking for a job, working at a firm in a regular job, or they are employed at a temporary work agency and lend out to a client firm which uses them in the production process.[3] Unemployed workers look for employment and accept the first job offer they get, independent of whether it is a temporary or regular job offer. Being regularly employed, the job gets destroyed at an exogenous destruction rate δ_R. Temporary employed workers lose their jobs at rate δ_T. Empirical research shows that temporary employment is more volatile, the turnover rate is higher than for regular employment, and the average duration of employment in temporary agency jobs is shorter than in regular employment (see e.g. Haller & Jahn, 2014). Therefore, it is assumed that $\delta_T > \delta_R$. While being employed in a temporary job, workers search on-the-job for regular employment. Regularly employed workers do not search on-the-job for other employment possibilities. On-the-job search for temporary employed workers is a decisive characteristic of temporary agency employment, which is modeled in the same way by Neugart & Storrie (2006) and Baumann et al. (2011). The idea behind it is that workers use temporary agency employment as a stepping stone to regular employment. Workers accept temporary employment offers, that are usually related to lower wages compared to regular jobs, to signal potential employers that they are willing to work and have specific abilities. By this, they hope to have an

[3]Other models, like Neugart & Storrie (2006) or Baudy & Cords (2016), include a fourth labor market state in which temporary workers are under contract at a temporary work agency but have not been assigned to a firm yet. Such a labor market state represents the institutional regulation that is called synchronization ban. It means that the contract of the worker at the agency has to exceed the assignment duration at the client firm. This synchronization ban still applies in some European countries, others got rid of it with the institutional deregulation of temporary agency employment. The model framework used in the present chapter fits to countries like UK or the US, but also to Germany who eliminated the synchronization ban recently.

advantage in finding a regular job compared to unemployed workers. This is also the political idea behind temporary agency employment. Furthermore, on-the-job search of temporary agency workers is the key difference to other forms of production alternatives, like outsourcing or offshoring.

Unemployed workers and vacant jobs meet each other randomly. This is formally described by the matching function

$$M = M(v, s). \tag{4.1}$$

The instantaneous flow of hires M is determined by the vacancy rate v and the rate of job seekers, s. As there are regular and temporary jobs in the economy, it holds that $v \equiv v_R + v_T$, where v_R denotes regular job vacancies and v_T denotes temporary job vacancies. Job-seekers are either part of the unemployment pool, u, or they are employed in temporary jobs, $(1-u)\varepsilon$, with ε being the fraction of temporary agency employment on overall employment $(1-u)$. The intensity of on-the-job search may deviate from the search intensity in case of unemployment. As workers use temporary agency jobs as a stepping stone to regular employment, it is assumed that their search intensity is higher than that of unemployed workers. They signal potential employers their abilities and willingness to work, which increases their search intensity and, thus, their arrival rate of regular job offers. This is covered by search intensity parameter λ with $\lambda \geq 1$.[4] Thus, the effective amount of (overall) job seekers is $s \equiv u + (1-u)\varepsilon\lambda$.

The matching function exhibits constant returns to scale, is increasing in both of its arguments, at least twice differentiable, and satisfies the Inada conditions. Vacancies meet job seekers at rate $M(v, s)/v \equiv m(\theta)$, whereby $\theta \equiv v/s$ denotes overall labor market tightness. The tighter the labor market, i.e. the more vacancies per job seeker, the smaller the arrival rate of job seekers per vacancy and, thus, $m'(\theta) < 0$. Similarly, the worker's instantaneous arrival rate of a new job offer is $M(v, s)/s = \theta m(\theta)$. The tighter the labor market, the higher the individual worker's chance of finding a job, i.e. the higher the

[4]Dolado et al. (2009) also model on-the-job search and introduce search-intensity parameter λ. However, they investigate on-the-job-search in regular jobs. Therefore, they assume the search intensity parameter to be positive but smaller 1. In the present case, $\lambda < 1$ is ruled out as it conflicts with the stepping stone idea of temporary agency work.

arrival rate of a new job offer and, thus, $\partial\theta m(\theta)/\partial\theta > 0$. The construction of the labor market tightness θ is one of the core differences between the model framework of Albrecht & Vroman (2002) and Neugart & Storrie (2006). While Albrecht & Vroman define overall labor market tightness θ and, e.g., distinguish the workers' effective arrival rates for the different types of jobs (i.e. different skill requirements) by multiplying the overall labor market tightness with the share of regular or temporary job vacancies, Neugart & Storrie define the labor market tightness for each submarket (i.e. temporary and regular employment) separately. Thus, they calculate specific values of θ for regular employment and another for assigned temporary workers, separately. The present model uses the approach of Albrecht & Vroman.[5]

There is also a unit mass of firms in the economy. Firms are small and offer one job. They decide ex-ante, before entering the market, whether to post a regular or temporary job vacancy. The difference between both types of vacancies is that the underlying technology differs. The technology used in regular jobs is more advanced. Hence, the production output per regular worker, y_R, is higher than the output produced per temporary worker, y_T. This is in line with the fact that - even if is used in almost all sectors - temporary agency employment is most intensively used in simple tasks (for Germany, see e.g. Bundesagentur für Arbeit, 2017a). The reason for assuming that the more productive technology requires regular employment is that production with more productive technologies often means more intensive training - even if the underlying skill requirements may be the same in both types of production technologies. Using temporary agency workers and the related higher labor turnover rate would lead to higher training costs and, thus, to decreasing profits. Hence, it is assumed that in order to avoid such training costs that are not explicitly modeled here the more advanced technology requires regular employment.

The fraction of temporary job vacancies on all vacancies is described by $\gamma = v_T/(v_R + v_T)$, with $\gamma \in (0, 1)$. Thus, the effective instantaneous arrival rate of a job offer for temporary employment is $\theta m(\theta)\gamma$, while its counterpart for regular employment is $\theta m(\theta)(1-\gamma)$. As there are two types of jobs and technologies, some workers will be regularly employed,

[5] Chapter 3, however, follows the approach of Neugart & Storrie (2006).

while others end up in temporary agency employment. Temporary agency employment can formally be stated as $l_T = (1-u)\varepsilon$, while $l_R = (1-u)(1-\varepsilon)$ represents regular employment.

4.3.2 Workers and Firms

Workers are either directly employed at a firm (regular employment), unemployed, or employed at a temporary work agency and lend to a firm for production. The worker's expected value of regular employment is

$$rV_R^E = w + \delta_R[V^U - V_R^E + f]. \tag{4.2}$$

The worker receives wage income w. Furthermore, following Neugart & Storrie (2006), in case of job destruction the worker receives severance payments f as a direct transfer from the firm. Regular jobs are destroyed at exogenous rate δ_R. With job destruction the worker loses V_R^E and falls back to the value of being unemployed, V^U. Hence, the loss of a change in the labor market state is given by $V^U - V_R^E + f$. The expected value of being unemployed is

$$rV_U = z + \theta m(\theta)(1-\gamma)[V_R^E - V^U] + \theta m(\theta)\gamma[V_T^E - V^U]. \tag{4.3}$$

Unemployed workers receive net unemployment income z. The total amount of job seekers is the sum of unemployed workers and temporary agency workers, $s = u + (1-u)\varepsilon\lambda$. As $v = v_R + v_T$, the arrival rate $\theta m(\theta)$ is the contact rate of *any* individual in the worker pool and *any* vacancy. To obtain the arrival rate on regular vacancies, this contact rate has to be multiplied by the share of suitable vacancies $(1-\gamma)$ leading to the effective regular job offer arrival rate $\theta m(\theta)(1-\gamma)$. For temporary job vacancies, the overall arrival rate has to be multiplied by γ leading to the effective temporary job offer arrival rate $\theta m(\theta)\gamma$. The gain of a change in the labor market state to regular employment is $V_R^E - V^U$ and the gain of a change in the labor market state to temporary employment is $V_T^E - V^U$. Once a worker is employed in a temporary employment agency, the expected value of this type of employment is

$$rV_T^E = \kappa w + \delta_T[V^U - V_T^E] + \lambda\theta m(\theta)(1-\gamma)[V_R^E - V_T^E]. \tag{4.4}$$

Agency workers receive a wage income of κw, i.e. they receive κ times the wage rate of regular workers, with $\kappa < 1$. Modeling the wage payment of temporary employment as a fraction of the regular worker's wage is based on Neugart & Storrie (2006). Next to the potential loss of a change from temporary employment to unemployment, $V^U - V_T^E$, which occurs at rate δ_T, temporary agency workers search on-the-job for regular employment. Contrary to regularly employed workers, temporary agency workers do not receive severance payments in case of job destruction.[6] $V_R^E - V_T^E$ gives the potential gain of a change in the labor market state to regular employment, which is multiplied by the effective job offer arrival rate $\lambda \cdot \theta m(\theta)(1-\gamma)$. The effective on-the-job search arrival rate of regular job offers exceeds the effective arrival rate of unemployed workers by λ with $\lambda \geq 1$. As the number of job seekers in θ includes both, unemployed workers and temporary agency workers, the arrival rate $\theta m(\theta)(1-\gamma)$ holds for workers in either of the two labor market states. However, according to the stepping stone idea, workers that engage in temporary agency employment signal their abilities and willingness to work to potential employers and, therefore, face a higher arrival rate for regular jobs than workers that look for a job out of being unemployed.

Firms are small and offer only one job. Before entering the market, firms ex-ante decide which type of job vacancy to post, a regular or a temporary job vacancy. The firm's expected profits of posting a vacancy for a regular and a temporary job are

$$r\pi_R^V = -h_R + m(\theta)[\pi_R^F - \pi_R^V] \tag{4.5}$$

$$r\pi_T^V = -h_T + \phi m(\theta)[\pi_T^F - \pi_T^V]. \tag{4.6}$$

Posting a vacancy is costly. These costs are denoted by h_R and h_T for regular and temporary job vacancies, respectively. It is assumed that posting a regular job vacancy – which is more productive when filled – is more expensive, i.e. $h_R > h_T$. Rate $m(\theta)$ is the rate at which a vacancy is filled with *any* type of job seeker. Since unemployed and temporarily employed workers are both looking for a regular job, the arrival rate

[6] This covers the lack in employment protection legislation for temporary employment. In many countries, the deregulation of temporary agency work was part of reforms in employment protection explicitly aiming at temporary agency employment to be more flexible than regular employment.

for firms that offer a regular job vacancy is $m(\theta)$. Temporary job vacancies can only be filled with unemployed workers. Thus, the arrival rate has to be weighted by the share of unemployed workers on all job seekers,

$$\phi = \frac{u}{u + (1-u)\varepsilon\lambda}. \tag{4.7}$$

The gain of filling a regular job vacancy is $\pi_R^F - \pi_R^V$, while the gain of filling a temporary job vacancy is $\pi_T^F - \pi_T^V$. Once a regular job vacancy is filled, the firm's expected profit is

$$r\pi_R^F = y_R - w + \delta_R[\pi_R^V - \pi_R^F - f]. \tag{4.8}$$

The firm's flow profit is $y_R - w$ with y_R being the production output and, hence, the firm's revenue. Wage rate w represents the firm's instantaneous labor costs. The job is destroyed at exogenous rate δ_R and the related loss from job destruction is $\pi_R^V - \pi_R^F - f$. Similarly, the firm's expected profit of a filled temporary job is

$$r\pi_T^F = y_T - \mu w + \delta_T[\pi_T^V - \pi_T^F] + \lambda\theta m(\theta)(1-\gamma)[\pi_T^V - \pi_T^F]. \tag{4.9}$$

The flow profit of a filled temporary job is $y_T - \mu w$. Temporary workers produce output y_T and the firm pays μw to the temporary employment agency. This is again in line with Neugart & Storrie (2006). Parameter μ will be further specified in Section 4.3.3. Firms lose $\pi_T^V - \pi_T^F$ if a job is quit. Temporary employment can either be destroyed exogenously at rate δ_T or it may be quit because the temporary worker succeeds in obtaining a regular job. This occurs at rate $\lambda\theta m(\theta)(1-\gamma)$. In contrast to regular jobs, firms do not have to pay severance payments in case of job destruction.

4.3.3 Temporary Employment Agencies

Temporary employment agencies are small and offer only one job. They work as intermediaries between unemployed workers and firms. The agency hires a worker in a temporary agency contract and lends the worker to a client firm for production. The firm pays a fee μw to the agency, which passes the wage payment κw on to the worker. For the firm, it is attractive not to directly employ the worker but to use the intermediary for two reasons: First, firms do not have to pay non-wage severance payments to temporary agency workers in case of job destruction. Second, as unemployed workers try to use temporary jobs as a stepping stone to regular employment, they tend to accept lower wages in temporary jobs. This will be further specified in Section 4.3.4. The instantaneous profit of the temporary employment agency is given by

$$r\Omega = (\mu - \kappa)w - c. \tag{4.10}$$

The agency's revenue for lending a worker to a client firm is μw and labor costs are κw. Parameter c denotes regulatory, institutional costs. As stated in Section 4.1, the sector of temporary agency employment has been – and partly still is – highly regulated. Legal regulations like the re-employment ban (i.e. that it is not allowed to lend the same worker to a client firm twice) or limitations in the maximum period of assignment of workers create costs for firms and agencies. These various costs are catched by parameter c. It may be argued that the agency does not have to bear all the costs of legal regulation but some costs incur at the firm. This is accounted for by assuming free market entry of agencies which drives profits down to zero, i.e. $\Omega = 0$. Thus, all costs related to temporary agency employment are passed on to the firms indirectly. Using the agency's zero profit condition, the mark-up μ that determines the costs that firms have to pay using temporary workers in relation to the costs for regular employment is

$$\mu = \frac{\kappa w + c}{w}. \tag{4.11}$$

Thus, there is a positive relationship between regulatory costs c and the mark-up μ. The higher regulatory costs of temporary employment, the more expensive is its use.

4.3.4 Wage Bargaining and Labor Costs

The wage rate of regular workers is determined by individual bargaining between firms and workers.[7] In the determination of the labor income of temporary workers, this model

[7] To depict the European labor markets properly, it may make sense to model collective bargaining for the wage determination of regular workers' wage. The majority of wage agreements in Europe are still based on collective bargaining between labor unions and employer organizations. In Germany, the commitment level of firms to industry-wide multi-firm agreements is about 50 percent (Brücker et al.,

follows Neugart & Storrie (2006) by assuming that the wage payment for temporary workers is set in a way that temporary agency workers are indifferent between temporary employment and unemployment, i.e. $V_T^E = V^U$. This is appropriate for two reasons. First, Jahn & Pozzoli (2013) show that there are substantial wage gaps between temporary and regular employed workers of up to 25%. At the same time, the replacement ratio of unemployment benefits is usually about 70% of the pre-earned income. Thus, the unemployment benefits are approximately of the same amount as labor income of temporary workers leading to more or less equal utilities of being unemployed or employed at a temporary work agency. Second, the equal value condition simplifies the formal analysis substantially.

Wages of regular workers are determined by bargaining between workers and firms. The generalized Nash-bargaining problem between the worker and the firm can be stated as

$$\max_{w} \left[V_R^E - V^U\right]^{\beta} \left[\pi_R^F - \pi_R^V\right]^{1-\beta}. \tag{4.12}$$

Parameter $\beta \in (0,1)$ denotes the worker's bargaining power. Maximizing the Nash product and taking account of the equal value condition, $V^U = V_T^E$, the wage rate is

$$w = z - \delta_R f + (y_R - z)\Gamma(\theta,\gamma) \quad \text{with} \quad \Gamma(\theta,\gamma) = \frac{\beta[r + \delta_R + \theta m(\theta)(1-\gamma)]}{r + \delta_R + \beta\theta m(\theta)(1-\gamma)}, \tag{4.13}$$

where $\Gamma(\theta,\gamma)$ denotes the worker's effective bargaining power. This notation of the wage rate and the effective bargaining power follows Cahuc et al. (2014). Appendix 4.A.1 provides the detailed derivation of the wage rate. Wage w is set as a mark-up over unemployment benefits and lowered by the severance payments. This latter transfer is weighted by its payment probability δ_R. The wage is higher, the higher the worker's effective bargaining power.

Applying the equal value condition, $V_T^E = V^U$, and using the worker's value functions,

2012) and more than 40 percent of the firms that are not part of the industry-wide multi-firm agreements nevertheless comply with the negotiated wage level (Ellguth & Kohaut, 2014). However, with the assumption of small firms, bargaining of labor unions and employer organizations leads to the same result as individual bargaining (see Masui, 2013). Thus, unions are left out in the present model.

eqs. (4.3) and (4.4), the wage payment for temporary employed workers can be stated as

$$\kappa w = z + \frac{\theta m(\theta)(1-\gamma)(1-\lambda)\beta(y_R - z)}{r + \delta_R + \theta m(\theta)(1-\gamma)\beta}. \tag{4.14}$$

Appendix 4.A.2 provides the derivation of the wage income for temporary workers. Eq. (4.14) shows that the wage payment of temporary workers κw decreases in search intensity λ. With $\lambda > 1$, temporary workers even accept wage payments that are lower than unemployment benefits. They do so as the high search intensity increases their probability of finding a regular job. Thus, they temporarily accept a lower wage income.

4.3.5 Labor Demand and Equilibrium

Firms enter the market and open vacancies as long as the expected profit of posting a vacancy is positive. Free market entry drives the expected profit of a vacancy down to zero, i.e. $\pi_T^V = \pi_R^V = 0$. Using the firm's value functions of regular jobs, eq. (4.5) and (4.8), the wage rate, eq. (4.13), and the firms' free market entry condition, the equilibrium labor demand for regular employment is

$$\frac{h_R}{m(\theta)} = \frac{(y_R - z)(1-\beta)}{r + \delta_R + \beta\theta m(\theta)(1-\gamma)}. \tag{4.15}$$

The average costs of a regular job vacancy (left-hand-side) equals the expected profit of a filled job (right-hand-side). Similarly, using the firm's value functions of agency jobs, eqs. (4.6) and (4.9), the endogenously determined mark-up μ, eq. (4.11), the firms' free market entry condition, and the endogenously determined wage payment for temporary workers, eq. (4.14), the equilibrium labor demand for temporary employment can be derived to be

$$\frac{h_T}{\phi m(\theta)} = \frac{(y_T - z - c) - \frac{\theta m(\theta)(1-\gamma)(1-\lambda)\beta(y_R - z)}{r+\delta_R+\theta m(\theta)(1-\gamma)\beta}}{r + \delta_T + \lambda\theta m(\theta)(1-\gamma)}. \tag{4.16}$$

As for regular employment, eq. (4.16) states that firms demand temporary agency employment such that the average cost of a temporary job vacancy equals the firm's expected profit of a filled temporary job.

In equilibrium, the inflow into employment and the outflow back to unemployment coincide, i.e. $\dot{u} = 0$. Job-seekers meet temporary job vacancies at rate $\theta m(\theta)\gamma$. Multiplying this arrival rate with the unemployment rate u gives the instantaneous inflow into temporary employment. At the same time, temporary employment $l_T = (1-u)\varepsilon$ is destroyed at rate δ_T. Furthermore, due to on-the-job search for regular employment, workers leave temporary agency employment at rate $\lambda\theta m(\theta)(1-\gamma)$. Summarizing the in- and outflows of temporary employment, in equilibrium it holds that

$$\theta m(\theta)\gamma u = (1-u)\varepsilon\delta_T + \lambda\theta m(\theta)(1-\gamma)(1-u)\varepsilon. \tag{4.17}$$

Unemployed workers find regular employment at rate $\theta m(\theta)(1-\gamma)$ and, due to on-the-job search, temporary workers enter regular employment at rate $\lambda\theta m(\theta)(1-\gamma)$. At the same time, regular employment $l_R = (1-u)(1-\varepsilon)$ is destroyed at rate δ_R. The equilibrium in- and outflows of regular employment can, thus, be summarized as

$$\theta m(\theta)(1-\gamma)u + \lambda\theta m(\theta)(1-\gamma)(1-u)\varepsilon = (1-u)(1-\varepsilon)\delta_R. \tag{4.18}$$

Adding up eqs. (4.17) and (4.18), the flows into and out of overall employment are

$$\theta m(\theta)u = (1-u)\big[\varepsilon\delta_T + (1-\varepsilon)\delta_R\big]. \tag{4.19}$$

Solving eq. (4.19) for u, the equilibrium rate of overall unemployment is

$$u = \frac{\varepsilon\delta_T + (1-\varepsilon)\delta_R}{\theta m(\theta) + \varepsilon\delta_T + (1-\varepsilon)\delta_R}. \tag{4.20}$$

Inserting eq. (4.20) into eq. (4.17), the equilibrium fraction of temporary agency employment on overall employment ε is

$$\varepsilon = \frac{\gamma\delta_R}{(1-\gamma)\big[\delta_T + \lambda\theta m(\theta)\big] + \delta_R\gamma}. \tag{4.21}$$

Inserting eqs. (4.20) and (4.21) into eq. (4.7), the fraction of unemployed workers on all job seekers is

$$\phi = \frac{\delta_T + (1-\gamma)\lambda\theta m(\theta)}{\delta_T + \lambda\theta m(\theta)}. \tag{4.22}$$

Re-inserting eq. (4.22) into eq. (4.16), the equilibrium values of the endogenous variables u, γ, ε, and θ can be determined using the equilibrium labor demand equations (4.15) and (4.16), and the expressions for the unemployment rate and fraction of temporary employment on overall employment, eqs. (4.20) and (4.21).

4.4 Comparative Statics

The model can be used to examine several important questions related to temporary agency employment. This section focuses on the effects of a legal deregulation of temporary agency employment as well as technological change, i.e. an increase in the productivity of both types of jobs. The latter is especially important as it may be an indirect, but logical consequence of the legal deregulation of temporary agency employment. An induced shift in the technology choice of firms in the economy may favor investments especially in the technology that is used more intensively.

4.4.1 Deregulation of Temporary Agency Employment

Temporary agency employment was highly regulated in most European countries. As discussed in Section 4.1, such regulations were, for example, that the maximum period of assignment of temporary workers was limited, it was forbidden to employ the same temporary agency worker twice at the same client firm, the period of employment at the agency had to exceed the assignment period, or there have been equal pay obligations for regular and temporary workers. The higher the degree of legal regulations, the higher the regulatory and institutional costs for the use of temporary agency work in the production. In recent years, there have been continuous efforts to deregulate temporary agency employment in almost all industrialized countries. Synchronization and re-employment bans have been relaxed or abolished, equal pay obligations are circumvent and the maximum period of assignment has been widely extended. The deregulation leads to a decrease in regulatory and institutional costs. In the present model, these various regulatory and institutional costs are modeled as c in the agency's profit function and, thus, legal deregulation is depicted by a decrease in c. The effects of this deregulation on the model's endogenous variables can be summarized in the following propositions.

Proposition 4.1. *Legal deregulation of temporary agency employment ($dc < 0$) leads to an increase in overall labor market tightness, θ. The fraction of temporary job vacancies on all vacancies, γ, increases and a larger share of workers is employed in temporary* *agency employment, ε.*[8]

$$\frac{d\theta}{dc} < 0, \quad \frac{d\gamma}{dc} < 0, \quad \frac{d\varepsilon}{dc} < 0.$$

Proof. Appendix 4.A.3 provides the formal proofs. □

It is straightforward that the share of temporary job vacancies on all vacancies increases in legal deregulation as the decline in regulatory costs directly translates into reduced costs of temporary agency jobs. Firm's expectations of increased profits from posting temporary job vacancies and the production with temporary agency workers boosts job creation in this sector. Firms enter the market and post vacancies until the expected profit of a temporary job vacancy is again driven down to zero. The job inflow leads to a higher rate of successful job matches, which increases overall labor market tightness. Furthermore, the increase in the labor market tightness increases the worker's overall job offer arrival rate $\theta m(\theta)$ and, hence, reduces the workers duration of being unemployment, which is defined as $1/\theta m(\theta)$.

The tighter the labor market and the more temporary job vacancies are available, the higher the share of temporary agency employment on overall employment, ε. Thus, the technological orientation and organization of the economy shifts from the use of the more advanced technology to the more intensive use of the less advanced, basic technology. The increased attractiveness of temporary agency work substantially shifts the orientation of the economy away from more advanced, innovative production.

Proposition 4.2. *Legal deregulation ($dc < 0$) leads to an increase in temporary agency employment, while the effects on regular employment and overall employment are ambiguous.*

$$\frac{du}{dc} \lesseqqgtr 0, \quad \frac{dl_T}{dc} < 0, \quad \frac{dl_R}{dc} \lesseqqgtr 0.$$

Proof. Appendix 4.A.3 provides the formal proofs. □

[8]Note that the signs of the induced changes in the endogenous variables are – as in propositions 4.2 and 4.3, too – given in the correct formal way which suggests the direction of the change in the exogenous parameter c to be positive. Therefore, as the deregulation in temporary agency employment is described $dc < 0$, the effects of the legal deregulation are opposite to what the signs suggest at first sight.

It follows from eq. (4.20) that there are two competing effects working on overall employment. While the increase in labor market tightness θ favors overall job finding $\theta m(\theta)$ and finally dampens unemployment, the induced change in the share of temporary agency employment on overall employment increases the weighted average rate of job destruction, $\varepsilon\delta_T + (1-\varepsilon)\delta_R$. The overall effect of a decrease in institutional costs c therefore depends on the relative strength of both effects.[9] In principle it holds that the smaller the difference in the job destruction rates for temporary and regularly employed workers, the more likely it is that overall employment increases in legal deregulation. Despite the ambiguity in overall employment, the inflow of new firms that are posting temporary agency jobs increases the number of successful job matches. The more firms enter the market and post temporary job vacancies and the higher the worker's job offer arrival rate for temporary jobs $\theta m(\theta)\gamma$, the higher the employment rate in temporary agency jobs. Whether regular employment in- or decreases in legal deregulation, depends – as for overall employment – on the strength of the effects in θ and ε and is therefore ambiguous.

Proposition 4.3. *A decline in legal regulation of temporary agency work ($dc < 0$) leads to a decrease in the wage rate of regular workers, w, and an increase in the labor income of temporary workers, κw.*

$$\frac{dw}{dc} > 0, \quad \frac{d\kappa w}{dc} < 0.$$

Proof. Appendix 4.A.3 provides the formal proofs. □

The decrease in the wage rate of regular workers is caused by cheaper production with temporary agency jobs. This leads to a wage restraint and dampens worker's wage claims in the wage negotiations with the firms. This is straightforward as higher wage claims would lead to a substantial decrease in regular employment. The increase in labor income in temporary agency jobs stems, first, from the increased demand for temporary agency workers due to the inflow of new jobs in this sector and, second, from the fact that the temporary workers' chance of finding regular employment on-the-job declines

[9] Appendix 4.A.3 provides the detailed calculations and discusses in which cases the sign can clearly be determined.

and this decline in the employment outlook has to be substituted by an increase in the wage payment to maintain the equality of the value of being unemployed and employed in a temporary job.

Another interesting result following from the opposed changes in the wage income in both types of jobs is that legal deregulation of temporary agency employment decreases the wage differential and, thus, wage inequality in the model economy.

4.4.2 Technological Progress of Temporary Agency Production

One of the most important results of Section 4.4.1 is that legal deregulation of temporary agency employment leads to its more intensive use in the economy and, thus, to a more intensive production with the less-advanced technology. Thinking about firms' investments in research and development, it is reasonable for them to focus on investments in further development of technologies they favor and use more intensively. As a logical consequence, the more attractive and the more likely the firm's use of the basic technology and production with temporary agency workers, the higher their incentive to especially invest in that type of technology. The technological progress that results from this development, i.e. the increase in production output y_T, again, may have substantial effects on the economy. Thus, in the following it is analyzed how an exogenous change in the productivity of temporary agency production affects the macroeconomic equilibrium. The results can be summarized in the following propositions.

Proposition 4.4. *Technological progress of temporary agency production leads to an increase in overall labor market tightness, θ. Furthermore, the fraction of temporary job vacancies on all vacancies, γ, and the share of workers that are employed in temporary agency jobs, ε, both increase.*

$$\frac{d\theta}{dy_T} > 0, \quad \frac{d\gamma}{dy_T} > 0, \quad \frac{d\varepsilon}{dy_T} > 0$$

Proof. Appendix 4.A.4 provides the formal proofs. □

The more productive temporary agency jobs, the higher the firm's expected profit from production with temporary agency workers. Hence, the increased expected profit encourages firms to choose the less advanced technology and to enter the market by posting temporary job vacancies. This boost increases the number of successful matches and makes the labor market tighter, i.e. θ increases. As there are (relatively) more vacancies to produce with temporary workers, γ increases. Furthermore, the availability of temporary job vacancies increases the share of employment in temporary jobs, ε. Hence, as similar to the deregulation of temporary agency work, technological progress of the agency production shifts the production in the economy towards an even more intensive use of the basic technology.

Proposition 4.5. *Technological progress of temporary agency production leads to an increase in temporary agency employment, l_T, while the effects on overall employment and regular employment, l_R, are ambiguous.*

$$\frac{dl_T}{dy_T} > 0, \quad \frac{du}{dy_T} \lesseqgtr 0, \quad \frac{dl_R}{dy_T} \lesseqgtr 0.$$

Proof. Appendix 4.A.4 provides the formal proofs. □

The enhanced posting of temporary job vacancies increases the number of successful job matches in this sector and favors employment in temporary agency jobs. Concerning the effects on overall unemployment an employment in regular jobs, the effect of technological progress in the less advanced technology is again ambiguous and depends on the relative strength of its effect on labor market tightness and the economy's average job destruction in temporary agency jobs.

Proposition 4.6. *Technological progress of temporary agency production leads to a decrease in the wage rate of regular workers, w, while it increases the wage payment of agency workers, κw.*

$$\frac{dw}{dy_T} < 0, \quad \frac{d\kappa w}{dy_T} > 0.$$

Proof. Appendix 4.A.4 provides the formal proofs. □

Due to the increased supply of temporary job vacancies and the increased profitability of this production method, the worker's bargaining power decreases. Workers have to reduce the wage claims which increase the firm's profitability of the regular job. Furthermore, the increased demand for temporary workers that is based on more intensive temporary-job creation and the deteriorating outlook of finding regular employment searching on-the-job require an increase in temporary workers wage payments.

To summarize, the effects of technological progress of the agency production coincide with the macroeconomic effects of the legal deregulation of temporary agency work. For technological progress being the consequence of more intensive investments in research and development that are induced by the more intensive use of this technology due to the deregulation, it even strengthens the initial effects of the deregulation. Most striking, it intensifies the use of agency production in the economy.

4.4.3 Technological Progress of Regular Production

In Section 4.4.2 it was argued that the more intensive use of temporary agency production and the related (basic) technology may give firms an incentive to invest more in this technology. However, it is also important to analyze whether specific investments in skill-biased technological change can improve the attractiveness of regular employment and, hence, the more productive technology. If so, governmental support and subsidies in research and development for more advanced technology and innovations may be a suitable economic policy to dampen or even balance the effects that are induced by the legal deregulation of temporary agency employment. Hence, this Section analyzes the macroeconomic effects of progress of the more advanced technology that is used in regular employment, y_R. The results can be summarized in the following propositions.

Proposition 4.7. *Technological progress of regular production leads to an increase in overall labor market tightness θ. The fraction of temporary job vacancies on all vacancies, γ, and the share of workers that are employed in temporary agency jobs, ε, both decrease.*

$$\frac{d\theta}{dy_R} > 0, \quad \frac{d\gamma}{dy_R} < 0, \quad \frac{d\varepsilon}{dy_R} < 0$$

Proof. Appendix 4.A.5 provides the formal proofs. □

The productivity increase in regular jobs increases its profitability. Firms post regular job vacancies. This leads to a decreasing fraction of temporary job vacancies in the economy. The inflow of new regular job vacancies increases the number of successful job matches and the tightness of the labor market, θ. The more regular job vacancies are available, the higher the rate of successful matches of this type of jobs and the higher the share of regular employment on overall employment, i.e. ε decreases.

Consequently, specific investments in more advanced technologies and public subsidies in their research and development is a suitable economic policy to dampen or even balance the unfavorable shift to more low-tech production that was induced by the legal deregulation of temporary agency work.

Proposition 4.8. *Technological progress of regular production decreases overall unemployment. The rate of temporary agency employment, l_T, decreases and the rate of regular employment, l_R, increases.*

$$\frac{du}{dy_R} < 0, \quad \frac{dl_T}{dy_R} < 0, \quad \frac{dl_R}{dy_R} > 0$$

Proof. Appendix 4.A.5 provides the formal proofs. □

The inflow of regular job vacancies increases the number of job matches. The effects of technological progress in regular production favors the labor market tightness and, due to the decrease in the share of temporary job creation, decreases the economy's average job destruction rate, $\varepsilon\delta_T + (1-\varepsilon)\delta_R$. These two effects lead to an overall increase in employment, i.e. a decrease in overall unemployment. Furthermore, the increase in the supply of regular job vacancies increases the share of regular employment on overall employment. Finally, the increase in overall employment and the inflow of jobs in regular production yields the share of temporary employment to decrease.

Proposition 4.9. *Technological progress in regular production leads to an increase in the wage rate of regular workers, w, while the labor income of temporary worker, κw, decreases.*

$$\frac{dw}{dy_R} > 0, \quad \frac{d\kappa w}{dy_R} < 0.$$

Proof. Appendix 4.A.5 provides the formal proofs. □

The productivity increase in regular production increases the worker's scope in the wage negotiations. The effective bargaining power increases, leading to a higher wage rate for regular jobs. Furthermore, as the labor market becomes tighter and the fraction of temporary job vacancies decreases – leading the arrival rate of regular job offers for temporary workers searching on-the-job to increase – it dampens the wage payment that is necessary to maintain the equality of being unemployed and temporarily employed. Thus, κw decreases.

4.5 Summary and Conclusions

This chapter develops a theoretical model to investigate the macroeconomic effects of the legal deregulation of temporary agency employment and of exogenous technological progress in the production. It especially focuses on the question of how the availability of a cheaper, but less advanced, less productive production possibility influences the technology choice of firms. Workers may either be directly hired by a firm (regular employment) or are employed at a temporary work agency and temporarily lend to client firms for production (temporary employment). Firms are ex-ante flexible in the choice of the technology to produce with. Before entering the market, they decide either to post a regular or temporary job vacancy. Regular jobs are more productive than temporary jobs. Furthermore, both types of jobs differ in labor costs and in job destruction. Temporary agency jobs are hit by job destruction more frequently. Unemployed workers accept the first job offer they get, independent of which type it is. Once employed in a temporary work agency, workers proceed searching on-the-job for regular employment. This is reasonable because working in temporary jobs signals their ability and willingness to work to other potential employers and, thus, increases their chance of finding a regular job. Their effective job offer arrival rate of regular jobs is higher compared to that of unemployed workers. Hence, workers use temporary agency jobs as a stepping stone to regular employment. Wages of regularly employed workers are determined by individual bargaining between workers and firms.

The model shows that the legal deregulation of temporary agency employment may increase the overall employment. However, the effect is a priori ambiguous and depends on the relative strengths on overall labor market tightness and average job-destruction in the economy. However, temporary agency employment increases unambiguously and, thus, the technological orientation of the economy changes from the use of more advanced technology to the more intensive use of the less advanced technology. The deregulation of temporary agency employment changes the economy's alignment away from high-tech production and innovations. Furthermore, it is shown that regular workers suffer from declining wages, while the inequality in labor income for temporary and regular workers decreases.

Next to legal deregulation, the model is used to investigate the macroeconomic effects of exogenous technological progress of the different production technologies. It is reasonable to assume that firms especially invest in technologies that they use more favorably and more intensively. Thus, the model shows that technological progress of temporary agency production even strengthens the macroeconomic effects that are induced by the legal deregulation. Temporary agency production will be used even more intensively and the technological orientation further deteriorates to the more intensive use of the less advanced technology.

Observing the consequences of legal deregulation and technological progress of temporary agency employment, the chapter raises the question of suitable economic policy instruments to dampen the depicted effects. It is shown that economic policies that support directed investments in the more advanced technology dampen these effects. Technological progress of the more advanced technology gives firms an incentive to use advanced technologies more intensively. It increases overall employment in the economy and changes its structure to the more regular employment and less temporary agency employment. Furthermore, regular workers also gain in terms of increasing wages.

4.A Appendix

4.A.1 Derivation of the Wage Rate for Regular Workers

Maximization of the Nash product, eq. (4.12), leads to the sharing rule

$$\beta\left[\pi_R^F - \pi_R^V\right] = (1-\beta)\left[V_R^E - V^U\right] \tag{4.23}$$

Using the value functions (4.2) and (4.8), the rent of firms and workers can be substituted by

$$V_R^E - V^U = \frac{w + \delta_R f - rV^U}{r + \delta_R} \quad \text{and} \quad \pi_R^F - \pi_R^V = \frac{y_R - w - \delta_R f}{r + \delta_R}, \tag{4.24}$$

respectively. Rearrangement leads to

$$w = \beta y_R + (1-\beta) r V^U - \delta_R f \tag{4.25}$$

Thus, the wage rate is the weighted sum of the worker's productivity and the reservation wage. Furthermore, the severance payment works like a staggered wage payment in case of job destruction and, thus, has to be subtracted from the wage payment. Knowing that the total surplus is $S = V_R^E - V^U + \pi_R^F - \pi_R^V$, applying the equal value condition, $V_T^E = V^U$, and using eq. (4.24), the expected value of being unemployed, eq. (4.3), can be rewritten to

$$rV^U = \frac{z(r+\delta_R) + \theta m(\theta)(1-\gamma)\beta y_R}{r + \delta_R + \theta m(\theta)(1-\gamma)\beta}. \tag{4.26}$$

Inserting eq. (4.26) into eq. (4.25) leads, after some rearrangement, to the wage rate given in eq. (4.13),

$$w = z - \delta_R f + (y_R - z)\Gamma(\theta,\gamma) \quad \text{with} \quad \Gamma(\theta,\gamma) = \frac{\beta[r + \delta_R + \theta m(\theta)(1-\gamma)]}{r + \delta_R + \beta\theta m(\theta)(1-\gamma)}.$$

4.A.2 Derivation of the Wage Payment for Temporary Workers

Using eqs. (4.3) and (4.4) and applying the equal value condition, $V_T^E = V^U$, the wage payment for temporary agency workers can implicitly be stated as

$$\kappa w = z + \theta m(\theta)(1-\gamma)(1-\lambda)\left[V_R^E - V^U\right] \tag{4.27}$$

From eq. (4.2) it follows that

$$V_R^E - V^U = \frac{w + \delta_R f - rV^U}{r + \delta_R}. \tag{4.28}$$

Furthermore, inserting $w = \beta y_R + (1-\beta)rV^U - \delta_R f$ and replacing rV^U by eq. (4.26), rearrangement leads to eq. (4.14),

$$\kappa w = z + \frac{\theta m(\theta)(1-\gamma)(1-\lambda)\beta(y_R - z)}{r + \delta_R + \theta m(\theta)(1-\gamma)\beta}.$$

4.A.3 Comparative Statics for a Change in c

The Change in the Variables θ, γ, and ε

Total differentiation of the equilibrium labor demand for regular workers, eq. (4.15), gives the change in γ that is induced by a change in c as

$$\frac{d\gamma}{dc} = A_0 \frac{d\theta}{dc} \quad \text{with} \quad A_0 \equiv \frac{h_R(1-\gamma)\beta\frac{\partial\theta m(\theta)}{\partial\theta} - m'(\theta)(y_R - z)(1-\beta)}{h_R\theta m(\theta)\beta}. \tag{4.29}$$

Recalling that $m'(\theta) < 0$ and $\partial\theta m(\theta)/\partial\theta > 0$, it is obvious that $A_0 > 0$. Substituting ϕ, the share of unemployed workers on all job seekers, by eq. (4.22), eq. (4.16) can be rearranged to

$$h_T\big[r + \delta_T + \lambda\theta m(\theta)(1-\gamma)\big]\big[\delta_T + \lambda\theta m(\theta)\big] = m(\theta)\big[\delta_T + \lambda\theta m(\theta)(1-\gamma)\big]B_0 \tag{4.30}$$

with

$$B_0 \equiv (y_T - c - z) - \frac{\theta m(\theta)(1-\gamma)(1-\lambda)\beta(y_R - z)}{r + \delta_R + \theta m(\theta)(1-\gamma)\beta}. \tag{4.31}$$

Total differentiation of eq. (4.30) and rearrangement leads to

$$\begin{aligned}
&h_T\lambda\Big[(1-\gamma)[\delta_T + \theta m(\theta)] + [r + \delta_T + \lambda\theta m(\theta)(1-\gamma)]\Big]\frac{\partial\theta m(\theta)}{\partial\theta}\frac{d\theta}{dc} \\
&- m'(\theta)[\delta_T + \lambda\theta m(\theta)(1-\gamma)]B_0\frac{d\theta}{dc} - m(\theta)\lambda(1-\gamma)B_0\frac{\partial\theta m(\theta)}{\partial\theta}\frac{d\theta}{dc} \\
&+ m(\theta)[\delta_T + \lambda\theta m(\theta)(1-\gamma)]\left[\frac{(1-\gamma)(1-\lambda)\beta(y_R - z)(r+\delta_R)}{[r + \delta_R + \theta m(\theta)(1-\gamma)\beta]^2}\right]\frac{\partial\theta m(\theta)}{\partial\theta}\frac{d\theta}{dc} \\
&= h_T\lambda\theta m(\theta)[\delta_T + \lambda\theta m(\theta)]\frac{d\gamma}{dc} - m(\theta)\lambda\theta m(\theta)B_0\frac{d\gamma}{dc} - m(\theta)[\delta_T + \lambda\theta m(\theta)(1-\gamma)] \\
&+ m(\theta)[\delta_T + \lambda\theta m(\theta)(1-\gamma)]\frac{\theta m(\theta)(1-\lambda)\beta(y_R - z)(r+\delta_R)}{[r + \delta_R + \theta m(\theta)(1-\gamma)\beta]^2}\frac{d\gamma}{dc}.
\end{aligned} \tag{4.32}$$

Using eq. (4.16), the term B_0 in the second line of eq. (4.32) can be substituted by

$$B_0 = \frac{h_T}{\phi m(\theta)}[r + \delta_T + \lambda\theta m(\theta)(1-\gamma)]. \tag{4.33}$$

By rearranging eq. (4.16), the term in corner brackets in the third line of eq. (4.32) can be substituted by

$$\begin{aligned}&\frac{(1-\gamma)(1-\lambda)\beta(y_R - z)(r+\delta_R)}{[r+\delta_R+\theta m(\theta)(1-\gamma)\beta]^2}\\ &= \frac{(r+\delta_R)}{\theta m(\theta)[r+\delta_R+(1-\gamma)\theta m(\theta)\beta]}\cdot\Big((y_T - z - c) - \frac{h_T}{m(\theta)\phi}\big(r+\delta_T+\lambda\theta m(\theta)(1-\gamma)\big)\Big).\end{aligned} \tag{4.34}$$

After using eqs. (4.33) and (4.34) and further rearrangement, eq. (4.32) can be stated as

$$B_1\frac{d\theta}{dc} = B_2\frac{d\gamma}{dc} - m(\theta)[\delta_T + \lambda\theta m(\theta)(1-\gamma)] \tag{4.35}$$

with

$$\begin{aligned}B_1 \equiv\ & h_T[\delta_T+\lambda\theta m(\theta)]\left[\frac{\lambda\theta^2 m(\theta)^2(1-\gamma)^2\beta - (r+\delta_R)(r+\delta_T)}{\theta m(\theta)[r+\delta_R+(1-\gamma)\beta\theta m(\theta)]}\right]\frac{\partial\theta m(\theta)}{\partial\theta}\\ &+ h_T\lambda\frac{[r+\delta_T+\lambda\theta m(\theta)(1-\gamma)]\delta_T\gamma}{\delta_T+(1-\gamma)\lambda\theta m(\theta)}\frac{\partial\theta m(\theta)}{\partial\theta} - m'(\theta)[\delta_T+\lambda\theta m(\theta)(1-\gamma)]B_0\\ &+ m(\theta)\frac{[\delta_T+\lambda\theta m(\theta)(1-\gamma)](y_T-z-c)(r+\delta_R)}{\theta m(\theta)[r+\delta_R+(1-\gamma)\theta m(\theta)\beta]}\frac{\partial\theta m(\theta)}{\partial\theta} > 0\end{aligned} \tag{4.36}$$

and

$$\begin{aligned}B_2 \equiv\ & -h_T\lambda\theta m(\theta)\frac{\delta_T+\lambda\theta m(\theta)}{\delta_T+(1-\gamma)\lambda\theta m(\theta)}r\\ &+ m(\theta)[\delta_T+\lambda\theta m(\theta)(1-\gamma)]\frac{\theta m(\theta)(1-\lambda)\beta(y_R-z)(r+\delta_R)}{[r+\delta_R+\theta m(\theta)(1-\gamma)\beta]^2},\end{aligned} \tag{4.37}$$

which is negative for $\lambda \geq 1$. Finally, substituting $d\gamma/dc$ by eq. (4.29), it can be shown that

$$\frac{d\theta}{dc} = -\frac{m(\theta)[\delta_T+\lambda\theta m(\theta)(1-\gamma)]}{B_1 - B_2 A_0} < 0. \tag{4.38}$$

Re-insertion of eq. (4.38) into eq. (4.29) shows that the change in γ that is induced by a change in c can formally be stated as

$$\frac{d\gamma}{dc} = -A_0\frac{m(\theta)[\delta_T+\lambda\theta m(\theta)(1-\gamma)]}{B_1 - B_2 A_0} < 0. \tag{4.39}$$

Total differentiation of the equilibrium share of temporary agency employment on overall employment, eq. (4.21), gives

$$\begin{aligned}\Big[(1-\gamma)[\delta_T+\lambda\theta m(\theta)]+\delta_R\gamma\Big]\frac{d\varepsilon}{dc}\\ =\Big[\varepsilon[\delta_T+\lambda\theta m(\theta)]+(1-\varepsilon)\delta_R\Big]\frac{d\gamma}{dc}-(1-\gamma)\lambda\varepsilon\frac{\partial\theta m(\theta)}{\partial\theta}\frac{d\theta}{dc}.\end{aligned} \tag{4.40}$$

After substituting $d\gamma/dc$ in eq. (4.40) by eq. (4.29), the change in ε that is induced by a change in c can be stated as

$$\frac{d\varepsilon}{dc}=\frac{B_3}{h_R\beta\theta m(\theta)\big[(1-\gamma)[\delta_T+\lambda\theta m(\theta)]+\delta_R\gamma\big]}\frac{d\theta}{dc}<0. \tag{4.41}$$

with

$$\begin{aligned}B_3\equiv\, & h_R\beta(1-\gamma)[\varepsilon\delta_T+(1-\varepsilon)\delta_R]\frac{\partial\theta m(\theta)}{\partial\theta}\\ & -m'(\theta)(y_R-z)(1-\beta)\Big[\varepsilon[\delta_T+\lambda\theta m(\theta)]+(1-\varepsilon)\delta_R\Big]>0.\end{aligned} \tag{4.42}$$

Eq. (4.41) can easily be verified to be negative as both, the numerator and the denominator, are both positive and $d\theta/dc<0$.

Unemployment

From eq. (4.20) it can be seen that the change in the equilibrium unemployment rate u depends on the changes in θ and ε. As $d\varepsilon/dc<0$, $d\theta/dc<0$, and $\partial\theta m(\theta)/\partial\theta>0$, it is obvious that a change in c changes the numerator and denominator in the same direction (for $\delta_T>\delta_R$). The overall change in u therefore depends on the relative strength of the changes in θ and ε. Using eqs. (4.20) and (4.21), the unemployment rate can be expressed as

$$u=\frac{\delta_R\delta_T+\delta_R(1-\gamma)\lambda\theta m(\theta)}{\delta_R\delta_T+(1-\gamma)\theta m(\theta)[\delta_R\lambda+\delta_T+\lambda\theta m(\theta)]+\theta m(\theta)\delta_R\gamma}. \tag{4.43}$$

Differentiation of eq. (4.43) gives

$$\begin{aligned}\frac{du}{dc}=\frac{1}{(B_4)^2}\Bigg(&\delta_R\theta m(\theta)(\delta_T-\delta_R)[\delta_T+\lambda\theta m(\theta)]\frac{d\gamma}{dc}\\ &-\delta_R\Big[\lambda^2\theta^2m(\theta)^2(1-\gamma)^2+2\delta_T\lambda(1-\gamma)\theta m(\theta)+\delta_T\big(\delta_R+\delta_T(1-\gamma)\big)\Big]\frac{\partial\theta m(\theta)}{\partial\theta}\frac{d\theta}{dc}\Bigg)\end{aligned} \tag{4.44}$$

with B_4 being the denominator of eq. (4.43), i.e. $B_4 \equiv \delta_R\delta_T + (1-\gamma)\theta m(\theta)[\delta_R\lambda + \delta_T + \lambda\theta m(\theta)] + \theta m(\theta)\delta_R\gamma$. Substitution of $d\gamma/dc$ by eq. (4.29) leads to

$$\frac{du}{dc} = \frac{1}{(B_4)^2}\frac{\theta h_R\delta_R}{h_R\beta\theta m(\theta)}\Big(\underbrace{-m'(\theta)B_5 - B_6\big[m(\theta)^2 + m'(\theta)\big]}_{B_7}\Big)\frac{d\theta}{dc} \tag{4.45}$$

with $B_5 \equiv \lambda^2(1-\gamma)^2\theta^2 m(\theta)^2 + \lambda(\delta_R+\delta_T)(1-\gamma)\theta m(\theta) + \delta_R\delta_T(2-\gamma)$ and $B_6 \equiv \big[r + \delta_R + \beta\theta m(\theta)(1-\gamma)(\delta_T-\delta_R)(\delta_T+\lambda\theta m(\theta))\big]$. It is obvious that the sign of term B_7 depends on the parametrization of the model and the matching function. Intuition suggests the sign of eq. (4.45) to be $du/dc > 0$. It is easy to show that $B_5 > B_6$. Thus, for eq. (4.45) indeed to be positive, it is sufficient to show that for $B_5 = B_6$ the expression $[-m'(\theta) - m(\theta) - m'(\theta)] < 0$. Following Petrongolo & Pissarides (2001), assuming a Cobb-Douglas matching function $M = a\cdot v^{1-\alpha}\cdot s^{\alpha}$ with a denoting the efficiency of the matching process and setting the matching elasticity $\alpha = 0.5$, it turns out that with $m(\theta) = a\theta^{-0.5}$ and $m'(\theta) = -0.5a\theta^{-1.5}$, the above inequality is fulfilled for $1/a^2 < \theta$, which is the more likely the higher the efficiency of the matching process is. Using a parametrization and Cobb-Douglas matching function similar to Albrecht & Vroman (2002), it turns out that the sign of eq. (4.45) is indeed $du/dc > 0$.

Regular Employment

Using eqs. (4.20) and (4.21), the rate of regular employment can be expressed as

$$l_R = \frac{(1-\gamma)\theta m(\theta)\big[\delta_T + \lambda\theta m(\theta)\big]}{\delta_R\delta_T + \theta^2 m(\theta)^2\lambda(1-\gamma)\theta m(\theta)\big[\delta_T(1-\gamma) + \lambda\delta_R(1-\gamma) + \delta_R\gamma\big]} \tag{4.46}$$

Differentiation of eq. (4.46) gives

$$\begin{aligned}\frac{dl_R}{dc} = -\frac{\delta_R}{(B_8)^2}\Bigg(&\theta m(\theta)[\delta_T + \theta m(\theta)][\delta_T + \lambda\theta m(\theta)]\frac{d\gamma}{dc}\\ &+ (1-\gamma)\Big[\lambda\theta^2 m(\theta)^2[\gamma(\lambda-1)-\lambda] - 2\delta_T\lambda\theta m(\theta) - \delta_T^2\Big]\frac{\partial\theta m(\theta)}{\partial\theta}\frac{d\theta}{dc}\Bigg),\end{aligned} \tag{4.47}$$

with B_8 denoting the denominator of eq. (4.46), i.e. $B_8 \equiv \delta_R\delta_T + \theta^2 m(\theta)^2\lambda(1-\gamma)\theta m(\theta)\big[\delta_T(1-\gamma) + \lambda\delta_R(1-\gamma) + \delta_R\gamma\big]$. While the term that is multiplied with $d\theta/dc$ is positive, the term that is multiplied with $d\gamma/dc$ is negative for $\gamma\lambda < \gamma + \lambda$, which is fulfilled.

Thus, without further assumptions about the matching function, the effect of a change in costs c on regular employment is ambiguous. Using a parametrization and Cobb-Douglas matching function similar to Albrecht & Vroman (2002), it turns out that the sign of eq. (4.47) is $dl_R/dc > 0$.

Temporary Agency Employment

Employment in temporary agency jobs is $l_T = (1-u)\varepsilon$. Using eq. (4.20), the rate of temporary agency employment can be stated as

$$l_T = \frac{\theta m(\theta)\varepsilon}{\varepsilon\delta_T + (1-\varepsilon)\delta_R + \theta m(\theta)}. \tag{4.48}$$

Total differentiation of eq. (4.48) gives

$$\frac{dl_T}{dc} = \frac{\varepsilon[\varepsilon\delta_T + (1-\varepsilon)\delta_R]\frac{\partial\theta m(\theta)}{\partial\theta}}{\left[\varepsilon\delta_T + (1-\varepsilon)\delta_R + \theta m(\theta)\right]^2}\frac{d\theta}{dc} + \frac{[\delta_R + \theta m(\theta)]\theta m(\theta)}{\left[\varepsilon\delta_T + (1-\varepsilon)\delta_R + \theta m(\theta)\right]^2}\frac{d\varepsilon}{dc} < 0. \tag{4.49}$$

It is easy to verify that eq. (4.49) is negative since $d\theta/dc < 0$ and $d\varepsilon/dc < 0$.

Labor Income

The change in the wage rate, eq. (4.13), that is induced by a change in c is given by

$$\frac{dw}{dc} = (y_R - z)\frac{d\,\Gamma(\theta,\gamma)}{dc}. \tag{4.50}$$

Total differentiation of the effective bargaining power $\Gamma(\theta,\gamma)$ leads to

$$\frac{d\,\Gamma(\theta,\gamma)}{dc} = \frac{\beta(r+\delta_R)(1-\beta)}{[r+\delta_R+\theta m(\theta)(1-\gamma)\beta]^2}\left[\frac{\partial\theta m(\theta)}{\partial\theta}(1-\gamma)\frac{d\theta}{dc} - \theta m(\theta)\frac{d\gamma}{dc}\right]. \tag{4.51}$$

Substituting of $d\gamma/dc$ by eq. (4.29) and some rearrangement yields

$$\frac{d\,\Gamma(\theta,\gamma)}{dc} = \frac{\beta(r+\delta_R)(1-\beta)}{[r+\delta_R+\theta m(\theta)(1-\gamma)\beta]^2}\,\frac{m'(\theta)(y_R-z)(1-\beta)\theta m(\theta)}{h_R\theta m(\theta)\beta}\,\frac{d\theta}{dc} > 0. \tag{4.52}$$

Eq. (4.52) is obviously positive as $m'(\theta) < 0$ and $d\theta/dc < 0$. Thus, according to eq. (4.50), the change in the wage rate in a change in costs c is positive,

$$\frac{dw}{dc} > 0. \tag{4.53}$$

Using eq. (4.14), labor income of temporary agency workers can be rewritten to

$$\kappa w = \frac{z(r+\delta_R) + \theta m(\theta)(1-\gamma)\beta\big[\lambda z + (1-\lambda)y_R\big]}{r+\delta_R+\theta m(\theta)(1-\gamma)\beta}. \tag{4.54}$$

Total differentiation of eq. (4.54) yields

$$\frac{d\kappa w}{dc} = \frac{\beta(r+\delta_R)(1-\lambda)(y_R - z)}{\big[r+\delta_R+\theta m(\theta)(1-\gamma)\beta\big]^2}\Big((1-\gamma)\frac{\partial\theta m(\theta)}{\partial\theta}\frac{d\theta}{dc} - \theta m(\theta)\frac{d\gamma}{dc}\Big). \tag{4.55}$$

Substituting $d\gamma/dc$ in eq. (4.54) by eq. (4.29), the change in labor income or temporary agency workers that is induced by a change in costs c is

$$\frac{d\kappa w}{dc} = \frac{(r+\delta_R)(1-\lambda)(y_R - z)^2(1-\beta)m'(\theta)}{h_R\big[r+\delta_R+\theta m(\theta)(1-\gamma)\beta\big]^2}\frac{d\theta}{dc}, \tag{4.56}$$

which is negative as $\lambda > 0$, $m'(\theta) < 0$, and $d\theta/dc < 0$. Thus,

$$\frac{d\kappa w}{dc} < 0.$$

From eqs. (4.53) and (4.56), it can be seen that the inequality in labor income of regular and temporary agency workers increases in the costs c.

4.A.4 Comparative Statics for a Change in y_T

The Change in the Variables θ, γ, and ε

Total differentiation of the equilibrium labor demand for regular workers, eq. (4.15), gives the change in γ by a change in y_T as

$$\frac{d\gamma}{dy_T} = A_0\,\frac{d\theta}{dy_T}. \tag{4.57}$$

The term $A_0 > 0$ is known from eq. (4.29). Substituting ϕ by eq. (4.22), differentiation of the equilibrium labor demand for temporary workers, eq. (4.16), and some rearrangement leads to

$$B_1\frac{d\theta}{dy_T} = B_2\frac{d\gamma}{dy_T} + m(\theta)\Big[\delta_T + (1-\gamma)\lambda\theta m(\theta)\Big]. \tag{4.58}$$

The terms B_1 and B_2 are given in eqs. (4.36) and (4.37), respectively. After replacing $d\gamma/dy_T$ by eq. (4.57), further rearrangement yields

$$\frac{d\theta}{dy_T} = \frac{m(\theta)\big[\delta_T + \lambda\theta m(\theta)(1-\gamma)\big]}{B_1 - B_2 A_0} > 0. \tag{4.59}$$

The sign of eq. (4.59) can easily be verified since term $A_0 > 0$, $B_1 > 0$ and $B_2 < 0$. Re-insertion of eq. (4.59) into eq. (4.57) leads to

$$\frac{d\gamma}{dy_T} = A_0 \, \frac{m(\theta)\big[\delta_T + \lambda\theta m(\theta)(1-\gamma)\big]}{B_1 - B_2 A_0} > 0. \tag{4.60}$$

Total differentiation of the equilibrium share of temporary agency employment on overall employment, eq. (4.21), rearrangement, and substitution of $d\gamma/dy_T$ by eq. (4.57), the change in ε by a change in y_T is

$$\frac{d\varepsilon}{dy_T} = \frac{B_3}{h_R\beta\theta m(\theta)\big[(1-\gamma)[\delta_T + \lambda\theta m(\theta)] + \delta_R\gamma\big]} \, \frac{d\theta}{dy_T} > 0. \tag{4.61}$$

Eq. (4.61) is positive as $B_3 > 0$, given in eq. (4.42), and $d\theta/dy_T > 0$.

Unemployment

Differentiation of eq. (4.43) gives

$$\begin{aligned}\frac{du}{dc} = \frac{1}{(B_4)^2}\Bigg(&\delta_R\theta m(\theta)(\delta_T - \delta_R)[\delta_T + \lambda\theta m(\theta)]\frac{d\gamma}{dy_T} \\ &- \delta_R\Big[\lambda^2\theta^2 m(\theta)^2(1-\gamma)^2 + 2\delta_T\lambda(1-\gamma)\theta m(\theta) + \delta_T\big(\delta_R + \delta_T(1-\gamma)\big)\Big]\frac{\partial\theta m(\theta)}{\partial\theta}\frac{d\theta}{dy_T}\Bigg)\end{aligned} \tag{4.62}$$

where B_4 denotes the denominator of eq. (4.43). Similar to the change in regulatory costs c, it turns out that the change in the unemployment rate that is induced by a increase in y_T is ambiguous without further assumptions about the matching function. However, the smaller the difference in the job destruction rates for temporary and regular jobs, the more likely the change to be positive.

Regular Employment

Differentiation of eq. (4.46) gives

$$\begin{aligned}\frac{dl_R}{dy_T} = -\frac{\delta_R}{(B_8)^2}\Bigg(&\theta m(\theta)[\delta_T + \theta m(\theta)][\delta_T + \lambda\theta m(\theta)]\frac{d\gamma}{dy_T} \\ &+ (1-\gamma)\Big[\lambda\theta^2 m(\theta)^2[\gamma(\lambda-1) - \lambda] - 2\delta_T\lambda\theta m(\theta) - \delta_T^2\Big]\frac{\partial\theta m(\theta)}{\partial\theta}\frac{d\theta}{dy_T}\Bigg),\end{aligned} \tag{4.63}$$

with B_8 denoting the denominator of eq. (4.46). As for changing regulatory costs c, the effect of technological progress in temporary agency production on regular employment is ambiguous.

Temporary Agency Employment

Differentiation of eq. (4.48) yields

$$\frac{dl_T}{dy_T} = \frac{\varepsilon[\varepsilon\delta_T + (1-\varepsilon)\delta_R]\frac{\partial\theta m(\theta)}{\partial\theta}}{\left[\varepsilon\delta_T + (1-\varepsilon)\delta_R + \theta m(\theta)\right]^2}\frac{d\theta}{dy_T} + \frac{[\delta_R + \theta m(\theta)]\theta m(\theta)}{\left[\varepsilon\delta_T + (1-\varepsilon)\delta_R + \theta m(\theta)\right]^2}\frac{d\varepsilon}{dy_T} > 0. \quad (4.64)$$

Wage Rate w

The change in the wage rate, eq. (4.13), that is induced by a change in y_T is given by

$$\frac{dw}{dy_T} = (y_R - z)\frac{d\,\Gamma(\theta,\gamma)}{dy_T}. \quad (4.65)$$

Total differentiation of the effective bargaining power $\Gamma(\theta,\gamma)$ and substitution of $d\gamma/dy_T$ by eq. (4.57) leads to

$$\frac{d\,\Gamma(\theta,\gamma)}{dy_T} = \frac{\beta(r+\delta_R)(1-\beta)}{[r+\delta_R+\theta m(\theta)(1-\gamma)\beta]^2}\,\frac{m'(\theta)(y_R-z)(1-\beta)\theta m(\theta)}{h_R\theta m(\theta)\beta}\,\frac{d\theta}{dy_T} < 0. \quad (4.66)$$

Thus, according to eq. (4.65), the change in the wage rate in a change in costs y_T is negative,

$$\frac{dw}{dy_T} < 0.$$

4.A.5 Comparative Statics for a Change in y_R

The Change in the Variables θ, γ, and ε

Total differentiation of the equilibrium labor demand for regular workers, eq. (4.15), and some rearrangement leads to

$$C_0\frac{d\theta}{dy_R} - \frac{(1-\beta)m(\theta)}{h_R\beta\theta m(\theta)} = \frac{d\gamma}{dy_R} \quad (4.67)$$

with

$$C_0 \equiv \frac{1}{h_R\beta\theta m(\theta)}\Big[\frac{\partial\theta m(\theta)}{\partial\theta}(1-\gamma)\beta y_R - m'(\theta)(y_R-z)(1-\beta)\Big] > 0. \quad (4.68)$$

Total differentiation of the equilibrium labor demand for temporary agency workers, eq. (4.16), yields, after some arrangement,

$$\begin{aligned} & h_T\lambda(1-\gamma)\frac{\partial\theta m(\theta)}{\partial\theta}\frac{d\theta}{dy_R} - m'(\theta)\phi B_0\frac{d\theta}{dy_R} - m(\theta)B_0\frac{\partial\phi}{\partial\theta}\frac{d\theta}{dy_R} \\ & + m(\theta)\phi\frac{(r+\delta_R)(1-\gamma)(1-\lambda)\beta(y_R-z)}{\left[r+\delta_R+(1-\gamma)\beta\theta m(\theta)\right]^2}\frac{\partial\theta m(\theta)}{\partial\theta}\frac{d\theta}{dy_R} = h_T\lambda\theta m(\theta)\frac{d\gamma}{dy_R} \\ & + m(\theta)B_0\frac{\partial\phi}{\partial\gamma}\frac{d\gamma}{dy_R} + m(\theta)\phi\frac{\partial B_0}{\partial\gamma}\frac{d\gamma}{dy_R} - m(\theta)\phi\frac{\theta m(\theta)(1-\gamma)(1-\lambda)\beta}{r+\delta_R+\theta m(\theta)(1-\gamma)\beta} \end{aligned} \tag{4.69}$$

with

$$\frac{\partial\phi}{\partial\theta} = -\frac{\frac{\partial\theta m(\theta)}{\partial\theta}\lambda\gamma\delta_T}{[\delta_T+\theta m(\theta)\lambda]^2}, \qquad \frac{\partial\phi}{\partial\gamma} = -\frac{\lambda\theta m(\theta)}{[\delta_T+\lambda\theta m(\theta)]}, \tag{4.70}$$

$$\frac{\partial B_0}{\partial\theta} = -\frac{\beta(1-\gamma)(1-\lambda)(y_R-z)(r+\delta_R)}{\left[r+\delta_R+(1-\gamma)\theta m(\theta)\beta\right]^2}\frac{\partial\theta m(\theta)}{\partial\theta}, \tag{4.71}$$

and

$$\frac{\partial B_0}{\partial\gamma} = \frac{\beta(1-\lambda)(y_R-z)(r+\delta_R)\theta m(\theta)}{\left[r+\delta_R+(1-\gamma)\theta m(\theta)\beta\right]^2}. \tag{4.72}$$

Substitution of B_0 by eq. (4.31) and further rearrangement leads to

$$C_1\frac{d\theta}{dy_R} = C_2\frac{d\gamma}{dy_R} - m(\theta)\phi\frac{\theta m(\theta)(1-\gamma)(1-\lambda)\beta}{r+\delta_R+\theta m(\theta)(1-\gamma)\beta} \tag{4.73}$$

with

$$\begin{aligned} C_1 \equiv & - m'(\theta)\phi B_0 - m(\theta)B_0\frac{\partial\phi}{\partial\theta} + m(\theta)\phi\frac{(r+\delta_R)(y_T-c-z)}{\left[r+\delta_R+\theta m(\theta)(1-\gamma)\beta\right]\theta m(\theta)}\frac{\partial\theta m(\theta)}{\partial\theta} \\ & + h_T\frac{\lambda\theta^2 m(\theta)^2(1-\gamma)^2\beta-(r+\delta_R)(r+\delta_T)}{\left[r+\delta_R+\theta m(\theta)(1-\gamma)\beta\right]\theta m(\theta)}\frac{\partial\theta m(\theta)}{\partial\theta} > 0 \end{aligned} \tag{4.74}$$

and

$$C_2 \equiv m(\theta)\phi\frac{\partial B_0}{\partial\gamma} - \frac{h_T\lambda\theta m(\theta)r}{\delta_T+(1-\gamma)\lambda\theta m(\theta)} < 0. \tag{4.75}$$

Finally, using eq. (4.67), it turns out that

$$\frac{d\theta}{dy_R} = -\frac{1}{C_1-C_2C_0}\left[C_2\frac{m(\theta)(1-\beta)}{\beta h_R\theta m(\theta)} + m(\theta)\phi\frac{\theta m(\theta)(1-\gamma)(1-\lambda)\beta}{r+\delta_R+(1-\gamma)\beta\theta m(\theta)}\right] > 0. \tag{4.76}$$

It is easy to verify that eq. (4.76) is positive as $C_0 > 0$, $C_1 > 0$, $C_2 < 0$ and $\lambda \geq 1$.

Re-substitution of eq. (4.76) into eq. (4.67) gives

$$\frac{d\gamma}{dy_R} = \frac{C_3}{C_1-C_2C_0} \tag{4.77}$$

with

$$C_3 \equiv -C_0 \frac{m(\theta)\phi\theta m(\theta)(1-\gamma)(1-\lambda)\beta}{r+\delta_R+(1-\gamma)\beta\theta m(\theta)} - C_1 \frac{m(\theta)(1-\beta)}{h_R\beta\theta m(\theta)}. \tag{4.78}$$

Inserting C_0 and C_1 into eq. (4.78), it can be written as

$$\begin{aligned} \frac{1}{h_R\beta\theta m(\theta)} \Bigg(& - \frac{\partial \theta m(\theta)}{\partial \theta} \frac{m(\theta)\phi(1-\gamma)(1-\lambda)\beta}{r+\delta_R+\beta\theta m(\theta)(1-\gamma)} \Bigg[h_R\beta(1-\gamma)\theta m(\theta) \\ & + m(\theta)(r+\delta_R) \underbrace{\frac{(1-\beta)(y_R-z)}{r+\delta_R+\beta(1-\gamma)\theta m(\theta)}}_{=h_R/m(\theta)} \Bigg] \\ & + m'(\theta)(y_R-z)(1-\beta) \frac{m(\theta)\phi\theta m(\theta)(1-\gamma)(1-\lambda)\beta}{r+\delta_R+\beta(1-\gamma)\theta m(\theta)} \\ & - m(\theta)(1-\beta)\left[-m'(\theta)\phi B_0 - m(\theta)\frac{\partial \phi}{\partial \theta} B_0 + \lambda h_T(1-\gamma)\frac{\partial \theta m(\theta)}{\partial \theta} \right] \Bigg). \end{aligned} \tag{4.79}$$

Further simplification and rearrangement finally yields

$$\begin{aligned} C_3 = \frac{1}{h_R\beta\theta m(\theta)} \Bigg(& - \frac{\partial \theta m(\theta)}{\partial \theta} m(\theta)(1-\gamma)\big[h_R\phi(1-\lambda)\beta + h_T\lambda(1-\beta)\big] \\ & + m(\theta)^2(1-\beta)\frac{\partial \phi}{\partial \theta} B_0 + m'(\theta)(1-\beta)m(\theta)\phi(y_T-c-z) \Bigg), \end{aligned} \tag{4.80}$$

which is negative as $\partial\phi/\partial\theta < 0$ and $m'(\theta) < 0$. Thus, it turns out that eq. (4.77) is negative and hence

$$\frac{d\gamma}{dy_R} < 0.$$

Total differentiation of the equilibrium share of temporary employment on overall employment, eq. (4.21), and some rearrangement gives

$$\begin{aligned} \frac{d\varepsilon}{dy_R} = & - \varepsilon \frac{(1-\gamma)\lambda}{\big[(1-\gamma)[\delta_T+\lambda\theta m(\theta)] + \delta_R\gamma\big]} \frac{\partial \theta m(\theta)}{\partial \theta} \frac{d\theta}{dy_R} \\ & + \frac{\delta_R[\delta_T+\lambda\theta m(\theta)]}{\big[(1-\gamma)[\delta_T+\lambda\theta m(\theta)]+\delta_R\gamma\big]^2} \frac{d\gamma}{dy_R}, \end{aligned} \tag{4.81}$$

which can easily be verified to be negative as $d\theta/dy_R > 0$ and $d\gamma/dy_R < 0$.

Unemployment

Total differentiation of the equilibrium unemployment rate, eq. (4.20), yields

$$\begin{aligned}\frac{du}{dy_R} = &- \frac{u}{\theta m(\theta) + \varepsilon\delta_T + (1-\varepsilon)\delta_R} \frac{\partial\theta m(\theta)}{\partial\theta} \frac{d\theta}{dy_R} \\ &+ \frac{(\delta_T - \delta_R)\theta m(\theta)}{\big[\theta m(\theta) + \varepsilon\delta_T + (1-\varepsilon)\delta_R\big]^2} \frac{d\varepsilon}{dy_R} < 0,\end{aligned} \tag{4.82}$$

which can easily be verified to be negative as $d\theta/dy_R > 0$ and $d\varepsilon/dy_R < 0$.

Regular Employment

Total differentiation of $l_R = (1-\varepsilon)(1-u)$ yields

$$\frac{dl_R}{dy_R} = -(1-u)\frac{d\varepsilon}{dy_R} - (1-\varepsilon)\frac{du}{dy_R} > 0. \tag{4.83}$$

Temporary Agency Employment

Using eqs. (4.20) and (4.21), employment in agency job, $l_T = (1-u)\varepsilon$, can be expressed as

$$l_T = \frac{\theta m(\theta)\varepsilon}{\theta m(\theta) + \varepsilon\delta_T + (1-\varepsilon)\delta_R}. \tag{4.84}$$

Total differentiation of eq. (4.84) leads to

$$\frac{dl_T}{dy_R} = \frac{\varepsilon\big[\varepsilon\delta_T + (1-\varepsilon)\delta_R\big]}{\big[\theta m(\theta) + \varepsilon\delta_T + (1-\varepsilon)\delta_R\big]^2} \frac{\partial\theta m(\theta)}{\partial\theta} \frac{d\theta}{dy_R} + \frac{\theta m(\theta)\big[\theta m(\theta + \delta_R)\big]}{\big[\theta m(\theta) + \varepsilon\delta_T + (1-\varepsilon)\delta_R\big]^2} \frac{d\varepsilon}{dy_R}. \tag{4.85}$$

After substitution of $d\varepsilon/dy_R$ by eq. (4.81), further rearrangement finally leads to

$$\begin{aligned}\frac{dl_T}{dy_R} = &\frac{1}{\big[\theta m(\theta) + \varepsilon\delta_T + (1-\varepsilon)\delta_R\big]^2} \Bigg[\left(\frac{\delta_T - \lambda\theta^2 m(\theta)^2(1-\gamma)}{(1-\gamma)[\delta_T + \lambda\theta m(\theta)] + \delta_R\gamma}\right)\frac{d\theta}{dy_R} \\ &+\delta_R[\delta_T + \theta m(\theta)]\frac{d\gamma}{dy_R}\Bigg] < 0.\end{aligned} \tag{4.86}$$

Wage Rate w

The change in the wage rate, eq. (4.13), that is induced by a change in y_R is given by

$$\frac{dw}{dy_R} = \Gamma(\theta,\gamma) + (y_R - z)\frac{d\,\Gamma(\theta,\gamma)}{dy_R}. \tag{4.87}$$

Total differentiation of the effective bargaining power $\Gamma(\theta, \gamma)$ leads to

$$\frac{d\Gamma(\theta,\gamma)}{dy_R} = \frac{\beta(r+\delta_R)(1-\beta)}{[r+\delta_R+\theta m(\theta)(1-\gamma)\beta]^2}\left[\frac{\partial\theta m(\theta}{\partial\theta}(1-\gamma)\frac{d\theta}{dy_R} - \theta m(\theta)\frac{d\gamma}{dy_R}\right] > 0, \quad (4.88)$$

and therefore

$$\frac{dw}{dy_R} > 0.$$

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Chapter 5

Conclusions

Temporary agency employment has gained much attention in public discussion and is still one of the most controversial discussed labor market instruments that politicians may use to make labor markets more flexible. Even if the rate of temporary agency employment is just about 2% of total employment in most industrialized countries, it is more intensively used in some sectors, especially in manufacturing, and therefore an issue politicians and the market participants have to cope with. This thesis contributes to the discussion about temporary agency employment and develops three theoretical models to examine the effects on selected economic determinants. It analyzes the optimal economic behavior of labor unions when firms threaten to use temporary agency work in the wage bargaining process to dampen the wage claims of the labor unions. Furthermore, it investigates the effect of the ongoing deregulation of temporary agency work on macroeconomic determinants like employment and the employment structure, and finally discusses how the technological alignment and orientation of the economy changes due to less expensive and more attractive temporary agency employment.

Chapter 2 aims at providing a better theoretical understanding of the effects of temporary agency work on the wage-setting process, labor unions' rents, firms' profits, and employment. Using a monopoly union model, a special variant of the right-to-manage model in which labor unions have the full wage-setting power, it is shown that labor unions may find it optimal to accept lower wages to prevent firms from using temporary agency workers. It is analyzed under which conditions and to which extent unions should adjust their wage claims downward and it is formally examined how the different options that labor unions and firms have in the bargaining process affect their utility and profit, respectively. It is shown it is optimal for firms to threaten the labor unions with the use of temporary agency employment as this leads to the highest profit possible. At the same time, labor unions inevitably suffer from the threat or actual use of temporary agency work and may, in order to minimize the loss in their utility, adjust their wage claims. Next to the formal analysis of the optimal behavior of firms and unions, the model provides an important contribution to the discussion of the effect of temporary agency work in the wage-setting process that should be considered in empirical research. As it is not observable in retrospect whether firms threatened the labor unions with substitution of parts of the workforce by temporary agency employment in the bargaining process, the firms' option to use agency workers may affect wage setting also in those firms that observably only employ regular workers. Furthermore, the model shows that if firms decide to employ temporary agency workers, the labor union's wage claims will increase for the remaining regular workers – and even exceed the level that labor unions claim without being threatened with temporary agency employment. An intensive use of temporary agency workers in high-wage firms may therefore be the cause and not the consequence of the high wage level in those firms. Finally, even though the model assumes monopoly unions that ascribe the highest possible wage-setting power to the unions, the model shows that the economic rents of labor unions decline because of the firms' option to use temporary agency work, whereas firms' profits may increase.

Chapter 3 seizes on the continuous deregulation efforts concerning temporary agency employment in almost all European countries that took part in recent decades. It comes off from the focus on the individual optimal behavior of the market participants and provides a general equilibrium matching model to investigate the effects of this labor market policy on wage setting and the employment structure in a unionized economy. Building up a matching model with multiple-worker firms that produce differentiated goods using regular employment and – optionally – temporary agency workers, firm-level labor unions, and temporary workers that search on-the-job for regular employment, it is shown that the institutional and legal deregulation increases overall employment. Due to the impact of cheaper temporary agency employment it deteriorates labor union's bargaining position and leads to lower wages and higher regular, union covered, employment. Furthermore, and more surprisingly, the model identifies a hump-shaped relationship between the degree of legal deregulation of temporary agency employment and the rate of temporary employment used in the production process. This relationship is based on voluntary, non-institutional agreements between firms and employee representations to limit the use of temporary agency employment at the firm-level. Such agreements become more important, the less expensive and therefore the more attractive temporary agency work is for firms. However, as such non-institutional agreements play an important role in the work of European employee representations in firms that operate in the manufacturing sector, the model sheds light on a plausible explanation for why the rate of temporary agency employment stays stable at a relatively low level in almost all industrialized countries. Furthermore, by showing that the deregulation does not lead to a steady increase in temporary agency employment but favors the rate of regular employment, it falsifies one of the main arguments of the opponents of temporary agency work which is that this form of employment inevitably leads to more precarious employment. The model suggests that the rate of temporary agency employment may even decrease despite its deregulation. However, the model does not conceal that even if the rate of regular employment increases, individual workers and labor unions suffer from the deregulation by declining wages and a reduction in labor union's utility.

Chapter 4 sets the focus on the technological orientation of the economy and the effect of the deregulation of temporary agency employment on the technology choice of firms. In the matching framework, it develops a model setting with two types of firms that produce the same good but either use regular employment or temporary agency employment for the production. The jobs differ in the technology used and regular jobs are more productive than temporary agency jobs. Workers randomly match with these vacancies. While labor costs for temporary agency work is less expensive than for regular work, job destruction and labor turnover is higher in agency jobs. Moreover, there is additional volatility in temporary agency jobs as temporary workers search on-the-job for regular employment. The model suggests that the institutional deregulation of temporary agency work leads to a more intensive use of the less productive technology and increases temporary agency employment. Workers that are employed in regular jobs suffer from declining wage rates, while the labor income of temporary workers increases. While the rate of temporary agency employment increases, the effect on regular and overall employment is ambiguous due to competing effects on the overall labor market tightness and and the job destruction rate in the economy. Next to the assessment of the change in the technological orientation due to the legal deregulation, the model investigates the effects of technological progress of the less advanced technology that is used in the production with agency workers. It shows that progress of this technology even strengthens the effects of the legal deregulation. Finally, it suggests that subsidies or other forms of support for directed investments in technological progress of more advanced technologies may be suitable economic policy instruments to dampen the macroeconomic effects of the deregulation of temporary agency work.