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Kai-Joseph Fleischhauer

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Department of Economics University of St. Gallen

Editor:	Prof. Jörg Baumberger University of St. Gallen Department of Economics Bodanstr. 1 CH-9000 St. Gallen Phone +41 71 224 22 41 Fax +41 71 224 28 85 Email joerg.baumberger@unisg.ch
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Kai-Joseph Fleischhauer

Author's address: Kai-Joseph Fleischhauer, lic.oec.HSG
Institute of Public Finance and Fiscal Law (IFF-HSG)
Varnbüelstrasse 19
CH-9000 St. Gallen
Tel. +41 71 224 30 86
Fax +41 71 224 26 70
Email kai-joseph.fleischhauer@unisg.ch
Website http://www.iff.unisg.ch

Abstract

There is an ongoing discussion in Germany about the implementation of tax credits in order to reintegrate low-skilled workers into the labor market. This paper aims at analyzing the policy instrument of tax credits in a theoretical model that systematically compares its costs and benefits in the context of the German system of apprenticeship training and social security. Building on recent training literature, a two-period partial-equilibrium model is developed that allows for worker heterogeneity in ability.

In our model, the implementation of tax credits in terms of a negative income tax solves a trade-off with respect to overall welfare. While tax credits reduce the number of unemployed workers at the extensive margin, they increase at the same time the opportunity costs of apprenticeship training, which implies that human capital formation is decreased. Furthermore, the model suggests that the reintegration of those workers at the bottom of the ability-distribution into the labor market is not optimal. The additional implementation of minimum wages is counteractive to the reduction of unemployment because firms would thus be prevented from employing workers with very low productivities.

Keywords

Unemployment of Low-Skilled Workers, Tax Credits, Labor Supply, Human Capital Formation

JEL Classification

H31, I38, J21, J24, J31, J68

1 Introduction

There is an ongoing discussion in Germany about the implementation of tax credits in order to reintegrate those low-skilled workers into the labor market who would stay outside otherwise. Since the seventies, Germany has experienced a dramatic increase in structural unemployment.[1] The German labor markets are particularly challenged by increasing unemployment among workers with low qualification.[2] This unemployment of low-skilled workers is very high in Germany compared to other OECD countries. Furthermore, German unemployment, like in most European countries, is largely made up of individuals suffering long spells (OECD (2004)). According to recent analyses of the IMF that concentrate on the labor supply of workers, one major reason lies in the compressed wage structure, i.e. in the downward rigidity in wages across skill categories (IMF (2004) and IMF (2005)).[3] This wage compression accrues because labor markets are heavily regulated and the level of unemployment benefits is high. Especially the German labor markets are characterized by a high level of employment protection and strong unions in the process of collective wage setting as well as downward rigidities with respect to wages of unskilled workers. In a nutshell, low-skilled workers stay outside the labor market because their potential labor income falls below the level of unemployment benefits defined by the German system of social security (Sinn, Holzner, Meister, Ochel, and Werding (2006)).

In order to approach the problem of rising unemployment among low-skilled workers, tax credits are proposed depending on the level of individual income. This policy instrument is part of the so-called welfare-to-work strategy which should reduce poverty by raising employment of low-skilled workers rather than by increasing welfare benefits for the unemployed. The objective is to balance assistance of low-income families and employment incentives for low-skilled workers. If a worker decides to work regularly, he receives an individual subsidy which depends on his level of income. One subsidy scheme which has been extensively discussed in the literature is the *Earned Income Tax Credit* (EITC) in the US. Unfortunately, the theoretical analysis of tax credits in the context of both labor supply and training decision of workers has been fragmentary so far. Previous research on tax credits has mainly focused on their effects on labor supply and employment (for example Meyer and Rosenbaum (2001)), whereas the impact on skill formation has been widely neglected. There are only few investigations that also refer to the consequences for the acquisition of human capital (for example Heckman, Lochner, and Cossa (2002)).

This paper aims at closing this gap by developing a two-period partial-equilibrium model that systematically compares the costs and benefits of tax credits. It is important to incorporate the training decision into the analysis of tax credits because subsidies to low-skilled workers increase the opportunity costs of training and thus reduce the worker's incentives to acquire skills (Heckman (2002)). In a nutshell, there are three key questions considered in this paper: First, what is the impact of tax credits on labor

[1] Cf. Bertola (2001) and Nickell (1997).

[2] In 2000, the rate of unemployment among workers without formal education was 19.4% in West Germany. In East Germany, 50.3% of low-skilled workers were unemployed (Reinberg and Hummel (2002)).

[3] Note that wage compression in imperfect labor markets is considered to be the major source of firm-sponsored general training (Acemoglu (1997) and Acemoglu and Pischke (1998)). However, this aspect is neglected because we concentrate on the labor supply and training decision of workers.

supply at the extensive margin? Second, what are the effects of tax credits on human capital formation? And third, what is the optimal level of tax credits subject to the training decision of workers?

The contribution of this paper is twofold because the formal analysis of tax credits, which is based on recent training literature with oligopsonistic labor markets, is extended in two important ways. First, we bring together the theoretical explanations of labor supply and human capital formation in the context of the German system of apprenticeship training and social security. Immervoll, Kleven, Kreiner, and Saez (2005) suggest that a model with unemployment due to labor market imperfections increases the attractiveness of tax credits and reduces the desirability of traditional social assistance like unemployment benefits. We demonstrate that tax credits in terms of a negative income tax[4] indeed succeed in reducing the number of unemployed workers, but only at the cost of decreased human capital formation. This conclusion is in line with the simulation results of Heckman, Lochner, and Cossa (2002). Second, our model allows for worker heterogeneity in ability and manages to explain endogenously the labor supply and training decision of workers at the extensive margin.

In our model, the implementation of tax credits in terms of a negative income tax solves a trade-off with respect to overall welfare. While tax credits reduce the number of unemployed workers at the extensive margin, they increase at the same time the opportunity costs of apprenticeship training, which implies that human capital formation is decreased. Our formal analysis demonstrates that optimal tax credits are positively related to the level of unemployment benefits and the costs of apprenticeship training. However, they depend negatively on the productivity-enhancement of apprenticeship training. Furthermore, the model suggests that the reintegration of those workers at the bottom of the ability-distribution into the labor market is not optimal. Because the costs in terms of decreased human capital formation would be too high, it is more efficient to leave aside those workers with the lowest productivities. The additional implementation of minimum wages is counteractive to the reduction of unemployment because firms would thus be prevented from employing workers with very low productivities.

The paper proceeds as follows: the next section discusses the theory of labor supply and human capital formation and its relationship to the literature on tax credits. In section 3 of this paper, the institutional setting of the German system of apprenticeship training and social security is illustrated. In section 4, our partial-equilibrium model is developed and the laissez-faire equilibrium without tax credits is discussed. Furthermore, we demonstrate that the implementation of unemployment benefits generates unemployment among low-skilled workers because private employment is crowded out by the welfare state. In section 5, the implementation of tax credits in terms of a negative income tax is analyzed and the optimal level of tax credits is derived. Section 6 concludes.

[4] This design of tax credits corresponds to the proposition of the ifo institute (Sinn, Holzner, Meister, Ochel, and Werding (2006)) which is introduced in section 3.3.

2 The Theory of Labor Supply and Human Capital

2.1 The Concept of Tax Credits

As a consequence of social security and downward rigidities in wages across skill categories, workers with low qualification have become less employable (Phelps (1997)).[5] Hence, economic policy should promote wage flexibility in order to reduce unemployment among these low-skilled workers. In this context, incentives for unemployment should be reduced by decreasing the level of unemployment benefits. However, the implementation of these policy instruments is difficult because of political constraints or because taxes and social assistance are set by distinct political institutions based on rather different interests (Boone and Bovenberg (2004)).[6]

In order to approach the problem of rising unemployment among low-skilled workers, tax credits are proposed depending on the level of individual labor income. This implies that the government pays a subsidy to those workers who are employed regularly and whose income does not exceed some critical level (Phelps (1997)). Tax credits are an important policy instrument to increase employment without lowering the standard of living because regular wages of unskilled workers are very low (the so-called "working poor") (Snower (1994)). However, compared to traditional social assistance, tax credits are less targeted at the poorest agents who suffer from involuntary unemployment (Boone and Bovenberg (2006)).

To some extent tax credits can be classified within the general set of wage subsidies.[7] However, wage subsidies are individually based, not means-tested and with limited duration (Phelps (1997)). Eligibility usually depends on a certain duration of receipt for the unemployment insurance. On the other hand, tax credits are typically subject to a family income based means-test and do not show a time limitation (Blundell (2005)). In the last years, several countries have introduced tax credits in various forms. In Europe, the most important examples are the *Working Families Tax Credit* (WFTC) in the UK, the *In-Work Tax Credit* in Belgium, the *Family Income Support Programme* in Ireland and the *Employment Tax Credit* in the Netherlands (OECD (2005)). However, theoretical and empirical research has mainly focused on the *Earned Income Tax Credits* (EITC) in the US. This transfer scheme works as a tax credit for workers with low labor incomes up to some critical level beyond which the subsidy is phased out. The EITC aims at reducing working poverty as well as generating greater work incentives for unemployed and workers with low income (Steuerle (1990)).

2.1.1 The Negative Income Tax

Based on Mirrlees (1971), optimal income tax theory shows that redistribution should take the form of a negative income tax (NIT) in order to reduce the high marginal tax rates on traditional social assistance

[5] This result is formally derived in section 4.4.

[6] For example, in some federal countries local governments determine social benefits while the central government decides about the tax system.

[7] Orszag and Snower (2003) distinguish between wage subsidies, which are paid to all workers with low income and not limited in time, and hiring subsidies, which are targeted exclusively at unemployed workers and limited in time.

(Immervoll, Kleven, Kreiner, and Saez (2005)). In general, the traditional NIT implies the following tax scheme which depends on the level of individual labor income:

$$T(I) = tI - y \quad \left\{ \begin{array}{ll} \leq 0 & \text{if } I \leq \bar{I} \equiv \frac{y}{t} \\ > 0 & \text{if } I > \bar{I} \end{array} \right\} \tag{1}$$

The NIT implies that all individuals receive a basic lump-sum transfer y which thus corresponds to the guaranteed income of each worker. Hence, workers with low income I below the critical level $\bar{I}$ face a negative amount of tax liability, i.e. they receive an income subsidy from the government. With increasing individual labor income, the subsidy is reduced by some portion of labor income which means that the labor income is taxed at the rate t.

In a general equilibrium model with continuous distribution of abilities, Hanushek, Leung, and Yilmaz (2003) investigate different redistribution policies and their implications for labor supply and human capital formation with respect to the trade-off between equity and efficiency. They conclude that wage subsidies, which are only directed to uneducated workers, dominate the implementation of education subsidies and a traditional NIT. By incorporating both margins of labor supply into the original approach of Mirrlees (1971), Saez (2002) analyzes the welfare consequences of the traditional NIT and the EITC. He demonstrates that subsidizing low-income workers by tax credits is welfare-enhancing if the labor supply response is concentrated along the extensive margin (participation).[8]

2.1.2 Implications of Tax Credits for Labor Supply

A central finding of the recent empirical literature in public finance and labor economics is that labor supply responses are concentrated more at the extensive margin than at the intensive margin (hours of work) (Blundell and MaCurdy (1999)). Evidence from tax-based transfers in the US and the UK shows substantial positive effects at the extensive margin, but only small negative effects on hours of work for those workers who already stay inside the labor market (Eissa and Liebman (1996) for the US and Blundell and Hoynes (2001) for the UK). Eissa, Kleven, and Kreiner (2004) stress that the extensive margin is particularly important for the labor supply incentives at the bottom of the income distribution.

With respect to the EITC, the empirical analysis by Meyer and Rosenbaum (2001) shows that indeed annual employment of single mothers has increased by 9% between 1984 and 1996.[9] However, hours worked have only slightly fallen at the intensive margin. Because the effect on total hours worked is very similar to the increase in employment, Meyer (2002) argues that labor supply adjustments take place at the extensive margin but not at the intensive margin. In almost the same manner, Heckman (1993) concludes that the extensive margin is empirically much more important than the intensive margin.

[8] Boone and Bovenberg (2004) suggest that there is a trade-off between low-skilled employment at the extensive margin and work effort of high-skilled workers at the intensive margin.

[9] Single mothers represent over three-quarters of all EITC recipients (Eissa and Hoynes (2005)). Meyer and Rosenbaum (2001) estimate that 60% of this increase in extensive labor supply is due to the EITC. For single mothers, this labor supply response at the extensive margin is confirmed by Eissa and Hoynes (2004). However, this result may be changed if an integrated model of family labor supply is considered (Hausman (1985)). Indeed, Eissa and Hoynes (2004) object that their results are different for married couples. While the labor force participation of the head of families is increased, it is decreased for secondary earners. In aggregate, the overall family labor supply is reduced among married couples.

With respect to European countries, Immervoll, Kleven, Kreiner, and Saez (2005) use the EUROMOD micro-simulation model to demonstrate that tax credits generate positive labor supply responses at the extensive margin.

Furthermore, the evidence from the NIT Experiments in the US suggests that the participation response is larger than the response at the intensive margin for both single female heads and married women (Robins (1985)).[10] Hence, labor supply adjustments take place at the extensive margin, which is mainly affected by the NIT guarantee, but only slightly at the intensive margin, which is influenced by the NIT tax rate. In line with Hausman (1985), we conclude that the basic transfer y is much more important for the labor supply response of low-income workers than the tax component t.

The reason for the dominance of the extensive margin could be that hours worked are fixed so that workers face quantity restrictions if they decide to enter the labor market (Hausman (1985)).[11] Simplifying, workers have the discrete choice between work and unemployment but can hardly decide on hours worked at the intensive margin (Zabalza, Pissarides, and Barton (1080)).[12] Indeed, empirical evidence shows that workers decide either to stay out of the labor market or to work at least some minimum number of hours (Eissa, Kleven, and Kreiner (2005)). This discrete labor supply behavior is theoretically explained by non-convexities generated by fixed costs of working (Cogan (1981)). With respect to the evaluation of tax reforms, Eissa and Hoynes (2005) suggest that ignoring the participation margin can lead to even the wrong sign of the welfare effect. Unfortunately, the theoretical public finance literature has largely ignored the participation decision and instead has focused on labor supply at the intensive margin. Hence, it is important to construct a theoretical model that explicitly allows for labor supply responses at the extensive margin if the incomes of low-skilled workers are raised by tax credits.

2.2 Human Capital Formation

"Human capital" can be defined as knowledge, skills, attitudes, aptitudes, and other acquired traits contributing to production (Goode (1959)). According to Blundell, Dearden, Meghir, and Sianesi (1999), there are two main components of human capital with strong complementarity: early ability (whether acquired or innate) and skills acquired through formal education or training on the job. An extensive review of the theory of human capital is given by Cahuc and Zylberberg (2004).

[10] The NIT experiments were randomized experiments conducted from 1968 to 1982 in order to investigate the impact of taxes on labor supply. By considering both substitution and income effects, labor supply at the intensive margin is reduced by the NIT (Barth and Greenberg (1971)).

In a model without unemployment benefits, this result is empirically confirmed by Robins and West (1980) who demonstrate that due to the NIT there is a significant reduction in labor supply by heads of families once the participation decision is controled for. However, the opposite is true if there have been unemployment benefits which are replaced by the NIT.

[11] In addition to these institutional restrictions, Eissa and Hoynes (2005) summarize further reasons why the extensive margin is more responsive than the intensive margin.

[12] With quantity restrictions, labor supply can be estimated by discrete choice models that allow for a distribution of preferences (Zabalza, Pissarides, and Barton (1080)). Also Diamond (1980) focuses on the case in which labor supply is reduced to a participation decision.

2.2.1 The Investment in Human Capital

In his original approach, Becker (1964) develops a model of individual investment in human capital. In this view, human capital is similar to "physical means of production". According to Becker (1962), investing in human capital means "all activities that influence future real income through the embedding of resources in people". Human capital investments are expenditures on education, training, health, information, and labor mobility (Weisbrod (1966)). They involve initial costs (direct tuition expenditures and foregone earnings during schooling)[13] in order to gain a return on this investment in the future (Becker (1992)).[14] In a nutshell, Mincer (1970) summarizes the empirical evidence concerning the age-earnings profile of individuals. Earnings positively depend on the stock of human capital; the age-earnings profile is concave and at least for a long time upward-sloping. If human capital investment increases, the age-earnings profile becomes steeper and has its maximum later.

Becker (1964) distinguishes between general and specific human capital. General human capital is defined to be not only useful with the current employer but also with other potential employers. In contrast, specific human capital increases the productivity of the worker only in his current job.[15] Hence, in competitive labor markets, where workers receive wages equal to their marginal product, firms cannot recoup investments in general skills, so that they refuse to pay for general training. However, workers themselves have the right incentives to invest in general human capital because they are the sole beneficiaries of their improved productivity (either with their current or with future employers) (Becker (1962)). If workers are not credit constrained, they efficiently invest in the accumulation of general human capital. On the other hand, Becker (1964) argues that training in specific skills is quite different because workers do not benefit from higher productivity after changing their jobs. Therefore, firms can recoup investments in specific skills and are thus willing to share some of the costs of these investments. By also sharing the returns, the accumulation of specific human capital leads to lower fluctuations because both firms and workers benefit from keeping their contractual partner.

Models of human capital accumulation over the life-cycle can be attributed to two different branches: earnings maximizing models and utility maximizing models. Earnings maximizing models abstract from the labor-leisure choice problem and only analyze the trade-off between investment and income (for example Ben-Porath (1967)). Utility maximizing models also incorporate the labor-leisure choice so that labor supply becomes endogenous to the model (for example Heckman (1976)).[16] In both types of models, human capital formation is rivalrous with working so that wage subsidies run the risk of discouraging investments in skills (Heckman, Lochner, and Cossa (2002)).

[13] Parsons (1974) distinguishes these major components of education costs.

[14] This return is based on two interrelated channels: increased earnings for the worker and higher productivity for the firm as well as increased employment probabilities (Bloch and Smith (1977)). Bloch and Smith (1977) indeed find a positive correlation of human capital and labor market employment. Also Mincer (1989) states that the probability of being unemployed decreases with the amount of education. In a nutshell, there are two key determinants of the return to education: the costs of education and the employment opportunities after education (Rephann (2002)).

[15] Parsons (1974) notes that this firm-specific human capital is analytically equivalent to transfer costs for adjusting a worker to other firms.

[16] The difference between these two types of models is illustrated by Snow and Warren (1990) who explain that the income effect of higher wages (due to investments in human capital) on future labor supply may reduce realized future earnings. However, there are efforts to integrate these two branches (for example Blinder and Weiss (1976)).

Besides this vast literature on life-cycle human capital investment, there is a strand of literature concentrating on the extensive margin. This extensive education decision divides the workforce into different skill groups such as low-skilled and high-skilled workers. This mostly empirical literature analyzes self-selection of students into skill groups according to ability types which affects estimates of occupational choice and thus the distribution of earnings.[17] For example, Willis and Rosen (1979) as well as Heckman, Lochner, and Taber (1998) derive a theoretical model of the demand for college attendance and empirically show that expected lifetime earnings differentials indeed influence the college attendance choice.

2.2.2 Implications of Tax Credits for Human Capital Formation

Not only labor supply but also human capital formation is affected by the implementation of tax credits. These effects could be very different and crucially depend on the design of transfer schemes. With respect to the EITC, the consequences for the acquisition of human capital are neglected by many contributions.[18] According to the analysis of Heckman, Lochner, and Cossa (2002), tax credits place important disincentives on the accumulation of human capital. They suggest that the average skill-level of workers is decreased because current workers reduce their investment in human capital at the intensive margin.[19] As a consequence, Blundell (2005) stresses the importance of these interactions between labor supply and human capital formation for further research. He suggests that a dynamic analysis of optimal income transfer programs has to take into account the incentive effects for human capital investments.

3 The Institutional Setting in Germany

3.1 The German System of Apprenticeship Training

The educational system of Germany is one of the most segregated among industrialized countries. There are four types of German secondary schools: lower (Hauptschule), middle (Realschule), upper (Gymnasium), and mixed (Gesamtschule). Upon their conclusion, all of these school tracks require the successful completion of exams which indicate whether students are qualified to enter into an apprenticeship, other vocational training, or the university (Cooke (2003)).

Apprenticeship training can be undertaken in a variety of skilled blue or white collar positions. It combines part-time schooling with a work-based component (the so-called "dual system") and is largely general. Firms offering apprenticeship training positions have to follow a prescribed curriculum and apprentices take a rigorous exam at the end of the apprenticeship. Industry or craft chambers certify whether firms fulfill the requirements to train apprentices adequately, while worker councils in the firms

[17] The first source is Roy (1951), which has received subsequent elaboration, e.g. by Heckman and Honoré (1990).

[18] For example, Orszag and Snower (2003) admit that consequences for the accumulation of human capital lie beyond the scope of their paper.

[19] The effects of the EITC on human capital investments are devided into a substitution effect, an income effect, and a direct effect (which accrues due to changes in marginal costs and returns) (Heckman, Lochner, and Cossa (2002)).

monitor the training. After having passed the exam, apprentices receive a formal skill certificate that is accepted nationwide (Bougheas and Georgellis (2004)).[20]

In a nutshell, the accumulation of human capital by apprenticeship training is determined by public regulations rather than investment decisions of workers at the intensive margin (hours of training). However, each worker decides at the extensive margin (participation) whether to receive apprenticeship training or to work regularly (i.e. to work full time without formal qualification).

3.2 Labor Market Regulation and Social Security in Germany

In Germany, the degree of labor market regulation is high compared to other OECD countries (OECD (2005)). Laws of employment protection and firing costs make it difficult for firms to respond flexibly to changing market conditions. With firing costs, job growth in response to GDP growth is diminished because firms account for the possibility of worsening business prospects in the future. Hence, they hire fewer workers or even decide to leave the market in order to avoid the costs of possibly having to fire them. As a consequence, it becomes harder to find a job for unemployed workers (Heckman (2002)). However, the total effect of firing costs on unemployment is ambiguous because the separating probability for employed workers is decreased and fewer separations lead to lower unemployment (Belot, Boone, and Ours (2002)).[21]

Wage bargaining is conducted by the collective bargaining parties. Although Germany does not have a legally mandated minimum wage, union wage floors effectively operate as wage minimums for certain groups of workers. Furthermore, replacement rates by social insurance are substantial. In the sixties, the social assistance benefits *Arbeitslosenhilfe* and *Sozialhilfe* were implemented to insure workers against the risk of unemployment. According to Immervoll, Kleven, Kreiner, and Saez (2005), total social benefits constituted 72.6% of the disposable income for the lowest decile group in Germany in 1998.

However, this system of traditional social assistance is criticized for keeping persons on welfare and out of the labor market.[22] This poverty trap accrues because unemployment benefits work as de facto minimum wage. This downward rigidity in wages across skill-categories leads to a compressed wage structure (Schöb and Weimann (2003)). As a consequence, unemployment is generated especially among low-skilled workers because private employment is crowded out by the welfare state as long as the replacement rate exceeds the market wage rate for unskilled workers (Sinn (2003)). According to Reinberg and Hummel (2002), the rate of unemployment in 2000 among workers without formal education was 19.4%

[20] For example, the German system of apprenticeship training is described by Soskice (1994) and Harhoff and Kane (1995).

[21] The empirical evidence concerning the relationship between firing costs and unemployment is mixed. For example, Scarpetta (1996) and Elmeskov, Marint, and Scarpetta (1998) find a negative correlation whereas Nickell (1998) does not.

Note that there is another implication of the decreased separating probability: firms invest more in the human capital of their workers because the expected rent from the increased output of trained workers is higher. The empirical evidence concerning this positive relationship between training and job tenure is unambiguous (Lynch (1991) and Loewenstein and Spletzer (1999)).

[22] In 1999, 2,790,000 people draw benefits from the *Sozialhilfe* and 1,300,000 from the *Arbeitslosenhilfe*. Subject to health condition, family obligation and training measures, the labor force potential is 2,200,000 or about 58% of all beneficiaries (Raffelhüschen (2001)).

in West Germany and 50.3% in East Germany.[23] Because social benefits are generously granted only in the case of no work and marginal tax rates on unemployment benefits are high, labor supply incentives for low-skilled workers are reduced by the welfare state (Sinn (2002)).

In the context of the German labor market reforms in 2005, both social assistance benefits were merged to the uniform social benefit *Arbeitslosengeld II* which falls below the previous replacement rates and is independent of earnings in the past. Furthermore, the requirements of eligibility and sanctions in the case of misuse were aggravated.[24] However, the negative impact on employment of low-skilled workers is reduced but still existent (Ochel (2005)). The alternative to this traditional form of social assistance are tax credits granted to those workers who stay inside the labor market but receive a low labor income below some critical level.

3.3 The German Concept of "Combined Wages"

In Germany, two different concepts of tax credits are discussed which both aim at reintegrating low-skilled workers into the labor market. This policy instrument is referred to as "combined wages" because the income of low-skilled workers in employment is augmented so that the total income is a combination of the individual labor income and the subsidy. The first concept of "combined wages" concentrates on the demand side of the labor market and proposes to pay employment subsidies to those firms that hire a formerly unemployed worker. In this context, some part of the unemployment benefits could be used as vouchers for the firms in order to reduce the net labor costs. Hence, each worker will prefer work to unemployment if his gross labor income exceeds the employment subsidy (Snower (1994)). With respect to the institutional setting in Germany, Schöb and Weimann (2003) suggest to exempt firms from paying the social security contributions for low-skilled workers in order to decrease the labor costs of firms by 34% (this proposition is called the *Magdeburger Alternative).* However, in our formal analysis we will focus on the second concept of "combined wages" that refers to the supply side of the labor market. This approach aims at increasing the labor supply incentives of low-skilled workers by paying them a subsidy in the case of employment.

In recent years, there have been various approaches to implement tax credits according to the second concept of "combined wages". The focus of most approaches has been on long-time unemployed, welfare recipients, or generally workers with low qualification. Besides some regionally defined projects[25], two approaches have been applied nationwide. First, the *Arbeitnehmerhilfe* determines wage subsidies for unemployed workers of at most 13 Euro per day if the working time exceeds 15 hours per week. Second, the *Mainzer Modell* was regionally designed in 2000[26], extended nationwide in 2002 and terminated by

[23] Empirical evidence is also shown by Layard and Nickell (1999). These negative effects become even stronger in a dynamic context, for the longer workers are unemployed and the more their skills depreciate (Snower (1994)). The existence of unemployment due to the implementation of unemployment benefits is formally derived in section 4.4.

[24] According to Peter Hartz, the chairman of the committee working on these labor market reforms, this part of the reform proposals is also referred to as *Hartz IV*.

[25] An overview is given by Kaltenborn (2001). For example, nine local authorities in the federal state Baden-Württemberg applied the *Einstiegsgeld* between 1999 and 2002 (Dann, Kirchmann, Spermann, and Volkert (2002)). In Hessen, "combined wages" were introduced by seven local authorities in 2000. It was hardly engaged and replaced by the *Kasseler Modell Kombilohn* (KAMOKO) in 2001. Like the *Mainzer Modell*, it was terminated in 2003.

[26] At the beginning, it was only designed for the federal states Rheinland-Pfalz and Brandenburg.

the end of 2003. It was composed of subsidies to social security contributions and child benefits for a minimum working time of 15 hours per week and a gross income of at least 325 Euro per month. For a family with two children, the two components add up to a maximum subsidy of 283 Euro per month.[27] However, the main problem of both approaches has been their limited time horizon. The maximum duration of advancement has been three years in the *Mainzer Modell* and only three months in the *Arbeitnehmerhilfe* (Kaltenborn (2003)). As a consequence, the demand of workers for these wage subsidies has been very low considering the enormous amount of more than two millions of unemployed workers with low qualification.[28]

The limited time horizon of these tax credit programs is the main criticism brought forward by the ifo institute, an economic research institute in Germany. Low-skilled workers should have to be subsidized permanently because their income permanently falls below the reservation wage as defined by the level of unemployment benefits (Sinn, Holzner, Meister, Ochel, and Werding (2006)). Furthermore, the previous concepts still face high marginal tax rates on social welfare benefits so that working incentives for low-skilled workers are reduced (Sinn (2002)). Hence, tax credits for workers in employment are proposed according to the concept of a NIT in order to generate stronger labor supply incentives. However, this assistance is fundamentally different from the traditional concept of a NIT: subsidies are only paid to those workers inside the labor market (Sinn, Holzner, Meister, Ochel, and Werding (2006)).[29]

Starting from these considerations, our model analyzes labor supply and training responses at the extensive margin. It refers to the concept of the ifo institute by designing tax credits in terms of a NIT for workers in employment. In order to analyze the effects of tax credits on labor market participation at the extensive margin, it is essential to consider all distortions generated by traditional social assistance that move the equilibrium away from its first-best optimum. By granting additional income only in the case of employment, some formerly unemployed workers will thus be motivated to enter the labor market because the combination of their own labor income plus the subsidy will make them better off than in the case of unemployment. The welfare analysis of tax credits is presented in section 5. Beforehand, we discuss the laissez-faire equilibrium (cf. section 4.3) and the equilibrium with unemployment benefits (cf. section 4.4) in order to point out the analytical basis of comparison.

4 The Model

We consider a discrete-time model with two types of agents, namely workers and firms. In line with Acemoglu and Pischke (1998), there are two periods, a training period (period 1) and a working period (period 2). The length of both periods is normalized to unity. Production takes place in worker-firm pairs and no capital is needed. According to Eissa, Kleven, and Kreiner (2005), a model of extensive labor

[27] Cf. Jülicher (2002) and Bittner, Hollederer, Kaltenborn, Rudolph, Vanselow, and Weinkopf (2001).

[28] The *Arbeitnehmerhilfe* covers about 8.000 workers per year. There were 6.137 participants in the *Mainzer Modell* (Dann, Kirchmann, Spermann, and Volkert (2002)).

[29] The ifo institute defines this concept as "activating social aid". This means that social benefits are paid in order to activate formally unemployed workers for the labor market. The whole concept is explained in more detail in Sinn, Holzner, Meister, Ochel, and Werding (2006).

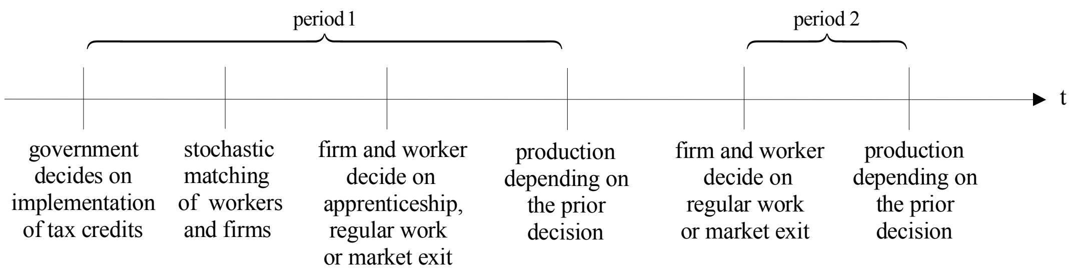

Figure 1: Evolution over Time

supply requires some type of heterogeneity, either in preferences or in ability. In our approach, workers have identical preferences but are heterogeneous in their initial ability which is exogenously given.

At the beginning of period 1, each firm meets one worker whose individual ability is drawn randomly from a distribution that is common knowledge. Firms and workers decide whether to engage in apprenticeship training, to produce with regular work or to stay in the market at all. Apprenticeship training only takes place if both parties prefer it to regular work. If one of the parties does not agree, the worker is employed regularly. In the second period, all workers are employed regularly, but only those workers who were trained in period 1 have increased productivity. In line with Acemoglu and Pischke (1999), there is no exogenous separation after the first period.[30] Altogether, the economy evolves over time as shown in figure 1. The model assumptions and the labor market decisions of firms and workers are described in the following subsections.

4.1 Workers and Firms

At the beginning of period 1, workers differ in their individual ability that is assumed to be uniformly distributed on the interval $[\theta_L, \theta_H]$.[31] Firms can unambiguously observe the workers' abilities.[32] In line with Hanushek, Leung, and Yilmaz (2003) and Malcomson, Maw, and McCormick (2003), the mass of workers is normalized to unity by defining $\theta_L \equiv 0$ and $\theta_H \equiv 1$. Hence, the cumulative distribution function of individual abilities is $F(\theta) = \theta$. By assumption, the mass of firms is also one, so that each firm meets one worker whose ability is uniformly distributed with $\theta \sim u[0, 1]$. At the extensive margin, each worker decides whether to receive apprenticeship training, to work regularly or to stay unemployed. The worker only has this discrete choice but cannot decide on the amount of apprenticeship training at the

[30] The implementation of an exogenous separating probability as in Malcomson, Maw, and McCormick (2003) does not change our analytical results because we concentrate on the supply side of the labor market. For the workers who face the training decision in period 1, it is irrelevant whether their higher wages in period 2 are paid by their current or by another employer.

[31] The continuous distribution of abilities allows to obtain a smooth participation decision at the individual level (Mirrlees (1971)). Mincer (1958) and Becker (1962) assume that abilities are normally distributed. Without changing our general results, we assume a uniform distribution of abilities in order to keep the following calculations as simple as possible.

[32] This assumption is in line with Boone and Bovenberg (2006). Furthermore, it is implicitly included into the whole literature on human capital and the life-cycle of earnings. Each worker offers his individual stock of human capital to the firms and is rewarded by a rental price per unit of human capital. Hence, we rule out asymmetric information (hidden knowledge). If the worker's productivity were not observed by the firm, there would be adverse selection as modeled e.g. by de Meza and Webb (2001).

intensive margin. This assumption is justified by the institutional setting of the German apprenticeship system as described in section 3.1.

In line with Malcomson, Maw, and McCormick (2003), workers are risk-neutral and maximize the sum of their discounted utilities over both periods:[33]

$$U(\theta) = u + \delta u' \tag{2}$$

The discount factor $\delta \equiv \frac{1}{1+r}$ with r as the market interest rate expresses the preference for current and future utility. The higher δ, the higher is the weighting of period 2 and the lower is the preference for period 1.

In period 1, the worker's utility is equal to the difference between consumption c and potential training costs e that only arise if training takes place:

$$u = c - ve \tag{3}$$
$$c = w(\theta) - s \tag{4}$$
$$w(\theta) = \beta\theta \tag{5}$$

v is a dummy variable which is one in the case of apprenticeship training and zero otherwise. In line with the literature on human capital accumulation over the life-cycle, there are training costs e that have to be borne by the worker in the case of an apprenticeship.[34] Note that the training costs are identical for each worker because the length of the apprenticeship is defined by the German system of apprenticeship training (cf. section 3.1). In both periods, the worker's wage corresponds to the Nash bargaining solution of oligopsonistic labor markets. According to Acemoglu (1997), the parameter $0 < \beta < 1$ indicates the (identical) bargaining power of workers concerning the division of output. Hence, there are labor market frictions because the worker's wage is below his marginal product (Masters (1998)). By defining the output good as numéraire and assuming an identical, linear one-to-one production function for the connection of output and labor (which is the only factor of production), the wage of a worker with ability θ is equal to $w(\theta) = \beta\theta$.[35] Furthermore, the worker can transfer wealth from period 1 to period 2 by reducing his consumption c and saving an amount s.

[33] In line with Ben-Porath (1967), we do not analyze a more general utility function of workers. Note that there is no uncertainty because the probability of exogenous separation is zero.

[34] Cf. Ben-Porath (1967) and Heckman (1976). Most models that analyze the accumulation of (general) human capital over the life-cycle completely concentrate on the investment decision of workers.

Alternatively, the parameter e could be interpreted as fixed costs according to Cogan (1981) in order to create non-convexities in the training decision. However, we do not consider disutilities of work effort in order to keep the calculations as simple as possible. By including effort of regular work, there would be unemployment also in the first-best optimum and in the laissez-faire equilibrium (cf. e.g. Immervoll, Kleven, Kreiner, and Saez (2005)).

[35] The production function exhibits constant returns to scale. Note that the wage $w(\theta)$ corresponds to the labor income of the worker with individual ability θ because the labor supply is implicitly normalized to unity.

In period 2, the worker's utility is determined by the level of consumption:[36]

$$
\begin{aligned}
u(\theta') &= c' && (6)\\
c' &= w(\theta') + Rs && (7)\\
w(\theta') &= \beta\theta' && (8)\\
\theta' &= (1+\upsilon\alpha)\,\theta && (9)
\end{aligned}
$$

Consumption c' is determined by the savings of period 1, that are augmented by the factor $R \equiv 1 + r$, and the wage in period 2 which corresponds to the Nash bargaining solution and thus depends on the worker's productivity θ'. The productivity of all workers employed regularly in period 1 is unchanged (i.e. $\theta' = \theta$). For all trained workers (i.e. $\upsilon = 1$), productivity in the second period increases to $\theta' = (1+\alpha)\,\theta$. The parameter $\alpha > 0$ represents the productivity-enhancement of apprenticeship training: the higher θ, the higher is the absolute productivity gain generated by the apprenticeship.[37] We assume that the productivity-enhancement α is identical for all trained workers.[38]

Altogether, the total utility of a worker with ability θ is obtained by substituting equations (3) to (9) into equation (2):

$$U(\theta) = \beta\theta - \upsilon e + \delta\beta\,(1+\upsilon\alpha)\,\theta \tag{10}$$

Note that savings s cancel out because they are augmented and discounted by the same market interest rate r. Hence, they only represent transfers from one period to another without influence on total utility.

Firms are risk-neutral and maximize the sum of their discounted profits over both periods:[39]

$$\pi(\theta) = \pi + \delta\pi' \tag{11}$$

In both periods, the firm's profit is equal to the difference between revenue and costs per worker. Hence,

[36] Our model does not consider search frictions which implies an identical matching probability equal to one for all workers. Alternatively, the probability of a match in period 2 may explicitly depend on the worker's status of employment in period 1. Different matching probabilities can be justified by different frictions in searching for employment. Mincer (1989) empirically confirms that the probability of unemployment decreases with education. In this context, Brown and Kaufold (1988) stress that the possibility of unemployment reduces expected returns to education. Hence, the return to education is based on higher productivity as well as higher employment probability (Bloch and Smith (1977)).

[37] Formally, this means $\frac{\partial(\theta'-\theta)}{\partial\theta} = \alpha > 0$. Intuitively, the accumulation of new skills is easier when more skills are already available. This relationship is also suggested by Ben-Porath (1967) and Mincer (1997). Because the parameter α determines the productivity and thus the wage in period 2, it constitutes the key determinant of the return to education as analyzed in the theory of human capital (c.f. Mincer (1974)).

[38] This assumption is analytically equivalent to the implication that the amount of training at the intensive margin is independent of the worker's ability and thus identical for each worker. This approach is in line with other models of human capital formation over the life-cycle. In almost the same manner. Ben-Porath (1967) and Heckman (1976) assume that the absolute (and not the relative) increase in human capital depends on the existing stock of human capital (which can be interpreted as initial ability). In Acemoglu (1997) and Acemoglu and Pischke (1998), there is no individual ability so that the relative gain in productivity is identical for all workers.

[39] The production side is modeled similar to Malcomson, Maw, and McCormick (2003). From the firm's point of view, the worker's ability can be interpreted as individual productivity.

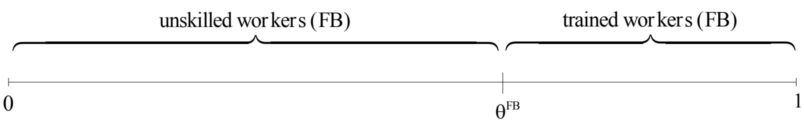

Figure 2: The First-Best Optimum

the profits in both periods depend on the worker's productivity in the following manner:

$$\pi = \theta - w(\theta) = (1-\beta)\theta \tag{12}$$

$$\pi' = \theta' - w(\theta') = (1-\beta)\theta' = (1-\beta)(1+\upsilon\alpha)\theta \tag{13}$$

Altogether, total profits of a firm that produces with a worker of ability θ is equal to

$$\pi(\theta) = (1+\delta(1+\upsilon\alpha))(1-\beta)\theta \tag{14}$$

4.2 The First-Best Optimum (FB)

In the first-best optimum, the total surplus of workers and firms is maximized. The overall welfare is equal to the sum of the aggregate utility of all workers and the aggregate profits of all firms over both periods. Obviously, there is no unemployment in the first-best optimum (i.e. $u^{FB} = 0$) because each unemployed worker would be equivalent to lost productivity. Each trained worker generates output equal to his productivity θ during the apprenticeship and $(1+\alpha)\theta$ after the apprenticeship has been completed. However, the financial burden e has to be borne by the workers.

In the case of regular work, a worker generates the individual output θ in both periods. In the following, we assume that θ^{FB} is the welfare maximizing pivotal ability[40] between apprenticeship training and regular work. Hence, the optimal number of apprentices in the first period is $n^{FB} = 1 - \theta^{FB}$.[41] This situation is illustrated in figure 2. The overall welfare in the first-best optimum unambiguously depends on θ^{FB}:[42]

$$W^{FB} = \underbrace{\int_0^{\theta^{FB}} (1+\delta)\theta d\theta}_{\text{unskilled workers}} + \underbrace{\int_{\theta^{FB}}^1 [(1+\delta(1+\alpha))\theta - e] d\theta}_{\text{trained workers}} \tag{15}$$

In order to determine θ^{FB}, we have to maximize equation (15) with respect to θ^{FB}:

$$\max_{\theta^{FB}} W^{FB} = \frac{1}{2}(1+\delta(1+\alpha)) - (1-\theta^{FB})e - \frac{1}{2}\delta\alpha(\theta^{FB})^2 \tag{16}$$

[40] Hanushek, Leung, and Yilmaz (2003) refer to it as "ability cutoff".
[41] More accurately, n^{FB} describes the *mass* of apprentices in the first-best optimum. In the following, we will neglect this inaccuracy.
[42] Note that the density function of individual abilities is $f(\theta) = 1$.

The first-order condition with respect to θ^{FB} is

$$\frac{\partial W^{FB}}{\partial \theta^{FB}} = e - \delta\alpha\theta^{FB} = 0 \tag{17}$$

Solving for θ^{FB} yields the first-best number of apprenticeship training positions.

Proposition 1 *In the first-best optimum, the lowest ability that should receive apprenticeship training is equal to*

$$\theta^{FB} = \frac{e}{\delta\alpha} \tag{18}$$

In the first-best optimum, the pivotal ability between apprenticeship training and regular work is increasing in e because higher training costs make it less profitable to provide apprenticeship training to workers. However, θ^{FB} is decreasing in the productivity-enhancement α because the productivity of trained workers becomes larger and thus the return to education is increased. Just as well, θ^{FB} is decreasing in the discount factor because an increase in δ is equivalent to a decrease in r. Hence, the welfare in period 2 is discounted less and thus weighted to a greater extent.

By substituting (18) into equation (16), we obtain the first-best level of overall welfare.

Proposition 2 *In the first-best optimum, the overall welfare is equal to*

$$W^{FB} = \frac{1}{2}\left(1 + \delta\left(1 + \alpha\right)\right) - e + \frac{1}{2}\frac{e^2}{\delta\alpha} \tag{19}$$

4.3 The Laissez-Faire Equilibrium (LF)

4.3.1 The Pivotal Abilities with Laissez-Faire

Without government intervention, workers never prefer to stay unemployed since this would be equivalent to receiving zero income. In the case of regular work, they receive wages equal to the Nash bargaining solution in both periods. However, workers will prefer to be trained in period 1 if their total utility according to equation (10) is bigger with apprenticeship training (i.e. $\upsilon = 1$) than with regular work (i.e. $\upsilon = 0$).

Definition 1 *The pivotal ability θ^{LF} is defined to be the lowest ability that decides to receive apprenticeship training. A worker prefers apprenticeship training to regular work if his utilities over both periods solve*

$$\beta\theta - e + \delta\beta\left(1 + \alpha\right)\theta \geq \left(1 + \delta\right)\beta\theta$$
$$\theta \geq \theta^{LF} \equiv \frac{e}{\delta\beta\alpha} \tag{20}$$

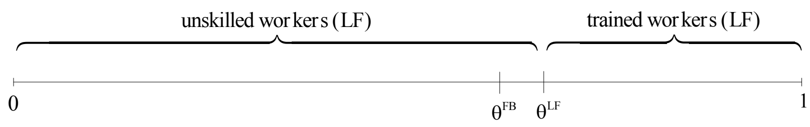

Figure 3: The Laissez-Faire Equilibrium

Like θ^{FB}, the pivotal ability θ^{LF} is increasing in the training costs and decreasing in the productivity-enhancement of apprenticeship training and the discount factor. Furthermore, θ^{LF} is decreasing in the worker's bargaining power β. The case $\beta = 1$ implies zero rents for the firms and the absence of labor market frictions so that the number of apprenticeship training positions achieves its first-best level, i.e. $n^{LF} = n^{FB}$. However, for $\beta < 1$ the training decision of workers implies $\theta^{LF} > \theta^{FB}$ and thus is distorted compared to the first-best optimum. This inefficiency arises because workers only consider their higher wages in period 2 but do not take into account increased profits of firms by the output share $(1 - \beta)$. Hence, workers underinvest in the acquisition of human capital. The difference between n^{LF} and n^{FB} and thus the degree of distortion become larger the lower the worker's bargaining power β.

Additionally, we have to consider the labor market decision of firms. As shown by equation (14), no firm will leave the market because it is always possible to make positive profits by employing the worker regularly. Furthermore, each firm prefers apprenticeship training to regular work because productivity and thus profits in period 2 are increased.

4.3.2 Overall Welfare with Laissez-Faire

In the first period, $n^{LF} = 1 - \theta^{LF}$ workers are trained while all other workers are employed regularly. With respect to the training decision at the extensive margin, the number of apprenticeship training positions is distorted compared to its first-best optimum, i.e. $n^{LF} < n^{FB}$. However, like in the first-best optimum there is no unemployment (i.e. $u^{LF} = u^{FB} = 0$) because workers and firms always prefer regular work to market exit. This situation is illustrated in figure 3. Hence, in the laissez-faire equilibrium, the aggregate welfare of workers (W) is equal to

$$W_W^{LF} = \underbrace{\int_0^{\theta^{LF}} (1+\delta)\,\beta\theta d\theta}_{\text{unskilled workers}} + \underbrace{\int_{\theta^{LF}}^1 \left[(1+\delta\,(1+\alpha))\beta\theta - e\right] d\theta}_{\text{trained workers}} \tag{21}$$

The first integral in equation (21) describes the discounted aggregate utility of regular workers without an apprenticeship training position. These unskilled workers receive wages equal to the Nash bargaining solution $\beta\theta$ in both periods which adds up to the present value of $(1+\delta)\,\beta\theta$ for all workers with individual ability below θ^{LF}. The second integral describes the discounted aggregate utility of workers who receive apprenticeship training in the first period. These workers with $\theta \geq \theta^{LF}$ have to bear the training costs e in period 1. In the second period, their productivity is increased by the factor $(1+\alpha)$. All wages correspond to the Nash bargaining solution so that the wages of the trained workers are increased by the same factor $(1+\alpha)$ compared to the wages of unskilled workers.

In almost the same manner, the aggregate welfare of firms (F) over both periods depends on the pivotal ability θ^{LF}:

$$W_F^{LF} = \underbrace{\int_0^{\theta^{LF}} (1+\delta)(1-\beta)\,\theta d\theta}_{\text{unskilled workers}} + \underbrace{\int_{\theta^{LF}}^1 (1+\delta(1+\alpha))(1-\beta)\,\theta d\theta}_{\text{trained workers}} \tag{22}$$

In equation (22), the first integral is equal to the aggregate profits of firms that employ unskilled workers regularly. These profits correspond to the Nash bargaining solution, i.e. the fraction $(1-\beta)$ determines the profit of the firms in both periods. The second integral is equal to the aggregate profits of those firms that provide apprenticeship training in period 1 and thus enjoy the higher productivity of their trained workers in period 2.

Altogether, the overall welfare in the laissez-faire equilibrium is determined by the aggregate welfare of workers and the aggregate welfare of firms as shown by equations (21) and (22). Hence, the overall welfare with laissez-faire is equal to

$$\begin{aligned} W^{LF} &= W_W^{LF} + W_F^{LF} \\ &= \underbrace{\int_0^{\theta^{LF}} (1+\delta)\,\theta d\theta}_{\text{unskilled workers}} + \underbrace{\int_{\theta^{LF}}^1 [(1+\delta(1+\alpha))\theta - e]\,d\theta}_{\text{trained workers}} \end{aligned} \tag{23}$$

Simplifying yields

$$W^{LF} = \frac{1}{2}(1+\delta(1+\alpha)) - (1-\theta^{LF})e - \frac{1}{2}\delta\alpha(\theta^{LF})^2 \tag{24}$$

Note that the worker's bargaining power β cancels out because it only determines how the output is divided between workers and firms. By substituting the pivotal ability θ^{LF} into equation (24) we obtain the following result.

Proposition 3 *In the laissez-faire equilibrium, the overall welfare is equal to*

$$W^{LF} = \frac{1}{2}(1+\delta(1+\alpha)) - e + (\beta - \frac{1}{2})\frac{e^2}{\delta\beta^2\alpha} \tag{25}$$

4.4 The Equilibrium with Unemployment Benefits (UB)

Unfortunately, the German labor markets are hardly characterized by the laissez-faire equilibrium determined in the previous section. As discussed in section 3.2, labor markets are heavily regulated and distorted by social benefits that change the labor market decision of workers. For this reason, we incorporate into our model unemployment benefits z that are paid to all unemployed workers in period 2.[43]

[43] In order to keep calculations as simple as possible, we concentrate on period 2 and do not consider unemployment benefits in period 1.

In accordance with the German system of social security (cf. section 3.2), z is identical for all workers and thus independent of the labor income in period 1. We assume that the government cannot observe why workers stay unemployed and thus also supports those workers who voluntarily refuse to work in order to become eligible for social benefits. The public expenditures for the unemployment benefits in the second period are financed by a lump-sum tax T that is levied on all workers independent of their status of employment. Hence, unemployment benefits z describe the gross transfer while unemployed workers receive net payments of $z' = z - T$.

4.4.1 The Pivotal Abilities with Unemployment Benefits

Obviously, the labor market decision of firms is not affected by the implementation of unemployment benefits. Also, the pivotal ability of workers between apprenticeship training and regular work remains the same because θ^{LF} is not affected by z. Hence, there are no additional distortions in the number of apprenticeship training positions. However, there are some low-ability workers who decide to stay unemployed in the second period because their utility is higher by receiving unemployment benefits than by working regularly. These distortions arise because z defines the reservation wage and thus determines the labor force participation of workers. In other words, unemployment benefits generate individual participation tax rates τ^{UB} which are higher the lower the individual ability θ' in the second period:[44]

$$\tau^{UB} = \frac{z}{\beta\theta'} \tag{26}$$

In line with Boone and Bovenberg (2004), the participation constraint is binding at the bottom of the skill distribution.[45] The pivotal ability between regular work and unemployment is described by the following definition.

Definition 2 *With unemployment benefits, the pivotal ability θ^{UB} is defined to be the lowest ability that decides to work regularly. A worker prefers regular work to unemployment if his utilities over both periods solve*

$$\begin{gathered}(1+\delta)\,\beta\theta - \delta T \geq \beta\theta + \delta\,(z-T) \\ \theta \geq \theta^{UB} \equiv \frac{z}{\beta}\end{gathered} \tag{27}$$

The pivotal ability between regular work and unemployment is increasing in z because higher unemployment benefits make it more attractive to stay outside the labor market. However, θ^{UB} is decreasing in β because more workers will decide to work regularly if their bargaining power and thus their wages

[44] The participation tax rate is defined as the average tax rate on labor market participation (Keuschnigg (2005)). In line with Eissa, Kleven, and Kreiner (2005), the labor supply at the extensive margin is linked to the participation tax rate. Note that the participation tax rate is zero in the laissez-faire equilibrium, i.e. $\tau^{LF} = 0$.

[45] In Immervoll, Kleven, Kreiner, and Saez (2005), the labor supply decision at the extensive margin is driven by fixed costs of work effort. In our approach, each worker decides on his labor market participation depending on his labor income and the level of unemployment benefits.

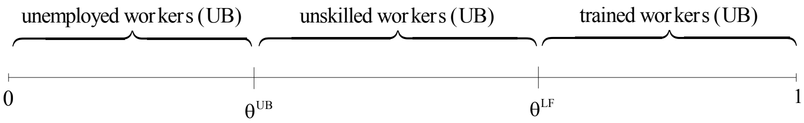

Figure 4: The Equilibrium with Unemployment Benefits

are high. We assume that the two pivotal abilities show the following relationship: $\theta^{UB} \leq \theta^{LF}$ (cf. figure 4).[46]

4.4.2 Overall Welfare with Unemployment Benefits

The number of trained workers is the same as in the laissez-faire equilibrium, i.e. $n^{UB} = n^{LF} = 1 - \theta^{LF}$. However, the implementation of unemployment benefits generates (voluntary) unemployment in the second period among those workers with individual ability below θ^{UB}: $u^{UB} = \theta^{UB} > 0 = u^{FB}$. Hence, with respect to labor supply at the extensive margin, labor market participation is too low and thus unemployment is too high compared to the first-best optimum. Only those workers with an ability above θ^{UB} are employed regularly in period 2. This situation is illustrated in figure 4. In period 1, there are no unemployment benefits so that all low-ability workers are working regularly.

By proceeding in the same manner as in the case of laissez-faire, the aggregate welfare of workers with unemployment benefits over both periods is equal to

$$W_W^{UB} = \underbrace{\int_0^{\theta^{UB}} [\beta\theta + \delta(z - T)]\, d\theta}_{\text{unemployed workers}} + \underbrace{\int_{\theta^{UB}}^{\theta^{LF}} [(1+\delta)\beta\theta - \delta T]\, d\theta}_{\text{unskilled workers}} + \underbrace{\int_{\theta^{LF}}^{1} [(1+\delta(1+\alpha))\beta\theta - e - \delta T]\, d\theta}_{\text{trained workers}} \quad (28)$$

Note that the labeling at the bottom refers to the worker's status of employment in period 2. The first integral in equation (28) is equal to the aggregate utility of workers staying unemployed in the second period, the second one describes the aggregate utility of workers employed regularly in both periods and the third integral is equal to the aggregate utility of trained workers. Note that each worker has to pay the lump-sum tax T.

In almost the same manner, the aggregate welfare of firms is determined:

$$W_F^{UB} = \underbrace{\int_0^{\theta^{UB}} (1-\beta)\,\theta d\theta}_{\text{unemployed workers}} + \underbrace{\int_{\theta^{UB}}^{\theta^{LF}} (1+\delta)(1-\beta)\,\theta d\theta}_{\text{unskilled workers}} + \underbrace{\int_{\theta^{LF}}^{1} (1+\delta(1+\alpha))(1-\beta)\,\theta d\theta}_{\text{trained workers}} \quad (29)$$

The first integral in equation (29) is equal to the aggregate profits of firms meeting low-ability workers who prefer to stay unemployed in the second period, which implies zero profits for the firms. The second

[46] This assumption implies that the unemployment benefits do not exceed some critical level, i.e. $z \leq \theta^{FB}$. Furthermore, the pivotal ability $\theta^{UB}_{A=U} \equiv \frac{e+\delta z}{\delta\beta(1+\alpha)}$ between apprenticeship training and unemployment lies between θ^{UB} and θ^{LF}. Without the assumption, we would have to consider the second case $\theta^{LF} < \theta^{UB}_{A=U} < \theta^{UB}$ which is economically less important.

integral describes the aggregate profits of firms meeting workers who prefer to work regularly in both periods and the third integral is equal to the aggregate profits of firms meeting high-ability workers who prefer to receive apprenticeship training.

In order to calculate the overall welfare with unemployment benefits, we have to consider the public budget constraint. The public expenditures for unemployment benefits are financed by lump-sum taxation of all workers independent of their status of employment. Hence, we omit further labor market distortions that would be generated by taxing only those workers inside the labor market and thus increasing the participation tax rate of workers. Balancing the budget implies

$$\int_0^{\theta^{UB}} z' d\theta = \int_{\theta^{UB}}^1 T d\theta \tag{30}$$

$$\int_0^{\theta^{UB}} z d\theta = \int_0^1 T d\theta \tag{31}$$

By summing up the aggregate welfare of workers and firms, the overall welfare with unemployment benefits is equal to

$$\begin{aligned} W^{UB} &= W_W^{UB} + W_F^{UB} \qquad (32) \\ &= \underbrace{\int_0^{\theta^{UB}} \left[\theta + \delta\left(z - T\right)\right] d\theta}_{\text{unemployed workers}} + \underbrace{\int_{\theta^{UB}}^{\theta^{LF}} \left[\left(1+\delta\right)\theta - \delta T\right] d\theta}_{\text{unskilled workers}} + \underbrace{\int_{\theta^{LF}}^1 \left[\left(1+\delta\left(1+\alpha\right)\right)\theta - e - \delta T\right] d\theta}_{\text{trained workers}} \end{aligned}$$

Applying equation (31) yields

$$\begin{aligned} W^{UB} &= \int_0^{\theta^{UB}} \theta d\theta + \int_{\theta^{UB}}^{\theta^{LF}} \left(1+\delta\right)\theta d\theta + \int_{\theta^{LF}}^1 \left[\left(1+\delta\left(1+\alpha\right)\right)\theta - e\right] d\theta \\ &= \frac{1}{2}\left(1+\delta\left(1+\alpha\right)\right) - \left(1-\theta^{LF}\right)e - \frac{1}{2}\delta\left[\left(\theta^{UB}\right)^2 + \alpha\left(\theta^{LF}\right)^2\right] \qquad (33) \end{aligned}$$

By substituting the pivotal abilities θ^{LF} and θ^{UB} into equation (33), we obtain the following result.

Proposition 4 *With unemployment benefits, the overall welfare is equal to*

$$W^{UB} = \frac{1}{2}\left(1+\delta\left(1+\alpha\right)\right) - e + \left(\beta - \frac{1}{2}\right)\frac{e^2}{\delta\beta^2\alpha} - \frac{1}{2}\delta\left(\frac{z}{\beta}\right)^2 \tag{34}$$

Comparing equations (25) and (34) demonstrates that the implementation of unemployment benefits decreases overall welfare because the working incentives for low-ability workers are reduced. For all workers with individual ability below θ^{UB}, the wage that could be earned by working regularly falls below the level of unemployment benefits z. Hence, these workers can increase their utility by staying outside the labor market. This inefficiency in the labor supply decision constitutes the necessary condition for welfare-enhancing government interventions.

Naturally, labor market distortions would be reduced by lowering the level of unemployment benefits.

However, if the level of unemployment benefits cannot be reduced by the government as suggested by Boone and Bovenberg (2004), tax credits are one possible policy instrument to move the economy towards its first-best optimum by decreasing the number of unemployed workers. Hence, the welfare implications of tax credits are analyzed in the following section.

5 The Welfare Analysis of Tax Credits (TC)

Tax credits imply that the government pays a subsidy to each worker who is employed regularly in the second period and whose labor income I does not exceed the critical income level $\bar{I}$. By paying low-skilled workers a subsidy S in addition to their individual labor income, formerly unemployed workers are motivated to enter the labor market because this "combined wage" makes them better off than unemployment benefits. Following the propositions of Sinn, Holzner, Meister, Ochel, and Werding (2006), tax credits are designed in terms of a NIT for those workers who stay inside the labor market. This design implies that all working (!) individuals receive a basic lump-sum transfer y which thus corresponds to the guaranteed income of each employed worker. Furthermore, the individual subsidy decreases continuously with labor income, i.e. it phases out at rate s up to the critical income level $\bar{I}$. This smooth reduction of the subsidy with rising income avoids undesirable jumps in the distribution of net incomes.[47] In contradiction to the traditional NIT, tax credits are only directed to net beneficiaries, while workers with labor income above $\bar{I}$ are not affected.[48]

Formally, the subsidy S in period 2 depends on the individual labor income in the following manner:

$$S(\theta') = \left\{ \begin{array}{ll} y - s\beta\theta' & \text{if } I(\theta') = \beta\theta' \leq \bar{I} \equiv \frac{y}{s} \\ 0 & \text{if } I(\theta') > \bar{I} \end{array} \right\} \tag{35}$$

with y as the basic transfer and s as the phase-out rate of the tax credits. This subsidy scheme is illustrated in figure 5.

Therefore, there is a critical ability $\bar{\theta}$ that indicates the worker just receiving zero subsidy. All workers with higher ability than $\bar{\theta}$ receive no subsidy. The critical income level $\bar{I}$ is equal to $\frac{y}{s}$ which implies that the critical ability is defined by $\bar{\theta} \equiv \frac{y}{s\beta}$. In line with Hanushek, Leung, and Yilmaz (2003), each unskilled worker is subsidized, i.e. the critical ability exceeds the pivotal ability between apprenticeship training

[47] If abilities are continuously distributed and not observable by the government, this transfer scheme is analytically equivalent to a lump-sum subsidy which is constant up to some critical level of individual labor income. Each worker with labor income above this critical level can imitate a lower ability in order to become eligible for the subsidy. Hence, the additional income due to the subsidy become smaller the higher the true ability of the worker and thus the higher the income loss necessary to fall below the critical level of income.

[48] In Hanushek, Leung, and Yilmaz (2003), the NIT is applied to all workers, i.e. workers with high income are taxed. However, paying a subsidy to low-income workers does not necessarily imply that high-income workers have to be taxed with the same marginal tax rate.

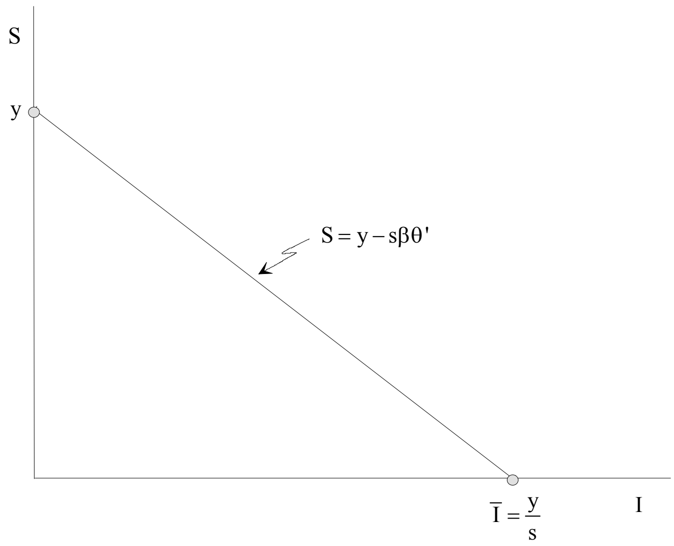

Figure 5: Tax Credits Depending on Labor Income

and regular work: $\bar{\theta} \geq \theta^{LF}$.[49] Depending on $\bar{\theta}$, the worker's total income in period 2 is equal to

$$I\left(\theta'\right) + S(\theta') = \left\{ \begin{array}{ll} y + (1-s)\,\beta\theta' & \text{if } \theta' \leq \bar{\theta} \\ \beta\theta' & \text{if } \theta' > \bar{\theta} \end{array} \right\} \tag{36}$$

The relationship between individual labor income (I) and total income including the tax credits ($I + S$) is graphically illustrated in figure 6.

According to Hausman (1985), the basic transfer is much more important for the labor supply response of low-income workers than the phase-out rate because the labor supply adjustments take place at the extensive margin. Hence, in our formal analysis, we concentrate on y and the optimal level of the basic transfer.[50]

5.1 The Pivotal Abilities with Tax Credits

As in section 4.4, public expenditures for unemployment benefits and tax credits are financed by lump-sum taxation of all workers independent of their status of employment. In line with Boone and Bovenberg (2004) and Boone and Bovenberg (2006), the level of social assistance is taken as given by the government. Hence, the worker still receives unemployment benefits z in the case of unemployment. As a consequence of the tax credits, the worker's decisions between apprenticeship training, regular work and unemployment are modified. The corresponding pivotal abilities are described by the following definition.

[49] This relationship is implied by the basic transfer exceeding some lower bound: $y \geq s\frac{e}{\delta\alpha}$. Furthermore, also in line with Hanushek, Leung, and Yilmaz (2003), we assume that there are some high-income workers who receive zero subsidy, i.e. $\bar{\theta} < 1$.

[50] By also considering the labor supply decision at the intensive margin, we would have to extend our analysis to the phase-out rate s.

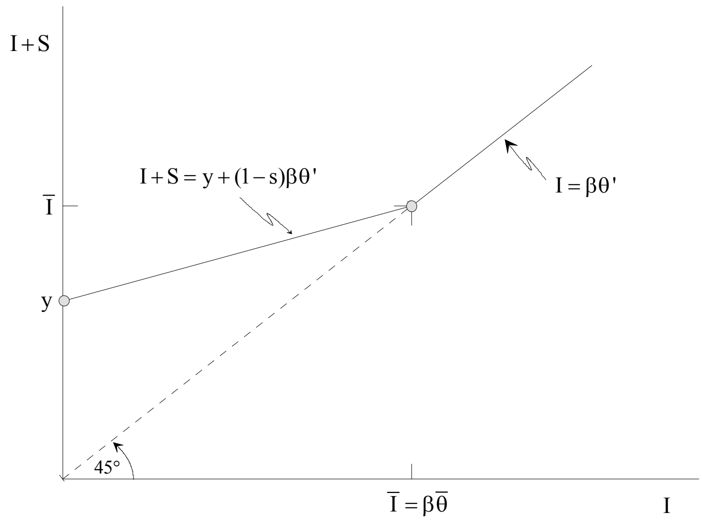

Figure 6: Total Income with Tax Credits

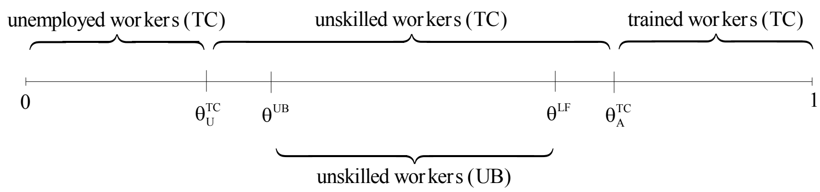

Figure 7: The Equilibrium with Tax Credits

Definition 3 *With tax credits, a worker prefers apprenticeship training to regular work if*[51]

$$\beta\theta - e + \delta\left[\beta\left(1+\alpha\right)\theta - T\right] \geq \beta\theta + \delta\left[\left(1-s\right)\beta\theta + y - T\right]$$

$$\theta \geq \theta_A^{TC} \equiv \frac{e+\delta y}{\delta\beta\left(\alpha+s\right)} \tag{37}$$

With tax credits, a worker prefers regular work to unemployment if

$$\beta\theta + \delta\left[\left(1-s\right)\beta\theta + y - T\right] \geq \beta\theta + \delta\left[z - T\right]$$

$$\theta \geq \theta_U^{TC} \equiv \frac{z-y}{\left(1-s\right)\beta} \tag{38}$$

The relationship of the two pivotal abilities with tax credits is $\theta_U^{TC} < \theta_A^{TC}$. This situation is is illustrated in figure 7.[52]

[51] We concentrate on those workers who receive no subsidy with increased productivity but a positive amount of subsidy without. This situation is implied by footnote 49.

[52] Note that the pivotal ability $\theta_{A=U}^{TC} = \frac{e+\delta(z-y)}{\delta(1-s)\beta(1+\alpha)}$ between apprenticeship training and unemployment lies between θ_U^{TC} and θ_A^{TC}.

5.2 The Equilibrium with Tax Credits

Tax credits aim at reducing the number of unemployed workers with low ability. Indeed, the pivotal ability between regular work and unemployment is decreased, i.e. $\theta_U^{TC} = u^{TC} < u^{UB}$. Hence, labor market distortions are reduced and thus the equilibrium approaches the first-best optimum with zero unemployment. The reason is that the subsidy S lowers the participation tax rates τ^{TC} for all beneficiaries compared to equation (26):

$$\tau^{TC} = \frac{z - S(\theta')}{\beta\theta'} \tag{39}$$

This reduction in the participation tax rate is equivalent to an increase in the opportunity costs of unemployment. Hence, some low-skilled workers who were unemployed in the equilibrium without tax credits now decide to enter the labor market.

On the other hand, the pivotal ability between apprenticeship training and regular work is increased, i.e. there are less workers that prefer apprenticeship training to regular work because the opportunity costs of apprenticeship training are increased ($n^{TC} = 1 - \theta_A^{TC} < n^{UB}$). Hence, compared to the equilibria with laissez-faire and with unemployment benefits, the number of apprenticeship training positions is further distorted compared to the first-best optimum. All workers with individual ability $\theta_U^{TC} \leq \theta < \theta_A^{TC}$ are employed regularly in period 1.

Altogether, the aggregate welfare of workers with tax credits over both periods is equal to

$$\begin{aligned} W_W^{TC} \quad = \quad & \underbrace{\int_0^{\theta_U^{TC}} \left[\beta\theta + \delta\left(z - T\right)\right] d\theta}_{\text{unemployed workers}} + \underbrace{\int_{\theta_U^{TC}}^{\theta_A^{TC}} \left[\left(1 + \delta\left(1 - s\right)\right)\beta\theta + \delta\left(y - T\right)\right] d\theta}_{\text{unskilled workers}} \\ & + \underbrace{\int_{\theta_A^{TC}}^{\bar{\theta}} \left[\left(1 + \delta\left(1 - s\right)\left(1 + \alpha\right)\right)\beta\theta - e + \delta\left(y - T\right)\right] d\theta}_{\text{trained workers with tax credits}} + \underbrace{\int_{\bar{\theta}}^{1} \left[(1 + \delta\left(1 + \alpha\right))\beta\theta - e - \delta T\right] d\theta}_{\text{trained workers without tax credits}} \end{aligned} \tag{40}$$

Again, the labeling at the bottom refers to the worker's status of employment in period 2. The first integral in equation (40) is equal to the aggregate utility of low-ability workers who stay unemployed in period 2 and the second one describes the aggregate utility of workers employed regularly in both periods. The third and the fourth integral describe the aggregate utility of trained workers. While the third integral is equal to the aggregate utility of trained workers who are eligible for tax credits because their labor income falls below the critical income level $\bar{I}$, the fourth one covers those workers who receive zero subsidy.

Compared to equation (29), the aggregate welfare of firms is only affected by the modified pivotal abilities:

$$W_F^{TC} = \underbrace{\int_0^{\theta_U^{TC}} \left(1 - \beta\right)\theta d\theta}_{\text{unemployed workers}} + \underbrace{\int_{\theta_U^{TC}}^{\theta_A^{TC}} \left(1 + \delta\right)\left(1 - \beta\right)\theta d\theta}_{\text{unskilled workers}} + \underbrace{\int_{\theta_A^{TC}}^{1} \left(1 + \delta\left(1 + \alpha\right)\right)\left(1 - \beta\right)\theta d\theta}_{\text{trained workers}} \tag{41}$$

The first integral in equation (41) is equal to the aggregate profits of firms meeting those workers who prefer to stay unemployed in period 2. The second integral describes the aggregate profits of firms producing with regular work in both periods and the third integral is equal to the aggregate profits of firms meeting high-ability workers who prefer to receive apprenticeship training in period 1.

In order to determine the overall welfare with tax credits, we have to consider the total amount of unemployment benefits and tax credits which are financed by lump-sum taxation of all workers independent of their status of employment.[53] Balancing the budget implies

$$\int_0^{\theta_U^{TC}} z' d\theta + \int_{\theta_U^{TC}}^{\bar{\theta}} \left[y - s\beta\theta' - T\right] d\theta = \int_{\bar{\theta}}^1 T d\theta \tag{42}$$

$$\int_0^{\theta_U^{TC}} z d\theta + \int_{\theta_U^{TC}}^{\bar{\theta}} \left[y - s\beta\theta'\right] d\theta = \int_0^1 T d\theta \tag{43}$$

By summing up the aggregate welfare of workers and firms, the overall welfare with tax credits depends on the basic transfer y that determines the labor supply of low-ability workers at the extensive margin:

$$\begin{aligned} W^{TC}(y) &= W_W^{TC} + W_F^{TC} \\ &= \underbrace{\int_0^{\theta_U^{TC}} \left[\theta + \delta\left(z - T\right)\right] d\theta}_{\text{unemployed workers}} + \underbrace{\int_{\theta_U^{TC}}^{\theta_A^{TC}} \left[\left(1 + \delta\left(1 - s\beta\right)\right)\theta + \delta\left(y - T\right)\right] d\theta}_{\text{unskilled workers}} \\ &\quad \underbrace{+ \int_{\theta_A^{TC}}^{\bar{\theta}} \left[\left(1 + \delta\left(1 - s\beta\right)\left(1 + \alpha\right)\right)\theta - e + \delta\left(y - T\right)\right] d\theta}_{\text{trained workers with tax credits}} \\ &\quad \underbrace{+ \int_{\bar{\theta}}^1 \left[\left(1 + \delta\left(1 + \alpha\right)\right)\theta - e - \delta T\right] d\theta}_{\text{trained workers without tax credits}} \end{aligned} \tag{44}$$

Applying equation (43) yields

$$W^{TC}(y) = \int_0^{\theta_U^{TC}} \theta d\theta + \int_{\theta_U^{TC}}^{\theta_A^{TC}} \left(1 + \delta\right)\theta d\theta + \int_{\theta_A^{TC}}^1 \left[\left(1 + \delta\left(1 + \alpha\right)\right)\theta - e\right] d\theta \tag{45}$$

In order to determine the optimal basic transfer, we have to maximize (45) with respect to y:

$$\max_y W^{TC}(y) = \frac{1}{2}\left(1 + \delta\left(1 + \alpha\right)\right) - \left(1 - \theta_A^{TC}\right)e - \frac{1}{2}\delta\left[(\theta_U^{TC})^2 + \alpha(\theta_A^{TC})^2\right] \tag{46}$$

The implementation of tax credits solves a trade-off with respect to overall welfare. On the one hand, tax credits are welfare-enhancing because they decrease the number of unemployed workers in period 2. On the other hand, tax credits increase the opportunity costs of training, which implies that less workers are willing to receive apprenticeship training. Differentiating equation (46) with respect to y yields the

[53] Like in the previous section with unemployment benefits, we omit further labor market distortions that would be generated by taxing only those workers inside the labor market.

first-order condition

$$\frac{\partial W^{TC}(y)}{\partial y} = 0$$

$$\underbrace{\delta \theta_U^{TC} \left(- \frac{\partial \theta_U^{TC}}{\partial y} \right)}_{\text{less unemployed workers}} = \underbrace{\delta \alpha \theta_A^{TC} \frac{\partial \theta_A^{TC}}{\partial y}}_{\text{less trained workers}} - \underbrace{\frac{\partial \theta_A^{TC}}{\partial y} e}_{\text{reduced training costs}} \tag{47}$$

Note that the partial derivatives have the following sign: $\frac{\partial \theta_U^{TC}}{\partial y} < 0$ and $\frac{\partial \theta_A^{TC}}{\partial y} > 0$. Equation (47) compares the marginal benefits and the marginal costs of an increase in y. On the left hand side, the marginal benefits are shown: there are less unemployed workers because the number of workers employed regularly is increased at the lower end by $(-\frac{\partial \theta_U^{TC}}{\partial y})$ which generates additional productivity δ per unit of initial ability. The (net) marginal costs of an increase in y are shown on the right hand side and consist of two effects with opposite signs that both accrue because the number of regular workers is increased at the upper end by $\frac{\partial \theta_A^{TC}}{\partial y}$. According to the first summand, there is a productivity loss of $\delta \alpha$ per unit of initial ability due to those workers who now reject apprenticeship training and thus no longer show increased productivity in the second period. However, the decrease in apprenticeship training positions also implies that aggregate training costs are reduced by e per worker formerly receiving apprenticeship training.

The welfare maximizing basic transfer y^* is obtained by substituting the pivotal abilities θ_U^{TC} and θ_A^{TC} into equation (47) and solving for y.[54]

Proposition 5 *The optimal basic transfer is equal to*

$$y^* = \frac{(\alpha + s)^2}{(1 + \alpha)(\alpha + s^2)} z + (1 - s)^2 \frac{(\alpha + s)\beta - \alpha}{\delta (1 + \alpha)(\alpha + s^2)} e \tag{48}$$

By choosing the basic transfer at least as high as the level of unemployment benefits, it is possible to achieve zero unemployment. However, because y^* is lower than z for any $s < 1$, the reintegration of those workers at the bottom of the ability-distribution into the labor market is not optimal. Because the costs in terms of decreased human capital formation are too high, it is more efficient to leave aside those workers with the lowest productivities. The comparative statics are illustrated in the following proposition.

[54] The calculation of y^* is shown in appendix A. Note that y^* describes a maximum because the second derivative is negative, i.e. $\frac{\partial^2 W^{TC}(y)}{\partial y^2} < 0$.

Proposition 6 *The comparative statics of the optimal basic transfer are as follows:*[55]

$$\frac{\partial y^*}{\partial z} > 0 \tag{49}$$
$$\frac{\partial y^*}{\partial s} > 0 \tag{50}$$
$$\frac{\partial y^*}{\partial e} > 0 \tag{51}$$
$$\frac{\partial y^*}{\partial \alpha} < 0 \tag{52}$$

The optimal basic transfer is increasing in z in order to countervail the detrimental effects of unemployment benefits on the number of regular workers. This result is completely in line with Boone and Bovenberg (2006) who demonstrate that, at high levels of social assistance, tax credits and traditional social benefits constitute complements: tax credits aim at offsetting the impact of social assistance on the labor supply decision at the extensive margin. With respect to empirical evidence for the UK, Blundell and Hoynes (2001) show that the positive impact of tax credits on labor force participation is reduced by the existence of other social benefits. In this context, Sinn, Holzner, Meister, Ochel, and Werding (2006) propose to combine the implementation of tax credits with a reduction in unemployment benefits. This reduction in z would decrease the optimal basic transfer and thus lower the negative effects of tax credits on human capital formation. Furthermore, y^* is increasing in s because greater deductions from labor income require a more generous basic transfer in order to reduce unemployment by the same amount. Because apprenticeship training becomes more expensive and thus, the decline in apprenticeship training positions becomes less costly, the optimal basic transfer is increasing in e. On the other hand, the optimal basic transfer is decreasing in α because the productivity-loss due to less trained workers in period 2 becomes larger.

5.3 Unemployment with Optimal Tax Credits

The implementation of tax credits aims at increasing labor force participation at the extensive margin by reducing the number of unemployed workers. By implementing tax credits with the optimal basic transfer y^*, unemployment is reduced at the cost of decreased human capital formation.

Proposition 7 *With tax credits, unemployment is reduced to*

$$\left(u^{TC}\right)^* = \frac{z - y^*}{(1-s)\,\beta} < u^{UB} \tag{53}$$

However, the number of apprenticeship training positions is decreased to

$$\left(n^{TC}\right)^* = 1 - \frac{e + \delta y^*}{\delta\beta\,(\alpha + s)} < n^{UB} \tag{54}$$

[55] The caculations are shown in appendix B.

Suppose that the government aims at reducing the number of unemployed workers to the target labor force participation $\hat{\theta}$. Then, the pivotal ability between regular work and unemployment must satisfy the following condition:

$$\theta_U^{TC} = \hat{\theta} \tag{55}$$

In order to achieve this target, the government chooses the phase-out rate s subject to the optimal basic transfer as described by equation (48). Substituting (48) into equation (55) yields

$$\begin{aligned} \frac{z - y^*}{(1-s)\,\beta} &= \hat{\theta} \\ \hat{s} &= s(\hat{\theta},\ y^*) \end{aligned} \tag{56}$$

In a nutshell, the government can realize its target labor force participation by setting the basic transfer according to equation (48) and the phase-out rate according to equation (56).

5.4 The Implementation of Minimum Wages

As discussed in section 3.2, there is no legally mandated minimum wage in Germany. In the context of recent political discussions about tax credits, the implementation of additional minimum wages is proposed in order to guarantee a minimum level of income even for unskilled workers. However, this policy measure would change the labor market decision of firms. Minimum wages prevent firms from paying wages which are below a defined minimum, thereby eliminating jobs with very low productivity and thus creating involuntary unemployment among the low-ability workers (Immervoll, Kleven, Kreiner, and Saez (2005)).

Definition 4 *The pivotal ability θ^{MW} is defined to be the lowest ability that firms decide to employ regularly if they face a minimum wage m. A firm prefers regular work to market exit if its profits over both periods solve*

$$\begin{aligned} (1+\delta)\,(\theta - m) &\geq 0 \\ \theta \geq \theta^{MW} &\equiv m \end{aligned} \tag{57}$$

Hence, all workers with ability $\theta < m$ stay unemployed because their output is lower than the minimum wage the firms have to pay. Because of the minimum wage it is no longer possible for low-ability workers to get out of unemployment by accepting a wage below m. Therefore, unemployment is bounded below because it is not possible to further reduce unemployment by increasing the basic transfer y. Hence, the optimal basic transfer with minimum wages is bounded above because $u^{MW} = m$ can be achieved by setting the basic transfer equal to $y^{MW} = z - (1-s)\,\beta m$.

Proposition 8 *With minimum wages, the optimal basic transfer is equal to*

$$y^{MW} = Min\,\{y^*,\ z - (1-s)\,\beta m\} \tag{58}$$

Hence, unemployment is equal to

$$u^{MW} = Max\left\{(u^{TC})^*,\ m\right\} \tag{59}$$

As shown by equation (59), the implementation of minimum wages increases unemployment if m exceeds the critical level $(u^{TC})^*$ which is equal to the number of unemployed workers with tax credits but without minimum wages. In this case, the optimal basic transfer is reduced according to equation (58). Compared to the situation without minimum wages, there are additional downward rigidities in wages across skill categories so that the positive effects of tax credits on the labor supply of low-skilled workers are counteracted.

6 Conclusion

This paper ranks among a new line of research that transcends the boundaries of labor economics and public finance. With respect to the German labor market, Sinn (2002) as well as Schöb and Weimann (2003) suggest that the only possibility to lower the poverty trap and to reactivate the low-skilled part of the labor force is by subsidizing work instead of unemployment. Our paper presents a two-period partial-equilibrium model that systematically compares the costs and benefits of tax credits which are granted to low-skilled workers. As proposed by Sinn, Holzner, Meister, Ochel, and Werding (2006), tax credits are designed in terms of a NIT for workers in employment.

In the laissez-faire equilibrium, there is no unemployment but the number of apprenticeship training positions is too low compared to the first-best optimum. Unfortunately, the implementation of unemployment benefits generates unemployment among low-ability workers because private employment is crowded out by the welfare state. The implementation of tax credits succeeds in reducing this unemployment by increasing the labor supply incentives of low-skilled workers at the extensive margin. However, the training decision of high-ability workers is distorted and the number of apprenticeship training positions is decreased relative to the laissez-faire equilibrium. In a nutshell, increased labor force participation is achieved at the cost of reduced human capital formation by workers inside the labor market. This result is in line with Heckman, Lochner, and Cossa (2002).

Our formal analysis is based on recent training literature with oligopsonistic labor markets but the model is adapted to the German system of apprenticeship training and social security. The implementation of tax credits in terms of a NIT solves a trade-off with respect to overall welfare. While tax credits reduce the number of unemployed workers at the extensive margin, they increase at the same time the opportunity costs of apprenticeship training, which implies that human capital formation is decreased. Subject to this trade-off, we derive the optimal basic transfer of tax credits which is positively related to the level of unemployment benefits, the costs of apprenticeship training and the phase-out rate of the tax credits. However, the optimal basic transfer depends negatively on the productivity-enhancement of apprenticeship training. Altogether, in line with the empirical results of Eissa, Kleven, and Kreiner (2004) and Immervoll, Kleven, Kreiner, and Saez (2005), the implementation of tax credits is justified on theoretical grounds.

Furthermore, the optimal basic transfer of tax credits is bounded above by the level of unemployment benefits which implies that the reintegration of those workers at the bottom of the ability-distribution into the labor market is not optimal. Because the costs in terms of decreased human capital formation would be too high, it is more efficient to leave aside those workers with the lowest productivities. If the government wants to realize a certain target labor force participation, it must also decide on the phase-out rate so that the pivotal ability between regular work and unemployment decreases to the desired extent. However, the additional implementation of minimum wages is counteractive to the reduction of unemployment because firms would thus be prevented from employing workers with very low productivities.

In our model, the number of unemployed workers and the number of apprenticeship training positions are endogenously determined and depend on the individual ability of workers. Nevertheless, the model has been kept simple for expositional and calculational reasons. The theoretical results of our stylized model only allow for qualitative conclusions concerning the implementation of tax credits in the context of the German system of apprenticeship training and social security. In order to assess the quantitative magnitude of these effects, we would have to estimate the elasticities of the workers' labor supply and training responses at the extensive margin. However, the underlying insights into the model presented here are robust to various types of generalization. Hence, they constitute a promising basis for policy recommendations and for future research.

A Calculation of the Optimal Basic Transfer

The optimization problem is described in part 5.2. Substituting the pivotal abilities θ_U^{TC} and θ_A^{TC} into the FOC (47) yields

$$\begin{aligned}
\frac{\partial W^{TC}(y)}{\partial y} &= 0 \\
\delta\theta_U^{TC}\left(-\frac{\partial\theta_U^{TC}}{\partial y}\right) &= \delta\alpha\theta_A^{TC}\frac{\partial\theta_A^{TC}}{\partial y} - \frac{\partial\theta_A^{TC}}{\partial y}e \\
\delta\frac{z-y}{(1-s)^2\beta^2} &= \alpha\frac{e+\delta y}{\beta^2(\alpha+s)^2} - \frac{e}{\beta(\alpha+s)} \\
\delta(\alpha+s)^2(z-y) &= (1-s)^2\alpha(e+\delta y) - (1-s)^2(\alpha+s)\beta e \\
\delta[(\alpha+s)^2+(1-s)^2\alpha]y &= \delta(\alpha+s)^2 z + (1-s)^2[(\alpha+s)\beta-\alpha]e
\end{aligned}$$

Solving for y yields the optimal basic transfer

$$y^* = \frac{(\alpha+s)^2}{(1+\alpha)(\alpha+s^2)}z + (1-s)^2\frac{(\alpha+s)\beta-\alpha}{\delta(1+\alpha)(\alpha+s^2)}e \tag{A1}$$

B Comparative Statics of the Optimal Basic Transfer

It is important to analyze in which way the optimal basic transfer is affected by changes in the key parameters of the model. The comparative statics with respect to unemployment benefits, phase-out rate, training costs and productivity-enhancement are as follows:

$$\frac{\partial y^*}{\partial z} = \frac{(\alpha+s)^2}{(1+\alpha)(\alpha+s^2)} > 0 \tag{B1}$$

$$\frac{\partial y^*}{\partial s} = \frac{2\delta(1-s)(\alpha+s)\alpha(1+\alpha)z + (1-s)(1+\alpha)[(1-s)\left(\alpha+s^2\right)\beta + 2(\alpha+s)(\alpha-(\alpha+s)\beta)]e}{\delta[(1+\alpha)(\alpha+s^2)]^2} > 0 \tag{B2}$$

$$\frac{\partial y^*}{\partial e} = (1-s)^2 \frac{(\alpha+s)\beta-\alpha}{\delta(1+\alpha)(\alpha+s^2)} > 0 \tag{B3}$$

$$\frac{\partial y^*}{\partial \alpha} = -(1-s)^2 \frac{\delta s(\alpha+s)z + [s(1-s)^2\beta + (\alpha+s)(s(1+\beta)-(1-\beta)\alpha)]e}{\delta[(1+\alpha)(\alpha+s^2)]^2} < 0 \tag{B4}$$

Note that the sign of the partial derivatives is unambiguous because the phase-out rate exceeds some lower bound. This condition is implied by the assumption $\bar{\theta} < 1$.

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