Spillovers in Vocational Training

An Analysis of Incentive Schemes and Reimbursement Clauses

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"[A] perspective on labor markets based on the view that 'monopsony' is important [leads] to a much better understanding of a very wide range of labor market phenomena." (Manning 2003, xi)

Abstract

The German apprenticeship system has often been considered a role model for vocational education. But recent shortages in apprenticeship positions have led to a renewed debate about appropriate training policy. At present, there are renewed calls to introduce a training levy scheme, which would impose training levies on non-training firms and give additional support to training firms. Some economists favor this policy in order to counteract poaching of trained apprentices. Other economists oppose it strongly on the basis that positive spillovers do not occur. Still others suggest to loosen training regulations and allow for reimbursement clauses in training contracts. Surprisingly, a general economic analysis and comparison of these alternative instruments is still lacking. This work attempts to close this gap. It investigates whether poaching enables to derive positive spillovers from apprenticeship training, and if so, whether training policy could play a mitigating role.

Following the recent training literature, we use a simple oligopsonistic labor market model with endogenous turnover. Such a setting allows us to explain why firms provide and (at least partially) finance general vocational training. Moreover, it demonstrates that a positive externality arises as competing firms benefit from vocational training through poaching. We then introduce alternative policy instruments into the model. In principle, the Pigouvian prescription of a perfect subsidy scheme financed by a non-distortionary tax could restore the social optimum. The proposed training levy scheme, however, is a particular scheme that links subsidies and levies. This paper demonstrates that it basically corresponds to a uniform subsidy on apprenticeship training that is financed by a distortionary tax on labor.

We show that introducing this training levy scheme can entail ambiguous repercussions on general welfare even when transaction costs are excluded.

Reimbursement clauses, in contrast, oblige the trainee to compensate for training when quitting the firm. They alter workers' outside options and thereby increase firms' wage-setting power. In this model, in opposition to earlier studies, we show that they do not affect training spillovers. Instead, they are identified as an implicit training loan.

JEL Classification: I22, H23, I28, J24, K31

Keywords: Vocational Education, Frictional Labor Markets, Poaching, Training Levy, Reimbursement Clauses

Inhaltsangabe

Die duale Ausbildung durch Betriebe und Berufsschulen in Deutschland gilt weltweit als vorbildhaft für die berufliche Bildung. Angesichts des Mangels an betrieblichen Ausbildungsplätzen werden nun jedoch staatliche Maßnahmen gefordert. So wird gegenwärtig erneut die Einführung einer Ausbildungsumlage vorgeschlagen, die nicht-ausbildende Betriebe mit einer Abgabe belegen und ausbildende Unternehmen zusätzlich fördern soll. Unter Ökonomen ist dieses Vorhaben umstritten. Einige befürworten diese Politik, um dem systematischen Abwerben von ausgebildeten Arbeitskräften durch nicht-ausbildende Betriebe (engl. *poaching*) entgegenzuwirken. Dagegen lehnen andere dieses Instrument ab und verneinen die Möglichkeit, aus fremder Ausbildung Vorteile erzielen zu können. Wiederum andere empfehlen, betriebliche Ausbildung zu deregulieren und hier insbesondere das gesetzliche Verbot von Rückzahlungsklauseln für die Kosten der Erstausbildung aufzuheben.

Erstaunlicherweise fehlt bisher eine eingehende und formale Untersuchung, die diese alternativen Instrumente analysiert und vergleicht. Dieser Beitrag versucht diese Lücke zu schließen. Er untersucht, ob sich durch systematisches Abwerben positive Ausbildungsexternalitäten erzielen lassen, und – wenn dem so ist – ob alternative Politikinstrumente hier zu einer Wohlfahrtssteigerung beitragen können.

Aufbauend auf aktuellen humankapitaltheoretischen Arbeiten wird ein einfaches Modell betrieblicher Ausbildung mit endogener Abwanderung entwickelt. In dem unterstellten Modellrahmen eines friktionellen Arbeitsmarktes werden rationale Unternehmen allgemeine Ausbildung bereitstellen sowie (zumindest partiell) finanzieren. Zugleich lässt sich ein positiver exter-

ner Effekt von Ausbildung auf abwerbende Firmen aufzeigen. Grundsätzlich könnte eine ideale Pigou-Subvention den externen Effekt internalisieren und somit das soziale Optimum wiederherstellen. Dagegen stellt die vorgeschlagene Ausbildungsumlage ein bestimmtes Steuer-Subventions-Verfahren dar. Mit diesem Instrument wird Ausbildung mit einer Einheitssubvention gefördert, während zu ihrer Finanzierung die aktuelle Beschäftigung mit einer Steuer belegt wird. Aus einer Wohlfahrtsanalyse folgt, dass – ungeachtet des positiven externen Effekts und ohne Einbeziehung von Transaktionskosten – die Einführung einer Ausbildungsplatzabgabe nicht zwingend wohlfahrtssteigernd ist.

Im Unterschied dazu verpflichten Rückzahlungsklauseln die Auszubildenden zur Rückzahlung von Ausbildungskosten beim Verlassen des Unternehmens. Hierdurch wird die Außenoption verändert und die Monopsonmacht des Unternehmens erhöht. Entgegen dem Ergebnis anderer Beiträge kann gezeigt werden, dass durch Rückzahlungsklauseln der externe Effekt nicht internalisiert werden kann. Vielmehr drückt eine solche vertragliche Verpflichtung einen impliziten Ausbildungskredit aus, durch den Auszubildende ungeachtet von Kreditbeschränkungen zur Finanzierung der allgemeinen Ausbildung beitragen können.

JEL Klassifizierung: I22, H23, I28, J24, K31

Stichworte: Berufliche Bildung, Arbeitsmarktfriktionen, Abwerbung, Steuer-Subventions-Verfahren, Ausbildungsplatzabgabe, Rückzahlungsklauseln

Contents

List of Figures

List of Tables

List of Symbols

α_{it}	Training quota of firm i in period t
$\hat{\alpha}$	Mandatory training quota
β_{it}	Incentive payment of firm i in period t
γ_{it}	Share of workforce of firm i in period t
δ	Mismatch costs
ε	Share of training returns
θ	Worker characteristics
$\hat{\theta}$	Indifferent worker
θ_i	Position of firm i
λ, μ	Lagrange multiplier
π_{it}	Profit of firm i in period t
ρ	Discount rate
τ	Tax amount
$\phi_{it}(.)$	Inverse of (net) training cost function of firm i in period t
ϖ	Share of training costs
A_{it}	Apprentices by firm i in period t
b_{it}	Reimbursement amount of workers trained at firm i in period t
$c_{it}(A_{it})$	(Net) Training cost function of firm i in period t
E	Training expenditures
G	Excess of future training receipts over wages
I	Interval length
k	Training expenses

N_{it}	Workers by firm i in period t
p	Penalty amount
r	Interest rate
R	Returns from training
v_{it}	Worker productivity in firm i in period t
w_{it}	Wage rate of firm i in period t
$\tilde{w}_{it}(\theta)$	Net wage of worker θ in firm i in period t
W_t	Welfare in period t
x	Training quantity
X_{it}	Externality from training in firm i in period t
z	Subsidy amount

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Stefan Bornemann

This document has been composed using LaTeX.

Chapter 1

Introduction

1.1 Motivation

The German apprenticeship system is often regarded as a role model for vocational education. Several characteristics have established this good reputation. Firstly, the system provides basic vocational education to a large share of the workforce. Secondly, apprenticeship training is well-structured and leads to a certified qualification that is widely recognized among employers. Thirdly, the system is renowned for its *duality* of simultaneous schooling and on-the-job training by employers. It thereby allows for learning to be both theoretical and practical. Likewise, the involvement of firms ensures that skills are highly applicable and useful in the labor market.

In recent years, however, the number of apprenticeships as well as the proportion of training firms has declined. Given the pivotal role of the apprenticeship system for vocational education in Germany, this development raises strong concerns among trade unions, industry associations, and political parties. On the one hand, it is feared that with fewer openings for apprenticeship training available to school leavers, more young people will enter the labor market without a formal qualification. This could add to unemployment, which is already staggering among unskilled workers. On the other hand, there are worries that less training at present will result in a smaller qualified workforce in the future. This could in the long term seriously damage technological progress and economic growth. In light of the decline in apprenticeship training, the German government is considering to introduce a *training levy scheme*. According to a recently proposed law, private firms would be eligible to receive training grants or required to pay training levies if their training exceeds or falls below a certain level. By using this incentive scheme, the federal government aims to revitalize apprenticeship training without requiring any public funds. While attempts for legislation have repeatedly failed at the federal level, similar schemes have in fact been set-up through collective agreements in some branches of the German industry. Also several other industrialized countries employ such incentive schemes for vocational or even continuous training.[1]

The public announcement to consider and possibly introduce such a training levy scheme has stirred a lively debate. While the majority of employers dismisses this proposal, unions welcome it widely. Naturally, this could simply arise from their opposing interests. Surprisingly however, this division also applies to economists. In their research they vary strongly in the assessment of the problem and appropriate policy responses. Some estimate the decline in training to be cyclical or demographic, and thus of a transitional or exogenous nature. Others, by contrast, conclude that higher training wages are the cause of reduced training. Still others explain the decline by *poaching* of trained apprentices by non-training firms.[2]

Proponents of the latter explanation admit a possible role for public policy to internalize training spillovers, yet they disagree with this particular proposal. Some authors paradoxically predict training and employment to decrease as a result of this scheme, although it would pay out grants for additional training. As an alternative, several publications suggest to suspend

[1] Neighboring Denmark and France are commonly cited examples. France actually uses training levies to fund vocational training as well as continuous training. The United Kingdom, by contrast, discontinued its levy-grant system for industrial training. For an international survey on such training schemes see in particular Gasskov (1994). See also below in section 5.3.1 for a short overview.

[2] Examples of these diverse views can be found in Alewell (2004), Bosch (2004*b*), Nagel & Jaich (2004), and Wößmann (2004) in an issue of ifo Schnelldienst focussing on vocational training policy.

legal restrictions on reimbursement clauses (Alewell 1997, Alewell & Richter 2001, e.g.). This also seems to be the position of the German Council of Economic Advisers:

> "Due to its negative consequences on employment and apprenticeship positions and its bureaucratic requirements, the training levy initially considered by the federal government is inappropriate to internalize particular external effects on non-training firms that benefit from employing skilled workers trained in other firms. If an internalization of such external effects and its inherent prevention of a possible underinvestment in vocational training is aimed for, then this could be achieved more easily. To this end, the [...] legal ban to negotiate reimbursement clauses could be lifted." (Sachverständigenrat 2004, 500, translation and omissions by author.)

Besides apprenticeship training, there is a similar debate on continuous on-the-job training. This debate discusses whether poaching of trained workers reduces firms' incentives for continuous training and whether public policy is required as a corrective. Economists disagree on continuous training policy in the same manner. The expert commission's report on life-long learning reflects this indecision. Nevertheless, the report proposes training levies at the branch level.

> It is originally not the task of the state to finance continuous vocational training. However, the state can improve the conditions for business initiatives, support pioneering models ... and broaden their use, or act where the market fails. [...] The Commission proposes, ... to declare collective agreements on cost-sharing of continuous training to be legally binding ... in order to increase firm participation in life-long learning. (Sachverständigenkommission 2004*b*, 189, translation and omissions by author.)[3]

[3] Explanatory note: A collective agreement between an employers' association and its

Apart from the practical interest in training policy, there is also a theoretical need for studying on-the-job training. So far, the theoretical literature offers conflicting responses to the question whether or not poaching induces training spillovers. The prominent work of Pigou (1912) argues that non-training firms can systematically offer higher wages because no training costs were incurred. This enables them to successfully poach workers that have been trained elsewhere. Training firms are then deprived of their investment and will as a result decrease their training efforts. If this reasoning is true, then vocational training would indeed be provided inefficiently. It would bring about positive spillovers since trained workers are beneficial to both firms. Hence, a policy that burdens poaching or supports on-the-job training could improve social welfare. This view has been disputed by human capital theory. It claims that poaching of skilled workers is not associated with an externality. Since firms only provide but do not pay for general training, such public policy would not be required.

1.2 Research Questions

Despite practical and theoretical interest in appropriate training policy, research that examines and compares effects of alternative instruments for on-the-job training is scarce. A formal theoretical analysis of the proposed training levy scheme is, at least to the author's knowledge, still lacking.[4] Likewise, although reimbursement clauses are claimed to be an effective instrument to counter poaching, they have not been intensively studied in the context of poaching.

It is the intention of this work to investigate these issues and contribute to the debate on vocational training theory and policy. In particular, this study aims to answer the following questions from an economic perspective:

complementary trade union can be declared legally binding for all employers and all workers in this branch if there is an overriding public interest. For conditions and legal procedure, see accompanying commentaries to §5 Tarifvertragsgesetz.

[4] See Franz (1983) on the study of an earlier policy proposal aiming for the introduction of a training levy scheme in Germany. However, his analysis is only partial and does not address the question of an externality.

- Does poaching of skilled workers enable non-training firms to benefit from apprenticeship training by training firms?
- Could a training levy scheme increase apprenticeship training and improve social welfare?
- Could reimbursement clauses in training contracts internalize training spillovers?

If the answer to the first question is affirmative, then vocational training would indeed give rise to positive spillovers, which could cause an underprovision of apprenticeship training. Consequently, there would be a potential role for public policy to internalize these external effects. However, it is another issue whether public policy could resolve, or at least alleviate, the problem. Since its instruments also bring about adverse effects and are commonly costly, this leads into questions on suitable policy instruments. With the second question we seek to shed light on training levy schemes. The third question, in contrast, addresses the alternative proposal of reimbursement clauses.

1.3 Course of the Analysis

In order to answer the questions raised, the analysis is divided into eight chapters. After this introduction, chapter two gives a short description of the German apprenticeship system. It offers stylized facts and recent figures on provision, financing, and possible spillovers of vocational training. This outlines important characteristics and puts the economic problem into an empirical perspective.

Chapter three surveys the existing theoretical literature on vocational training and positive spillovers. It reviews the classical references on human capital investments and discusses very recent advances in the economics of on-the-job training.

Inspired by this literature, chapter four introduces a simple training model where firms can choose to provide vocational training or poach skilled workers later on. In this model, firms can be explained to rationally provide and (partially) finance general on-the-job training. Moreover, poaching can be shown to give rise to positive spillovers on non-training firms.

Subsequent chapters then turn to vocational training policy. Chapter five studies incentive schemes. In particular, it analyzes the training levy scheme proposed for Germany and discusses some possible variations. The analysis is self-contained, but builds on the simple model for ease of presentation. Chapter six then generalizes the model by applying it to an unspecified number of firms. In chapter seven the focus is on reimbursement clauses. Finally, the analysis is summarized and conclusions and recommendations for vocational training policy are made. Moreover, a critical evaluation identifies fields for further research.

Chapter 2

Training Institutions and Stylized Facts

This chapter introduces the reader to vocational training in Germany. It will first describe training institutions and then present important stylized facts in order to put the research question into an empirical perspective.

2.1 Training Institutions

Vocational training subsequent to compulsory education differs across jurisdictions. Some countries use *school-based* vocational training. Other countries, in contrast, rely upon *on-the-job* vocational training. The German apprenticeship system represents a mixture of the two distinct types. As apprentices are trained both in vocational schools and at the workplace, it is often described as a *dual system*.[1]

The German apprenticeship system has a long history. It can be traced back to the trade guilds of the middle ages where apprentices joined a master craftsman for training with whom they lived and worked. After a certain training period they could then seek employment in their trade as a journey-

[1] Note that similar vocational training systems exist in Austria and Switzerland. For an international comparison of alternative vocational training systems see for example Gasskov (1994).

man.[2] Since this time, of course, the apprenticeship system has experienced several important changes. Today, it is an integrated part of the greater educational system. Following compulsory secondary education individuals commonly seek vocational education to enter a profession of their choice.

Figure 2.1 displays the main career paths in the German educational system. With the exception of graduates from higher secondary education, who can continue into tertiary education, school leavers typically can choose to directly enter the labor market, enroll into a full-time vocational school or apply for apprenticeship training. In recent history, almost two thirds of the school leavers have typically opted for an apprenticeship.[3]

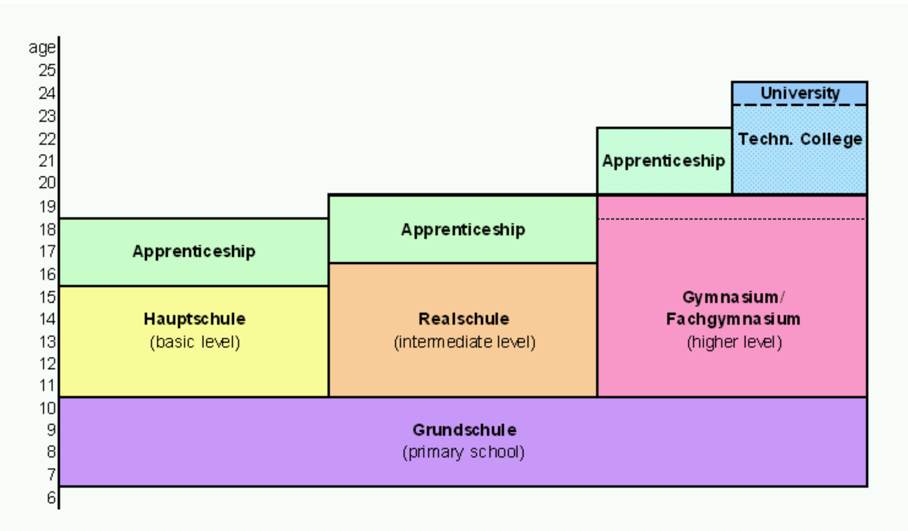

Figure 2.1: Educational System in Germany

Although vocational training in Germany is traditionally based on apprenticeships, there is no legal obligation of firms to offer apprenticeships. Such openings, just as any employment, remain a decision of the firm. But if a firm chooses to do so, it must consent to the legal regulations and conditions

[2] See Smits & Stromback (2001), 1-30, for an interesting historical survey of the apprenticeship system in general. It reveals apprenticeships to be quite common in medieval Europe and traces origins back to Roman times. For the history of the German apprenticeship system see also Kempf (1985), Münch (1987), and Thelen (2004).

[3] Among the population aged between 16 and 24 in 2003, 59.5% have at some point in time been enrolled in apprenticeship training (BMBF 2005, 95).

imposed. The Federal Law on Vocational Training (dt. *Berufsbildungsgesetz*, abbr. *BBiG*) is of central relevance here. It specifies, in particular, that

- the firm and the apprentice are to sign a written contract that specifies, among other things, the trained profession as well as the structure and duration of training (§§3–4 BBiG),
- any clauses restricting the apprentice's choice of employer beyond the contract duration, in particular any provision requiring a training reimbursement, are void (§5 BBiG),
- the firm must provide any instruction and training materials free of charge and is to enable the apprentice to attend the vocational school (§§6–7 BBiG),
- the apprentice is to receive an appropriate remuneration (§§10–12 BBiG),
- the firm as well as its instructors must be eligible and qualified for apprenticeship training (§§20–24 BBiG),
- the training must comply with the profession's training rules (dt. *Ausbildungsverordnung*) (§25–29 BBiG),
- the apprentice is to be examined according to the profession's training rules and receive a letter of reference (§§34ff. BBiG).

Several institutional bodies are involved with apprenticeship training. The Federal Ministry of Education recognizes training occupations and sets corresponding training rules. At present, training rules have been formulated for about 350 professions. They specify the duration, structure and timing of training as well as examination contents and procedures that lead to the vocational degree.[4] Local chambers of industry and commerce as well as craft chambers monitor on-the-job training, examine instructors, and hold final trainee examinations.[5]

[4] For a complete list of all recognized professions see BIBB 2005.

[5] See Münch (1987) for a more extensive description of the German apprenticeship system. Short descriptions can also be found in Neubäumer (1999), 27-30, and Niederalt (2004), 23-27.

On the basis of this description, it can be concluded that apprenticeship training is highly structured and formalized. On the one hand, of course, this puts limits on firms to design on-the-job training according to their needs. On the other hand, this assures training to be broadly applicable. A vocational degree is therefore often depicted as a general training standard that is commonly recognized among employers.

2.2 Stylized Facts

After this short institutional description we will now turn to the empirical facts. Apart from assessing who actually provides and finances training, we seek evidence for the widespread claim that poaching firms benefit from training firms.[6] Public debate as well as the training literature refer to several indicators to substantiate the view of a poaching externality. However, the statistical collection procedure and the informative value of these indicators differ strongly.[7] Moreover, as several institutional bodies monitor and record vocational training, statistics often do not match, which could result in inconsistent or even contradictory conclusions.[8]

In order to thoroughly deal with the economic issue under question, we will proceed in three steps. First, we will look at training provision and firm participation. This will inform on who actually provides vocational training and how it has evolved in recent years. Second, we will look into costs and returns of apprenticeships. At this point we will ask who carries the financial burden of training and whether apprenticeship training remains costly to firms even when benefits are taken into account. Third, we will discuss training spillovers. Here we will search for evidence of poaching showing

[6] For comprehensive information on vocational education in general, see the yearly official reports by the Federal Ministry of Education (e.g. BMBF 2005).

[7] For a thorough discussion of several training indicators see in particular Richter (2000).

[8] The Federal Training Institute counts apprenticeships with the *school year* that have been contracted and registered. By contrast, the Federal Statistical Office counts such apprenticeships contracts with the *calendar year*. The Federal Agency for Employment obtains information on apprenticeship training from unemployment and job registrations. It offers its data to the *end of the second quarter*. In addition, an employer panel survey is conducted by its research branch.

other firms to benefit from apprenticeship training.

2.2.1 Providing Training

At first, take a glance at the *volume of apprenticeship training.* In 2004, a total of 1.2 million individuals were registered as apprentices in a vocational training program. Roughly 450,000 entered into an apprenticeship while about 500,000 successfully passed the final examination. This hints that prior enrollments have been greater than those in 2004. Table 2.1 also informs that most apprenticeship training is provided in industry and commerce, crafts as well as in free professions while maritime shipping, housekeeping and agriculture are of minor importance.[9]

Sector	*Apprentices*	*in %*	*Entrants*	*in %*	*Graduates*	*in %*
Industry & Commerce	639,214	52.7	242,992	54.5	282,924	57.4
Crafts	384,258	31.7	137,261	30.8	133,239	27.1
Agriculture	26,628	2.2	10,717	2.4	11,815	2.4
Public Service	33,213	2.7	11,613	2.6	14,708	3.0
Free Professions	121,582	10.0	39,535	8.9	43,569	8.8
Housekeeping	8,685	0.7	3,239	0.7	6,470	1.3
Maritime Shipping	444	0.0	202	0.1	111	0.0
Total	1,214,024	100.0	445,559	100.0	492,836	100.0

Table 2.1: Volume of Vocational Training by Sector in 2004
Source: StBA 2005*a*, 12, 24, 42.

When comparing with previous years, however, the absolute count of apprentices as well as new entrants has declined significantly. This is displayed in figure 2.2. Considering only *Western* Germany, the number of registered apprentices shrank from 1,715,481 in 1980 to 1,214,024 in 2004, which reflects a reduction of about 30%. However, most of this decline already occurred in the eighties and early nineties. Since 1991, vocational training in *unified* Germany decreased from 1,665,618 to 1,564,064, which is a reduction of

[9] Note that vocational training statistics use a different sectoral classification than common business statistics. Apprentices are attributed to a sector according to the institutional body which is responsible for the training of their trade. An office clerk, for example, is registered among industry and commerce although the training firm may operate in the public sector. The statistics will thus underestimate training by the public sector (StBA 2005, 5).

about 6%.

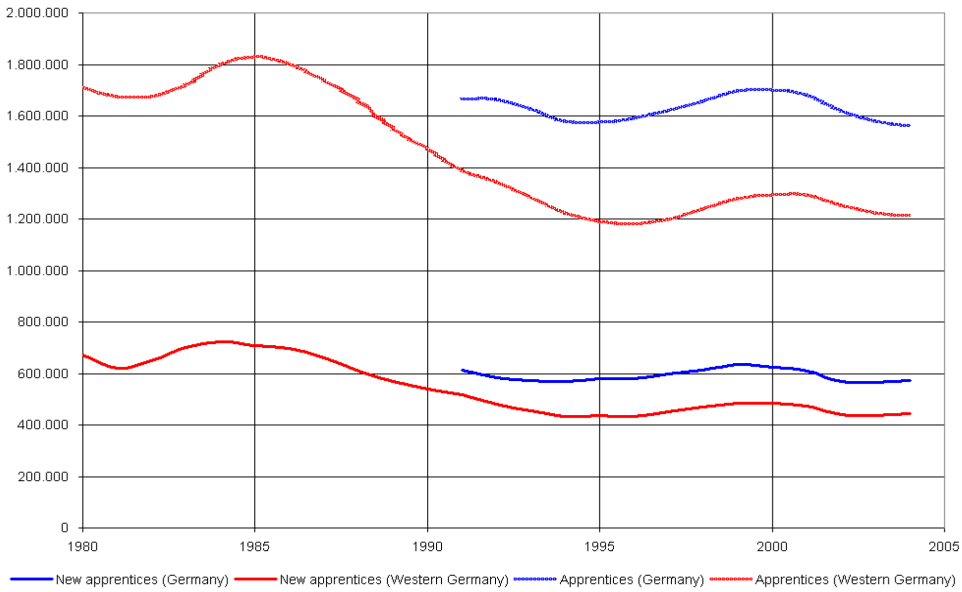

Figure 2.2: Volume of Training over Time
Source: StBA 2005*a*, 11.

Apprenticeship training also declined in relative terms. This is commonly displayed by the *trainee rate* (dt. *Ausbildungsquote*) which denotes the share of apprentices to regular employees.[10] Figure 2.3 depicts the trainee rate in recent years. Since 1980, the trainee rate shrank from 8.2% to 5.2% in *Western* Germany. For *unified* Germany, a slight increase from 5.6% to 5.9% can be displayed between 1991 and 2004.

The absolute and relative development of apprenticeship training implies a general decline in vocational training. This trend is usually attributed to cyclical, structural and demographic changes (Sachverständigenrat 2004,

[10] Trainee rates differ to a great extent with the underlying population. Here, as is common throughout the literature, the trainee rate is the proportion of apprentices to employees that are subject to social insurance contributions (*sozialversicherungspflichtig Beschäftigte*). However, the trainee rate can also be based on the active working population (*Erwerbstätige*). As this is a broader measure, trainee rates are somewhat lower, yet the overall relative decline in training persists (Sachverständigenrat 2004, 497).

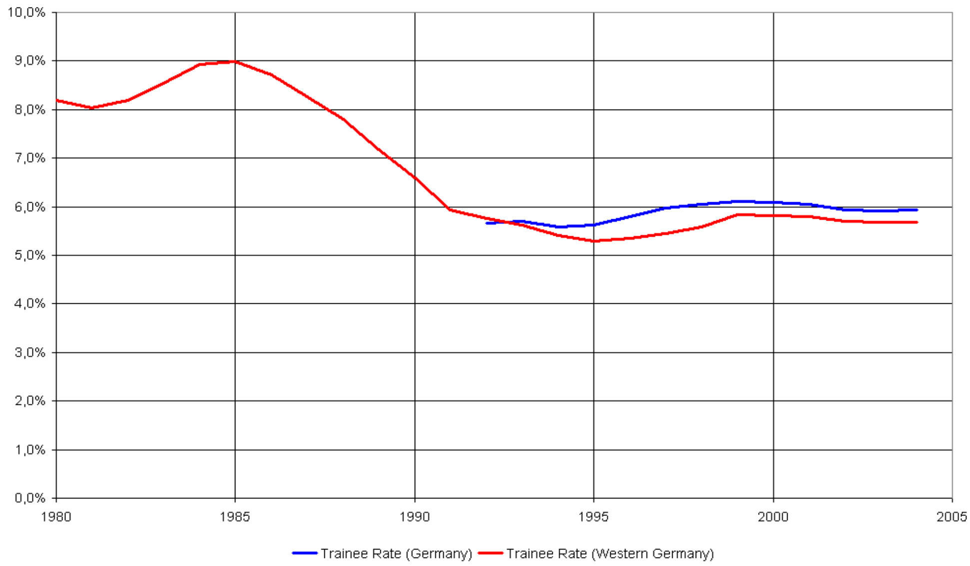

Figure 2.3: Trainee Rate over Time
Source: Own calculation based on table 2.10.

497). However, these figures do not reveal whether there is actually a shortage or a surplus of apprenticeship training. This is a matter of supply and demand for apprenticeships on the labor market.

A rough estimate for supply and demand can be obtained from the Federal Employment Agency. It collects openings and requests for apprenticeship positions, which it aims to match later on. Supply of apprenticeship positions can be inferred from new contracts and unmatched openings. In contrast, demand for apprenticeships can be deduced from new contracts and unmatched applicants. If supply exceeds demand, this would indicate the apprenticeship market to be in surplus. In the opposite case, there would be a shortage.[11]

Table 2.2 displays these figures for unified Germany. It shows that the market for apprenticeships undulates. While there was an excess offer of apprenticeships in the early nineties, recent years increasingly showed a shortage. This can also be demonstrated by the *ratio of supply and demand* where

[11] Note that it is common throughout the literature to use the terms supply and demand inversely to the traditional terminology in labor economics.

a figure above (below) 100 indicates a surplus (shortage).

Year	*Entrants*	*Remain. Openings*	*Remain. Seekers*	*Supply*	*Demand*	*Surplus*	*Ratio*
	a	b	c	d=a+b	e=a+c	f=d-e	g=d/e
1992	595,215	126,610	12,975	721,825	608,190	113,635	118.7
1993	570,120	85,737	17,759	655,857	587,879	67,978	111.6
1994	568,082	54,152	18,970	622,234	587,052	35,182	106.0
1995	572,774	44,214	24,962	616,988	597,736	19,252	103.2
1996	574,327	34,947	38,458	609,274	612,785	-3,511	99.4
1997	587,517	25,864	47,421	613,381	634,938	-21,557	96.6
1998	612,529	23,404	35,675	635,933	648,204	-12,271	98.1
1999	631,015	23,439	29,365	654,454	660,380	-5,926	99.1
2000	621,693	25,690	23,642	647,383	645,335	2,048	100.3
2001	614,236	24,535	20,462	638,771	634,698	4,073	100.6
2002	572,323	18,005	23,383	590,328	595,706	-5,378	99.1
2003	557,634	14,840	35,015	572,452	592,627	-20,175	96.6
2004	572,980	13,394	44,576	586,374	617,556	-31,182	95.0
2005	550,180	12,636	40,900	562,816	591,080	-28,264	95.2

Table 2.2: Supply and Demand of Apprenticeship Training from 1992-2005
Source: BMBF (2005), 7. (own translation)

The recent shortages in apprenticeships are sometimes taken as an indicator for reduced training efforts or for free-riding behavior of firms. However, these figures do not imply the existence of a poaching externality at all. They carry rather general information on aggregated supply and demand for apprenticeship training. In order to investigate whether non-training firms benefit from training firms, evidence on *training participation*, i.e. who actually provides training, is of high interest. Some additional information can be offered by differentiating the volume of apprenticeship training by firm size and branch.

Table 2.3 displays employees, apprentices and trainee rates by firm size. In absolute terms, nearly half of all apprentices are employed by firms with fewer than 50 employees. This highlights the importance of small and medium firms for vocational training. In relative terms, however, the trainee rate as the proportion of apprentices to employees decreases with firm size. Apprentices made up 8.0% of the workforce in smallest firms, but 5.5% in large firms with more than 500 workers. When comparing with previous years, smallest firms experienced a decrease in the trainee rate while larger firms remained unchanged or slightly increased.

Firm Size		*1990*	*1999*	*2002*	*2003*
1-9 workers	Employees	3,643,073	5,011,977	4,882,068	4,785,142
	Apprentices	398,648	395,963	389,889	385,114
	in %	10.9	7.9	8.0	8.0
10-49 workers	Employees	4,703,761	6,631,573	6,441,285	6,243,816
	Apprentices	392,582	467,501	440,604	424,286
	in %	8.3	7.0	6.8	6.8
50-499 workers	Employees	7,558,395	10,058,550	10,039,054	9,892,569
	Apprentices	448,587	575,317	582,248	573,007
	in %	5.9	5.7	5.8	5.8
≥500 workers	Employees	6,462,849	6,054,392	5,998,090	5,824,857
	Apprentices	334,461	321,150	325,272	321,627
	in %	5.2	5.3	5.4	5.5
Total	Employees	22,368,078	27,756,492	27,360,497	26,746,384
	Apprentices	1,574,278	1,759,931	1,738,013	1,704,034
	in %	7.0	6.3	6.4	6.4

Table 2.3: Trainee Rate by Firm Size
Source: BMBF 2005, 123, and BMBF 1999, 138.

Vocational training not only differs with firm size, but also across branches. Table 2.4 displays the trainee rate by various branches in Western and Eastern Germany.[12] In the construction industry 7.6% of all employees are apprentices. This is a ratio of about one in every thirteen employees. In the field of transport and communications, in contrast, only 2.0% of all employees receive vocational training, which equals a ratio of about one in every 50 employees.

These trainee rate figures demonstrate strong structural differences in apprenticeship training. This is often taken as an indication for free-riding behavior. Yet, this conclusion is premature. The trainee rate is an imperfect indicator of training participation because strong firm size and branch effects are an obvious implication of varying production technologies and factor inputs.

[12] These figures result from the employer panel survey. Trainee rates therefore do not match perfectly with previous figures.

Branch	*Western Germany*				*Eastern Germany*			
	2000	2001	2002	2003	2000	2001	2002	2003
Agriculture, forestry, fishery	5.6	6.8	6.3	6.6	6.3	5.1	4.6	6.0
Mining, energy, water supply	4.0	4.3	3.7	3.5	5.0	4.6	5.4	5.5
Food and stimulants	5.2	5.4	5.5	5.2	10.3	8.8	7.8	8.6
Consumer goods	2.8	3.7	4.2	4.0	4.5	6.1	6.6	6.2
Investment and durable goods	3.3	3.2	3.4	3.5	5.5	4.4	4.9	4.8
Producer goods	4.2	4.2	4.7	4.4	5.1	5.7	5.9	5.4
Construction	8.5	7.9	8.0	7.6	7.8	7.0	7.3	6.0
Trade, maintenance, repair	5.8	5.9	5.4	5.6	7.0	7.3	6.9	6.9
Transport, communications	2.5	2.2	2.3	2.0	2.4	2.9	2.7	2.2
Bank and insurance industry	4.8	5.0	5.2	5.3	6.2	6.1	5.7	4.9
Hotel and restaurant industry	4.9	5.1	4.8	5.7	8.1	5.9	9.3	9.9
Teaching and instruction	6.6	6.0	5.5	6.3	19.9	20.6	19.1	17.7
Health, veterinary and social	5.8	5.5	5.5	5.4	4.6	4.6	4.6	4.9
Business services	5.1	4.0	4.8	4.7	5.5	7.0	4.5	4.9
Other business services	1.2	1.8	1.9	1.6	1.7	1.5	1.6	1.5
Other services	4.4	4.4	4.3	3.9	3.8	5.4	3.9	4.5
Non-profit, government	3.0	3.4	3.3	3.5	2.9	3.3	3.1	3.3
Total	4.6	4.6	4.7	4.6	6.2	6.2	5.9	5.9

Table 2.4: Trainee Rate by Branch in Western and Eastern Germany
Source: BMBF 2004*a*, 99, BMBF 2005, 128 (own translation).

Another indicator of training participation is the share of training firms (dt. *Ausbildungsbeteiligungsquote*). It denotes the proportion of firms presently providing any apprenticeships to all firms.[13] Figure 2.4 reveals that the share of training firms has decreased considerably over time. For Western Germany, it is down from 34.3% in 1985 to 24.6% in 2003. In Eastern Germany, the share attains only 23.4% in 2003.

Note that this indicator describes average training participation at some point in time. It considers a firm to be a training firm with a single apprentice already. Clearly, training volumes could differ across firms which this indicator could not differentiate.

As before, the share of training firms may be also displayed in relation to firm size and branch. Table 2.5 displays training participation according to firm size. It shows that firms with less than 50 employees make up the vast majority of all training firms. In relative terms, however, training participa-

[13] A slight variant of this indicator is the proportion of training firms to *eligible* training firms. Eligible training firms are the subset of all training firms, which fulfill the legal requirements for training apprentices.

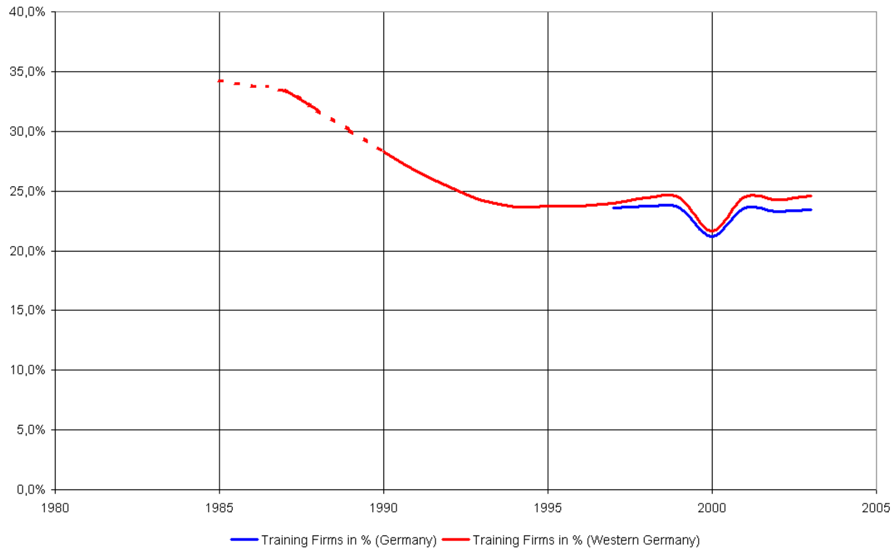

Figure 2.4: Share of Training Firms
Source: Own calculation based on table 2.10.

tion increases with firm size. Only 16.8% of smallest firms train, while this share attains 90.4% for large firms.[14]

Clearly, training participation also differs across branches. Table 2.6 depicts the share of training firms by branch separate for Western and Eastern Germany. A high training participation can be observed in food, investment goods, construction, or health, while transport or business services show rather low participation rates.

Despite their shortcomings, the figures to this point indicate vocational training to be declining. As some demand for vocational training remains unmatched, shortages of apprenticeships are present. However, even though training participation by firms is small and declining, this does not imply an externality problem. Above figures rather imply structural changes in the demand and supply for apprenticeships.

In order to substantiate the claim of positive training spillovers, which could principally account for some training shortages, more knowledge is

[14]Firms' training participation according to firm size is sometimes referred to as density of training firms (dt. *Ausbildungsbetriebsdichte*).

Firm Size		*1990*	*1999*	*2002*	*2003*
1-9 workers	All firms	1,237,052	1,708,241	1,670,382	1,644,449
	Training firms	264,984	282,915	277,090	275,542
	in %	21.4	16.6	16.6	16.8
10-49 workers	All firms	236,762	333,384	323,120	312,842
	Training firms	122,439	157,879	148,051	143,939
	in %	51.7	47.4	45.8	46.0
50-499 workers	All firms	59,063	81,168	80,679	79,542
	Training firms	43,494	55,929	54,322	54,249
	in %	73.6	68.9	67.3	68.2
≥500 workers	All firms	4,794	5,038	4,976	4,829
	Training firms	4,508	4,603	4,496	4,366
	in %	94.0	91.4	90.4	90.4
Total	All firms	1,537,671	2,127,831	2,079,157	2,041,662
	Training firms	435,425	501,326	483,959	478,096
	in %	28.3	23.6	23.3	23.4

Table 2.5: Share of Training Firms by Firm Size
Source: BMBF (1999), 137, BMBF (2005), 122.

Branch	*Western Germany*				*Eastern Germany*			
	2000	2001	2002	2003	2000	2001	2002	2003
Agriculture, forestry, fishery	22.0	26.9	32.6	27.8	26.3	25.9	31.7	27.5
Mining, energy, water supply	32.5	23.2	28.1	25.1	42.5	43.7	34.5	34.6
Food and stimulants	48.5	45.3	53.2	52.0	53.6	45.7	45.1	53.2
Consumer goods	22.2	40.0	38.5	34.8	28.1	41.6	39.3	40.1
Investment and durable goods	36.1	41.2	41.4	43.1	43.0	35.2	35.0	33.1
Producer goods	43.7	39.0	44.3	40.0	39.9	45.9	44.2	45.1
Construction	47.0	44.4	45.8	40.8	35.9	34.3	34.3	29.5
Trade, maintenance, repair	29.3	32.3	32.0	29.6	27.2	28.1	28.0	28.7
Transport, communications	20.3	15.7	15.1	15.3	12.1	12.9	12.9	13.1
Bank and insurance industry	29.7	28.1	30.9	31.3	20.6	35.5	20.5	15.3
Hotel and restaurant industry	10.3	10.2	13.9	13.2	19.2	14.6	23.5	23.2
Teaching and instruction	33.3	32.9	23.5	21.7	17.3	17.7	15.1	16.6
Health, veterinary and social	39.5	40.9	40.8	42.9	20.5	26.0	19.9	19.3
Business services	30.7	23.7	29.1	32.7	31.0	31.4	21.1	25.8
Other business services	16.8	18.8	19.3	17.7	13.8	16.1	17.8	13.3
Other services	27.6	29.3	29.4	25.7	21.9	23.2	17.1	19.2
Non-profit, government	13.2	22.1	16.6	15.9	12.3	12.4	13.9	12.8
Total	29.7	30.4	31.3	29.9	26.1	27.0	25.7	25.0

Table 2.6: Share of Training Firms by Branch in Western and Eastern Germany
Source: BMBF (2005), Table 49, 123 (own translation).

needed. In particular, we require information on whether training is costly to firms and whether non-training firms benefit from this effort. We will therefore now have a closer look at the financing of training.

2.2.2 Financing Training

Firms that employ apprentices for vocational training incur costs. These costs consist of *direct costs* and also *indirect costs*. Expenses for training materials and trainee wages are examples for the former category whereas foregone production of experienced workers are examples for the latter. At the same time, firms also receive benefits from training. Similar to costs, these can be *direct benefits* and *indirect benefits*. The productive output of apprentices denotes an example for direct benefits. In contrast, savings on future recruitment costs are of an indirect nature since they arise only if apprentices enter into a regular employment after training.

Several studies seek to estimate the net position of firms from apprenticeship training. Bardeleben et al. (1995) use an accounting approach in order to estimate the yearly training costs per apprentice. They conduct an employer survey for information on four cost categories: personnel costs of apprentices, personnel costs of instructors, equipment costs, and other costs. Figure 2.5 displays their classification of training costs.

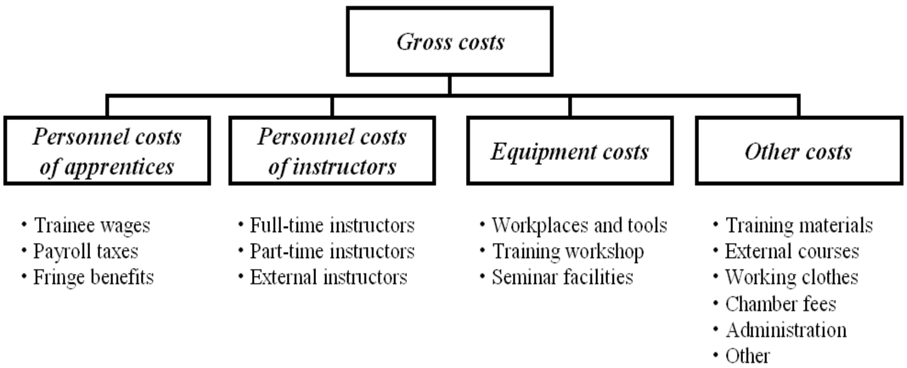

Figure 2.5: Gross Costs of Apprenticeship Training
Source: Shorted translation of Bardeleben et al. (1995), 27.

The results of their representative survey are displayed in table 2.7. It states gross training costs per apprentices to average about DM 30,000 annually (≈ € 15,000). Most of these costs arise from trainee wages and costs of instructors, whereas equipment and administrative costs are of minor importance. Moreover, the figures are generally higher in industry and commerce than in crafts.

By accounting for training returns, this study also provides a measure for net yearly training costs.[15] They are estimated to equal about DM 18,000 annually (≈ € 9,000) per apprentice. This study therefore concludes that apprenticeship training is costly to firms.

Cost Item	*Industry and Commerce*		*Crafts*		*Average*	
	in DM	in %	in DM	in %	in DM	in %
Personnel Costs of Apprentices	15,930	50.0	11,323	45.4	14,435	48.8
Personnel Costs of Instructors	12,018	37.7	10,889	43.7	11,652	39.3
Equipment Costs	1,236	3.8	657	2.6	1,048	3.5
Other Costs	2,639	8.3	2,019	8.1	2,437	8.2
Gross Costs	*31,824*	*100.0*	*24,889*	*100.0*	*29,573*	*100.0*
./. Returns	11,315	35.5	12,536	50.3	11,711	39.6
Net Costs	*20,509*	*64.4*	*12,352*	*49.6*	*17,862*	*60.3*

Table 2.7: Yearly Training Costs per Apprentice
Source: Bardeleben et al. (1995), 125 (own translation).

Several authors criticize these costs estimates for methodological reasons. In particular, they question the calculation method to account only insufficiently for indirect costs and benefits (e.g. Acemoglu & Pischke 1998, Smits & Stromback 2001, 100ff.). Subsequent studies have tried to overcome these shortcomings. Acemoglu & Pischke (1998) display various evidence for firm-financed general training in general. Harhoff & Kane (1997), in contrast, also estimate vocational training costs by sector and firm size. They calculate the *gross* costs of apprenticeship training across sectors at $17,645 per apprentice and year with on average higher costs in larger firms and industrial sectors. Even after taking apprentices' productivity into account, *net* costs to firms

[15] Bardeleben et al. (1995) estimate training returns using the 'equivalence method', i.e. they estimate the productive value of apprentices from the costs of alternative employment that would be needed to replace the apprentices.

remain high at $10,657 per apprentice and year, or 60% of the gross costs.

2.2.3 Turnover and Poaching

The last section provided some evidence that vocational training is on average costly to firms. If firms are profit-seeking, then this implies an apprenticeship to be an investment in expectation of future returns. Otherwise, these expenses could be allocated in alternative uses. However, if trained workers are poached by competitors, this investment could be lost and give rise to positive spillovers.

Let us now assess whether a poaching externality exists. We therefore study retention rates of former apprentices. Table 2.8 depicts the percentage of workers that enter an employment with the training firm directly after the apprenticeship. These figures indicate that only about 45% of apprentices remain with the training firm. Moreover, the retention rate is generally higher in larger firms.

Firm Size	*Western Germany*				*Eastern Germany*			
	2000	2001	2002	2003	2000	2001	2002	2003
1-9 workers	45.7	44.3	46.6	49.3	48.8	41.3	39.6	30.2
10-49 workers	59.7	50.6	51.4	53.9	49.5	45.9	49.8	43.8
50-499 workers	65.3	65.5	61.8	57.5	40.7	43.7	42.4	39.4
$\geq$ 500 workers	72.4	76.9	72.1	69.4	48.3	35.9	43.5	36.9
Total	60.4	58.8	57.0	56.7	46.0	42.7	44.1	38.7

Table 2.8: Retention Rates of Apprentices by Firm Size
Source: BMBF 2003, 187, BMBF 2004*a*, 152, BMBF 2005, 198.

Table 2.9 again distinguishes for branches. It displays that retention rates differ remarkably with the area of business activity. In teaching and instruction, 7% of apprentices remain for employment with the firm. This contrasts to apprentices in bank and insurance where this figure attains 75%.

This indicator is of course imperfect as it displays the retention rate of apprentices only at a single point in time. Studies based on panel data show retention rates to decline steeply. For Germany, they state that only about 30% of apprentices remain after five years in a typical firm (Harhoff & Kane 1997, 179). So if we accept that vocational training is beneficial

Sector	*Western Germany*				*Eastern Germany*			
	2000	2001	2002	2003	2000	2001	2002	2003
Agriculture, forestry, fishery	43.5	30.5	14.8	45.9	38.7	36.0	30.9	21.8
Mining, energy, water supply	73.1	85.2	72.0	60.4	68.2	61.3	66.3	61.6
Food and stimulants	64.9	61.3	58.3	59.7	47.9	52.0	50.6	28.4
Consumer goods	65.3	55.0	60.9	55.0	74.5	67.0	51.8	49.6
Investment and durable goods	79.3	68.5	72.5	68.0	68.4	68.4	60.0	60.9
Producer goods	70.8	84.9	80.0	79.0	74.3	72.4	69.6	65.1
Construction	63.0	64.7	56.3	54.2	50.3	48.1	48.9	44.2
Trade, maintenance, repair	63.0	59.6	56.4	52.0	53.6	41.5	59.0	43.4
Transport, communications	74.4	67.0	63.9	69.4	67.3	68.2	67.0	40.0
Bank and insurance industry	87.2	85.0	81.4	74.5	67.8	75.4	63.3	71.9
Hotel and restaurant industry	31.4	28.3	28.3	32.6	39.8	49.7	31.3	31.4
Teaching and instruction	9.4	16.1	16.2	7.0	10.8	7.8	3.4	5.1
Health, veterinary and social	46.0	49.7	44.3	48.5	31.7	32.6	34.5	32.3
Business services	60.5	44.6	46.6	62.9	43.6	52.4	43.6	40.0
Other business services	39.9	33.7	58.7	42.8	74.7	39.9	49.2	44.3
Other services	52.6	42.4	52.9	56.3	75.3	32.4	62.0	51.4
Non-profit, government	64.5	60.7	65.6	65.2	45.2	47.2	58.2	48.5
Total	60.4	58.8	57.0	56.7	46.0	42.7	44.1	38.7

Table 2.9: Retention Rates of Apprentices by Branch
Source: BMBF 2002, 487, BMBF 2003, 187, BMBF 2004*a*, 153, BMBF 2005, 199 (own translation).

for several consecutive periods, this strongly supports the claim of positive training spillovers.

2.3 Discussion

This chapter provided a short introduction to the German apprenticeship system. It pointed out that rules and institutions strongly formalize and regulate apprenticeship training. This is to ensure that apprenticeships offer quite general skills that are widely applicable within a profession. A vocational degree can thus be regarded as a standard vocational qualification that is commonly accepted across firms.

A rough survey of statistics and empirical studies then sought to understand who actually provides and finances apprenticeship training and whether there is evidence for a poaching externality. The absolute count of apprentices underlined the importance of the apprenticeship system for vocational education in Germany. Yet, several indicators pointed to the fact that the volume of training as well as the participation by firms have declined in recent years. While this could result from structural changes, it could also be shown that training firms bear an important share of the training costs and face a considerable risk of apprentices quitting after training. Although these figures differ strongly with firm size and sector, they are supportive to the claim of apprenticeship training giving rise to training spillovers. Thus, in light of these stylized facts, there is a need to theoretically investigate whether poaching induces training spillovers and whether training policy could have a mitigating role.

2.A Appendix

Year	*Employees*	*Apprentices*	*Entrants*	*Trainee Rate*
		Western Germany		
1980	20,953,864	1,715,481	669,901	8.19%
1985	20,378,397	1,831,501	709,322	8.99%
1990	22,368,078	1,476,880	538,179	6.60%
1991	23,409,885	1,391,010	515,667	5.94%
1995	22,547,730	1,194,043	434,934	5.30%
2000	22,323,721	1,297,202	482,913	5.81%
2001	22,356,509	1,296,327	474,761	5.80%
2002	22,036,653	1,255,634	441,898	5.70%
2003	21,555,574	1,226,492	436,873	5.69%
2004	21,342,537	1,214,024	445,559	5.69%
		Unified Germany		
1991	30,000,000	1,665,618	613,852	5.55%
1995	28,057,050	1,579,339	578,582	5.63%
2000	27,979,593	1,702,017	622,967	6.08%
2001	27,864,091	1,684,669	609,576	6.05%
2002	27,360,497	1,622,441	568,082	5.93%
2003	26,746,384	1,581,629	564,493	5.91%
2004	26,381,842	1,564,064	571,978	5.93%

Table 2.10: Volume of Employees, Apprentices, and Entrants
Source: StBA 2005*a*, 12, 24, 42; StBA 2005*b*, 76.

Year	*All Firms*	*Training Firms*	*Rate*
Western Germany			
1985	1,453,907	498,304	34.3%
1987	1,475,983	493,543	33.4%
1988	1,506,765	478,652	31.8%
1990	1,537,671	435,425	28.3%
1991	1,572,491	419,774	26.7%
1995	1,633,747	387,874	23.7%
1999	1,639,210	400,873	24.5%
2000	1,828,405	395,984	21.7%
2001	1,648,709	403,675	24.5%
2002	1,631,390	396,560	24.3%
2003	1,602,954	394,051	24.6%
Eastern Germany			
1997	2,044,773	482,414	23.6%
1998	2,080,041	493,258	23.7%
1999	2,127,831	501,326	23.6%
2000	2,328,952	493,941	21.2%
2001	2,107,467	496,476	23.6%
2002	2,079,157	483,959	23.3%
2003	2,041,662	478,096	23.4%

Table 2.11: Volume of Firms and Training Firms
No data available in 1980-1984, 1986, 1989 for Western Germany, and prior to 1997 in Eastern Germany.
Source: BMBF 2000, 141; BMBF 2003, 114; BMBF 2004*a*, 104, 106; BMBF 2005, 122.

Chapter 3

Vocational Training and Positive Spillovers

The question of positive spillovers from vocational training has long ago attracted the interest of economists. Early contributions hinted at the problem of positive externalities accruing to society and proposed policy measures to improve welfare. Later contributions, quite to the contrary, questioned the existence of such positive spillovers and offered completely different policy conclusions. In light of these opposing views, a short review of the literature on vocational education and positive spillovers seems strongly mandated.[1]

3.1 Theoretic Precursors

The existence of educational spillovers has already been claimed by classical economists. Smith (1776), in his renowned contribution, emphasizes that education positively affects social life beyond mere skill acquisition. In view of these social benefits he derives a role for the state in providing basic education and suggests partial public contributions.

> "For a very small expen[s]e the public can facilitate, can encourage, and can even impose upon almost the whole body of

[1] For an extended overview on the history of educational economics see, for instance, Pfahler (2000).

> the people, the necessity of acquiring [the] most essential parts of education. The public can facilitate this acquisition by establishing in every parish or district a little school [...]; the master being partly, but not wholly, paid by the public, because, if he was wholly, or even principally, paid by it, he would soon learn to neglect his business." (Smith 1776, 990)

While Smith's analysis was concerned with education in general and with incentives for instructors in particular, later writers dealt more specifically with industrial training. Marshall (1920) compared basic education to a technical education for a particular occupation. He also distinguished general abilities from specialized abilities, with the former applicable in all industries and the latter only in an individual trade. Moreover, he pointed out that public and private expenditures into training should not be measured on the basis of their direct returns alone (Marshall 1920, IV, Ch. vi, §3.).

Simultaneous with the industrial revolution, economists increasingly observed a lack of technical education. On the one hand, universal apprenticeship training declined as machines and assembly lines replaced manual techniques and pushed traditional trades and crafts aside. On the other hand, the expanding industrial sector offered only little on-the-job training. Industrial workers were left to execute simple and repeatable tasks, despite striking opportunities to enlarge their skills and qualifications Smits & Stromback (2001).

This development led to concerns on whether technical education was an employer obligation or foremost a public duty. Pigou (1912) is acknowledged for the first economic analysis of on-the-job training. He emphasized that a training firm may be inhibited from obtaining the full returns to its training efforts because, with some workers quitting for another firm, the new employer also participates in the returns to training. Thereby he identified *poaching* as the source of the discrepancy between private and social returns to training. The following quotation illustrates this idea.

> "It is, however, obvious that openings exist for investments by the tenant (i.e. the employer) in workpeople's capacity, which

> would yield considerable social net product. Under a slave economy, since the employer could secure for himself the whole result of increased efficiency in his workpeople and their families, the whole of the social net product of any unit of resources invested in the improvement of their quality would be represented in private net product. Under a free economy, however, since workpeople are liable to change employers, and so to deprive investing tenants of the fruits of their investment, the private net product is apt to fall considerably short of the social net product. Hence, socially profitable expenditure by employers in the training of their workpeople, in building up their health, and in defending them against accident does not carry a corresponding private profit." (Pigou 1912, 153)

Pigou observed that this positive spillover from training is lost to the investing firm, but not to society as a whole. From a social point of view, therefore, training will be undersupplied because private investment is only carried out up to the point where additional private returns equal the additional costs. With the extra social returns not taken into account by the training firm, welfare falls short of its optimal level.

Following this assessment of the economic situation, Pigou identified a possible role for the state to improve overall welfare. He proposed to introduce fiscal incentives to private activities that bring about additional returns to society and, vice versa, fiscal disincentives to private activities that entail social costs. With such a policy, the social externalities caused by an action can be attributed to an individual decision and will thereby lead to a true economic calculation. Modern economists now commonly refer to this policy instrument as 'Pigouvian subsidy' or 'Pigouvian tax'.

> "It is plain that divergences between private and social net product of the kind just considered cannot [...] be mitigated by a modification of the contractual relation between any two contracting parties, because the divergence arises out of a service or disservice rendered to persons other than the contracting parties.

> It is, however, possible for the State, if it so chooses, to remove the divergence in any field by 'extraordinary encouragements' or 'extraordinary restraints' upon investments in that field. The most obvious forms, which these encouragements and restraints may assume, are, of course, those of bounties and taxes." (Pigou 1912, 164)

While a Pigouvian tax deliberately discourages the taxed activity and brings about some revenues, a Pigouvian subsidy, by contrast, requires additional financial resources in order to encourage socially beneficial activities. Public funds are however scarce. Thus, in case subsidies are introduced, either alternative public spending is to be discarded or additional funds must be collected. Pigou noted that raising tax revenue inflicts costs on society. Therefore, in case subsidies are introduced to encourage activities beneficial to social welfare, their benefits are to exceed their financial costs.

> "The raising of an additional £ of revenue ... inflicts indirect damage on the taxpayers as a body over and above the loss they suffer in actual money payment. Where there is indirect damage, it ought to be added to the direct loss of satisfaction involved in the withdrawal of the marginal unit of resources by taxation, before this is balanced against the satisfaction yielded by the marginal expenditure." (Pigou 1947, 33-34)

Economists widely accepted Pigou's conjecture of a poaching externality in vocational education. In light of his theoretical assessment, public policy supported a stronger public role in vocational education. Several countries introduced fiscal incentives towards vocational training, both in the form of training grants and training levies. See below in section 5.3.1 for some examples.

However, Pigou's assessment of training, as well as the role of public policy therein, became challenged by human capital theory. It led to major revisions in the economics of on-the-job training.

3.2 On-the-Job Training in Perfect Labor Markets

In contrast to neoclassical economics, human capital theory endorsed a more general concept of capital that allowed in particular for human resources. In analogy to physical or financial capital, *human capital* is perceived as the *stock of knowledge, skills, health, or abilities* that is *embodied in a person* and that *can be put to productive work*. Moreover, human capital can be increased, alike investments in physical or financial capital, by training, schooling or health provisions (Becker 1962, 11).[2]

Despite its intuitive economic appeal, the *concept* of human capital has been the subject of severe debates. In particular, there is a great reluctance to model people as a stock of capital, worrying to reduce mankind to a mere material category. Only recently, the term 'human capital' received the yearly doublespeak award for particularly obscure terminology by a German language watch association Schlosser (2005).

Although understandable from an ethical point of view, this concern can clearly be refuted. Rather than belittling the human nature, human capital theory recognizes the importance of people for economic growth and social progress. Irrespective of its unaesthetic semantics and inherent conceptual limitations, it incorporates the value of education, training, health, and social relationships into economic theory. Moreover, the notion of a capital stock of human resources embodies positive economic properties. Once skills and knowledge have been invested and built up, they enable people to reap a steady flow of economic returns. Thereby their choices and welfare increase (Schultz 1961, 2).

In a well-known contribution, Becker (1962) analyzes incentives for human capital investments. He focuses in particular on motives for on-the-

[2] Initially, the human capital literature drew attention to the shortcomings of neoclassical economics and criticized in particular the prevailing assumption of homogeneous labor. It pointed out that the growth in per capita incomes across countries cannot be explained by using a standard production function approach with stocks of land and capital and the size of the workforce. Therefore, early propopents of human capital theory (Schultz 1961, Becker 1962, Mincer 1974, e.g.) urged to reconsider the representation of people in economic models. They emphasized to account for workers' skills and knowledge as key determinants of economic performance.

job training and questions the emergence of positive spillovers. In contrast to school training, on-the-job training is carried out at the workplace and through the firm. It raises the productivity of the workforce in the future, but it involves costs to the training firm at present, such as time, effort, material, and equipment. Becker points out that resources spent for on-the-job training compete with alternative investment opportunities. Consequently, a firm that incurs additional costs or lower revenues from providing training at present necessarily expects larger revenues or fewer expenditures in the future.

Since Becker's assessment of on-the-job training possesses a central place in the training literature, let us sketch his approach. Let E_t and R_t denote expenditures and receipts from on-the-job training by a firm in period t. Moreover, let r be the market rate of interest. Analogous to investments in physical or financial assets, an investment in human capital is carried out at most so that the present value of expenditures equals those of receipts. Thus, a firm carries out a human capital investment to the extent of fulfilling equation (3.1).

$$\sum_{t=0}^{n} \frac{R_t}{(1+r)^t} = \sum_{t=0}^{n} \frac{E_t}{(1+r)^t} \tag{3.1}$$

The receipts of on-the-job training are the increased marginal product of the worker, while expenditures obviously consist of training costs and wages to employ the worker.

Assume further that training be only given during the initial period, $t = 0$. With v_t referring to the worker's marginal product in period t, w_t being the wage paid to the worker and k standing for any training expenses, the firms investment condition can be rewritten to

$$v_0 + \sum_{t=1}^{n} \frac{v_t}{(1+r)^t} = w_0 + k + \sum_{t=1}^{n} \frac{w_t}{(1+r)^t} \tag{3.2}$$

Becker defines G as the excess of future receipts over future outlays, i.e. $G = \sum_{t=1}^{n-1} \frac{v_t - w_t}{(1+r)^t}$. It can be interpreted as a measure of the return of on-the-job training to the firm. Using G, equation (3.2) simplifies to

$$v_0 + G = w_0 + k \tag{3.3}$$

This states that trainings costs and wage payments in the training period are equal to the marginal productivity and the return from training.

Note that k only measures actual training expenses, but excludes opportunity costs from training. Clearly, if the worker were not receiving training, she could produce v_0^u instead of v_0, where v_0^u denotes the marginal product of an unskilled worker. Total training costs c thus are the sum of actual expenses and opportunity costs, $c = (v_0^u - v_0) + k$. Inserting into condition (3.3) then obtains

$$v_0^u + G = w_0 + c \tag{3.4}$$

Given this basic set-up, Becker now introduces the distinction between *general* and *specific* training. General training raises the worker's marginal product in all firms, regardless whether the worker remains with the firm or quits for another employer. Specific training, by contrast, gives rise to an increase in the marginal product of labor only in the training firm. Depending on the type of training, the model makes different predictions.

3.2.1 General Training

General training is equally valuable to all firms. This enables workers to use their skills in any employment and forces the training firm to pay workers the corresponding market wage. Otherwise, workers could quit for another firm and immediately yield the prevailing market wage. If labor markets are competitive, the market wage equals the marginal product of labor. This implies that firms cannot draw any returns from training workers. All returns from the human capital investment are reflected in the higher wage and accrue fully to the worker.

Receiving the full benefits, however, the worker has proper incentives to bear the investment costs, too. Becker concludes that firms might provide general training, but workers pay for it. They pay for training either directly or indirectly via wage reductions in the investment period. Moreover, as all returns accrue to the worker, there are no spillovers from general training on other firms. Thus, contrary to Pigou, training is efficient (Becker 1962, 17).

Formally, if training is general and labor markets are competitive, wages are equal to worker's marginal product, $w_t = v_t$. As $G = 0$, there are consequently no returns from on-the-job training to the firm. From the investment condition then follows equation (3.5)

$$w_0 = v_0 - k = v_0^u - c \tag{3.5}$$

This clearly shows that the wage in the training period is reduced by the training costs, which implies that all costs of general training are incurred by the worker.

3.2.2 Specific Training

For specific training, Becker argues that firms will be able to recover training costs. The worker cannot gain from quitting as these skills are of no use to other firms. Thus, the competitive market wage remains unaffected and the training firm captures all returns from specific training in the form of increased worker productivity.

Formally, if training returns are specific, we now have $G > 0$. Firm optimal training investment is equal to $G = c$, and the investment condition then simplifies to

$$w_0 = v_0^u \tag{3.6}$$

This states in contrast to general training that worker's training wage remains unaffected if training is specific. But since this investment is rewarding only as long as the worker stays with the firm, some of the returns from this investment will be shared between the firm and the worker in order to prevent workers from quitting. Also note that all returns are again collected by the private parties. Hence, there are no spillovers on other firms by this type of investment and specific training is efficient (Becker 1962, 21).

In sum, standard human capital theory negates positive spillovers from vocational training. As private and social returns do not diverge, human capital investment will be at its socially optimal level. General training is paid for by the worker, specific training by both the employer and the worker. Becker acknowledges that insufficient general training may indeed arise if workers are exposed to credit constraints and/or are risk averse (Becker 1962, 41f.). In this case, however, training subsidies or public training provision are not warranted. Rather, educational policy should address the problems prevailing in credit and insurance markets that cause these training limitations.

Although standard human capital theory is theoretically appealing, it faces profound criticism. *Firstly*, it is (at least partially) contradicted by empirical evidence. In contrast to its central proposition, a large number of empirical studies confirm the existence of firm-provided *and* firm-financed general training. Despite the risk of quits, firms actually incur substantial training costs to provide their workforce with general skills. This has also been demonstrated for apprenticeship training.[3]

Secondly, human capital theory is unable to explain some common features of apprenticeship training, such as the fixed duration of training contracts or the restrictions on unilateral termination. Under the assumption of competitive labor markets with full information and perfect contracting, these particularities should be superfluous (Smits & Stromback 2001, 32).

3.3 On-the-Job Training in Imperfect Labor Markets

The contradictions between human capital theory and empirical evidence have ignited new interest in the economics of training. Modern research seeks to offer rationales for firm-financed general training. In particular, it analyzes on-the-job training in the context of imperfect competition. Even though Becker already noted the role of labor market conditions, he left oligopsonistic labor markets unconsidered and regarded the dichotomy of general and specific skills a useful simplification.

[3] See supra in section 2.2.2.

3.3.1 Wage Compression

Several recent contributions question the assumption of a perfect labor market for general skills altogether and analyze training technology and labor market conditions separately. In order to explain firm-financed general training these studies commonly feature labor market imperfections that give rise to a compressed wage structure. In such a setting, firms can extract a rent from employing skilled workers, as the market wage is below the marginal product of labor.

The reasoning is as follows: General training increases the marginal product of labor. Because of the compressed wage structure, however, wages increase to a smaller degree. This turns technologically general skills into de facto firm-specific skills. Contrary to standard human capital theory it is therefore profitable for a firm to finance general training. In the optimum, a firm will provide a training level where the marginal increase in the rent is equal to the marginal cost of training.

Acemoglu & Pischke (1998) offer a simple formal set-up. Let $v(x)$ describe a worker's marginal product resulting from firm's training efforts x. With training possessing positive and diminishing marginal returns, the function is increasing and concave, $v' > 0$, $v'' < 0$. Denote training costs by $c(x)$. They are commonly assumed to increase convex in the amount of training, $c' > 0$, $c'' < 0$. Moreover, denote the market wage by $w(x)$. Thus, rational firms will choose x such as to maximize the profit function $\pi = v(x) - w(x) - c(x)$.

In competitive labor markets, wages correspond to the marginal product of labor, $v(x) = w(x)$ and firms do not carry any training costs. Workers however are willing to invest in training such that $w'(x^*) = v'(x^*) = c'(x^*)$. In order for firms to provide training, workers must incur a wage cut $\triangle$. This is Becker's result, which is displayed in figure (3.1).

This contrasts with the situation of imperfect competition. If labor market frictions compress the wage structure, then the market wage $w(x)$ does not increase to $v(x)$, but only to a lesser degree. This inhibits workers from obtaining a wage corresponding to their marginal product and allows the firm to earn a rent from employment $\triangle(x)$. A rational firm will carry out train-

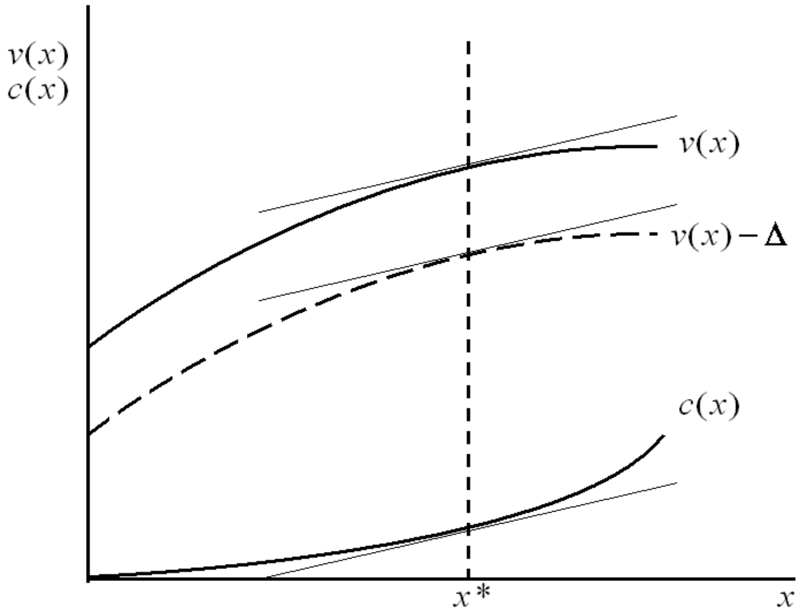

Figure 3.1: General Training in Competitive Labor Markets
Source: Acemoglu & Pischke (1999), F118.

ing such that the marginal increase in the rent corresponds to the marginal training costs, $\triangle'\left(x^f\right) = c'\left(x^f\right)$. See figure (3.2).

This set-up predicts firms to finance some general training even though workers are mobile and able to quit. But will human capital investment also be carried out to a socially optimal extent? In these models training is necessarily accompanied by a positive externality. Labor market frictions cause workers not to react instantaneously to wage differentials. They yield rents to firms and thereby provide training incentives. While frictions reduce turnover, they cannot inhibit quits entirely. Thus, positive spillovers arise because non-training firms benefit from training by employing workers trained in other firms without requiring a wage payment equal to the marginal product of labor. This is commonly referred to as *poaching*.[4] With an externality present, private incentives are insufficient and training will not

[4] More precisely, poaching may be active or passive in nature, i.e. attempts to recruit skilled workers may be systematic or resulting from general job turnover. However, we do not pursuit this distinction further.

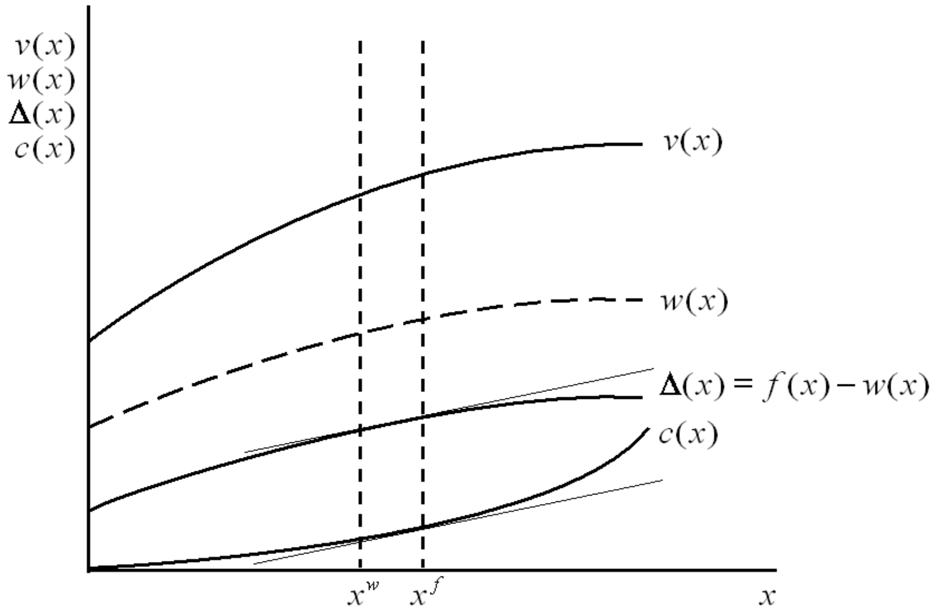

Figure 3.2: General Training in Frictional Labor Markets
Source: Acemoglu & Pischke (1999), F120.

be provided to an optimal extent Stevens (1994*b*).

3.3.2 Labor Market Frictions

The literature has identified several mechanisms causing a compressed wage structure. They relate to production technology, market competition as well as informational and institutional conditions.[5]

A compressed wage structure could result from *technological complementarities*. If firm's production function is complementary in capital and labor input, a training investment increases the marginal product of labor more than if it were not. The value of a trained worker is therefore higher to the training firm than to outside firms (Acemoglu & Pischke 1998, 559).

Similar complementarities may arise in the training process. Simultaneous general and firm-specific training can be complementary, if general

[5] For a survey of recent training literature see in particular Acemoglu & Pischke (1998) and Leuven (2005).

skills are a prerequisite to specific skills, or both training types use the same training infrastructure (Franz & Soskice 1995, 219f.).

Competitive conditions on the output market could also account for wage compression. Hentschirsch (1999) analyzes training investments for product markets that are characterized by Cournot or Bertrand competition. Similarly, Gersbach & Schmutzler (2003) show in a game-theoretic structure that firms will provide training when competition on the final market is sufficiently soft.

Another source of wage compression may be *informational asymmetries*. In a pioneering contribution, Katz & Ziderman (1990) show that when training is not verifiable to outside firms, workers will be unable to receive a wage reflecting their training level. In comparison to other firms, the training firm has an informational advantage with respect to both training quantity or quality. Consequently, training will be worthwhile, as productivity increases more than wage payments.

In a similar manner, a training firm could possess superior knowledge about a worker's characteristics, i.e. worker's innate abilities, talents and personal qualities. These characteristics are however difficult to assess by other firms because they do not draw on work experience. Facing asymmetric information, these employers will only pay for average abilities whereby outside wage offers could fall short of a worker's marginal product (Acemoglu & Pischke 1998, 556f.).

Other labor market frictions impeding workers to quit instantaneously for outside firms may result from *mobility restrictions*. Job turnover is costly to workers due to *search costs*, search uncertainties and matching problems. Workers will abstain from perfect job turnover in regard of the costs associated with it. Again, the employing firm can appropriate a rent and wages are compressed, rendering general training investments profitable Holzner (2005).

Finally, *labor market institutions* have been identified to cause wage compression, e.g., through minimum wages, collective bargaining, dismissal protection and unions Acemoglu & Pischke (1998), Smits & Stromback (2001).

3.4 Discussion

In sum, labor market imperfections allow for an explanation of firm-financed vocational training. But they also assert the existence of a positive externality. This contrasts with conventional human capital theory and therefore invites to reconsider appropriate public policy. However, comprehensive studies analyzing different policy instruments are lacking. The next chapter therefore introduces a simple model in order to put different policy instruments into analysis.

Chapter 4

Simple Model of Vocational Training

This chapter proposes a simple model of apprenticeship training. By considering an oligopsonistic labor market with frictions, the model allows to explain why firms partially finance vocational training. At the same time, an externality can be shown to exist which leads to insufficient training. In the appendix and in later chapters, the limiting assumptions of this model will be relaxed and further complications will be added.

4.1 Model Set-up and Assumptions

Consider an economy where firms rely on skilled workers to produce goods and services. Firms can obtain skilled workers in two ways: On the one hand, they can train unskilled workers by offering apprenticeship training. On the other hand, they can recruit skilled workers through the labor market by offering competitive wages.

Wage Competition for Skilled Labor

Let firms compete for the services of skilled workers by posting wage offers. Workers arbitrage between firms' wage offers and choose to work for the firm with the highest wage. If labor markets were perfect, workers would instantaneously move to the highest paying firm. This forces firms to pay skilled workers a wage equal to their marginal product. In such a situation firms cannot obtain any return for general training expenses. They would therefore shift the costs of training onto trained workers or provide no general training at all. Essentially, this is the standard result of human capital theory according to Becker (1962).

In reality, labor markets are imperfect. Skilled individuals usually do not quit a firm instantaneously, although they could obtain a somewhat higher wage elsewhere. The literature review above in section 3.3 has specified a number of labor market frictions that inhibit workers from perfect wage arbitrage, such as search and switching costs, information asymmetries, and institutional conditions. We abstain from modeling such frictions in full detail and use a reduced form instead. More precisely, we simply represent such frictions by assuming that workers favor high wages but also have some preferences over firms. We thereby bring about some attachment to firms even when wage differences are present. Workers will consequently only quit for another firm if the wage increase at least compensates for the lost attachment to the firm.

As an example, firms could differ in their geographical location and workers incur commuting costs from their residence to the workplace. Therefore, when choosing among job offers, workers will trade off firms' wage offers against the costs of travelling to work. Alternatively, the quality of a job match could differ so that workers must decide between wages and good job matches. Similarly, affection to a firm could also be grounded to the liking of particular sectors, products and services, co-workers, working conditions, etc.

Formally, assume workers to differ in location. We represent this by the differentiation parameter θ. Along the lines of Hotelling (1929) let there be a mass of homogeneously skilled workers N_t which are uniformly distributed along a street with length normalized to unity. There are two firms, $i = \{1, 2\}$, that produce at either end of the street.[1] Firms make wage offers w_{it}

[1] In the appendix, the model is generalized to allow for varying firm position and street

in order to attract skilled workers. The higher a firm's wage offer in period t, the greater will be its share in recruiting the available skilled workforce. Workers, on the other hand, incur commuting costs in order to work for a firm. Each worker will choose to work for the firm with the higher net wage $\tilde{w}_i$ where the net wage is simply the wage minus individual commuting costs $T_i(\theta)$.

$$\tilde{w}_{it} = w_{it} - T_i(\theta) \tag{4.1}$$

Let δ be the (time-invariant) linear rate of commuting expenses. A worker at θ faces travel costs $T_1(\theta) = \delta\theta$ to work with firm 1 and $T_2(\theta) = \delta(1-\theta)$ to work with firm 2.[2] Figure 4.1 graphically illustrates workers' net wages depending on firms' wage offers and workers' residence locations. The worker located at $\hat{\theta}$ is indifferent between working for either firm. Workers located to the left of $\hat{\theta}$ will choose the wage offer of firm 1, workers to the right of $\hat{\theta}$ will choose to work for firm 2.

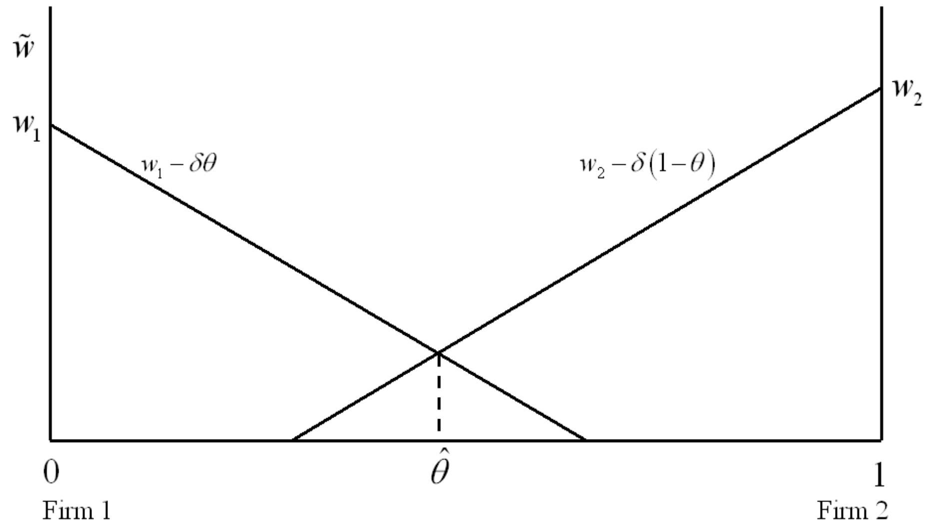

Figure 4.1: Hotelling Street with Two Border Firms

length.

[2]It may reasonably be argued that commuting costs increase convex rather than linear with the distance from work. Assuming these costs to be quadratic, i.e. $T_1(\theta) = \delta\theta^2$ and $T_2(\theta) = \delta(1-\theta)^2$, leads to the same results. We use the linear set-up for simplicity.

Production

Let firms' production technology use skilled labor as the only input and possess constant returns to skilled labor. Equation (4.2) denotes the production function of firm i where v_{it} is a worker's (constant) marginal product and N_{it} is skilled labor employed by firm i in period t.

$$y_{it} = v_{it} N_{it} \tag{4.2}$$

This production function assumes workers to possess homogeneous productivity, i.e. workers do not differ in abilities and all skills are transferable among firms. Clearly, this is a strong assumption. It is made to reflect that vocational education, at least in Germany, can be regarded as providing mainly general skills. The curriculum of apprenticeship training is regulated and training leads to a widely accepted training certificate. Moreover, this training is provided at an early stage of life, i.e. when the labor market is first entered. Any acquired skills will therefore be useful for many years and jobs to come.

To further motivate this assumption, note also that recent research questions the adequacy of distinguishing specific training altogether. Lazear (2003) forwards that few skills are limited only to a single firm and thereby doubts sizeable firm-specific skills to exist. Instead he argues that firms seek specific input-combinations of general skills, stressing the importance of labor market conditions rather than skill-types.

Labor productivity in equation (4.2) can be given two interpretations. The parameter v_{it} could simply indicate the firm's technological productivity. Alternatively, it could signify the firm's competitiveness in the output market to be able to obtain large selling prices.

Labor Supply

Firms offering apprenticeship training to unskilled workers affect future labor supply. They enlarge the skilled workforce that can potentially be recruited by all firms. Skilled workers available for employment in the future period N_{t+1} consist of the skilled workforce from the previous period N_t and the sum of newly trained apprentices A_{it}.

$$N_{t+1} = N_t + \sum_i A_{it} \tag{4.3}$$

This formulation abstracts from retirement and assumes all apprentices to enter the labor market. Also, it neglects any acquisition of general skills outside on-the-job training, for instance through full-time vocational schools or universities. These are clearly simplifications which could be accounted for in a richer setting.[3] For this model, however, it is only important that apprenticeship training increases the future skilled workforce.

Moreover, let labor supply in each period increase in workers' net wages, i.e. $N_t(\tilde{w}_t)$ with $\frac{\partial N_t(\tilde{w}_t)}{\partial \tilde{w}_t} > 0$. This upward sloping labor supply function simply reflects the standard labor-leisure choice of workers, i.e. as wages rise, the value of employment increases in comparison to alternative choices outside of the labor market. Such alternatives could be, for instance, the value of home production, leisure and/or unemployment benefits.

Training Costs

Apprenticeship training brings about costs to firms. It involves direct costs that are made up of remuneration to trainers and material expenses. Moreover, there are indirect costs that result from forgone production when staff or machines are used for training. Let $c_i(A_{it})$ denote the training cost function of firm i where A_{it} is the number of apprentices trained by the firm in period t. We assume increasing marginal training costs in order to display limitations to the capacity of training facilities and training staff. Equation (4.4) summarizes these properties.

$$c_i(A_{it}) \text{ with } c_i' > 0,\ c_i'' > 0,\ c_i(0) = 0 \tag{4.4}$$

Note that cost assessments of apprenticeship training often include direct

[3] Equation (4.3) could be expanded for retirees exiting from the labor force and university graduates entering into it.

pay by the firm to apprentices.[4] Our formulation makes the simplifying assumption that there is no production value of apprentices during the training period. Any pay to apprentices therefore only constitutes a transfer mechanism between firms and workers that allows to shift the costs of training between both parties.

Also note that an explicit training cost function tacitly assumes that production and training technology can be separated. This assumption is often made in the literature to simplify the problem (Stevens 1994*b*,*a*, Acemoglu & Pischke 1998, e.g.) . Of course, this assumption does not represent reality in small companies where older, experienced employees train apprentices and thereby necessarily incur opportunity costs from forgone production. By contrast, large companies often have special training departments and respective instructing staff so that this assumption represents reality in large firms rather well.[5]

Apprentice's Training Decision

Firms may choose to offer vocational training. Yet, this offer is met only if unskilled workers are willing to accept. An unskilled worker will undergo apprenticeship training (and thereby become a skilled worker) if this is better or equal to remaining unskilled and obtaining an income from simple labor, home production or welfare benefits. Let u_t denote the exogenous income available to an unskilled worker in period t. By contrast, apprentices usually receive some apprenticeship pay in the initial training period, w_t^a, which usually falls considerably short of the income for unskilled labor. However in the future period, upon completion of the vocational education, they can obtain the wage for skilled labor.

Similar to Becker (1962), the apprentice's training decision can be formalized by an investment problem. A rational, risk-neutral unskilled worker will choose apprenticeship training if the present value of the expected net

[4] *Gross* training costs measure all expenses of firms and will therefore also take *apprentices' wages* into account. By contrast, *net* training costs take the contribution of apprentices to production into account (Bardeleben et al. 1995, e.g.).

[5] For a model with training costs as foregone production see, for example, Booth et al. (2002)

income stream as a skilled worker exceeds the present value of the income stream from remaining unskilled. This is put formally in equation (4.5) where $\tilde{w}_t$ is the skilled net wage accounting for commuting costs and ρ denotes the discount factor at the market rate of interest r, $\rho = \frac{1}{1+r}$.

$$w_0^a + \sum_{t,t\neq 0} \rho^t E\left(\tilde{w}_t\right) \geq \sum_t \rho^t u_t \tag{4.5}$$

This formulation declines any non-monetary costs or benefits of apprenticeship training, such as joy or effort from learning. Note also that w_0^a can be negative. In this case, instead of receiving apprenticeship pay, apprentices transfer "tuition fees" to the firm in the training period.

For simplicity, normalize the present value of the income stream of an unskilled worker to zero, $\sum \rho^t u_t \equiv 0$. The participation constraint of an apprentice to become a skilled worker thus reduces to equation (4.6).

$$w_0^a + \sum_{t,t\neq 0} \rho^t E\left(\tilde{w}_t\right) \geq 0 \tag{4.6}$$

When rewriting to $-w_0^a \leq \sum_{t,t\neq 0} \rho^t E\left(\tilde{w}_t\right)$, this essentially states that an apprentice is willing to initially forgo earnings at most equal to the increase in future net income. With the alternative income (of remaining unskilled) normalized to zero, then the apprentice's investment into vocational training may at most be equal to the expected present value of future net income.

Notice that this participation constraint tacitly assumes apprentices to face no credit constraints. In particular, they are able to forego earnings and transfer the training investment w_0^a to the firm by borrowing against their future income. By contrast, if workers are credit constraint from having only partial access to capital markets, they are unable to carry out the investment as the wage in the training period is to exceed some threshold value m. In this case, the additional credit constraint (4.7) is to be taken into account.

$$w_0^a \geq m \tag{4.7}$$

Time Structure

To keep things simple, we restrict ourselves to a two-period model with a present and a future period only. In the present period, firms compete for the currently existing skilled workforce. In addition, they may decide to train unskilled workers through an apprenticeship that will thereby become skilled workers in the future. We call this period the *training period.* In the future period, firms compete anew for skilled workers. With training being sufficiently general, this allows for poaching of the newly trained workers by other firms. We therefore refer to this period as the *poaching period.* Thus, the time structure of this two-period model can be summarized as follows:

- Training period t:
  Firms make wage offers w_{it} and take A_{it} apprentices for training.
  $N_t(.)$ workers choose their employer and production takes place.

- Poaching period $t+1$:
  Firms make wage offers $w_{i,t+1}$
  $N_{t+1}(.)$ workers choose their employer and production takes place.

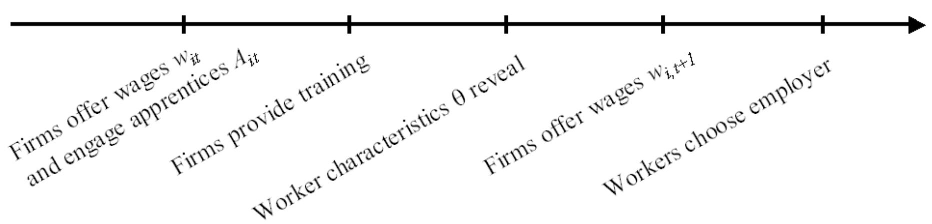

Figure 4.2: Model Time Structure

4.2 Private Optimum

With this being the basic set-up let us now solve the model by backward induction. Consider first the poaching period.

4.2.1 Poaching Period

Firms compete for skilled workers by posting appropriate wage offers, $w_{1,t+1}$ and $w_{2,t+1}$. A proportion of the skilled workforce will take the offer at firm 1, while the remainder will take the offer at firm 2. We can infer the share of the skilled workforce to each firm from the worker located at $\hat{\theta}_{t+1}$, who is just indifferent between working for either firm. This is the case if net wages equal, or, put differently, if the arbitrage condition (4.8) is fulfilled.

$$w_{1,t+1} - \delta \cdot \hat{\theta}_{t+1} = w_{2,t+1} - \delta \cdot \left(1 - \hat{\theta}_{t+1}\right) \tag{4.8}$$

The share of workers employed by each firm can therefore be stated as a function of wages. For firm 1 the share is

$$\hat{\theta}_{t+1} = \frac{w_{1,t+1} - w_{2,t+1} + \delta}{2\delta}$$

and likewise for firm 2

$$1 - \hat{\theta}_{t+1} = \frac{w_{2,t+1} - w_{1,t+1} + \delta}{2\delta}$$

Firms maximize profits by optimally choosing the wages they pay. Profits are simply $\pi_{i,t+1} = (v_{i,t+1} - w_{i,t+1}) N_{i,t+1}$ and the objective functions of firms 1 and 2 are therefore

$$\max_{\{w_{1,t+1}\}} \pi_{1,t+1} = (v_{1,t+1} - w_{1,t+1}) \, \hat{\theta}_{t+1} (.) \, N_{t+1}$$
$$\max_{\{w_{2,t+1}\}} \pi_{2,t+1} = (v_{2,t+1} - w_{2,t+1}) \left(1 - \hat{\theta}_{t+1} (.)\right) N_{t+1}$$

From the first order conditions

$$-2w_{1,t+1} + w_{2,t+1} - \delta + v_{1,t+1} = 0$$

$$-2w_{2,t+1} + w_{1,t+1} - \delta + v_{2,t+1} = 0$$

we can obtain the reaction functions, i.e. firm's optimal wage offer as a function of the other firm's wage offer.

$$w^*_{1,t+1}(w_{2,t+1}) = \frac{1}{2}\left(v_{1,t+1} + w_{2,t+1} - \delta\right)$$

$$w^*_{2,t+1}(w_{1,t+1}) = \frac{1}{2}\left(v_{2,t+1} + w_{1,t+1} - \delta\right)$$

The second order conditions for a local maximum are fulfilled with $\frac{\partial^2 \pi_{i,t+1}}{\partial^2 w_{i,t+1}} = -2 < 0$. From equating the reaction functions then follow the equilibrium wages $w^*_{1,t+1}$ and $w^*_{2,t+1}$.

$$w^*_{1,t+1} = \frac{2}{3}v_{1,t+1} + \frac{1}{3}v_{2,t+1} - \delta \tag{4.9}$$

$$w^*_{2,t+1} = \frac{1}{3}v_{1,t+1} + \frac{2}{3}v_{2,t+1} - \delta \tag{4.10}$$

Using $\hat{\theta}_{t+1}(.)$ and $1 - \hat{\theta}_{t+1}(.)$, the equilibrium wages $w^*_{1,t+1}$ and $w^*_{2,t+1}$ determine the allocation of skilled workers across both firms in period $t+1$. A share $\hat{\theta}^*_{t+1}$ of the workforce is employed by firm 1 and a share $(1 - \theta^*_{t+1})$ by firm 2.

$$\begin{aligned} \hat{\theta}^*_{t+1} &= \frac{w^*_{1,t+1} - w^*_{2,t+1} + \delta}{2\delta} = \frac{1}{2} + \frac{v_{1,t+1} - v_{2,t+1}}{6\delta} \\ 1 - \hat{\theta}^*_{t+1} &= \frac{w^*_{2,t+1} - w^*_{1,t+1} + \delta}{2\delta} = \frac{1}{2} - \frac{v_{1,t+1} - v_{2,t+1}}{6\delta} \end{aligned}$$

Using $w^*_{1,t+1}$, $w^*_{2,t+1}$ and $\hat{\theta}^*_{t+1}$, equilibrium firm profits can be derived as

$$\pi^*_{1,t+1} = \left(v_{1,t+1} - w^*_{1,t+1}\right)\hat{\theta}^*_{t+1}N_{t+1} = \frac{\left(v_{1,t+1} - v_{2,t+1} + 3\delta\right)^2}{18\delta}N_{t+1} \tag{4.11}$$

$$\pi^*_{2,t+1} = \left(v_{2,t+1} - w^*_{2,t+1}\right)\left(1 - \hat{\theta}^*_{t+1}\right) N_{t+1} = \frac{\left(v_{2,t+1} - v_{1,t+1} + 3\delta\right)^2}{18\delta} N_{t+1} \tag{4.12}$$

These results can be summarized in a proposition.

Proposition 1 *When labor market frictions render job mobility costly, i.e. for $\delta > 0$, workers refrain from perfect wage arbitrage and show some attachment to a firm. This gives firms some wage-setting power. In equilibrium, firms post wages below the worker's marginal product, $w^*_{i,t+1} < v_{i,t+1}$. Firms therefore earn some employment rents and realize positive profits, $\pi^*_{i,t+1} > 0$.*

Proof. See appendix. ■

In order to easily understand these results, consider the case of *homogeneous technology* across firms, $v_{1,t+1} = v_{2,t+1} = v_{t+1}$. With identical production functions, firms will also post identical wage offers for skilled labor, $w^*_{1,t+1} = w^*_{2,t+1} = w^*_{t+1}$, and the equilibrium wage is simply $w^*_{t+1} = v_{t+1} - \delta$. This can be easily interpreted: A worker located at firm 1 would incur commuting costs δ to quit for an employment at firm 2. The same is true, vice versa, for the worker at firm 2. Firms can therefore safely reduce the wage below the marginal product v_{t+1} by an amount δ without risking to lose all workers. Thus, firms earn a rent of δ for each skilled employment. With identical wage offers, both firms will acquire half of the available workforce, $N^*_{1,t+1} = N^*_{2,t+1} = \frac{1}{2}N_{t+1}$, and earn profits from employment of $\pi^*_{1,t+1} = \pi^*_{2,t+1} = \frac{1}{2}\delta N_{t+1}$.

For *heterogeneous technology*, in contrast to the case of homogeneous technology, there is wage dispersion and differing firm sizes in equilibrium. Wages and employment increase in own, but decrease in foreign productivity, $\frac{\partial w^*_{i,t+1}}{\partial v_{i,t+1}} \geq 0$ and $\frac{\partial w^*_{i,t+1}}{\partial v_{j,t+1}} \leq 0$. These results conform to empirical estimates of the labor market and also reproduce the outcomes from other frictional labor market models (Montgomery 1991, Lang 1991, e.g.).

4.2.2 Training Period

With this being the situation in the poaching period let us now turn to the training period. In this period, firms compete for the (initial) skilled workforce N_t and decide whether to provide costly training or not. Firms' objective functions consist of profits from employing skilled workers in the present and the future period reduced by pay to apprentices and training costs.

$$\underset{\{w_{it},A_{it}\}}{\arg\max}\{\underbrace{\rho\pi^*_{i,t+1}}_{\text{profit in } t+1} + \underbrace{\pi_{it}}_{\text{profit in } t} - \underbrace{w^a_t A_{it}}_{\text{trainee wages}} - \underbrace{c_i\left(A_{it}\right)}_{\text{costs}}\} \; \forall i = \{1,2\}$$

In this period, just as in the poaching period, firms' shares of the available workforce are determined from their wage offers w_{1t} and w_{2t}. Using the arbitrage condition of the indifferent worker $\hat{\theta}_t$ analogous to equation (4.8) and replacing $\pi^*_{i,t+1} = R^*_{i,t+1}N_{t+1}$ for (4.11) and (4.12) then allows to write the optimization problem for each firm

$$\underset{\{w_{1t},A_{1t}\}}{\arg\max}\left\{\rho R^*_{1,t+1}N_{t+1} + \left(v_{1t} - w_{1t}\right)\hat{\theta}_t N_t - w^a_t A_{1t} - c_1\left(A_{1t}\right)\right\}$$
$$\underset{\{w_{2t},A_{2t}\}}{\arg\max}\left\{\rho R^*_{2,t+1}N_{t+1} + \left(v_{2t} - w_{2t}\right)\left(1-\hat{\theta}_t\right) N_t - w^a_t A_{2t} - c_2\left(A_{2t}\right)\right\}$$

The partial derivatives with respect to the wage offers w_{1t} and w_{2t} are given by (4.13) and (4.14) which, as before, represent a pair of reaction functions $w^*_{1t}\left(w_{2t}\right)$ and $w^*_{2t}\left(w_{1t}\right)$.

$$-2w_{1t} + w_{2t} - \delta + v_{1t} = 0 \tag{4.13}$$

$$-2w_{2t} + w_{1t} - \delta + v_{2t} = 0 \tag{4.14}$$

Setting equal then again allows to solve for the equilibrium wages.

$$w^*_{1t} = \frac{2}{3}v_{1t} + \frac{1}{3}v_{2t} - \delta \tag{4.15}$$

$$w^*_{2t} = \frac{1}{3}v_{1t} + \frac{2}{3}v_{2t} - \delta \tag{4.16}$$

Equations (4.15) and (4.16) state, analogous to before, that wages for skilled workers in period t are below the marginal product of labor. Firms' respective shares of the workforce in period t are thus $\hat{\theta}_t^*$ and $1-\hat{\theta}_t^*$.

Now consider the partial derivatives with respect to the number of apprentices by the firm to obtain the first order training conditions. Note that the second order conditions are satisfied with $\frac{\partial^2}{\partial A_{it}} = -c_i'' < 0$. Thus, equations (4.17) and (4.18) display the conditions for optimal firm provision of apprenticeship training.

$$\rho R_{1,t+1}^* - w_{1t}^a - c_1'(A_{1t}) = 0 \tag{4.17}$$

$$\rho R_{2,t+1}^* - w_{2t}^a - c_2'(A_{2t}) = 0 \tag{4.18}$$

Training Participation *without* Credit Constraints

When firms possess all bargaining power, the direct pay to apprentices in the training period can be inferred from the participation constraint (4.6), i.e. $w_t^a = -\rho E(\tilde{w}_{t+1})$, where the expected future net wage depends on frictions and firm's future productivity. See the appendix for a derivation of the expected future net wage. Inserting the participation constraint into the first order conditions then gives the optimality conditions for vocational training.

$$\rho R_{1,t+1}^* + \rho E(\tilde{w}_{t+1}) = c_1'(A_{1t}^*) \tag{4.19}$$

$$\rho R_{2,t+1}^* + \rho E(\tilde{w}_{t+1}) = c_2'(A_{2t}^*) \tag{4.20}$$

Conditions (4.19) and (4.20) state that vocational training in the private optimum is carried out such that marginal costs and returns of an additional apprentice are equal. Training returns consist of returns to the firm and the worker. Firms provide A_{1t}^* and A_{2t}^* apprenticeships. From these conditions we can directly deduce proposition (2).

Proposition 2 *Costs and returns from apprenticeship training - although it is perfectly general - are shared by the apprentice and the firm in the training contract.*

Proof. Obvious from (4.19) and (4.20). ■

The intuition for this result is straightforward: Apprenticeship training is beneficial to both parties and, consequently, both parties are willing to incur training costs. The apprentice, on the one hand, is turned from an unskilled worker to a skilled worker. She is willing to invest in vocational training as she can thereby expect an increase in her future net income. The firm, on the other hand, receives returns from training through an employment rent. When it employs former apprentices as skilled workers, mobility frictions allow for wages below the marginal product of labor.

Proposition 3 *Rising labor market frictions increase firm's share in costs for general training, but decrease worker's share. Overall, however, they reduce incentives for apprenticeship training.*

Proof. Apply the implicit function theorem on conditions (4.19) and (4.20) and obtain $\frac{\partial A_{it}^{*}}{\partial \delta} < 0$. For detailed formal proof see appendix. ■

This result can be explained quite intuitively. Rising labor market frictions dampen wage arbitrage by workers and increase firms' monopsony power. The wage for skilled workers decreases, thereby obviously diminishing the incentives for unskilled workers to seek training. By contrast, a lower wage allows firms to obtain larger rents from employing workers which improves firms' training incentives. Overall, however, private incentives decrease in the costs of labor market frictions as the training firm cannot collect all rents from training.

Training Participation *with* Credit Constraints

The private optimum for vocational training is disturbed when apprentices face financial constraints. In this case, apart from the participation constraint, apprenticeship training is subject to the credit constraint $w_t^a \geq m$, i.e. apprentices may forego earnings and invest into training only up to the threshold value m. The credit constraint is binding for $w_t^a = m$ where

$m > -\rho E(\tilde{w}_{t+1})$. The optimality conditions for vocational training are then

$$\rho\pi^*_{1,t+1} - m = c_1'\left(A^{cc}_{1t}\right) \tag{4.21}$$

$$\rho\pi^*_{2,t+1} - m = c_2'\left(A^{cc}_{2t}\right) \tag{4.22}$$

Proposition 4 *Credit constraints reduce the private optimum for vocational training to A^{cc}_{it}, where $A^{cc}_{it} < A^*_{it}$.*

Proof. Rewriting the credit constraint to $-m < \rho E(\tilde{w}_{t+1})$ and inserting allows to compare the training conditions (4.21) and (4.22) to (4.19) and (4.20). With the left-hand side smaller under credit constraints, it becomes immediately clear that $A^{cc}_{it} < A^*_{it}$. ■

If capital market imperfections and informational restraints inhibit the apprentice from fully borrowing against her future net income, then the apprentice cannot make the necessary training investment. Training will therefore be lower than it would otherwise be. This result essentially replicates earlier results from human capital theory in the context of apprenticeship training (Becker 1962, Smits & Stromback 2001, e.g.) .

From comparative-static analysis some further results can be derived that characterize the private optimum. They are summarized in the following propositions:

Proposition 5 *Apprenticeship training*
a) increases in firms with higher productivity, $\frac{\partial A^*_{it}}{\partial v_{it}} > 0$,
b) decreases in the opponents productivity, $\frac{\partial A^*_{it}}{\partial v_{jt}} < 0$,
c) decreases in the interest rate, $\frac{\partial A^*_{it}}{\partial r} < 0$,
d) decreases in the training costs, $\frac{\partial A^*_{i}}{\partial c_i} < 0$.

Proof. Apply the implicit function theorem on the optimal training conditions (4.19) and (4.20). ■

A higher productivity increases the value of a skilled worker to a firm and thus stimulates to train more. By contrast, a higher productivity of the opponent decreases the ability to retain skilled workers. Larger training costs and a higher interest rate obviously diminish training.

It is noteworthy that these differences in apprenticeship training will also be reflected in training quotas, i.e. in the proportion of apprentices to employees. Let α_{it} define the training quota of firm i where $\alpha_{it} = \frac{A_{it}}{N_{it}}$.

Proposition 6 *Firms differ in training quotas α_{it}. In particular, a firm's training quota increases in own productivity, $\frac{\partial \alpha_{it}}{\partial v_{it}} > 0$, and decreases in costs to apprentices, $\frac{\partial \alpha_{it}}{\partial c_i} < 0$.*

Proof. Inserting the values from the individual firm's optimum and applying the implicit function theorem then leads to the proposition. ■

This proposition reflects an important empirical observation of the German apprenticeship system. In reality, training quotas differ strongly within a sector as well as across sectors. According to this model, these differences are due to differences in labor productivity and training costs.

4.3 Social Optimum

The analysis so far has shown that firms provide apprenticeship training and the training costs are shared by the firm and the apprentice. It is now of interest whether the actions of the contracting parties are also socially efficient. We will therefore compare the private optimum with the social optimum.

In this simple two-firm two-period model, social welfare can be denoted by the net output produced by skilled workers in both periods. Training costs are subtracted because resources put to vocational training have alternative uses.

$$W = \sum_{t,t+1} \rho^t W_t - \sum_{i=1,2} c_i \left(A_{it}\right)$$

In period t, social welfare W_t consists of profits and net wages at both firms.

$$W_t = \int_0^{\hat{\theta}_t} (\underbrace{v_{1t} - w_{1t}}_{\text{profit}} + \underbrace{w_{1t} - \delta\theta}_{\text{net wage}}) N_t d\theta + \int_{\hat{\theta}_t}^{1} (\underbrace{v_{2t} - w_{2t}}_{\text{profit}} + \underbrace{w_{2t} - \delta\left(1-\theta\right)}_{\text{net wage}}) N_t d\theta$$

The first term denotes profits and net wages from employment at firm 1 and while the second term does so for firm 2. Simplifying and rearranging leads to equation (4.23). Intuitively, it states that social welfare is total production net of commuting and training costs.

$$W = \sum_{t,t+1} \rho^t N_t \left(\int_0^{\hat{\theta}_t^*} (v_{1t} - \delta\theta) d\theta + \int_{\hat{\theta}_t^*}^{1} (v_{2t} - \delta\left(1-\theta\right)) d\theta \right) - \sum_{i=1,2} c_i \left(A_{it}\right) \tag{4.23}$$

Solving the integral, inserting for $\hat{\theta}_t^*$ and some algebraic rearrangements then gives equation (4.24). See the appendix for detailed derivation.

$$W = \sum_{t,t+1} \rho^t N_t \left(\tfrac{v_{1t}+v_{2t}}{2} + \tfrac{5}{36\delta} \left(v_{1t} - v_{2t}\right)^2 - \tfrac{1}{4}\delta \right) - \sum_{i=1,2} c_i \left(A_{it}\right) \tag{4.24}$$

The social planner's problem is to optimally choose the number of apprentices to train:

$$\max_{\{A_{1t},A_{2t}\}} W\left(A_{1t},A_{2t}\right) \tag{4.25}$$

From the first order conditions then obtain the conditions for socially optimal apprenticeship training A_{it}° in each firm.

$$\rho\left(\tfrac{v_{1t}+v_{2t}}{2}+\tfrac{5}{36\delta}\left(v_{1t}-v_{2t}\right)^{2}-\tfrac{1}{4}\delta\right)-c_{i}^{\prime}\left(A_{it}^{\circ}\right)=0 \quad \forall i=\{1,2\} \tag{4.26}$$

This allows to state proposition (7).

Proposition 7 *In the private optimum, apprenticeship training in each firm is lower than socially desirable, i.e.* $A_{it}^{*}<A_{it}^{\circ}$.

Proof. From comparing the condition for the social optimum (4.26) with the conditions for the private optimum (4.17) and (4.18) follows that too few apprentices receive training, $A_{it}^{*}<A_{it}^{\circ}$. See the appendix for detailed proof. ■

Proposition (7) states nothing different than that apprenticeship training induces positive spillovers. They arise because some training returns are lost to competing firms through poaching. Since social returns exceed the private returns collected by the apprentice and the training firm, apprenticeship training is socially inefficient.

To pinpoint this result, look at the returns from vocational training separately. For the *apprentice* the return from vocational training is the expected net wage increase in present value terms from becoming a skilled worker.

$$R_{w}=\rho E\left(\tilde{w}_{t+1}^{*}\right)=\rho\left(\frac{v_{1,t+1}+v_{2,t+1}}{2}+\frac{\left(v_{1,t+1}-v_{2,t+1}\right)^{2}}{6\delta}-\frac{5}{4}\delta\right)$$

Recall that the unskilled wage is normalized to unity. It suffices therefore to calculate the expected net wage of a skilled worker using $w_{1,t+1}^{*}$ and $w_{2,t+1}^{*}$. See the appendix for detailed algebraic derivation.

For the *training firm* the return consists of the rent that is earned in the future on skilled employment from apprentices that remain with the firm. It arises as the worker's marginal product exceeds the wage due to frictions. Note that employment rents differ across firms according to labor productivity.

$$R_{1,f} = \rho \frac{(v_{1,t+1} - v_{2,t+1} + 3\delta)^2}{18\delta}$$

$$R_{2,f} = \rho \frac{(v_{2,t+1} - v_{1,t+1} + 3\delta)^2}{18\delta}$$

Private returns collected by the parties in each training contract are then simply the sum of worker's and firm's returns.

$$R_{1,priv} = R_w + R_{1,f} = \rho \left(\frac{5v_{1,t+1} + v_{2,t+1}}{6} + \frac{4\,(v_{1,t+1} - v_{2,t+1})^2}{18\delta} - \frac{3}{4}\delta \right)$$

$$R_{2,priv} = R_w + R_{2,f} = \rho \left(\frac{v_{1,t+1} + 5v_{2,t+1}}{6} + \frac{4\,(v_{1,t+1} - v_{2,t+1})^2}{18\delta} - \frac{3}{4}\delta \right)$$

Social returns are given by

$$R_{social} = \rho \left(\frac{v_{1,t+1} + v_{2,t+1}}{2} + \frac{5}{36\delta}\,(v_{1,t+1} - v_{2,t+1})^2 - \frac{1}{4}\delta \right)$$

Finally, an *externality* of vocational education can be easily derived from calculating the difference between social and private returns, $X_i = R_{social} - R_{i,priv}$. Thus, the positive externality associated with an additional apprenticeship by each firm is given by

$$X_1 = \rho \left(\frac{1}{2}\delta - \frac{(v_{1,t+1} - v_{2,t+1})}{12\delta}\,(v_{1,t+1} - v_{2,t+1} + 4\delta) \right)$$

$$X_2 = \rho \left(\frac{1}{2}\delta - \frac{(v_{2,t+1} - v_{1,t+1})}{12\delta}\,(v_{2,t+1} - v_{1,t+1} + 4\delta) \right)$$

Proposition 8 *Vocational training brings about a positive externality onto other firms. The externality decreases in firm's productivity, but increases in opponent's productivity and labor market frictions.*

Proof. From comparative-static analysis follows $\frac{\partial X_i}{\partial v_{i,t+1}} < 0$, $\frac{\partial X_i}{\partial v_{j,t+1}} > 0$, and $\frac{\partial X_i}{\partial \delta} > 0$ for $i, j = \{1, 2\}\,; i \neq j$. ■

The intuition for this result is straightforward. Because of wage competition among firms, only a share of apprentices remain with the training firm. Put differently, due to poaching of skilled workers, vocational training carries a positive externality onto other firms.

As an illustration, consider again the simple case of *homogeneous technology.* By setting $v_{1,t+1} = v_{2,t+1} = v_{t+1}$, the expected return from apprenticeship training to an unskilled worker is simply

$$R_w = \rho \left(v_{t+1} - \frac{5}{4}\delta \right)$$

Likewise, firms' returns from training an apprentice are

$$R_f = R_{1f} = R_{2f} = \rho\frac{\delta}{2}$$

Private returns of the apprentice and the firm are therefore

$$R_{priv} = R_w + R_f = \rho \left(v_{t+1} - \frac{3}{4}\delta \right)$$

Social returns are however

$$R_{social} = \rho \left(v_{t+1} - \frac{1}{4}\delta \right)$$

which clearly indicates a positive externality from training an apprentice.

$$X = X_1 = X_2 = \rho\frac{\delta}{2}$$

Intuitively, there is a return to vocational training that can neither be obtained by the apprentice, nor the training firm, but rather accrues to the rival firm. The opponent obtains a rent which arises because it can poach some apprentices without being required to pay these skilled workers their full marginal product. In the symmetric case this rent amounts to $\rho\frac{\delta}{2}$. With some returns from training remaining unconsidered by the private parties, vocational training will be short of its socially efficient level, $A^*_{it} < A^\circ_{it}$. Figure (4.3) summarizes this situation for the symmetric case with homogeneous technology.

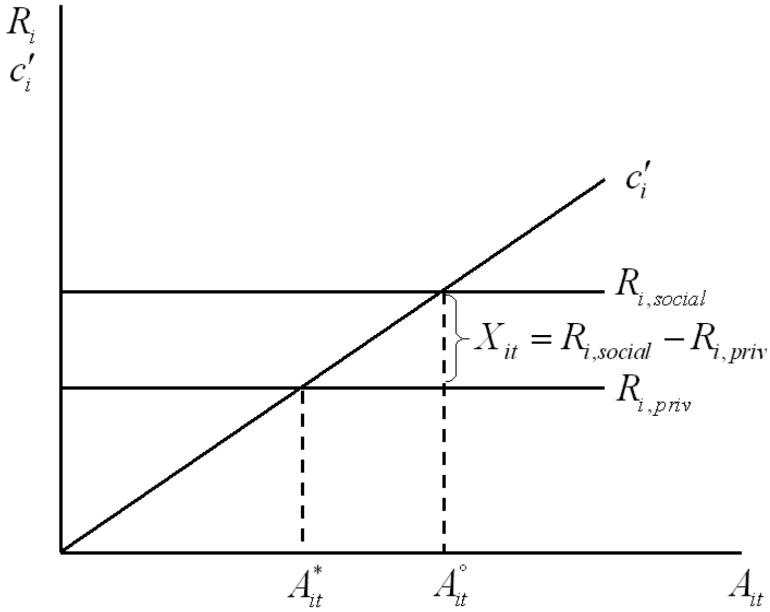

Figure 4.3: Social and Private Returns to Education

4.4 Discussion

In this simple model, due to costly labor market frictions, skilled workers are inhibited from perfect wage arbitrage. Firms therefore possess some monopsony power and obtain rents from employment. At the same time, these labor market frictions cause some attachment of skilled individuals to work for firm i although a higher wage could be earned elsewhere. This induces firms not only to provide but also to partially finance apprenticeship training.

The model also predicts the existence of an externality from vocational training. Rival firms are able to reap positive spillovers from poaching workers. While frictions cause some attachment of workers to the firm, some fraction still quits for another employer, thereby depriving the firm of its training investment. With training efforts distorted, then from a social point of view too few apprenticeships are provided.

This model builds on a number of simplifying assumptions. Firstly, the model is limited to only two periods. Secondly, apprenticeship training consists of perfectly general skills with no firm-specific element. Thirdly, apprentices and workers stay within the sector and there is no retirement. These assumptions can be relaxed, altering the results quantitatively, but not qualitatively. See the appendix for a generalization with varying firm positions and chapter 6 for a generalization to an indefinite number of firms.

In the following chapters, emphasis will be put on the question whether public policy possesses instruments to internalize the externality and thereby to increase social welfare.

4.A Appendix

Proof of Proposition (1)

Firms' wage offers differ since their valuations for skilled workers vary. Thus, the problem arises whether the respective wage offers allow both firms to recruit skilled workers. This requires that $\theta^*_{t+1} > 0$ and also $1 - \theta^*_{t+1} > 0$. Put differently, conditions $v_{1,t+1} - v_{2,t+1} + 3\delta \geq 0$ and $v_{2,t+1} - v_{1,t+1} + 3\delta \geq 0$ must be met. Some rearranging of both inequalities gives

$$v_{1,t+1} - v_{2,t+1} \geq -3\delta \tag{4.27}$$

and

$$-\left(v_{1,t+1} - v_{2,t+1}\right) \geq -3\delta \iff 3\delta \geq v_{1,t+1} - v_{2,t+1} \tag{4.28}$$

One of these conditions will always be fulfilled. Clearly, the firm with the higher labor productivity will always be able to acquire skilled workers from the labor market because it can offer higher wages. For the other condition to hold (and also the second firm to recruit workers from the labor market) the productivity difference is not to exceed the threefold of the commuting cost rate. We assume this to be the case because we wish to analyze the duopson case. From straightforward inspection of (4.9), (4.10), (4.11), and (4.12) using conditions (4.27) and (4.28) then directly follows proposition (1).

If both conditions were not met, the market for skilled labor would be a monopson. Naturally, poaching cannot arise in a monopson. However, it is a standard result that the monopson wage falls below the marginal product, too.

Expected Future Net Wage

The present value of a skilled workers future net income is represented by the discounted expected net wage $\rho E\left(\tilde{w}^*_{t+1}\right)$ when working for firm 1 or 2.

$$E\left(\tilde{w}^*_{t+1}\right) = \int_0^{\hat{\theta}^*_{t+1}} \left(w^*_{1,t+1} - \delta\theta\right) d\theta + \int_{\hat{\theta}^*_{t+1}}^1 \left(w^*_{2,t+1} - \delta\left(1-\theta\right)\right) d\theta$$

Dissolving the integral yields

$$E\left(\tilde{w}_{t+1}^{*}\right)=\left[w_{1,t+1}^{*}\theta-\frac{\delta}{2}\theta^{2}\right]_{0}^{\hat{\theta}_{t+1}^{*}}+\left[w_{2,t+1}^{*}\theta-\delta\theta+\frac{\delta}{2}\theta^{2}\right]_{\hat{\theta}_{t+1}^{*}}^{1}$$

or

$$E\left(\tilde{w}_{t+1}^{*}\right)=w_{1,t+1}^{*}\hat{\theta}_{t+1}^{*}-\frac{\delta}{2}\hat{\theta}_{t+1}^{*2}+w_{2,t+1}^{*}-\delta+\frac{\delta}{2}-w_{2,t+1}^{*}\hat{\theta}_{t+1}^{*}+\delta\hat{\theta}_{t+1}^{*}-\frac{\delta}{2}\hat{\theta}_{t+1}^{*2}$$

which can be simplified to

$$E\left(\tilde{w}_{t+1}^{*}\right)=\left(w_{1,t+1}^{*}-w_{2,t+1}^{*}\right)\hat{\theta}_{t+1}^{*}+\delta\hat{\theta}_{t+1}^{*}\left(1-\hat{\theta}_{t+1}^{*}\right)+w_{2,t+1}^{*}-\frac{\delta}{2}$$

Inserting for $\hat{\theta}_{t+1}^{*}$, $w_{1,t+1}^{*}$, $w_{2,t+1}^{*}$ and a couple of algebraic rearrangements then yields

$$E\left(\tilde{w}_{t+1}^{*}\right)=\frac{v_{1,t+1}+v_{2,t+1}}{2}+\frac{\left(v_{1,t+1}-v_{2,t+1}\right)^{2}}{6\delta}-\frac{5}{4}\delta$$

Proof of Proposition (3)

Firm's return from apprenticeship training is

$$R_{i,f}=\rho R_{i,t+1}=\rho\frac{\left(v_{i,t+1}-v_{j,t+1}+3\delta\right)^{2}}{18\delta}$$

Firm's training incentives increase in labor market frictions since the partial derivative with respect to δ is positive.

$$\frac{\partial}{\partial\delta}R_{i,f}=\frac{-\left(v_{i,t+1}-v_{j,t+1}\right)^{2}+9\delta^{2}}{18\delta^{2}}>0$$

Note that the numerator denotes the familiar existence condition for both firms to be in the market.

Worker's return from apprenticeship training is equal to the present value of expected future net income.

$$R_{w}=\rho E\left(\tilde{w}_{t+1}\right)=\frac{v_{1,t+1}+v_{2,t+1}}{2}+\frac{\left(v_{1,t+1}-v_{2,t+1}\right)^{2}}{6\delta}-\frac{5}{4}\delta$$

The partial derivative with respect to frictions is clearly negative, i.e. frictions decrease worker's training incentives.

$$\frac{\partial}{\partial\delta}R_w = -\frac{6\left(v_{1,t+1} - v_{2,t+1}\right)^2}{6\delta} - \frac{5}{4} < 0$$

The sum of private returns of training at firm i is given by

$$R_{i,priv} = \rho\left(\frac{5v_{i,t+1} + v_{j,t+1}}{6} + \frac{4}{18\delta}\left(v_{i,t+1} - v_{j,t+1}\right)^2 - \frac{3}{4}\delta\right)$$

Again, the partial derivative with respect to frictions is clearly negative, thus implying private training incentives to decrease in labor market frictions.

$$\frac{\partial}{\partial\delta}R_{i,priv} = -\frac{72\left(v_{i,t+1} - v_{j,t+1}\right)^2}{\left(18\delta\right)^2} - \frac{3}{4} < 0$$

Derivation of Equation (4.24)

Welfare in this economy consists of the profits and wages net of commuting frictions.

$$W_t = \int_0^{\hat{\theta}_t}\left(v_{1t} - w_{1t} + w_{1t} - \delta\theta\right)N_t d\theta + \int_{\hat{\theta}_t}^1 (v_{2t} - w_{2t} + w_{2t} - \delta\left(1-\theta\right))N_t d\theta$$

Put simpler, welfare is net production.

$$W_t = \int_0^{\hat{\theta}_t}(v_{1t} - \delta\theta)N_t d\theta + \int_{\hat{\theta}_t}^1 (v_{2t} - \delta\left(1-\theta\right))N_t d\theta$$

By dissolving the integral

$$W_t = N_t\left[v_1\theta - \frac{\delta}{2}\theta^2\right]_0^{\hat{\theta}_t} + N_t\left[v_2\theta - \delta\theta + \frac{\delta}{2}\theta^2\right]_{\hat{\theta}_t}^1$$

obtain

$$W_t = N_t\left(v_1\hat{\theta}_t - \frac{\delta}{2}\hat{\theta}_t^2 + v_2 - \delta + \frac{\delta}{2} - v_2\hat{\theta}_t + \delta\hat{\theta}_t - \frac{\delta}{2}\hat{\theta}_t^2\right)$$

which can be simplified to

$$W_t = N_t \left(v_1 \hat{\theta}_t - v_2 \hat{\theta}_t + \delta \hat{\theta}_t + v_2 - \frac{\delta}{2} - \delta \hat{\theta}_t^2 \right)$$

$$W_t = N_t \left(\hat{\theta}_t \left(v_1 - v_2 + \delta - \delta \hat{\theta}_t \right) + v_2 - \frac{\delta}{2} \right)$$

Inserting for $\hat{\theta}_t^*$

$$W_t = N_t \left(\frac{v_1 - v_2 + 3\delta}{6\delta} \left(v_1 - v_2 + \delta - \delta \frac{v_1 - v_2 + 3\delta}{6\delta} \right) + v_2 - \frac{\delta}{2} \right)$$

$$W_t = N_t \left(\frac{v_1 - v_2 + 3\delta}{6\delta} \cdot \frac{5v_1 - 5v_2 + 3\delta}{6} + v_2 - \frac{\delta}{2} \right)$$

$$W_t = N_t \left(\frac{1}{36\delta} \left(18\delta v_1 - 10 v_1 v_2 + 5v_1^2 + 5v_2^2 + 18\delta v_2 - 9\delta^2 \right) \right)$$

then yields

$$W_t = N_t \left(\frac{v_1 + v_2}{2} + \frac{5}{36\delta} \left(v_1 - v_2 \right)^2 - \frac{1}{4}\delta \right)$$

From $W = \sum_{t,t+1} \rho^t W_t - \sum_{i=1,2} c_i \left(A_{it} \right)$ then follows equation (4.24).

Proof of Proposition (7)

In order to show that social returns of apprenticeship training exceed the private returns, compare the condition for the social optimum (4.26)

$$\rho \left(\frac{v_1 + v_2}{2} + \frac{5}{36\delta} \left(v_1 - v_2 \right)^2 - \frac{1}{4}\delta \right) - c_i' \left(A_i \right) = 0 \quad \forall i = \{1, 2\}$$

with the conditions for the private optimum (4.17) and (4.18)

$$\rho \frac{\left(v_1 - v_2 + 3\delta \right)^2}{18\delta} - c_1' \left(A_1 \right) = 0$$

and

$$\rho \frac{\left(v_2 - v_1 + 3\delta \right)^2}{18\delta} - c_1' \left(A_1 \right) = 0$$

Consider first apprenticeship training at firm 1. Social returns to training will be above private returns if

$$\frac{v_1 + v_2}{2} + \frac{5}{36\delta}(v_1 - v_2)^2 - \frac{1}{4}\delta > \frac{(v_1 - v_2 + 3\delta)^2}{18\delta}$$

This simplifies to

$$9\delta(v_1 + v_2) + \frac{5}{2}v_1^2 - 5v_1v_2 + \frac{5}{2}v_2^2 - \frac{9}{2}\delta^2 > v_1^2 - 2v_1v_2 + 6\delta v_1 - 6\delta v_2 + v_2^2 + 9\delta^2$$

which gives

$$3\delta v_1 + 15\delta v_2 - \frac{27}{2}\delta^2 > -\frac{3}{2}(v_1 - v_2)^2$$

or differently

$$-9\delta^2 + 2\delta v_1 + 10\delta v_2 + (v_1 - v_2)^2 > 0$$

The last equation essentially states combinations of δ, v_1 and v_2 for which training will cause a positive or negative externality to arise. Moreover, from above follows that both firms are in the market if conditions (4.27) and (4.28) are fulfilled. Inserting for $(v_1 - v_2)$ we can rewrite to

$$-9\delta^2 + 2\delta v_1 + 10\delta v_2 + 9\delta^2 > 0$$

which then rearranges to

$$2\delta v_1 + 10\delta v_2 > 0$$

This condition is always fulfilled as long as commuting costs are positive.

Proceed likewise for apprenticeship training at firm 2.

$$\frac{v_1 + v_2}{2} + \frac{5}{36\delta}(v_1 - v_2)^2 - \frac{1}{4}\delta > \frac{(v_2 - v_1 + 3\delta)^2}{18\delta}$$

which can be simplified to

$$9\delta(v_1 + v_2) + \frac{5}{2}v_1^2 - 5v_1v_2 + \frac{5}{2}v_2^2 - \frac{9}{2}\delta^2 > v_2^2 - 2v_1v_2 - 6\delta v_1 + 6\delta v_2 + v_2^2 + 9\delta^2$$

and

$$15\delta v_1 + 3\delta v_2 - \frac{27}{2}\delta^2 > -\frac{3}{2}(v_1 - v_2)^2$$

and finally

$$10\delta v_1 + 2\delta v_2 + (v_1 - v_2)^2 - 9\delta^2 > 0$$

Again inserting for $(v_1 - v_2)$ this condition is also fulfilled.

$$10\delta v_1 + 2\delta v_2 > 0$$

Extension for Varying Firm Locations and Market Length

The exposition so far assumed a Hotelling street of unit length with firms located at either end. Yet, interval length as well as firms' position may vary freely. In order to assess this general case, denote the length of the interval by I and the position of each firm by θ_i. Figure 4.4 illustrates this extension.

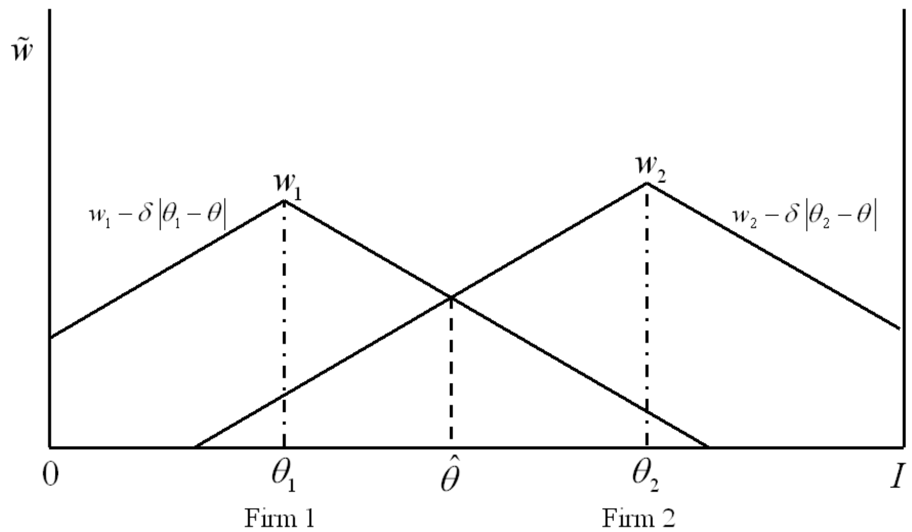

Figure 4.4: Hotelling Street with Unspecified Firm Location

Poaching Period

The arbitrage condition for the indifferent worker $\hat{\theta}$ is

$$w_{1,t+1} - \delta\left(\hat{\theta} - \theta_1\right) = w_{2,t+1} - \delta\left(\theta_2 - \hat{\theta}\right)$$

Rearrange to obtain the equation for the indifferent worker that again marks the share of workers to firm 1.

$$\hat{\theta} = \frac{w_{1,t+1} - w_{2,t+1}}{2\delta} + \frac{\theta_1 + \theta_2}{2}$$

Accordingly, all workers in the interval $\left(I - \hat{\theta}\right)$ will work for firm 2. With the workforce given we can write firms wage setting problem.

$$\begin{aligned}
\max_{\{w_{1,t+1}\}} \pi_{1,t+1} &= \left(v_{1,t+1} - w_{1,t+1}\right)\hat{\theta}(.)N_{t+1} \\
\max_{\{w_{2,t+1}\}} \pi_{2,t+1} &= \left(v_{2,t+1} - w_{2,t+1}\right)\left(I - \hat{\theta}(.)\right)N_{t+1}
\end{aligned}$$

The first order conditions are now

$$\begin{aligned}
-\left(w_{1,t+1} - w_{2,t+1}\right) - \delta\left(\theta_1 + \theta_2\right) + \left(v_{1,t+1} - w_{1,t+1}\right) &= 0 \\
-2\delta I + w_{1,t+1} - w_{2,t+1} + \delta\left(\theta_1 + \theta_2\right) + \left(v_{2,t+1} - w_{2,t+1}\right) &= 0
\end{aligned}$$

$$\begin{aligned}
-\hat{\theta}(.) + \left(v_{1,t+1} - w_{1,t+1}\right)\frac{1}{2\delta} &= 0 \\
-\left(I - \hat{\theta}(.)\right) + \left(v_{2,t+1} - w_{2,t+1}\right)\frac{1}{2\delta} &= 0
\end{aligned}$$

which can be rearranged to the reaction functions

$$\begin{aligned}
w^*_{1,t+1}\left(w_{2,t+1}\right) &= \frac{1}{2}\left(v_{1,t+1} + w_{2,t+1} - \delta\left(\theta_1 + \theta_2\right)\right) \\
w^*_{2,t+1}\left(w_{1,t+1}\right) &= \frac{1}{2}\left(v_{2,t+1} + w_{1,t+1} - \delta\left(2I - \left(\theta_1 + \theta_2\right)\right)\right)
\end{aligned}$$

Solving for the equilibrium wages then yields

$$\begin{aligned} w^*_{1,t+1} &= \frac{2}{3}v_{1,t+1} + \frac{1}{3}v_{2,t+1} - \frac{1}{3}\delta\left(2I + \theta_1 + \theta_2\right) \\ w^*_{2,t+1} &= \frac{1}{3}v_{1,t+1} + \frac{2}{3}v_{2,t+1} - \frac{1}{3}\delta\left(4I - \theta_1 - \theta_2\right) \end{aligned}$$

For $\theta_1 = 0$, $\theta_1 = 1$, and $I = 1$ we obtain the equilibrium wages of the simple case above. In addition, the general formulation allows to derive the effects of interval length and firms' position: Equilibrium wages decrease the greater the interval, $\frac{\partial w^*_{i,t+1}}{\partial I} < 0$. Intuitively, longer travels are costly and reduce wage arbitrage.[6] Note also that wage offers by firm 1 decrease the more both firms are located to the 'right' of the interval, $\frac{\partial w^*_{1,t+1}}{\partial \theta_1} < 0$ and $\frac{\partial w^*_{1,t+1}}{\partial \theta_2} < 0$. Vice versa, wage offers by firm 2 increase, $\frac{\partial w^*_{2,t+1}}{\partial \theta_1} > 0$ and $\frac{\partial w^*_{2,t+1}}{\partial \theta_2} > 0$.

From the equilibrium wages again follows the allocation of the workforce

$$\begin{aligned} \hat{\theta}^*_{t+1} &= \frac{v_{1,t+1} - v_{2,t+1} + \delta\left(2I + \theta_1 + \theta_2\right)}{6\delta} \\ I - \hat{\theta}^*_{t+1} &= \frac{v_{2,t+1} - v_{1,t+1} + \delta\left(4I - \theta_1 - \theta_2\right)}{6\delta} \end{aligned}$$

Equilibrium profits in the future period from employing skilled workers

$$\begin{aligned} \pi^*_{1,t+1} &= \frac{\left(v_{1,t+1} - v_{2,t+1} + \delta\left(2I + \theta_1 + \theta_2\right)\right)^2}{18\delta}N_{t+1} \\ \pi^*_{2,t+1} &= \frac{\left(v_{2,t+1} - v_{1,t+1} + \delta\left(4I - \theta_1 - \theta_2\right)\right)^2}{18\delta}N_{t+1} \end{aligned}$$

Training Period

The training decision is denoted by the maximization problem

$$\begin{aligned} &\arg\max_{\{A_{1t}\}} \left\{\rho R^*_{1,t+1}N_{t+1} - w^a_t A_{1t} - c_i\left(A_{1t}\right)\right\} \\ &\arg\max_{\{A_{2t}\}} \left\{\rho R^*_{2,t+1}N_{t+1} - w^a_t A_{2t} - c_i\left(A_{2t}\right)\right\} \end{aligned}$$

[6] In this model, an increase in the length of the interval works essentially similar to an increase in frictional cost parameter δ.

The first order conditions with respect to the number of apprentices by each firm are now

$$\begin{aligned}\rho R^*_{1,t+1} - w^a_t - c'_i\left(A_{1t}\right) &= 0\\ \rho R^*_{2,t+1} - w^a_t - c'_i\left(A_{2t}\right) &= 0\end{aligned}$$

Note that for $\theta_1 = 0$, $\theta_1 = 1$, and $I = 1$ we obtain the same training result as in the simple case. Additionally, we learn that training increases in interval length since $\frac{\partial R^*_{i,t+1}}{\partial I} > 0$. Intuitively, with a more segmented labor market, firms possess higher monopsony power. This allows for lower wages which in turn enables to yield higher training returns. Note also that firms' positions on the interval affect training outcomes. Since $\frac{\partial R^*_{1,t+1}}{\partial \theta_1} > 0$ and $\frac{\partial R^*_{1,t+1}}{\partial \theta_2} > 0$, firm 1 will train more apprentices, the more both firms are located to the 'right' of the interval. Vice versa, firm 2 will train less since its training returns decrease, $\frac{\partial R^*_{2,t+1}}{\partial \theta_1} < 0$ and $\frac{\partial R^*_{2,t+1}}{\partial \theta_2} < 0$. This essentially states that if a firm has a strong position on the labor market, this will also lead to higher training efforts.

Chapter 5

Incentive Schemes

The literature review in chapter 3 pointed to Pigou (1912) for having first named poaching as the cause of underprovision of vocational training. Concluding that training possesses additional social returns, he proposed to introduce a system of '*bounties and taxes*' as a means to provide firms with additional training incentives. Training systems in several countries have been build on this advise. This chapter will therefore take up this proposal and analyze public policies for providing training incentives in further detail.

Policies to encourage employer training can be distinguished into voluntary arrangements and compulsory measures (Gasskov 1994, 8). *Voluntary training arrangements* are private agreements among firms, employer organizations and unions. The social partners thereby assume joint responsibility for vocational training. A common example are collective labor agreements in Germany, which often include provisions for apprenticeship training. The joint training initiative (dt. *Ausbildungspakt*) of the federal government and the confederation of employers' associations and training chambers also falls into this category. *Compulsory employer training*, in contrast, describes training regulations from government intervention. Examples for such mandatory measures include the regulation of training contracts, training rules, or incentive schemes.

The focus of this section are *incentive schemes*. Besides training subsidies or tax breaks, they can be of manifold form. In view of the policy debate in

Germany, we will put special emphasis on training levy schemes as a means to encourage vocational training. Other policies, in particular the regulation of training contracts, will not be considered here.[1]

5.1 Pigouvian Subsidies

For theoretical reference consider at first the case of ideal Pigouvian subsidies. Under this scheme, firm i receives a subsidy z_{it} per apprentice it trains in period t. The total subsidy payment β_{it} to firm i is therefore

$$\beta_{it} = z_{it} A_{it} \tag{5.1}$$

The subsidy payment alters firms' objective functions by an additional term. Using the simple training model of chapter 4 the optimization problems for firm 1 and 2 in the training period become

$$\begin{aligned}
&\underset{\{w_{1t}, A_{1t}\}}{\arg\max} \left\{ \rho R_{1,t+1} N_{t+1} + (v_{1t} - w_{1t}) N_{1t} - w_t^a A_{1t} - c_1 (A_{1t}) + z_{1t} A_{1t} \right\} \\
&\underset{\{w_{2t}, A_{2t}\}}{\arg\max} \left\{ \rho R_{2,t+1} N_{t+1} + (v_{2t} - w_{2t}) N_{2t} - w_t^a A_{2t} - c_2 (A_{2t}) + z_{2t} A_{2t} \right\}
\end{aligned}$$

The first order conditions with respect to firms' wage offers remain unaffected. Equilibrium wages in the training period are therefore again given by equations (4.15) and (4.16). However, the subsidy payment modifies firms' optimality conditions for its choice of apprentices.

$$\rho R_{1,t+1} - w_t^a + z_{1t} = c_1'(A_{1t}^{Pigou}) \tag{5.2}$$

$$\rho R_{2,t+1} - w_t^a + z_{2t} = c_2'(A_{2t}^{Pigou}) \tag{5.3}$$

Equations (5.2) and (5.3) state, similar to before, that firms will offer vocational training such that the marginal returns from an additional apprentice equal the marginal costs. Naturally, with the subsidy payment raising the marginal returns, the optimal number of apprenticeships in each firm in-

[1] See below in chapter 7 for a discussion on regulation of reimbursement clauses in training contracts.

creases. Using the inverse of the cost function, the optimal provision of apprenticeships can be deduced for each firm.

$$A_{1t}^{Pigou} = c_1'^{-1}(.) = \phi_1 (z_{1t}, v_{1,t+1}, v_{2,t+1}, \rho, \delta)$$

$$A_{2t}^{Pigou} = c_2'^{-1}(.) = \phi_2 (z_{1t}, v_{1,t+1}, v_{2,t+1}, \rho, \delta)$$

A benevolent social planner would strive to set the subsidy such that the private training conditions equal the social training condition. Optimal subsidy rates for each firm are thus equal to z_{1t} and z_{2t}.

$$z_{1t} = \rho \left(\tfrac{1}{2}\delta - \tfrac{(v_{1,t+1} - v_{2,t+1})}{12\delta} (v_{1,t+1} - v_{2,t+1} + 4\delta) \right) \equiv X_1$$

$$z_{2t} = \rho \left(\tfrac{1}{2}\delta - \tfrac{(v_{2,t+1} - v_{1,t+1})}{12\delta} (v_{2,t+1} - v_{1,t+1} + 4\delta) \right) \equiv X_2$$

From the optimal subsidy rates we can derive a proposition on training efficiency:

Proposition 9 *An ideal Pigouvian subsidy scheme internalizes training spillovers and restores efficiency.*

Proof. Equate conditions (5.2) and (4.26) as well as (5.3) and (4.26) and easily obtain z_{1t} and z_{2t}. For detailed derivation see appendix. ■

The intuition to this result is commonplace. By providing firms with a subsidy per apprentice that is equal to the marginal externality, private and social incentives to training are aligned. This internalizes positive spillovers from apprenticeship training and first best training levels can be achieved.

Note that optimal subsidy rates vary across firms since the size of the training externality differs. Comparative-static analysis shows that the optimal subsidy rate z_{it} decreases in firm's own productivity $v_{i,t+1}$, but increases in the opponent's productivity $v_{j,t+1}$ and the friction parameter δ. Also note that the ideal subsidy does not depend on firm's training cost function.

Figure 5.1 depicts this situation graphically. In the private optimum, firm i equalizes the marginal private returns of an additional apprenticeship $R_{i,priv}$ to its marginal costs c_i'. An additional subsidy per apprentice z_{it} increases the marginal private returns such that the social optimum A_i° can be achieved. The Pigouvian subsidy thereby brings about a welfare gain that is equivalent to the striped triangle.

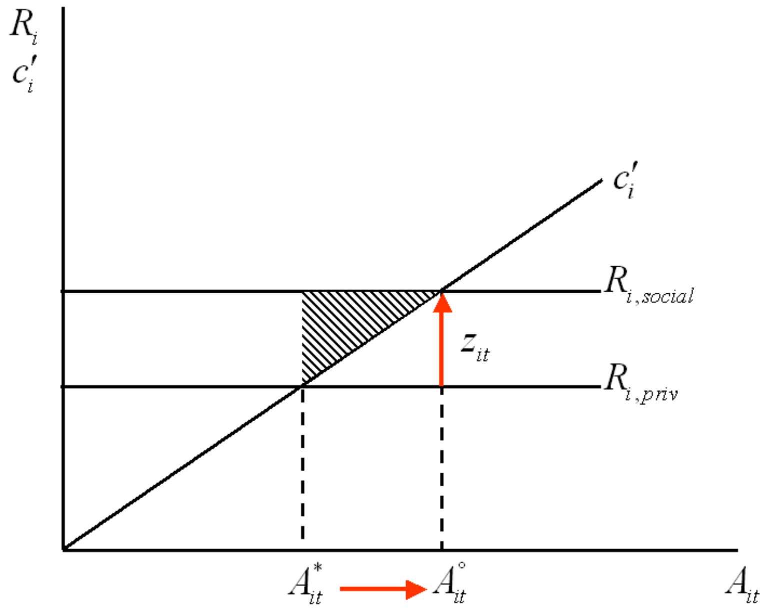

Figure 5.1: Perfect Pigouvian Subsidy

Although an ideal Pigouvian subsidy possesses a strong theoretical appeal for its ability to internalize positive spillovers, its premises are highly unrealistic. In particular, the instrument requires to calculate subsidy rates for vocational training at the firm level. Because the externality arises from poaching, the specific subsidy must be determined from firms' *future* labor productivity. This demands to gather and process very accurate and detailed information on production as well as output market parameters, which would already cause severe difficulties in practice. Additionally, and making matters even worse, the interests of firms and government to disclose the information may strongly diverge. While the government seeks to obtain precise information to assess the size of the externality, firms have an interest to falsely state their productivity levels in order to obtain larger subsidy payments.[2]

[2]More precisely, government faces asymmetric information with respect to firms' pro-

Clearly, with only limited and inaccurate information available, the possibility to calculate firm-specific subsidies is strongly reduced. Alternatively, one may therefore consider to introduce a uniform subsidy that provides additional training incentives *on average* for the economy or a particular sector. Although this departs from the theoretical ideal, such an instrument could be much simpler to determine and administer. It will now be analyzed.

5.2 Uniform Subsidies

Under a uniform subsidy scheme, government is constraint to a single subsidy rate z. The total payment to firm i for training apprentices thus becomes

$$\beta_{it} = zA_{it} \tag{5.4}$$

As before, include the uniform subsidy in firms' decision problem in the training period. The optimality conditions for apprenticeship training are now

$$\rho R_{1,t+1} - w_t^a + z = c_1'(A_{1t}^{uni}) \tag{5.5}$$

$$\rho R_{2,t+1} - w_t^a + z = c_2'(A_{2t}^{uni}) \tag{5.6}$$

Firms' optimal training levels A_{1t}^{uni} and A_{2t}^{uni} again increase in the subsidy rate and can be determined from the inverse cost functions $\phi_i(.)$.

$$A_{1t}^{uni} = c_1'^{-1}(.) = \phi_1(z, v_{1,t+1}, v_{2,t+1}, \rho, \delta)$$

$$A_{2t}^{uni} = c_2'^{-1}(.) = \phi_2(z, v_{1,t+1}, v_{2,t+1}, \rho, \delta)$$

When introducing a uniform subsidy scheme, the government seeks to determine the optimal subsidy rate z such that social welfare $W(A_{1t}^{uni}(z), A_{2t}^{uni}(z))$ is maximized. This uniform rate trades off the disadvantages of insufficient and excessive subsidization. Using the social welfare function 4.24 and after

ductivity which cause a typical *adverse selection* problem to arise.

some simplications, the optimization problem of a benevolent government can be stated by

$$\underset{\{z\}}{\arg\max} \left\{ \sum_{i=1,2} A_{it}^{uni} \cdot \rho \left(\frac{v_{1,t+1}+v_{2,t+1}}{2} + \frac{5}{36\delta} \left(v_{1,t+1} - v_{2,t+1} \right)^2 - \frac{1}{4}\delta \right) - \sum_{i=1,2} c_i' \left(A_{it}^{uni} \right) \right\}$$

The first order condition (5.7) denotes the optimality condition for the welfare-maximizing uniform subsidy rate z°.

$$\sum_{i=1,2} \frac{\partial A_{it}^{uni}}{\partial z} \cdot \rho \left(\frac{v_{1,t+1}+v_{2,t+1}}{2} + \frac{5}{36\delta} \left(v_{1,t+1} - v_{2,t+1} \right)^2 - \frac{1}{4}\delta \right) - \sum_{i=1,2} c_i' \left(A_{it}^{uni} \right) \frac{\partial A_{it}^{uni}}{\partial z} = 0 \tag{5.7}$$

For the optimal uniform subsidy rate z°, equation (5.7) states that the sum of the marginal social returns from an increase in the subsidy rate is to equal the sum of the marginal increases in the training costs. This allows to deduce the next proposition.

Proposition 10 *A **uniform** Pigouvian subsidy scheme, in contrast to an **ideal** Pigouvian subsidy scheme, cannot achieve Pareto-optimality. At the optimal subsidy rate z there will be over- and undertraining.*

Proof. Rearrange the first order condition (5.7) and obtain

$$\sum_{i=1,2} \frac{\partial A_{it}^{uni}}{\partial z} \left(\rho \left(\frac{v_{1,t+1}+v_{2,t+1}}{2} + \frac{5}{36\delta} \left(v_{1,t+1} - v_{2,t+1} \right)^2 - \frac{1}{4}\delta \right) - c_i' \left(A_{it}^{uni} \right) \right) = 0$$

Note that the term in the round brackets displays the social training condition. In the Pareto-optimum, this term should equal zero for both firms. However, unless firms were identical, the training cost functions and also the number of apprentices vary across firms. But with $c_i'(A_{it}^{uni}) \neq c_j'(A_{jt}^{uni})$, the social training condition cannot be fulfilled and training therefore cannot be efficient.

Furthermore, because $\frac{\partial A_{it}^{uni}}{\partial z} > 0$, the whole condition equalizes to zero only if the bracket term is positive for one firm, and negative for the other. This clearly implies that the optimal subsidy causes overtraining in one firm and undertraining in the other. ■

The intuition for this result is straightforward. Subsidization leads firms to increase training, but government is constraint to set a single subsidy rate. Because the size of the training externality varies across firms, the optimal subsidy will exceed the ideal amount for the low externality firm and fall short of the ideal amount at the high externality firm. Hence, the Pareto optimal allocation cannot be achieved.

Figure 5.2 demonstrates this point graphically. Without a subsidy scheme, firms take A^*_{1t} and A^*_{2t} apprentices for training which equates the private marginal returns $R_{1,priv}$ and $R_{2,priv}$ to the marginal training costs c'. Socially optimal training at each firm A°_{1t} and A°_{2t} follows from the intersection with R_{social}. An uniform subsidy z now raises the marginal returns to $R_{1,priv} + z$ and $R_{2,priv} + z$. This increases vocational training to A^{uni}_{1t} and A^{uni}_{2t}. However, since private training returns differ, there is undertraining in firm 1, $A^{uni}_{1t} < A^\circ_{1t}$, and overtraining in firm 2, $A^{uni}_{2t} < A^\circ_{2t}$.

Welfare effects can also be displayed within the graph. The uniform subsidy brings about welfare gains from increasing training above the private level (striped areas). However, welfare losses from overtraining must be substracted (shaded area). For the optimal uniform subsidy, the marginal social loss from overtraining equals the marginal social gain from larger subsidization. Put differently, this is equivalent to $R_{social} - (R_{1,priv} + z) = -(R_{social} - (R_{2,priv} + z))$.

Because a uniform subsidy scheme cannot achieve first best training, this instrument cannot restore *Pareto-efficiency*. However, its introduction can be shown to be *Pareto-improving*.[3]

Proposition 11 *The introduction of a small uniform subsidy leads to a Pareto-improvement.*

Proof. At a subsidy rate of zero, the welfare function is increasing in z. Or, formally, $\frac{\partial W}{\partial z}|_{z=0} > 0$. ∎

[3] For the distinction between Pareto-optimality and Pareto-improvement see Atkinson & Stiglitz (1980).

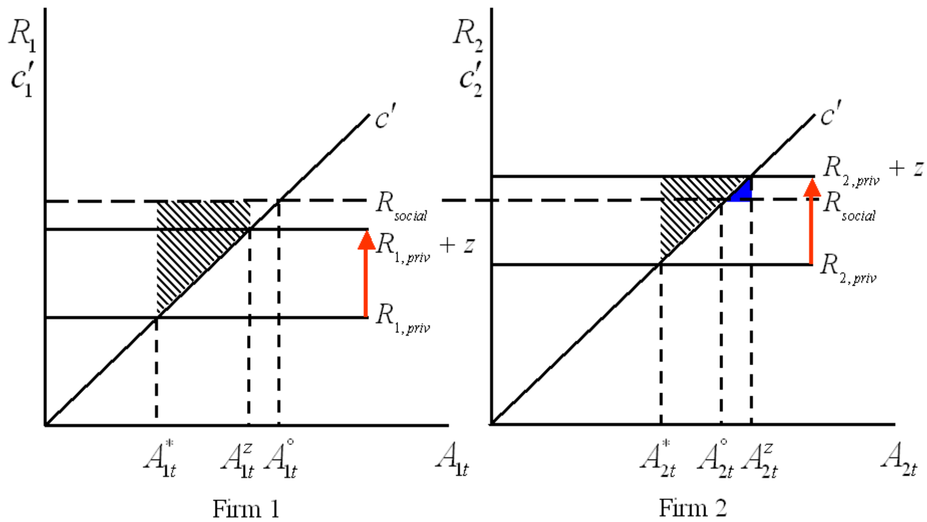

Figure 5.2: Uniform Pigouvian Subsidy

Despite the constraint to use a uniform subsidy rate, introducing a subsidy scheme is welfare-improving. A small positive subsidy increases training at the margin. It thereby slightly internalizes the externality which is beneficial to welfare.

This analysis so far makes a positive judgement on introducing (small) training subsidies. But note that it has not yet spent any thoughts on the financing of the subsidy payments. In fact, it implicitly assumed costless funding from the general budget. Yet, the government budget itself is constrained because public funds are limited and subject to alternative uses. Moreover, non-distortionary revenues from lump-sum taxes are not feasible. The financing of the subsidy payments may therefore require a tax increase or the introduction of a new distortionary tax. Without taking the funding of the subsidy payments into account, the present results must therefore be treated with strict caution.

5.3 Training Levies

To this point, the analysis focussed on subsidy schemes to internalize spillovers from vocational training. We now turn to training levies, which have received much attention in Germany. Before analyzing the recent training levy proposal, we first take a look at training levy schemes in general.

5.3.1 Policy Alternatives

The basic idea of training levies is to penalize firms that do not train at all or only to an insufficient extent. These firms are considered to benefit from positive spillovers and to free-ride on competitors' training efforts. Proponents of training levy schemes claim that imposing training levies on these firms offers additional training incentives and distributes training costs fairly among firms.

Training levies schemes have been introduced in several industrialized countries. These schemes differ in scope, financing and institutional set-up. Gasskov (1994), pp. 75ff., distinguishes the following variants:

- Revenue-generating levy schemes
- Levy-exemption schemes
- Levy-grant schemes
- Reimbursement schemes

Revenue-generating levy schemes impose a special compulsory tax on employers in order to fund major training programs. Training levies are usually collected in proportion to workforce or payroll. The revenues, in contrast, are spent on public or sectoral programs beyond the control of individual employers. Thus, revenue-generating levy schemes correspond closely to other employment taxes collected from firms since they generate revenues for public training programs, but do not provide direct training incentives to firms.

Levy-exemption schemes also impose a compulsory tax on workforce or payroll. Its revenues are also spent on public training programs as in the case of revenue-generating levy schemes. Additionally, however, there is an exemption mechanism, which allows firms to eliminate or reduce their levy obligations if they provide training. The compulsory levy induces a minimum level of training expenses as employers possess strong incentives for own training, both to reduce their levy obligation and to retain control on spending. If firms have better knowledge of training needs compared with an administrative body, this exemption mechanism prevents misallocations of training funds.

Levy-grant schemes differ from levy-exemption schemes in the withdrawal of spending control. This scheme collects training levies from all firms as before, but training grants are made subject to certain eligibility criteria. From the view of training policy, this enables for some discretion. A levy-grant scheme thus permits a greater redistribution of levy-based funds towards firms or sectors considered to be of particular importance. Note also that levy-grant schemes require an administration which collects and redistributes funds. This contrasts to levy-exemption schemes, which operate only in case employer's actions do not meet the training standard.

Reimbursement schemes entitle firms for (partial) reimbursement of training expenditures if their training complies with the spending rules of the training fund. Thus, these schemes are essentially subsidy programs. The fund's financial resources that are spent on reimbursement often result from general tax receipts.

From this general classification, let us discuss some actual training levy schemes in industrialized countries.[4] Revenue-generating levies are common in countries with a strong public element in vocational education. In contrast, levy-exemption, levy-grant and reimbursement schemes are applied in countries predominantly relying on on-the-job vocational training.

The literature often cites Britain as an example for levy-grant-schemes. The British Training Act of 1972 introduced a levy-grant scheme at the sectoral level to overcome market failure in firm training. The scheme was

[4] For an international comparison on the financing of vocational training see in particular Gasskov (1994) and Gasskov (2000). Greenhalgh (1999), Stevens (1999) and Bosch (2004*b*) also provide some account of training levies throughout the world.

however abandoned in favor for more market-oriented solutions in 1982.[5]

France applies a levy-exemption scheme both for vocational and continuous education. In fact, it is considered to be the first country to have introduced such a scheme on a national scale. Firms are levied a compulsory payroll tax, but are exempt if their training expenses exceed this threshold (Gasskov 1994, 86).[6]

An example of reimbursement schemes is Denmark. Unions and employers manage a training fund. It collects a general training levy from all firms, but reimburses for trainee wages (Bosch 2004*a*, 221).

5.3.2 German Levy Proposal

Let us now turn to the recent training levy proposal for Germany. Yet, it must be emphasized that training levies have been proposed for many years. In the late 1960s already, the federal government sought solutions in order to react on shortages of apprenticeship training. Then as now, it considered vocational education an area of utmost public responsibility and mandated an expert commission to assess different policy instruments and come up with a policy proposal. The commission emphasized the advantage of integrated on-the-job training and schooling within the German dual system but it also recognized important inequalities in firms' efforts and activities towards vocational training. As a remedy it proposed a training levy on all firms to feed funds for additional apprenticeship training Schulz (1972).

In the past, alike today, a training levy scheme was not universally accepted in the political landscape but eventually entered into legislation. The training bill passed in 1976 mandated the federal government to raise a training levy if the demand for apprenticeships exceeds the supply by 12.5%. In reality, however, the scheme was never implemented. A ruling of the federal constitutional court in 1980 overthrew the law on formal grounds, because the training law was passed without the approval of the federal council

[5] See Finegold & Soskice (1988) and Stevens (1999) for an account of vocational training policy in Britain.

[6] More detailed descriptions of the French system can be found in Gasskov (1994), Greenhalgh (1999) and Bosch (2004*b*).

Bundesverfassungsgericht (1980).[7] Hereafter, training levy schemes vanished from the political scene.[8]

The idea of training levies persisted within party manifests and union activities. It reappeared recently in response to renewed shortages of apprenticeship positions. This resulted into a federal law proposal that has entered the formal legislative readings, but has been held in the federal parliament prior to the final vote. The issue whether to pass the law or not still remains debated at present.[9]

If the bill were enacted in its present form, it would enable the federal government to collect levies from firms that train less than a certain standard and redistribute the revenues to firms that exceed this standard. The benchmark is a mandatory training quota that has been set to 7% of the employed workforce. If a firm falls short of this prescribed quota, it is to pay a training levy, and if it exceeds the quota, it is eligible to additional funds. Moreover, training levies and training grants increase the larger the deviation from the benchmark level. The scheme thereby intends to discriminate between varying training efforts across firms.[10]

More precisely, firms are entitled to a subsidy for every apprentice exceeding the training quota. Monthly subsidies per apprentice are to range from €580 to €1240 depending on the profession. This variation is aimed

[7] According to the German constitution, bills concerning taxation and administrative duties affecting the federal states are subject to vote by the federal council, Germany's upper legislative chamber representing the federal states.

[8] Although the introduction of a training levy scheme by federal law had failed, such schemes have been introduced at the sectoral level. In 1975, the social partners in the construction industry negotiated a collective agreement which set-up a levy-grant scheme for vocational training in this sector. This agreement has been declared generally binding and is therefore valid for all firms in this sector. The scheme collects a training levy of 1.6% on firms' payroll and redistributes the money according to firms' training efforts. In the first year, a firm receives a grant amounting to the tenfold of a monthly training allowance. In the second year, the payment shrinks to the sixfold, and in the third year to the singlefold. Some authors consider this scheme to be examplary as the trainee rate has since increased (Bosch 2004*a*, 222).

[9] For the legislative status, the precise text of the law and an explanatory statement to the legislative intentions see in particular Deutscher Bundestag (2004).

[10] For details to the law proposal see the draft in Deutscher Bundestag (2004), in particular §§9-11 BerASichG.

to reflect trainee wages that differ strongly across occupations. In contrast, firms are levied a certain penalty per employee if the training quota is not attained.[11] Other than the subsidy rate and the mandatory training quota, the law proposal leaves the penalty rate unspecified. Instead, it is to be determined such that the whole scheme is self-financing, i.e. that subsidies and administrative expenses can be financed.

In order to allow for a detailed economic analysis, we now transform this proposal into formal terms. Let β_{it} again be the payment to firm i resulting from the scheme in the training period. Moreover, let α_{it} define the training quota of firm i, i.e. firm's ratio of apprentices to employees.

$$\alpha_{it} = \frac{A_{it}}{N_{it}} \tag{5.8}$$

Define $\hat{\alpha}$ to be the mandatory training quota that specifies the desired training standard. Now, if a firm falls short of the mandatory level, i.e. $\alpha_{it} < \hat{\alpha}$, the firm has to pay a penalty p for every skilled worker it employs. Because the penalty intends to reflect differences in training across firms, the total levy decreases for every apprentice the firm trains. Accordingly, the workforce that would be equivalent to the actual number of apprentices at the mandatory training quota, i.e. $\hat{N} = \frac{A_{it}}{\hat{\alpha}}$, is deducted from the levy base. Training levies to firm i are thus calculated according to

$$levy_{it} = -\left(N_{it} - \frac{A_{it}}{\hat{\alpha}}\right) \cdot p$$

By contrast, if a firm exceeds the mandatory level, i.e. $\alpha_{it} > \hat{\alpha}$, the firm receives a grant z per apprentice it trains above the mandatory training

[11] The law defines apprentices as those trainees employed by a firm that fall under the conditions of the apprenticeship training law. Employees are full-time workers that are subject to social insurance contributions. Thus, the law excludes interns, student apprentices, freelance workers, temporary workers and so-called minor employments. Thereby some substitution between different trainee and worker categories may arise resulting in distortions from the levy-grant scheme. These issues are however neglected here.

level. The training grant to firm i is thus

$$grant_{it} = (A_{it} - \hat{\alpha} N_{it}) \cdot z$$

Equation (5.9) summarizes the payment to firm i resulting from the proposed training levy scheme.

$$\beta_{it} = \left\{ \begin{array}{ccc} -\left(N_{it} - \frac{A_{it}}{\hat{\alpha}}\right) \cdot p & & \alpha_{it} < \hat{\alpha} \\ (A_{it} - \hat{\alpha} N_{it}) \cdot z & \text{if} & \alpha_{it} > \hat{\alpha} \\ 0 & & \alpha_{it} = \hat{\alpha} \end{array} \right\} \tag{5.9}$$

Factoring out N_{it} and using (5.8) to replace for firm's training quota then leads to

$$\beta_{it} = \left\{ \begin{array}{ccc} (\alpha_{it} - \hat{\alpha}) \cdot \frac{p}{\hat{\alpha}} N_{it} & & \alpha_{it} < \hat{\alpha} \\ (\alpha_{it} - \hat{\alpha}) \cdot z N_{it} & \text{if} & \alpha_{it} > \hat{\alpha} \\ 0 & & \alpha_{it} = \hat{\alpha} \end{array} \right\} \tag{5.10}$$

For analytical simplicity, let us assume firms are given the same financial incentive for an additional apprentice, regardless of whether the firm exceeds or falls short of the training quota. Then, as follows from (5.10), penalty and subsidy must obey the relation $\frac{p}{\hat{\alpha}} = z$ or $p = z\hat{\alpha}$.[12] The net payment thereby simplifies to

$$\beta_{it} = (\alpha_{it} - \hat{\alpha})\, z N_{it} \tag{5.11}$$

Note the close similarity of equation (5.11) to an incentive scheme for the *private* provision of public goods discussed in Falkinger (1996), which proposes to punish or reward deviations from the average contribution level.

When replacing for the training quota in equation (5.11), the scheme can be split up into two parts. One term depends on the number of apprentices, the other on the number of employees.

$$\beta_{it} = z A_{it} - z\hat{\alpha} N_{it} \tag{5.12}$$

[12] This assumption could be justified on efficiency grounds because otherwise an additional redistributive element would be introduced into the scheme.

For notational ease define the tax rate τ, $\tau \equiv z\hat{\alpha}$. The payment term then simplifies to $\beta_{it} = zA_{it} - \tau N_{it}$ whereby it becomes evident that firms receive a uniform subsidy z per apprentice and pay a tax τ per employee. This directly leads to the following conclusion.

Proposition 12 *The proposed training levy scheme corresponds to a tax-subsidy-system. It subsidizes apprenticeship training and raises an additional employment tax.*

Proof. Obvious. ■

Despite their apparent similarity, there are nevertheless notable differences between tax-subsidy-systems and levy-grant-systems. Under a tax-subsidy-system, an economic agent is paying taxes as well as receiving subsidies for providing a beneficial activity. All monetary flows pass through the public budget. Under a levy-grant-system, by contrast, the agent only exchanges a net payment with the public budget, i.e. a levy amount *net* of any subsidies. The transaction volume is therefore much smaller. Essentially, levy-grant-systems possess the feature of central *clearing* while tax-subsidy-systems do not. This property can bring about some savings in administration, collection, and payment transactions (Falkinger 1996, 414). However, as our analysis completely neglects administrative costs, these differences are not taken up further.

The proposed levy scheme is self-financing only if the budget balances. This is the case when all levies raised equal grants and administrative expenses. Assume the scheme to work without any cost.[13] The budget constraint is thus given by

$$\sum_i \beta_{it} = \sum_i (\alpha_{it} - \hat{\alpha}) \cdot zN_{it} = \sum_i zA_{it} - \sum_i \tau N_{it} = 0 \quad \forall t \tag{5.13}$$

From equation (5.13) we can infer the next proposition.

[13] Of course, this is not an innocuous assumption. It is made here for expositional purposes. Below the analysis reconsiders the issue of administrative costs more explicitly.

Proposition 13 *The budget of the training levy scheme balances if the mandatory training quota is set to equal the average training quota.*

Proof. From (5.13) follows that the budget balances for $\sum_i (\alpha_{it} - \hat{\alpha}) \cdot zN_{it} = 0$. This can be rearranged to $\sum_i \alpha_{it} N_{it} = \hat{\alpha} \sum_i N_{it}$ which then leads to $\hat{\alpha} = \frac{\sum_i A_{it}}{\sum_i N_{it}} \equiv \bar{\alpha}$. ■

Intuitively, by setting the mandatory training quota to equal the average quota, the budget will automatically be equalized as training below and above this standard will reciprocally balance.

5.3.3 Private Optimum

Given these general remarks on the training levy proposal, let us now investigate how firms' training decisions are affected from an introduction of this scheme. The optimization problems for firm 1 and 2 are again altered in the training period.

$$\arg\max_{\{w_{1t}, A_{1t}\}} \left\{ \rho R_{1,t+1} N_{t+1} + (v_{1t} - w_{1t} - \tau) N_{1t} - w_t^a A_{1t} - c_1 (A_{1t}) + zA_{1t} \right\}$$
$$\arg\max_{\{w_{2t}, A_{2t}\}} \left\{ \rho R_{2,t+1} N_{t+1} + (v_{2t} - w_{2t} - \tau) N_{2t} - w_t^a A_{2t} - c_2 (A_{2t}) + zA_{2t} \right\}$$

The optimality conditions for training are identical to equations (5.5) and (5.6). Thus, as in the case of uniform subsidies, the optimal number of apprentices increases in the subsidy z. The optimality conditions for firms' wage offers w_{1t} and w_{2t} in contrast are given by (5.14) and (5.15). As before, they denote a pair of reaction functions.

$$-2w_{1t} + w_{2t} - \tau - \delta + v_{1t} = 0 \tag{5.14}$$

$$-2w_{2t} + w_{1t} - \tau - \delta + v_{2t} = 0 \tag{5.15}$$

Again solving for the Hotelling-Nash-equilibrium then allows to derive the equilibrium wages w_{1t}^{levy} and w_{2t}^{levy}.

$$w_{1t}^{levy} = \frac{2}{3} v_{1t} + \frac{1}{3} v_{2t} - \tau - \delta \tag{5.16}$$

$$w_{2t}^{levy} = \frac{1}{3}v_{1t} + \frac{2}{3}v_{2t} - \tau - \delta \tag{5.17}$$

Proposition 14 *The employee tax to finance the training subsidies is fully shifted onto workers.*

Proof. This follows from (5.16) and (5.17) with $\frac{\partial w_{it}^{levy}}{\partial \tau} = -1$. ■

The intuition for this result can be put as follows: The employee tax decreases the value product that a firm can earn from employing skilled workers. Firms will therefore reduce their wage offer by this amount. The training levy scheme thus burdens skilled workers employed in the training period and leaves firms' profits unaffected.

It must be noted, however, that this proposition results from the assumptions on the production function. Assuming an exogenous and constant labor productivity considers the output market to be perfectly competitive, such that the employee tax cannot be shifted onto consumers by increasing prices. Moreover, with labor as the only input, tax shifting resulting from substitution effects is excluded.

5.3.4 Social Optimum

So far, the training levy scheme was revealed to provide additional training incentives by paying out a uniform subsidy z that is financed from an employment tax $\tau = z\hat{\alpha}$ on all firms. It has two immediate effects. Firstly, the subsidy encourages additional apprenticeship training. Similar to the uniform subsidy scheme, marginal training returns increase for all firms. Secondly, the employment tax reduces the wage offers to the present skilled workforce. Thus skilled work becomes less attractive in comparison to alternative income sources. In the training period, labor supply will therefore decrease and production output will shrink.

When deciding on introducing the levy scheme, a rational and benevolent government will trade off the welfare gains from additional training against the welfare losses for the present workforce. It is additionally constraint to a balanced budget. Aiming to determine the optimal subsidy and tax rates, the government's decision problem can be displayed by

$$\begin{aligned}\max_{\{z,\hat{\alpha}\}} W &= \sum_{t=1,2} \rho^{t-1} W_t - \sum_{i=1,2} c_i(A_{it}^{levy}) \\ \text{s.t.} \quad & \sum_{i=1,2} \left(z A_{it}^{levy} - z\hat{\alpha} N_{it} \right) = 0\end{aligned}$$

This constrained maximization problem can be solved using the Lagrangian method.

$$\max_{\{z,\hat{\alpha}\}} \mathcal{L} = \sum_{t=1,2} \rho^{t-1} W_t - \sum_{i=1,2} c_i(A_{it}^{levy}) - \lambda \sum_{i=1,2} \left(z A_{it}^{levy} - z\hat{\alpha} N_{it} \right)$$

The first order conditions are

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial z} &= \sum_{t=1,2} \rho^{t-1} \tfrac{\partial W_t}{\partial z} - \sum_{i=1,2} c_i' \tfrac{\partial A_{it}^{levy}}{\partial z} - \lambda \sum_{i=1,2} \left(z \tfrac{\partial A_{it}^{levy}}{\partial z} - z\hat{\alpha} \tfrac{\partial N_{it}}{\partial z} \right) = 0 \\ \frac{\partial \mathcal{L}}{\partial \hat{\alpha}} &= \sum_{t=1,2} \rho^{t-1} \tfrac{\partial W_t}{\partial \hat{\alpha}} - \lambda \sum_{i=1,2} \left(-z N_{it} - z\hat{\alpha} \tfrac{\partial N_{it}}{\partial \hat{\alpha}} \right) = 0 \\ \frac{\partial \mathcal{L}}{\partial \lambda} &= \sum_{i=1,2} \left(z A_{it}^{levy} - z\hat{\alpha} N_{it} \right) = 0\end{aligned}$$

Merging these conditions, the optimal subidy rate and mandatory training quota can be solved for. The optimality condition (5.18) links all optimal values of z^* and $\hat{\alpha}^*$.

$$\sum_{t=1,2} \rho^{t-1} \left(\tfrac{\partial W_t}{\partial z} + \tfrac{\partial W_t}{\partial \hat{\alpha}} \frac{\sum_{i=1,2} \left(\frac{\partial A_{it}^{levy}}{\partial z} - \hat{\alpha} \frac{\partial N_{it}}{\partial z} \right)}{\sum_{i=1,2} \left(N_{it} + \hat{\alpha} \frac{\partial N_{it}}{\partial \hat{\alpha}} \right)} \right) = \sum_{i=1,2} c_i' \tfrac{\partial A_{it}^{levy}}{\partial z} \tag{5.18}$$

Also address the question whether the introduction of the training levy scheme would be welfare-improving. From the balanced budget constraint (5.13) follows that the mandatory training quota cannot be set independently, but depends positively on the subsidy rate chosen. The higher the subsidy, the higher the training quota is to be set. Formally we have $\hat{\alpha}(z)$ with $\hat{\alpha}' > 0$. Using the budget constraint in this implicit form, the welfare problem can be rewritten as $W(z, \hat{\alpha}(z))$. The total differential with respect to the subsidy rate is stated in equation (5.19).

$$\frac{dW}{dz} = \sum_{t=1,2} \rho^{t-1} \left(\frac{\partial W_t}{\partial z} + \frac{\partial W_t}{\partial \hat{\alpha}} \frac{\partial \hat{\alpha}}{\partial z} \right) - \sum_{i=1,2} c_i' \frac{\partial A_{it}^{levy}}{\partial z} \gtreqless 0 \tag{5.19}$$

Proposition 15 *The introduction of a levy-grant-scheme can be ambiguous to welfare.*

Proof. If the total differential were positive for $z = 0$, $\frac{dW}{dz}|_{z=0} > 0$, the introduction of the levy scheme would be welfare-improving. Equation (5.19) consists of three terms. The first term represents the discounted welfare gain of training brought about by a subsidy. The second term depicts the welfare loss resulting from the levy. It is negative since $\frac{\partial W_t}{\partial \hat{\alpha}} < 0$ and $\frac{\partial \hat{\alpha}}{\partial z} > 0$. The third term states the marginal cost of additional training, which must be deducted from welfare when training incentives are introduced. The overall results is thus ambiguous since the total differential cannot be signed without specific functional forms. ■

The proposition essentially states that the welfare effects from introducing a levy scheme for apprenticeship training cannot be determined *theoretically*. Whether this scheme would be beneficial or detrimental to the economy's welfare critically depends on firms' training reaction to the subsidy and workers' change in labor supply. An *empirical* assessment of the training and labor supply elasticities would therefore be required to determine net welfare.

5.4 Discussion

The model of the previous chapter demonstrated that apprenticeship training exhibits positive spillovers on other firms in imperfect labor markets. Public policies addressing this problem and increasing training efforts are therefore of interest. This chapter analyzed various fiscal instruments that introduce incentives for vocational training.

It was shown that an ideal Pigouvian subsidy could, at least in theory, restore the social optimum. For this to be the case the subsidy should depend on future productivity levels of both training and competing firms. In reality, however, this information may not be available. Thus, the use of an uniform subsidy may be required. In comparison to the ideal Pigouvian scheme it will bring about additional distortions. Because a uniform rate cannot account for differences between firms, such a training subsidy scheme may lead to undertraining in some firms and overtraining in others. Nevertheless, we were able to demonstrate that introducing a small uniform subsidy would be welfare-improving if non-distortionary funding were available.

This chapter also investigated the widespread proposal of training levies. It was unveiled that such schemes are a particular form of tax-subsidy-systems. A tax is levied on employment and a subsidy is paid per apprenticeship. The analysis furthermore showed this tax, although paid by the firm, to be fully shifted onto workers in the form of lower wages. This outcome is however an artifact of the model. If also output markets are imperfectly competitive, some tax shifting onto consumers may occur.

Our analysis of the levy scheme predicts a decrease in labor supply and output if the tax is at least partially shifted onto workers and labor supply is somewhat elastic. A training levy thus brings about welfare gains from subsidizing apprenticeship training and simultaneously causes welfare losses from lower output due to reduced labor supply. The net welfare effect was shown to be theoretically ambiguous, thus requiring an empirical estimation.

Additionally, since no administrative costs have been taken into account so far, this analysis requires some caution. Clearly, there are costs to administer, monitor and verify the subsidy scheme, that arise both for the government as for firms. In particular, non-negligible costs are associated with the collection and distribution of funds as well as with the gathering and processing of the necessary information. Once these costs are included, they are an additional detriment on welfare.

5.A Appendix

Derivation of the Perfect Pigouvian Subsidy

To attain the social optimum $A^*_{it}(z) = A^{\circ}_{it}$ must hold. For firm 1 set conditions (5.2) and (4.26) equal:

$$\rho R_{1,t+1} - w^a_t + z_1 = \rho R_{social}$$

Recall that $w^a_t = -\rho E\left(\tilde{w}_{t+1}\right) = -R_w$. Thus z_{1t} can be rearranged to

$$z_{1t} = \rho\left(R_{social} - R_{1,t+1} - R_w\right)$$

Inserting for R_{social}, $R_{1,t+1}$ and R_w and simplifying then yields the optimal subsidy to firm 1.

$$z_{1t} = \rho\left(\tfrac{1}{2}\delta - \tfrac{(v_{1,t+1}-v_{2,t+1})}{12\delta}\left(v_{1,t+1} - v_{2,t+1} + 4\delta\right)\right) \equiv X_1$$

Proceed likewise for firm 2 and obtain the optimal subsidy rate z_{2t}.

$$z_{2t} = \rho\left(\tfrac{1}{2}\delta - \tfrac{(v_{2,t+1}-v_{1,t+1})}{12\delta}\left(v_{2,t+1} - v_{1,t+1} + 4\delta\right)\right) \equiv X_2$$

Chapter 6

Generalized Model of Vocational Training

Vocational training has so far been analyzed within a simplified two-firm two-period model. This chapter now generalizes the model by allowing for an indefinite number firms. It thereby reflects reality a bit closer. Moreover, it enables to study the effects of varying labor market competition on the provision and financing of vocational training.

6.1 Model Set-up and Assumptions

In comparison to above, model set-up and assumptions differ only slightly. Instead of a linear Hotelling-street consider now a Salop-circle with length again normalized to unity.[1] Let there be n firms which are located evenly across the economic space. The position of a firm can therefore be denoted by $q_i = \frac{i-1}{n}$ for all $i = \{1...n\}$. Figure (6.1) depicts this situation for the case of 4 firms.

As before, assume workers to be homogeneous in skills, but to vary in location. This is represented by the differentiation parameter θ which is distributed uniformly across the unit interval. Workers again incur commuting

[1] This model is originally due to Salop (1979). See also the common textbook presentations in Tirole (1988), pp. 282ff., and Bester (2004), pp. 124ff.

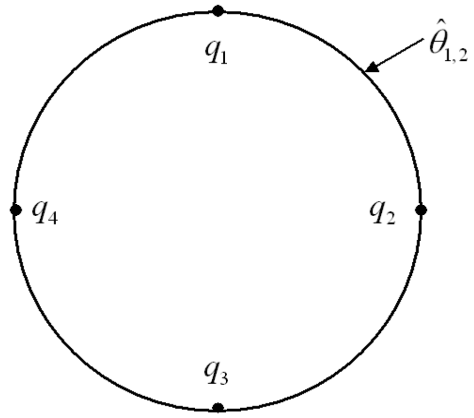

Figure 6.1: Salop Circle for $n = 4$

costs in order to work for a firm. These costs increase in the distance between the worker and the firm at the linear rate δ. The net wage of worker θ when working for firm i can therefore be denoted by equation (6.1).

$$\tilde{w}_{it}\left(w_{it}|\theta\right) = w_{it} - \delta\left|q_i - \theta\right| \tag{6.1}$$

Taking these modifications into account, let us again solve this two-stage game using backward induction. Similar to above, we will first consider the private optimum and then turn to the social optimum.

6.2 Private Optimum

6.2.1 Poaching Period

Consider at first the poaching period $t+1$. Firms strive to attract skilled workers by making appropriate wage offers $w_{i,t+1}$. Workers, on the other hand, aim for a high wage income net of commuting costs. They will choose to work for the firm yielding the highest net wage $\tilde{w}_{i,t+1}$. Consequently, the allocation of the workforce depends on firms' wage offers and workers' locations.

A worker will decide between the wage offers of his two neighboring firms. Let $\hat{\theta}_{i,i+1}$ be the worker in the interval $[q_i, q_{i+1}]$ who is indifferent between working for firm i or firm $i+1$ in this period. For this worker net wages of working at either firm are equal and, therefore, the arbitrage condition (6.2) is fulfilled.

$$w_{i,t+1} - \delta\left(\hat{\theta}_{i,i+1} - q_i\right) = w_{i+1,t+1} - \delta\left(q_{i+1} - \hat{\theta}_{i,i+1}\right) \tag{6.2}$$

Simplifying and rearranging the arbitrage condition allows to obtain the indifferent worker $\hat{\theta}_{i,i+1}$ as a function of firms' wage offers $w_{i,t+1}$ and $w_{i+1,t+1}$.

$$\hat{\theta}_{i,i+1} = \frac{(q_{i+1} + q_i)}{2} - \frac{(w_{i+1,t+1} - w_{i,t+1})}{2\delta}$$

Likewise, equations for indifferent workers between all other firms are obtained. Now, all workers in the interval $\left[\hat{\theta}_{i-1,i}, \hat{\theta}_{i,i+1}\right]$ will choose to work for firm i. The share of the skilled workforce that is employed by the firm in this period can thereby be denoted by

$$\gamma_{i,t+1} = \int_{\hat{\theta}_{i-1,i}}^{\hat{\theta}_{i,i+1}} f(\theta)\, d\theta$$

For simplicity workers are assumed to be uniformly distributed along the Hotelling-circle, $f(\theta) = 1$. Thus, firm's share in the workforce can be determined by

$$\gamma_{i,t+1} = \hat{\theta}_{i,i+1} - \hat{\theta}_{i-1,i} = \frac{q_{i+1} - q_i + q_i - q_{i-1}}{2} + \frac{(2w_{i,t+1} - w_{i-1,t+1} - w_{i+1,t+1})}{2\delta}$$

Recall that firms are located evenly across the economy. The distance between two firms is $\triangle q = q_{i+1} - q_i = \frac{i+1-1}{n} - \frac{i-1}{n} = \frac{1}{n}$. Therefore, $\gamma_{i,t+1}$ reduces to

$$\gamma_{i,t+1} = \frac{1}{n} + \frac{1}{2\delta}\left(2w_{i,t+1} - w_{i-1,t+1} - w_{i+1,t+1}\right) \tag{6.3}$$

Intuitively, equation (6.3) states that firm i's recruitment of skilled workers increases in its own wage offer, but decreases in the wage offers of the neighboring firms.

Firms derive profits from the excess of worker's marginal product over wages paid to the employed workforce, $\pi_{i,t+1} = (v_{i,t+1} - w_{i,t+1})\,\gamma_{i,t+1} N_{t+1}$. In order to maximize profits, firms strive to post appropriate wage offers. On the one hand, wages are a costly input that reduces profits. On the other hand, wages are a means to attract a larger fraction of the skilled workforce and thereby increase profits. Firm i's optimization problem in the poaching period is thus

$$\max_{w_{i,t+1}} \pi_{i,t+1} = (v_{i,t+1} - w_{i,t+1}) \left(\frac{1}{n} + \frac{1}{2\delta} \left(2w_{i,t+1} - w_{i-1,t+1} - w_{i+1,t+1} \right) \right) N_{t+1} \tag{6.4}$$

Equation (6.5) displays the first order condition with respect to w_i. The second order condition for a local maximum is satisfied with $\frac{\partial^2 \pi_{i,t+1}}{\partial w_{i,t+1}} = -\frac{2}{\delta} < 0$.

$$-\frac{1}{n} - \frac{1}{2\delta} \left(2w_{i,t+1} - w_{i-1,t+1} - w_{i+1,t+1} \right) + \frac{1}{\delta} \left(v_{i,t+1} - w_{i,t+1} \right) = 0 \tag{6.5}$$

Proceeding likewise for all firms $i = \{1...n\}$ results into a system of n linear equations. They denote the wage reaction functions, i.e. firm's optimal wage offer given the wage offers by the neighboring firms.

$$\frac{1}{2} v_{i,t+1} - w_{i,t+1} + \frac{1}{4} w_{i-1,t+1} + \frac{1}{4} w_{i+1,t+1} - \frac{\delta}{2n} = 0 \quad \forall i = \{1...n\} \tag{6.6}$$

For the purposes of this analysis, consider only the case of identical technology across firms. With homogeneous productivity, $v_{i,t+1} = v_{j,t+1} = v_{t+1}$, firms' wage offers will also be identical, $w_{i,t+1} = w_{j,t+1} = w_{t+1}$.[2] The prevailing market wage in this period can thus be determined by (6.7)

$$w^*_{t+1} = v_{t+1} - \frac{\delta}{n} \tag{6.7}$$

This allows to state the next proposition:

[2] In the case of heterogeneous productivity, alike the two-firm setting above, the issue arises whether all firms are actually able to recruit workers from the labor market. Firms possessing an inferior production technology can naturally only post lower wage offers. In the case of an interior solution, there will be no uniform market wage. Instead, wages will differ across firms according to labor productivity.

Proposition 16 *Firms' equilibrium wage offers to skilled workers fall below the marginal product of labor,* $w^*_{t+1} < v_{t+1}$.

Proof. Inspection of (6.7) directly shows $w^*_{t+1} < v_{t+1}$ for $\delta > 0$ and $n > 0$. ■

Note that this result essentially restates proposition (1) for the case of n firms. Labor market frictions again inhibit workers from perfect wage arbitrage. This lends some wage-setting power to firms such that in equilibrium the wage is below the marginal product of labor. In fact, higher frictions reduce worker turnover and increase the monopsony power of firms. Correspondingly, comparative-static analysis shows the equilibrium wage to decline in the commuting rate δ. Moreover, with respect to the number of firms, the following proposition can be made.

Proposition 17 *The market wage increases in the number of firms competing for skilled labor. Furthermore, on perfectly competitive labor markets, wages equal the marginal product of labor,* $w^*_{t+1} = v_{t+1}$.

Proof. From (6.7) obtain $\frac{\partial w^*_{t+1}}{\partial n} > 0$ and $\lim_{n\to\infty} w^*_{t+1} = v_{t+1}$. ■

Intuitively, the more firms strive to recruit skilled workers, the more competitive is the labor market. This drives up workers' wages to the marginal product of labor.

With wages below the marginal product, firms will consequently earn employment rents. For the symmetric case under consideration, firms' equilibrium profits in the poaching period can be determined according to

$$\pi^*_{i,t+1} = \pi^*_{j,t+1} = \left(v_{t+1} - w^*_{t+1}\right)\gamma^*_{t+1}N_{t+1} = \frac{\delta}{n^2}N_{t+1} \tag{6.8}$$

6.2.2 Training Period

Now consider the training period t. In this period, just as in the poaching period, firms compete for skilled workers by making appropriate wage offers. Additionally, firms can decide to take apprentices for training.

In the training period, firm i's recruitment of skilled workers again depends on its own wage offer and on wage offers by neighboring firms. As before, firm's workforce can be determined by using the arbitrage condition of the indifferent worker. Thus, analogous to equation (6.3), firm i's share of the existing workforce in the training period, γ_{it}, can be denoted by (6.9).

$$\gamma_{it} = \frac{1}{n} + \frac{1}{2\delta}\left(2w_{it} - w_{i-1,t} - w_{i+1,t}\right) \tag{6.9}$$

In the training period, a firm's optimization problem consists of discounted future profits and present profits from employment minus any wages to apprentices and training costs, $\rho\pi_{i,t+1} + \pi_{it} - w^a A_{it} - c_i\left(A_{it}\right)$. Firms strive to maximize profits by optimally choosing their wage offer w_{it} and the number of apprentices A_{it} to take for training.

$$\underset{w_{it},A_{it}}{\arg\max}\left\{\rho\frac{\delta}{n^2}N_{t+1} + \left(v_{it} - w_{it}\right)\gamma_{it}N_t - w^a A_{it} - c_i\left(A_{it}\right)\right\}$$

The first order conditions are

$$\frac{\partial}{\partial w_{it}} = -\frac{1}{n} - \frac{1}{2\delta}\left(2w_{it} - w_{i-1,t} - w_{i+1,t}\right) + \frac{1}{\delta}\left(v_{it} - w_{it}\right) = 0 \tag{6.10}$$

$$\frac{\partial}{\partial A_{it}} = \rho\frac{\delta}{n^2} - w^a - c_i'\left(A_{it}^*\right) = 0 \tag{6.11}$$

where second order conditions are fulfilled with $\frac{\partial^2}{\partial w_{it}} < 0$ and $\frac{\partial^2}{\partial A_{it}} < 0$.

At first, analyze the first order condition with respect to firm's wage offer. Equation (6.10) states firm i's wage reaction function for the training period. Given the wage reaction functions of all firms and assuming homogeneous productivity as in the poaching period, the equilibrium wage for skilled labor in the training period can be determined by (6.12).

$$w_t^* = v_t - \frac{\delta}{n} \tag{6.12}$$

Equation (6.11) displays the first order condition with respect to the number of apprentices. It provides firm i's optimality condition for apprenticeship training equating the returns of an additional apprentice to the apprentice wage and the marginal training costs. Again, we can infer the apprentice wage from the participation constraint. Apprentices are willing to forego earnings in the training period that correspond to the increase in the expected future net wage, $-w^a \leq \rho E(\tilde{w}_{t+1})$. After solving for the expected net wage, apprentices' pay can be determined from equation (6.13).

$$-w^a = \rho E(\tilde{w}_{t+1}) = \rho \left(v_{t+1} - \frac{5}{4}\frac{\delta}{n} \right) \tag{6.13}$$

See the appendix for a detailed derivation of the expected net wage. Recall that condition (6.13) assumes the wage of unskilled workers to be normalized to zero and all bargaining power in the apprenticeship contract to be with the training firm. Inserting the apprentices' wage into the training condition, the optimality condition for apprenticeship training becomes

$$\rho \left(\frac{\delta}{n^2} + (v_{t+1} - \frac{5}{4}\frac{\delta}{n}) \right) = \rho \left(v_{t+1} - \frac{n-1}{n}\frac{\delta}{n} - \frac{\delta}{4n} \right) = c_i' \left(A_{it}^* \right) \tag{6.14}$$

Using the inverse of the cost function we can infer firm i's optimal number of apprenticeships.

$$A_{it}^* = c_i'^{-1}(.) = \phi_i \left(v_{t+1,} \delta, n, \rho \right)$$

Proposition 18 *In the private optimum, a firm will provide A_{it}^* apprenticeships. Although vocational training is characterized as perfectly general, firms will partially carry its costs.*

Proof. This follows from (6.14) where $\rho \frac{\delta}{n^2} > 0$, $\rho E(\tilde{w}_{t+1}) > 0$ and $c_i' > 0$. ■

With labor market frictions inhibiting wage arbitrage and slowing worker turnover, firms can expect to earn some rents from employing workers they have previously trained. Thus, in contrast to conventional human capital theory, this model proposes firms not only to provide and but also to partially finance costly apprenticeships.

Proposition 19 *The share in training costs borne by the training firm decreases in labor market competition. Moreover, on perfectly competitive labor markets, all costs of vocational training are financed by the apprentice.*

Proof. Apply the implicit function theorem on (6.14). ■

This proposition restates Becker's famous result. On competitive labor markets, firms cannot obtain any returns from general training. However, with wages being equal to the marginal product of labor, workers reap the full returns from vocational training.

6.3 Social Optimum

The previous section essentially restated the results of the two-firm setting for the n-firm model. The analysis pointed out that firms provide apprenticeship training, but training costs are shared by the firm and the apprentice depending on the competition on the labor market. This section now investigates welfare implications of training. It will be asked whether the training choices by the private parties are also socially efficient.

Social welfare consists of the net output produced by skilled workers in both periods reduced by resources spent on training.

$$W = \rho W_{t+1} + W_t - \sum_{i=1}^{n} c_i \left(A_{it}\right) \tag{6.15}$$

Net output in period t can be determined from the following integral over workers which denotes output minus commuting costs.

$$W_t = \int_0^1 \left(v_t - \psi(\theta, n)\right) f\left(\theta\right) N_t d\theta \tag{6.16}$$

Dissolving the integral and inserting above then allows to state social welfare (6.17). See the appendix for a complete derivation.

$$W = \sum_{t,t+1} \rho^{t-1} \left(v_t - \frac{\delta}{4n}\right) N_t - \sum_{i=1}^{n} c_i \left(A_{it}\right) \tag{6.17}$$

A benevolent social planner aims to maximize social welfare by optimally choosing firms' training levels. Socially optimal training can be derived from condition (6.18) which equates the marginal social return to training to the marginal training cost.

$$\rho\left(v_{t+1}-\frac{\delta}{4n}\right)-c_i'(A_{it}^o)=0 \tag{6.18}$$

Proposition 20 *Apprenticeship training is socially inefficient as private optimal training is short of the social optimum,* $A_{it}^{*}<A_{it}^{\circ}$.

Proof. Compare conditions (6.14) and (6.18). Note that the social training returns exceed private returns, $\rho\left(v_{t+1}-\frac{\delta}{4n}\right)>\rho\left(\frac{\delta}{n^2}+v_{t+1}-\frac{5}{4}\frac{\delta}{n}\right)$. With increasing training costs, $c_i'>0$, then immediately follows $A_{it}^{\circ}>A_{it}^{*}$. ■

The intuition to this result is similar to above. Apprenticeship training brings about positive spillovers to other firms. With social returns exceeding the private returns, the private provision of vocational training will be socially inefficient.

Let us again illustrate this result by pointing out the returns from vocational training separately for all parties involved. The return from vocational training for *apprentices* is the expected increase in the net wage by becoming a skilled worker.

$$R_w=\rho E\left(\tilde{w}_{t+1}\right)=\rho\left(w_{t+1}-\frac{\delta}{4n}\right)=\rho\left(v_{t+1}-\frac{5}{4}\frac{\delta}{n}\right)$$

Returns to the *training firm* result from labor market frictions. As workers do not react to small wage differentials, firms enjoy some monopsony power and the equilibrium wage is reduced below the marginal product of labor. Thus, from employing former apprentices as skilled workers firms will earn a rent that can be used to cover training costs.

$$R_f=\rho\frac{1}{n}\frac{\delta}{n}$$

Private returns to vocational education consist of returns to the apprentice and the training firm.

$$R_{priv} = R_w + R_f = \rho \left(v_{t+1} - \frac{n-1}{n} \frac{\delta}{n} - \frac{\delta}{4n} \right)$$

With *social returns* to vocational education being equal to

$$R_{social} = \rho \left(v_{t+1} - \frac{\delta}{4n} \right)$$

it can be easily seen that $R_{social} > R_{priv}$. Thus, there is a positive externality associated with vocational education that amounts to X.

$$X = R_{social} - R_{priv} = \rho \frac{n-1}{n} \frac{\delta}{n}$$

Proposition 21 *The positive externality from apprenticeship training diminishes in labor market competition. In perfectly competitive labor markets there is no externality.*

Proof. $\frac{\partial X}{\partial n} < 0$ and $\lim\limits_{n \to \infty} \rho \frac{n-1}{n} \frac{\delta}{n} = 0$. ■

The intuition for this result is straightforward. Labor market frictions allow firms to earn rents from employment which can be used to finance training. With some apprentices changing for another employer, a part of the rent is lost to other firms, thereby bringing about a positive externality. On the one hand, stronger labor market competition diminishes the rent that can be reaped from employment. It reduces firms' incentives to finance training and, accordingly, positive spillovers also decrease. On the other hand, stronger labor market competition pushes the wage for skilled workers. It thereby raises training incentives for unskilled workers. On perfectly competitive labor markets wages correspond to the marginal product of labor and workers reap the full returns from training. Essentially, this characterizes Becker's result for general training as an extreme case.

6.4 Discussion

This chapter generalized the initial two-firm two-period model to an indefinite number of firms. Also in this setting it could be shown that firms provide vocational training and share the cost with the apprentice. Apprenticeship training again brings about positive spillovers on rival firms and too few apprenticeships are provided from a social point of view. Thus, the previous results can be upheld, changing only quantitatively, but not qualitatively.

In addition to the initial setting the generalized model allowed to study the effects of labor market competition on the provision and financing of vocational training. It could be pointed out that firms' training incentives decline the more firms compete for skilled labor. Intuitively, stronger labor market competition reduces employment rents and thereby also decreases firms' training returns. By contrast, this increase wages and enables unskilled workers to realize larger training returns. Apprentices will therefore bear more training costs. For an infinite number of firms, this converges to Becker's famous result.

6.A Appendix

Derivation of Expected Future Net Wage (6.13)

We can derive the expected future net wage both formally and graphically. For intuition, consider at first the graphical solution. An apprentice will work for firm i in the future if his differentiation parameter happens to be in the interval $\left[\hat{\theta}^*_{i-1,i}, \hat{\theta}^*_{i,i+1}\right]$. In the symmetric case, when firms offer identical wages, the interval possesses a length of $\frac{1}{n}$. A worker at $\hat{\theta}^*_{i-1,i}$ travels the distance of $\frac{1}{2n}$ to firm i and therefore incurs commuting costs of $\delta\frac{1}{2n}$. Likewise, a worker at $\hat{\theta}^*_{i,i+1}$ also travels $\frac{1}{2n}$ and incurs $\delta\frac{1}{2n}$. The closer the location to firm i, the smaller will be the commuting costs $\psi(\theta, n)$. This can be displayed using figure (6.2).

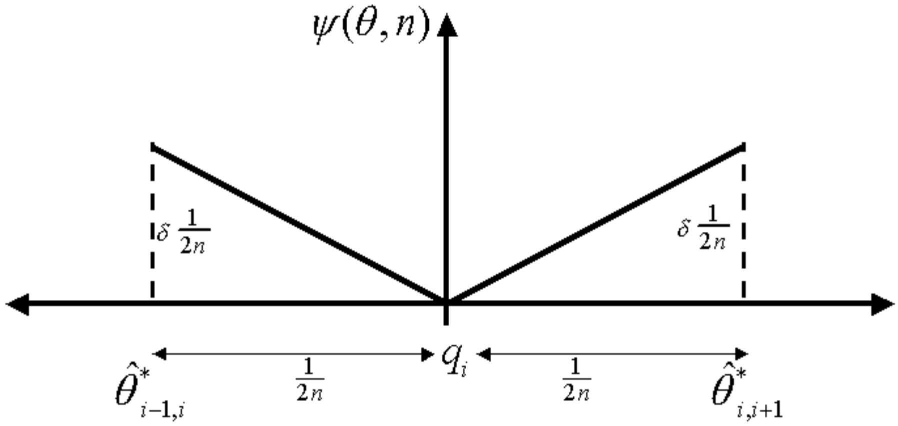

Figure 6.2: Commuting Costs at Firm i

The expected commuting costs of an employment at firm i is thus the surface of both triangles under the commuting cost curve.

$$\psi(\theta, n) = 2 \cdot \frac{1}{2}\frac{1}{2n}\frac{\delta}{2n} = \frac{\delta}{4n^2}$$

Expected commuting costs over all n firms then become

$$E(\psi(\theta, n)) = \sum_{i=1}^{n} \frac{\delta}{4n^2} = \frac{\delta}{4n}$$

Figure (6.3) illustrates this for the case of four firms.

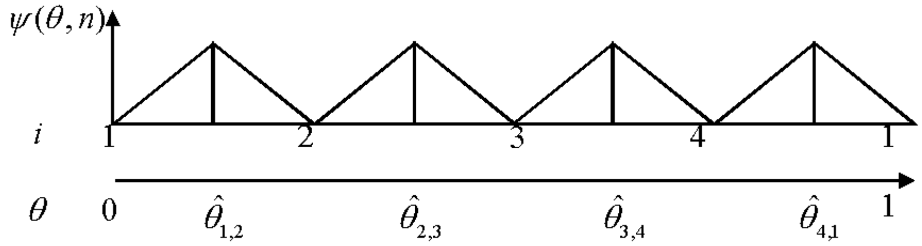

Figure 6.3: Commuting Costs for $n = 4$

Now consider the formal solution. A worker's expected future net wage can be displayed by the expected value of the future net wage. It derives from the integral over θ of the net wage $\tilde{w}(\theta, n)$ weighted with the probability function $f(\theta)$.

$$E(\tilde{w}^*) = \int_0^1 \tilde{w}^*(\theta, n) f(\theta)\, d\theta$$

Recall that a worker's future net wage consists of the wage at the future employer minus commuting costs, $\tilde{w}^*(\theta) = w_i^* - \delta |q_i - \theta|$. In the symmetric case under consideration, firms offer identical wages w^*, but workers net wage will result after commuting costs are taken into account. These costs depend on a worker's location and the number of firms.

$$E(\tilde{w}^*) = \int_0^1 (w^* - n \cdot \psi(\theta, n)) f(\theta)\, d\theta$$

A worker would work for firm i if her differentiation parameter θ lies in the interval $\left[\hat{\theta}^*_{i-1,i}, \hat{\theta}^*_{i,i+1}\right]$, i.e. from being indifferent to work for firm $i-1$ and to work for firm $i+1$. Expected commuting costs when working for firm i can be derived from the sum of two intervals

$$\psi(\theta, n) = \delta \int_{\hat{\theta}^*_{i-1,i}}^{q_i} (q_i - \theta)\, d\theta + \delta \int_{q_i}^{\hat{\theta}^*_{i,i+1}} (\theta - q_i)\, d\theta$$

Dissolving the integral obtains

$$\psi(\theta, n) = \delta\left[q_i\theta - \tfrac{1}{2}\theta^2\right]_{\hat{\theta}^*_{i-1,i}}^{q_i} + \delta\left[\tfrac{1}{2}\theta^2 - q_i\theta\right]_{q_i}^{\hat{\theta}^*_{i,i+1}}$$

which is

$$\psi(\theta, n) = \delta\left(\tfrac{1}{2}q_i^2 - q_i\hat{\theta}^*_{i-1,i} + \tfrac{1}{2}\hat{\theta}^{*2}_{i-1,i}\right) + \delta\left(\tfrac{1}{2}\hat{\theta}^{*2}_{i,i+1} - q_i\hat{\theta}^*_{i,i+1} + \tfrac{1}{2}q_i^2\right)$$

This can be simplified and rearranged to

$$\psi(\theta, n) = \delta\left(q_i^2 + \hat{\theta}^*_{i-1,i}\left(\tfrac{1}{2}\hat{\theta}^*_{i-1,i} - q_i\right) + \hat{\theta}^*_{i,i+1}\left(\tfrac{1}{2}\hat{\theta}^*_{i,i+1} - q_i\right)\right)$$

Now recall that firms are considered to be distributed evenly across space. Firm i's location is simply $q_i = \frac{i-1}{n}$. Moreover, in the symmetric case, the indifferent workers are located at $\hat{\theta}^*_{i-1,i} = \frac{2i-3}{2n}$ and $\hat{\theta}^*_{i,i+1} = \frac{2i-1}{2n}$. From inserting follows

$$\psi(\theta, n) = \delta\left(\left(\tfrac{i-1}{n}\right)^2 + \tfrac{2i-3}{2n}\left(\tfrac{1}{2}\tfrac{2i-3}{2n} - \tfrac{i-1}{n}\right) + \tfrac{2i-1}{2n}\left(\tfrac{1}{2}\tfrac{2i-1}{2n} - \tfrac{i-1}{n}\right)\right)$$

Simplifying the fractions gives

$$\psi(\theta, n) = \delta\left(\left(\tfrac{i-1}{n}\right)^2 + \tfrac{2i-3}{2n}\left(\tfrac{2i-3}{4n} - \tfrac{4i-4}{4n}\right) + \tfrac{2i-1}{2n}\left(\tfrac{2i-1}{4n} - \tfrac{4i-4}{4n}\right)\right)$$

or

$$\psi(\theta, n) = \delta\left(\left(\tfrac{i-1}{n}\right)^2 - \tfrac{2i-3}{2n}\tfrac{2i-1}{4n} - \tfrac{2i-1}{2n}\tfrac{2i-3}{4n}\right)$$

which then reduces to

$$\psi(\theta, n) = \delta\left(\tfrac{1}{n^2}\left(i^2 - 2i + 1\right) - \tfrac{1}{4n^2}\left(4i^2 - 8i + 3\right)\right)$$

or

$$\psi(\theta, n) = \frac{\delta}{4n^2}$$

Inserting $\psi(\theta, n)$ into the formula for the expected future net wage from above then yields

$$E\left(\tilde{w}^{*}(\theta)\right)=\int_{0}^{1}\left(w^{*}-n\frac{\delta}{4n^{2}}\right)f\left(\theta\right)d\theta$$

Under the assumption of an uniform distribution, $f\left(\theta\right)=1$,this simplifies to

$$E\left(\tilde{w}^{*}(\theta)\right)=w^{*}-\frac{\delta}{4n}$$

Inserting for the future equilibrium wage w^{*} then yields

$$E\left(\tilde{w}^{*}(\theta)\right)=v-\frac{\delta}{n}-\frac{\delta}{4n}=v-\frac{5}{4}\frac{\delta}{n}$$

which is equation (6.13).

Derivation of Welfare Function (4.23)

Recall that the net wage of a worker θ at firm i is given by firm's wage minus the commuting costs.

$$\tilde{w}^{*}(\theta)=w_{i}^{*}-\delta\left|q_{i}-\theta\right|$$

Firm i employs all workers in the interval $\left[\hat{\theta}_{i-1,i}^{*},\hat{\theta}_{i,i+1}^{*}\right]$. Commuting costs of all workers at firm i are thus given by the sum

$$\int_{\hat{\theta}_{i-1,i}^{*}}^{q_{i}}\delta\left(q_{i}-\theta\right)d\theta+\int_{q_{i}}^{\hat{\theta}_{i,i+1}^{*}}\delta\left(\theta-q_{i}\right)d\theta$$

In the symmetric case, we can insert $q_{i}=\frac{i-1}{n}$, $\hat{\theta}_{i-1,i}^{*}=\frac{2i-1}{2n}-\frac{1}{n}=\frac{2i-3}{2n}$ and $\hat{\theta}_{i,i+1}^{*}=\frac{2i-1}{2n}$ which then allows to dissolve the integrals and obtain $\frac{\delta}{4n^{2}}$. The social costs of commuting in all n firms are therefore $\frac{\delta}{4n}$. Social welfare in period t consists of firms' profits $n\frac{\delta}{n^{2}}N_{t}$ and net wages $\left(w_{t}^{*}-\frac{\delta}{4n}\right)N_{t}$ which is simply

$$W_{t}=\left(v_{t}-\frac{\delta}{4n}\right)N_{t}$$

Summing over both periods and including training costs $\sum c_i\left(A_{it}\right)$ then yields

$$W=\sum_{t,t+1}\rho^{t-1}\left(v_t-\frac{\delta}{4n}\right)N_t-\sum_i c_i\left(A_{it}\right)$$

which is equation (4.23).

Chapter 7

Reimbursement Clauses

Chapter 5 analyzed training levy schemes to internalize spillovers from apprenticeship training. The analysis drew attention to substantial practical difficulties of such instruments caused by informational and administrative requirements. Moreover, it revealed adverse effects that substantially reduce the impact of this policy. In light of these problems, alternative policies are sought that enhance welfare without the shortcomings of training subsidies and levies.

Some authors suggest contractual agreements between firms and workers to internalize training spillovers (Alewell 1997, Alewell & Richter 2001, e.g.) . They point to the observation of work contracts in the real world where firms frequently negotiate reimbursement clauses when providing professional or continuous on-the-job training. Several empirical studies confirm the common use of such agreements.[1] Typically, they oblige workers to a compensation for received training when unilaterally terminating the work contract. Similarly, contracts sometimes specify a mandatory work period at the training firm or restrict the worker in another way beyond the training period. For this reason, reimbursement clauses are often considered to reduce

[1] Note that unlike wages, which regularly enter social security or income tax statistics, reimbursement clauses are usually not statistically reported. Empirical evidence derives mostly from case studies or surveys. Although surveys that have been conducted for Germany vary strongly in study design and poll size, they generally support the common usage of reimbursement clauses. See Alewell (1997), 149ff., for an overview of several studies.

turnover of trained workers and thereby prevent training spillovers to arise onto other firms.

There are legal restrictions on such agreements. In particular, common law, labor protection law, and case law prohibit 'exploitative' clauses in work contracts. While this generally applies for work contracts, the law specifically rules out reimbursement clauses in vocational training contracts. This regulation has been questioned strongly. Alewell & Richter (2001) argue that firms have a natural interest to negotiate reimbursement clauses. By means of such agreements, firms intend to limit worker turnover and secure their human capital investment against the risk of future quits. The ban on such contractual agreements yet prohibits this instrument and thereby prevents to address poaching and positive training spillovers. The authors therefore conclude this regulation to be counterintentional since abolishing it could help to internalize spillovers and increase apprenticeship training as well as social welfare.

In view of the ongoing debate on vocational training policy, it is of course an important question whether or not this claim is correct. Obviously, abolishing a counterproductive regulation would be costless and therefore preferable to introducing additional training incentives that necessarily bring along further bureaucracy and distortions. Yet, surprisingly, there is little research on reimbursement clauses or similar contractual arrangements. While several legal contributions deal with the legitimacy of training clauses for professional and continuous training, economic research on their private and social effects is scarce.

This chapter aims to provide an economic analysis of reimbursement clauses in the context of frictional labor markets. It will extend the model framework from previous chapters and incorporate conditional reimbursement obligations. This shall firstly allow to study their effects on training, wages and social welfare. Secondly, it shall allow for an appraisal of the regulation under question. Beforehand, however, legal conditions and existing research on reimbursement obligations in training contracts will be reviewed.

7.1 Legal Terms and Conditions

Firms investing into on-the-job training inevitably face the risk of workers quitting after the training period. They therefore seek to secure their human capital investment by formulating training contracts that constitute claims in the event of workers leaving after training. The general freedom of contract entitles private parties to negotiate all terms and conditions of an employment contract. Accordingly, they may write a contract at their own will that specifies how to share costs, benefits, and risks of on-the-job training. A *reimbursement clause* entitles the training firm to claim a monetary compensation in the event of the worker terminating the employment contract within a certain period. Similarly, parties may agree on a mandatory work period at the training firm or specify other limitations on the worker to recompense for training.

Obviously, any contractual arrangement is only valuable if claims can be substantiated, exercised, and, if necessary, also enforced before a court of law. Even if the apprentice were fully solvent when quitting and the reimbursement amount could be collected, some agreements are void and unenforceable due to common law, labor protection law, and case law. An extensive legal literature investigates the admissibility of reimbursement clauses and similar contractual provisions. It reviews both court decisions and legal practice of specific training clauses and particular training programs (Becker-Schaffner 1991, Hanau & Stoffels 1992, Alewell 1997, e.g.) .

For the purposes of this work it suffices to outline the legal framework of reimbursement clauses. As a simple legal yardstick, an agreement is admissible as long as it balances the property right of the training firm with the employee's right to freely choose her employment. However, the agreement must not be excessive, prohibitive, and undue. Roughly speaking, it must decrease over time and usually cannot exceed three years after completion of the training (Alewell 1997, 154ff.).

Hanau & Stoffels (1992) provide a legal summary, whereby the admissibility of any training clause can be determined from three criteria.

1. Is the clause admissible *on its merits*?
   This criterion demands a legitimate and approvable interest of the employer to use this clause. Furthermore it requires the clause to be reasonable and acceptable for the employee.

2. Is the *form* of the clause admissible?
   This criterion addresses particular terms of the training clause. Is the time span tolerable? Is the amount to reimburse or an equivalent restriction tolerable? Is the condition which creates the reimbursement obligation tolerable?

3. Is the employer acting *unduly* when exercising the claim?
   This criterion excludes unfair practices that are not with the legal principle of good faith.

Within these legal restraints, reimbursement clauses substantiate enforceable claims in work contracts. By contrast, they are null and void in vocational training contracts. The federal law on vocational training specifically rules out any arrangement that limits an apprentice in her occupational choice.[2] This regulation is commonly justified by a need of protecting apprentices from being exploited by the training firm. It is argued that apprentices typically possess little bargaining power since they are young and inexperienced labor market entrants that require a vocational qualification.

In summary, reimbursement clauses are admissible in normal employment contracts if training is mostly general. For vocational training, however, they are prohibited by law. To be able to evaluate this legal framework we will now turn to the economics of reimbursement clauses.

[2] This ban follows from §5 BBiG. See the appendix for the precise text of the law.

7.2 Previous Research

Unlike the legal literature, economic research on reimbursement clauses is scarce. In business economics, such agreements are discussed within human resources management. This literature emphasizes training contracts as managerial tools to bind workers to the firm and secure training investments (Sadowski 2002, 60f.). Human capital theory, by contrast, pays little attention to reimbursement clauses. In particular, it lacks an analysis on the effects of such agreements on worker turnover, wages, training provision and spillovers. In order to provide a starting point for our analysis, this section reviews human capital theory with respect to reimbursement clauses.

7.2.1 Reimbursement Clauses in Perfect Labor Markets

Classical human capital theory has not explicitly studied on-the-job training with reimbursement clauses. Nevertheless, such agreements can be analyzed in this theoretical setting. To do so, again assume perfectly competitive labor markets and distinguish general and firm-specific training.[3]

Human capital theory predicts firms not to pay for *general training* as it brings along a congruent wage increase that inhibits the training firm to collect any compensation for its training efforts. If the firm nevertheless provides this training, the worker will bear the investment costs in form of a wage cut in the training period or through a training loan. Since the worker receives all returns and incurs all costs, training provision will be efficient and independent of worker turnover. As the worker is paying for the training in any case, there is no economic need for a contractual agreement contingent upon resignation. By consequence, a reimbursement clause does not affect the training decision.

Firm-specific training, by contrast, is valuable only within the training firm. It leaves workers' outside wages unaffected and all returns of this type of training accrue to the training firm. Should the worker quit, however,

[3] For an extended presentation of human capital investments in perfect labor markets see above in section 3.2.

the investment vanishes. Firms will therefore try to decrease turnover by offering a training contract with appropriate incentives. Such a contract makes the trainee a co-investor by sharing costs and returns of the firm-specific investment. But this cannot be achieved through a reimbursement clause. It rather characterizes a barrier to quit than a sharing device since it puts a unilateral burden on the worker in case of contract termination.

To summarize, standard human capital theory negates a need for reimbursement clauses. It predicts that both general and firm-specific on-the-job training is efficient without any reimbursement obligation on workers when quitting the firm. From this follows, however, that the theory can neither explain the existence nor the use of such contractual arrangements. This implication of standard human capital theory for reimbursement clauses is at odds with empirical observation, practical experience as well as common intuition. As training clauses with conditional reimbursement are widespread, a revised theory is therefore required.

7.2.2 Reimbursement Clauses in Imperfect Labor Markets

Alewell (1997) takes up this contradiction in the context of continuous on-the-job training. Starting from the observation that firms often provide this training using reimbursement obligations, she proposes a simple model of human capital investment under uncertainty. We will briefly discuss her approach and thereby provide a starting point and reference for our own analysis.[4]

Her exposition starts from the assumption that firms incur costs and receive returns from providing continuous training. Let x be the amount of training chosen and $c(x)$ denote the present value of monetary training costs. Similarly, the present value of training returns is represented by a function $v(x)$. As is common throughout the literature, she assumes a convex cost

[4] For uniformity and ease of reading, the subsequent review continues in our notation. See Alewell (1997), 160ff., for the original presentation.

function, $c' > 0$ and $c'' \geq 0$, but decreasing marginal returns to the volume of training, $v' > 0$ and $v'' < 0$.[5]

When providing continuous training, the firm faces uncertainty. First, there is the risk of uncertain investment returns. This is the *investment risk*. Second, there is the risk of workers quitting the firm after training. This is commonly referred to as *turnover risk*. In order to model this, Alewell proposes two separate two-point distributions. With probability p training yields high returns $v^h(x)$, and with the complementary probability $1 - p$ it yields low returns $v^n(x)$. Similarly, she assumes workers to quit the firm with probability q and stay with probability $1 - q$.

Given this set-up, firms' optimal training investment can be derived and compared to the benchmark of a benevolent social planner. In line with human capital theory, Alewell first discusses general and then firm-specific training.

General Training

Since general training is socially valuable whether or not the worker remains with the training firm, a benevolent social planner would maximize the expected returns from training minus the training costs.

$$\arg\max_{\{x\}} \left\{ pv^h\left(x\right) + \left(1 - p\right) v^n\left(x\right) - c(x) \right\}$$

In the *social optimum*, therefore, training is to be carried out such that the *expected* marginal returns equal the marginal training costs. This follows straightforward from the first order condition.

$$pv^{h\prime} + \left(1 - p\right) v^{n\prime} = c'$$

With this reference in mind, now consider the decision problem of a profit-

[5] Alewell also considers effects of continuous training on workers' utility levels. She models this by postulating non-monetary effects that can either be costs, such as workers' costs associated with time and effort spent on training, or benefits, such as utility from learning and experience. However, the qualitative results of her model do not depend on non-monetary effects incurred by workers. In order to shorten and simplify the exposition, they are therefore neglected here.

maximizing firm.

$$\arg\max_{\{x\}} \left\{ (1-q) \left(pv^h(x) + (1-p)\, v^n(x) \right) - c(x) \right\}$$

Because trained workers quit with probability q, firm's training returns are only the expected return weighted by the probability of the worker staying with the firm. Clearly, there is an externality as some returns are lost to the training firm, but not to society. The *private optimum* can be represented by the following first order condition.

$$pv^{h\prime} + (1-p)\, v^{n\prime} = \frac{1}{1-q} c'$$

It states that the expected marginal returns are to equal the marginal costs weighted by the inverse of the remainder probability. Since $1 - q < 1$, the right hand side will be larger than before. Thus, in comparison to the social optimum, there will be underinvestment in continuous training.

Now introduce a *reimbursement clause* whereby the training firm can claim some compensation for training in case the worker quits. Denote the repayment amount by a positive and increasing function $b(x)$. This formulation allows the repayment to depend on the amount of training received. Firm's optimization problem thereby alters to

$$\arg\max_{\{x\}} \left\{ (1-q) \left(pv^h(x) + (1-p)\, v^n(x) \right) + qb(x) - c(x) \right\}$$

which results into the following first order condition

$$(1-q) \left(pv^{h\prime} + (1-p)\, v^{n\prime} \right) + qb' = c'$$

With $q > 0$ and $b' > 0$, a conditional repayment obligation increases training incentives. Thus, a reimbursement clause can possibly internalize the external effect. In this simple setting, in fact, an appropriate choice of the reimbursement amount can perfectly internalize the external effect and fully restore efficient training. In order to demonstrate this, either set the conditional repayment obligation equal to training costs, $b(x) = c(x)$. Likewise, the repayment could be set equivalent to firm's expected net training return, $b(x) = pv^h(x) + (1-p)v^n(x) - c(x)$. In both cases, the first order conditions then shows firm's individual training decision to be identical to the social choice.[6]

In view of this analysis, Alewell concludes that reimbursement clauses can reduce the externality problem of general on-the-job training. For vocational training, she therefore recommends to abolish the present regulation and to permit to negotiate conditional repayment obligations within training contracts.

Specific Training

We now follow Alewell in also investigating reimbursement clauses in the context of specific training. Since this type of training only yields returns when working with the training firm, socially optimal training follows from

$$\arg\max_{\{x\}} \left\{ (1-q)\left(pv^h(x) + (1-p)v^n(x)\right) - c(x) \right\}$$

The first-order condition states that training is efficient when expected marginal returns weighted by the remainder probability are equal to marginal training costs. As firm-specific training has no value to other firms, there are no spillovers and training is efficient.

$$(1-q)\left(pv^{h\prime} + (1-p)v^{n\prime}\right) = c'$$

Although all returns of firm-specific training accrue to the firm, it will be reluctant to incur training costs. For if the work contract is terminated, the investment is lost. This can be mitigated by sharing the training investment so that both parties will be hurt from contract separation.

To demonstrate a shared investment, let ε denote worker's share of train-

[6]In an extended analysis, Alewell also discusses cases where over- or underprovision could arise with reimbursement clauses when turnover risk and investment risk are interrelated.

ing returns where $0 \leq \varepsilon \leq 1$. Similarly, let worker's share of training costs be κ, $0 \leq \kappa \leq 1$. In order for the worker to participate in firm-specific training, the training contract must satisfy the worker's participation constraint $(1-q)\,\varepsilon\left(pv^{h\prime}+(1-p)\,v^{n\prime}\right)-\kappa c\,(x)\geq 0$. Firm's investment problem can thus be stated by

$$\arg\max_{\{x\}}\left\{(1-q)\,(1-\varepsilon)\left(pv^{h\prime}+(1-p)\,v^{n\prime}\right)-(1-\kappa)\,c\,(x)\right\}\ \text{s.t. (PC)}$$

As the first order condition yields the same equation as before, training with the sharing rule remains efficient.

$$(1-q)\left(pv^{h\prime}+(1-p)\,v^{n\prime}\right)=c^{\prime}$$

Alewell points out that firms could just as well use a reimbursement clause to share the firm-specific investment. To show this, let the worker as before receive a share ε of training returns when with the firm, but repay an amount $b(x)$ when quitting. With this specification, worker's participation constraint is now $(1-q)\,\varepsilon v\,(x)-qb\,(x)\geq 0$. From firm's modified decision problem

$$\arg\max_{\{x\}}\left\{(1-q)\,(1-\varepsilon)\left(pv^{h\prime}+(1-p)\,v^{n\prime}\right)-c\,(x)+qb\,(x)\right\}\ \text{s.t. (PC)}$$

then directly follows the optimality condition

$$(1-q)\left(pv^{h\prime}+(1-p)\,v^{n\prime}\right)=c^{\prime}$$

This is the same equation as above. Reimbursement clauses are therefore a possible contractual means to share costs and returns of training among both parties. Yet, according to this model, a training contract with cost sharing or reimbursement clauses are essentially equivalent. Thus, a statement on when either instrument is preferred cannot be inferred.

Heterogeneous Workers and Asymmetric Information

Reimbursement clauses may additionally possess screening properties. If workers differ in their quitting probability, but this information is unavailable to firms, then reimbursement clauses can be used as a *self-selection device* to distinguish between heterogeneous workers. Alewell demonstrates this property by assuming two types of workers. The high type has a quitting probability q^h while the low type has a quitting probability q^l, with $q^h > q^l$. Type information is asymmetrically distributed, i.e. workers know their quitting probability, but firms possess only general information on turnover and therefore cannot distinguish between worker types.

Since specific training is lost in case of termination, a firm would naturally like to train the low type only. To this end, it could offer a menu of training contracts in such a way that the low type accepts, while the high type rejects, i.e. only the participation constraint of the low type is fulfilled.

$$\begin{aligned} \left(1 - q^h\right) \varepsilon E\left[v\left(x\right)\right] - q^h b\left(x\right) &< 0 \\ \left(1 - q^l\right) \varepsilon E\left[v\left(x\right)\right] - q^l b\left(x\right) &\geq 0 \end{aligned}$$

Straightforward rearrangements allow to summarize this menu of contracts in a self-selection condition.

$$q^l \leq \frac{\varepsilon E\left[v\left(x\right)\right]}{b\left(x\right) + \varepsilon E\left[v\left(x\right)\right]} < q^h$$

By setting $b\left(x\right)$ and ε in an appropriate way, the employer can ensure that only the low type will accept the offer.

If only the low type accepts the training contract, then lower turnover results into higher training returns. Given the optimal training condition $\left(1 - q^l\right) E\left[v'\left(x\right)\right] = c'$ and $q^l < q^h$, this implies the firm to offer a higher level of firm-specific training.

Despite the advantages of screening to reduce turnover risk, practical concerns impose serious objections. Typically, workers with a lower propensity to quit are older, less mobile, or in lack of job alternatives. From a long term business perspective, therefore, it seems risky to concentrate firm-specific training on workers with such characteristics (Alewell 1997, 174).

7.2.3 Discussion

This literature review points out that conventional human capital theory cannot explain training contracts to include reimbursement clauses. Clearly, this prediction is troubling as it runs counter to empirical surveys and common experience. Alewell's model of continuous on-the-job training addresses this contradiction and aims to explain their use in training contracts. According to her analysis, worker turnover deteriorates on-the-job training. In case of general training, it causes a training externality that leads to an underprovision of training. Here, a reimbursement clause denotes a simple contractual instrument to internalize the external effect and thereby restore efficient training incentives. In case of specific training, no externality arises as all costs and returns accrue to the training parties. Still, reimbursement clauses could enter training contracts within a mechanism to share the training investment. Moreover, if worker turnover differs and firms face asymmetric information, then reimbursement clauses could act as a self-selection device. This could allow to differentiate among heterogeneous workers and increase the firm-specific investment.

On the basis of her analysis, Alewell concludes that reimbursement clauses can enhance efficiency as they internalize spillovers or reduce information asymmetries. Hence, legal restrictions on such contractual terms should be lifted. However, some conclusions arise from simplifying assumptions in the analysis. They now demand further discussion.

Alewell's approach essentially models continuous on-the-job training as an investment problem under uncertainty. In this setting, a representative firm decides on continuous training subject to uncertain returns and the risk of workers leaving the firm. Training costs, investment returns and turnover risk are exogenously given and independent of labor market conditions. While the set-up has the advantage of being simple, it has the drawback of neglecting the labor market. Unfortunately, this is not an innocuous simplification of the problem as the labor market provides an important channel for human capital investments. This was also stressed by Becker (1962) who observed that market wages determine firms' and workers' returns to on-the-job training and likewise affect turnover. Even though some quits might be driven by exogenous forces, worker turnover clearly results from differences between the wage of the firm and its close competitors. Assuming turnover risk to be *solely* exogenous is therefore questionable. Moreover, since worker turnover in this model causes training spillovers, the policy conclusion critically hinges on this assumption, too.

In sum, Alewell provides a first comprehensive analysis of reimbursement clauses, but the results draw from quite restrictive assumptions. This calls for a revised approach that relaxes the assumptions and checks whether the results can be maintained. In particular, an improved analysis requires a model with endogenous wage setting and endogenous worker turnover which reflects wages to be the central mechanism for on-the-job training and turnover. Our simple training model allows for this. In the next section we therefore extend the model and study reimbursement clauses.

7.3 Simple Model with Reimbursement Clauses

Return to the simple model of chapter 4. As before, we distinguish two periods, a training period where on-the-job training of apprentices occurs, and a poaching period where workers can leave for other employers. Now additionally, the training contract may entail a reimbursement clause. We model this clause in form of an absolute payment b_i that firm i can claim in case the worker quits after training.[7] Clearly, when choosing among competing wage offers in the poaching period, workers will take this monetary obligation into account.

With this slight modification, now again solve the game using backward induction, i.e. by first analyzing the poaching period and then turning to the training period. Figure (7.1) summarizes the time structure of the extended model.

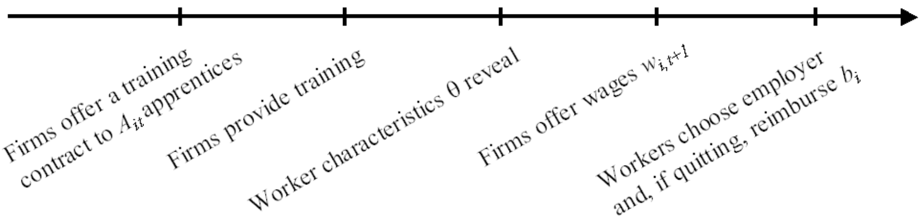

Figure 7.1: Model Time Structure with Reimbursement Clauses

7.3.1 Poaching Period

In the poaching period, firms post wage offers to compete for three groups of workers: apprentices trained at firm 1, apprentices trained at firm 2 and existing skilled workers. Wage offers may be set separately for each group,

[7] In this setting, in contrast to Alewell's model where training intensity can be chosen, firms decide only about the number of workers to train. An absolute reimbursement amount therefore suffices.

w_{iA_1}, w_{iA_2} and w_{iL}. This just reflects the common practice to differentiate on applicants' information through a curriculum vitae or interviews.[8]

A repayment obligation affects the apprentices' choice between alternative employers. Some apprentices will remain with the training firm while others will choose to reimburse and quit for firm 2. In our model, the individual decision depends on wage offers, personal characteristics, and the reimbursement amount. An arbitrage consideration can again be used to determine the decisive worker in each group who is indifferent to work for either firm. As before, workers are assumed to be uniformly distributed along a Hotelling street and to incur frictional costs to work for either firm. Thus, when deciding whether to stay or quit, workers compare the net wage when staying with the training firm to the net wage of another employer *less* the reimbursement amount b_i.

For skilled workers L, the arbitrage condition is identical to above

$$w_{1L} - \delta\hat{\theta}_L = w_{2L} - \delta\left(1 - \hat{\theta}_L\right) \tag{7.1}$$

Firms' share of this workforce then again follow from $\hat{\theta}_L = \frac{w_{1L}-w_{2L}+\delta}{2\delta}$ and $1 - \hat{\theta}_L = \frac{w_{2L}-w_{1L}+\delta}{2\delta}$. Next consider apprentices trained by firm 1. Here it is the apprentice with characteristics $\hat{\theta}_{A_1}$ who is indifferent between the wage offer of firm 1 or leaving for firm 2 and reimbursing b_1.

$$w_{1A_1} - \delta\hat{\theta}_{A_1} = w_{2A_1} - \delta\left(1 - \hat{\theta}_{A_1}\right) - b_1 \tag{7.2}$$

Thus, $\hat{\theta}_{A_1}$ is the fraction of apprentices trained by firm 1 that remains while a fraction $1 - \hat{\theta}_{A_1}$ quits for the competitor.

$$\begin{aligned}
\hat{\theta}_{A_1} &= \frac{w_{1A_1} - w_{2A_1} + \delta + b_1}{2\delta} \\
1 - \hat{\theta}_{A_1} &= \frac{w_{2A_1} - w_{1A_1} + \delta - b_1}{2\delta}
\end{aligned}$$

Prima facie, an obligation to compensate the firm for training when quit-

[8] Note that separate wage offers did not matter before as worker groups did not differ. With the repayment obligation, however, they do.

ting for alternative employers reduces turnover, $\frac{\partial\left(1-\hat{\theta}_{A_1}\right)}{\partial b_1} < 0$. Vice versa, it increases the share of apprentices remaining with the firm, $\frac{\partial\hat{\theta}_{A_1}}{\partial b_1} > 0$. This is graphically illustrated in figure (7.2). Here, the reimbursement obligation

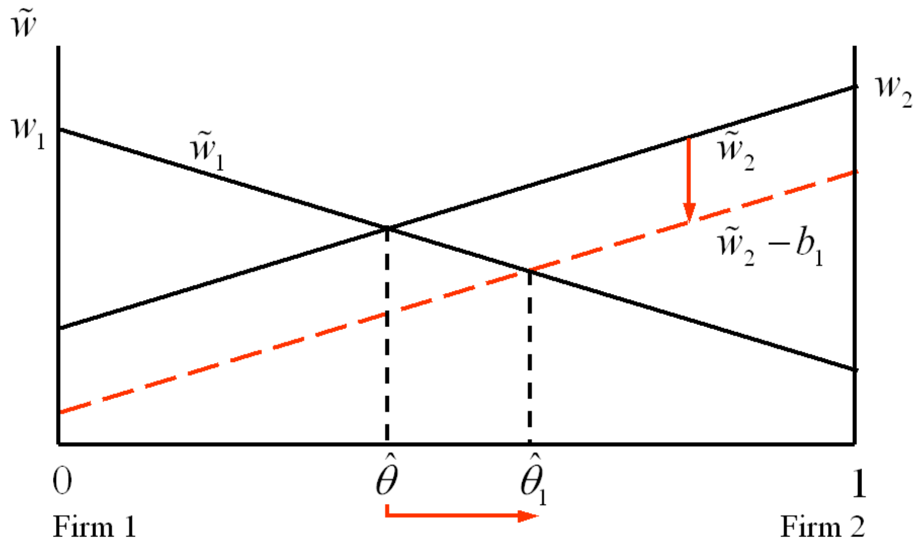

Figure 7.2: Reimbursement Clause and Trainee Turnover of Firm 1

reduces the outside wage offer. The net wage of alternative firm 2 decreases from $\tilde{w}_2$ to $\tilde{w}_2 - b_1$. Accordingly, a larger proportion of workers will remain with the training firm. In comparison to the situation without a reimbursement obligation, the share of apprentices staying in employment with firm 1 will increase from $\hat{\theta}$ to $\hat{\theta}_1$.

By symmetry, the same reasoning applies to apprentices that were trained by firm 2. An arbitrage condition determines the indifferent apprentice $\hat{\theta}_{A_2}$.

$$w_{1A_2} - \delta\hat{\theta}_{A_2} - b_2 = w_{2A_2} - \delta\left(1 - \hat{\theta}_{A_2}\right) \tag{7.3}$$

Accordingly, the fraction of apprentices A_2 that will quit for firm 1 is $\hat{\theta}_{A_2}$

and the fraction $1 - \hat{\theta}_{A_2}$ will stay for employment with firm 2.

$$\begin{aligned} \hat{\theta}_{A_2} &= \frac{w_{1A_2} - w_{2A_2} + \delta - b_2}{2\delta} \\ 1 - \hat{\theta}_{A_2} &= \frac{w_{2A_2} - w_{1A_2} + \delta + b_2}{2\delta} \end{aligned}$$

As before, the reimbursement obligation increases the share of apprentices remaining with the training firm, $\frac{\partial(1-\hat{\theta}_2)}{\partial b_2} > 0$. This is illustrated in figure (7.3) where the reimbursement obligation decreases the alternative wage offer of firm 1 from $\tilde{w}_1$ to $\tilde{w}_1 - b_2$.

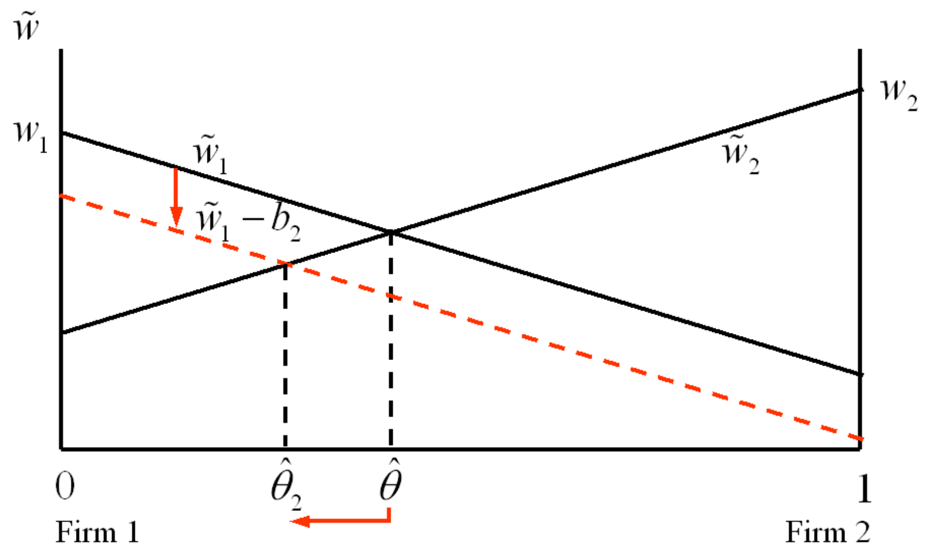

Figure 7.3: Reimbursement Clause and Trainee Turnover of Firm 2

From firms' perspective, the allocation of skilled workers and completed apprentices across firms depends both on firms' wage offers as well as reimbursement amounts. In the poaching period, firms will optimize their wage offers to attract skilled workers while taking advantage of any reimbursement obligations from the past. Using the equations for the indifferent workers

$\hat{\theta}_k(.)$ from above, firm's profit functions are given by (7.4) and (7.5).

$$\max_{\{w_{1L},w_{1A_1},w_{1A_2}\}} \pi_1 = \sum_{k=A_1,A_2,L} (v_1 - w_{1k})\,\hat{\theta}_k(.)\,k + \left(1 - \hat{\theta}_{A_1}(.)\right) b_1 A_1 \quad (7.4)$$

$$\max_{\{w_{2L},w_{2A_1},w_{2A_2}\}} \pi_2 = \sum_{k=A_1,A_2,L} (v_2 - w_{2k}) \left(1 - \hat{\theta}_k(.)\right) k + \hat{\theta}_{A_2}(.)\, b_2 A_2 \quad (7.5)$$

In contrast to before, the profit functions now consist of two terms. The first term represents the margin of productivity over wages when employing skilled workers. The second term denotes repayment revenues from apprentices quitting for another employer.

Again, obtain the Hotelling-Nash-equilibrium from the intersection of firms' profit-maximizing wage reaction functions. See the appendix for a detailed derivation. The equilibrium wages for workers

$$\begin{aligned} w_{1L}^* &= \frac{2}{3}v_1 + \frac{1}{3}v_2 - \delta \\ w_{2L}^* &= \frac{1}{3}v_1 + \frac{2}{3}v_2 - \delta \end{aligned}$$

Note that they are identical to before. For apprentices trained by firm 1, however, equilibrium wage offers are

$$\begin{aligned} w_{1A1}^* &= \frac{2}{3}v_1 + \frac{1}{3}v_2 - \delta - b_1 \\ w_{2A1}^* &= \frac{1}{3}v_1 + \frac{2}{3}v_2 - \delta \end{aligned}$$

and for apprentices trained by firm 2

$$\begin{aligned} w_{1A2}^* &= \frac{2}{3}v_1 + \frac{1}{3}v_2 - \delta \\ w_{2A2}^* &= \frac{1}{3}v_1 + \frac{2}{3}v_2 - \delta - b_2 \end{aligned}$$

In view of these equilibrium wage offers, we can state the next proposition.

Proposition 22 *An obligation to reimburse for training conditional upon quitting leads to a loss for the worker regardless of remaining at or quitting* *from the firm.*

Proof. For $i = \{1, 2\}$, $\frac{\partial w^*_{A_i}}{\partial b_i} = -1$. ■

To understand this result, simply observe that a reimbursement obligation introduces additional *switching costs* for the worker. It offers firms further monopsony power on apprentices and thereby allows to decrease the wage for continued employment by this amount. Thus, if remaining with the firm, apprentices forgo a higher wage. If quitting, they earn the higher competing wage, but have to reimburse for training through a nominal transfer.

As before, use the equilibrium wages to determine worker allocation. The allocation of skilled workers that have no reimbursement obligation will be identical to before.

$$\begin{aligned}
\hat{\theta}^*_L &= \frac{w^*_{1L} - w^*_{2L} + \delta}{2\delta} = \frac{1}{2} + \frac{v_1 - v_2}{6\delta} \\
1 - \hat{\theta}^*_L &= \frac{w^*_{2L} - w^*_{1L} + \delta}{2\delta} = \frac{1}{2} - \frac{v_1 - v_2}{6\delta}
\end{aligned}$$

However, the same allocation also results for apprentices trained by firm 1

$$\begin{aligned}
\hat{\theta}^*_{A_1} &= \frac{w^*_{1A_1} - w^*_{2A_1} + \delta + b_1}{2\delta} = \frac{1}{2} + \frac{v_1 - v_2}{6\delta} \\
1 - \hat{\theta}^*_{A_1} &= \frac{w^*_{2A_1} - w^*_{1A_1} + \delta - b_1}{2\delta} = \frac{1}{2} - \frac{v_1 - v_2}{6\delta}
\end{aligned}$$

as well as for apprentices trained by firm 2.

$$\begin{aligned}
\hat{\theta}^*_{A_2} &= \frac{w^*_{1A_2} - w^*_{2A_2} + \delta - b_2}{2\delta} = \frac{1}{2} + \frac{v_1 - v_2}{6\delta} \\
1 - \hat{\theta}^*_{A_2} &= \frac{w^*_{2A_2} - w^*_{1A_2} + \delta + b_2}{2\delta} = \frac{1}{2} - \frac{v_1 - v_2}{6\delta}
\end{aligned}$$

This is summarized in the next proposition:

Proposition 23 *A reimbursement obligation does not affect turnover.*

Proof. For $k = \{A_1, A_2, L\}$, clearly $\frac{\partial \hat{\theta}^*_k}{\partial b_k} = 0$. ■

Contrary to expectations and in opposition to Alewell's result, a repayment obligation does not affect worker turnover. This prediction follows directly from the previous proposition. Since a reimbursement clause has workers repay for training regardless of whether or not she quits, equilibrium turnover remains unaffected. The equilibrium worker allocation depends only on firm productivity, personal characteristics and frictions.

Insert equilibrium wages and worker allocations into firms' profit functions (7.4) and (7.5) and obtain firms' equilibrium profits.

$$\pi_1^* = \frac{(v_1 - v_2 + 3\delta)^2}{18\delta}(A_1 + A_2 + L) + b_1 A_1$$

$$\pi_2^* = \frac{(v_2 - v_1 + 3\delta)^2}{18\delta}(A_1 + A_2 + L) + b_2 A_2$$

Note, that a reimbursement clause increases firms' profits when apprentices have been trained by the firm. This follows immediately from $\frac{\partial \pi_i^*}{\partial b_i} > 0$, for $A_i > 0$. Put differently, a reimbursement clause gives additional returns to the firm in the poaching period. We will now investigate, how this affects the training decision.

7.3.2 Training Period

Given the results from the poaching period, now turn to the training period where firms can decide on the number of apprentices, trainee wages and the reimbursement amount. Moreover, for apprentices to enter into training, the firm must respect the participation constraint.

Training Participation *without* Credit Constraints

If capital markets are perfect and allow for transfer of funds between both periods, an unskilled worker will accept the training contract if – in present value terms – the net income from training exceeds the net income from remaining unskilled. From the participation constraint (4.6) follows that with unskilled wages normalized to zero and in absence of any credit constraints, the unskilled worker will be willing to forego earnings in the training period at most equal to the discounted expected future net income, $-w_i^a \leq \rho E_i(\tilde{w})$.

Using the equilibrium wages from the poaching period, the participation constraints are

$$\begin{aligned} -w_1^a &\leq \rho E_1(\tilde{w}) = \rho\left(\tfrac{1}{2}(v_1+v_2) + \tfrac{1}{36\delta}(v_1-v_2)^2 - \tfrac{5}{4}\delta - b_1\right) && (7.6) \\ -w_2^a &\leq \rho E_2(\tilde{w}) = \rho\left(\tfrac{1}{2}(v_1+v_2) + \tfrac{1}{36\delta}(v_1-v_2)^2 - \tfrac{5}{4}\delta - b_2\right) && (7.7) \end{aligned}$$

See again the appendix for a complete derivation of the expected net wages. Note that the participation constraint differs to the simple model only by the reimbursement amount b_i. Firms' training decision problem follows from

$$\begin{aligned} &\underset{\{A_1,w_1^a,b_1\}}{\arg\max}\ \{\rho\pi_1^* - w_1^a A_1 - c_1(A_1)\}\ \text{ s.t. } (\mathrm{PC}_1) \\ &\underset{\{A_2 w_2^a,b_2\}}{\arg\max}\ \{\rho\pi_2^* - w_2^a A_2 - c_2(A_2)\}\ \text{ s.t. } (\mathrm{PC}_2) \end{aligned}$$

If firms possess all bargaining power, the participation constraint will be binding and can be substituted into each firm's decision problem. Replacing for π_1^* and π_2^* as well as w_1^a and w_2^a, the first order conditions are

$$\begin{aligned} \rho\left(\tfrac{1}{2}(v_1+v_2) + \tfrac{1}{12\delta}(v_1-v_2)(v_1-v_2+4\delta) - \tfrac{3}{4}\delta\right) &= c_1' && (7.8) \\ \rho\left(\tfrac{1}{2}(v_1+v_2) + \tfrac{1}{12\delta}(v_2-v_1)(v_2-v_1+4\delta) - \tfrac{3}{4}\delta\right) &= c_2' && (7.9) \end{aligned}$$

Proposition 24 *In absence of credit constraints, reimbursement clauses leave training efficiency unaltered.*

Proof. For $i = \{1, 2\}$, $\frac{\partial A_i}{\partial b_i} = 0$. ■

A reimbursement clause does not enter the optimality conditions for training. The intuition for this result is as follows: The repayment obligation reduces worker's future income regardless of whether or not she remains with the firm. With a binding participation constraint, worker's training incentives are reduced. With the reimbursement clause, by contrast, future profits of the training firm increase by the same amount. As both effects cancel out, total incentives for training are unaltered. The reimbursement clause just shifts worker's cost burden from the trainee wage to the foregone future wage.

Training Participation *with* Credit Constraints

Now study the private training condition under credit constraints. With the credit constraint (4.7) binding, $w_i^a = m$, the apprentice is restrained from foregoing earnings necessary for to firm to provide efficient training. As she cannot borrow up to her discounted future net income, we have $m > -\rho E_i(\tilde{w})$. Firms' training decision problem thus alters

$$\begin{array}{l} \underset{\{A_1, w_1^a, b_1\}}{\arg\max} \{\rho\pi_1^* - w_1^a A_1 - c_1(A_1)\} \text{ s.t. } (\mathrm{PC}_1) \text{ and } (\mathrm{CC}) \\ \underset{\{A_2 w_2^a, b_2\}}{\arg\max} \{\rho\pi_2^* - w_2^a A_2 - c_2(A_2)\} \text{ s.t. } (\mathrm{PC}_2) \text{ and } (\mathrm{CC}) \end{array}$$

Replacing for π_1^* and π_2^* as well as w_1^a and w_2^a, the first order conditions are

$$\rho\left(\tfrac{(v_1 - v_2 + 3\delta)^2}{18\delta} + b_1\right) - m = c_1' \tag{7.10}$$

$$\rho\left(\tfrac{(v_2 - v_1 + 3\delta)^2}{18\delta} + b_2\right) - m = c_2' \tag{7.11}$$

The bracket term denotes firm's profits from an additional apprentices whereas $-m$ denotes the worker's constrained investment.[9] At the constrained optimum, both should be equal to the marginal costs. Since firms' optimal training now depends on the reimbursement amount b_i, we can state the following proposition.

Proposition 25 *Reimbursement clauses constitute an implicit firm-provided training loan since they defer a worker's training investment to the future. If workers face credit constraints, then this can reduce the inefficiency and increase on-the-job training.*

Proof. For $i = \{1, 2\}$ and $m > -\rho E_i(\tilde{w})$, $\frac{\partial A_i}{\partial b_i} > 0$. ■

[9] Note that the credit constraint is a negative amount, i.e. the amount that the apprentice could borrow.

In order to explain this result, observe that credit constraints inhibit apprentices from sufficiently foregoing earnings or taking up adequate training loans. This would normally give rise to an underinvestment in general training. However, by means of a contractual obligation to reimburse, apprentices can (fully or partially) defer their training investment to the future. Either they reimburse the firm for training when quitting or they pay through foregone wages. By consequence, a reimbursement clause can be characterized as an implicit training loan. As it can mitigate investment-restraining credit constraints, the use of this instrument enhances efficiency.

7.4 Generalized Model with Reimbursement Clauses

We will now extend the analysis to a labor market with an indefinite number of firms. This allows, as before, to generalize the simple two-firm setting and to compare results of competitive labor markets with many firms to rather incompetitive labor markets with only few firms.

Return to the model of chapter 6 and again consider a Salop-circle of unit length with n firms evenly located across the circular economic space. In addition, worker and training firm can now agree to sign a training contract obliging the worker to reimburse for training when leaving the firm in the future.

7.4.1 Poaching Period

In the poaching period, after having completed the apprenticeship, apprentices choose among firms' wage offers. They will work for the firm offering the highest net income, i.e. the highest wage net of frictional costs *and* training reimbursements. Let b_i again denote the repayment amount when quitting from training firm i. Thus, the net wage $\tilde{w}_j$ of a worker with characteristics θ, trained at firm i and working for firm j can now be written as

$$\tilde{w}_j(\theta) = \left\{ \begin{array}{ll} w_j - \delta\,|q_j - \theta| & \text{if } j = i \\ w_j - \delta\,|q_j - \theta| - b_i & \text{if } j \neq i \end{array} \right\} \tag{7.12}$$

Consider apprentices with characteristics in the interval $[q_i, q_{i+1}]$. They will arbitrage between the wage offers of firm i and firm $i+1$. Let $\hat{\theta}_{i,i+1}$ be the worker who is indifferent between working for either firm. Net wages of working at either firm are equal for this worker and the indifference condition (7.13) is fulfilled.

$$w_i - \delta\left(\hat{\theta}_{i,i+1} - q_i\right) = w_{i+1} - \delta\left(q_{i+1} - \hat{\theta}_{i,i+1}\right) - b_i \tag{7.13}$$

From rearranging we obtain the indifferent worker $\hat{\theta}_{i,i+1}$ as a function of firms' wage offers.

$$\hat{\theta}_{i,i+1} = \frac{q_i + q_{i+1}}{2} + \frac{1}{2\delta}(w_i - w_{i+1} + b_i)$$

Obtain analogously the arbitrage condition for worker $\hat{\theta}_{i-1,i}$ in the interval $[q_{i-1}, q_i]$ who is indifferent between firm $i-1$ and i.

$$w_{i-1} - \delta\left(\hat{\theta}_{i-1,i} - q_{i-1}\right) - b_i = w_i - \delta\left(q_i - \hat{\theta}_{i-1,i}\right) \tag{7.14}$$

The position of the indifferent worker is thus

$$\hat{\theta}_{i-1,i} = \frac{q_{i-1} + q_i}{2} + \frac{1}{2\delta}(w_{i-1} - w_i - b_i)$$

From $\hat{\theta}_{i-1,i}(\cdot)$ and $\hat{\theta}_{i,i+1}(\cdot)$ follows that, since the indifferent worker is located farther away, training firm i can obtain a larger share of workers from its neighbors. Figure 7.4 illustrates this reasoning graphically.

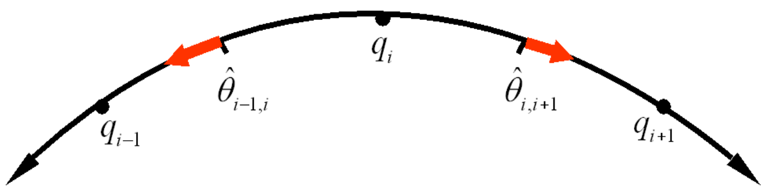

Figure 7.4: Indifferent Worker with Reimbursement Obligation to Firm i

It is also possible that workers take an employment offer with a firm other than training firm i or its neighbors. In this case, from worker's characteristics parameter θ, the worker has '*delocated*' to an extent as to quit the training firm in any case. For workers in the interval $[q_j, q_{j+1}]$, where $j \neq i, i-1, i+1$, it is the worker at $\hat{\theta}_{j,j+1}$ who is indifferent between wage offers of firm j and $j+1$. From the arbitrage condition

$$w_j - \delta\left(\hat{\theta}_{j,j+1} - q_j\right) - b_i = w_{j+1} - \delta\left(q_{j+1} - \hat{\theta}_{j,j+1}\right) - b_i \tag{7.15}$$

again obtain the position of the indifferent worker.

$$\hat{\theta}_{j,j+1} = \frac{q_j + q_{j+1}}{2} + \frac{1}{2\delta}(w_j - w_{j+1})$$

A firm will employ all workers in the interval $\left[\hat{\theta}_{j-1,j}, \hat{\theta}_{j,j+1}\right]$. For simplicity we remain with the assumption of uniformly distributed worker characteristics across the unit interval. Firm j's share of apprentices trained in firm i is thus

$$\gamma_j = \int_{\hat{\theta}_{j-1,j}}^{\hat{\theta}_{j,j+1}} f(\theta)\, d\theta = \hat{\theta}_{j,j+1} - \hat{\theta}_{j-1,j}$$

Substituting for $\hat{\theta}_{j,j+1}$, there are four equations for worker shares.

$$\gamma_j = \left\{ \begin{array}{ll} \frac{1}{n} + \frac{1}{2\delta}(2w_{i-1} - w_i - w_{i-2} - b_i) & \text{if } j = i-1 \\ \frac{1}{n} + \frac{1}{2\delta}(2w_i - w_{i-1} - w_{i+1} + 2b_i) & \text{if } j = i \\ \frac{1}{n} + \frac{1}{2\delta}(2w_{i+1} - w_i - w_{i+2} - b_i) & \text{if } j = i+1 \\ \frac{1}{n} + \frac{1}{2\delta}(2w_j - w_{j-1} - w_{j+1}) & \text{if } j \neq i, i-1, i+1 \end{array} \right\} \tag{7.16}$$

Note that the reimbursement clause adds some additional term for the training firm and its neighboring competitors. Firms' optimal wage offer can now be determined from the profit maximization problem.

$$\max_{\{w_j\}} \pi_j = \left\{ \begin{array}{ll} (v_j - w_i)\,\gamma_j + \left(1 - \gamma_j\right) b_i & \text{if } j = i \\ (v_j - w_j)\,\gamma_j & \text{if } j \neq i \end{array} \right\}$$

First order conditions are

$$\frac{\partial \pi_j}{\partial w_j} = \left\{ \begin{array}{ll} -\gamma_j + (v_j - w_j - b_i)\,\frac{1}{\delta} & \text{if } j = i \\ -\gamma_j + (v_j - w_j)\,\frac{1}{\delta} & \text{if } j \neq i \end{array} \right\} \tag{7.17}$$

with second order conditions satisfied, $\frac{\partial^2 \pi_j}{\partial w_j} < 0$. To solve for the local maximum, we set the first order condition equal to zero, insert for all γ_j and rearrange. This yields a system of n linear equations with n unknown wage variables to be determined.

$$\begin{array}{ll}
w_{i-1} - \frac{1}{4}w_i - \frac{1}{4}w_{i-2} = \frac{1}{2}\left(v_j - \frac{\delta}{n}\right) + \frac{b_i}{4} & \text{if } j = i-1 \\
w_i - \frac{1}{4}w_{i+1} - \frac{1}{4}w_{i-1} = \frac{1}{2}\left(v_j - \frac{\delta}{n}\right) - b_i & \text{if } j = i \\
w_{i+1} - \frac{1}{4}w_{i+2} - \frac{1}{4}w_i = \frac{1}{2}\left(v_j - \frac{\delta}{n}\right) + \frac{b_i}{4} & \text{if } j = i+1 \\
w_j - \frac{1}{4}w_{j+1} - \frac{1}{4}w_{j-1} = \frac{1}{2}\left(v_j - \frac{\delta}{n}\right) & \text{if } j \neq i, i-1, i+1
\end{array}$$

Using matrix notation, the system of linear equations can be written in the form $A \cdot w = B$.

$$\begin{pmatrix}
1 & -\frac{1}{4} & 0 & \cdots & \cdots & \cdots & \cdots & 0 & -\frac{1}{4} \\
-\frac{1}{4} & 1 & -\frac{1}{4} & 0 & & & & & 0 \\
0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & & & & \vdots \\
\vdots & 0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & & & \vdots \\
\vdots & & 0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & & \vdots \\
\vdots & & & 0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & \vdots \\
\vdots & & & & 0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 \\
0 & & & & & 0 & -\frac{1}{4} & 1 & -\frac{1}{4} \\
-\frac{1}{4} & 0 & \cdots & \cdots & \cdots & \cdots & 0 & -\frac{1}{4} & 1
\end{pmatrix}
\cdot
\begin{pmatrix} w_1 \\ \vdots \\ \vdots \\ \vdots \\ w_i \\ \vdots \\ \vdots \\ \vdots \\ w_n \end{pmatrix}
=
\begin{pmatrix}
\frac{1}{2}\left(v_1 - \frac{\delta}{n}\right) \\
\vdots \\
\frac{1}{2}\left(v_{i-2} - \frac{\delta}{n}\right) \\
\frac{1}{2}\left(v_{i-1} - \frac{\delta}{n}\right) + \frac{b_i}{4} \\
\frac{1}{2}\left(v_i - \frac{\delta}{n}\right) - b_i \\
\frac{1}{2}\left(v_{i+1} - \frac{\delta}{n}\right) + \frac{b_i}{4} \\
\frac{1}{2}\left(v_{i+2} - \frac{\delta}{n}\right) \\
\vdots \\
\frac{1}{2}\left(v_n - \frac{\delta}{n}\right)
\end{pmatrix}$$

For simplicity, consider only the case of homogeneous productivity, i.e. assume $v_i = v$, $\forall i$.[10] Note that w_i and b_i affect only the reaction functions of firms i, $i-1$ and $i+1$, i.e. the training firm and its neighbors. We can

[10] For heterogeneous productivity some firms may not be competitive enough to recruit from the labor market. This depends on firms' productivity levels, frictional costs, and the number of competitors. For suitable parameter values a solution could also be derived from $w = A^{-1} \cdot B$.

substitute for $\hat{w}_i = w_i - b_i$ and the system of linear equations reduces to

$$\begin{pmatrix} 1 & -\frac{1}{4} & 0 & \cdots & \cdots & \cdots & \cdots & 0 & -\frac{1}{4} \\ -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & & & & & 0 \\ 0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & & & & \vdots \\ \vdots & 0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & & & \vdots \\ \vdots & & 0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & & \vdots \\ \vdots & & & 0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 & \vdots \\ \vdots & & & & 0 & -\frac{1}{4} & 1 & -\frac{1}{4} & 0 \\ 0 & & & & & 0 & -\frac{1}{4} & 1 & -\frac{1}{4} \\ -\frac{1}{4} & 0 & \cdots & \cdots & \cdots & \cdots & 0 & -\frac{1}{4} & 1 \end{pmatrix} \cdot \begin{pmatrix} w_1 \\ \vdots \\ \vdots \\ w_{i-1} \\ \hat{w}_i \\ w_{i+1} \\ \vdots \\ \vdots \\ w_n \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\left(v - \frac{\delta}{n}\right) \\ \vdots \\ \vdots \\ \frac{1}{2}\left(v - \frac{\delta}{n}\right) \\ \frac{1}{2}\left(v - \frac{\delta}{n}\right) \\ \frac{1}{2}\left(v - \frac{\delta}{n}\right) \\ \vdots \\ \vdots \\ \frac{1}{2}\left(v - \frac{\delta}{n}\right) \end{pmatrix}$$

As in the case without reimbursement clauses we have a symmetric problem yielding a symmetric solution. Using $w_1 = ... = w_{i-1} = \hat{w}_i = w_{i+1} = ... = w_n$ firms' equilibrium wage offers can be deduced as

$$w_j^* = \begin{Bmatrix} w_j - \frac{\delta}{n} - b_i & \text{if } j = i \\ w_j - \frac{\delta}{n} & \text{if } j \neq i \end{Bmatrix}$$

Just as in the two-firm setting, a reimbursement clause introduces switching costs. This provides the training firm with some additional wage-setting power which can thereby reduce wages to its apprentices. In equilibrium, turnover is not affected. Worker allocation thus remains at

$$\gamma_j^* = \frac{1}{n}$$

and firms' equilibrium profits are

$$\pi_i^* = \sum_{i=1}^{n} \frac{1}{n} \frac{\delta}{n} A_i + b_i A_i$$

As in the two-firm setting, a reimbursement obligation on apprentices increases firm's profits in the poaching period.

7.4.2 Training Period

Using the results of the poaching period, now turn to the training period. Firms' decision problem with regard to the number of apprentices is

$$\underset{\{A_i, w_i^a, b_i\}}{\arg\max} \left\{\rho \pi_i^* - w_i^a A_i - c_i(A_i)\right\}$$

and from the first order condition follows the optimality condition for the number of apprentices.

$$\frac{1}{n}\frac{\delta}{n} + b_i - w_i^a = c_i' \tag{7.18}$$

It simply states that training is optimal when marginal costs equal firm's return from an additional apprentice minus the trainee wage. The trainee wage can again be inferred from the participation constraint of the apprentice.

Training Participation *without* Credit Constraints

In absence of credit constraints, the trainee wage is $w^a = -\rho E_i(\tilde{w}) = -\left(v - \frac{\delta}{n} - b_i\right)$, i.e. the apprentices pays the firm for vocational training at most the discounted future net income. Substituting into the training condition yields

$$v - \frac{n-1}{n}\frac{\delta}{n} = c_i' \tag{7.19}$$

which is identical to equation (6.14).

Training Participation *with* Credit Constraints

In presence of credit constraints, the apprentice can incur training costs in the initial period at most equal to $w^a = -m$. Thus, the optimality condition for training is

$$\frac{1}{n}\frac{\delta}{n} + b_i + m = c_i' \tag{7.20}$$

With convex training costs, it can again be concluded that firm's optimal number of apprentices increases with the reimbursement amount, $\frac{\partial A_i}{\partial b_i} > 0$.

7.5 Discussion

This chapter focussed on reimbursement clauses. Such clauses typically oblige a worker to reimburse the firm for training when quitting for another employer. As firms use this instrument to secure training returns, they are often seen as a contractual means to prevent training spillovers to arise from worker turnover. Hence, they are often discussed as an alternative policy for training levies when addressing a poaching externality.

Prior research predicts reimbursement clauses to resolve the externality problem and restore efficient training. However, these studies do not explicitly model worker turnover as a function of wages. Instead, they assume an exogenous probability of quits. While this assumption simplifies the problem, a worker's decision to stay with the training firm or to quit for another employer clearly depends on firms' wage offers. Abstracting from wage-setting and assuming exogenous turnover could affect the results. A revision is therefore required.

In order to overcome this shortcoming, we seek a more general setting that endogenizes the decision whether or not to stay with the training firm. We refer to the simple two-firm two-period model from chapter 4 and extend it for reimbursement clauses. This set-up explicitly treats worker turnover as a function of firms' wage offers as well as exogenous personal characteristics. Our analysis points out that reimbursement clauses, on the one hand, put additional costs on apprentices to take alternative jobs. Clearly, this affects workers' arbitrage decision by reducing the value of competing wage offers. On the other hand, since this causes additional frictions and reduces wage arbitrage, monopsony power increases. This allows the training firm to reduce its wage offer for its apprentices and earn larger employment rents.

While a reimbursement obligation increases training returns to the firm, it decreases worker's returns. It can be shown that both effects cancel out, i.e. a repayment obligation yields a future return for the firm, but reduces training returns for the worker by the same amount. On total, this leaves private incentives for training unaltered.

Our simple model concludes that a reimbursement clause does not affect turnover and the poaching externality remains. The quitting decision is not changed since an apprentice reimburses for training in any case, either by repaying in nominal terms or by foregone earnings. Effectively, a reimbursement obligation can therefore be characterized as an implicit training loan which defers worker's training investment from the training period to the future.

In this model, the implicit training loan has no efficiency effects on training in the situation of perfect capital markets. However, in case of credit constraints, a reimbursement clause can improve on efficiency. If workers cannot (sufficiently) borrow against their future income, a reimbursement clause allows to defer the training investment into the future and thereby soften credit limitations.

In line with previous research, this model therefore also concludes that the legal ban on reimbursement clauses for vocational training should be lifted. Yet, this conclusion arises for different reasons. According to this model, reimbursement clauses do not affect the poaching externality, but they overcome credit constraints by substituting for training loans.

7.A Appendix

§ 5 BBiG (Nichtige Vereinbarungen)

> (1) Eine Vereinbarung, die den Auszubildenden für die Zeit nach Beendigung des Berufsausbildungsverhältnisses in der Ausübung seiner beruflichen Tätigkeit beschränkt, ist nichtig. Dies gilt nicht, wenn sich der Auszubildende innerhalb der letzten sechs Monate des Berufsausbildungsverhältnisses dazu verpflichtet, nach dessen Beendigung mit dem Ausbildenden ein Arbeitsverhältnis einzugehen.
>
> (2) Nichtig ist eine Vereinbarung über
> 1. die Verpflichtung des Auszubildenden, für die Berufsausbildung eine Entschädigung zu zahlen,
> 2. Vertragsstrafen,
> 3. den Ausschluß oder die Beschränkung von Schadensersatzansprüchen,
> 4. die Festsetzung der Höhe eines Schadensersatzes in Pauschbeträgen.

Derivation of Equilibrium Wage Rates

In order to solve for equilibrium wage rates derive the first order conditions from (7.4) and (7.5). For firm 1 this yields

$$\begin{aligned}
\frac{\partial \pi_1}{\partial w_{1L}} &= -\hat{\theta}_L L + (v_1 - w_{1L})\frac{1}{2\delta}L = 0 \\
\frac{\partial \pi_1}{\partial w_{1A_1}} &= -\hat{\theta}_{A_1} A_1 + (v_1 - w_{1A_1})\frac{1}{2\delta}A_1 - \frac{1}{2\delta}b_1 A_1 = 0 \\
\frac{\partial \pi_1}{\partial w_{1A_2}} &= -\hat{\theta}_{A_2} A_2 + (v_1 - w_{1A_2})\frac{1}{2\delta}A_2 = 0
\end{aligned}$$

and similarly for firm 2

$$\begin{aligned}
\frac{\partial \pi_2}{\partial w_{2L}} &= -\left(1-\hat{\theta}_L\right)L + \left(v_2 - w_{2L}\right)\frac{1}{2\delta}L = 0 \\
\frac{\partial \pi_2}{\partial w_{2A_1}} &= -\left(1-\hat{\theta}_{A_1}\right)A_1 + \left(v_2 - w_{2A_1}\right)\frac{1}{2\delta}A_1 = 0 \\
\frac{\partial \pi_2}{\partial w_{2A_2}} &= -\left(1-\hat{\theta}_{A_2}\right)A_2 + \left(v_2 - w_{2A_2}\right)\frac{1}{2\delta}A_2 - \frac{1}{2\delta}b_2 A_2 = 0
\end{aligned}$$

The second order conditions are again fulfilled with $\frac{\partial^2}{\partial w_k} < 0$, $\forall k$. Simplification yields a pair of reaction functions for each worker group. For the general group of skilled workers it is as before

$$\begin{aligned}
v_1 - 2w_{1L} + w_{2L} - \delta &= 0 \\
v_2 - 2w_{2L} + w_{1L} - \delta &= 0
\end{aligned}$$

For apprentices originating from firm 1 we have

$$\begin{aligned}
v_1 - 2w_{1A_1} + w_{2A_1} - \delta - 2b_1 &= 0 \\
v_2 - 2w_{2A_1} + w_{1A_1} - \delta + b_1 &= 0
\end{aligned}$$

and for apprentices originating from firm 2 we have

$$\begin{aligned}
v_1 - 2w_{1A_2} + w_{2A_2} - \delta + b_2 &= 0 \\
v_2 - 2w_{2A_2} + w_{1A_2} - \delta - 2b_2 &= 0
\end{aligned}$$

The equilibrium wages then follow from the intersection of the reaction functions.

Derivation of Expected Net Wage $E(\tilde{w})$

If training at firm 1

$$
\begin{aligned}
E\left(\widetilde{w}\right) &= \int_0^{\theta^*_{A_1}} \left(w_1^* - \delta\theta\right) d\theta + \int_{\theta^*_{A_1}}^1 \left(w_2^* - \delta\left(1-\theta\right) - b_1\right) d\theta \\
&= \left[w_1^*\theta - \frac{\delta}{2}\theta^2\right]_0^{\theta^*_{A_1}} + \left[w_2^*\theta - \delta\theta + \frac{\delta}{2}\theta^2 - b_1\theta\right]_{\theta^*_{A_1}}^1 \\
&= w_1^*\theta^*_{A_1} - \frac{\delta}{2}\theta^{*2}_{A_1} + w_2^* - \delta + \frac{\delta}{2} - b_1 - w_2^*\theta^*_{A_1} + \delta\theta^*_{A_1} - \frac{\delta}{2}\theta^{*2}_{A_1} + b_1\theta^*_{A_1} \\
&= w_1^*\theta^*_{A_1} - \delta\theta^{*2}_{A_1} + w_2^* - \frac{\delta}{2} - b_1 - w_2^*\theta^*_{A_1} + \delta\theta^*_{A_1} + b_1\theta^*_{A_1} \\
&= \left(w_1^* - w_2^* + \delta + b_1 - \delta\theta^*_{A_1}\right)\theta^*_{A_1} + w_2^* - \frac{\delta}{2} - b_1 \\
&= \tfrac{1}{2}\left(v_1 + v_2\right) + \tfrac{1}{36\delta}\left(v_1 - v_2\right)^2 - \frac{5}{4}\delta - b_1
\end{aligned}
$$

If training at firm 2

$$
\begin{aligned}
E\left(\widetilde{w}\right) &= \int_0^{\theta^*_{A_2}} \left(w_1^* - \delta\theta - b_2\right) d\theta + \int_{\theta^*_{A_2}}^1 \left(w_2^* - \delta\left(1-\theta\right)\right) d\theta \\
&= \left[w_1^*\theta - \frac{\delta}{2}\theta^2 - b_2\theta\right]_0^{\theta^*_{A_2}} + \left[w_2^*\theta - \delta\theta + \frac{\delta}{2}\theta^2\right]_{\theta^*_{A_2}}^1 \\
&= w_1^*\theta^*_{A_2} - \frac{\delta}{2}\theta^{*2}_{A_2} - b_2\theta^*_{A_2} + w_2^* - \delta + \frac{\delta}{2} - w_2^*\theta^*_{A_2} + \delta\theta^*_{A_2} - \frac{\delta}{2}\theta^{*2}_{A_2} \\
&= w_1^*\theta^*_{A_2} - w_2^*\theta^*_{A_2} + \delta\left(1 - \theta^*_{A_2}\right)\theta^*_{A_2} - b_2\theta^*_{A_2} + w_2^* - \frac{\delta}{2} \\
&= \left(w_1^* - w_2^* + \delta\left(1 - \theta^*_{A_2}\right) - b_2\right)\theta^*_{A_2} + w_2^* - \frac{\delta}{2} \\
&= \tfrac{1}{2}\left(v_1 + v_2\right) + \tfrac{1}{36\delta}\left(v_1 - v_2\right)^2 - \frac{5}{4}\delta - b_2
\end{aligned}
$$

Chapter 8

Final Remarks

8.1 Summary

This work focuses on spillovers in vocational training. It investigates the widespread claim that non-training firms obtain training returns through poaching, and studies whether training policy could mitigate the problem by means of incentive schemes or reimbursement clauses. As a starting point, this work takes up the recent debate to introduce training levies. As a result of the shortages in apprenticeship training, this policy proposal has received a lot of attention. Current economic research is however divided on the issue. It questions whether non-training firms take advantage of apprenticeship training through poaching. Moreover, it discusses training levies and reimbursement clauses as alternative remedies.

Despite conflicting theoretical assessments and policy recommendations, a formal analysis of these policy instruments on poaching and general welfare has been lacking. The aim of this work is to close this gap. It investigates poaching and analyzes whether it could be resolved by alternative policy measures. In particular, it seeks to shed light on the following three questions:

1. By its very nature, apprenticeship training is of potential use to many firms. A training firm thus faces the risk of workers quitting for competing firms. So why do profit-seeking firms provide and finance apprenticeship training in the first place?

2. As an alternative to costly training, firms can recruit already trained workers through poaching. It is a widespread claim that they can thereby derive benefits from vocational training without incurring any cost. Yet, does poaching indeed give rise to positive spillovers that would lead to socially inefficient training?

3. If we suppose that positive spillovers do indeed arise from vocational training, is there a mitigating role for public policy? In particular, could training levies or reimbursement clauses improve welfare? And how do both alternatives compare?

In order to answer these questions, the analysis proceeds in several consecutive steps. Chapter two offers a short description of the German apprenticeship system. It points out that apprenticeships, as a consequence of tight regulation, offer generally applicable occupational skills. Moreover, a review of training statistics shows that training is – by and large – costly to firms. It also strongly suggests that positive spillovers arise as only about a quarter of all firms actually provide apprenticeship training and a few apprentices remain with their training firm in the long term.

The third chapter then surveys existing research on vocational training and positive spillovers. It reveals that the issue of poaching has already been of concern to classical economists. However, economic answers have varied over time. While early writers accepted that poaching does give rise to an externality and favored appropriate policy remedies, human capital theory strongly disputes this view. It argues that poaching drives up wages for generally trained workers. This leaves training firms unable to recoup any returns beyond the training period. Since all training returns accrue to the worker via the wage increase, firms may only provide, but not finance general training. By consequence, there is no poaching externality.

Several empirical studies cast doubt on human capital theory. In contrast to its theoretical prediction, they find strong evidence of firms both providing and financing general training. This has also been shown for the German apprenticeship system. Recent contributions to human capital theory therefore set out to explain this contradiction. They argue that labor market frictions lead to imperfect wage competition. With wages below marginal product, this allows firms to recoup training costs. However, this also gives rise to a poaching externality as non-training firms need not pay the competitive wage in order to recruit workers.

The fourth chapter then proposes a simple two-firm two-period model of vocational training. In this model, firms can choose to offer apprenticeship training in the first period and face wage competition for trained workers in the second period. Workers will decide to remain with the firm or to quit for a competitor depending on firms' wage offers whereby turnover is endogenously determined. In line with the recent training literature, wage competition is assumed to be imperfect. The model proposes that the arbitrage decision depends on firms' wage offers as well as an exogenously determined switching costs.

Given this setting, firms can be shown to rationally provide and partially finance apprenticeship training although this training is mostly general and workers are subject to poaching by other firms. At the same time, this model predicts a poaching externality to exist. Its size depends on labor market frictions and firms' varying productivity. With vocational training therefore possessing positive spillovers on other firms, training will fall short of the socially optimal level.

As the simple training model predicts a poaching externality, there is thus an interest in counteracting policies. Chapter five concentrates on alternative incentive schemes. At first, as a reference case, it analyzes an ideal Pigouvian subsidy. In principle, this scheme could restore the social optimum if the training firm receives a subsidy equal to the value of the spillovers it causes. However, such an instrument raises exceptional informational requirements as it demands that the subsidies are calculated contingent on firm characteristics and labor market frictions. As an alternative, the analysis then discusses a uniform subsidy. Since this instrument does not distinguish between firms, but is set *on average* for all firms, it could lead to under- and overtraining. Nevertheless, it can be shown that the introduction of a marginal uniform subsidy, conforming to public economic theory, would be welfare-improving if non-distortionary sources of funding were available.

The analysis then turns to the training levy scheme that has recently been proposed for Germany. It reveals that this proposal corresponds to a tax-subsidy-system where a tax is levied on employment and a uniform subsidy paid out per apprentice. Moreover, the analysis predicts that the tax burden of this scheme will be fully shifted onto workers. This training levy scheme can therefore be characterized as a *pay-as-you-go* system where present workers pay for the vocational education of future workers.

A welfare analysis of the training levy scheme offers an ambiguous result even when transaction costs are neglected. On the one hand, it provides additional incentives for apprenticeship training and thereby increases welfare. On the other hand, it reduces wages of the skilled workforce whereby present labor supply will shrink and production is reduced. Ultimately, net welfare will depend on the size of both effects.

Chapter six generalizes the model to an indefinite number of firms. This extension allows to study varying degrees of labor market competition. The analysis demonstrates that the poaching externality shrinks the more firms compete for trained workers. At the extreme of perfect competition, i.e. with an infinite number of firms, the externality disappears as wages approach the marginal product of labor. By contrast, at the opposite extreme of perfect monopsony, the externality disappears as well. In this generalized model, therefore, the predictions of standard human capital theory can be replicated by extreme labor market assumptions.

Chapter seven then studies reimbursement clauses which are often considered to be a preferable alternative to training levies. Such arrangements oblige the worker to reimburse for training costs in case she quits the firm. Prior research therefore characterizes them as a simple contractual mechanism to address the poaching externality. Our analysis points out, however, that this claim relies on the assumption of exogenous quits. In reality, of course, wages are an important determinant of worker turnover. For a proper understanding of reimbursement clauses, therefore, a model of endogenous worker turnover is required.

As our simple training model features endogenous turnover, we extend it for reimbursement clauses. It shows that a reimbursement clause introduces a wedge between the firm's wage offer and the market wage. Contrary to previous research, however, this does not affect the externality at all. Instead, reimbursement clauses transfer training costs on workers regardless of whether they remain with the firm or quit for competitors. In case of quitting, they pay the nominal reimbursement amount. In case of remaining, by contrast, they forego a wage increase by the same amount. Our analysis therefore characterizes reimbursement clauses as an implicit training loan, but not an instrument to address poaching.

8.2 Conclusions and Policy Recommendations

This work allows us to derive some conclusions for the debate on vocational training policy. Essentially, the analysis states that proponents and opponents of training levies are both partially right. It predicts that in frictional labor markets poaching of skilled workers induces training spillovers. With some training benefits accruing to parties outside the training contract, this may indeed lead to an inefficient underprovision of apprenticeship training. In principle, our simple training model therefore makes a case for vocational training policy. It should seek to internalize the externality by providing additional incentives to training firms or burdening non-training firms.

Nonetheless, the existence of a poaching externality does not immediately recommend the introduction of training levies in Germany. On the contrary, this analysis reveals serious shortcomings in this proposal. This particular scheme would subsidize socially beneficial apprenticeships at the expense of additional economic distortions. Even in absence of transaction costs, they could actually exceed the benefits from additional training.

If training policy is nevertheless set for training levies, then this proposal is in need of serious improvement. In particular, less distortionary means of financing and subsidizing should be sought. With spillovers varying with firm productivity and labor market conditions, subsidies should not be calculated uniformly, but rather on firm or branch level. Moreover, it would be desirable to fund subsidies from general tax receipts that induce no additional distortions on regular employment. Given the state of the public budget at present this does not seem a feasible choice. Therefore, when additional sources of financing are needed, a levy depending on payroll, i.e. firms' total wage bill, should be given preference over the present scheme which refers only to the number of employees. Otherwise, firms may strive to substitute low-skilled workers with fewer high-skilled workers, which would add yet another distortion induced from taxation.

Overall, however, the case for a training levy scheme appears to be rather weak. Apart from the massive informational demands necessary to calculate levies with minimal distortions, high administrative costs are to be expected. Since these are also to be financed from tax receipts, they increase tax distortions and reduce welfare. The introduction of this scheme seems therefore distinctly inferior to offering additional training incentives through the existing fiscal system.

In light of these shortcomings, the alternative proposal of deregulating apprenticeship training and allowing for reimbursement clauses seems highly attractive. Yet, this analysis concludes that reimbursement clauses do not internalize the poaching externality at all. In contrast, it demonstrates that a contractual obligation to reimburse for training costs is essentially an implicit training loan.

Despite this negative result, this model still suggests to deregulate vocational training and legally permit reimbursement clauses. As reimbursement clauses implicitly provide a training loan, they could aid apprentices in overcoming credit constraints to finance general training. Present regulation negates this option, which actually harms rather than protects young people seeking a vocational education.

8.3 Fields for Further Research

An honest and critical retrospective of this analysis also reveals some shortcomings. These should be addressed by further research.

As a first point, our simple training model is highly stylized. This has of course the advantage of simplicity, but also the disadvantage that it lacks realism. The assumption of constant labor productivity is particularly troubling. As was noted before, it drives the result of perfect tax shifting. It seems promising to relax this assumption and model decreasing returns to labor in an extended framework.

The model predicts both firms and workers to pay for general training and a poaching externality in imperfect labor markets. This result is in line with empirical studies of vocational training in Germany. Since externalities are ubiquitous in the economy, it would be desirable to quantify the value of the externality. This would also enable us to evaluate the welfare-effects of training policy. Existing studies provide some rough indication, but an evaluation at the branch level is lacking. Certainly, this is also due to data limitations. According to this model, the value of the externality depends on characteristics of the individual worker, the training firm and its competitors as well as the labor market. An assessment would therefore require panel data for the employee and her past and present employer.

In this analysis, in contrast to previous literature, reimbursement clauses are essentially a training loan. Instead of a nominal credit, an apprentice implicitly borrows from the firm to finance general training. This can aid to overcome credit constraints and thus improve welfare. While reimbursement clauses and nominal credits were characterized as substitutes, they are treated differently in the tax system, thus probably causing additional distortions. These effects could be analyzed in future research.

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