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An analysis of individual accounts for the unemployment risk in the Netherlands

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Abstract in English

Individual savings accounts are a recurring reform option for unemployment insurance. Under a system of individual accounts individuals are forced to save part of their income into an individual account out of which benefits are paid during unemployment. Individuals are allowed to have a negative balance and still have the same access to income during unemployment. When negative balances at the end of working life are nullified some risk pooling remains. To study the impact of introducing individual accounts for unemployment we construct a simulation model, which we calibrate for the Netherlands. The simulation results suggest that an optimal combination of forced savings/borrowing and insurance can slightly increase welfare, when unemployed are credit constrained. When credit constraints are not that important for the unemployment risk, individual accounts are less interesting for unemployment, but then current UI replacement rates seem rather generous. Empirical studies suggest that the role of credit constraints in unemployment is limited.

Key words: individual savings accounts, benefits, unemployment, welfare state

Abstract in Dutch

Een regelmatig terugkerende hervormingsoptie voor de werkloosheidsverzekering is de introductie van een zogenoemde spaar-WW. In plaats van een premie te betalen moeten werknemers dan verplicht sparen op een individuele rekening waaruit de uitkering tijdens werkloosheid wordt betaald. Omdat werknemers ook ’rood’ kunnen staan, blijven zij verzekerd van voldoende inkomen tijdens werkloosheid. Verder blijft een zekere mate van risicodeling bestaan wanneer negatieve saldi aan het eind van het werkzame leven worden kwijtgescholden. Om een inschatting te maken van de effecten van een spaar-WW voor Nederland construeren we een simulatiemodel. De simulaties geven aan dat een optimale combinatie van spaarvoet en uitkeringsvoet de welvaart licht kan verhogen, mits werklozen tegen leenbeperkingen aanlopen. Wanneer werklozen niet tegen leenbeperkingen aanlopen, dan is een spaar-WW minder interessant, maar in dat geval lijkt de huidige WW-uitkering vrij genereus. Het schaarse empirisch onderzoek daarnaar suggereert dat het belang van leenbeperkingen beperkt is.

Steekwoorden: spaar-WW, uitkeringen, werkloosheid, welvaartsstaat

Contents

Preface

It has become increasingly popular to study labour market risk and labour market policy from a lifecycle perspective. So-called unemployment insurance savings accounts (UISA) have come up as an interesting alternative to the current system of premium financed unemployment insurance. UISA allow the policy maker to distinguish between the need for liquidity and the need for insurance in unemployment, potentially improving welfare. This document covers the relevant literature and studies the impact of UI and UISA in a lifecycle model with unemployment risk. The model is calibrated to Dutch data and pays special attention to the role of liquidity constraints.

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Coen Teulings
Director

Summary

What are individual savings accounts for unemployment?
Under the current unemployment insurance system employees pay a premium to finance unemployment insurance for the unemployed. Under a system of individual savings accounts for unemployment (UISA) the premium is replaced by mandatory savings into an individual account out of which benefits are paid during unemployment. Because individuals can have a negative balance they still have access to income during unemployment. Furthermore, in a popular proposal, negative terminal balances at the end of working life are nullified, which is financed by a tax, and positive terminal balances go to the individual pension account.

UISA improve incentives ...
Individuals that expect to end up with a positive terminal balance will have a stronger incentive to keep their job and to find a new one in case of job loss. Individuals that expect to end up with a negative terminal balance will have weaker incentives. As most individuals will end up with a positive terminal balance, on net incentives are improved and unemployment will fall.

... but reduce insurance
But the pooling of the unemployment risk will fall as well. Individuals that are unemployed often or for a long duration will have a lower lifetime income. However, some risk pooling remains when negative terminal balances are nullified.

UISA can improve the trade-off between incentives and insurance in the case of borrowing constraints ...
Hence, also UISA do not escape the trade-off between incentives and insurance. However, they may improve this trade-off. When unemployed have no assets and can not borrow then their consumption is determined solely by their unemployment benefits. UISA force individuals to build up some precautionary savings for job loss and allow the unemployed to borrow in the case of job loss. In this way, individuals can 'self-insure' against the risk of unemployment and the need for public insurance against unemployment is reduced. This improves the incentives of the unemployed. However, UISA only have an advantage over a standard UI system when individuals can not implement the self-insurance themselves. When unemployed individuals do not run into borrowing constraints this advantage of UISA over the UI system disappears.

.... but the role of borrowing constraints in unemployment seems limited
Most unemployed individuals do not run into liquidity constraints during unemployment. Most unemployment spells do not last that long, and most unemployed have sufficient assets or access to funds to cover the larger part of the income shock due to unemployment. Indeed, studies that

look into the effect of a change in the unemployment benefit on the consumption of the unemployed find that consumption falls only slightly even when benefits are reduced substantially.

Simulation results indicate that the welfare gains of UISA in the Netherlands are small
We study the effects of introducing UISA in a lifecycle model with unemployment risk, calibrated on Dutch data. The introduction of UISA leads to a substantial drop in unemployment, but also to a substantial loss in risk pooling. Starting from an optimal unemployment benefit level the overall welfare gains are small (< .1% in consumption terms). Also in the model, most unemployed do not run into borrowing constraints. Starting from a higher benefit level, the welfare gains from introducing UISA are larger, but then simply reducing benefit levels seems a more direct alternative.

Lessons for unemployment insurance
The model also illustrates the determinants of the optimal benefit level of unemployment insurance. The optimal benefit level is higher when workers are more risk averse or when the use of unemployment benefits is less responsive to the level of benefits. The novelty is that the optimal benefit level also depends on the extent to which workers can 'self-insure' via precautionary savings and borrowing. The optimal benefit level is significantly higher when individuals are constrained in their ability to save and borrow for the unemployment risk than when they are not.

1 Introduction

During their working life, many employees run a non negligible and persistent income risk due to unemployment. The main policies that target this risk are unemployment insurance (UI), active labour market policies and (ALMPs) employment protection legislation (EPL). In this paper we focus on the system of UI.[1] In particular, we consider how so-called unemployment insurance savings accounts (UISA) affect the workings of the labour market and welfare. Under a system of UISA individuals are forced to save part of their income into an individual account out of which benefits are paid during unemployment. Individuals are allowed to have a negative balance which gives ’liquidity insurance’ for periods of unemployment. Furthermore by nullifying negative balances at the end of the working life, as suggested by Feldstein and Altman (1998), some risk pooling and redistribution, ’lifetime income insurance’, remains.

Bovenberg and Sorensen (2004) and Stiglitz and Yun (2005) have shown that a UISA system can raise welfare in theory. We will consider the main mechanisms in these papers and some potential caveats below. The focus of this paper is on the quantitative impact of individual accounts on the labour market and welfare. Unfortunately we have no empirical knowledge on the impact of individual accounts for unemployment, apart from some descriptive statistics on the recent reform in Chili. To study the impact of individual accounts we therefore develop and calibrate a lifecycle model with unemployment risk to simulate the impact of individual accounts. In the model individuals decide on consumption, savings and search effort, where individuals may be constrained in their choices by credit constraints. The latter plays a crucial role in the impact of individual accounts. We calibrate the model on the panel data from De Koning *et al.* (2006) on the incidence and duration of unemployment in the Netherlands, and the international literature on the extent of moral hazard and the insurance gains from unemployment insurance.

This is not the first paper on UISA in the Netherlands, see *e.g.* Kock and Den Butter (2001), Rezwani and Hendrix (2002), Van Kuringen (2005), De Koning *et al.* (2006) and Rezwani (2006). However, these papers still leave many questions unanswered. The analysis in Kock and Den Butter (2001) gives an interesting discussion of pros and cons but given their informal analysis the net effects remain unclear. Rezwani and Hendrix (2002), Van Kuringen (2005), De Koning *et al.* (2006) and Rezwani (2006) give interesting data on resulting account surpluses and deficits given current transitions between unemployment and employment, but do not consider the impact of a UISA system on behaviour and welfare. In this paper we try to go beyond the previous analyses to answer the question whether individual accounts can improve welfare and how much if anything can be gained.

[1] For an analysis of ALMPs in the Netherlands see *e.g.* Jongen *et al.* (2003), and for an analysis of EPL in the Netherlands see *e.g.* Deelen *et al.* (2006) and Jongen and Visser (2009).

The analysis also tries to go beyond previous simulation analyses of a UISA system for other countries. Brown *et al.* (2006) calibrate a model for a number of large European countries where individuals are either 0, 50 or 100 percent unemployed over their working life, which leads to an unrealistic distribution of unemployment over individual lifecycles. Furthermore, they ignore credit constraints and do not compare a UISA with an optimised UI system, which raises some questions on the welfare gains they find. Hopenhayn and Hatchondo (2002) consider UISA in an extension of Hopenhayn and Nicolini (1997) to multiple unemployment spells, and calibrate the model to Estonian data. Unfortunately, they do not give the optimisation problem and first order conditions for the adapted model with the UISA system, and the discussion of the simulation outcomes is an overview of numerical results without discussing the mechanisms driving the results. Hopefully this will be overcome when the paper is published. Until then, in this paper we try to be clear on the mechanisms driving our results, and we go beyond the analysis of Hopenhayn and Hatchondo (2002) by allowing the search technology to differ between age and education groups and we calibrate the model on Dutch rather than Estonian data.

The outline of the paper is as follows. In Section 2 we first consider the bare bones of a system of individual accounts, illustrate how it works using some hypothetical lifecycles and review some empirical 'bookkeeping' exercises on how UISA affect the distribution of lifetime incomes for different countries. Section 3 then considers how a UISA can improve welfare in theory. In Section 4 we review the empirical findings on the moral hazard and insurance gains of UI, and the role of credit constraints. We use these findings, and the incidence and duration data of De Koning *et al.* (2006) to calibrate a lifecycle model with unemployment risk, in Section 5. Section 6 gives the simulation results for UI and UISA. Section 7 then discusses some limitations of the analysis and how these might affect the results. Section 8 concludes.

2 UISA: definition and accounting

In this section we consider what is meant by a UISA system, how such a system affects lifetime income with the help of some hypothetical lifecycles, and review some ’real life’ accounting exercises on the impact of a UISA system on the lifetime income distribution.

2.1 What are UISA?

The unifying element of all proposals for unemployment insurance savings accounts is that workers (and potentially employers) are forced to save into an individual account when they are employed, rather than paying a tax or premium. From this account individuals can draw funds during periods of unemployment. Beyond this there are a large number of design options in a UISA system, which we consider below.[2]

Savings into the UISA can be voluntary or mandatory. Mandatory savings may be necessary to prevent individuals from claiming funds in times of unemployment via *e.g.* welfare benefits, sickness benefits or disability benefits (to the extent that individuals have a choice there). Mandatory savings may also be necessary when there is an element of redistribution in the system. Furthermore, mandatory savings may be called for when individuals are myopic.[3]

The rules for withdrawing funds like eligibility conditions, replacement rates and maximum benefit durations are typically assumed to be the same as under the UI system that is to be replaced. When negative terminal balances are nullified (more on this below), we still need monitoring and counselling of workers that potentially end up with a negative terminal balance. With more lax eligibility conditions (*e.g.* voluntary quits) or more favourable withdrawal rights (*e.g.* a higher ’replacement rate’) the group of workers that may end up with a negative account will grow and moral hazard among this group will increase.[4]

An important design question is how to treat negative balances, during working life and at retirement. When individuals can not have a negative balance at any point during their working life, the benefits from an UISA scheme as a device for intra personal redistribution are severely

[2] For a discussion of the pros and cons of different choices in a UISA system see *e.g.* Orszag and Snower (1997), Brown *et al.* (2006) and Bovenberg *et al.* (2008).

[3] A downside of mandatory savings is that some individuals may be forced to save too much which they can not undo with their free savings/borrowings. One way to mitigate excessive savings is to set an upper limit on the individual account balance beyond which the individual is no longer forced to save into the UISA. Another option is to integrate the UISA with the pension system.

[4] In this respect, one type of eligibility deserves special mention: early retirement. Individuals in the Netherlands can decide to retire early, and the system typically assumes that the UISA funds become available at retirement. Some people fear that individuals may use UISA to retire even earlier still. However, below we will argue that the incentives under a UISA system to retire early may very well be lower than under an UI system. The former mainly has an income effect (typically assumed to be small) whereas the latter also has a substitution effect (typically assumed to be large, at least relative to the income effect).

limited and all interpersonal redistribution disappears. A scheme that does allow for negative balances during working life increases the possibilities to use the UISA scheme for intra personal redistribution, ’liquidity insurance’. Furthermore, one can still maintain some interpersonal redistribution on a lifetime basis by bailing out individuals that end up with a negative terminal balance, ’lifetime income insurance’. The downside of this is that the moral hazard from the UI system remains for individuals who expect to end up with a negative terminal balance. Furthermore, the taxes needed to bail out the individuals with a negative balance still reduce the private gain from holding or finding a job. On the upside may be that the remaining lifetime income insurance is targeted at individuals that face large or frequent unemployment shocks, they are the ones that end up with a negative terminal balance.

Some authors suggest a scheme where the UISA tops up a minimum benefit level financed out of taxes/premiums (Van Kuringen, 2005), or a scheme where only the withdrawals during say the first 6 months of unemployment (Sorensen *et al.*, 2006) or after the first 6 months of unemployment (to keep the role of UI as a subsidy to search for alternative employment) are debited to the account. In this case there will be more moral hazard but also more insurance relative to a UISA scheme where all UI benefits are part of the system.

The discussion above makes clear that there are many different ways to devise a UISA scheme. In this paper we will focus on a scheme along the lines of Feldstein and Altman (1998). In their scheme we have mandatory savings, entitlement conditions according to the current UI scheme and individuals are allowed to have negative balances during their career. Furthermore, individuals that end up with a negative terminal balance at retirement are bailed out, and this is financed by a tax.

2.2 The effect of UISA on lifetime incomes

To illustrate how the Feldstein and Altman (1998) UISA system works we consider how it affects the lifetime income for the following three hypothetical individuals. Lucky Luke is a highly educated worker who only suffers from a brief unemployment spell after finishing university and is employed for the rest of his life. Medium Mike is a somewhat less fortunate worker who not only suffers from an unemployment spell early in his career, but also suffers from a longer unemployment spell later on. Finally, Tough Ted faces recurring unemployment spells. To be more specific, we assume that all three types of workers enter the labour market at the age of 20 and exit at the age of 60. Workers are uniformly distributed over the three types. They all have an annual wage equal to 1 and an UI replacement rate of .7. Lucky Luke is unemployed for one year at the age of 20, and employed for the rest of his career. Medium Mike is unemployed at 20 and at 21, and also later on at 35 and 36, and employed in the other periods. Tough Ted is unemployed at 20, 21, 35, 36, and also at 45 and 46. The incidence and duration of unemployment of the three types are meant merely as an illustration.

Figure 2.1 Cumulated lifetime income gain or loss from UI

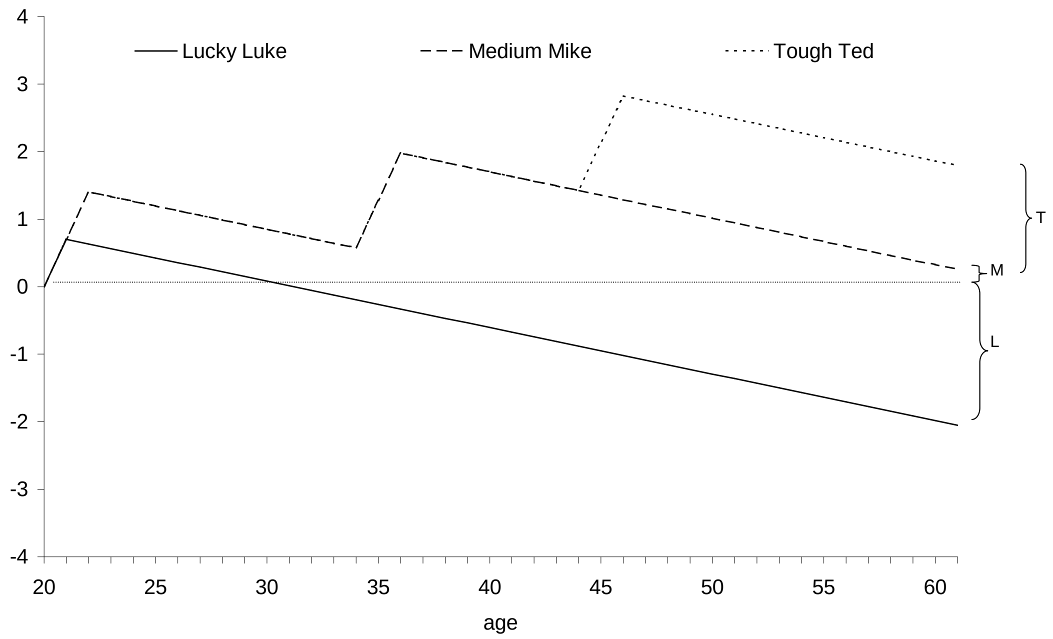


Figure 2.2 Account balances and cumulated taxes, mandatory savings rate = UI premium

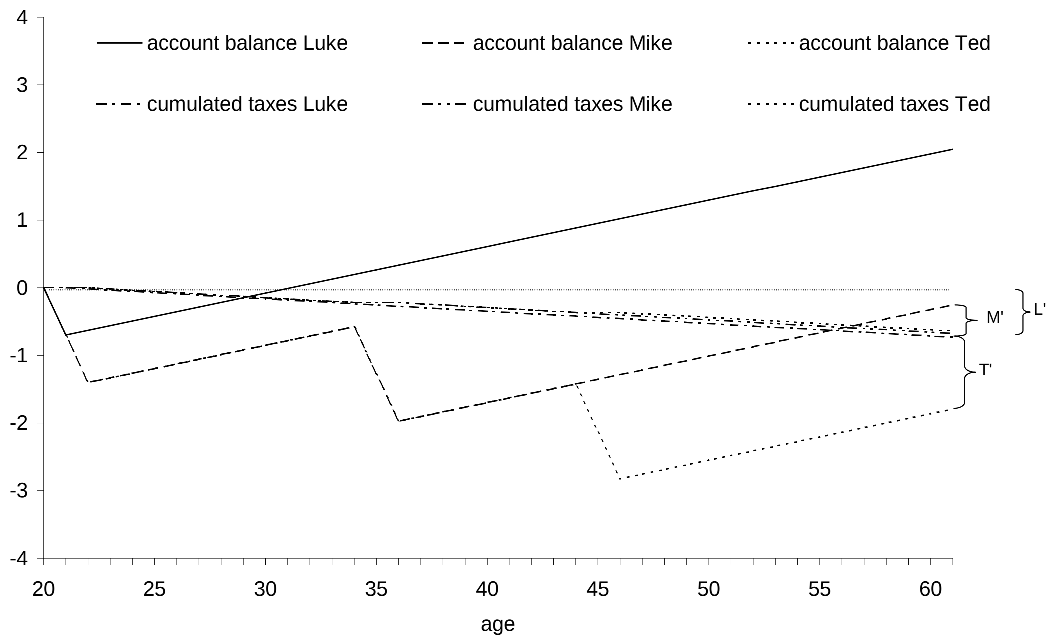


Figure 2.3 Account balances and cumulated taxes, mandatory savings rate > UI premium

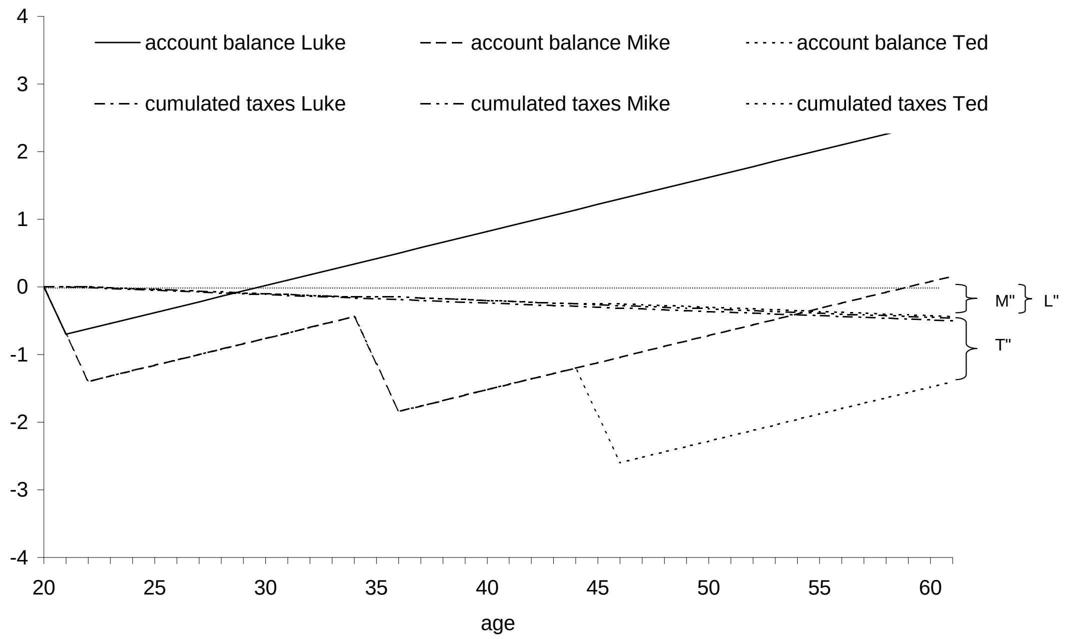


Figure 2.4 Account balances and cumulated taxes, mandatory savings rate < UI premium

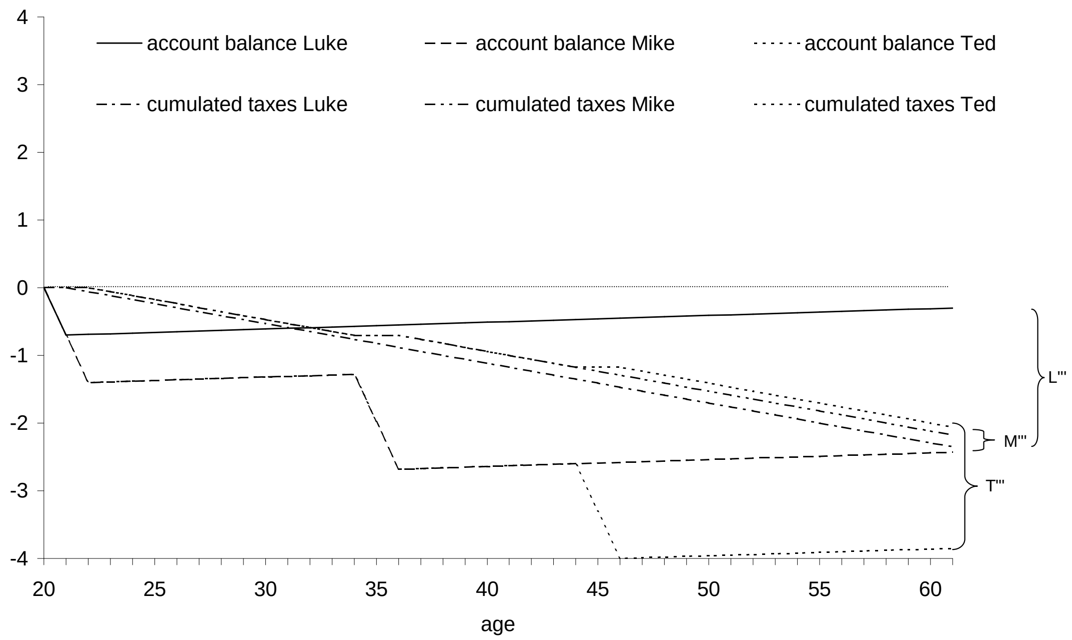


Figure 2.1 gives the cumulated income gain for these three workers under a standard UI system, financed by a premium levied on employed workers. When individuals are employed they pay an UI premium to finance the UI benefits, in this case 6.9 percent (= 11 · 0.7/(3 · 41-11) · 100%) covers the expenditures of the UI fund.[5] All individuals are unemployed in the first period and hence start with an income gain from the UI system of .7. Lucky Luke is employed in all subsequent periods and ends up paying L on net when he exits the labour market at the age of 61. Note that this does not necessarily imply that he would not like to participate in the scheme. When he does not know his type *ex ante* he may want to participate because of the lifetime income insurance. Furthermore, even when he does know he is Lucky Luke *ex ante* he may still want to participate if he can not borrow income from future periods, he is willing to pay premiums later on to have liquidity insurance when he is 20. Medium Mike is less fortunate than Lucky Luke, but over his working life he is a net receiver from the UI find, he gets M on net. Tough Ted is unemployed the most and ends up with a lifetime income gain from the UI system of T.

When we flip the vertical axis, Figure 2.1 also gives the changes in lifetime incomes when we would shift to a system of individual accounts without bailout, with the mandatory savings rate equal to the UI premium. In this case Lucky Luke gets to keep L at the end of his working life, and Medium Mike and Tough Ted lose M and T respectively. This may seem identical to abolishing unemployment insurance altogether, but there is a difference. Under a UISA system individuals would still have access to liquidity during periods of unemployment. Hence, although lifetime income under the UISA system without bailout would (*ceteris paribus*) be the same as in the case where we abolish UI altogether, the consumption and hence the utility stream could be different.

Figure 2.2 shows what happens to lifetime incomes when we introduce a system of individual accounts with bailout at the end of working life. The mandatory savings rate is set equal to the UI premium, 6.9 percent[6], and to pay for the bailout the government levies a tax on employed workers, which turns out to be 1.8 percent. Lucky Luke now gets to keep his positive balance in the UISA at the end of working life, but still has to pay some taxes to bail out Mike and Ted. Overall Luke now has to pay less into the system, L', because Mike and Ted will pay more into the system. Indeed, the mandatory savings act like a tax for Mike and Ted, because they end up with a negative terminal balance. In addition, they now also have to contribute to the tax to bail themselves out at the end of their career, their effective tax rate rises from 6.9 to 8.7 (= 6.9 + 1.8) percent. In fact, Mike used to be a net beneficiary of the UI system but now becomes a net contributor, he now pays M' into the system. Tough Ted still pays less into the system than he gets out, but over his working life he now only gets T' on net. Hence, *ceteris paribus*,

[5] 6.9 percent is rather high when compared to actual rates, the incidence and duration of unemployment used are meant merely as an illustration.

[6] Again, this is merely an illustration.

individuals that are infrequently unemployed gain in terms of lifetime income, and individuals that are frequently unemployed and/or for a long time lose in terms of lifetime income, when we move to this UISA system.

Figure 2.3 gives the individual accounts when the mandatory savings rate is set higher than the initial UI premium, to 8.0 percent (1.1 percentage points more). In this case all accounts are more positive/less negative. Hence, expenditures on bailouts and the associated taxes to pay for them fall, from 1.8 to 1.3 percent. Luke is even better off than under the UISA system above due to this drop in taxes. Although Mike now ends up with a positive balance, he is still worse off than under the original UI system. He now pays *M*" into the system on net, where he was receiving *M* on net under the original UI scheme. Hence, 'ends up with a positive balance' is not equivalent to 'better off'. Ending up with a positive balance only means that you pay for your own benefits over your working life. Ted loses the most from the move to this UISA system, for him the rise in mandatory savings is like a rise in taxes from 6.9 percent to 9.3 (= 8.0 + 1.3) percent. In the extreme case that we set the mandatory savings rate so high that no one ends up with a negative balance all interpersonal redistribution disappears, and we are left only with potential intra personal redistribution over the life cycle.

Figure 2.4 gives the reverse, when we set the mandatory savings rate lower than the initial UI premium, in this case only 1.0 percent (5.9 percentage points lower). With this low mandatory savings rate all individuals end up with a negative balance, even Lucky Luke. Since there are no net contributors, the forced savings rate of 1.0 percent and the tax rate for the bailout of 5.9 percent add up to the original UI premium of 6.9 percent. Indeed, with a sufficiently low mandatory savings rate the system works out just like the initial UI scheme. Hence, the UI system could be viewed as a special case of the UISA system.

2.3 Some accounting exercises using real data

A handful of studies calculate the impact of moving to a system of UISA on the lifetime income distribution, using data on lifecycle patterns of employment and unemployment. We first consider the seminal study by Feldstein and Altman (1998) for the US, then consider Vodopivec and Rejec (2002) for Estonia and conclude with the study by De Koning *et al.* (2006) for the Netherlands. Unfortunately, the studies consider different setups of the UISA in terms of the mandatory savings rate and benefit levels/durations in labour markets that also differ quite a lot. This makes it hard to compare the results. However, these studies still give some idea of the magnitude of the lifetime income effects and the proportion of workers that ends up with a positive/negative terminal balance with real life data.

2.3.1 Feldstein and Altman (1998) on the US

Feldstein and Altman (1998) consider the following setup for the UISA in the US. Individuals are forced to save 4 percent of their gross wages into their UISA. Withdrawals are according to current UI rules across US states, typically a gross replacement rate of 50 percent and a maximum entitlement of 6 months. Furthermore, there is a five year start-up period in which individuals contribute to their accounts, but UI benefits are still financed by the government. Within this setup they consider five alternatives:

1. Forced savings apply to most of the wage income.
2. Forced savings only apply up to the median wage income, high wage income individuals are less likely to be unemployed.
3. A ceiling for individual account balance of 50 percent of wage income, sufficient to cover one unemployment spell of 6 months.
4. A savings rate that depends on recent unemployment experiences, individuals that are frequently unemployed are forced to save more.
5. Employers are forced to cover the UI benefits of the first five weeks of an unemployment spell for employees of their (ex-)employees.

To determine the effect on lifetime income Feldstein and Altman use longitudinal data from the Panel Study of Income Dynamics. They consider individuals that were a household head in 1967 and follow them up to 1991 (about 25 years). Taking the transitions between employment, unemployment and non-participation (in this case retirement) as given, they come to the following results. Only some 5.2 (option 1) to 7.0 (option 4) percent of the household heads end up with a negative balance at the end of the data period, whereas some 1.4 (option 4) to 2.2 (option 2) percent experience a negative balance at some point in the 25 year period but still end up with a positive terminal account (they would benefit from the ’liquidity insurance’ from the UISA). Next they consider what this means for the tax burden. Between 44 (option 1) and 58 (option 4) percent of ’UI benefit dollars’ go to individuals that end up with a positive terminal balance. As a result, only 27 (option 1) to 39 (option 4) percent of benefits paid are now financed by taxes, the rest is covered by individuals that end up with a positive account and by the contributions made by individuals that end up with a negative balance when they are employed. This drop in the tax burden will further improve employment incentives.[7]

Feldstein and Altman also calculate the impact on the distribution of discounted lifetime income. As noted in the Section 2.2 above, individuals that are infrequently unemployed should benefit, and individuals that are frequently unemployed should lose, *ceteris paribus*. Specifically, the latter will experience a rise in their total tax rate, since the mandatory savings are *de facto* a

[7] A bit troubling is the assumption that for the first 5 years (starting in 1967), individuals pay in the account but withdrawals are tax financed. This will make the account balances more favourable for individuals that are unemployed in the first 5 years. Unfortunately, Feldstein and Altman do not discuss how this affects their results.

tax for them. The lifetime income effects turn out to be rather small, the largest change across all options is somewhat above 1 percent of mean annual income. The lowest lifetime income quintile has a mean annual income of 12293 dollars (in 1991) and loses between 95 (option 1) and 132 (option 3) dollars. The second and third quintile (from ’below’) are typically slightly negative, whereas the fourth quintile with a mean annual income of 40977 dollars gains between 94 (option 1) and 151 (option 3) dollars and the fifth quintile with a mean annual income of 71561 dollar gains between 438 (option 3) and 468 (option 1) dollars.

Feldstein and Altman also consider the impact on account balances and taxes when unemployment incidence would fall as a result of the UISA system. Specifically, they consider how a 10 respectively 30 percent reduction in unemployment affects the results for option 1 above. Let us consider the case of a 30 percent reduction in unemployment days. In this case the share of individuals that end up with a negative terminal balance drops from 5.2 to 3.7 percent, though still some 1.4 percent of individuals would have a negative balance at some point but not at the end. The share of UI benefits that go to individuals that end up with a negative account drops from 44 to 33 percent. The part of UI benefits that has to be financed by the government drops further from 27 to only 14 percent. Indeed, with this behavioural change taxes for UI would largely disappear in the US.

2.3.2 Vodopivec and Rejec (2002) on Estonia

Vodopivec and Rejec (2002) study the impact of introducing UISA in Estonia. In their baseline simulation they assume that the contribution rate is set to 3 percent of the gross wage up to a maximum account balance of 3.6 months of wages, which covers a 6 month unemployment spell with a replacement rate of 60 percent (somewhat higher than the 50 percent replacement rate in the US).[8]

Vodopivec and Rejec use data from the Estonian Labor Force Survey for 1995, which covers retrospectively the period 1989 to 1995, and the Labor Force Survey 1997 and 1998. Potential pitfalls are recall bias and extrapolating from a period of transition to a market economy. They use the data to construct synthetic lifecycles for workers, connecting segments of work histories from workers with similar characteristics. They do so for two periods: the early 1990s with low unemployment, and the late 1990s with high unemployment.

Under the low unemployment scenario 7 percent of workers end up with a negative terminal balance. Under the high unemployment scenario this number rises to 27 percent of workers. 28 respectively 27 percent of individuals have a negative account at some point in their career but do not end up with a negative terminal balance. Hence, a larger proportion would benefit from the ’liquidity insurance’ from this UISA in Estonia than from the UISA scheme of Feldstein and

[8] A replacement rate of 60 percent is higher than under the UI system in Estonia, a flat rate which Vodopivec and Rejec calculate is less than 40 percent for the average worker.

Altman (1998) for the US. Only 5 respectively 16 percent of all benefits paid needs to be financed by a tax under the two scenario's, a significant drop in tax rates.[9]

Vodopivec and Rejec also consider the effects on the lifetime income distribution when compared to a hypothetical UI system with the same replacement rate, eligibility rules *etc.* Under the low-/high-unemployment scenario the lowest quintile of the lifetime income distribution loses .6/.9 percent of their lifetime income from the move to the UISA system. The top quintile gains 1.7/2.8 percent of their lifetime income from the move to the UISA system under the low-/high-unemployment scenario. The distributional gains and losses for Estonia are larger than for the US.

The analysis from Vodopivec and Rejec (2002) illustrates that for a given mandatory savings rate and given benefit levels/durations, a UISA system has a larger effect on the lifetime income distribution when unemployment is high than when it is low. Furthermore, in the high unemployment case more individuals end up with a negative balance and as a result less individuals get better incentives under the UISA system. Hence, we should be careful in extrapolating the results from Feldstein and Altman (1998) for the US to *e.g.* continental European countries with typically much higher unemployment rates.

2.3.3 Studies on Dutch data

There are a number of studies that consider the effects of introducing an UISA on lifetime incomes in the Netherlands: Rezwani and Hendrix (2002)[10], Van Kuringen (2005) and De Koning *et al.* (2006). Although the first two present some interesting data, we will not consider them below, for two reasons. First, they use only one year of data on transition probabilities to generate synthetic lifecycles. This raises the issue to what extent their results depend on the state of the business cycle in the year from which the data are taken and may further lead to an underestimate of the persistence and recurrence of unemployment shocks over the lifecycle. Second, they consider a UISA system where individuals can not borrow.[11] However, the ability to borrow is one of the key points of a UISA system, to ensure that individuals have the same access to liquidity as under the UI system. For these two reasons we will focus on De Koning *et al.* (2006) who use panel data and allow for negative balances during working life, noting that the focus of their paper is not on individual accounts though.

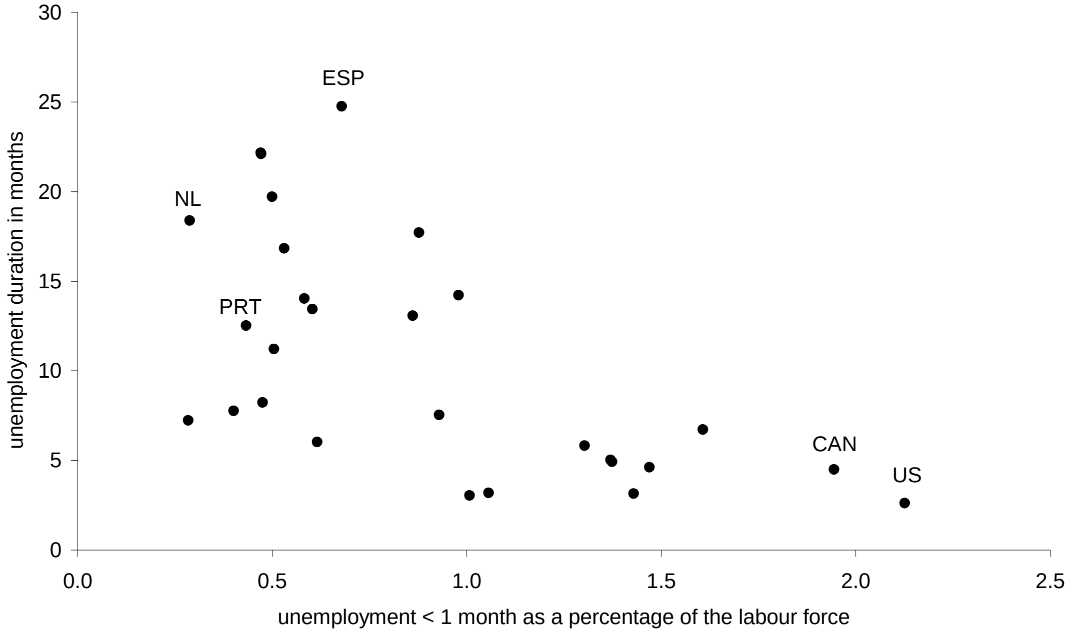
Before we consider the findings of De Koning *et al.* (2006) it is instructive to consider some data for OECD countries on unemployment. Over the period 1990-2004 the unemployment rate

[9] They also present some sensitivity analyses. For example, they show that the introduction of a grace period of 5 years, following Feldstein and Altman (1998), leads to a fall in the share of workers with a negative terminal balance of up to 10 percentage points.

[10] See also Rezwani (2006).

[11] Though some solidarity remains in both papers. In particular, Rezwani and Hendrix (2002) consider a UISA system where individuals are still covered by UI when they have insufficient savings in their UISA for the first 6 months, and Van Kuringen (2005) considers a UISA system with a minimum UI after 6 months of unemployment.

Figure 2.5 Flows in and out of unemployment



was 5 percent in the Netherlands, compared to 6 percent in the US. However, hiding behind these stocks is a huge difference in flow rates. Figure 2.5 gives the average flows in and out of unemployment over the period 1990-2004 for OECD countries.[12] Where the 'dynamic' US labour market is characterized by a high flow into unemployment and a short average duration, the 'sclerotic' Dutch labour market is characterized by a low flow into unemployment and a long average duration. Unless the same people in the US become unemployed over and over again, these data suggests that the unemployment risk over the lifetime is more concentrated in the Netherlands than in the US. As a result we expect larger distributional effects of a UISA in the Netherlands on lifetime incomes relative to the US.

De Koning *et al.* (2006) use data from the Dutch IPO-panel for the period 1989-2000. They know when these individuals were working and when they were receiving some kind of benefits.

[12] Source: own calculations using OECD (2006). Figure 2.5 is an update of the data constructed by Blanchard and Portugal (2001). The average unemployment duration is calculated as the total number of unemployed divided by the inflow into unemployment, which is measured by the number of individuals unemployed for less than one month. The relation above only holds for a steady state. Furthermore, we can not exclude the possibility that the data are not fully comparable across countries. For example, the method above and the OECD data yield an average unemployment duration for the Netherlands over the period 1990-2004 of 18 months. Some have suggested that this might be too high for the Netherlands, but is it really? There is no official statistic for the Netherlands on the average unemployment duration. However, Statistics Netherlands reports numbers of individuals in unemployment duration classes 0-5 months, 6-11 months, 12-17 months, 18-23 months and 24 months and over. When we take the average of the duration class and 40 months for the class 24 months and over we come to an average unemployment duration of 13 months for the period 2001-2005. Given that the average unemployment rate dropped from 6,6% over the period 1990-2000 to 5.2% over the period 2001-2005 (CPB, 2007), when we assume this was all due to a drop in average duration we would come to 17 months for the 1990-2000 period, and some 16 months for the period 1990-2004, which comes close to the 18 months from the OECD data.

Based on these data, they calculate transition rates between employment and the different states of non-employment for the 12-year period, and subsequently they combine the experiences of the different groups in the data to construct synthetic lifecycles for the period from age 15 to 65. Here we focus on the results for the synthetic lifecycles.[13]

For their synthetic lifecycles they consider what would happen if we introduce a mandatory savings rate equal to the number of UI periods over the number of employed periods. Some 60 percent never claims benefits and ends up with a positive balance. Another 13 percent claims benefits at some point but still ends up with a positive terminal balance. Of the remaining 27 percent, 16 percent ends up with a negative terminal balance larger in absolute terms than half on the benefits received. De Koning *et al.* (2006) distinguish between two groups of individuals that end up with a negative terminal balance because they argue that the latter group will never end up with a positive account due to behavioural changes. These results are not directly comparable with the results for the US. In particular, benefit levels and maximum benefit entitlement are much more generous in the Netherlands. But even with the same benefit entitlements, insofar as the difference in labour market flows are not solely the result from differences in the UI system[14], a UISA will have a larger distributional effect on lifetime incomes in the Netherlands than in the US.[15]

[13] More on the 12-years data below, when we consider the calibration of our model.

[14] But for example also due to differences in employment protection.

[15] Then again, one could argue that this is because the distributional effect of the UI system in the Netherlands is much larger than in the US.

3 How can a UISA system improve welfare?

Now that we understand how a UISA works and have considered the effects on lifetime incomes *ceteris paribus*, we now turn to the question of how a UISA can improve welfare. The literature on individual accounts suggests that there are at least two ways in which a UISA can improve welfare: i) more efficient liquidity insurance, and ii) more efficient lifetime income insurance. Two recent papers provide a thorough analysis of the relevant mechanisms. Stiglitz and Yun (2005) focus on 'liquidity insurance', whereas Bovenberg and Sorensen (2004) also consider lifetime income insurance. We consider the setup and some key findings of both papers below.[16]

3.1 Stiglitz and Yun (2005)

Stiglitz and Yun (2005) show that the option to borrow against future income can improve welfare when workers run a risk of unemployment. Their setup is as follows. In the first period all individuals are working. In the second period individuals run the risk of becoming unemployed. The risk of unemployment consists of an exogenous shock and a job search decision by the worker who takes a random draw from a search cost distribution. After the second period everybody is employed again, independent of whether they were employed or unemployed in the second period, for many periods up to retirement. The motivation for this setup is that a large share of unemployment spells occurs when individuals are young, and liquidity constraints may be particularly relevant for young unemployed who did not have time to build up a large enough buffer stock of savings and may not be able to borrow against the future returns of their human capital. Furthermore, by including an initial employed period Stiglitz and Yun are also able to study the interaction with precautionary savings.

In this setting, Stiglitz and Yun first consider the optimal level of unemployment insurance when there are no capital market imperfections. The optimal level of unemployment insurance is lower when individuals are less risk averse, when the elasticity of unemployment with respect to the UI benefit level is higher and when the duration of unemployment is relatively short compared to the rest of working life.

Next, they consider whether it makes sense to give individuals access to their future pension benefits when they become unemployed, integrating the UI system with the pension system. We could see this as a UISA where benefits are topped up by a loan, but without bailout. Giving individuals access to their future pension benefits only makes sense when individuals are credit constrained, otherwise they can implement the optimal saving/borrowing scheme themselves. The point of allowing individuals to borrow is then that "... a perfect capital market allows an

[16] Since we are going to discuss another model in Section 5 below, we keep the analysis here informal. For the interested reader, Appendix 1 considers optimal UI in a first-best world, in a second-best world and the 'third-best' of UISA when there are liquidity constraints, in a simple setup with only two periods and two outcomes.

individual to spread out the reduction in lifetime income over the working and retirement periods and thus to reduce the risk burden associated with incomplete provision of insurance against unemployment. This is how the capital market perfection improves the trade-off between insurance and incentive, thereby enhancing welfare." (Stiglitz and Yun, 2005, p. 2049)

So the question is then whether or not the credit constraint is binding for unemployed in their model? First of all, this is more likely to hold for unemployed youngsters, hence the modelling choice. Furthermore, the young unemployed are more likely to be credit constrained when optimal UI benefits are low and when they have less opportunities to save in the first period for unemployment due to *e.g.* high mandatory pension savings. For benefits they argue that the reserve is also true "[I]n the absence of integration, the "third best" levels of first period savings and unemployment benefits will be higher than they would be in the constrained optimum with integration." (Stiglitz and Yun, 2005, p. 2053) We consider the empirical relevance of credit constraints for the unemployed below in Section 4.[17]

3.2 Bovenberg and Sorensen (2004)

Bovenberg and Sorensen (2004) show that next to more efficient liquidity insurance individual unemployment accounts can also provide lifetime income insurance more efficiently than a tax financed UI system. In their setup there is no initial employment period, but they add additional heterogeneity by introducing a potential scarring effect of unemployment on subsequent wages. There are three types of individuals: i) employed in both periods ('high income individuals'), ii) unemployed in the first period, employed but not scarred in the second period ('medium income individuals') and iii) unemployed in the first period, employed but scarred in the second period ('low income individuals'). The probability of becoming unemployed depends on initial search effort. In the second period individuals can choose their working hours/employment duration.

Bovenberg and Sorensen show that replacing part of UI benefits in the first period by a loan can improve welfare. The ability to borrow reduces the need for more distortionary insurance, as in Stiglitz and Yun (2005). On top of this Bovenberg and Sorensen show that individual accounts can give more efficient lifetime income insurance. However, for UI this seems an artefact of their model setup. Individuals are unemployed in the first period and employed in the second period. They can pay for the benefits in the first period with a lump sum payment from their

[17] Stiglitz and Yun also consider some extensions of their analysis informally. One potential complication is myopic behaviour, in which case the borrowed funds might still be perceived as a subsidy, and welfare analysis becomes difficult when there are multiple selves over the lifecycle. They further note that one also has to look at distributional effects, in their model all workers are homogeneous *ex ante*, though they argue that the distributional effects could in principle be dealt with by an explicit redistribution scheme across groups of workers with different risk profiles. They also consider the option of integrating not only unemployment and lifetime risk but also other risks into one individual savings account. Indeed, they argue that "[U]nless the risks are perfectly positively correlated, ..., the integrated lifetime insurance system will always bring *some* welfare gain." (Stiglitz and Yun, 2005, p. 2065, emphasis in original text) For the case of individual accounts for various risks see *e.g.* Orszag and Snower (1997) and Sorensen *et al.* (2008).

individual account or with a marginal tax. The latter then distorts labour supply in the second period whereas the former does not. The question is if this generalizes to a multi-period setting where individuals move between employment and unemployment. When, as in *e.g.* the Netherlands, not only UI premiums but also potential UI benefits rise with hours worked it is not directly clear the UI system distorts hours worked (the 'intensive margin').[18] Hence, the 'more efficient lifetime income insurance' argument seems questionable. This is also the reason why we do not consider endogenous working hours in the model in Section 5 below. The 'more efficient liquidity insurance' argument remains however. Below we consider the empirical relevance of liquidity constraints for the unemployed. Specifically, we review the handful of papers that looks at this question directly, and the handful of papers that looks at this indirectly by considering the impact of unemployment on consumption. Furthermore, we also consider how distortionary UI actually is in terms of increasing the use of UI.

[18] A similar observation is made in the related paper by Bovenberg *et al.* (2008, p.73 and footnote 3) "[B]y linking benefits to contributions in an actuarially fair way, the savings accounts reduce the tax wedge on labor income. Social security contributions essentially become benefit taxes. ... To the extent that existing social-security contributions finance wage-linked benefits, they are in fact already, at least in part, benefit taxes."

4 Empirical studies into the costs and benefits of UI, and liquidity constraints

Below, we consider the costs and benefits of UI and the relevance of liquidity constraints for the unemployed, all of which are relevant for the impact of a UISA. In Section 6 below, we use this information in the calibration of the model for unemployment risk over the lifecycle.

4.1 The costs of insurance

Layard *et al.* (1991) reading from the 'older' literature was that a 1 percent increase in benefits raises unemployment durations by .2 to .9 percent. Holmlund (1998, p.120) is more cautious and suggests that "the "benefit effect" is hardly a firmly established parameter." Indeed, he cites some studies that find no or even reverse effects, and gives some rationale for this (for example, individuals are only entitled to UI after a period of employment). He suggests that we should be careful given that there are few natural experiments when it comes to variations in UI benefits. The more recent literature survey of Krueger and Meyer (2002) suggest a value of .5. An interesting recent paper by Chetty (2008) suggests that UI benefits only increase unemployment durations for individuals that have no assets and no partner, *i.e.* for unemployed that are more likely to be credit constrained.

Studies on the impact of maximum benefit durations also typically find a positive effect on unemployment durations. For example, Katz and Meyer (1990) find that one more week of UI benefits raises average unemployment durations by one day in the US. Card and Levine (2000) find .5 days per extra week of benefits for the US whereas Lalive and Zweimuller (2004) find .4 days extra per week for benefits in Austria. The positive relation between benefit duration and unemployment duration is also supported by cross-country studies, see *e.g.* Nickell and Layard (1999). Lalive *et al.* (2004) show that the findings on the effect of maximum benefit durations is more mixed for studies on European data (though most find a positive effect), and they review a substantial number of recent studies. They further suggest that more recent studies (that take into account unobserved heterogeneity, which is typically not the case for older studies) find on average a larger effect (a range of .35 to 1.7) than the older studies (a range of .1 to 1.0).

For the Netherlands, Van den Berg (1990) finds that the elasticity of the unemployment duration with respect to the level of UI is about .1, and the elasticity of the unemployment duration with respect to the level of unemployment assistance ranges from .1 for high-educated workers to .5 for low-educated workers. Lindeboom and Theeuwes (1993) estimate the effect of the benefit level and the remaining benefit duration on the exit rate from UI. They do not find a significant effect of the benefit level, but they note that this may be due to limited variation in the UI variable and collinearity among the explanatory variables. They find that shortening maximum UI entitlement by one week reduces the expected unemployment duration by 1.3

weeks. In a recent study on Dutch data, Bloemen (2008) finds an elasticity of unemployment duration with respect to the benefit level in the range of .35 to .5.

Returning to the US, another type of ’moral hazard’ from UI works via spousal labour supply. Cullen and Gruber (2000) consider the extent to which UI crowds out insurance via spousal labour supply. They find that for every UI dollar the breadwinner receives, the spouse works some 70 dollar cents less, quite a sizeable effect. Spousal labour supply as insurance against unemployment may become increasingly relevant in the Netherlands given the steep rise in female participation since the mid 1980s.

Finally, UI benefits may further increase unemployment by increasing labour costs and hence reducing labour demand, either directly through higher UI premiums or indirectly via higher wage claims by workers in the wage bargain, see *e.g.* the meta analysis in Folmer (2009). Using a CGE model for the Netherlands which includes a wage bargaining model De Mooij *et al.* (2006) find that a 10 percent reduction in UI and unemployment assistance reduces unemployment by 7 percent, with a significant contribution from the drop in wages to the overall drop in unemployment.

4.2 The benefits of insurance

4.2.1 Consumption smoothing

There are only a few papers that consider the insurance gains from UI empirically. Using data on food consumption in the US, Gruber (1997) finds that a transition into unemployment is associated with a sizeable drop in income of 6.8 percent, whereas remaining employed has only a very small positive effect on consumption. What is the role of UI in this drop? His estimations suggest that when we reduce UI benefits by 10 percent, consumption in unemployment would drop by 2.7 percent. He also calculates the effect when the replacement rate would go to zero, in which case consumption would drop by 22-26 percent. This implies that there is an insurance gain from UI. However, at the same time this also implies that individuals have other means to smooth income over the states of employment and unemployment.

Engen and Gruber (2001) find that the decline in consumption is 21 percent of the decline in benefits. Furthermore, they find that reducing UI has a larger effect for single heads than for married heads, consistent with the idea that spousal labour supply gives additional insurance (see above).

Browning and Crossley (2001) study the consumption smoothing gains of UI using data for Canada. An important extension is that they use information on asset holdings. They find only a small average consumption effect from UI, a fall in the replacement rate by 10 percentage points reduces total consumption by some .8 percent on average. However, this effect is concentrated among individuals with no assets at the start of the unemployment spell. A drop in UI of 10 percentage points decreases consumption by 2.9 percent for this group (reducing UI by 1 dollar reduces expenditures by 25 dollar cents). They further find that breadwinners without a working spouse show a larger consumption response, though the effect for singles is insignificant.[19]

Bloemen and Stancanelli (2005) study the impact of job loss on food consumption using UK data. They find that job loss is associated with a drop in food consumption of 17 percent, with a larger drop for households with zero or negative financial wealth. For the whole sample, the replacement rate does not have a significant effect on the drop in consumption. However, for individuals that have no positive wealth lower replacement rates increase the drop in food consumption, with a 10 percent fall in the replacement rate resulting in a 2 percent fall in food consumption (for single-earner households).

4.2.2 Studies on the importance of liquidity constraints

The studies by Chetty (2008) into the costs of UI in terms of moral hazard, and the studies by Browning and Crossley (2001) and Bloemen and Stancanelli (2005) into the benefits of UI in terms of consumption smoothing suggest that UI mainly affects individuals that face liquidity constraints. We have no empirical studies into UI that distinguish between individuals with and without assets for the Netherlands. Indeed, there are no empirical studies into the consumption effects of Dutch UI. To get some idea of the relevance of liquidity constraints for the unemployed in the Netherlands we consider two studies that look at comparable data for the Netherlands, the US and Italy: Crook and Hochguertel (2005) and Kapteyn and Panis (2003).

Crook and Hochguertel (2005) consider household debt holdings and the role of credit constraints. They have data for both the demand and supply side of the market for credit (credit applications and credit approvals). First they consider the ’demand side’, credit applications. They find that in the Netherlands, and even more so in the US, unemployed individuals are less likely to apply for credit. This does not support the hypothesis that unemployed individuals use credit to smooth their income. However, they can not exclude the possibility that this is the result of constraints from the supply side.[20]

Next, Crook and Hochguertel consider the supply side, whether credit is denied or less credit is given than demanded. They find that being unemployed has a small, positive yet insignificant effect on the probability of being denied credit in the Netherlands. The effect is significant and larger in some specifications for Italy and the US. Furthermore, having an unpaid job does increase the probability of a credit application being rejected in the Netherlands. Perhaps UI

[19] Consumption is measured as expenditures. Browning and Crossley (2001) note that the drop in expenditures may be all in reduced expenditures on durables. This may have little effect on consumption, individuals simply continue to live with the old durables that depreciate slowly, and hence so does the consumption stream resulting from them. Unemployment then merely shifts the purchase of durables backwards. They present evidence for this mechanism in the data of Browning and Crossley (2000). Hence, the effect on expenditures may still overstate the effect on consumption.

[20] Some other findings of some relevance to this study are that credit applications fall with wealth (unsurprisingly) and age, and when current income is above permanent income, in line with the standard lifecycle model of consumption and savings. Income and education do not seem to have a significant effect on the probability of a credit application in the Netherlands.

benefits and durations are so generous that we do not notice the liquidity constraints that might surface when we significantly reduce UI generosity. Then again, individuals in unpaid jobs and unemployed workers are probably quite different groups as well, so perhaps we should not read too much into this.[21]

Crook and Hochguertel conclude with an analysis of debt holdings, *e.g.* the result of demand and supply. In all three countries the unemployed seem to hold less debt conditional on the other variables, though the effect is insignificant for Italy and the US and only borderline significant for the Netherlands. Whether this is because individuals do not demand (additional) credit during unemployment, or whether this is the result of credit constraints seems still largely an open question. Overall, a fair conclusion of Crook and Hochguertel (2005) seems to be that there is no strong evidence that unemployed workers run into credit constraints, though this may in part be the result of the generosity of the UI system.

Kapteyn and Panis (2003) seek to explain differences in asset holdings in the Netherlands, Italy and the US. Their analysis is not as detailed as Crook and Hochguertel (2005). In particular, they do not consider the unemployed separately. They argue that overall liquidity constraints are more important in Italy than in the Netherlands or the US.

Summarizing, most studies find that higher UI benefits lead to higher unemployment. A recent study by Chetty (2008) suggests that the ’moral hazard’ is concentrated among individuals that are credit constrained. There is also some evidence that UI benefits help to smooth consumption over periods of employment and unemployment, where again the smoothing gains are concentrated among individuals that are credit constrained. Empirical studies for the Netherlands also find that higher UI benefits increase unemployment. However, there are no studies on smoothing gains of UI for the Netherlands nor do the available studies distinguish between those individuals that are and those that are not credit constrained. The few papers that look at liquidity constraints directly do not suggest a significant role for credit constraints for Dutch unemployed, though this may in part be due to the relatively generous UI system in the Netherlands.

[21] Other findings are that income and education do not have a significant effect on the probability of credit denial in the Netherlands.

5 A lifecycle model with unemployment risk

To study the impact of introducing a system of UISA on the workings of the labour market and the welfare of individuals we construct a simple lifecycle model. We calibrate the model to Dutch data on the incidence and duration of unemployment and the findings in the international literature on the elasticity of benefit use and consumption with respect to unemployment benefits and on the extent of risk aversion.

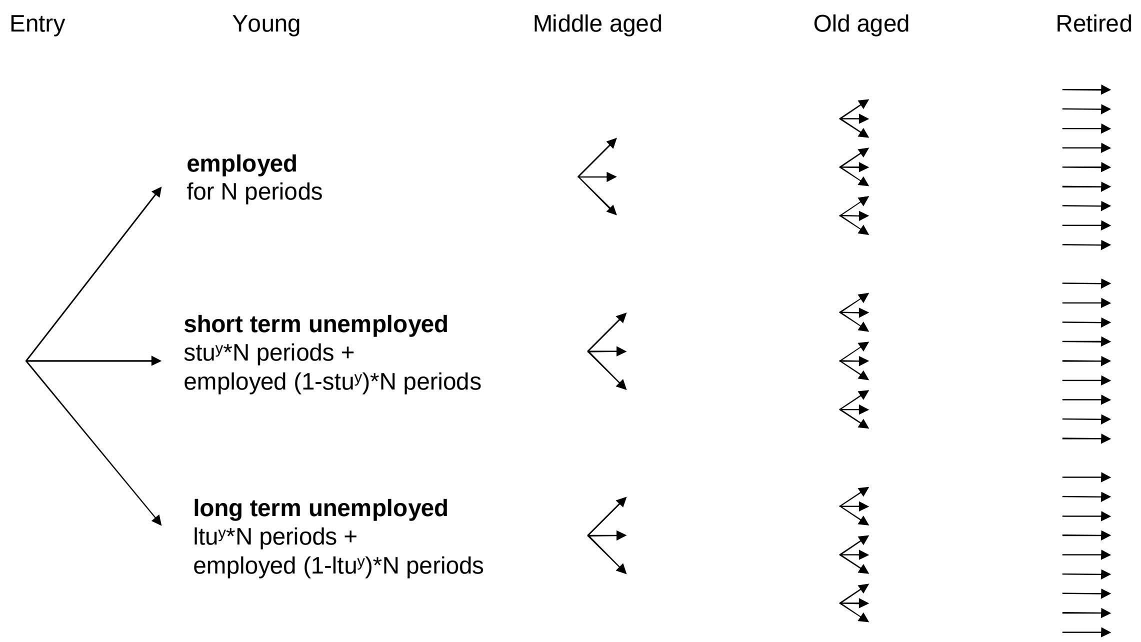
In the construction of the model we used the following criteria. First, the model has to contain the main mechanisms through which UI and UISA affect the workings of the economy. In particular, we want to have risk averse agents so as to have insurance gains/losses, moral hazard to prevent full insurance, and an endogenous consumption/saving decision to study the interaction between free savings, UI and mandatory savings. Furthermore, we want to have the option of binding liquidity constraints. Second, we want the model to be parsimonious but also realistic. To keep the results tractable we divide the lifecycle into only four phases, and shocks occur only at the beginning of each of the first three phases. Still, we believe this setup below captures enough heterogeneity in unemployment patterns over the lifecycle for a meaningful analysis of UISA. Indeed, we are able to take into account the differences in unemployment rates and durations between and within our groups of young, middle aged and older workers. As a result the distribution of potential terminal balances is in line with the findings of De Koning *et al.* (2006).

5.1 General setup of the model

Figure 5.1 gives the lifecycle phases we distinguish and the shocks that may occur. After entering the labour market individuals go through four phases: i) youth, ii) middle age, iii) old age and iv) retirement. All phases are of equal length N. At labour market entry individuals draw a search technology with three possible outcomes: i) employment, ii) short-term unemployment, or iii) long-term unemployment. The 'employed' draw a such a favourable search technology that given their optimal search effort they immediately find a job and hence are employed all through their 'young' phase. The 'short-term unemployed' draw a search technology so that it is optimal for them to be short-term unemployed for $stu^y N$ periods and employed for the remaining part of their young phase. Similarly, the 'long-term unemployed' draw a search technology so that given their search technology it is optimal to be long-term unemployed for $ltu^y N$ periods and employed for the remaining part of their young phase.

At the start of the middle age and also at the start of the old age phase individuals draw another search technology with again the three possible outcomes of employment, short-term unemployment and long-term unemployment. For simplicity we assume that the probability of

Figure 5.1 Phases and shocks in the model



drawing one of the three outcomes does not depend on the draws in the past[22], though subsequent decisions/unemployment durations do depend on the realizations in the past through asset holdings (but this effect is small). There is no uncertainty beyond the old age period, individuals enter the retirement phase after which life ends. In all phases individuals have to choose their optimal consumption and savings profile, given the technology and policy parameters. In the first three phases they also have to choose their optimal search effort. We consider the optimisation problem for the individual and the resulting first-order conditions for (privately) optimal behaviour below.[23]

[22] In the calibration below, we do use data on the concentration of the unemployment risk over a 12-year period, but we have no information on the correlation of the unemployment risk between these 12-year periods. However, empirical studies suggest that individuals that were unemployed in the past are more likely to become unemployed again in the future, see *e.g.* Heckman and Borjas (1980), and our model may understate the concentration of the unemployment risk over the lifecycle.

[23] It may be important to note that there is no uncertainty on the unemployment duration once the search technology is drawn. As most other papers that deal with unemployment insurance over the lifecycle (Bovenberg and Sorensen, 2004, Stiglitz and Yun, 2005, Crossley and Low, 2005, but for example not Hopenhayn and Hatchondo, 2002) we assume that at the start of the unemployment shock the duration of unemployment is known with certainty. This precludes a meaningful analysis of the time profile of unemployment benefits (see e.g. Shavell and Weiss, 1979, Hopenhayn and Nicolini, 1997, and Shimer and Werning, 2008). Indeed, in our setup the government could achieve the first-best by setting up a system with initial transfers depending on the search technology draw. We assume that this is not possible and instead consider only a 'second-best' setting where the government sets the benefit level and the individual has some control over how many benefits he or she gets by choosing the search effort. For the moment we leave a model with uncertain unemployment durations as a topic for future research.

5.2 Labour market entry

When individuals enter the labour market they have expected lifetime utility

$$E[V^0] = \sum_{d^y} \rho^y_{d^y} V^y_{d^y}, \quad \sum_{d^y} \rho^y_{d^y} = 1, \quad d^y \in \{emp, stu, ltu\}. \tag{5.1}$$

where the superscript y indicates the lifecycle phase and the subscript d indicates the search technology draw (employed, short-term unemployed or long-term unemployed), $\rho^y_{d^y}$ are the probabilities of drawing the respective technologies and $V^y_{d^y}$ are the associated remaining lifetime utilities at the start of the young phase.

5.3 Young

For the young we consider three setups in turn, adding more complexity in each step. First we consider optimal behaviour given UI and in the absence of credit constraints. Next, we consider optimal behaviour given UI but then with credit constraints. Finally, we consider optimal behaviour given UISA and credit constraints.

5.3.1 UI and no credit constraints

After drawing a search technology young individuals decide on their optimal search effort $e^y_{d^y}$, consumption path $c(s)$ and end-of-period assets $a^y_{d^y}$. Specifically, young individuals solve the following optimisation problem

$$V^y_{d^y} = \max_{\{c(s)\}_{s=0}^N, e^y_{d^y}, a^y_{d^y}} \left\{ \int_0^N u(c(s))ds - \frac{(e^y_{d^y})^{1+\gamma}}{1+\gamma} + E[V^m_{d^m}(a^y_{d^y})] \right\},$$
$$\gamma > 0, \quad 0 \leq \alpha_{d^y} e^y_{d^y} \leq 1,$$

$$\text{s.t.} \quad a^y_{d^y} = \int_0^{(1-\alpha_{d^y} e^y_{d^y})N} b^y ds + \int_{(1-\alpha_{d^y} e^y_{d^y})N}^N (1-t_1) w^y ds - \int_0^N c(s) ds, \tag{5.2}$$

where $u(.)$ is instantaneous utility, $e^y_{d^y}$ is the search effort for search technology draw d^y, γ is a parameter to steer the marginal utility cost of search, $E[V^m_{d^m}(a^y_{d^y})]$ is expected remaining utility in middle age, which depends on the search technology draw d^m in middle age and the (potentially negative) assets an individual takes from the young period to the middle age period. α_{d^y} is the search technology associated with draw d^y, a scale parameter that translates a given amount of search effort into a given reduction in the unemployment periods during the young phase, with the unemployment period during the young phase equal to $(1 - \alpha_{d^y} e^y_{d^y})N$. Furthermore, b^y are per period UI benefits when young, w^y are per period gross wages when young, and t_1 is the linear tax rate for the taxes used to finance UI benefits (see below). For simplicity we set the discount rate and the interest rate on assets equal to zero.[24]

[24] More on this below in Section 7.

The value function depends on the sum of instantaneous utilities when young, the cost of search and expected future utility which depends on the choice of end-of-period assets. Note that the benefits of search only enter via the 'budget constraint' for $a^y_{d^y}$, with a higher effort $e^y_{d^y}$ reducing the time spent in unemployment and thereby increasing lifetime income. Below we will see that there is an additional gain from search when individuals are credit constrained during unemployment.

The first-order conditions for optimal consumption, end-of-period assets and search effort for the respective search draws are

$$c(s) = c^y_{d^y}, \tag{5.3}$$

$$u'(c^y_{d^y}) = E\left[\frac{\partial V^m_{d^m}(.)}{\partial a^y_{d^y}}\right] \Rightarrow u'(c^y_{d^y}) = E[u'(c^m_{d^m})], \tag{5.4}$$

$$e^y_{d^y} = \max\left\{0, \min\left\{(\alpha_{d^y} N u'(c^y_{d^y})((1-t_1)w^y - b^y))^{\frac{1}{\gamma}}, \frac{1}{\alpha_{d^y}}\right\}\right\}. \tag{5.5}$$

The first-order condition for consumption (5.3) shows that after a shock has been realized, consumption will be constant until the next shock. From the optimal choice of end-of-period assets (5.4) it follows that consumption will be set so that marginal utility of consumption when young equals expected marginal utility of consumption when middle aged, given the draw d^y when young. Below we will see that the derivative of the value function for the middle aged with respect to end-of-period assets when young equals the marginal utility of consumption in middle age. The first-order condition for search effort (5.5) shows that the individual will increase search effort until the marginal cost of doing so (the left hand side) equals the marginal increase in lifetime income times the marginal utility of consumption when young. Since we do not allow negative unemployment periods, optimal search effort hits a corner at $\frac{1}{\alpha_{d^y}}$ beyond which search is fruitless. Individuals that draw the 'employed' search technology are at this corner, they immediately find a job at the start of the period. However, if the replacement rate would go to 1 they too would choose to remain unemployed for some time. We further assume that effort has to be positive, but this is never a binding constraint in our simulations. From the first-order condition for search it is also clear how tax financed UI benefits distort search effort. Both the benefit b^y and the associated taxes t_1 draw a wedge between the private and the social gains from additional job search. However, since UI benefits also imply a redistribution from individuals with a lower marginal utility of consumption (employed) to individuals with a higher marginal utility of consumption (short- and long-term unemployed) UI benefits may still be welfare improving (increase $E[V^0]$).

5.3.2 Credit constraint for the unemployed

Next, we consider the optimisation problem for a young worker when he or she is credit constrained during periods of unemployment. For simplicity we will assume the extreme case where a young unemployed individual can not borrow at all against future income.[25] Individuals start with zero assets and benefits are lower than future wages, hence the credit constraint is indeed binding.[26]

The young individuals now solve the following respective optimisation problems

$$V^y_{d^y} = \max_{\{c(s)\}^N_{s=0}, e^y_{d^y}, a^y_{d^y}} \left\{ \int_0^{(1-\alpha_{d^y} e^y_{d^y})N} u(b^y) ds + \int_{(1-\alpha_{d^y} e^y_{d^y})N}^N u(c(s)) ds \right.$$
$$\left. - \frac{(e^y_{d^y})^{1+\gamma}}{1+\gamma} + E[V^m_{d^m}(a^y_{d^y})] \right\},$$

$$\text{s.t.} \quad a^y_{d^y} = \int_0^{(1-\alpha_{d^y} e^y_{d^y})N} b^y ds + \int_{(1-\alpha_{d^y} e^y_{d^y})N}^N (1-t_1) w^y ds$$
$$- \int_0^{(1-\alpha_{d^y} e^y_{d^y})N} b^y - \int_{(1-\alpha_{d^y} e^y_{d^y})N}^N c(s) ds. \tag{5.6}$$

The individual is now forced to consume only b^y during the initial unemployment period. The first order conditions now become[27]

$$c(s) = \begin{cases} b^y & \forall \quad s \in [0, (1-\alpha_{d^y} e^y_{d^y})N > \\ c^y_{d^y} & \forall \quad s \in [(1-\alpha_{d^y} e^y_{d^y})N, N], \end{cases} \tag{5.7}$$

$$u'(c^y_{d^y}) = E\left[\frac{\partial V^m_{d^m}(.)}{\partial a^y_{d^y}}\right] \Rightarrow u'(c^y_{d^y}) = E[u'(c^m_{d^m})], \tag{5.8}$$

$$e^y_{d^y} = \max\left\{0, \min\left\{(\alpha_{d^y} N(u'(c^y_{d^y})((1-t_1)w^y - b^y)\right.\right.$$
$$\left.\left. + u(c^y_{d^y}) - u(b^y) - u'(c^y_{d^y})(c^y_{d^y} - b)))^{\frac{1}{\gamma}}, \frac{1}{\alpha_{d^y}}\right\}\right\}. \tag{5.9}$$

The individual can only consume b^y while unemployed, and consumes a constant $c^y_{d^y}$ in the remainder of the young phase. Marginal utility of consumption during the subsequent employed period is equalized with expected marginal utility in middle age. The search effort of the individual will be higher when the unemployed is faced with a binding credit constraint. Search now not only generates more lifetime income, but in this case also allows the individual to smooth his or her consumption over the unemployed and the employed period. This smoothing gain is captured by the terms $u(c^y_{d^y}) - u(b^y) - u'(c^y_{d^y})(c^y_{d^y} - b)$ which is positive since we assume that agents are risk averse ($u''(.) < 0$). The model is in line with the findings of Chetty

[25] Given the empirical findings on the consumption smoothing gains from UI this probably causes us to overstate the insurance gains from UI. Then again, for the elderly we may understate the relevance of liquidity constraints since we assume they have full access to their pension wealth. On average, the consumption response to changes in the UI benefit level is in line with the empirical studies from Section 4, see the calibration below.

[26] In the calibration we will assume a rising wage profile which makes matters even worse for the credit constrained, individuals would like to bring more income from with low marginal utility from future periods to the present with high marginal utility but they can not. Note that this potentially leads to an optimal replacement rate larger than 1 in the model.

[27] For simplicity we do not use separate notation to distinguish these optimal choices and hence also t_1 from the ones above.

(2008) that suggest that benefits affect the search behaviour of credit constrained unemployed more than unconstrained unemployed.

5.3.3 With individual savings accounts

Finally, we consider the optimisation problem for a young worker who is credit constrained, but now under a UISA system of the type we studied in Section 2. The individual is forced to save p of his or her gross wage into an individual account when working and benefits b^y are debited to this account. Negative terminal account balances at retirement are nullified and this is financed by a linear tax on wage income t_2.

With a system of UISA in place young individuals solve the following optimisation problem

$$
\begin{aligned}
V^y_{d^y} = & \max_{\{c(s)\}_{s=0}^N, e^y_{d^y}, a^y_{d^y}} \left\{ \int_0^{(1-\alpha_{d^y} e^y_{d^y})N} u(b^y) ds + \int_{(1-\alpha_{d^y} e^y_{d^y})N}^N u(c(s)) ds \right. \\
& \left. - \frac{(e^y_{d^y})^{1+\gamma}}{1+\gamma} + E[V^m_{d^m}(a^y_{d^y}, uisa^y_{d^y})] \right\}, \\
\text{s.t.} \quad & a^y_{d^y} = \int_0^{(1-\alpha_{d^y} e^y_{d^y})N} b^y ds + \int_{(1-\alpha_{d^y} e^y_{d^y})N}^N (1-p-t_2) w^y ds \\
& - \int_0^{(1-\alpha_{d^y} e^y_{d^y})N} b^y - \int_{(1-\alpha_{d^y} e^y_{d^y})N}^N c(s) ds, \\
\text{s.t.} \quad & uisa^y_{d^y} = - \int_0^{(1-\alpha_{d^y} e^y_{d^y})N} b^y ds + \int_{(1-\alpha_{d^y} e^y_{d^y})N}^N p w^y ds.
\end{aligned}
\tag{5.10}
$$

where $uisa^y_{d^y}$ are end-of-period assets in the mandatory individual savings account, which may be negative for unemployed individuals. The first-order conditions now become

$$
c(s) = \begin{cases} b^y & \forall \quad s \in [0, (1-\alpha_{d^y} e^y_{d^y})N > \\ c^y_{d^y} & \forall \quad s \in [(1-\alpha_{d^y} e^y_{d^y})N, N], \end{cases} \tag{5.11}
$$

$$
u'(c^y_{d^y}) = E\left[\frac{\partial V^m_{d^m}(.)}{\partial a^y_{d^y}}\right] \Rightarrow u'(c^y_{d^y}) = E[u'(c^m_{d^m})], \tag{5.12}
$$

$$
\begin{aligned}
e^y_{d^y} = & \max\left\{0, \min\left\{(\alpha_{d^y} N(u'(c^y_{d^y})((1-p-t_2)w^y - b^y) + u(c^y_{d^y}) - u(b^y) \right.\right. \\
& \left.\left. - u'(c^y_{d^y})(c^y_{d^y} - b) + \phi^y_{d^y}(pw^y - b^y))^{\frac{1}{\gamma}}, \frac{1}{\alpha_{d^y}} \right\}\right\},
\end{aligned}
\tag{5.13}
$$

where

$$
\phi^y_{d^y} = E\left[\frac{\partial V^m_{d^m}(.)}{\partial uisa^y_{d^y}}\right]. \tag{5.14}
$$

The interesting novelty is in the condition for optimal search effort. The term $\phi^y_{d^y}$ is the value of an additional unit in the individual savings account. This gives different incentives for job search for individuals that expect to end up with a positive terminal account and those that expect to end up with a negative terminal account.

First consider individuals that expect to end up with a negative terminal account, their optimal search effort is

$$e^y_{d^y} = \max\left\{0, \min\left\{(\alpha_{d^y} N(u'(c^y_{d^y})((1-p-t_2)w^y - b^y) \right.\right.$$
$$\left.\left. + u(c^y_{d^y}) - u(b^y) - u'(c^y_{d^y})(c^y_{d^y} - b))^{\frac{1}{\gamma}}, \frac{1}{\alpha_{d^y}}\right\}\right\}.$$

For them, both the tax t_2 and the mandatory savings p drive a wedge between the social and private return from job search. And since p plus t_2 is typically larger than t_1 this implies that their incentives for job search will be reduced.

Next, consider individuals that expect to end up with a positive terminal account. Their optimal search effort is given by

$$e^y_{d^y} = \max\left\{0, \min\left\{(\alpha_{d^y} N(u'(c^y_{d^y})(1-t_2)w^y + u(c^y_{d^y}) - u(b^y) - u'(c^y_{d^y})(c^y_{d^y} - b) \right.\right.$$
$$\left.\left. - \alpha_{d^y} N(u'(c^y_{d^y}) - E[u'(c^r)])(pw^y + b^y))^{\frac{1}{\gamma}}, \frac{1}{\alpha_{d^y}}\right\}\right\},$$

after some rearrangements. Suppose for simplicity that $u'(c^r) = u'(c^y_{d^y})$. The condition above then shows that in this case the wedge from benefits and mandatory savings in the job search decision disappears. What remains is the distortion from t_2 which is typically smaller than t_1.[28]

Now, individuals do not expect to end up negative or positive in all lifecycle paths, hence the incentives in the model are a mixture from these two cases, depending on past and future draws of the search technology. Furthermore, although the net effect on incentives is not directly clear, below in the calibrated model we will see that most individuals end up with a positive terminal balance and the net effect on incentives is positive.

Finally, it is important to realize that the effect of introducing UISA on search effort will be smaller than an equivalent drop in lifetime income due to lower benefits. Lower benefits not only reduce lifetime income but also make credit constraints more pressing. The introduction of UISA does not increase the difference in consumption during unemployment and employment, and thus does not 'benefit' in terms of additional search effort from more unequal consumption. Hence, we should be careful in using an empirical elasticity from changes in benefits to the case of UISA. Indeed, Chetty (2008) suggests that most of the effect of lower benefits works via the credit constraint that becomes more pressing. Sorensen *et al.* (2006) use a rather conservative elasticity of unemployment with respect to benefits of .1 in calculating the effects of introducing UISA in Denmark. The analysis above suggests that they are right in doing so.

[28] When individuals are myopic they may still perceive the mandatory savings as a tax and the benefit as a subsidy, something we take up in Section 7.

5.4 Middle age

Next, the individual enters the middle age phase. In middle age we assume that unemployed individuals no longer face liquidity constraints, in part motivated by the empirical studies above. Furthermore, in the base simulations with homogeneous agents middle aged and old aged individuals never have negative assets, so we might as well assume that they are also potentially credit constrained, but this constraint is never binding.[29] We further do not consider the case with and without UISA separately, zero forced savings is a special case that brings us back to the UI system. We assume that the search technology draw d^m in middle age is independent of the draw d^y when young, for simplicity and because we lack the data to study the relation between the two. The only thing individuals take with them from the young to the middle age phase are the free savings (or deficit) and the forced savings (or deficit) in the individual account. The probability to draw d^m is $\rho^m_{d^m}$ where $d^m \in \{emp, stu, ltu\}$. The search technology draw is again exogenous (there are no endogenous separations).

Individuals in middle age solve

$$\begin{aligned}
V^m_{d^m} = & \max_{\{c(s)\}_{s=0}^N, e^m_{d^m}, a^m_{d^m}} \left\{ \int_0^N u(c(s))ds - \frac{(e^m_{d^m})^{1+\gamma}}{1+\gamma} + E[V^o_{d^o}(a^m_{d^m}, uisa^m_{d^m})] \right\}, \\
\text{s.t.} \quad & a^m_{d^m} = a^y + \int_0^{(1-\alpha_{d^m} e^m_{d^m})N} b^m ds + \int_{(1-\alpha_{d^m} e^m_{d^m})N}^N (1-p-t_2)w^m ds - \int_0^N c(s)ds, \\
\text{s.t.} \quad & uisa^m_{d^m} = uisa^y - \int_0^{(1-\alpha_{d^m} e^m_{d^m})N} b^m ds + \int_{(1-\alpha_{d^m} e^m_{d^m})N}^N pw^m ds, \\
& 0 \leq \alpha_{d^m} e^m_{d^m}, \leq 1,
\end{aligned} \tag{5.15}$$

where d^o is the technology draw in old age, and $E[V^o_{d^o}(a^m_{d^m}, uisa^m_{d^m})]$ is expected remaining lifetime utility in old age.

The first-order conditions for optimal behaviour of a middle aged person are

$$c(s) = c^m_{d^m}, \tag{5.16}$$

$$u'(c^m_{d^m}) = E\left[\frac{\partial V^o_{d^o}(.)}{\partial a^m_{d^m}}\right] \Rightarrow u'(c^m_{d^m}) = E[u'(c^o_{d^o})], \tag{5.17}$$

$$\begin{aligned}
e^m_{d^m} = & \max\left\{0, \min\left\{(\alpha_{d^m} N(u'(c^m_{d^m})((1-p-t_2)w^m - b^m) \right.\right. \\
& \left.\left. + \phi^m_{d^m}(pw^m - b^m))^{\frac{1}{\gamma}}, \frac{1}{\alpha_{d^m}}\right\}\right\},
\end{aligned} \tag{5.18}$$

with

$$\phi^m_{d^m} = E\left[\frac{\partial V^o_{d^o}(.)}{\partial uisa^m_{d^m}}\right]. \tag{5.19}$$

Although past realizations do not have a direct effect on the probability of unemployment, they do affect the search effort of workers in middle age via the asset position in an individual's 'free'

[29] But this is under the assumption that they have full access to the assets that they accumulate for the retirement period.

and mandatory individual account. In particular, when an individual starts the middle age phase with more free savings consumption will be higher and hence the marginal utility from search will be lower. This effect on search effort is small however. More important is the asset position in the mandatory savings account. When an individual starts with a more favourable UISA in the middle age phase, because he or she was employed in the young phase, the more likely it is that he or she ends up with a positive terminal balance in the UISA. In this case the wedge from benefits and mandatory savings disappears in (5.18), and the search effort will be higher.

From the conditions above we can now determine that $\frac{\partial V^m_{d^m}(.)}{\partial a^y_{d^y}} = u'(c^m_{d^m})$, so the value of shifting one unit of assets to the future when young indeed equals the expected marginal utility of consumption in middle age. Furthermore, $\frac{\partial V^m_{d^m}(.)}{\partial uisa^y_{d^y}} = \phi^m_{d^m}$, so the three $\phi^y_{d^y}$ associated with the three outcomes for d^y branch into nine $\phi^m_{d^m}$ in the middle aged phase, one for each combination of d^y and d^m.

5.5 Old age

Individuals then enter the old age period, which is the last working phase before retirement. Also for old age we assume there are no liquidity constraints.[30] Furthermore, after the individual draws d^o there is no uncertainty left for the remainder of the lifecycle. After the old age period there is only retirement and the end of life in the model. The probability to draw d^o is $\rho^o_{d^o}$ where $d^o \in \{emp, stu, ltu\}$. This search technology draw is also exogenous to the individual.

Old age persons solve the following optimisation problem

$$\begin{aligned}
V^o_{d^o} = & \max_{\{c(s)\}^N_{s=0}, e^o_{d^o}, a^o_{d^o}} \left\{ \int_0^N u(c(s))ds - \frac{(e^o_{d^o})^{1+\gamma}}{1+\gamma} + V^r(a^o_{d^o}, uisa^o_{d^o}) \right\}, \\
\text{s.t.} \quad & a^o_{d^o} = a^m + \int_0^{(1-\alpha_{d^o} e^o_{d^o})N} b^o ds + \int_{(1-\alpha_{d^o} e^o_{d^o})N}^N (1-p-t_2) w^o ds - \int_0^N c(s) ds, \\
\text{s.t.} \quad & uisa^o_{d^o} = uisa^m - \int_0^{(1-\alpha_{d^o} e^o_{d^o})N} b^o ds + \int_{(1-\alpha_{d^o} e^o_{d^o})N}^N p w^o ds, \\
& 0 \leq \alpha_{d^o} e^o_{d^o} \leq 1.
\end{aligned} \tag{5.20}$$

This gives first order conditions

$$c(s) = c^o_{d^o}, \tag{5.21}$$

$$u'(c^o_{d^o}) = \frac{\partial V^r_{d^o}(.)}{\partial a^o_{d^o}} \Rightarrow u'(c^o_{d^o}) = u'(c^r_{d^o}), \tag{5.22}$$

$$\begin{aligned}
e^o_{d^o} = \max \Bigg\{ 0, \min \Bigg\{ & (\alpha_{d^o} N (u'(c^o_{d^o})((1-p-t_2)w^o - b^o) \\
& + \phi^o_{d^o}(pw^o - b^o))^{\frac{1}{\gamma}}, \frac{1}{\alpha_{d^o}} \Bigg\} \Bigg\},
\end{aligned} \tag{5.23}$$

[30] Which in at least in the base calibration with homogeneous agents is never binding anyway, but assuming that pension savings are fully liquid.

where

$$\phi^{o}_{d^o} = \frac{\partial V^{r}_{d^o}(.)}{\partial uisa^{o}_{d^o}}. \tag{5.24}$$

Again, after the shock has occurred consumption will be constant, and marginal utility is equated with (now certain) marginal utility in retirement by choosing the optimal asset level at the end of the period. Furthermore, the search effort again depends negatively on the wedge created by mandatory savings, taxes and benefits. But the wedge caused by mandatory savings and benefits is nullified when the individual ends up with a positive terminal account balance in the UISA. Finally, again we can now determine that $\frac{\partial V^{o}_{d^o}(.)}{\partial a^{m}_{d^m}} = u'(c^{o}_{d^o})$ and $\frac{\partial V^{o}_{d^o}(.)}{\partial uisa^{m}_{d^m}} = \phi^{o}_{d^o}$. Each $\phi^{m}_{d^m}$ in middle age branches again into three $\phi^{o}_{d^o}$ in old age, so 27 in total, one for each combination of search technology draw in the young, middle and old age phase.

5.6 Retirement

Finally, in retirement individuals solves

$$\begin{aligned} V^{r} &= \max_{c(s)_{s=0}^{N}} \int_{0}^{T} u(c(s))ds, \\ \text{s.t.} &\quad \int_{0}^{T} c(s)ds = a^{o} + \max\{uisa^{o}, 0\}. \end{aligned} \tag{5.25}$$

This gives

$$c^{r} = \frac{a^{o} + \max\{uisa^{o}, 0\}}{T} \tag{5.26}$$

This implies that when the terminal account balance in the UISA is positive ($uisa^{o} \geq 0$) we have $\frac{\partial V^{r}(.)}{\partial uisa^{o}_{d^o}} = u'(c^{r})$. For lifecycles that end with a negative terminal account balance is negative we have $\frac{\partial V^{r}(.)}{\partial uisa^{o}_{o}} = 0$. So the ϕ's that branch out in each working life phase, are actually expected marginal utility's of consumption in retirement of an additional unit in the UISA.

5.7 Equilibrium

Next to consistent optimal choices for consumption, end-of-period assets and search effort, an equilibrium further requires that the tax rate is set so that tax receipts cover the UI benefits or negative terminal balances under the UISA. We assume that the population is constant, there is no discounting and the four phases of the life-cycle are of equal length. The tax rate that balances the budget is then simply the sum of the negative terminal balances over the gross earned income of employed workers in all working lifecycle phases (note that the terminal balances are the cumulative result of the preceding three lifecycle phases). Note also that the UI system is just a UISA system with mandatory savings $p = 0$, so we can use the same procedure for the UI and the UISA system.

6 Simulations

We calibrate the model above to Dutch data and run various simulations for an UI system and a UISA system. We do this exercise first for an economy populated by ex ante homogeneous agents and then consider an economy with ex ante heterogeneity in the level of education and the associated differences in wage profiles and probabilities of becoming and remaining unemployed. For both models we consider the optimal replacement rate of UI, the impact of introducing a system of individual accounts, and the optimal mix of mandatory savings and insurance. For the economy with ex ante heterogeneity we consider the effect on expected utility per type of education and overall. For both models types we also consider the impact of the presence or absence of liquidity constraints, and for the model with ex ante homogeneous agents we also consider the impact of a different value for risk aversion, the elasticity of the use of UI with respect to the benefit level and an economy where the flows are twice as high (*i.e.* to compare the effect in a ’dynamic’ US style economy and a ’sclerotic’ continental European style economy).

6.1 Ex ante homogeneous agents

6.1.1 Calibration

The instantaneous utility function is characterized by constant relative risk aversion $u(c) = \frac{c^{1-\theta}}{1-\theta}$ with $\theta > 0$, so that $u'(c) = c^{-\theta}$ and $u''(c) < 0$.[31] The empirical literature on risk aversion and intertemporal substitution suggests .5, 2 and 4 are all reasonable parameter choices for θ, see *e.g.* Gollier (2001, Chapter 2).[32] In our base calibration we use a value of 2, but later on we also consider a value of 4, to see how sensitive the results are to the degree of risk aversion.

Ter Rele (2007) gives net wage profiles for a number of education groups in 2002, see Figure 6.1 below. For the young period we take the average wage of individuals aged 24-35, for the medium period ages 36-47, and for the old period ages 48-59.[33] This gives the following monthly wages for the young, middle age and old age phase respectively: 1460, 1920 and 2240 euro. For simplicity we ignore technological progress and discounting and simply take the cross-section of net wages across ages in 2002 reported by Ter Rele (2007). Excluded from net wages are pension premiums, so total compensation is too low, but assuming that pension premiums are basically a constant proportion of the net wage, these wage profiles are a good approximation of total compensation profiles.

[31] For simplicity we do not use *e.g.* Epstein-Zin preferences to disentangle intertemporal substitution and risk aversion.

[32] In Hopenhayn and Hatchondo (2002) relative risk aversion ranges from .5 for low wage workers to 4 for high wage worker, where the values differ because they use an instantaneous utility function with constant absolute risk aversion.

[33] We do not take wages from before 24 and after 59 because it seems that low participation rates causes outliers to have a large impact on average wages for those age groups.

Figure 6.1 Wage profiles by level of educational attainment, and overall, 2002

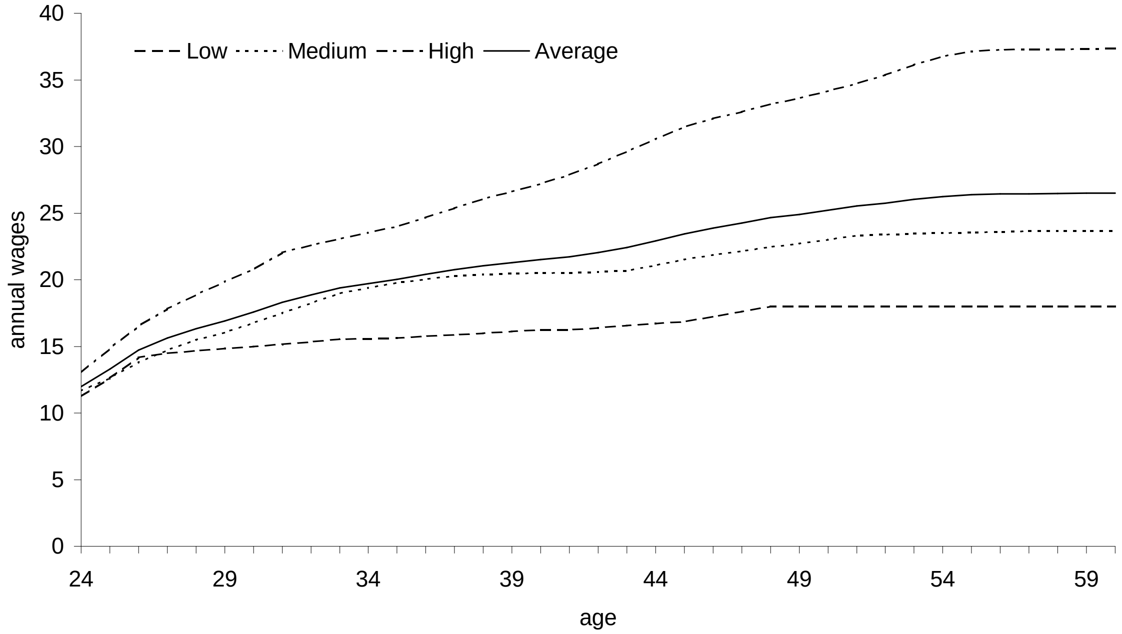


Table 6.1 Data from De Koning *et al.* (2006) on the probability of and time spent in UI: 1989-2000

	UI users	Time in UI by users	Time in UI	UI users > 2 year UI
Gender				
Male	.20	.15	.029	.26
Female	.14	.15	.021	.28
Year of birth				
1970-1985	.17	.10	.017	.09
1960-1969	.28	.10	.029	.19
1950-1959	.17	.14	.023	.32
1940-1949	.13	.19	.025	.46
1925-1939	.08	.40	.032	.72
Education indicator[a]				
Low	.23	.18	.042	.37
Medium	.25	.12	.031	.22
High	.18	.10	.018	.17

[a] The sample is divided into three groups of equal size according to their income, those with the lowest incomes are in the low education group and those with the highest incomes are in the high education group. As noted by De Koning *et al.* (2006) this may mistakenly put high educated women that work part-time in the medium or low educated group.

Table 6.2 Parameter values and calibration outcomes

Parameter values

	'Employed'	'Short-term unemployed'	'Long-term unemployed'
UI incidence ρ			
- young	.79	.18	.03
- middle age	.82	.12	.06
- old age	.90	.04	.06
Replacement rate b/w	.7		
'Search elasticity' γ	30.		
Risk aversion θ	2.		
Time units per phase N	168.		
Wages			
- young w^y	1.46		
- middle age w^m	1.92		
- old age w^o	2.24		

Calibration outcomes

	'Employed'	'Short-term unemployed'	'Long-term unemployed'
UI duration (in months)			
- young	0	12	50
- middle age	0	15	42
- old age	0	18	76
UI rate (in %)	2.63		
- young	2.18		
- middle age	2.57		
- old age	3.14		
Tax rate t_2	1.94		

To calibrate the incidence and duration of unemployment we use data from De Koning *et al.* (2006), part of which is reproduced in Table 6.1. Table 6.1 gives the incidence of UI, the average share of time spent in UI, and the share of UI users that use more than 2 years of UI, for their sample for the period 1989-2000. They report data by gender, year of birth and an indicator for education. The data in Table 6.1 indicate that men are more likely to use some UI than women.[34] For those that do use UI, men and women spend about an equal amount of time in UI during the 12-year period, and the share of 'long-term' UI users (> 2 years) is about the same as well. Regarding age, we see that older workers are less likely to enter UI than younger workers. However, when older workers use UI they use more of it than younger workers, which we can also see from the share of older 'long-term' UI users, in particular the cohorts born in 1925-1939. For the overall use of UI in days per worker for the 12-year period , older workers seem to claim more UI than younger workers. Regarding education, lower educated workers are

[34] Which may be due to the higher eligibility of men due to longer employment durations.

more likely to use UI and on average also spend more time in UI when they use UI.

In the model with ex ante homogeneous agents we use the data for the incidence and duration by year of birth. For the ’young’ phase we take the data from the cohorts born 1970-1985 and two thirds of the cohorts born 1960-1969, for the ’middle age’ phase we take the average from one third of the cohorts born 1960-1969, the cohorts born 1950-1959 and one third of the cohort born 1940-1949. For the ’old age’ phase we take the average from two thirds of the cohorts born 1940-1949 and the cohorts born 1925-1939. We shift part of the cohorts to get three more or less comparable groups in terms of cohorts covered. The group of ’employed’ in each lifecycle phase of the model is simply equal to the share of individuals that did not use UI.

Next, we construct, with some abuse of terminology, a group of ’short-’ and ’long-term’ unemployed. We divide the group of UI users per period in individuals that use UI less than 2 years, the ’short-term unemployed’, and individuals that use more than 2 years, the ’long-term unemployed’. Per age group we know the average share of time spent in UI, but not for individuals that use more or less than 2 years separately. From the Ministry of Social Affairs we have data on the number of individuals in a certain duration class in UI for the period 2001-2006. These data suggest that the average unemployment duration of individuals unemployed for less than 1 year for 20-34, 35-49 and 50-64 year olds is in the order of respectively, 4, 5 and 6 months of UI. However, this is only for one spell. We calibrate the data for a lifecycle period of 14 years. To get reasonable durations for ’short-’ and ’long-term’ unemployed over a 14 year period we use 12, 15 and 18 months of UI for young, middle aged and old aged ’short-term’ unemployed individuals, respectively. The duration of ’long-term’ unemployed is then calculated so as to let the weighted average per age group accord with the data of De Koning *et al.* (2006). The resulting probabilities of becoming ’employed’, ’short-term unemployed’ and ’long-term unemployed’ (ρ) and the shares of time spent unemployed per age group are given in Table 6.2.[35] The value for γ, a technology parameter that determines the elasticity of UI use with respect to the UI benefit level, is set to 30 which gives a benefit elasticity of .6, in line with the empirical literature.[36]

[35] We use the search technology parameter α_d per lifecycle phase to calibrate the unemployment duration of ’employed’, ’short-term unemployed’ and ’long-term unemployed’ in each lifecycle phase.

[36] We set this value somewhat above .5, which seems a focal point in the empirical literature, as most micro-econometric studies do not take into account the effect of higher UI premiums on the use of UI.

Figure 6.2 Income profiles over the lifecycle, with liquidity constraint

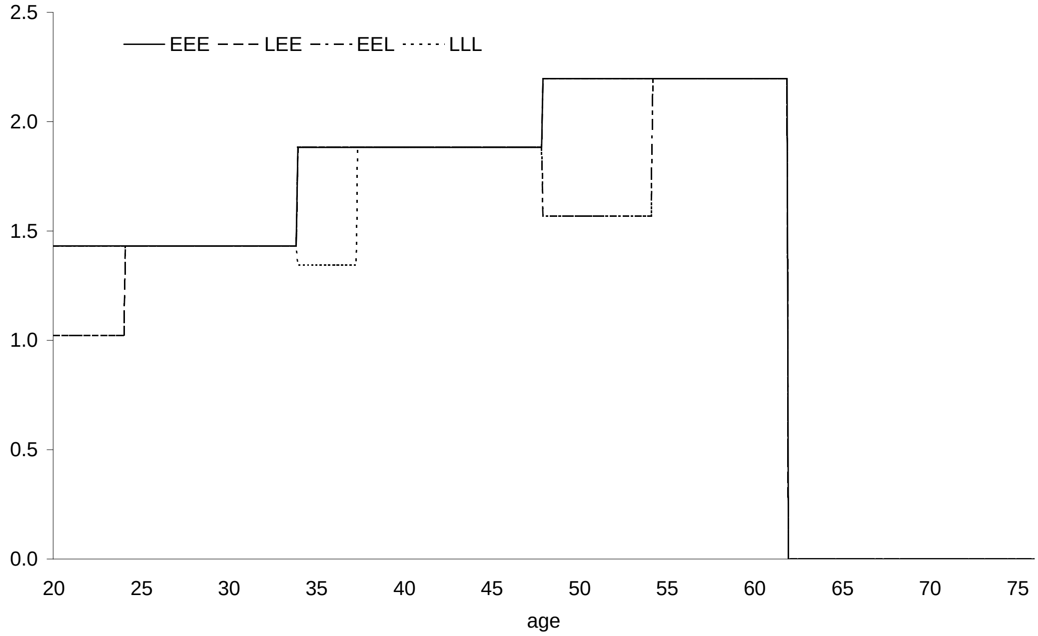


Figure 6.3 Consumption profiles over the lifecycle, with liquidity constraint

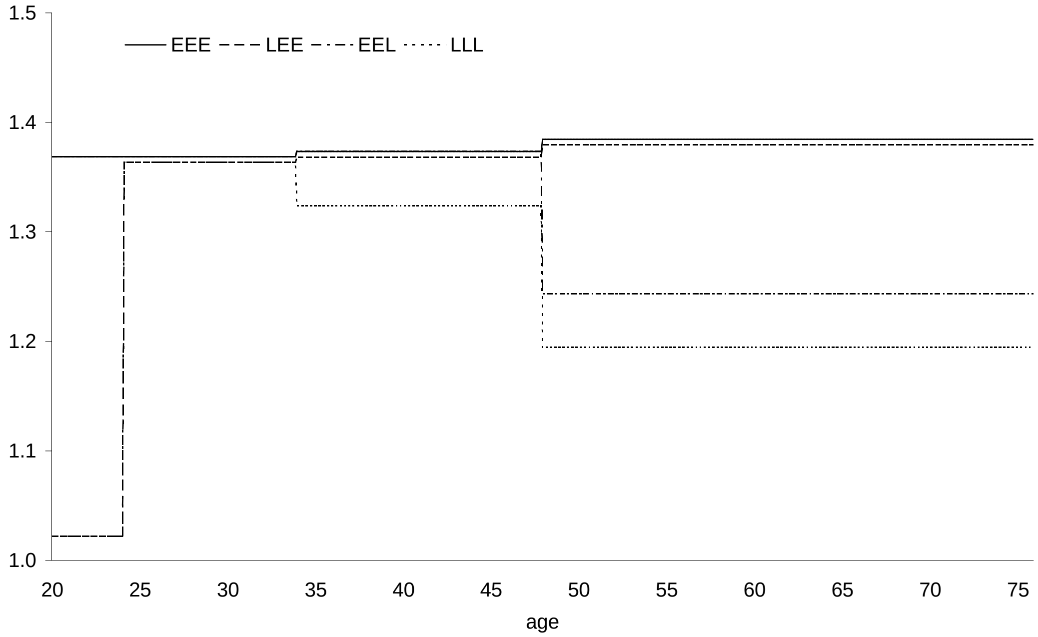


Figure 6.4 Asset profiles over the lifecycle, with liquidity constraint

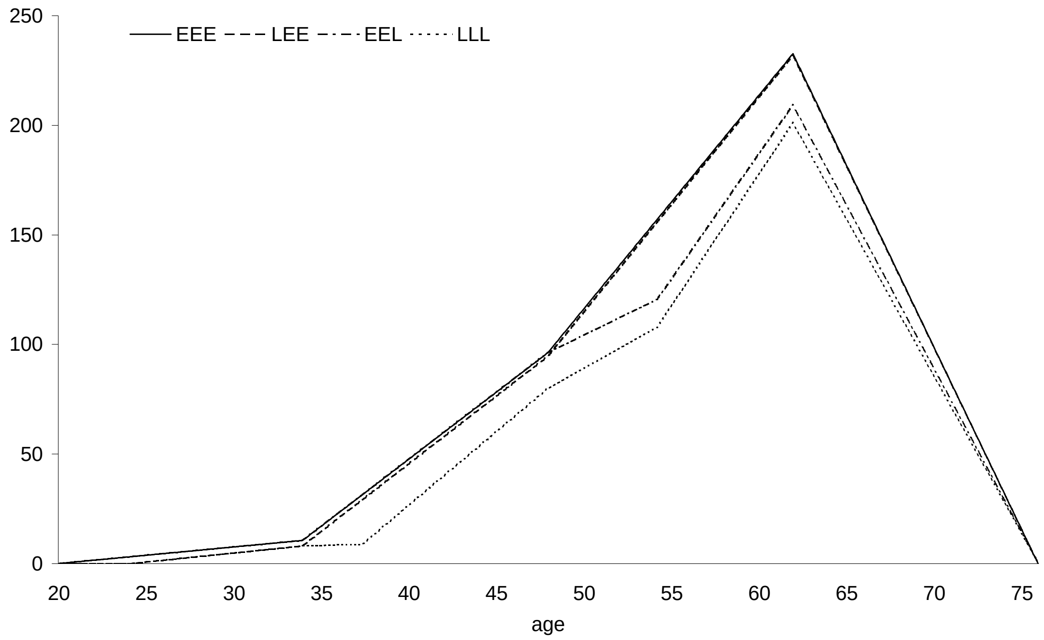


Figure 6.5 Income profiles over the lifecycle, without liquidity constraint

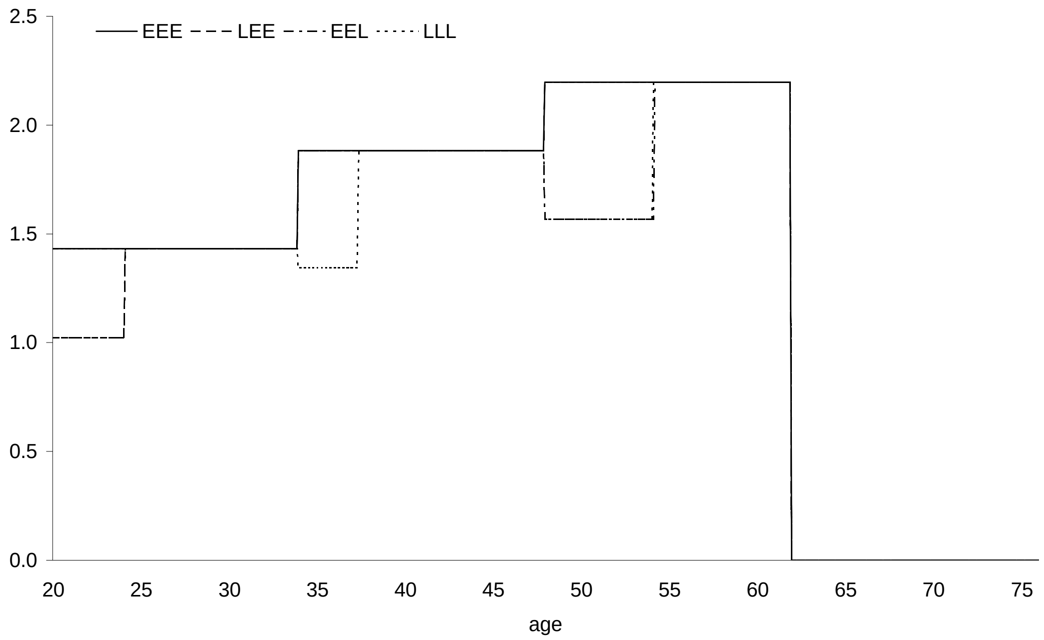


Figure 6.6 Consumption profiles over the lifecycle, without liquidity constraint

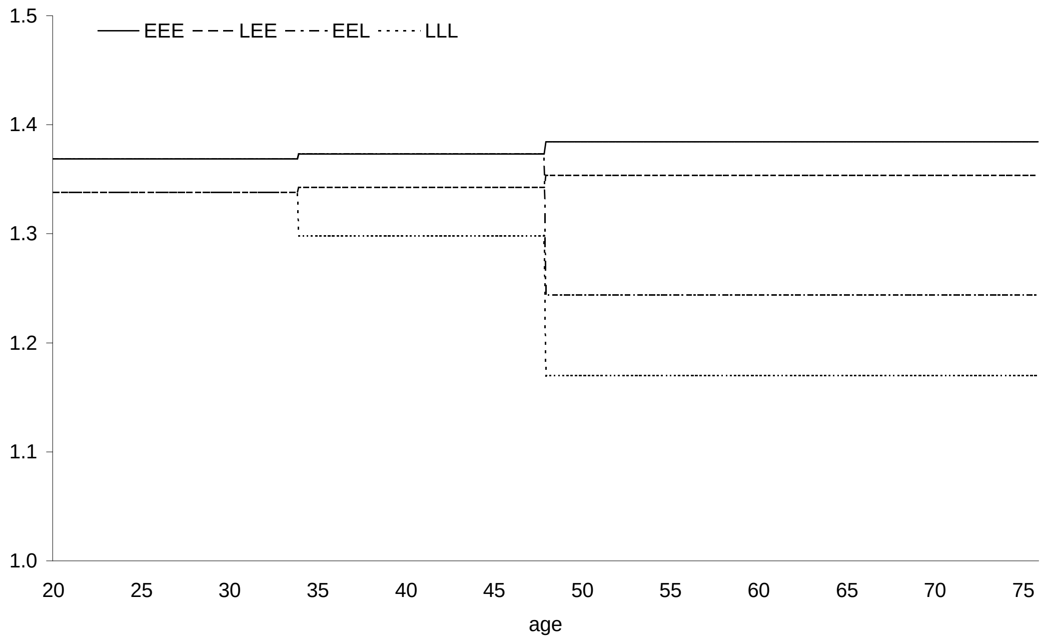
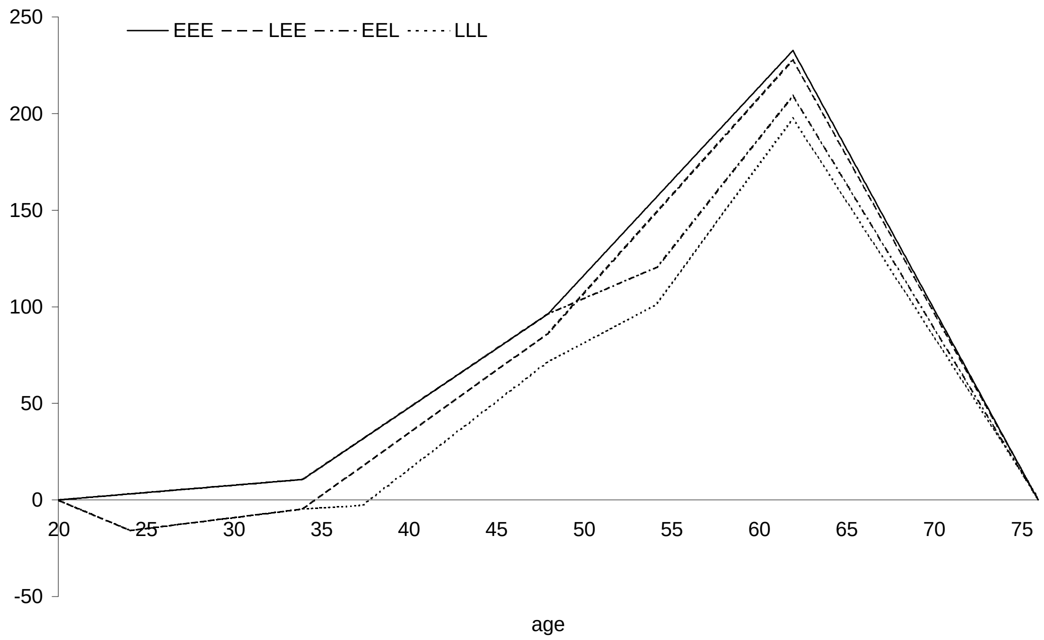


Figure 6.7 Asset profiles over the lifecycle, without liquidity constraint



The resulting ’UI rates’ increase with age: 2.18. 2.57 and 3.14 for the young, middle aged and old aged respectively, with an average of 2.63. The tax rate t_2 that balances the budget is 1.94.[37]

Figures 6.2-6.4 give respectively the income, consumption and assets lifecycle patterns for a selection of lifecycles. In particular we consider the profiles of individuals that are: i) employed in all working phases of the lifecycle (EEE), ii) long-term unemployed in the young phase and employed thereafter (LEE), iii) employed in the first two lifecycle phases and long-term unemployed in old age (EEL), and iv) long-term unemployed in all working lifecycle phases (LLL). We discuss some patterns of particular interest.

From Figure 6.2, we can see that young employed immediately start with an income equal to the wage (for the young), the long-term unemployed first only receive benefits and then join the employed and receive the wage (for the young). Income then remains constant up to the age of 34 when they take a search technology draw again at the start of the middle age phase. Note that the income streams for the young are the same for the lifecycle phases EEE and EEL (and also for LEE and LLL) as the outcomes for the middle and old age phase are still probabilistic when young. Also note that the income profiles in old age for EEL and LLL almost lie on top of each other. Indeed, the additional wealth that the EEL individuals take into old age relative to the LLL individuals (see below) hardly affects their search effort in old age and hence their unemployment duration and income pattern in old age.

Figure 6.3 shows the consumption patterns. Differences are stark between the young employed and unemployed, a direct result of the assumption that young unemployed can not borrow against future wages and hence can only consume their unemployment benefit. We see that consumption jumps up in middle age for individuals that are lucky enough to draw ’employed’ in middle age. Then individuals move into old age, relative to middle age the differences between the individuals that draw ’employed’ and those that draw ’long-term unemployed’ in terms of consumption are bigger. This is due to two effects. First, long-term unemployment is longer for old age workers than for middle age workers (in line with the data). Second, there are less remaining periods to smooth the income shock. However, note that the drop in consumption due to the longer unemployment spell in old age is less dramatic than the ’drop’ in consumption due to the liquidity constraint for the young unemployed. Note also that consumption is the same in old age and retirement, as there is no uncertainty left after the search technology at the start of old age is drawn.

Finally, comparing Figure 6.3 with Figure 6.2 we see that during working phases all

[37] Van Kuringen (2005) presents data on macro expenditures on UI and the costs of running the system. The employer pays 1.75% of the gross wage plus 2.45% over gross daily wages between 58 and 167 euros. The employee pays 5.85% over gross daily wages between 58 and 167 euros. In total some 5.5 billion euro in 2005, with compensation for employees at 211 billion euro (CPB, 2007) this is about 2.6% of labour costs (for the private sector, the public sector runs its own UI scheme). This is higher than in our model. Indeed, in our abstract model individuals are either unemployed and receiving UI or employed, hence we ignore nonparticipation other than UI, this leads us to overstate share of the number of employed periods relative to the number of unemployed periods.

individuals consume less then their wages, to save for retirement. Figure 6.4 shows this in terms of assets. Assets remain at zero for young unemployed, but as soon as individuals find a job they start accumulating assets. When they enter middle age the income shock from unemployment is never that big that individuals run into trouble again by hitting the liquidity constraint. So, as noted above, at least for the case with ex ante homogeneous agents we might as well assume that they are also potentially liquidity constrained but the fact that this constraint is never binding in any lifecycle path makes it irrelevant. However, in real life at least part of these assets are in *e.g.* illiquid pension or housing wealth, and unemployed middle aged or old aged workers may still face binding liquidity constraints even though they have positive wealth. Also note that with perfect foresight about lifetime length and without a bequest motive individuals build down their assets to zero at the end of the lifecycle.

Figures 6.5-6.7 give respectively the income, consumption and assets lifecycle patterns for the same lifecycles, but now in the absence of liquidity constraints. We briefly discuss some important differences with the figures above from the model with liquidity constraints. The income patterns are the same, by construction, because we change the technology parameters α_d to keep unemployment durations in the various lifecycle phases in line with the data.

The differences start to appear in the lifecycle profiles for consumption. Without liquidity constraints for the unemployed, benefits only determine part of consumption in unemployment for the young. Indeed, the difference in consumption between the employed and the unemployed is much smaller. Compared to lifetime income, the income shock from the unemployment period when young is not that big. Also note that individuals that draw the long-term unemployed search technology in all three lifecycle phases end up with lower consumption in old age than in the case with liquidity constraints. This is because they will have consumed more assets when they were young and long-term unemployed, being able to borrow from future income.

The asset profiles show that the young unemployed now initially can run up a debt, consuming more than their benefits, with the long-term unemployed still ending up with a debt when they enter the middle age phase of the lifecycle. Further note that individuals that draw the 'long-term unemployed' search technology when young start borrowing, additional consumption when young and unemployed is more important than in retirement, but when they draw 'long-term unemployed' again in middle age they start saving, the need for additional consumption in retirement starts to dominate the need for additional consumption when unemployed.

6.1.2 Simulation: varying the replacement rate

First we study the impact of changes in the replacement rate, and see if optimal outcomes are in the vicinity of actual levels. Furthermore, we can also check some elasticities in the calibrated model, like the use of UI with respect to the benefit level and the consumption of unemployed with respect to the benefit level.

In our base simulation we assume that young unemployed are fully credit constrained. Table 6.3 gives the outcomes for a selection of variables in the base simulation for different levels of the replacement rate. For the base setup a replacement rate in the order of .6-.7 is optimal (the second-best optimum). At this replacement rate the marginal insurance gains from moving units of consumption of the employed to the unemployed equal the marginal moral hazard losses due to reduced search effort. The first row gives the difference in expected lifetime utility expressed in units of consumption.[38] Low replacement rates are not optimal because the marginal insurance gain is higher than the marginal loss due to moral hazard. High replacement rates are not optimal because then the marginal insurance gain is smaller than the marginal loss due to moral hazard. Furthermore, close to the optimum, welfare losses from sub optimal replacement rates are small. Further away they rise, up to 1.6% at a replacement rate of .1.

Table 6.3 also shows that a 10 percent increase in the replacement rate (from .7 to .77) increases the use of benefits by 6.1% (from 2.63 to 2.79), in line with the findings of empirical research. The tax rate rises faster than the unemployment rate, due to the interaction effect of higher benefits and a higher number of recipients. The model also gives us a consumption elasticity of benefits for the unemployed (not shown in the table). In the base simulation, consumption of the unemployed rises by 2.8% when we increase benefits by 10%. In the case where we assume no liquidity constraints for the unemployed (see below), consumption rises by .7% when we increase benefits by 10%. The empirical studies in Section 4 suggest a value for the consumption elasticity of benefits in this range.[39]

In the last row of Table 6.3 we also give outcomes in the absence of moral hazard, as an indication of the relative size of moral hazard.[40] Specifically, this row shows the difference in utility (in consumption units) between the outcome without moral hazard for different replacement rates and the second best optimum with moral hazard at the replacement rate of .6-.7. To get rid of the moral hazard we give the unemployed access to the same level of consumption in unemployment, but the net transfer of unemployment benefits and UI premiums (once employed) to the unemployed is kept constant during the lifecycle phase. Hence, any savings on unemployment benefits due to higher search effort and any additional UI premiums go to the unemployed, effectively removing the search distortion. In this case we see that compared to the case with moral hazard, utility is either virtually unchanged (for low benefit levels, where the extent of moral hazard is limited anyway) or rises (for higher benefits levels). At a replacement rate of .6 the cost of moral hazard is .1 percent of per period consumption, and

[38] In particular, let V_0^0 be expected utility at the optimal replacement rate and V_1^0 be expected utility at some other replacement rate. The first row then shows $((V_1^0/V_0^0)^{1/(1-\theta)} - 1) * 100\%$.

[39] The drop in consumption upon entering unemployment also seems in line with empirical studies. In the presence of liquidity constraints, consumption drops on average by 10.4% upon entering unemployment. Without liquidity constraints, consumption drops on average by 3.6% upon entering unemployment. Gruber (1997) reports an average drop of 6.8% in consumption upon entering unemployment.

[40] And the insurance gains from UI, at the optimum the marginal loss in moral hazard equals the marginal insurance gain.

Table 6.3 Varying the replacement rates of UI, base simulation

Replacement rate UI	.1	.3	.5	.6	.7	.77	.8	.9
Utility difference in consumption units (in %)[a]	− 1.6	− 0.4	− 0.1	0.0	0.0	− 0.1	− 0.1	− 0.5
'UI rate' (in %)	1.81	2.01	2.30	2.45	2.63	2.79	2.87	3.30
Tax rate (in %)	.20	.66	1.22	1.56	1.94	2.25	2.40	3.09
Utility diff. in cons. units, no moral hazard (in %)[a]	− 1.6	− 0.4	0.0	0.1	0.2	0.2	0.2	0.2

[a] Utility difference relative to the second best UI system, expressed in consumption units.

Table 6.4 Varying the replacement rates of UI, risk aversion $+100\%$

Replacement rate UI	.1	.3	.5	.6	.7	.8	.9
Utility difference in consumption units (in %)[a]	− 23.2	− 2.4	− 0.5	− 0.2	0.0	0.0	− 0.3
'UI rate' (in %)	1.79	1.93	2.27	2.45	2.63	2.86	3.24
Tax rate (in %)	.20	.64	1.22	1.56	1.94	2.39	3.03

[a] Utility difference relative to the second best UI system, expressed in consumption units.

Table 6.5 Varying the replacement rates of UI, 'moral hazard' $+50\%$

Replacement rate UI	.1	.3	.5	.6	.7	.8	.9
Utility difference in consumption units (in %)[a]	− 1.3	− 0.2	0.0	0.0	− 0.1	− 0.3	− 0.8
'UI rate' (in %)	1.61	1.78	2.13	2.36	2.63	2.99	3.66
Tax rate (in %)	.18	.59	1.15	1.51	1.94	2.50	3.41

[a] Utility difference relative to the second best UI system, expressed in consumption units.

Table 6.6 Varying the replacement rates of UI, no liquidity constraints

Replacement rate UI	.1	.3	.5	.6	.7	.8	.9
Utility difference in consumption units (in %)[a]	− 0.2	0.0	0.0	0.0	− 0.1	− 0.3	− 0.7
'UI rate' (in %)	1.98	2.13	2.33	2.46	2.63	2.88	3.36
Tax rate (in %)	.21	.68	1.23	1.56	1.94	2.42	3.15

[a] Utility difference relative to the second best UI system, expressed in consumption units.

Table 6.7 Varying the replacement rates of UI, flows in and out of unemployment $+100\%$

Replacement rate UI	.1	.3	.5	.6	.7	.8	.9
Utility difference in consumption units (in %)[a]	− 1.4	− 0.3	0.0	0.0	0.0	− 0.2	− 0.5
'UI rate' (in %)	1.82	2.03	2.31	2.45	2.63	2.87	3.32
Tax rate (in %)	.20	.66	1.23	1.56	1.94	2.41	3.12

[a] Utility difference relative to the second best UI system, expressed in consumption units.

at .7 it is .2. At a replacement rate of .9 removing moral hazard changes the difference in utility with the second-best optimum from -.5 to +.2. We can actually reach the first-best level, by giving unemployed a lump sum transfer equivalent to net wages for the duration of the unemployed period.[41] The first-best leads to a rise in utility measured in consumption units by .3 percent when compared to the second-best UI with a replacement rate of .6 to .7. Hence, (expected) utility in the second-best optimum is not that far from utility in the first-best.

Table 6.4 considers the optimal replacement rate when we increase the coefficient of relative risk aversion θ from 2 to 4. With more risk averse agents the optimal replacement rate rises to the range .7 to .8, the range of current UI benefit levels, due to higher insurance gains from UI.[42] Table 6.5 shows the optimal replacement rate when we increase the elasticity of UI use with respect to UI benefits from .6 to .9, a larger value seems outside the empirically plausible range, by reducing γ from 30 to 20.[43] With more 'moral hazard' the optimal replacement drops, to the range .5 to .6.

Table 6.6. gives the optimal replacement rate when there are no credit constraints for unemployed youngsters. When there are no credit constraints, unemployed youngsters can smooth the income shock from unemployment over the rest of their life, reducing marginal utility from additional income in unemployment. As a result, the gains from insurance fall. Indeed, the optimal replacement rate drops to the range .3 to .6.[44]

Finally, Table 6.7 considers whether a more dynamic labour market results in a different optimal replacement rate. Specifically, we assume that the probability to become 'short-term unemployed' or 'long-term unemployed' doubles but that the duration of unemployment in these

[41] This is also true when there are credit constraints. In our calibration all employed workers consume less than their income, and hence the inability to borrow from future income is no longer binding when income is the same in employment and unemployment.

[42] In this simulation, we change γ (from 30 to 36) and the different α_{d^y},α_{d^m} and α_{d^o} for the different outcomes of the search technology draw to keep *ceteris* at *paribus*. That is, we keep the elasticity of unemployment with respect to benefits (evaluated at $b/w = .7$) and unemployment durations constant in the calibration.

[43] And again changing the α_d's to keep the elasticity of unemployment with respect to benefits and unemployment durations unchanged.

[44] Again changing the α_d's and γ to keep the elasticity of unemployment with respect to benefits and unemployment durations unchanged. Note that this simulation is not the same as when we abolish credit constraints, for we keep the benefit elasticity and unemployment durations the same in the calibration.

states is cut in half.[45] The optimal replacement rate is in the same range as in the base simulation, though departures from the optimum seem to be a bit less costly. Hence, we do not find that workers in more dynamic labour market need less insurance. However, if the shortening of the unemployment durations would reduce the importance of liquidity constraints, we probably would find a bigger effect of the dynamics on the optimal replacement rate, so this result seems to be rather model specific.

6.1.3 Simulation: introducing UISA

In the base model above we then introduce individual accounts for unemployment. We keep the replacement rate fixed and consider what happens when we introduce mandatory savings into a UISA. The main goal here is to show what happens to the labour market and try to understand the welfare effects under different assumptions. To determine whether a UISA can actually improve welfare we have to go a step further by comparing a UISA with the second-best UI system, which we do below.

Table 6.8 gives the results for mandatory savings rates ranging from 0%, the initial UI system, to 10% (for expositional purposes). Let us first consider the effect on unemployment and taxes. The higher the saving rate the more people will end up with a positive terminal account. This implies that for more people the distortion from the benefits and the mandatory savings disappears. In the model this dominates the worse incentives due to a higher effective tax rate for individuals that end up with a negative terminal account. Time in UI falls, for example by 14 percent for a mandatory savings rate of 4 percent. With less individuals in unemployment and more contributions to the individual accounts the negative account balances shrink, leading to a substantial drop in the tax rate, by more than 50 percent in the case of a mandatory savings rate of 4%.

Turning to welfare, we see that for a mandatory savings rate of 4% welfare increases. This is the gain in expected utility, ex post individuals that end up with a negative terminal balance still lose relative to the UI system. However there are a number of competing explanations for this welfare gain, the UISA may provide more efficient liquidity insurance but may also simply reduce the level of insurance, and the optimal UI on a finer grid is somewhat below .7. Below we disentangle these potential gains. Table 6.8 also shows that for a sufficiently high mandatory savings rate welfare will start to fall, indeed the result is an inefficiently large drop in risk pooling among individuals.

Finally, we also report the shares of individuals that end up with different balances. Without behavioural changes, De Koning *et al.* (2006, Box 3.2, p.37) compute that 57% never use UI over the lifecycle, 16 percent uses UI at some point but ends up with a positive terminal balance,

[45] Due to *e.g.* a reduction in employment protection. That employment protection reduces labour market flows is a robust finding whereas the net effect on the level of unemployment seems relatively minor, see *e.g.* Deelen *et al.* (2006).

Table 6.8 Introduction of UISA in the existing UI system, base simulation

Mandatory savings rate	0%	2%	4%	6%	8%	10%
Change in utility, in consumption units[a]	0.0	0.0	0.1	0.0	0.0	− 0.1
Unemployment rate (in %)	2.63	2.47	2.26	2.23	2.16	2.15
Tax rate (in %)	1.94	1.20	.84	.58	.43	.32
Never unemployed (in %)	58	58	58	58	58	58
Unemployed but with pos. terminal account (in %)	.	14	27	30	35	35
Unemployed with neg. term. account < 50% of benefits (in %)	.	13	8	6	5	6
Unemployed with neg. term. account > 50% of benefits (in %)	.	15	7	6	2	1

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.9 Introduction of UISA in the existing UI system, risk aversion $+100\%$

Mandatory savings rate	0%	2%	4%	6%	8%	10%
Change in utility, in consumption units[a]	0.0	0.0	− 0.1	− 0.2	− 0.3	− 0.4
Unemployment rate (in %)	2.63	2.52	2.36	2.32	2.26	2.25
Tax rate (in %)	1.94	1.20	.84	.58	.43	.32

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.10 Introduction of UISA in the existing UI system, 'moral hazard' $+50\%$

Mandatory savings rate	0%	2%	4%	6%	8%	10%
Change in utility, in consumption units[a]	0.0	0.1	0.1	0.1	0.1	0.0
Unemployment rate (in %)	2.63	2.39	2.08	2.04	1.92	1.91
Tax rate (in %)	1.94	1.19	.83	.57	.42	.31

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.11 Introduction of UISA in the existing UI system, no credit constraint

Mandatory savings rate	0%	2%	4%	6%	8%	10%
Change in utility, in consumption units[a]	0.0	0.0	0.1	0.1	0.0	0.0
Unemployment rate (in %)	2.63	2.41	2.18	2.14	2.04	2.04
Tax rate (in %)	1.94	1.19	.83	.57	.42	.31

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.12 Introduction of UISA in the existing UI system, flows in and out of unemployment $+100\%$

Mandatory savings rate	0%	2%	4%	6%	8%	10%
Change in utility, in consumption units[a]	0.0	0.1	0.1	0.1	0.1	0.0
Unemployment rate (in %)	2.63	2.32	2.20	2.18	2.11	2.09
Tax rate (in %)	1.94	.89	.45	.20	.05	.01

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

10 percent ends up with a negative balance of less than 50 percent of benefits used and 17 percent ends up with a negative balance of more than 50 percent of benefits used. The simulation that comes closest to their mandatory savings rate (1.4-1.9 percent) is 2.0%. We get numbers that are very close: 58, 14, 13 en 15 percent respectively. This does not come as a surprise since we calibrated our incidence and durations on their data. However, to arrive at this distribution it was necessary to distinguish between 'short-' and 'long-term' unemployed in our simulation model, and this distribution seems adequate to capture a realistic distribution of terminal balances. Table 6.8 further shows that even for a mandatory savings rate of 10 percent, 7 percent of the individuals still ends up with a negative terminal balance.

Table 6.9 shows what happens when we increase risk aversion. In this case a UISA does not improve welfare. The optimal replacement rate in the UI system is above .7 in this case (see above), and the UISA works in the wrong direction by effectively reducing it. Indeed, beyond 2% welfare already begins to fall. This is another illustration of the remark before that it is important to choose the optimal *combination* of mandatory savings and benefit levels. The results on unemployment, tax rates and the distribution of terminal balances (not in tables 6.9-6.12) are not qualitatively affected.

Table 6.10 shows how the results for the UISA change when we increase the 'moral hazard' in UI. The optimal UI replacement rate is then lower, and higher mandatory savings achieve this, up to a mandatory savings rate of 8% welfare increases. Table 6.11 illustrates a similar effect, without credit constraints the optimal replacement rate is lower and the UISA reduce the sub optimal high level of risk pooling. Finally, again the results are basically the same for the more dynamic labour market, Table 6.12, though the range of mandatory savings rates that generate a welfare improvement is not somewhat wider. Furthermore, unemployment drops more than in the more 'polarised' labour market in the base simulation.

6.1.4 Simulation: the optimal mix of mandatory savings and replacement rates

Above we already noted that comparing a UISA with a sub optimal UI system makes it hard to determine where the gains from a UISA are coming from. Here we consider a grid of combinations of mandatory savings rates and replacement rates to see whether a UISA can improve welfare starting from an optimised UI system.

Table 6.13 gives the welfare effects of different combinations of mandatory savings rates

Table 6.13 **Welfare effects combinations of mandatory savings and repl. rates, base simulation[a]**

Savings/replacement rate	0%	1%	2%	3%	4%	6%	8%	10%
.01	− 11.77	− 11.78	− 11.78	− 11.78	− 11.78	− 11.78	− 11.78	− 11.78
.10	− 1.63	− 1.68	− 1.73	− 1.73	− 1.74	− 1.74	− 1.74	− 1.74
.20	− .75	− .79	− .84	− .89	− .93	− .95	− .95	− .95
.30	− .39	− .42	− .46	− .50	− .54	− .64	− .65	− .66
.40	− .17	− .18	− .21	− .25	− .28	− .36	− .45	− .47
.50	− .04	− .04	− .04	− .07	− .11	− .16	− .24	− .34
.60	.02	.03	.04	.03	.01	− .03	− .10	− .17
.70	.00	− .02	.03	.06	**.07**	.02	.00	− .06
.80	− .12	− .14	− .03	.04	.01	.03	.04	− .01
.90	− .46	− .50	− .55	− .31	− .38	− .29	NA	NA

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.14 **Welfare effects combinations of mandatory savings and repl. rates, no credit constraints[a]**

Savings/replacement rate	0%	1%	2%	3%	4%	6%	8%	10%
.01	− .19	− .20	− .20	− .20	− .20	− .20	− .20	− .20
.10	− .10	− .15	− .20	− .20	− .20	− .20	− .20	− .20
.20	− .01	− .05	− .10	− .14	− .19	− .20	− .20	− .20
.30	.05	.03	− .01	− .05	− .09	− .19	− .20	− .20
.40	.09	.09	.06	.02	− .01	− .09	− .18	− .19
.50	.10	.11	.11	.08	.04	− .01	− .09	− .18
.60	.08	.11	**.12**	**.12**	.09	.05	− .01	− .09
.70	.00	− .02	.05	.11	.11	.06	.04	− .02
.80	− .16	− .18	− .05	− .08	.04	.03	− .02	.01
.90	− .56	− .60	− .66	− .38	− .45	− .34	NA	NA

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.15 **Welfare effects combinations of mandatory savings and repl. rates, risk aversion +100%[a]**

Savings/replacement rate	0%	1%	2%	3%	4%	6%	8%	10%
.01	− 99.30	− 99.30	− 99.30	− 99.30	− 99.30	− 99.30	− 99.30	− 99.30
.10	− 54.63	− 54.71	− 54.80	− 54.81	− 54.81	− 54.81	− 54.81	− 54.81
.20	− 16.78	− 17.01	− 17.26	− 17.52	− 17.81	− 17.89	− 17.90	− 17.90
.30	− 6.89	− 7.13	− 7.39	− 7.66	− 7.96	− 8.63	− 8.73	− 8.80
.40	− 3.39	− 3.57	− 3.79	− 4.05	− 4.30	− 4.88	− 5.59	− 5.73
.50	− 1.46	− 1.60	− 1.72	− 1.94	− 2.19	− 2.66	− 3.24	− 3.97
.60	− .43	− .49	− .58	− .72	− .91	− 1.31	− 1.77	− 2.37
.70	.00	− .10	− .10	− .12	− .20	− .56	− .87	− 1.33
.80	− .07	− .15	.02	**.14**	.07	− .16	− .36	− .72
.90	− .85	− .95	− 1.10	− .59	− .82	− .51	NA	NA

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.16 Welfare effects combinations of mandatory savings and repl. rates, moral hazard +50%[a]

Savings/replacement rate	0%	1%	2%	3%	4%	6%	8%	10%
.01	− 7.97	− 7.98	− 7.98	− 7.98	− 7.98	− 7.98	− 7.98	− 7.98
.10	− 1.19	− 1.24	− 1.28	− 1.29	− 1.29	− 1.29	− 1.29	− 1.29
.20	− .44	− .48	− .52	− .56	− .60	− .61	− .61	− .61
.30	− .14	− .16	− .20	− .24	− .28	− .36	− .37	− .37
.40	.01	.01	− .02	− .06	− .08	− .16	− .23	− .24
.50	.07	.08	.10	.06	.03	− .01	− .09	− .19
.60	.08	.11	**.15**	.14	.11	.09	.03	− .05
.70	.00	− .02	.05	.14	**.15**	.10	.10	.04
.80	− .21	− .23	− .26	− .10	.02	.07	.02	.07
.90	− .74	− .80	− .87	− .96	− .58	− .42	NA	NA

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.17 Welfare effects combinations of mandatory savings and repl. rates, flows +100%[a]

Savings/replacement rate	0%	1%	2%	3%	4%	6%	8%	10%
.01	− 1.92	− 1.92	− 1.92	− 1.92	− 1.92	− 1.92	− 1.92	− 1.92
.10	− 1.37	− 1.41	− 1.41	− 1.41	− 1.41	− 1.41	− 1.41	− 1.41
.20	− .59	− .61	− .64	− .65	− .65	− .65	− .65	− .65
.30	− .27	− .29	− .32	− .34	− .35	− .35	− .35	− .35
.40	− .09	− .09	− .11	− .14	− .16	− .17	− .17	− .17
.50	.01	.03	.02	.00	− .03	− .06	− .06	− .06
.60	.04	.08	.09	.09	.07	.01	.01	.01
.70	.00	.04	**.11**	.10	**.11**	.06	.05	.04
.80	− .13	− .04	.01	.07	.10	.09	.02	.07
.90	− .49	− .51	− .31	− .09	− .09	.02	NA	NA

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

(columns) and replacement rates (rows), relative to the UI system with zero mandatory savings and a replacement rate of .7, in terms of changes in consumption units. In the first column we see that when we look at the second digit, an UI system with a replacement rate of 60 percent is actually superior to the UI system with a replacement rate of 70 percent. Then we see that for all replacement rates below 60 percent in Table 6.13 welfare falls with the introduction of mandatory savings. The insurance is insufficient to start with and this becomes worse with the introduction of individual accounts. However, starting from the optimal UI system with a replacement rate of 60 percent we see that mandatory savings up to 3% can (slightly) improve welfare. Giving some individuals support only through liquidity reduces the distortionary effect of UI benefits leading to an overall welfare gain. However, we can do even better, the biggest welfare gain, .07 percent in terms of consumption relative to the initial UI scheme (.05 percent relative to the optimal UI scheme), comes from a combination of a replacement rate of .7 and a mandatory savings rate of 4 percent. This is because the UISA scheme can target the insurance to individuals that suffer long unemployment spells. Note that the gain is still relatively small though, $<.1\%$ in consumption terms. Note also that for all replacement rates there is a point where more mandatory savings are no longer optimal. This suggests that liquidity alone is not optimal, some (targeted) insurance is always optimal.[46] Finally, note that as a policy maker you need quite precise knowledge on the extent of *e.g.* moral hazard and risk aversion. For example, picking the right savings rate of 4% in Table 6.13 but picking the wrong replacement rate, say .6 or .8 instead of .7 already leads to an inferior outcome compared to the second-best UI system with a replacement rate of .6. Given our limited knowledge of moral hazard and risk aversion, a mistake is easy to make, making it less likely that welfare will rise.

The next question is whether some welfare gains remain when we assume that there are no liquidity constraints? Table 6.14 gives the results when there are no liquidity constraints. Perhaps the first thing to notice is that even for low replacement rates the welfare effects are now relatively small. Indeed, without liquidity constraints even long unemployment spells are not that big a deal as employment spells are much longer still.

Now that we have more precision we can see that 50 percent is actually the optimal replacement rate without credit constraints. What is interesting is that starting from this optimal replacement rate some mandatory savings of 1-2 percent can still improve welfare, and a combination of 60 percent and 2-3 percent of mandatory savings does even better. Since we assume there are no liquidity constraints this can not come from more efficient liquidity insurance. So, where does this welfare gain come from? The answer is that a UISA implicitly differentiates in the replacement rate for individuals that face short unemployment spells and those that face long unemployment spells over the lifecycle, *i.e.* those that become unemployed when they are young and those that become unemployed when they are old. The UI system is only optimised under the restriction that the replacement rate is the same for all lifecycle phases (and the same for short- and long-term unemployed). To study this issue we did a grid search to look for the optimal combination of replacement rates for individuals in the young, middle age and old age phase. The optimal replacement rates for these three groups when there are no credit constraints turns out to be 10, 25 en 70 percent respectively.[47] The trade-off between insurance and moral hazard shifts in favour of insurance for older workers. Most individuals that are only unemployed when they are young still end up with a positive terminal balance, those that are unemployed when they are old typically end up with a negative terminal balance. In this way the UISA gives more insurance to older workers. When we start from the optimal replacement rates for the different lifecycle phases, mandatory savings no longer raise welfare in the simulations.

[46] Also note that for very high replacement rates and mandatory savings rates the model does not solve anymore. This happens because some individuals would like to exert negative search effort. For a high mandatory savings rate still some long-term unemployed end up with a negative terminal account, making income in employment lower than income in unemployment, hence zero search effort is optimal. We do not 'fix' the numerical problems in these simulations by setting the search effort of these groups to zero because these mandatory savings rate and replacement rate combinations are not that interesting anyway.

[47] In the case of credit constraints for young unemployed their optimal replacement rate rises to 65%.

Hence, again this welfare gain can be achieved by optimising the UI system.

Table 6.15 shows that when risk aversion is higher the optimal combination is less mandatory saving, 3 percent relative to 4 percent in the base case, and more insurance, a replacement rate of 80 percent compared to 70 percent in the base case.

Table 6.16 shows that with 50% more moral hazard the optimal combination does not really change. But now there is another optimum which has a bit less insurance, 60 percent. Table 6.17 shows that higher flows basically result in the same optimal combination for savings and insurance in our setup, again suggesting that making the labour market more dynamic does not necessarily leads to a stronger case for UISA.

6.2 Ex ante heterogeneous agents

Next we consider optimal UI, the introduction of a UISA and the optimal combination of mandatory savings and replacement rates in a setup where individuals are ex ante heterogeneous (next to having different lifecycle outcomes for employment and unemployment *ex post*). Specifically, we divide the working population in three education groups: low, medium and high educated.

6.2.1 Calibration

In each lifecycle phase, the education groups differ in their wages, and the incidence and duration of UI use. The parameters and some values in the calibration are given in Table 6.18. The groups are by construction of equal size, in line with the grouping of De Koning *et al.* (2006) so as to fit the model to their incidence and duration data by education. The incidence data per lifecycle phase and by education are taken directly from De Koning *et al.* (2006), see Table 6.1. We use the same methodology as in the homogeneous case to construct the UI durations of short- and long-term unemployed per lifecycle phase, *i.e.* assume durations for short-term unemployed based on information of the Ministry of Social Affairs and Employment and then calculate the average duration in long-term unemployment so that the average UI duration per lifecycle phase and education matches the data from De Koning *et al.* (2006). For simplicity (and a lack of information) we assume that the duration of short-term unemployment is the same for the three education groups. The resulting outcomes for incidence in Table 6.19 reflect the inputs from Table 6.1 discussed above. The low educated are more likely to enter UI than the high educated, and also have a longer average duration in UI.

We take the wage profiles from Ter Rele (2007), see Figure 6.1. Specifically, for the low educated we use the average wage of those individuals with only elementary and those with the lowest level of secondary education. For the high educated we take individuals with higher vocational training or a university degree. The rest is medium educated. The resulting average wages per education for the three different lifecycle phases are given in Table 6.18. In particular

Table 6.18 Parameter values and calibration outcomes, ex ante heterogeneity

Parameter values

UI incidence ρ	'Employed'	'Short-term unemployed'	'Long-term unemployed'
Low educated			
- young	.78	.18	.04
- middle age	.81	.10	.09
- old age	.90	.01	.09
Medium educated			
- young	.76	.21	.03
- middle age	.80	.14	.06
- old age	.89	.05	.06
High educated			
- young	.83	.15	.02
- middle age	.85	.12	.03
- old age	.92	.05	.03
	Low educated	Medium educated	High educated
Wages			
- young	1.26	1.41	1.71
- middle age	1.43	1.81	2.48
- old age	1.56	2.02	3.11
Replacement rate b/w	.7		
Risk aversion θ	2.		
'Search elasticity' γ	30.		
Time units per phase N	168.		

Calibration outcomes

UI duration (in months)	'Employed'	'Short-term unemployed'	'Long-term unemployed'
Low educated			
- young	0.	12	71
- middle age	0.	15	50
- old age	0.	18	77
Medium educated			
- young	0.	12	42
- middle age	0.	15	37
- old age	0.	18	74
High educated			
- young	0.	12	22
- middle age	0.	15	27
- old age	0.	18	71
UI rate (in %)	Low educated	Medium educated	High educated
All lifecycle phases	3.45	2.47	1.41
- young	2.96	2.25	1.32
- middle age	3.63	2.57	1.55
- old age	4.28	3.19	1.82
Overall UI rate (in %)	2.62		
Tax rate t_2	1.78		

in the later stage of life wages between low and high educated start to diverge.[48]

Table 6.18 also gives some aggregate variables. The UI rate falls with education, with the low educated being more than twice as often unemployed as the high educated. Furthermore, the tax rate t_2 that balances the budget of 1.78 in the heterogeneous agents case is lower than the 1.94 in the homogeneous case. The reason for this is that low educated are more likely to use UI than high educated and they get lower benefits[49], as a result total expenditures on UI and hence taxes required to finance these expenditures are lower than in the homogeneous agents case.

6.2.2 Simulation: varying the replacement rate

As before, we first consider the optimal replacement rate in a tax financed UI system, to check the elasticities and to see whether plausible optimal replacement rates come out. For the heterogeneous case we only consider the base simulation and the case of no liquidity constraints.

The results for the base simulation, with credit constraints for unemployed during the young phase, are given in Table 6.19. For the low educated a replacement rate in the order of .7 to .8 is optimal.[50] For the medium educated the optimal replacement rate is in the order of .6 to .7 and for the high educated it is in the order of .3 to .5. Hence, also the high educated prefer a positive replacement rate, despite the redistribution in the system, in part due to the credit constraint when they are young and unemployed and no have no way to access their future high wages.

In the second set of rows we consider the welfare effects relative to the starting point, a replacement rate of .7. To compare the welfare results across agents and overall we now present compensating variations in terms of euro per month.[51] As an overall welfare measure we look at the sum of compensating variations and see which replacement rate generates the highest level of welfare.[52] This turns out to be in the range of .5 to .7, somewhat broader than the range of .6 to .7 in the homogeneous case (and the welfare cost at .5 is also relatively minor). A somewhat higher replacement rate of .8 or .9 generates a welfare loss in terms of monthly consumption of about 2 respectively 6 euro. For a much lower replacement rate like .1 there is a much larger welfare loss of 17 euro per month. At this replacement rate the liquidity constraint really starts to bite.

Table 6.20 gives the results for the case without liquidity constraints. The first thing to notice, again, is that the welfare effects are much smaller, unemployment benefits are not the

[48] This suggests that young high educated individuals want to bring more income from the future to the present than young low educated, potentially making a credit constraint in unemployment more problematic for them (for a given incidence and duration of unemployment).

[49] The replacement rate is the same, but the wages of the low educated are lower.

[50] Under the constraint that all education groups have a uniform replacement rate and tax rate.

[51] Specifically, we calculate the consumption equivalent of a given utility V^0 as $V^0 = \int_0^{4N} {c_0}^{1-\theta}/(1-\theta)ds \Rightarrow c_0 = ((1-\theta)V^0/(4N))^{1/(1-\theta)}$ and then report $c_1 - c_0$ where $c_1 = ((1-\theta)V^1/(4N))^{1/(1-\theta)}$.

[52] As noted in *e.g.* Varian (1992) compensating variation is a limited welfare measure since we assign equal value to the utility of all agents. Furthermore, the welfare gain is only in expectation, due to the *ex post* heterogeneity in labour market outcomes it is not a Pareto improvement where all agents win in all possible lifecycle paths.

Table 6.19 Varying the replacement rates of UI, ex ante heterogeneity, base simulation

Replacement rate UI	.1	.3	.5	.6	.7	.8	.9
Compensating variation relative to optimum per type (in % of consumption at the optimum)							
Low educated	− 3.4	− 1.1	− .3	− .1	.0	.0	− .2
Medium educated	− 1.4	− .4	− .1	.0	.0	− .1	− .4
High educated	− .1	.0	.0	− .1	− .2	− .5	− .9
Compensating variation in consumption per month in euro relative to replacement rate of .7							
Low educated	− 35	− 11	− 3	− 1	0	0	− 2
Medium educated	− 18	− 5	− 1	0	0	− 1	− 5
High educated	2	4	4	2	0	− 4	− 11
Total CV/3	− 17	− 4	0	0	0	− 2	− 6
UI use and tax rate (in %)							
’UI rate’ low educated	2.80	3.02	3.30	3.45	3.62	3.85	4.23
’UI rate’ medium educated	1.74	1.97	2.30	2.47	2.67	2.94	3.43
’UI rate’ high educated	.88	1.05	1.29	1.41	1.57	1.77	2.13
’UI rate’ overall	1.81	2.01	2.30	2.44	2.62	2.85	3.26
Tax rate	.18	.59	1.12	1.43	1.78	2.22	2.85

Table 6.20 Varying the replacement rates of UI, ex ante heterogeneity, no credit constraint

Replacement rate UI	.1	.3	.5	.6	.7	.8	.9
Compensating variation relative to optimum per type (in % of consumption at the optimum)							
Low educated	− 1.0	− .6	− .2	− .1	.0	.0	− .3
Medium educated	− .2	− .1	.0	.0	− .1	− .2	− .5
High educated	.0	− .1	− .3	− .4	− .6	− .9	− 1.3
Compensating variation in consumption per month in euro relative to replacement rate of .7							
Low educated	− 11	− 6	− 2	− 1	0	0	− 3
Medium educated	− 2	0	1	1	0	− 2	− 6
High educated	11	9	6	3	0	− 5	− 13
Total CV/3	− 1	1	1	1	0	− 2	− 7
UI use and tax rate (in %)							
’UI rate’ low educated	2.99	3.14	3.35	3.48	3.65	3.89	4.35
’UI rate’ medium educated	1.94	2.11	2.34	2.49	2.68	2.96	3.50
’UI rate’ high educated	1.02	1.15	1.32	1.43	1.57	1.78	2.18
’UI rate’ overall	1.98	2.14	2.33	2.46	2.63	2.88	3.34
Tax rate	0.19	0.62	1.13	1.43	1.79	2.24	2.93

sole determinant of consumption for unemployed youngsters. The lower educated still have an optimal replacement rate in the order of .7 to .8, though lower replacement rates are now less costly. The medium educated now have a lower optimal replacement rate of about .5 to .6, and the high educated prefer the low .1 in this case. Indeed, the liquidity insurance disappears when there are no liquidity constraints and the high educated then prefer only little lifetime income insurance, given the limited insurance gains for them and the distribution to the lower educated in the system. Overall, .7 is no longer in the optimal replacement rate range, which now drops to .3 to .6, the same range as for the homogeneous agents case. The welfare loss from a replacement rate of .7 is still limited though, on average 1 euro per month per person for a period of (4x14=) 56 years compared to the optimum of .3 to .6.

6.2.3 Simulation: introducing UISA

Next we consider the effects on introducing mandatory savings accounts for the heterogeneous agents case, keeping the replacement rate at .7. The results for the base simulation are given in Table 6.21, and for the case without liquidity constraints in Table 6.22.

Table 6.21 shows that the low educated only lose from the mandatory savings, for them this is simply less insurance. The medium educated also do not gain from mandatory savings, and for savings rates beyond 2 percent actually lose. The higher educated prefer more mandatory savings, which implies less redistribution to low and medium educated. Overall, for the three groups in total there is a small welfare gain of 1 euro per month. Also in the heterogeneous case the net incentives are positive for all education groups leading to a fall in unemployment. Table 6.21 also gives the distribution of account balances for the total and by education group. The pattern for the total is the same as for the homogenous case, with more people having more positive balances the higher we set the mandatory savings rate. Furthermore, unsurprisingly the lower educated are more likely to end up with a negative balance than the medium and in particular the high educated. For a mandatory savings rate of 4% respectively 21, 15 and 7 percent of the low, medium and high educated end up with a negative terminal balance.

Table 6.22 shows what changes when there are no liquidity constraints. The loss for the low educated from mandatory savings is virtually the same, but the loss for the medium educated is lower and the gain for the high educated is higher, they now prefer a lower replacement rate. With the high educated being more ’over insured’ at a replacement rate of .7 a mandatory savings rate of 4% now generates an overall welfare gain of 2 euro per month.

6.2.4 Simulation: the optimal mix of mandatory savings and replacement rates

Finally, also in the heterogeneous case we consider the optimal combination of mandatory savings and replacement rates per education type and overall.[53]

[53] But still under the restriction that the replacement and tax rates are the same across education types.

Table 6.21 Introduction of UISA, ex ante heterogeneity, base simulation

Mandatory savings rate	0%	2%	4%	6%	8%	10%
Compensating variation in euro per month relative to an UI with rr=.7						
Low educated	0	0	− 1	− 4	− 7	− 9
Medium educated	0	− 1	− 1	− 2	− 2	− 2
High educated	0	2	5	8	9	10
Total CV/3	0	0	1	1	0	− 1
UI use and tax rate (in %)						
’UI rate’ low educated	3.62	3.44	3.31	3.31	3.32	3.22
’UI rate’ medium educated	2.67	2.48	2.24	2.15	2.12	2.11
’UI rate’ high educated	1.57	1.45	1.23	1.15	1.15	1.15
’UI rate’ overall	2.62	2.46	2.26	2.21	2.20	2.16
Tax rate	1.78	1.06	.74	.54	.39	.28
Terminal account balances						
Total						
Never unemployed (in %)	.59	.59	.59	.59	.59	.59
Unemployed but with positive terminal account (in %)	.	.13	.27	.30	.31	.34
Unemployed with negative account < 50% of used benefits (in %)	.	.14	.04	.04	.08	.07
Unemployed with negative account > 50% of used benefits (in %)	.	.14	.10	.07	.02	.00
Low educated						
Never unemployed (in %)	.57	.57	.57	.57	.57	.57
Unemployed but with positive terminal account (in %)	.	.13	.22	.23	.23	.30
Unemployed with negative account < 50% of used benefits (in %)	.	.09	.00	.11	.18	.11
Unemployed with negative account > 50% of used benefits (in %)	.	.21	.21	.10	.03	.02
Medium educated						
Never unemployed (in %)	.54	.54	.54	.54	.54	.54
Unemployed but with positive terminal account (in %)	.	.15	.31	.38	.40	.40
Unemployed with negative account < 50% of used benefits (in %)	.	.16	.08	.02	.05	.06
Unemployed with negative account > 50% of used benefits (in %)	.	.15	.07	.06	.01	.00
High educated						
Never unemployed (in %)	.65	.65	.65	.65	.65	.65
Unemployed but with positive terminal account (in %)	.	.12	.28	.32	.32	.32
Unemployed with negative account < 50% of used benefits (in %)	.	.16	.04	.00	.02	.03
Unemployed with negative account > 50% of used benefits (in %)	.	.07	.03	.03	.01	.00

Table 6.22 Introduction of UISA in the existing UI system, ex ante heterogeneity, no credit constraint

Mandatory savings rate	0%	2%	4%	6%	8%	10%
Compensating variation in euro per month relative to UI with rr=.7						
Low educated	0	0	− 1	− 4	− 7	− 9
Medium educated	0	− 1	0	− 1	− 1	− 2
High educated	0	3	6	9	10	10
Total CV/3	0	1	2	1	1	0
UI use and tax rate (in %)						
’UI rate’ low educated	3.65	3.43	3.27	3.27	3.28	3.16
’UI rate’ medium educated	2.68	2.43	2.15	2.04	2.00	2.00
’UI rate’ high educated	1.57	1.38	1.09	1.03	1.03	1.03
’UI rate’ overall	2.63	2.41	2.17	2.12	2.10	2.06
Tax rate	1.79	1.06	.74	.54	.39	.28

Table 6.23 gives the base simulation with credit constraints for the low educated. Now that we also can vary the replacement rate we find that at least some mandatory savings can improve their welfare, when combined with a somewhat higher replacement rate of .8 (at a mandatory savings rate of 3%), though the gain is only 70 euro cents per month. Table 6.24 shows that medium educated actually prefer no mandatory savings. Table 6.25 shows that the high educated typically prefer mandatory savings, less redistribution. What is interesting is that their optimal combination is a replacement rate of .7 and a mandatory savings rate of 10 percent (or more). This illustrates they value liquidity when they run the risk of liquidity constraints, but apart from that they would like to have as little lifetime income insurance in the system as possible. Table 6.26 shows that across education groups we find an optimal mandatory savings rate of 4% and a replacement rate of .7, similar to the homogeneous agents case. The overall gain is only 1 euro per worker per month though.

Tables 6.27-6.30 give the optimal combinations in the absence of liquidity constraints. The optimal choice of low educated is hardly affected, they now prefer 4% mandatory savings and a replacement rate of .8. The medium educated still prefer no mandatory savings, but now prefer a lower replacement rate of .5. The high educated now no longer require liquidity, and as a result they now only go for a low replacement rate and high mandatory savings, to minimize the redistribution in the system. Overall welfare is now maximized at a lower replacement rate of .6, and also a lower mandatory savings rate of 2%.[54]

[54] The welfare gain is higher than in the case with liquidity constraints, but this is because we compare welfare relative to zero mandatory savings and a replacement rate of .7. The extent of ’over insurance’ is than higher to begin with than in the case with liquidity constraints.

Table 6.23 Welfare effects combinations mandatory savings/replacement rates, low educated, base simulation[a]

Savings/replacement rate	0%	1%	2%	3%	4%	6%	8%	10%
.01	− 221.39	− 221.57	− 221.57	− 221.57	− 221.57	− 221.57	− 221.57	− 221.57
.10	− 34.79	− 36.19	− 37.13	− 37.32	− 37.39	− 37.41	− 37.41	− 37.41
.20	− 18.23	− 19.25	− 2.96	− 22.05	− 22.88	− 23.26	− 23.41	− 23.42
.30	− 11.05	− 11.78	− 13.15	− 14.85	− 16.02	− 17.76	− 18.14	− 18.51
.40	− 6.45	− 6.95	− 7.99	− 9.42	− 11.13	− 13.33	− 15.02	− 15.39
.50	− 3.31	− 3.75	− 4.29	− 5.48	− 6.94	− 9.84	− 11.81	− 13.43
.60	− 1.20	− 1.70	− 1.72	− 2.52	− 3.73	− 6.80	− 9.16	− 1.96
.70	.00	− .46	− .38	− .51	− 1.33	− 3.90	− 7.20	− 8.96
.80	.09	− .38	− .68	.68	.02	− 1.86	− 4.72	− 7.19
.90	− 2.02	− 2.77	− 3.70	− 4.51	− 2.32	NA	NA	NA

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.24 Welfare effects combinations mandatory savings/replacement rates, med. educated, base sim.[a]

Savings/replacement rate	0%	1%	2%	3%	4%	6%	8%	10%
.01	− 106.18	− 106.31	− 106.31	− 106.31	− 106.31	− 106.31	− 106.31	− 106.31
.10	− 17.71	− 18.43	− 19.00	− 19.04	− 19.04	− 19.02	− 19.02	− 19.02
.20	− 9.15	− 9.98	− 1.51	− 11.05	− 11.55	− 11.65	− 11.62	− 11.62
.30	− 5.26	− 6.01	− 6.77	− 7.08	− 7.53	− 8.58	− 8.72	− 8.72
.40	− 2.58	− 3.25	− 3.85	− 4.52	− 4.74	− 5.65	− 6.67	− 6.77
.50	− .87	− 1.52	− 1.83	− 2.50	− 2.99	− 3.44	− 4.45	− 5.41
.60	.00	− .53	− .77	− 1.06	− 1.74	− 2.17	− 2.72	− 3.75
.70	.00	− .92	− .84	− .84	− .82	− 1.57	− 1.76	− 2.43
.80	− 1.11	− 2.07	− 1.66	− .84	− 1.13	− 1.76	− 1.86	− 1.98
.90	− 4.76	− 6.10	− 7.65	− 9.06	− 6.20	NA	NA	NA

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.25 Welfare effects combinations mandatory savings/replacement rates, high educated, base simulation[a]

Savings/replacement rate	0%	1%	2%	3%	4%	6%	8%	10%
.01	− 3.53	− 3.53	− 3.53	− 3.53	− 3.53	− 3.53	− 3.53	− 3.53
.10	2.17	2.64	2.50	2.55	2.55	2.55	2.55	2.55
.20	3.78	4.21	4.82	4.82	4.63	4.73	4.78	4.78
.30	4.25	4.82	5.58	6.15	6.29	6.06	6.10	6.20
.40	4.40	5.25	5.91	6.82	7.39	7.72	7.44	7.48
.50	3.83	4.68	5.63	6.67	7.58	8.58	8.72	8.48
.60	2.41	3.64	4.87	5.82	6.96	8.53	9.24	9.34
.70	.00	.61	2.31	4.21	5.35	7.72	9.01	9.53
.80	− 3.81	− 3.34	− .90	1.84	2.64	5.58	7.58	8.67
.90	− 11.20	− 11.20	− 11.53	− 8.68	− 6.39	NA	NA	NA

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.26 Welfare effects combinations mandatory savings/replacement rates, total/3, base simulation[a]

Savings/replacement rate	0%	1%	2%	3%	4%	6%	8%	10%
.01	− 11.37	− 11.47	− 11.47	− 11.47	− 11.47	− 11.47	− 11.47	− 11.47
.10	− 16.77	− 17.33	− 17.87	− 17.94	− 17.96	− 17.96	− 17.96	− 17.96
.20	− 7.87	− 8.34	− 8.88	− 9.43	− 9.93	− 1.06	− 1.08	− 1.09
.30	− 4.02	− 4.32	− 4.78	− 5.26	− 5.75	− 6.76	− 6.92	− 7.01
.40	− 1.54	− 1.65	− 1.98	− 2.38	− 2.83	− 3.75	− 4.75	− 4.89
.50	− .12	− .19	− .17	− .44	− .78	− 1.57	− 2.51	− 3.45
.60	.40	.47	.79	.75	.50	− .14	− .88	− 1.79
.70	.00	− .25	.36	.95	1.07	.75	.02	− .62
.80	− 1.61	− 1.93	− 1.08	.56	.51	.65	.33	− .16
.90	− 5.99	− 6.69	− 7.63	− 7.42	− 4.97	NA	NA	NA

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.27 Welfare effects combinations mandatory savings/replacement rates, low educ., no credit constraint[a]

Savings/replacement rate	0%	1%	2%	3%	4%	6%	8%	10%
.01	− 13.28	− 13.59	− 13.59	− 13.59	− 13.59	− 13.59	− 13.59	− 13.59
.10	− 1.69	− 12.22	− 13.27	− 13.48	− 13.57	− 13.59	− 13.59	− 13.59
.20	− 8.08	− 9.16	− 1.92	− 12.10	− 12.97	− 13.39	− 13.56	− 13.57
.30	− 5.76	− 6.48	− 7.90	− 9.67	− 1.91	− 12.70	− 13.10	− 13.47
.40	− 3.73	− 4.17	− 5.25	− 6.73	− 8.47	− 1.74	− 12.43	− 12.82
.50	− 2.05	− 2.36	− 2.94	− 4.17	− 5.64	− 8.58	− 1.58	− 12.19
.60	− .76	− 1.17	− 1.06	− 1.94	− 3.18	− 6.29	− 8.61	− 1.41
.70	− .00	− .44	− .21	− .16	− 1.12	− 3.71	− 7.03	− 8.72
.80	− .14	− .57	− .84	− .17	.09	− 1.73	− 4.54	− 6.93
.90	− 2.61	− 3.26	− 4.01	− 4.65	− 2.66	NA	NA	NA

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.28 Welfare effects combinations mandatory savings/replacement rates, med. educ., no cred. constr.[a]

Savings/replacement rate	0%	1%	2%	3%	4%	6%	8%	10%
.01	− 3.49	− 3.63	− 3.63	− 3.63	− 3.63	− 3.63	− 3.63	− 3.63
.10	− 2.27	− 3.03	− 3.59	− 3.63	− 3.63	− 3.63	− 3.63	− 3.63
.20	− 1.11	− 1.95	− 2.51	− 3.03	− 3.54	− 3.66	− 3.63	− 3.63
.30	− .22	− .89	− 1.71	− 2.02	− 2.48	− 3.51	− 3.66	− 3.63
.40	.41	− .12	− .72	− 1.40	− 1.64	− 2.53	− 3.51	− 3.61
.50	.72	.22	.00	− .68	− 1.16	− 1.59	− 2.60	− 3.54
.60	.65	.29	.19	− .05	− .75	− 1.11	− 1.66	− 2.70
.70	− .00	− .92	− .55	− .19	− .31	− 1.01	− 1.18	− 1.83
.80	− 1.64	− 2.55	− 1.78	− 2.24	− 1.16	− 1.52	− 1.37	− 1.52
.90	− 6.03	− 7.25	− 8.61	− 9.82	− 6.94	NA	NA	NA

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.29 Welfare effects combinations mandatory savings/replacement rates, high educ., no credit constraint[a]

Savings/replacement rate	0%	1%	2%	3%	4%	6%	8%	10%
.01	11.11	11.16	11.16	11.16	11.16	11.16	11.16	11.16
.10	1.68	11.21	11.11	11.16	11.16	11.16	11.16	11.16
.20	9.92	1.54	11.16	11.21	11.07	11.11	11.16	11.16
.30	8.82	9.59	1.45	11.02	11.21	1.97	11.07	11.11
.40	7.44	8.54	9.25	1.25	1.83	11.16	1.88	1.97
.50	5.59	6.78	8.01	9.01	9.92	1.88	11.02	1.83
.60	3.22	4.73	6.35	7.25	8.49	1.02	1.73	1.83
.70	.00	.61	2.74	5.02	6.30	8.63	9.92	1.45
.80	− 4.66	− 4.10	− 1.13	1.75	2.93	6.30	8.16	9.35
.90	− 13.31	− 13.17	− 13.26	− 9.53	− 7.94	NA	NA	NA

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

Table 6.30 Welfare effects combinations mandatory savings/replacement rates, total/3, no credit constraint[a]

Savings/replacement rate	0%	1%	2%	3%	4%	6%	8%	10%
.01	− 1.89	− 2.02	− 2.02	− 2.02	− 2.02	− 2.02	− 2.02	− 2.02
.10	− .76	− 1.35	− 1.91	− 1.98	− 2.02	− 2.02	− 2.02	− 2.02
.20	.24	− .19	− .75	− 1.31	− 1.82	− 1.98	− 2.01	− 2.02
.30	.95	.74	.28	− .22	− .73	− 1.75	− 1.90	− 2.00
.40	1.37	1.42	1.09	.71	.24	− .70	− 1.69	− 1.82
.50	1.42	1.54	1.69	1.39	1.04	.23	− .72	− 1.63
.60	1.04	1.29	1.83	1.75	1.52	.87	.15	− .76
.70	.00	− .25	.66	1.56	1.62	1.30	.57	− .04
.80	− 2.15	− 2.41	− 1.25	− .22	.62	1.02	.75	.30
.90	− 7.32	− 7.89	− 8.63	− 8.00	− 5.85	NA	NA	NA

[a] Utility difference relative to an UI system with rr=.7, in consumption units.

6.3 Summarizing the simulation results

The model suggests that in the presence of credit constraints for young unemployed the optimal replacement rate is in the range of .6 to .7 in our preferred setup, .8 with more risk aversion, and closer to .5 with more moral hazard or in the absence of liquidity constraints. Low educated prefer a higher replacement rate and high educated prefer a lower replacement rate, much lower in the absence of liquidity constraints in unemployment.

Introducing some mandatory savings in the order of 4% into an UI system with a replacement rate of .7 leads to a small gain in welfare of about 1 euro per month in welfare in our preferred setup and with liquidity constraints. More risk aversion makes mandatory savings no longer welfare improving, but more moral hazard strengthens the case for mandatory savings, as does the absence of liquidity constraints. The latter may seem counterintuitive, but that is because a replacement rate of .7 is too high in the case without liquidity constraints, and mandatory savings effectively reduce the replacement rate.

The question then is whether mandatory savings can still improve welfare when we start from the second-best UI system with the optimal replacement rate. When the unemployed are liquidity constrained, a small welfare gain is indeed possible, but the gain is only .05% in consumption terms. Furthermore, to realize this welfare gain you have to pick the right combination of the mandatory savings rate and the replacement rate, a sub optimal choice quickly leads to no welfare gain at all or even a loss. Given our limited knowledge of the extent of moral hazard and risk aversion it is easy to make a mistake.

Surprisingly, a UISA can also improve welfare slightly starting from the second-best UI system in the absence of liquidity constraints, by .02% in consumption terms. In this case, clearly the benefit can not come from more efficient liquidity insurance. A system with mandatory savings implicitly differentiates the replacement rate between individuals that suffer few unemployment periods, they get little or nothing, and those that suffer many periods of unemployment, they keep their current insurance. By doing so, a UISA may still slightly improve welfare in the absence of liquidity constraints. However, when we differentiate the replacement rate in the UI system between different groups of workers the welfare gains from mandatory savings in the absence of liquidity constraints indeed disappears.

As for the effects by education, the low educated prefer no mandatory savings (more redistribution) and the high educated prefer more mandatory savings (less redistribution). When there are liquidity constraints the high educated prefer a generous replacement rate (high liquidity) with high mandatory savings (low redistribution). When there are no liquidity constraints, the high educated prefer both a low replacement rate and high mandatory savings (no need for liquidity and low redistribution). Also in the case of heterogeneous agents, overall welfare may rise when we introduce mandatory savings, due to the implicit differentiation in the replacement rate. But again, the same can be achieved in the UI system.

7 Limitations of the analysis

Any model is an abstract representation of the real world where one tries to capture the main mechanisms relevant for a certain research question. Below we consider some limitations of the analysis above and consider how these might affect the outcomes.

For simplicity we have set the subjective discount rate, interest rate and productivity growth rate to zero. With a subjective discount rate higher than the interest rate individuals would like to borrow more from the future, this would increase the demand for liquidity, making liquidity constraints more problematic. Similarly, productivity growth would increase wage profiles, part of which individuals want to consume earlier in working life, again making liquidity constraints more problematic.

Another simplification is that we assume there is a liquidity constraint at zero assets when unemployed. We could assume a constraint at some negative number or a higher interest rate on borrowing than on saving as in *e.g.* Imrohoroglu (1989), both would result in more borrowing by the young unemployed reducing the need for government provided liquidity or insurance. We also assume the unemployed person has no access to other income from *e.g.* a working spouse or relatives, again overstating the need for liquidity or insurance. The liquidity constraint we consider above should therefore be viewed as an extreme case for the young unemployed. On the other hand, we may understate the relevance of liquidity constraints for elderly unemployed, because we assume they have full access to their accumulated (pension) assets. But on average, we seem to get the role of liquidity constraints about right, as the average consumption response to a change in benefits is in line with empirical studies.[55] A drawback of the model is that the liquidity constraint is exogenously imposed.[56] Ideally we would derive the liquidity constraint from some sort of optimising behaviour by creditors. Indeed, with an optimally set endogenous liquidity constraint the government can perhaps not improve welfare by giving young unemployed loans.

Another simplification is that we abstract from an endogenous retirement choice. Some people fear that individual accounts will lead to more early retirement. However, this is not clear from the outset. To the extent that individual accounts lead to higher asset holdings close to retirement it is important to realize that this is only an income effect, and income effects on the work-leisure choice are typically assumed to be small. Well, at least for individuals that do not

[55] We further do not consider liquidity constraints for employed workers. When *e.g.* young employed also face liquidity constraints we face a trade-off between reducing a liquidity constraint for unemployed via a premium or a loan and increasing a liquidity constraint for employed workers due to the premium or mandatory savings. One solution to this problem is integrating the unemployment risk with the longevity risk, as suggested by *e.g.* Stiglitz and Yun (2005). Also, 'oversaving' can be mitigated by setting a ceiling on the account beyond which the contributions are no longer mandatory.

[56] Actually, the liquidity constraint is not consistent with the rest of the model, as all individuals are working most of the time in the remainder of their working life. The same holds for Bovenberg and Sorensen (2004) and Stiglitz and Yun (2005) by the way.

face credit constraints, which is more likely to be the case for the individuals that end up with a positive terminal balance. In contrast, the UI entitlement has a substitution effect, which directly affects the relative price of work and leisure, making individuals more eager to 'retire early' via UI and not look for a job again. Hence, it seems dubious that a UISA will lead to more early retirement than UI.[57]

Perhaps a more severe limitation is that we do not consider the case of myopic individuals. When individuals are 'nearsighted' (as in the case of hyperbolic time preferences, see *e.g.* Laibson, 1997) they may perceive the mandatory savings (at least in part) as a tax and the UI loan (at least in part) as a subsidy. When the mandatory savings and the tax to bail out individuals with a negative terminal balance are higher than the UI premium, which is the case when we maintain the same replacement rate, this will reduce the incentives to find and keep a job. However, this potential problem actually becomes less of a problem when we think that the individuals that are myopic are also the ones that end up with a negative terminal balance. For them the mandatory savings are *de facto* a tax.

We further assume that individuals are either working or in UI. In real life there are many more states. This presumably leads to a tax rate for UI on employment that is too low, but this can easily be fixed by adjusting the employment/unemployment ratio in the lifecycle phases. More interesting seems to be the correlation between UI and other types of labour market risks, like sickness and disability. Stiglitz and Yun (2005) and Bovenberg and Sorensen (2004) suggest that individuals accounts can provide more efficient intra personal insurance when these risks are not perfectly correlated. Next to more states it would also be interesting to study individual accounts with more periods. In particular, the interaction of the optimal replacement rate profile and a UISA can not be meaningfully studied in our setup where individuals know immediately how long they will be unemployed once they draw the search technology.

Let us conclude by noting that we also use a simple UI setup in the model above. In real life, after UI there is often welfare and an integrated analysis seems to be called for. However, we doubt whether individual accounts for the basic tax financed income level is a realistic scenario. Also, there are lower and upper limits on UI contributions and benefits which affect the redistribution and insurance in the system. Indeed, our analysis above suggests that high educated individuals might currently be 'over insured' which is mitigated by the upper limit on UI contributions and benefits. We further found that the optimal replacement rate for older unemployed workers is higher than for younger unemployed workers, and given the longer UI entitlement for individuals with more tenure this also seems to be 'captured' in the current system.

[57] In any case, if one believes that individual accounts do lead to more early retirement we can mitigate this problem by integrating the mandatory savings for unemployment with those for pensions (individuals can consume part of their pension for certain contingencies, in this case unemployment), or by setting a ceiling on the maximum account balance and/or the mandatory savings rate.

Clearly, this list of potentially relevant limitations is not exhausting, one can also think of *e.g.* wage bargaining, endogenous education and transition issues for older workers *etc.*

8 Concluding remarks

The analysis above suggests that the welfare gains from individual accounts for the unemployment risk in the Netherlands are small. Indeed, the welfare gain is only .05% in consumption terms relative to the second-best UI system. The main advantage UISA have over premium financed UI is the ability to distinguish between the need for just liquidity and lifetime income insurance. However, liquidity constraints seem to play a minor role in most unemployment spells, unemployment benefits mainly act as lifetime income insurance.[58] Furthermore, to reap a welfare gain the policy maker needs to have precise knowledge on the extent of moral hazard and risk aversion of the workers. A sub optimal choice easily results in a welfare loss, and a mistake is easy to make given our limited knowledge of moral hazard and risk aversion. All in all, UISA then do not seem to offer much over the current UI system in the Netherlands. However, this does not mean that individual accounts are not interesting for other types of income 'shocks', like education expenditures and subsidies for early retirement, which have a larger intra personal and a smaller interpersonal component than unemployment benefits.[59]

The analysis above also gives insight in the optimal level of the replacement rate of UI. The current level of UI (75% in the first two months of unemployment, and 70% thereafter) comes close to the optimum in the calibrated model, provided that the unemployed in the Netherlands are quite risk averse and sometimes run into liquidity constraints. When risk aversion is smaller and liquidity constraints do not play a role in unemployment, the optimal replacement rate is lower. But then again, close to the optimum the costs of a deviation are typically small, in the order of .1% in consumption terms when we miss the optimal replacement rate by 10 percentage points. The analysis further shows that the optimal benefit level varies with age and education, in line with the current system that links the maximum UI duration with the preceding employment duration and the minimum and maximum income borders for UI premiums and benefits.

[58] Also, for the individuals that are the most likely to run into liquidity constraints, the long-term unemployed, incentives typically do not change under the UISA system, because they end up with a negative terminal account. Furthermore, even for those unemployed for which liquidity constraints are relevant and that do not end up with a negative terminal balance, converting benefits into a loan still has a smaller effect on job search behaviour than reducing benefits.

[59] See *e.g.* Orszag and Snower (1997) and Sorensen *et al.* (2006).

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Appendix 1 First-, second- and ’third’-best in a simpler model

In this appendix we consider first-best UI, second-best UI and ’third-best’ UISA in a simplified setup of the model in Section 5, with only one lifecycle phase (instead of four) and only two search technology outcomes (instead of three).

First-best

With (exogenous) probability ρ individuals are ’employed’ and with probability $1-\rho$ they are ’unemployed’. That is, the ’unemployed’ are initially unemployed and then become employed for the remainder of the lifecycle phase, where the duration of unemployment is endogenous. The ’employed’ are employed for the whole lifecycle phase, and for simplicity we assume they do not have to search (in the main text we assume they are at a corner). Expected lifetime utility V^0 is

$$V^0 = \rho V^e + (1-\rho)V^u \tag{A.1}$$

where V^e and V^u are the lifetime utility of ’employed’ and ’unemployed’ respectively

$$V_e = \int_0^N u(c^e(x))dx \tag{A.2}$$

$$V_u = \int_0^N u(c^u(x))dx - f(s) \tag{A.3}$$

where $c^e(.)$ and $c^u(.)$ are the respective consumption streams and $f(s)$ is a function that converts search units into effective search effort (with $f'(s) > 0$ and $f''(s) > 0$). The lifecycle phase lasts N periods. We further have the resource constraint

$$\int_0^N u(c^e(x)) + u(c^u(x))dx \leq (\rho N + (1-\rho)g(s)N)w \tag{A.4}$$

where $g(s)$ is the duration of the lifecycle phase that the ’unemployed’ are employed (with $g'(s) > 0$). During the initial unemployment periods, the ’unemployed’ produce nothing (*e.g.* no household production or additional leisure).

Maximizing (A.1) with respect to $c^e(.)$, $c^u(.)$ and s, taking (A.4) into account gives the first-best solution for consumption and search effort

$$c^u(x) = c^e(x) = c \tag{A.5}$$

$$f'(s) = g'(s)Nwu'(c) \tag{A.6}$$

consumption is equalized across states and search effort is set so that the marginal cost of search equals the marginal gain (the additional consumption units $g'(s)Nw$ times the marginal utility gain from higher consumption).

Second-best

Next we characterize the second-best UI system, where the social planner can control consumption via the benefit level, but does not control search effort, which is chosen by the unemployed. We first consider the case without credit constraints, and subsequently the case with credit constraints.

Without credit constraint

Individuals now choose their own consumption and search effort. When employed, individuals now pay a tax t to finance benefits b for the unemployment periods. The indirect utility function of the employed is

$$V^e = u(w-t)N. \tag{A.7}$$

The indirect utility function of the unemployed is

$$V^u = u((1-g(s))b + g(s)(w-t))N - f(s), \tag{A.8}$$

where

$$f'(s) = g'(s)N(w-t-b)u'(c^u), \tag{A.9}$$

with c^u the consumption chosen by the unemployed. Taxes and benefits drive a wedge between the socially and privately optimal search effort. Even though consumption in unemployment will be lower than in the first-best case, and hence the marginal utility of additional consumption will be higher, the search effort will typically be inefficiently low compared to the first-best.

What is the best the social planner can do? Taking into account the budget constraint

$$(\rho N + (1-\rho)g(s)N)t = (1-\rho)(1-g(s))Nb, \tag{A.10}$$

and noting that by the envelope theorem the direct effect of b and t on V^U is 0 (s is chosen optimally by the 'unemployed'), maximizing (A.1) with respect to b we arrive, after some rearranging, at the Baily (1978) condition for the second-best level of b

$$\left(\frac{\rho}{\rho+(1-\rho)g(s)}u'(c^e) + \frac{(1-\rho)g(s)}{\rho+(1-\rho)g(s)}u'(c^u)\right)(1+\eta(b)) = u'(c^u) \tag{A.11}$$

where $\eta(b)$ is the elasticity of the ratio of unemployment to employment with respect to the benefit level

$$\eta(b) \equiv \frac{\partial\left(\frac{(1-\rho)(1-g(s))}{\rho+(1-\rho)g(s)}\right)}{\partial b}\frac{b}{\left(\frac{(1-\rho)(1-g(s))}{\rho+(1-\rho)g(s)}\right)}. \tag{A.12}$$

That is, at the optimal benefit level the marginal utility of consumption in employment, the weighted average on the left hand side (of the employed periods of the 'employed' and the employed periods of the ’unemployed’), times one plus the elasticity of the ratio of unemployment to employment with respect to the benefit level has to equal the marginal utility of consumption in unemployment. A special case arises when η is zero, no moral hazard, in this case we have full insurance. But typically $\eta > 0$, so to maintain equality in the condition above the marginal utility of consumption in unemployment has to be higher than in employment, *i.e.* consumption in unemployment has to be lower than in employment.

With credit constraint

Now suppose that the unemployed face a credit constraint, so that they can not borrow from future wage income. How does this affect the optimal benefit level? The indirect utility function of the unemployed is now given by

$$V^u = (1-g(s))Nu(b) + g(s)Nu(w-t) - f(s), \tag{A.13}$$

where optimal private search effort is now

$$f'(s) = g'(s)N((w-t-b)u'(w-t) + u(w-t) - u(b) + u'(w-t)(w-t-b), \tag{A.14}$$

the unemployed will search harder than in the absence of the credit constraint, as more search now not only leads to more lifetime income, but also to a smoother consumption pattern.

Again maximizing (A.1) taking into account the budget constraint and using the envelope theorem we now arrive at the following simpler expression for optimal b

$$u'(w-t)(1+\eta(b)) = u'(b), \tag{A.15}$$

because consumption by the ’employed’ and by the ’unemployed’ once employed will be the same. How does this compare to the case without credit constraint? Without the credit constraint the ’unemployed’ will consume $c^u > b$ while unemployed. Now he or she can only consume b. As a result the marginal utility on the righthandside will be higher, the insurance gain of unemployment benefits rises. This means that η can be higher as well, we will also have more moral hazard at the optimum. Typically this implies that the optimal benefit level will be higher with than without credit constraints for the unemployed.

’Third-best’

Finally, we may consider how a simple UISA system gives the social planner an additional tool to raise welfare. Specifically, suppose that the unemployed receive a loan p per period next to their benefit b, which needs to be repaid during the subsequent employment period (all redistribution runs via b). The indirect utility function of the unemployed is now given by

$$V^u = (1-g(s))Nu(b+p) + g(s)Nu\left(w-t-\frac{1-g(s)}{g(s)}p\right) - f(s). \tag{A.16}$$

Maximizing (A.1) with respect to p gives

$$u'(b+p) = u'\left(w - t - \frac{1-g(s)}{g(s)}p\right), \tag{A.17}$$

so the loan is used to equalize consumption over the unemployment and employment periods of the ’unemployed’. Maximizing (A.1) with respect to b then simply gives

$$\left(\frac{\rho}{\rho+(1-\rho)g(s)}u'(c^e) + \frac{(1-\rho)g(s)}{\rho+(1-\rho)g(s)}u'(c^u)\right)(1+\eta(b,p)) = u'(c^u) \tag{A.18}$$

so the optimal benefit level is set as if there were no credit constraint.[60]

[60] Provided that $p > 0$ is optimal. Indeed, it may actually not be optimal to remove the liquidity constraint in the presence of other distortions, as noted by e.g. Stiglitz and Yun (2005, p. 2042, footnote 14), because the welfare loss from reduced search effort may dominate the gain in consumption smoothing.