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Empirical Evidence from a Large Administrative Sample

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Abstract

We study entrepreneurs' behavioral responses of effort (moral hazard) to avoid business failure. This is done in the context of an unemployment insurance scheme for self-employed, where we estimate how much of the transition probability to unemployment can be causally attributed to being insured. To disentangle moral hazard from adverse selection we use an institutional feature of the Danish unemployment system that provides an additional motive to choose insurance (an early retirement option). We estimate a bivariate random effects probit on a self-employment sample drawn from register data. We find that those who are insured are 2 percentage points more likely to subsequently become unemployed compared to the uninsured, however only 0.6 percentage points can be attributed to behavioral responses.

Keywords: moral hazard, entrepreneurs, self-employment, unemployment insurance, panel data

JEL codes: C33, C35, J2, D82, L26, J65

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1 Introduction

Businesses come and go. The vast majority of disappearing firms consists of very small, and often young, unincorporated firms without any employees. Whereas this churning is arguably a necessary side effect of economic dynamism, huge risks are involved from the point of view of the individual owner-manager. Markets or societies at large need to provide insurance mechanisms.

Fan and White (2003), for instance, argue that access to the capital market coupled with the possible recourse to bankruptcy proceedings featuring asset exemptions and (partial) debt discharge in fact constitutes a prime insurance mechanism in the United States that encourages would-be entrepreneurs to actually start up new ventures.

One of the unintended side effects of insurance is moral hazard, i.e., a behavioral response to insurance that is caused by the mere existence of insurance itself. In the business case, this may mean excessive risk taking or inappropriate precaution against failure. Both can be viewed as a result of lack of effort. The adverse social welfare implications can be important. They can materialize in, for instance, inefficiently high costs due to overinflated bankruptcy filings, or job search (crowding) externalities when the formerly self-employed individual tries to find a job.

Despite a very large literature on incentive provision for wage earners' work effort (reviewed in Parsons, 1986) very little empirical research has been conducted on effort effects under asymmetric information for the self-employed, however. This is disappointing, as there is a number of theoretical contributions stressing the importance of incentivizing entrepreneurs through private contracts with a financier (Bergemann and Hege, 1998, Repullo and Suarez, 2000, Chakraborty and Citanna, 2005, Clementinti and Hopenhayn, 2006, and Newman, 2007). One of the few empirical papers is Paulson *et al.* (2006). Building on an occupational choice model of Aghion and Bolton (1997), they infer that moral hazard is consistent with the data: failure prevention is low on the agenda of low-wealth prospective entrepreneurs, so they will be either redlined or offered a costly incentive-compatible contract. Successful borrowers will then reduce their borrowing when wealth increases. This is observed in Thai cross sectional data.

We, instead, study the case of Denmark, where voluntary unemployment insurance (UI) is the main (partial) income insurance mechanism for self-employed, and we do find a way to show the existence of moral hazard and to precisely quantify its importance. Specifically, we examine to what

extent the transition from self-employment into unemployment can be attributed to moral hazard effects as opposed to adverse selection. This approach is reminiscent of another strand of the literature which has looked at the impact of UI on the subsequent duration of unemployment (see Mortensen, 1990, for a theoretical framework).

Our study also relates to the empirical insurance contract literature, since we are faced with the same difficulties to disentangle moral hazard from adverse selection (Chiappori, 2000, Cohen and Siegelman, 2010). However, in contrast to, for instance, car insurance settings (Abbring *et al.*, 2003), no price discrimination or experience rating takes place, as the UI ‘contract’ is ‘one-size-fits-all’ and the choice is ‘take-it-or-leave-it’.

The main idea of this paper is straightforward to understand, once the institutional context has been sketched. UI in Denmark is a large insurance program, but obtaining UI cover is at the discretion of the individual. Insurance is highly subsidized by the government, and applicants cannot be rejected.

While we can control for industry risk (or peer-group risk) to characterize unemployment risk classes, we need an instrument that captures variation in the demand for insurance without being correlated with unobserved factors in an equation measuring unemployment risk in order to identify moral hazard. Such an instrumental variable is provided by an orthogonal incentive to join the UI system: insurees have the option to participate in an early retirement (ER) program (de-coupled from social security) which is not available for non-insured. UI participants become ER-eligible if they sign up for UI 10 years before a certain threshold age. Half-way through our sample period the threshold age was lowered drastically by 10 years. This policy change provides the relevant variation in our instrument to be non-collinear with age or cohort effects that may be present in the data anyhow.

Figure 1 illustrates very neatly the force of the ER incentive, by showing for the cohort of males born in 1945 UI insurance rates as a function of time. The age threshold leads to a discrete jump of enrollment between ages 47 and 48 by 11.5 percentage points. The reform will lead to different cohorts having differential age thresholds.

Figure 1 about here

The exceptionally rich data we use constitute a 10% random sample of the Danish self-employed population, and come in the shape of classical panel data (longitudinal individual observations at annual frequency), spanning 20 years. All information derives from government registers, most notably

population registers and tax and benefit administration records.

The raw data suggest that insured self-employed have an exit rate to unemployment of almost 3 percent while the exit rate of uninsured self-employed is less than 1 per cent. The empirical estimation relies on a bivariate random effects probit model. Our data allows controlling for demographics, income, health, industry, etc., at a very detailed level. Furthermore, we also control separately for age, cohort and (restricted) time effects.

The bivariate probit results reveal that only about 30 percent of the original difference between insurees and non-insurees can be attributed to moral hazard, as the marginal effect of being insured is only about 0.6 percentage points. This effect is precisely estimated. The remaining 70 percent of the difference is generated by (adverse) selection or heterogeneity. This leads us to conclude that business failure is not predominantly due to lack of effort.

Summarizing the contributions of the present paper, we provide first-time empirical evidence on the relevance of moral hazard for entrepreneurs within a “large insurance program”. We provide a link between the risk of bankruptcy and incentives to insure that are unrelated to risk-reducing benefits of insurance, and show the identification of moral hazard through institutional design. We show empirically that the self-employed have a demand for insurance, and we take care of the endogeneity of insurance choice by exploiting exogenous variation in the sample that comes about by way of a policy change (‘natural experiment’).

Furthermore this paper adds to the scarce literature that empirically identifies and quantifies behavioral responses. Although these effects are identified in a particular setting, we believe that they resonate more general effort choices for entrepreneurs.

The remainder of the paper proceeds as follows. Section 2 provides relevant details on the main institutional features of the Danish UI and ER system. Section 3 contains our insurance model and puts it in the institutional context. Section 4 gives a brief data introduction, specifies clearly how our instrumental variable is defined and provides descriptives and the intuition of where identification comes from in the data. Section 5 contains a brief review of estimation strategy, presents estimation results and comments on sensitivity checks. Section 6 concludes.

2 Institutional Background

This section provides some background information on the Danish system applicable to the period under study (1981-1998).

The vast majority of firms in Denmark are small, unincorporated businesses in sole proprietorship. 90% of all firms have less than 10 employees (in 1999). Self-employed entrepreneurs have two main formal income insurance mechanisms at their disposal: bankruptcy proceedings and unemployment insurance. There are two types of proceedings in which the bankruptcy law foresees: those extending to corporate liabilities, and those intended for personal liabilities including debt of unincorporated businesses. The latter protection was included in the bankruptcy reform act of 1984 in Denmark, making discharge of some part of debt possible for small firms but typically involving a repayment plan out of income for the remainder of nondischarged debt.

We argue, however, that bankruptcy proceedings are not of first-order importance for the majority of self-employed entrepreneurs. Unlike in the United States where insolvency is not a necessary condition for bankruptcy and debt discharge, filing for bankruptcy in Denmark is tied to being “hopelessly indebted and [...] the proceedings [being] warranted by the circumstances of the debtor” (Alexopoulos and Domowitz, 1998). Out-of-court settlements are subject to rules and discretionary negotiation outcomes. Thus, bankruptcy, insolvency, and debt restructuring will apply only in the minority of cases where a self-employed person terminates his business. In many cases, decreasing or nonpositive profits will be reason enough to close shop, without being insolvent.

Rather, unemployment insurance provides the main mechanism to partially insure against income losses. Denmark is one of the very few countries where unemployment insurance is voluntary¹ and where, quite uniquely, also the self-employed can insure themselves along with wage employed workers (Schoukens, 2000).

The insurance system is organized around about 35 private, industry/occupation-specific unemployment insurance (UI) funds. A typical UI fund is a not-for-profit organization without selection restrictions for applicant members. UI funds finance UI benefits through membership fees, payroll taxes (‘arbejdsmarkedsbidrag’) and government subsidies.²

¹Sweden and Finland also have similar systems, see Parsons *et al.* (2003).

²Lentz (2009) reports that the average worker pays about 1/3 of the actual premium, the rest being subsidies.

Benefit duration can be characterized as generous in international comparison: this used to be 36 months during the 1990s, but has been changed to include activation programs with mandatory participation that starts within 12 months of first registration; maximum duration of UI benefits from 1996 onwards is 60 months.

The premium, or fee, paid by individual workers can amount to around 10,000 DKK per year, depending on age and insurance status.³

There are mainly two funds that focus on the self-employed, DANA and ASE. The funds are free (within legal limits) to determine regulation of benefit entitlements, although there tends to be close alignment. Self-employed's insurance status is restricted to always being full time. To illustrate, according to ASE⁴ regulations, the self-employed and entrepreneurs can file for UI benefits in cases where all of the following conditions apply.

- the UI fund membership has lasted for at least 12 months
- the applicant has worked at least 52 weeks full-time during the past 3 years, and has run his business for at least three years
- the applicant enrolls with the public job centre from the first day of unemployment
- the applicant is willing to take on any job as a wage employee; the benefit recipient must perform active job search while receiving compensation
- the business is sold, liquidated, or leased (mutually irrevocable for a period of at least five years).

The self-employed may also temporarily suspend their business and register as unemployed upon experiencing an extraordinary event. In such cases, the event must be beyond control of the self-employed and excludes ordinary industry risk (idiosyncratic exogenous shock). Incomes must have been critically exhausted.

The amount of the UI benefit is a function of an average of profits of the two best performing annual financial reports within the last five financial years during which the applicant was UI fund

³The fee covers both insurance premium, administration fee, and, as explained below, a contribution to the early retirement system, and may differ between UI funds.

⁴www.ase.dk

member. The parameters of that function are set centrally and are not at the discretion of the fund: the rate equals 90% of the average profit (excluding interests, including depreciations and labor market contribution), bracketed by a ceiling and a floor. The ceiling/floor correspond to that for workers.⁵ In the data, the vast majority (exceeding two in three) of self-employed would face potential benefits corresponding to the ceiling, and much of the rest (about one in five) would see potential benefits corresponding to the floor.

Jobless persons not covered by UI fund benefits, including those who have exhausted the maximum benefit period, can receive social assistance. The social assistance depends on spousal income and individual circumstances, but is for the vast majority considerably lower than the UI-benefit. To receive social assistance the requirements are that the person is registered as unemployed and is actively searching for a job. Municipalities can, however, coerce recipients to work in public sector jobs.

The Danish old-age retirement pension is compulsory and foresees in retirement from age 67 onward. Integrated in the UI fund system, however, is an early retirement (ER) option open to UI fund members, allowing retirement at a reduced pension from age 60 onwards. The ER scheme was introduced in 1979, with an eye towards general labor market conditions at the time, and politically supported with the argument that it would bring relief to ‘worn-out’ blue-collar workers. Access to the ER system is possible irrespective of whether an individual is a wage earner or self-employed. The latter have to sell their business before they can claim benefits. UI fund members aged 60 and older used to qualify if they had been enrolled in the UI system for the last 10 years, typically leading to a spike in the enrollment hazard at age 50, both for wage earners and even more pronounced for self-employed workers.

Importantly, there is no additional premium associated with benefiting from the ER plan. In other words, ER can be had at zero marginal cost for the interested participant. ER benefits correspond to the UI benefits, as discussed earlier. However, once an individual has commenced his ER period, other labor market activities, and hence additional income generation possibilities, are precluded.

OECD (2006) illustrates the incentive effects of the ER system (and its current implementation)

⁵The ceiling amounted to about 135,000 DKK p.a. in 1996, 173,000 DKK p.a. in 2006. 1000 DKK \approx 134 Euro. The floor amounts to 82% of the ceiling, and is essentially due to minimum wage regulation that applies for wage employed (thus, about 142.000 DKK p.a. in 2006). For temporary suspensions, the benefit rate equals 80% of the ceiling.

by showing that the ‘implicit tax on continued work’ from age 60 onward exceeded 50%. Due to these incentives and because of its generosity, ER became a very popular exit route from the labor force, but caused financial strain to the system and hampered productivity growth. The most important reform during the early 1990s concerned a policy shift in 1992 that required continued membership of at least 20 years before retirement, implying the latest age for joining a UI fund decreased to 40. Individuals aged between 40 and 50 in 1992 were required to join the UI fund in 1992 and stay members until 60 if they were to collect early retirement benefits. For reference, we shall denote members of the cohort unaffected by the 1992 reform as being subject to the 10-year-membership rule, while those who are falling entirely under the new regime as being subject to the 20-year rule. We shall show below that the empirically relevant variable for enrollment is the implied age threshold and not membership duration per se.

The ER system was substantially overhauled in 1999. We shall be looking at the situation in the years before the 1999 reform.⁶

During the sample period other self-employment-relevant policy changes were introduced. From 1986 to 1993, a special subsidy scheme was available that was aimed at the unemployed to setting up their own business. Eligible persons could receive 50% of the maximum unemployment benefit as a start-up allowance for a period of up to 42 months (iværksætterydelsen). With the advent of the 1994 labor market policy reform, which launched an array of active labor market programs, the scheme was re-designed (etableringsydelse), with maximum subsidy duration of 30 months, before it finally expired at the end of 1997. In our empirical work, we control for participation in such programs by way of including a dummy variable.

3 A Model of Unemployment Insurance Choice

We now turn to modeling the choice of insurance against unemployment. The model will deliver empirical equations that can be used to estimate individual unemployment risk, and will identify the moral hazard effect of insurance on experiencing unemployment.

⁶Focus of the reform was in particular flexibility in terms of retirement age and possibilities to continue paid work while receiving ER benefits. The reform also removed the tight link between UI fund membership and ER eligibility by making ER eligibility depend on a special contribution to the ER system (Beskæftigelsesministeriet, 2001, 2005).

The model is fairly standard and static, and incorporates the salient features of the Danish unemployment system, as detailed in Section 2. An individual has a take-it-or-leave-it choice in terms of UI.

The insurance contract offered by UI funds is a undifferentiated pooling contract: it specifies a single premium and a single benefit which do not depend on insuree characteristics. UI funds have no possibility of declining membership to an applicant. However, they receive substantial government subsidies. Subsidies render the insurance premium paid by insurees actuarially ‘unfair’ in the sense that the premium paid falls short of the expected loss.

As a consequence, UI funds are not concerned about selection issues, and there is no pricing response when the pool of insurees changes quality over time. No effort is made at separating the population of insurees in the system by offering a menu of contracts. Given these characteristics, we need not model the contract or any other decisions of the insurer.

Let us consider a utility maximizing agent whose utility function u depends on current consumption, C , and leisure, l . Since the model is static, consumption equals income. We make minimal assumptions on u .

Let $u(C, l)$ be twice differentiable and concave in each of its arguments, $u_1(C, l) > 0$, $u_2(C, l) > 0$, $u_{12}(C, l) = u_{21}(C, l) \geq 0$, $u_{11}(C, l) < 0$ and $u_{22}(C, l) < 0$. Income, and hence consumption, is a random variable since it depends on the state of the world. We consider two states: the agent is active as a self-employed entrepreneur, E , or he is unemployed, U . To simplify the exposition we normalize leisure to zero in state E , $l^E = 0$, and to one if unemployed, $l^U = 1$. Following Chiu and Karni (1998), we instead introduce a parameter $\gamma \geq 0$ capturing intensity of preferences for leisure in the utility function, such that $u = u(C, \gamma l)$.

Denote the probability of unemployment by $\pi \in [0, 1]$. The expected utility can then be written

$$E(u(C)) = (1 - \pi) \cdot u(C^E, 0) + \pi \cdot u(C^U, \gamma).$$

Unemployment risk is partially insurable by paying premium P . Let s indicate the insurance status ($s = 1$ if the agent is insured and 0 otherwise). If the agent is insured he receives unemployment benefits B when unemployed. Reflecting Danish institutions to first approximation, we assume B to be constant (i.e., independent of past earnings). If the agent is not insured he will receive social assistance (welfare), A , which is likewise constant. The difference between benefits and assistance

is that benefit eligibility is tied to UI fund membership when a premium must be paid. Assistance is available without payment of premia (see Kim and Schlesinger (2005) for an adverse selection model with private insurers and a government-provided consumption floor).

Allowing for additional non-labor income, the agent's consumption possibilities depend on the following sources:

Y^E : earnings (in state E)

Y^0 : non-labor market income (e.g., spousal or capital income)

B : unemployment benefit (if insured)

A : social assistance (if not insured)

P : premium for being insured

Consumption in state E is conditional on insurance status s and equals

$$C^E = Y^E + Y^0 - P \cdot s$$

and consumption in state U ,

$$C^U = Y^0 + A \cdot (1 - s) + (B - P) \cdot s$$

Furthermore, we assume that earnings net of the insurance premium exceed benefits net of premium, which in turn exceed social assistance,

$$Y^E - P > B - P > A. \tag{1}$$

This way, we avoid that social assistance, which an agent can collect without directly paying contributions, dominates incomes associated with participating in the labor market. For the purposes of this paper, we ignore feedbacks in a general equilibrium sense and those that run via the government budget constraint, and will therefore not model the financing of social assistance or the UI system.

Now, consider the possibility that the unemployment probability is partly chosen by the agent,

$$\pi = \pi(\theta, e).$$

We assume π depends on two factors: an exogenous individual risk component, θ , capturing both e.g. region-specific unemployment risk, but possibly also macro or industry risks, and secondly, effort

$e \in [0; 1]$.⁷ We assume $\pi(\theta, 0) = 1$, so that agents with strong preferences for leisure will purposely provide no effort to make sure that they will be unemployed. We make the following additional assumptions on first and second derivatives of π : $\pi_e < 0$, $\pi_{ee} > 0$, $\pi_\theta > 0$ and $\pi_{\theta e} > 0$. These imply first order stochastic dominance of $\pi(\theta, e^a)$ compared to $\pi(\theta, e^b)$ for any two effort levels $e^a > e^b$. The assumption implies that the probability of unemployment is decreasing in effort, but increasing effort has decreasing returns. Higher exogenous risk leads to a higher unemployment probability. And finally, for given increase of effort, the unemployment probability decreases more when exogenous risks decrease. Put differently, it is easier to prevent unemployment out of own effort when times are good.⁸

Effort is associated with utility costs (search or time cost, or cost of avoiding employment loss), denoted $f(e)$, with $f'(e) > 0$. Without loss of generality, we assume that $f(e) = \lambda e$, $\lambda > 0$.

The problem of the agent is to choose both insurance status s and effort e ,

$$\max_{s=\{0,1\},e} E(u(C, e)) = \max_{s=\{0,1\},e} (1 - \pi(\theta, e)) \cdot u(C^E, 0) + \pi(\theta, e) \cdot u(C^U, \gamma) - \lambda e.$$

The budget constraint, given that we consider a single period with fixed UI system parameters, is directly incorporated into consumption. To solve the problem we compare the optimal effort provided in the two cases where the agent is or is not insured, and then determine whether utility is higher with or without insurance.

For reference, we define the following symbols:

$$\begin{aligned} a &= u(Y^0 + Y^E, 0) - u(Y^0 + Y^E - P, 0) > 0 \\ b &= u(Y^0 + Y^E - P, 0) - u(Y^0 + B - P, \gamma) \leq 0 \end{aligned} \quad (2)$$

$$\begin{aligned} c &= u(Y^0 + B - P, \gamma) - u(Y^0 + A, \gamma) > 0 \\ d &= u(Y^0 + Y^E, 0) - u(Y^0 + A, \gamma) \equiv a + b + c \leq 0 \end{aligned} \quad (3)$$

Owing to our assumptions in (1), these magnitudes can be read off from Figure 2. Note that $d > b$.

We also may want to interpret b and d as functions of various income, preference, and insurance

⁷This is in line with the notation used in Chiu and Karni (1998). Essentially it makes deriving analytical results concerning moral hazard easier, a case we consider below.

⁸See Figure B.1 for illustration.

parameters, and define for reference

$$b = b(Y^0, Y^E, B, P, \gamma) \quad (4)$$

$$d = d(Y^0, Y^E, A, \gamma). \quad (5)$$

Figure 2 about here

3.1 Choice of Effort

3.1.1 Agent is Insured

If the agent is insured, his problem is

$$\max_e E(u(C, e|s = 1)) = \max_e (1 - \pi(\theta, e)) \cdot u(Y^E + Y^0 - P, 0) + \pi(\theta, e) \cdot u(Y^0 + B - P, \gamma) - \lambda e$$

From the first order condition

$$-\pi_e(\theta, e) \cdot u(Y^E + Y^0 - P, 0) + \pi_e(\theta, e) \cdot u(Y^0 + B - P, \gamma) - \lambda = 0$$

we get

$$\pi_e(\theta, e) = -\frac{\lambda}{b} \quad (6)$$

where b has been defined in (2). From our assumptions that $\pi_e < 0$ and $\pi_{ee} > 0$ follows that, conditional on θ , there is a unique optimal effort when insured, $e^{*I}(\theta)$. Unless we impose some sort of separability between θ and e , we will not be able to write e^{*I} as an explicit function, however.

In addition to interior solutions, depending on the specific functional form, there may be corner solutions, applying in the following two cases

$$e^{*I} = \begin{cases} 0 & \text{if } \lambda > -\pi_e(\theta, 0) \cdot b \\ 1 & \text{if } \lambda < -\pi_e(\theta, 1) \cdot b. \end{cases}$$

From the expression above follows that if $b < 0$ (the agent prefers to be unemployed with benefits over working with earnings) then $e^{*I} = 0$ and the agent will be unemployed. Assuming an interior solution we can sign the effects of various model parameters on effort:

$$e^{*I} = e(\theta, \lambda, \gamma, Y^E, Y^0, B, P).$$

$\begin{matrix} - & \leq 0 & - & + & - & - & + \end{matrix}$

The sign on θ is determined by our assumption that $\pi_{e\theta} > 0$ (otherwise, reverse), and the sign on λ is negative if $b > 0$.

It is also possible to show that effort decreases to zero as the UI replacement rate approaches unity,⁹

$$e^{*I} \rightarrow 0 \quad \text{if} \quad Y^E \rightarrow B^+.$$

For reference, denote the expected utility at optimal effort when insured as

$$Eu^I = (1 - \pi(\theta, e^{*I})) \cdot u(Y^E + Y^0 - P, 0) + \pi(\theta, e^{*I}) \cdot u(B + Y^0 - P, \gamma) - \lambda e^{*I} \quad (7)$$

3.1.2 Agent is Not Insured

If the agent is not insured the problem is

$$\max_e E(u(C, e|s = 0)) = \max_e (1 - \pi(\theta, e)) \cdot u(Y^E + Y^0, 0) + \pi(\theta, e) \cdot u(Y^0 + A, \gamma) - \lambda e$$

solving the first order conditions

$$-\pi_e(\theta, e) \cdot u(Y^E + Y^0, 0) + \pi_e(\theta, e) \cdot u(Y^0 + A, \gamma) - \lambda = 0$$

yields

$$\pi_e(\theta, e) = -\frac{\lambda}{d}. \quad (8)$$

Again, besides an (implicit) interior solution for e^{*0} , there may be corner solutions characterized by

$$e^{*0} = \begin{cases} 0 & \text{if } \lambda > -\pi_e(\theta, 0) \cdot d \\ 1 & \text{if } \lambda < -\pi_e(\theta, 1) \cdot d. \end{cases}$$

Again, if $d < 0$ then $e^{*0} = 0$. The signs of the derivatives of effort with respect to model parameters are as follows

$$e^{*0} = e(\theta, \underset{- \leq 0}{\lambda}, \underset{-}{\gamma}, \underset{+}{Y^E}, \underset{-}{A}, \underset{-}{Y^0}).$$

The sign on λ is negative if $d > 0$.

⁹See Appendix B.1 for details.

We shall refer to expected utility at optimal effort when not insured as

$$Eu^0 = (1 - \pi(\theta, e^{*0})) \cdot u(Y^E + Y^0, 0) + \pi(\theta, e^{*0}) \cdot u(A + Y^0, \gamma) - \lambda e^{*0}. \quad (9)$$

3.1.3 Moral Hazard

The effort undertaken by insured and uninsured agents can be compared due to our assumptions on derivatives of π and $d > b$. We find

$$e^{*0} \geq e^{*I}. \quad (10)$$

In addition, if $\lambda < -\pi_e(\theta, 1) \cdot b$ both insured and uninsured will provide maximum effort, $e = 1$, and if $\lambda > -\pi_e(\theta, 0) \cdot d$ no-one will provide any effort, $e = 0$.¹⁰ This behavioral effect (moral hazard) arises because of the cost of effort and the preference for leisure. If there is no cost of effort, $\lambda = 0$, and the preference for leisure is low such that $u(Y^0 + B - P, \gamma) < u(Y^0 + Y^E - P, 0)$ (i.e., $b > 0$) then there is no moral hazard problem, since in this case both insured and uninsured will provide maximum effort. On the other hand, if preferences for leisure are strong such that $u(Y^0 + A, \gamma) > u(Y^0 + Y^E, 0)$ (or, $d < 0$), then no-one will provide any effort, $e = 0$. Figure 3 illustrates the optimal effort as function of the marginal cost of effort, for the case that the relation between the two at an interior solution is linear.

Figure 3 about here

One can show several features associated with the moral hazard problem. We will say that the moral hazard problem becomes more pronounced if the difference between the effort provided by insured and non-insured, $e^{*0} - e^{*I}$, increases. The problem of moral hazard decreases if A increases, if P increases or if B decreases.¹¹

In general we can write the optimal effort as a function of insurance status, cost of effort and the various income sources:¹²

$$e^* = e(\underset{-}{\theta}, \underset{-}{s}, \underset{\leq 0}{\lambda}, \underset{-}{\gamma}, \underset{+}{Y^E}, \underset{-}{A}, \underset{-}{Y^0}, \underset{-}{B}, \underset{+}{P}).$$

¹⁰This case arises if $d < 0$ meaning that the agent prefers drawing social assistance to working.

¹¹This implies that the gain from being insured becomes smaller.

¹²Details of these derivatives are spelled out in Appendix B.1

Given optimal effort in the insured and non-insured state, we write

$$\pi^{*0} \equiv \pi(\theta, e^{*0}), \quad \text{and} \quad \pi^{*I} \equiv \pi(\theta, e^{*I}).$$

3.2 Choice of Insurance

3.2.1 Optimal Insurance Status

To find the optimal insurance status the agent compares the expected utilities (7) and (9), Eu^I and Eu^0 . Let $D = Eu^I - Eu^0$. The agent will choose to insure himself if $D > 0$. Using the notation introduced earlier, D can be written as

$$D = -a + (a + c) \cdot \pi^{*0} + b \cdot (\pi^{*0} - \pi^{*I}) - \lambda(e^{*I} - e^{*0}) \quad (11)$$

Notice that if there is no moral hazard problem (both insured and uninsured provide the same amount of effort) (14) reduces to $D = -a + (a + c) \cdot \pi(\theta, e^*)$.

3.2.2 Exogenous Risk

From (14) follows that agents with higher exogenous risk θ are more likely to insure themselves,

$$\frac{\partial D}{\partial \theta} = (a + c) \cdot \pi_{\theta}(\theta, e^{*0}) + [b \cdot (\pi_{\theta}(\theta, e^{*0}) - \pi_{\theta}(\theta, e^{*I}))] \geq 0.$$

The derivative will be zero only if $d < 0$.

Under this assumption, and assuming continuity, there will be a “threshold level of risk” $\tilde{\theta}$ where an agent is just indifferent between being insured or not $D(\tilde{\theta}) = 0$. Absent further restrictions on functional form of π , an explicit expression for $\tilde{\theta}$ cannot be given.

Agents with a low risk of unemployment ($\theta < \tilde{\theta}$), will choose not to insure themselves against unemployment ($s = 0$) while agents with a high risk of unemployment will take out an insurance ($s = 1$). We label this ‘adverse selection’.¹³

¹³We shall refer to the risk-insurance correlation as adverse selection, although our approach would go through if selection were advantageous (De Meza and Webb, 2001); we shall eventually be interested in isolating the effect of moral hazard.

The problem of adverse selection exists independently of whether the moral hazard problem is present. To see this, notice that the “threshold risk” in the absence of moral hazard ($\pi^{*0} = \pi^{*I}$) is determined by $\pi^{*0}(\tilde{\theta}, e) = \frac{a}{a+c}$. In this case, only high risk individuals choose to insure themselves.¹⁴

To illustrate how the cost of effort affects the likelihood of insurance, Figure 4 shows the “threshold risk” as a function of marginal effort cost.

Figure 4 about here

3.2.3 Other Determinants

One can show that the insurance decision is affected by the individual risk, the cost of effort and the income sources

$$s = s(\theta, \lambda, \gamma, Y^E, A, Y^0, B, P).$$

We remark at this stage that the effect of earned and unearned income cannot be signed in general. This also holds true for the effect of exogenous risk. If $b > 0$, the effect will be positive (as mentioned above).¹⁵

3.3 Identification of Adverse Selection and Moral Hazard

The presence of adverse selection can be identified if the insurance status is observed and individual risk is partially observed. Partition the individual exogenous risk into two components, $\theta = \bar{\theta} + \varepsilon$, of which $\bar{\theta}$ is observed by the econometrician, and ε is only known to the agent. Insurance status as a function of parameters is then given by

$$s = s(\bar{\theta} + \varepsilon, \lambda, \gamma, Y^0, Y^E, A, B, P).$$

Even if part of the individual risk is unobserved, a positive correlation between $\bar{\theta}$ and s indicates adverse selection.

¹⁴Likewise, adverse selection surfaces when agents with high preferences for leisure (such that $d < 0$) take up unemployment insurance. They also will provide no effort to be sure that they become unemployed. However, in this case there are both aspects of adverse selection and moral hazard.

¹⁵See Appendix B.1.

The main problem is to identify moral hazard. The problem arises because both ε and effort e are only known to the agent. To illustrate the identification problem, consider the impact of insurance status on the risk of becoming unemployed. We assume that agents have rational expectations of the risk of unemployment, implying $\Pr(U) = \pi(\theta, e)$. Since effort is unobserved we can use the expression for optimal effort

$$\Pr(U) = \pi(\theta, e(s, \lambda, \gamma, Y^0, Y^E A, B, P)).$$

The effect of effort could be detected through the effect of insurance status. Unfortunately, this will not work unless we are able to fully control for the effect of individual risk, θ . Using the partitioning into $\bar{\theta}$ and ε , the model can be written as

$$\begin{aligned} s &= s(\bar{\theta} + \varepsilon, \lambda, \gamma, Y^0, Y^E, A, B, P) \\ \Pr(U) &= \pi(\bar{\theta} + \varepsilon, e(s, \lambda, \gamma, Y^0, Y^E A, B, P)) \end{aligned}$$

The model predicts that being insured increases the likelihood of becoming unemployed through its effect on effort. However, the positive impact is caused by both moral hazard and adverse selection. Moral hazard implies that insured agents provide less effort which increases π , while adverse selection implies individuals with a high ε are more likely to insure themselves but also have a higher risk of unemployment. Therefore, the effect of insurance status on subsequent unemployment does not disentangle the moral hazard problem from adverse selection.

To overcome this problem, we exploit the early retirement feature of the Danish unemployment insurance system: for some agents (at some ages) additional benefits R associated with the insurance are available, which we model as additively enhancing utility. The problem of the agent is then

$$\max_{s \in \{0,1\}, e} E(u(C, e)) = \max_{s \in \{0,1\}, e} (1 - \pi(\theta, e)) \cdot u(C^E, 0) + \pi(\theta, e) \cdot u(C^U, \gamma) - \lambda e + sR.$$

Due to additivity, optimal effort conditional on insurance status is unaffected by the additional benefit. Optimal insurance status will, however, be affected positively. This implies that the problem is

$$s = s(\bar{\theta} + \varepsilon, \lambda, \gamma, Y^0, Y^E A, B, P, R) \tag{12}$$

$$\Pr(U) = \pi(\bar{\theta} + \varepsilon, e(s, \lambda, \gamma, Y^0, Y^E A, B, P)) \tag{13}$$

By using the variation in insurance status caused by the additional benefit we can identify the effect of insurance status solely caused by the moral hazard problem. The identifying assumption is that the retirement option is uncorrelated with the unobserved individual risk ε .

The empirical results presented below can be interpreted under this assumption. We shall devote some space below to discussing the validity of the instrument.

4 Data and Descriptives

4.1 Register Data

The CAM 10% Sample is based on a 10% random sample of the Danish population aged 16 and above from the Danish National Register. The data thus covers more than half a million individuals. Underlying the data are various administrative sources which are linked into a single large database. Sampled individuals are followed over time, annually, from 1981 onwards. We use all waves up to and including 1998. The sample is unbalanced in the sense that new qualifying residents (turning 16, or newly arrived immigrants) enter, whereas people leave due to death or emigration.

Due to its administrative nature, the data is very reliable in terms of measuring observable income reports and tax file status of individuals. In particular, any relevant fact that is related to receiving benefits is accurately observed, such as membership in a UI fund or labor market status. Labor market status is recorded in calendar week 48 (late November) of any given year. Individuals are classified self-employed according to their main economic activity in that particular week.

Individuals are ‘unemployed’ when registered as such with the job center. Registration, which is not limited to UI fund members, is a condition not only for receiving UI benefits,¹⁶ but also for receiving social assistance benefits. The data will therefore even record those as unemployed that are not eligible for UI benefits.^{17,18}

¹⁶We shall interchangeably speak of UI fund membership and being insured.

¹⁷We have no reason to presume that unemployed non-UI-fund-members may not register as being ‘unemployed’ and would be counted as ‘out of the labor force’ in the data. The transition rates from out of the labor force (in particular into employment) are the same for both UI fund members and non-members. If non-members actually had been unemployed we would expect them to a larger extent to return to employment.

¹⁸Further note that being registered as unemployed does not automatically imply receipt of benefits for UI fund members, but take-up rates are about 97%.

Unemployment can be measured in two ways. First, using the week-48 labor market indicator, we observe the stock of unemployed in that week. Second, the data records the ‘unemployment degree’ during the entire year, i.e., the fraction of time that UI benefits are received. In the empirical analyses we exploit both measures.

Due to its sheer size, the CAM 10% Sample covers a very large number of self-employed individuals and will hence reliably reflect population transitions in terms of labor market status and insurance membership. Sample size is important because of three reasons: (a) the level of self-employment in Denmark is rather low in cross-European comparison, (b) transitions are not very frequently observed and are essential for our analysis, and (c) as can be gleaned from the empirical literature on self-employment, there is substantial heterogeneity requiring large samples in order to reliably measure responses to policy variation and changes in characteristics.

We restrict the sample according a few observable variables, in order to reduce heterogeneity. First, we only consider Denmark-born males with Danish citizenship. Second, we restrict attention to the age group of 25-59 year olds, since we are primarily interested in individuals choosing UI fund membership and occupation before actually exiting into early retirement.¹⁹

We exclude students and individuals who are retired at the time of observation, as well as those who are out of the labor force in every year. We also require that any individual should have at least one employment spell over the entire observation period. We also exclude any remaining observations of persons receiving public pensions in a given year.

We exclude all individuals that in the period 1981-1998 have been working either as wage earners or self-employed in the agricultural sector. Sectoral change strongly affected employment opportunities for these people. Moreover, there are likely behavioral differences between farmers and other self-employed persons that are not easily explained by observables.

We retain a final sample of about 92,000 persons who are followed over up to 18 years, totalling 1.65m observations.

¹⁹The data reveal that among those self-employed who are eligible for early retirement, the vast majority actually does use this route out of the labor force.

4.2 Labor Market Status and Unemployment Insurance Status

Inspection of the raw data reveals that the sample grows with time, reflecting population growth and labor market expansion. Wage employment is the largest group with 83% on average, exhibiting a secular increase (from 81.4% to 86.6%). On average, 9% of all individuals in the sample are self-employed, with a strong negative time trend (10.3% in 1981 to 7.7% in 1998). Compared to other published statistics from Denmark the level is somewhat higher, owing to the fact that we only consider males aged 25-59, with self-employment being a predominantly male activity with strong age patterns. The unemployment rate exhibits typical cyclical patterns with a trough in 1986 and a peak in 1993, numbers closely matching other available statistics for prime-aged males. Around 2% of all sampled individuals are out of the labor force.^{20, 21, 22}

Figure 5 further breaks down self-employment (as percentage of the labor force) by time and year-of-birth cohort, for selected cohorts. Older cohorts appear to be more likely self-employed than younger ones (cohort effects, suggested by the ‘vertical difference’ between the various lines), while behavior also changes with age: the oldest cohorts appear to be leaving self-employment quicker, while the younger ones appear to become more likely self-employed as they grow older. Time effects (business cycle patterns) are less clearly visible.

Figure 5 about here

As stressed by Evans and Leighton (1989) transition studies are often more informative, so in Table 1 we show overall transition rates between labor market states, averaged over time. Of those being self-employed in one year, close to 90% are self-employed a year later. About 8% transit into wage employment, very few (between 1 and 2%) into unemployment or leave the labor market

²⁰Detailed figures are in Table B.1.

²¹Given our sample selection criteria, there is a small and heterogeneous group of people who are out of the labor force for reasons of long-term illness, labor market activation, but also for welfare reasons. Most of these receive either sickness benefits or social assistance.

²²In addition to the labor market states mentioned, a tiny proportion of the sample is originally classified as ‘on leave’: members of an unemployment insurance fund may, as from 1994 on, go on a paid leave for a number of reasons (child care, education, and others). In order not to complicate further analyses by introducing an additional labor market state, we re-classify these people according to their state of origin. Leave schemes became relatively popular around the time of first introduction, but popularity decreased markedly within a few years.

altogether. 95% of all wage earners in one year are wage earners a year later, less than 4% become unemployed, and a mere 1% transits from wage to self-employment.

Table 1 about here

Turning to UI fund membership, Figure 6 displays the percentage of UI fund members among those in the labor force by cohort and age. Again, we see a number of pronounced patterns in the data. The first panel relates to some of those cohorts that were subject to the rules before the policy change in 1992 ('10 year membership rule'), the last panel relates to those who were clearly subject to the new regime ('20 year rule'). The graph in the middle refers to some cohorts falling into the intermediary regime (compare Figure 1, discussed in the introduction). People from the 10-year-rule join UI funds as they get older, the curve flattening out towards them reaching age 60. There is clear upward jump in the figure at age 50. Likewise, we observe a distinct time effect for the people from the intermediary group whose enrollment hazard peaks sharply in 1992, the year when the new rule came into force and provided the incentive to join in that particular year and stay member for reasons of ER eligibility. The enrollment rate after 1992 for this group exceeds that of the 10-year-rule group by 5 percentage points (87 v 82 percent) at even earlier ages, suggesting that the law change may have pushed additional people into joining the insurance funds (perhaps those who did not want to forfeit the option for ER eligibility). Finally, the figures for the 20-year-rule group display likewise a pronounced jump at age 40. This group quickly (at early ages) reaches an enrollment rate of close to 85%.

Figure 6 about here

The last panel of Figure 6 reveals a pronounced dip in enrollment, occurring between 1989 and 1992, across all cohorts from the late group. This pattern is also present in official statistics. While we are not particularly concerned with explaining the underlying causes of the dip, its strong pattern does ask for comment. Some institutional changes between 1988 to 1989 in the UI legislation may provide a partial explanation, as it was no longer possible to work part-time and get an income supplement from the UI fund. A further investigation of the data also indicates that it is especially among the unemployed where UI fund membership falls (in 1988 71% of the unemployed were UI fund members, in 1989 only 60%). We have also looked at whether expiring UI benefit periods can

explain the dip, but found that they do not.

Whatever the reason, though, the dip presumably has to do with unemployment insurance rather than with early retirement incentives, which is the more important aspect for our purposes. In all empirical estimates discussed below we include a near-exhaustive set of time dummies, making sure that this peculiar pattern will not bias our results and compromise identification of the parameter of interest.

Splitting out the information in the graphs by labor market status (while suppressing the time/age and cohort information) shows in particular that the self-employed are far less likely than wage earners to be UI fund member. Across all years and ages, 3 out of 5 self-employed are UI fund members, as opposed to 4 in 5 wage earners.²³

Interestingly, if we split the sample according to whether (33%) or not (67%) an individual would be eligible for early retirement benefits (according to the institutional rules), the percentage among the self-employed who are member of a UI fund changes from 73% (eligible) to 53% (not eligible), whereas there is no dramatic change for wage earners (from 84% to 81%). This clearly suggests that the ER incentive to sign up for UI fund membership works particularly strongly for the self-employed.

Table 2 about here

It is instructive to have a look at UI fund entry rates, split by the years before and after the ER eligibility incentive is relevant. The numbers are in Table 2, where we condition on labor market status in year $t - 1$. The Table shows that (both self-employed and wage) workers are about equally likely to join a UI fund while the deadline for signing up in order to be eligible for ER incentives is not imminent. In the last year before the deadline, the self-employed have a clearly larger spike in the enrolment hazard than wage earners. The gap even widens after the deadline has passed (or has been missed).

In passing, we mention that exit rates from UI funds, while rather small in absolute levels, are twice as high for the self-employed compared to wage earners, for both the ones that are eligible (self-employed: 1.3%, wage earners: 0.7%) and the ones that are ineligible for early retirement (3.7% and 1.8%, respectively).

²³See Table B.2 for insightful figures.

The descriptives reported here suggest two things: (a) there is an insurance motive to join the UI fund, resulting in a transition rate into UI funds of roughly 10% (across employment types and time—this motive is present both before and after the reform); (b) there is an additional incentive to join the UI fund stemming from the ER plan, resulting in an additional 20% transition. It is the ER incentive that stimulates in particular the self-employed to join the insurance fund and to not subsequently leave it.

5 Estimation and Results

5.1 Econometric Approach

Following the exposition in the theoretical section, we proceed to estimate the effect of unemployment insurance on subsequently becoming unemployed. This can be most simply and transparently done using a binary regression estimating the probability of being unemployed in year t when the past state of origin is self-employment. We measure unemployment in year t by an indicator equal to one if the individual was registered unemployed in excess of 10% of the year (‘unemployment degree’), and zero otherwise.

We consider the sub-sample of people who have been self-employed in the first three years during which they are observed in the sample, conforming with the institutional rules for drawing benefits. We further restrict the estimation sample to those that are not classified as unemployed according to this measure in any of those three years. The latter restriction reduces the sample size very slightly.

Both the unemployment measurement and the sample exclusion are meant to reduce the number of individuals that temporarily dip into unemployment when in between jobs or ventures, as well as to clean out those that in the initial three-years period are partly self-employed and partly unemployed. We prefer to work with a sample allowing to observe actual transitions from (full-time) self-employment to unemployment, to obtain a cleaner estimate of the effect of interest. A sensitivity analysis (Section 5.4) will check some of the sample restrictions as well as specification choices. We are left with 13,434 individuals and 86,092 observations in the estimation sample.

Table 3 supplies summary statistics, broken down by insurance status in year $t - 1$. Clearly, those who are insured are more likely to transit into unemployment than those who are uninsured. The

difference is about 1.8 percentage points (also see Table 7). We see further pronounced observable differences between both groups. Some of the difference in unemployment between the insured and the uninsured may simply have to do with heterogeneity rather than behavioral responses: the insured subsample is, on average, more likely to be older, married, poorer (in terms of wealth or income), experienced (as wage earner), and receiving start-up support.

Table 3 about here

Introducing notation for the econometric model, let y_{jit}^* denote the latent variable j (say, the demand for insurance or the propensity to become unemployed) for individual i at time t . We model this as a function of a vector of observables x_{jit} , as well as unobservables ξ_{it} ,

$$y_{jit}^* = \beta_j x_{jit} + \xi_{it}.$$

We observe the indicator y_{jit} in the data

$$y_{jit} = \mathbf{1}[y_{jit}^* > 0],$$

where $\mathbf{1}[A]$ takes value 1 if A is true and zero otherwise. The specification of the probability model is completed by making assumptions on the structure and distribution of the unobservables. In particular, we shall assume that ξ_{it} equals the sum of a random individual effect η_{ji} and an error term ε_{jit} .

We choose a random effects model in order to be able to calculate marginal effects of the coefficient of interest on the probability of becoming unemployed. We do cross-check in the sensitivity analysis with a fixed effects approach.

Both random effects and errors are assumed i.i.d., the random effects (bivariate) normal, the errors (bivariate) standard normal,

$$\begin{pmatrix} \eta_{1i} \\ \eta_{2i} \end{pmatrix} \sim \mathcal{N} \left(0, \begin{pmatrix} \sigma_{\eta_1}^2 & \rho_{\eta} \sigma_{\eta_1} \sigma_{\eta_2} \\ \rho_{\eta} \sigma_{\eta_1} \sigma_{\eta_2} & \sigma_{\eta_2}^2 \end{pmatrix} \right)$$

$$\begin{pmatrix} \varepsilon_{1it} \\ \varepsilon_{2it} \end{pmatrix} \sim \mathcal{N} \left(0, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \right).$$

The univariate and bivariate random effect probit models are estimated by Maximum Likelihood. We rely on Gauss-Hermite quadrature and a Newton-Raphson optimization algorithm.

We start the analysis with estimating (standard) univariate random effects models for unemployment, y_{2it} , hence assuming $\rho = \rho_\eta = 0$, and include in x_{2it} the lagged insurance indicator y_{1it-1} . These estimates allow us to calculate the marginal effect of being insured on the probability of becoming unemployed as the difference in the predicted probability $\Pr(y_{2it} = 1|\cdot)$ when the insurance indicator y_{1it-1} is set to 1 and 0, respectively. The predicted probabilities are conditional on the observed regressor values in the sample, hence we calculate the sample average partial effect of insurance. Since the probabilities are also a function of the unobserved random effects, we integrate them out (Monte Carlo) using the estimated distributional parameters. These calculations are done post-estimation, and we do not display separate standard errors on these marginal effects.

The univariate models are interesting in their own right, as they may give us some understanding as to the importance of sorting in a heterogeneous population into unemployment. However, they are potentially misspecified in the sense that they disregard the endogeneity of insurance. To take account of the latter, we model the insurance decision by a function of observables and unobservables, and allow for cross-equation correlation among both the individual-specific effects and the idiosyncratic errors. Fully spelled out, the bivariate model is a recursive (or triangular) system of equations

$$\text{(insurance)} \quad y_{1it}^* = \gamma z_{it-1} + \beta_1 x_{it-1} + \eta_{1i} + \varepsilon_{1it} \quad (14)$$

$$\text{(unemployment)} \quad y_{2it}^* = \alpha y_{1it-1} + \beta_2 x_{it-1} + \eta_{2i} + \varepsilon_{2it} \quad (15)$$

as implied by (12) and (13).

We also introduce an instrumental variable into our insurance choice equation (14), the institutional rule of ER eligibility, z , to make sure that the identification of α is not coming from functional form assumptions. Given proper handling of the insurance endogeneity, the resulting average partial effects of insurance from (15) correspond to average treatment effects in the population of interest.

5.2 Empirical Specification

In all our models we control for age, cohort and time effects by including a cubic polynomial each in age and cohort together with a near-exhaustive set of time dummies. We do this to make sure that the instrument is not picking up age, cohort or time effects and that the identification only comes through the changes over year and cohort in the retirement eligibility rule. Clearly, specifications

allowing for linear functions of age, cohort, and time will not separately identify the three effects, unless certain restrictions are being imposed. Being very flexible in the age and cohort functions, we constrain the number of time dummies. There are at most 18 years from 1981 to 1998 per individual, and three years are being used to condition the sample on self-employment status. We thus use 12 time dummies for 1987-1998.

We use a specification that closely mirrors the economic model set out above but also controls for characteristics or conditions found relevant in the empirical literature.²⁴ The unemployment equation (15) should therefore include not only insurance status, but also observable risk, and proxies for the cost of effort and the marginal value of leisure (taste shifters) and human capital. Furthermore, we ought to control for own income and exogenous resources (such as spousal income and wealth).

Additional taste shifters included relate to marital status (“single”), having children of age 17 or younger living in the household, and the number of years of experience as wage-earner, which will pick up labor market attachment. We further wish to control for health as far as observable. Unfortunately, data limitations leave us no choice but to use the receipt of sickness benefits as health or illness measure. Finally, we control for whether a start-up allowance was received for persons entering self-employment from unemployment through active labor market programs.

Income from self-employment (surplus or profit of business) is included linearly, supplemented by a dummy whether it was negative. Income and wealth amounts are measured in constant 1981 million DKK.

Model parameters such as the unemployment insurance premium, and effectively also the unemployment benefit level have no or only marginal variation in the cross section. Their temporal variation will be picked up by the time dummies included. The potential social assistance cannot be calculated since it depends on an assessment of the individual’s needs. The risk indicators included vary across broad groups (region, industry, or education), and over time. Our standard specification relies on regional unemployment calculated from the micro data.

As indicated by the variable labels in the results tables, most regressors have been lagged at least once or three times. These lags ought to make sure that the value we condition on is pre-determined

²⁴Taylor (1999), Bates (1990) and Holmes and Schmitz (1996) found that human capital variables are important for the duration of self-employment. Carrasco (1999) focuses on aggregate labor market conditions that are important for exits from self-employment.

for the choice under consideration, and not a current choice variable that is determined jointly with the outcome variable of interest.

5.3 The Univariate Model

In Table 4 we present estimates of the univariate model for three different specifications. In Specification 0 we only include insurance status together with age, cohort and year effects. The standard deviation of the random effects distribution is very precisely estimated, indicating a substantial statistical contribution of the random effect to the model.

Table 4 about here

The estimation results show that membership of a UI fund has a large and significant positive correlation with unemployment. The average marginal effect is 2.2 percentage points and is hence in the same order of magnitude as the sample average unemployment probability: insured individuals are twice as likely to fall into unemployment than uninsured ones.

The marginal effect falls slightly to 2.0 percentage points when we include demographics and income variables (Specification 1). A likelihood ratio test reveals that inclusion of these observables that are partly suggested by theory are a statistically important addition to the model. We also note that these additional regressors have a noticeable impact on the implied marginal age and cohort effects.

It is conceivable that the risk to become unemployed also differs across regions, industries and education groups. We hence include additional sets of dummy variables (without displaying the estimated coefficients for brevity), giving rise to our preferred Specification 2. Education is a relevant proxy for both human capital and life-time earnings potential or permanent income, industry dummies pick up differential industry risks in bankruptcy and unemployment, and regional dummies allow for geographical differences in unemployment risk (local labor markets). Inclusion of these extra effects leads to a further significant improvement of the likelihood function, and the average marginal effect shows that insurees are 1.8 percentage points more likely to become unemployed than non-insurees.

However, these estimates do not reveal if this difference is due to selection or sorting effects caused by unobserved characteristics (heterogeneity) or due to moral hazard (the causal effect of insurance). We will return to this issue when discussing the results of the bivariate model.

We very briefly discuss the other covariates in the preferred Specification 2. Results show that

the probability of unemployment varies across age, industries, and education groups. Furthermore, we also find that spouse characteristics and health affect the probability; i.e. a non working spouse and illness increase the probability of unemployment. These effects are consistent with a model where a non-working spouse and illness increase the value of leisure or increase the cost of effort. The income and wealth variables also have a significant impact. Income as self-employed, wealth and spousal income all decrease the likelihood of unemployment. According to our theoretical model, non labor-market income such as spousal income and return on wealth should increase the probability, but in the current specification it is difficult to say if this is a pure income effect or if these measures also act as proxies of abilities or human capital e.g. via assortative matching. Finally, we find that self-employed who previously received support for start-up are more likely to become unemployed. Again, this can be due to lack of abilities. In general our results are consistent with those previously found in the literature.

5.4 Sensitivity Tests

Comparison of the magnitudes of marginal effects of insurance on unemployment in Table 4 bears evidence to a fundamental robustness to specification choices. To corroborate this further, we estimate a number of additional specifications. Whereas the univariate model is not the focus of this paper, it turns out that estimating the full bivariate model is computationally very demanding, and we will hence need to confine ourselves to checking the sensitivity of the univariate baseline to specification and sample changes. The main conclusion drawn from the exercise is that the estimates are remarkably robust. In addition, the insurance equation (14) in the bivariate model is quite well determined. We are thus confident that the robustness of the estimates will prevail in the more general bivariate model.

Results of the sensitivity checks are in Table 5, where we report the estimates of our key parameter α , the coefficient on the UI insurance status and the associated marginal effect. Full results are available on request.

Table 5 about here

The first variation replaces the random effects probit with a fixed effects logit model. Sample size is reduced to a tenth, as only observations with changes in the dependent variable (unemployment)

contribute to the likelihood. We exclude industry, education, region, and past experience from the specification, since there are only very few individuals who change category in any of those measurements. The coefficient and standard errors displayed are rescaled with factor $\sqrt{3}/\pi$ to make them comparable to the probit metric. The rescaled coefficient is very close to the probit estimate. Given that the fixed individual effect is conditioned out of the likelihood, we are unable to provide comparable marginal effects.

In the second deviation we define our indicator of unemployment based on labor market status in week 48 (i.e., the measure displayed in Tables 1 and 2), instead of the measure that refers to the whole year. We estimate an unchanged coefficient, although a somewhat smaller marginal effect. Using this unemployment definition does however lead to convergence problems in the bivariate model that we want to focus on.

In the next two variations we replace the aggregate risk measure ‘regional unemployment rate’ with (1) an education-specific unemployment rate (calculated from the micro data) and with (2) an industry-specific bankruptcy rate (available as a separate series from Statistics Denmark, from 1984 on). The estimates are unchanged for the education-specific unemployment rate, and only slightly lower for the bankruptcy rate.

Next, it may be of interest to explore if different subgroups of the population experience different speeds of falling into unemployment. The risk may be particularly high for declining industries, since upon receiving a shock that pushes the firm towards bankruptcy it will be more difficult for the self-employed entrepreneur to steer away from unemployment if in general the industry does not support as many firms as previously. We flag as declining industries those whose share show a marked decrease in our estimation sample. These are manufacturing and retail. We do not, however, find significant heterogeneous effects.

The sixth specification excludes income-related variables and wealth. While those are significant in the baseline, and their exclusion impacts on some of the other coefficients in the model, the parameter of interest is virtually unaffected, and hence there is no bias from including these potentially non-exogenous variables. The seventh variation draws a different sample, but estimates the same model: here, we only condition on being self-employed (and not unemployed) in the first year. Whereas the sample grows by a quarter, the marginal effect of insurance is unaffected.

5.5 The Bivariate Model

The estimation results of the bivariate model are shown in Tables 6a and 6b. Across all specifications, the random effects modeling is a valuable addition in a statistical sense. We do note, conforming with intuition, that the estimated random effects standard deviations (σ_{η_1} and σ_{η_2}) decrease as more and more observables are being added to the model. At the same time, both correlation coefficients ρ and ρ_{η} are robustly and precisely estimated, with the random effects correlation ρ_{η} being about twice as large as the idiosyncratic error correlation ρ . As these correlations are large and positive, our bivariate modeling approach is indispensable. The same unobserved factors that lead people to choose insurance also predispose them to unemployment.

Table 6a about here

Commenting briefly on the estimates, we consider the insurance equation first (Table 6a). We find that the instrument (the retirement incentive) has a large and significant effect on the likelihood to be insured in all three specifications. The Wald test statistics (χ^2 -distributed with 1 degree of freedom) for the instruments to be relevant varies between 37.7 and 79.9 across the specifications displayed. This indicates that we do not have a problem with weak instruments.

The average marginal effect (separately displayed in Table 7) of the presence of the retirement incentive varies from 2.9 to 3.7 percentage points across specifications. It is smaller than the raw data suggested (Figure 6), but does control for both observed and unobserved heterogeneity. In particular, we control for age, cohort and year effects in a very flexible way and do not impose any particular pattern on the data. We view this as convincing evidence that the measured effect is not due to a pure age or cohort or time effect but is in fact separately identified by the changing retirement incentive.

Continuing with a focus on the preferred Specification 2, the Table shows that the probability of being insured against unemployment also varies across background characteristics. All income variables have a negative effect although it is only spousal income that is significant. Wealth enters significantly negatively. Previous labor market experience as wage earner has a strong positive impact on the likelihood of being insured, owing to the higher insurance rate among wage earners. Persons who previously have received support to start up their business are more likely to be insured, which may be explained by the institutional setting. Among the less intuitive results we find that the regional

unemployment rate has a negative impact. Note, however, that we have controlled for both year and regional effects, so the displayed coefficient on the unemployment rate reflects only the remaining variation.

Table 6b about here

Turning to the equation for unemployment in Table 6b, we still find a positive and significant effect of the insurance on the probability of subsequent unemployment. However, both coefficient and average partial effect have dropped to 0.6 percentage points—a mere third of that in Table 4. We shall return to this observation in Section 5.6. The estimated effects of the remaining covariates do not differ much from the univariate specification in terms of significance and sign.

Table 7 about here

5.6 Assessment and Interpretation

In order to get some idea how well the model fits the data, we look at some summary measures of predicted values. Table 8 predicts probabilities for insurance choice (\hat{P}_{1it}) and unemployment (\hat{P}_{2it}) from the estimated parameters for each observation, while integrating out the random effects. Comparing to sample averages in the data, the average predicted probability for being insured is quite close to the observed average indicator. The model clearly overpredicts unemployment, however. It is, in other words, very difficult to predict unemployment at the level of the individual observation, despite a number of highly significant covariates in the regression, not least due to the fact that the relevant observations are in the extreme tail of the distribution.

Table 8 about here

Alternatively, we construct per observation the indicator whether or not the predicted probability exceeds the threshold of 0.5 (i.e., $\hat{P}_{jit} > 0.5$), and use this as the predicted dummy variable. The distribution of these dummies is very different from the data, however. One reason is certainly the fact that the marginal distribution of predicted probabilities is left skewed for the insurance choice and strongly right skewed for the unemployment incidence.

Leaving the predicted dummies unchanged will hence make it impossible to assess in how far the model reflects the correlation in the data. We therefore change the threshold τ_j (i.e., $\hat{P}_{jit} > \tau_j$)

from which on we classify an observation as being insured or unemployed, such that the marginal distributions of the predicted dummies match those in the data. The bivariate distributions in Table 9 show that the model picks up the correlation in the data reasonably well, although much of the covariation is already captured by the simplest Specification 0.

Table 9 about here

There are two conditions that a good instrument has to fulfil. First, it needs to be correlated with the instrumented variable. Figure 1 and the first stage estimation (see Table 6a) clearly show that this is the case. Second, there must be no correlation between the error in the outcome equation and the instrument. Following Angrist *et al.* (1996), the IV assumptions can be rephrased from a potential-outcomes perspective by putting the emphasis on a valid exclusion restriction and a monotonicity assumption. These imply that there is no direct effect on the outcome from the instrument, except through ‘treatment’ (insurance), and that there are no ‘defiers’.

The latter means in our application that there is no-one who would be insured if being ER-ineligible but not if being ER-eligible. We can reasonably rule out such behavior since ER benefits can be had at zero marginal cost for the insuree, and hence becoming eligible will not drive individuals out of insurance.

Moving on to a short discussion of the economic interpretation, the bivariate model identifies the effect of having an insurance on subsequent unemployment through the parameter α in (15), when the selection into insurance (14) is adequately modeled. This is what we call moral hazard, occurring conditional on being insured.

The treatment effect α in the bivariate model is quite precisely estimated and its magnitude does not diminish as we add in more observable variables into the model, compare Table 7. Since moral hazard is essentially a story of unobservables (‘hidden action’), the structural equation allows us to estimate an upper bound, but as the results presented here suggest, this upper bound is quite tightly estimated.

Our results are broadly in line with related studies that focus on moral hazard effects, albeit in different contexts. The study by Chetty (2008) finds that moral hazard effects explain at most 40% of the increased unemployment duration caused by increased UI benefits. Also the results in the insurance literature seem to only find residual moral hazard of lesser importance (e.g., Chiappori and

Salanié, 2000, or Abbring *et al.*, 2003).

6 Conclusions

In this paper we empirically identify and estimate the magnitude of moral hazard effects among self-employed in an environment where a partial insurance mechanism exists against income loss. Such insurance systems (exemption levels and debt discharge in bankruptcy proceedings are one example) are of first-order importance for individuals' willingness to take on large risks.

Although moral hazard plays a prominent role in the theoretical literature that studies incentive provision through contracts when the entrepreneur contracts with a financier, empirical evidence on the existence and magnitude of moral hazard effects for the self-employed is scarce.

We do provide such evidence. We examine to what extent the transitions from self-employment to unemployment are due to the mere fact that the person is (voluntarily) insured against unemployment risk. In keeping with the usual interpretation in the insurance literature, we view such effects as evidence of lack of effort to prevent business failure.

The empirical specification takes the form of a bivariate random effects probit model for insurance choice and unemployment incidence, estimated on a large longitudinal sample of self-employed individuals drawn from register data. To disentangle such moral hazard effects from adverse selection we use an institutional feature of the Danish UI system that provides an additional motive (an early retirement option) for taking up insurance at certain ages. We exploit an eligibility reform of this early retirement option within our sample period as an instrument ("natural experiment") to achieve identification.

To summarize our results, we find that the raw data suggest that insurees are more likely to subsequently become unemployed than the uninsured. The difference in transition rates is about 1.8 percentage points, and hence very sizeable compared to a raw unemployment rate of about 2 percent in the sample.

This observed difference will be due to both adverse selection and moral hazard. Correcting for age, time, and cohort effects in a univariate model, the marginal effect of insurance actually increases to 2.2 percentage points. If we furthermore control for individual characteristics the marginal effect of insurance decreases again to 1.8 percentage points.

Moving to the bivariate model, the marginal effect drops to 0.6 percentage points. This suggests that of the original difference only about 30 percent is due to moral hazard, while the remaining 70 percent is due to heterogeneity or sorting. The main contribution of this paper is thus to be able to establish the existence of moral hazard and to quite precisely estimate its magnitude. To our knowledge this is the first study that quantifies the moral hazard effect among self-employed and we provide first-time empirical evidence on the relevance of moral hazard for entrepreneurs within a “large insurance program”. The overall magnitude is not very big, however, such that only a limited proportion of business failure can be attributed to the lack of effort.

Many if not most countries will exclude the self-employed from UI or other formal insurance mechanisms, possibly for fear of them exploiting the system. Our results suggest, however, that the Danish system that is in some sense particularly vulnerable to such behavior, does not suffer from moral hazard to a large extent. There is reason to believe that these behavioral responses are probably higher in the context of the actual system than would be if the insurance parameter choice (premium, maximum amount and duration of benefits, etc.) were to optimally anticipate on such behavior. Hence, provision of or easing access to insurance to the self-employed in other countries may deserve consideration.

In addition, to the extent that moral hazard in the unemployment insurance as measured in this paper is closely correlated with moral hazard behavior at the individual level in other areas, we might suspect that the latter will also be limited for instance in the relation between a financier and a self-employed entrepreneur.

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A Figures and Tables

Figure 1: UI Choice and Change of ER Eligibility (cohort born 1945)

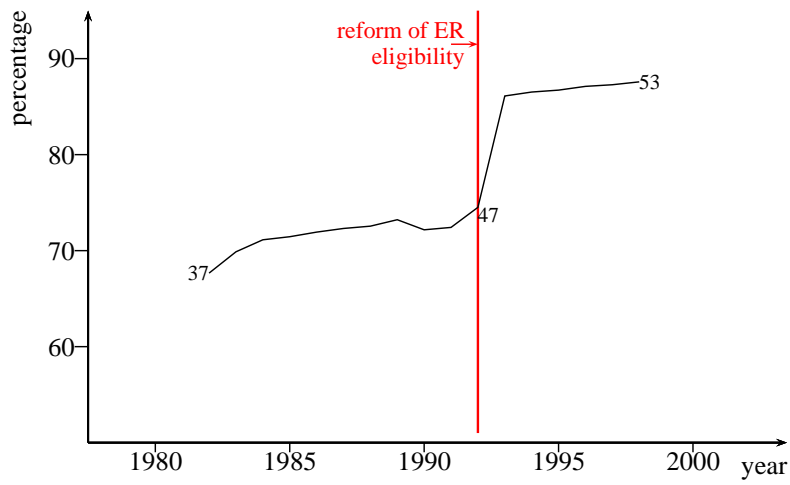


Figure 2: Utility of Consumption

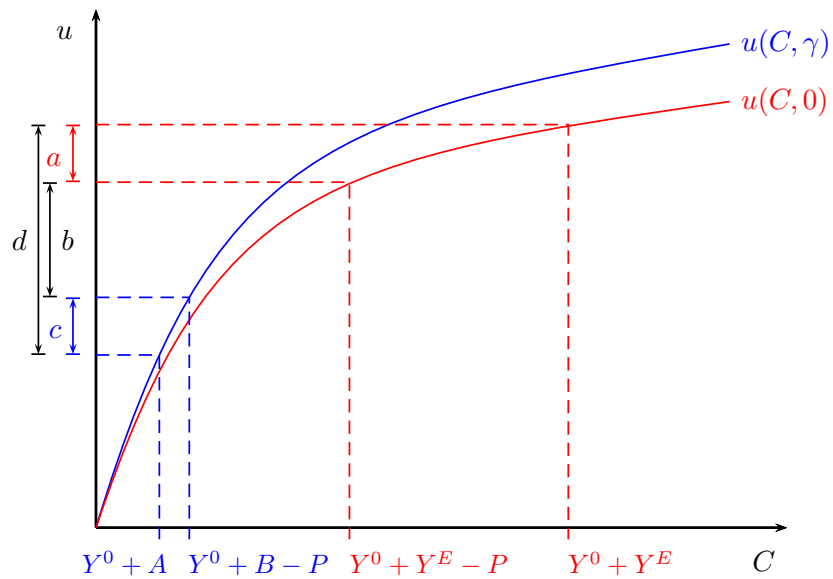


Figure 3: Effort and Cost of Effort

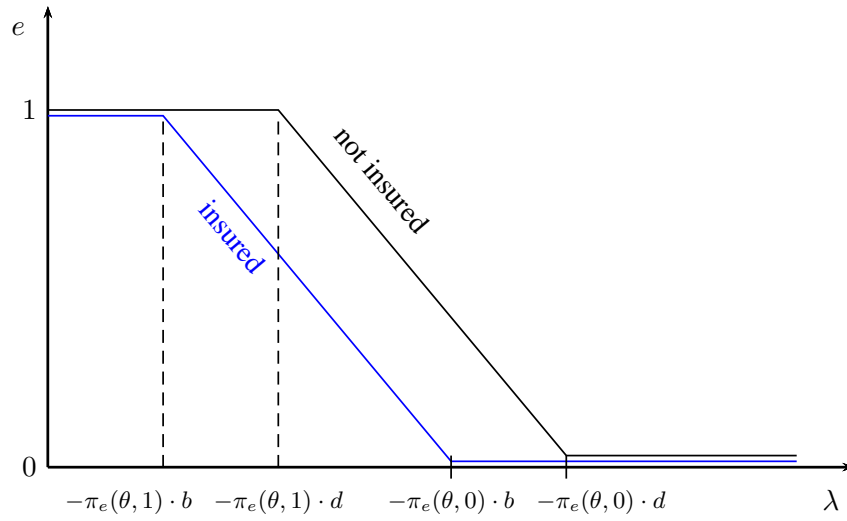


Figure 4: Insurance and Cost of Effort

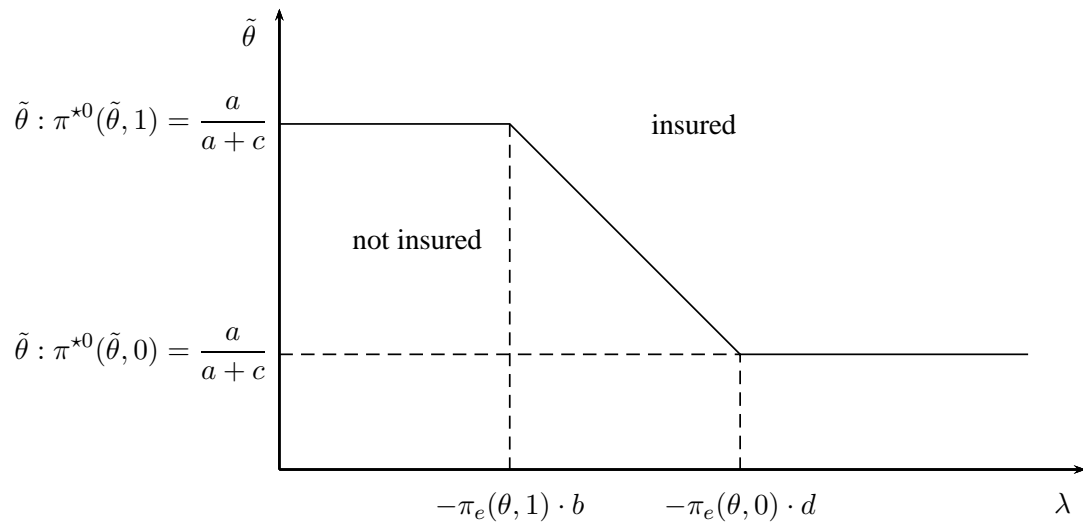


Figure 5: Self-employment by year-of-birth cohort and year in percent of labor force

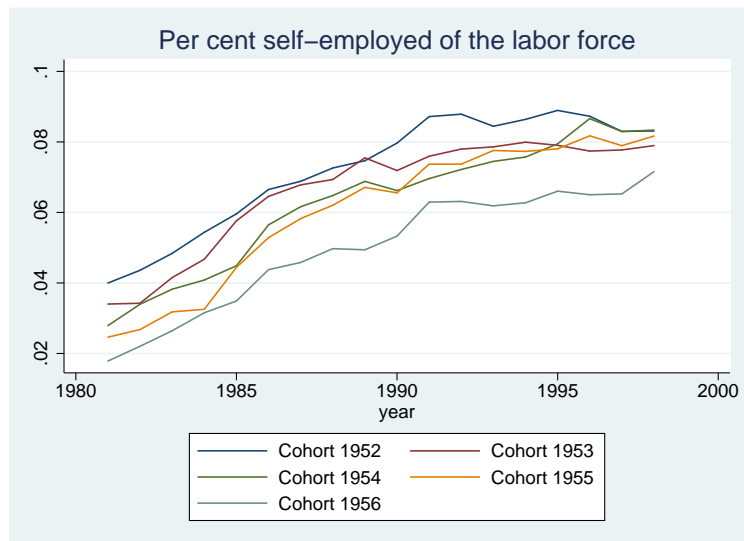
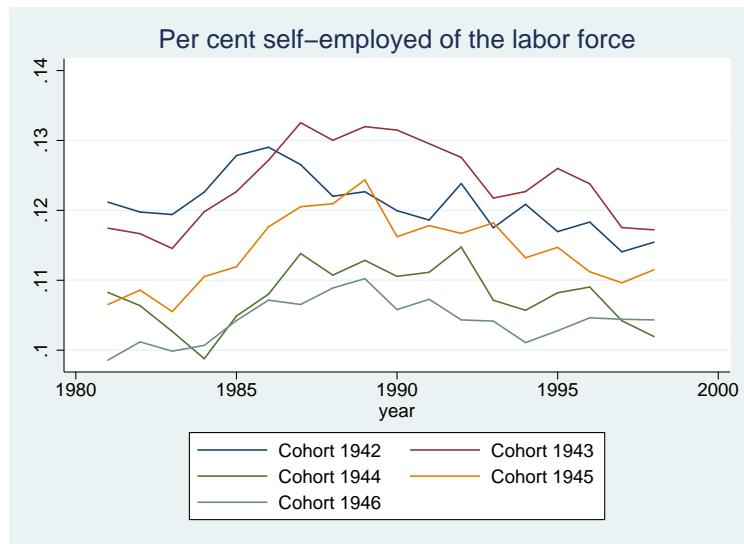
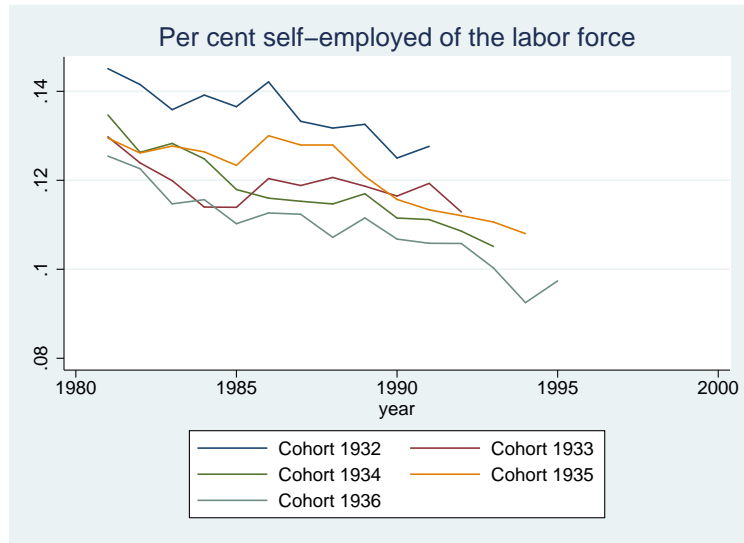


Figure 6: UI Fund Membership as Percentage of Labor Force

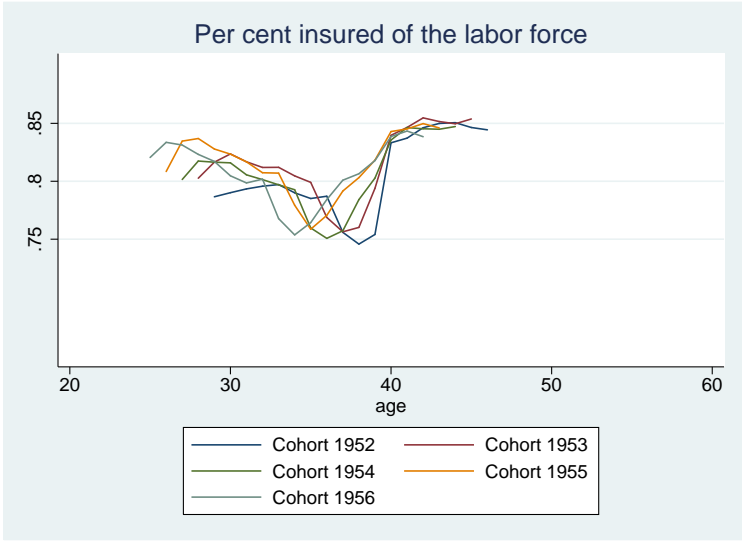
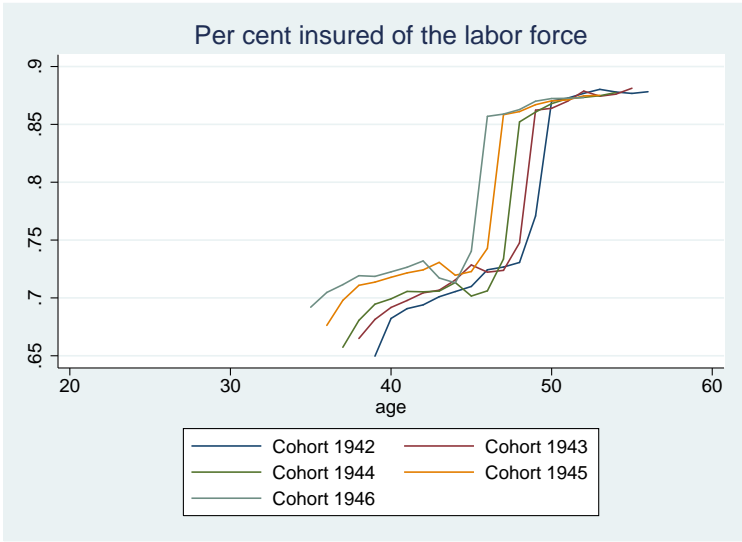
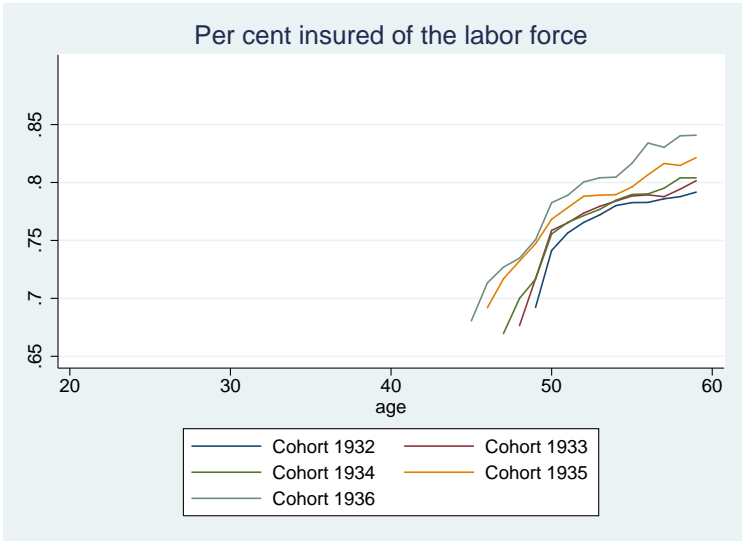


Table 1: Overall Transition Rates between Labor Market States

labor market status year $t - 1$	labor market status, year t				Total
	self-employed	wage earner	unemployed	out of LF	
self-employed	88.87	7.67	2.02	1.44	132,203
wage earner	0.94	94.84	3.49	0.72	1,256,712
unemployed	2.62	47.06	42.84	7.49	93,542
out of LF	6.68	27.76	14.44	51.12	28,341

Note: row percentages, totals are frequencies. LF: labor force. *Source:* CAM 10% Sample, Danish males 25-59, and further restrictions (see text).

Table 2: Joining UI Fund by Labor Market Status and Force of ER Incentive

UI fund entry between $t - 1$ and t	labor market status, year $t - 1$			
	self-employed	wage earner	unemployed	out of LF
all years before ER eligibility				
no	90.51	91.40	85.97	89.70
yes	9.49	8.60	14.03	10.30
last year to sign up in order to be ER-eligible				
no	69.90	71.73	89.25	90.08
yes	30.10	28.27	10.75	9.92
years after eligi- bility incentive (no ER gain from joining)				
no	88.81	91.20	91.95	94.43
yes	11.19	8.80	8.05	5.57

Note: column percentages. LF: labor force.
Source: CAM 10% Sample, Danish males 25-59, and further restrictions (see text), and not UI-fund member in $t - 1$.

Table 3: Means, Estimation Sample

Variable	All	uninsured, $t - 1$	insured, $t - 1$
UI fund member, t	0.654	0.091	0.983
at least 10% of time unemployed, t	0.019	0.008	0.026
early retirement eligibility, $t - 1$	0.447	0.301	0.532
age	46.3	44.7	47.3
year of birth	1944.4	1944.9	1944.0
regional unemployment rate, $t - 1$	0.066	0.065	0.067
age spouse, $t - 1$	37.1	33.8	38.9
spouse does not work, $t - 1$	0.078	0.098	0.066
total income spouse, $t - 1$	80,005.7	76,871.8	81,833.7
income from self-employment, $t - 3$	189,751	200,617	183,413
had negative income from SE, $t - 3$	0.025	0.030	0.022
wealth, $t - 1$	128,175	183,480	95,916
experience (years) as wage earner, $t - 3$	7.5	6.5	8.1
receipt sickness benefits, $t - 1$	0.002	0.002	0.002
marital status: single, $t - 1$	0.137	0.177	0.113
children age ≤ 17 living at home, $t - 1$	0.505	0.567	0.468
SE start-up support, $t - 3$	0.013	0.003	0.019
Number of observations (NT)	86,092	31,717	54,375
Number of individuals (N)	13,434		

Source: CAM 10% Sample; Danish males, 25-59, selfemployed in previous three years, and further restrictions (see text).

Table 4: Transitions from Self-employment to Unemployment (Random Effects Probits)

variable	at [†]	Specification 0			Specification 1			Specification 2		
		coeff.	std. error	marg. effect [†]	coeff.	std. error	marg. effect [†]	coeff.	std. error	marg. effect [†]
UI fund member, $t - 1$		0.5779	0.039***	2.233	0.5450	0.036***	1.992	0.5031	0.036***	1.81
age	25	0.3673	0.174**	0.479	0.4082	0.160**	0.115	0.3070	0.162*	-0.40
age squared/100	35	-0.9651	0.383**	0.028	-0.9672	0.350***	0.015	-0.9357	0.351***	-1.94
age cubed/1000	45	0.0847	0.028***	0.113	0.0804	0.026***	0.009	0.0782	0.026***	-1.83
	55			0.376			0.008			-0.32
cohort/10	1940	-1.2032	1.001	0.007	-1.1072	0.889	0.021	-1.8592	0.932**	0.00
cohort squared/100	1950	0.3002	0.214	0.013	0.3055	0.186	0.048	0.2938	0.187	0.00
cohort cubed/10000	1960	-0.2111	0.157	0.010	-0.2153	0.136	0.060	-0.2152	0.137	0.00
	1970			-0.009			0.002			0.00
regional unemployment rate $\times 10$, $t - 1$					0.1834	0.093**	0.804	-0.3669	0.212*	-1.58
age spouse/100, $t - 1$					-0.1246	0.273	-0.546	0.0563	0.272	0.24
spouse does not work, $t - 1$					0.1151	0.044***	0.547	0.1371	0.044***	0.65
total income spouse, $t - 1$ [100kDKK]					-0.1749	0.030***	-0.766	-0.1540	0.030***	-0.66
income from self-employment, $t - 3$ [mDKK]					-0.9078	0.086***	-3.978	-0.7833	0.086***	-3.37
had negative income from SE, $t - 3$					-0.0286	0.069	-0.123	-0.0055	0.069	-0.02
wealth, $t - 1$ [mDKK]					-0.0824	0.014***	-0.361	-0.0712	0.013***	-0.30
experience [100 years] as wage earner, $t - 3$					0.4213	0.218*	1.845	0.0320	0.224	0.13
receipt sickness benefits, $t - 1$					0.4917	0.171***	3.244	0.4499	0.170***	2.80
marital status: single, $t - 1$					0.1282	0.128	0.603	0.2040	0.129	0.98
children age ≤ 17 living at home, $t - 1$					-0.0967	0.033***	-0.419	-0.0598	0.033*	-0.25
SE start-up support, $t - 3$					0.3038	0.077***	1.706	0.3289	0.077***	1.84
[12] year dummies (p -value)		0.0000			0.0000				0.0000	
[6] education dummies (p -value)		—			—				0.0001	
[14] industry dummies (p -value)		—			—				0.0000	
[7] region dummies (p -value)		—			—				0.0726	
σ_η		0.7969	0.061***		0.5124	0.061***		0.4802	0.0634***	
Log-likelihood:		-7,883.3			-7,674.6				-7,482.6	

Notes: Sample description: see Table 3. Asterisks indicate significance levels: *** 1% or less, ** 5% or less, * 1% or less. [†]The column labeled 'at' denotes ages and birth years at which the marginal effect of an additional year is calculated. All marginal effects expressed as percentage point changes.

Table 5: Variations on Spec. 2, Table 4

variation	UI fund member, $t - 1$			NT	N	log-lik.
	coeff.	std.err.	m.eff.			
baseline (Spec. 2, Table 4)	0.5031	0.036***	1.817	86,092	13,434	-7,482.6
fixed effects logit [†]	0.5542	0.127***	—	8,234	1,358	-1,187.5
unempl. status as depend. var.	0.5076	0.043***	1.308	86,066	13,434	-5,609.0
education/year-spec. unempl. rate	0.5023	0.036***	1.815	86,092	13,434	-7,484.1
industry/year-spec. bankruptcy rate	0.4615	0.038***	1.619	76,532	12,479	-6,521.5
interact with declining industries dummy	0.4830	0.039***	1.751	86,092	13,434	-7,481.9
excl. income variables	0.5115	0.037***	1.879	86,092	13,434	-7,555.5
sample conditioned on 1 year self-empl.	0.4002	0.027***	1.866	108,419	17,640	-11,328.8

Notes: Sample description: see Table 3. Asterisks indicate significance levels: *** 1% or less, ** 5% or less, * 1% or less. All marginal effects expressed as percentage point changes. [†]Logit coefficient and standard error estimates rescaled with $\sqrt{3}/\pi$.

Table 6a: Insurance Choice and Transitions from Self-employment to Unemployment (Bivariate Random Effects Probits) — Insurance Choice

variable	Specification 0		Specification 1		Specification 2	
	coeff.	std. error	coeff.	std. error	coeff.	std. error
early retirement eligibility, $t - 1$	0.3749	0.042***	0.3710	0.042***	0.2804	0.046***
age	-2.0406	0.147***	-2.0553	0.152***	-2.5554	0.156***
age squared/100	5.1915	0.328***	5.1530	0.335***	5.9729	0.346***
age cubed/1000	-0.3655	0.024***	-0.3642	0.025***	-0.4224	0.026***
cohort/10	2.9370	1.181**	1.3254	1.317	-1.0056	1.258
cohort squared/100	0.4040	0.259	0.6577	0.282**	0.7904	0.272***
cohort cubed/10000	-0.5313	0.188***	-0.6965	0.201***	-0.7287	0.197***
regional unemployment rate $\times 10$, $t - 1$			-0.1712	0.098*	-0.6527	0.186***
age spouse/100, $t - 1$			1.0753	0.299***	2.7567	0.325***
spouse does not work, $t - 1$			-0.2264	0.041***	-0.3060	0.041***
total income spouse, $t - 1$ [100kDKK]			-0.1156	0.022***	-0.0630	0.025**
income from self-employment, $t - 3$ [mDKK]			-0.2317	0.053***	-0.0267	0.061
had negative income from SE, $t - 3$			-0.0570	0.065	0.0804	0.066
wealth, $t - 1$ [mDKK]			-0.0467	0.012***	-0.0408	0.013***
experience [100 years] as wage earner, $t - 3$			1.4688	0.290***	4.5176	0.435***
receipt sickness benefits, $t - 1$			-0.2855	0.248	-0.3080	0.218
marital status: single, $t - 1$			-0.1461	0.132	0.4012	0.141***
children age ≤ 17 living at home, $t - 1$			-0.1280	0.029***	-0.1729	0.033***
SE start-up support, $t - 3$			1.1897	0.157***	1.0160	0.139***
[12] year dummies (p -value)	0.0000		0.0000		0.0000	
[6] education dummies (p -value)	—		—		0.0000	
[14] industry dummies (p -value)	—		—		0.0000	
[7] region dummies (p -value)	—		—		0.0000	

Notes: Sample description: see Table 3. Asterisks indicate significance levels: *** 1% or less, ** 5% or less, * 1% or less.

Table 6b: Insurance Choice and Transitions from Self-employment to Unemployment (Bivariate Random Effects Probits) — Unemployment Incidence

variable	Specification 0		Specification 1		Specification 2	
	coeff.	std. error	coeff.	std. error	coeff.	std. error
UI fund member, $t - 1$	0.1312	0.062**	0.1406	0.057**	0.1512	0.057***
age	0.2397	0.181	0.2955	0.168*	0.2098	0.168
age squared/100	-0.6448	0.398	-0.6829	0.367*	-0.6914	0.365*
age cubed/1000	0.0630	0.029**	0.0609	0.027**	0.0613	0.027**
cohort/10	-1.3630	1.052	-1.2743	0.937	-2.0307	0.973**
cohort squared/100	0.4139	0.226*	0.4089	0.197**	0.3787	0.196*
cohort cubed/10000	-0.3119	0.166*	-0.3061	0.145**	-0.2857	0.144**
regional unemployment rate $\times 10$, $t - 1$			0.1772	0.099*	-0.3756	0.219*
age spouse/100, $t - 1$			-0.1550	0.288	0.0975	0.285
spouse does not work, $t - 1$			0.1223	0.046***	0.1372	0.046***
total income spouse, $t - 1$ [100kDKK]			-0.1867	0.032***	-0.1665	0.032***
income from self-employment, $t - 3$ [mDKK]			-0.9532	0.093***	-0.8244	0.092***
had negative income from SE, $t - 3$			-0.0282	0.072	-0.0010	0.071
wealth, $t - 1$ [mDKK]			-0.0885	0.015***	-0.0772	0.014***
experience [100 years] as wage earner, $t - 3$			0.2603	0.242	0.0400	0.243
receipt sickness benefits, $t - 1$			0.5078	0.179***	0.4625	0.177***
marital status: single, $t - 1$			0.1204	0.135	0.2104	0.134
children age ≤ 17 living at home, $t - 1$			-0.1002	0.035***	-0.0622	0.035*
SE start-up support, $t - 3$			0.3008	0.083***	0.3310	0.081***
[12] year dummies (p -value)	0.0000		0.0000		0.0000	
[6] education dummies (p -value)	—		—		0.0000	
[14] industry dummies (p -value)	—		—		0.0000	
[7] region dummies (p -value)	—		—		0.0880	
ρ	0.1610	0.045***	0.1867	0.042***	0.1617	0.041***
ρ_η	0.3364	0.038***	0.4016	0.049***	0.3493	0.047***
σ_{η_1}	3.4877	0.029***	3.4086	0.030***	2.8109	0.028***
σ_{η_2}	0.9145	0.835	0.6394	0.209***	0.5859	0.161***
Log-likelihood	-33,078.1		-32,697.0		-31,974.5	

Notes: Sample description: see Table 3. Asterisks indicate significance levels: *** 1% or less, ** 5% or less, * 1% or less.

Table 7: Marginal or Average Partial Effects / Average Treatment Effects

	instrument on insurance status	insurance status on unempl.
raw data, Table 3		1.762
univariate model		
— Spec. 0, Table 4		2.233
— Spec. 1, Table 4		1.992
— Spec. 2, Table 4		1.817
bivariate model		
— Spec. 0, Tables 6a, 6b	3.722	0.566
— Spec. 1, Tables 6a, 6b	3.725	0.575
— Spec. 2, Tables 6a, 6b	2.908	0.613

Notes: Marginal effects calculated for the estimates in Tables 4, 6a, and 6b. All marginal effects expressed as percentage point changes.

Table 8: Average Predicted Probabilities (Percentages)

Variable	Data		Model				
	incidence	\hat{P}_{jit}	Spec. 0 $\hat{P}_{jit} \geq \tau_j$	Spec. 1 $\hat{P}_{jit} \geq \tau_j$	Spec. 2 $\hat{P}_{jit} \geq \tau_j$	\hat{P}_{jit}	$\hat{P}_{jit} \geq \tau_j$
insured	65.43	63.83	89.92	64.25	89.43	66.17	80.23
unemployed	1.94	5.87	0.00	5.88	0.01	5.84	0.01

Note: This Table shows incidence of insurance and unemployment in the data, and, per model, the mean predicted probability \hat{P}_{jit} and the mean of the indicator whether or not $\hat{P}_{jit} \geq 0.5$ ($\tau_j = 0.5$).

Table 9: Bivariate Distributions (Percentages)

UI fund member	Data		Spec. 0		Spec. 1		Spec. 2	
	no	yes	no	yes	no	yes	no	yes
no	34.31	0.26	34.37	0.20	34.37	0.20	34.27	0.30
yes	63.75	1.68	63.69	1.74	63.69	1.74	63.79	1.64

Note: This Table shows classification of observations in 2×2 dimensions *after* matching the marginal distributions (shifting τ_j in Table 8), based on models in Tables 6a and 6b.

B Additional Material

B.1 Model

This appendix supplies a few core derivatives whose signs are discussed in the text. It may be useful to partition the set of parameters into the following:

- exogenous risk, θ
- cost of effort, λ
- preference, income, and insurance parameters,

$$M = \{Y^0, Y^E, A, B, P, \gamma, \} \quad (\text{B.1})$$

B.1.1 Derivatives of Effort

The derivatives of optimal effort with respect to some parameter can be calculated, assuming an interior solution, by relying on implicit differentiation. We may distinguish between effort when insured (e^{*I}) and uninsured (e^{*0}).

Exogenous Risk

$$\frac{de^{*I}}{d\theta} = -\frac{\pi_{e\theta}}{\pi_{ee}} = \frac{de^{*0}}{d\theta} < 0$$

which is independent of whether the agent is insured or not. The sign follows from the assumption $\pi_{e\theta} > 0$.

Cost of Effort

$$\frac{de^{*I}}{d\lambda} = -\frac{1}{\pi_{ee}} \cdot \frac{1}{b} \leq 0 \quad \text{and} \quad \frac{de^{*0}}{d\lambda} = -\frac{1}{\pi_{ee}} \cdot \frac{1}{d} \leq 0.$$

For $b > 0$ and $d > 0$, respectively, effort decreases with effort cost. For $b < 0$ and $d < 0$, respectively, effort will not react to effort cost since optimal effort is already zero.

Preference, Income, and Insurance Parameters Let $\mu \in M$ where M is defined in (B.1). Then,

$$\begin{aligned} \frac{de^{*I}}{d\mu} &= \frac{1}{\pi_{ee}} \cdot \frac{\lambda}{[b(\cdot)]^2} \cdot b_\mu \\ \frac{de^{*0}}{d\mu} &= \frac{1}{\pi_{ee}} \cdot \frac{\lambda}{[d(\cdot)]^2} \cdot d_\mu \end{aligned}$$

Where $b(\cdot)$ and $d(\cdot)$ are defined through (4) and (5). The sign of these derivatives equals the sign of b_μ and d_μ , respectively, since $\pi_{ee} > 0$ by assumption.

Derivatives at a corner solution are zero.

Earnings

$$\frac{\partial b}{\partial Y^E} = u_1(Y^0 + Y^E - P, 0) > 0$$

and

$$\frac{\partial d}{\partial Y^E} = u_1(Y^0 + Y^E, 0) > 0.$$

Insured or not, labor income increases effort.

Nonlabor Income Analogously, we find

$$\frac{\partial b}{\partial Y^0} = \overbrace{[u_1(Y^0 + Y^E - P, 0) - u_1(Y^0 + B - P, \gamma)]}^{\kappa_1} < 0$$

and

$$\frac{\partial d}{\partial Y^0} = \underbrace{[u_1(Y^0 + Y^E, 0) - u_1(Y^0 + A, \gamma)]}_{\kappa_0} < 0$$

both follow from the concavity of the utility function and from our assumptions on the relative sizes of income components: effort decreases with sufficient fall-back resources, irrespective of insurance status.

Social Assistance

$$\frac{\partial b}{\partial A} = 0 \quad \text{and} \quad \frac{\partial d}{\partial A} = -u_1(Y^0 + A, \gamma) < 0$$

Increasing the outside option is irrelevant for those that are insured, but decreases effort for those that are not.

UI Benefits

$$\frac{\partial b}{\partial B} = -u_1(Y^0 + B - P, \gamma) < 0 \quad \text{and} \quad \frac{\partial d}{\partial B} = 0$$

Increasing UI benefits is detrimental for effort for those that are insured and does not affect those that are not.

UI Premium

$$\frac{\partial b}{\partial P} = u_1(Y^0 + B - P, \gamma) - u_1(Y^0 + Y^E - P, 0) > 0 \quad \text{and} \quad \frac{\partial d}{\partial P} = 0.$$

Higher premiums encourage provision of effort, whereas they are irrelevant for behavior of uninsured people.

Preferences for Leisure

$$\frac{\partial b}{\partial \gamma} = -u_2(Y^0 + B - P, \gamma) < 0 \quad \text{and} \quad \frac{\partial d}{\partial \gamma} = -u_2(Y^0 + A, \gamma) < 0.$$

B.1.2 Insurance

In this section, we study how insurance choice depends on variation in various parameters.

Exogenous Risk From (14) follows

$$\frac{\partial D}{\partial \theta} = (a + c) \cdot \pi_\theta(\theta, e^{*0}) + [b \cdot (\pi_\theta(\theta, e^{*0}) - \pi_\theta(\theta, e^{*I}))] \geq 0.$$

If $b < 0$ and $d < 0$ then $e^{*I} = e^{*0} = 0$ and $\pi(\theta, e^{*I}) = \pi(\theta, e^{*0}) = 1$. It then follows that $\pi_\theta(\theta, 0) = 0$. The expression above reduces to $\partial D / \partial \theta = 0$. In the case where $b < 0$ and $d > 0$ we have $e^{*I} = 0$ and $\pi(\theta, e^{*I}) = 1$. It then follows that $\pi_\theta(\theta, 0) = 0$.

$$\begin{aligned} \frac{\partial D}{\partial \theta} &= (a + c) \cdot \pi_\theta(\theta, e^{*0}) + [b \cdot (\pi_\theta(\theta, e^{*0}))] \\ &= (a + b + c) \cdot \pi_\theta(\theta, e^{*0}) \\ &= d \cdot \pi_\theta(\theta, e^{*0}) > 0. \end{aligned}$$

Cost of Effort

$$\frac{\partial D}{\partial \lambda} = -(e^{*I} - e^{*0}) > 0$$

due to (10).

Preference, Income, and Insurance Parameters For $\mu \in M$ (see (B.1)),

$$\frac{\partial D}{\partial \mu} = a_\mu(\pi^{*0} - 1) + c_\mu \cdot \pi^{*0} + b_\mu \cdot \underbrace{(\pi^{*0} - \pi^{*I})}_{\leq 0}.$$

Earnings The derivative is

$$\frac{\partial D}{\partial Y^E} = (1 - \pi^{*I}) \cdot u_1(Y^0 + Y^E - P, 0) - (1 - \pi^{*0}) \cdot u_1(Y^0 + Y^E, 0)$$

which we rewrite slightly as

$$\frac{\partial D}{\partial Y^E} = (1 - \pi^{*I}) \cdot \alpha_1 - (1 - \pi^{*0}) \cdot \alpha_0 \quad (\text{B.2})$$

where we have introduced the symbols $\alpha_1 \equiv u_1(Y^E + Y^0 - P, 0)$ and $\alpha_0 = u_1(Y^E + Y^0, 0)$. Note that $\alpha_1 \geq \alpha_0$ (due to concavity). It is apparent that the derivative is not easily signed since we know from (10) and $\pi_e < 0$ that $\pi^{*0} \leq \pi^{*I}$. That means that the association of a large α_1 with a small probability may or may not weigh up against the association of a relatively smaller α_0 with a larger weight.

We can rewrite (B.2) as

$$\frac{\partial D}{\partial Y^E} = \underbrace{(1 - \pi^{*0}) \cdot [\alpha_1 - \alpha_0]}_{>0} + \underbrace{[\pi^{*0} - \pi^{*I}] \cdot \alpha_1}_{\leq 0}$$

In the (near) absence of an insurance effect on effort ('moral hazard'), $\pi^{*I} \approx \pi^{*0}$, the derivative is positive and richer people (in terms of own income) are more likely to insure themselves.

There is a second aspect of interest. This concerns behavior when UI benefits get large relative to earnings. In particular, effort taking will be diminished, and instead taking out insurance becomes more likely.

If $Y^E \rightarrow B^+$ and $e^{*I} \rightarrow 0$, and hence

$$\begin{aligned} D &\rightarrow u(B + Y^0 - P, \gamma) - (1 - \pi^{*0}) \cdot u(B + Y^0, 0) - \pi^{*0} \cdot u(A + Y^0, \gamma) + \lambda e^{*0} \\ &\geq u(B + Y^0 - P, \gamma) - (1 - \pi^{*0}) \cdot u(B + Y^0, \gamma) - \pi^{*0} \cdot u(A + Y^0, \gamma) + \lambda e^{*0} \end{aligned}$$

By using Jensen's inequality we get that

$$\begin{aligned} u(B + Y^0 - P, \gamma) - (1 - \pi^{*0}) \cdot u(B + Y^0, \gamma) - \pi^{*0} \cdot u(A + Y^0, \gamma) + \lambda e^{*0} &\geq \\ u(B + Y^0 - P, \gamma) - u((1 - \pi^{*0})(B + Y^0) + \pi^{*0}(A + Y^0), \gamma) + \lambda e^{*0} &= \\ u(B + Y^0 - P, \gamma) - u(B + Y^0 - \pi^{*0}(B - A), \gamma) + \lambda e^{*0} & \end{aligned}$$

The last expression is positive if $P < \pi(\theta, e^{*0}) \cdot (B - A)$. This means that if the premium is small then agents with an income $Y^E \rightarrow B^+$ will chose to insure themselves.²⁵

²⁵If the UI premium is actuarially fair then $P = \pi(\theta, e^{*0}) \cdot (B - A)$.

Nonlabor Income

$$\frac{\partial D}{\partial Y^0} = \left((1 - \pi^{*I}) \cdot u_1(Y^0 + Y^E - P, 0) + \pi^{*I} \cdot u_1(Y^0 + B - P, \gamma) \right) - \left((1 - \pi^{*0}) \cdot u_1(Y^0 + Y^E, 0) + \pi^{*0} \cdot u_1(Y^0 + A, \gamma) \right).$$

Rewriting leaves

$$\frac{\partial D}{\partial Y^0} = \underbrace{[\alpha_1 - \alpha_0]}_{<0} + \underbrace{\pi^{*0} \cdot \kappa_0}_{<0} - \underbrace{\pi^{*I} \cdot \kappa_1}_{<0}$$

where α_1 , α_0 , κ_1 and κ_0 have been defined before. Again, the derivative cannot be signed in general. If we assume no moral hazard, then

$$\frac{\partial D}{\partial Y^0} \approx \underbrace{[\alpha_1 - \alpha_0]}_{<0} + \underbrace{\pi^{*0} \cdot (\kappa_0 - \kappa_1)}_{<0} < 0.$$

That is, income other than earnings decreases insurance demand.

Social Assistance

$$\frac{\partial D}{\partial A} = -\pi^{*0} \cdot u_1(Y^0 + A, \gamma) < 0.$$

UI Benefits

$$\frac{\partial D}{\partial B} = \pi^{*I} \cdot u_1(Y^0 + B - P, \gamma) > 0.$$

UI Premium

$$\frac{\partial D}{\partial P} = -(1 - \pi^{*I}) \cdot u_1(Y^0 + Y^E - P, 0) - \pi^{*I} \cdot u_1(Y^0 + B - P, \gamma) < 0.$$

Preferences for Leisure

$$\frac{\partial D}{\partial \gamma} = \pi^{*I} \cdot u_2(Y^0 + B - P, \gamma) - \pi^{*0} \cdot u_2(Y^0 + A, \gamma) > 0.$$

B.2 Figures and Tables

Figure B.1: Probability of Unemployment

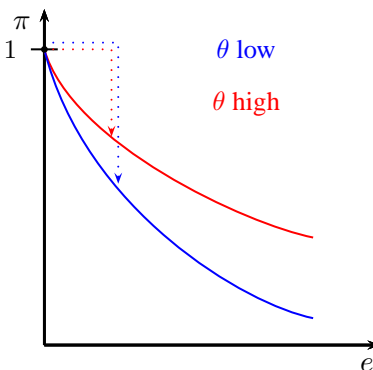


Table B.1: Labor Market Status Over Time

year	self-employed	wage earner	unemployed	out of LF	Total
1981	10.27	81.41	6.78	1.55	87,358
1982	9.79	81.17	7.22	1.81	88,462
1983	9.33	81.31	7.53	1.83	89,054
1984	9.23	82.82	6.19	1.76	89,535
1985	9.22	84.61	4.55	1.61	90,003
1986	9.35	84.82	4.25	1.58	90,417
1987	9.27	84.44	4.42	1.86	90,773
1988	9.11	82.69	6.29	1.91	91,196
1989	8.97	82.77	5.91	2.35	91,656
1990	8.57	82.19	6.65	2.59	92,291
1991	8.63	81.30	7.73	2.35	93,223
1992	8.35	80.85	8.39	2.41	93,969
1993	8.05	80.42	9.24	2.29	94,301
1994	7.95	82.33	7.52	2.20	94,418
1995	7.98	83.68	5.95	2.40	93,775
1996	7.96	84.46	5.02	2.56	93,742
1997	7.68	85.54	4.19	2.59	93,586
1998	7.68	86.60	3.19	2.53	92,953

Note: row percentages, totals are frequencies. LF: labor force.

Source: CAM 10% Sample, Danish males 25-59, and further restrictions (see text).

Table B.2: Overall Unemployment Insurance Status by Labor Market Status

UI fund membership	labor market status			
	self-employed	wage earner	unemployed	out of labor force
total sample				
no	39.00	18.16	12.14	67.90
yes	61.00	81.84	87.86	32.10
total	144,061	1,369,648	101,867	35,136
thereof:				
ER eligible				32.7%
no	27.31	15.82		
yes	72.69	84.18		
ER non-eligible				67.3%
no	47.03	19.25		
yes	52.97	80.75		

Note: column percentages, totals are frequencies.

Source: CAM 10% Sample, Danish males 25-59, and further restrictions (see text).