The Role of Commitment in Dynamic Contracts: Evidence from Life Insurance †

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Abstract

We use data from the life insurance industry to study the properties of long term contracts in a world where buyers cannot commit to a contract. We develop a theoretical model that captures the main features of this industry, in particular, how contracts are designed to deal with reclassification risk. The data is especially suited for a test of the theory since it includes information on the entire profile of future premiums. The lack of commitment by consumers shapes contracts in the way predicted by the theory: all types of contracts involve front-loading; this generates a partial lock-in of consumers; contracts that are more front-loaded have a lower present value of premiums over the period of coverage. This is consistent with the idea that more front-loaded contracts retain better risk pools.

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1 Introduction

The effect of agents’ inability to commit to long term plans has been investigated in a wide variety of settings, and has been shown to have potentially far reaching implications on economic arrangements. The goal of this paper is to examine empirically the role of imperfect commitment in shaping contractual relations by using data from the life insurance market.

Lack of consumer commitment can generate inefficiencies in markets such as health and life insurance. In these markets, short term contracts do not offer insurance against reclassification risk (premium increase insurance), the risk that future premiums may be substantially higher as a consequence of learning about a consumer’s risk characteristics. Lack of long term insurance is considered an important market failure in health and life insurance markets, and it has underscored much of the policy debate concerning health reform.\footnote{cf. Diamond (1992), Cochrane (1995). In a 1993 Gallup poll (Piucci (1993)), 56\% of the respondents were very concerned of the possibility of losing health insurance for medical reasons. For a recent survey of the literature and issues in life insurance, see Villeneuve (1999).}

Several factors make the life insurance market an interesting environment for studying commitment to long term contracts. Learning –about health status– is a quantitatively important phenomenon. Life insurance contracts are simple and explicit. Other contractual relations like labor contracts, in contrast, are plagued by unobservables (e.g. performance related) and by the presence of implicit agreements. Issues such as adverse selection, moral hazard, misreporting or mismeasuring the magnitude of an accident do not seem important in the case of life insurance.\footnote{These claims will be justified more fully in Section 6.}

Finally, very rich data on contracts is available. A contract pre-specifies all future renewal prices and conditions for renewal. To our knowledge no previous work on the dynamics of contracts has used direct contract information.

We first present a theoretical framework to understand how we should expect lack of commitment to be reflected in observed contracts. The model adapts Harris and Holmstrom’s (1982) model of symmetric learning that was first developed in a labor market context.\footnote{The model is also related to De Garidel (1998). We discuss the relation with these papers in more detail later.} The main predictions of the model are then tested using a unique data set on the U.S. life insurance industry.

We assume that the initial health status of agents is known to all, and that new information about the health type of the insured is revealed over time symmetrically.
to all market participants. We also assume that there is one-sided commitment, i.e.,
insurance companies can commit to long term contracts but buyers cannot.

The fact that there is learning about the health of consumers implies that short-
term (spot) contracts involve reclassification risk: future premiums will reflect the
future health status of consumers. If consumers could commit to the future terms of
contracts, then this risk could be insured by a constant future premium that reflects
the average future health of the consumer. Lack of commitment makes such a contract
infeasible since healthy consumers would have the incentive to drop out of the con-
tract to obtain cheaper coverage from competing companies. Hence, the only way for
consumers to obtain insurance against reclassification risk involves pre-paying or front-
loading some of the premiums, thereby creating a lock-in that makes dropping out of
the contract less appealing. To be completely successful, the amount of front-loading
must guarantee that no consumers drop coverage in the future, i.e., the future premium
must be no higher than the fair premium for the healthiest type. A sufficiently front-
loaded contract implements the same allocation that would be achieved under consumer
commitment, i.e., full insurance against reclassification risk. All contracts we observe
in life insurance markets in the U.S. (see Section 4.1) are front-loaded, and some of the
contracts come close to achieving full insurance (see Section 5). However, most of these
contracts leave consumers subject to some reclassification risk. The model will help us
study why there is such variety of contracts, linking them to consumers’ heterogeneity
in willingness to front-load. More importantly, given the variety of observed contracts
the model will generate testable predictions about the cross section of contracts.

In return for the front-loading, policies offer a cap on the premium required in the
second period. Good risks can still reenter the market in the future while bad risks are
protected against steeper premium increases if they remain in the front-loaded policy
pool. The key comparative statics that comes out from the model is that contracts that
are more front-loaded lock in consumers to a greater extent. Thus, more front-loaded
contracts retain a better risk pool and have a lower present value of premiums. In
Sections 4 and 5 we study the extent of front-loading in life insurance contracts, the
link between front-loading and reclassification risk and the role of prepayment in order
to commit to a long term contract.

As predicted by the model, life insurance contracts are offered in several varieties,
involving different time profiles of premiums. They differ in how steeply premiums in-

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4This heterogeneity is assumed to be orthogonal to consumers’ risk characteristics at the time of
initial contracting. We discuss several sources for this heterogeneity: access to capital markets, time
preferences, needs for insurance, subjective perceptions of future health.

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crease over time. Different premium profiles represent different degrees of front-loading (commitment). A steeper time profile means less front-loading. We use the diversity in the slope of premiums across contracts to test the implications of the model. As predicted by the model we find that virtually every contract is front-loaded. The pervasiveness of front loading is in accordance with the contract theoretic predictions, and suggests that firms lock-in consumers in order to overcome their lack of commitment. An important aspect of the data is that there are large differences in the present value of premiums across contracts. The model predicts a negative correlation between front loading and the present value premiums. This negative relation is present in the data, and most of the dispersion in the present value of premiums can be accounted for by the extent of front-loading. We confirm the role of front-loading as a commitment device by looking at the relation between lapsation and front-loading. As predicted, more front-loaded contracts have lower lapsation.

All the patterns in the data suggest that contracts are designed in a way that fits a model of symmetric learning with one-sided commitment. Alternative commitment assumptions are rejected by the data. Furthermore, standard asymmetric information models deliver predictions that are inconsistent with the data.\(^5\)

In Section 2 we describe the available life insurance contacts in the U.S. and the available data. Section 3 presents the model. The predictions of the model are put to test in Section 4. We conclude by evaluating alternative explanations in Section 6.

\section{The Contracts and the Data}

\subsection{The Contracts}

The life insurance market is segmented in Term and Cash Value contracts.\(^6\) We focus our analysis on the market for Term insurance for two reasons. First, term is simpler since it involves pure insurance: a fixed sum is paid upon death of the insured should death occur within the period of coverage. Cash value policies in contrast offer a combination of insurance and savings; policy-holders deposit over time with the possibility of withdrawing later on. Second, we do not have data on cash values. Term contracts have gained popularity since 1945. They represented only 6\% of all ordinary life insurance in 1954 (Life Insurance Fact Book, 1993), but over 37\% in 1997 according to LIMRA (Life Insurance Marketing Research Association, 1997).

\(^5\)This is discussed in some detail in Section 6.

\(^6\)We focus on the individual market as opposed to employer provided insurance.
The main distinction among term contracts is the premium profile. Some contracts charge premiums that increase yearly, these are called Annual Renewable Term (ART) contracts. Other contracts offer premiums that increase only every N years, N ranging from 2 to 30 years. These are called Level Term contracts (LTN), as premiums are level for N periods, then jump and are level again.

Term contracts are renewable, without medical examination, up to a pre-specified age (generally 70 or higher). Future premiums for renewal are specified at the moment of underwriting. Premiums are guaranteed for a pre-specified period of time, ranging from a year to twenty years. It should be noted that: First, since no medical examination is needed to renew, price changes are not insured specific. Second, insurers rarely change the premiums that they announced at the moment of underwriting, even after the guaranteed period expires. Consumer Reports (July 1993) surveyed 67 companies and found that only one increased term premiums between 1989 and 1993. Hence, although not legally binding, pre-announced premiums can be taken as the relevant future terms of the contract.

To illustrate what term contracts look like, and what distinguishes contracts, we now describe three contracts types.

The first column of Table 1 illustrates an aggregate ART. This contract has premiums that vary exclusively by attained age. Column 2 illustrates a 10-year Level Term contract (LT10). We discuss the difference between these contracts in detail later. For now, observe that the contracts differ substantially in the time profile of premiums; the premiums for the ART start below those for the LT10 but increase much more rapidly.

The right side of Table 1 illustrates a S&U ART. These contracts offer state contingent prices; premiums vary by issue age and duration since underwriting. The logic is to reflect the lower mortality rates of those just screened by the medical examination. Payments are expressed as a matrix since they are contingent on two state variables: age and years since underwriting (captured by Policy Year). Insureds can avoid the increased premiums by requalifying for the select period, provided they are still in good health.\(^7\) For instance, at age 41 the insured would pay $475 (first row, second column of matrix) for renewing his two year old policy if he does not requalify. Had he requalified, he would have paid $385 (second row, first column). The incentive to requalify increases in age. While the saving is moderate for a 41 year old, at 59 not requalifying means a 31% premium increase, the insured would pay $1750 instead of

\(^7\)As Dukes and MacDonald (1980) put it, “The insured may only have to answer three of four questions about his health in the last year. The reversion process can be repeated as long as the insured remains a standard risk and below a specified age (typically 70).”
$1340.

<table>
<thead>
<tr>
<th>Age</th>
<th>ART</th>
<th>LT10</th>
<th>S&amp;U ART</th>
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<tr>
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<td>3</td>
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<tr>
<td>59</td>
<td>2289</td>
<td>1064</td>
<td>1340</td>
</tr>
</tbody>
</table>

Note: These are contracts offered in 7/1997 to a preferred non-smoker, male, by Northwestern Mutual (ART and LT20) and Jackson National (S&U ART) for 500,000$ of coverage.

ART=annual renewable term policy.

LT10=term policy with level premiums for 10 years.

S&U ART=annual contract that allows for reclassification, by showing good health.

Table 1: Types of Term Contracts

The big difference in premiums in the alternative scenarios of a S&U ART shows that learning about the health status of an individual is an important phenomenon, and that consumers may be left to suffer significant reclassification risk. A 59 year old might end up paying as little as $1340 or as much as $6375 for coverage.

This initial look at contracts highlights some patterns that we will investigate more systematically in what follows. First, there are contingent and non contingent contracts. Second, the time profile of premiums can look quite different across contracts. Contracts that have a relatively low initial premium, seem to have relatively high premiums later on.

We will argue that the differences across contracts can be interpreted as being designed to appeal to consumers with different abilities to commit. The heterogeneity in premium profiles can be exploited to test the contract theoretic model.
According to LIMRA (1997) the market shares of the different contracts are the following: ARTs (aggregate and S&U) 22.4%, LT5 34.8%, LT10 5.23% and LT20 11.0%.

2.2 The Data

The source of information on contracts is the Compulife Quotation System (July 1997). Compulife is an information system compiled for the use of insurance agents; it contains quotes by the main U.S. Life insurers (240 firms). Premiums are reported by consumer characteristics such as age, smoking status, gender, etc. It is an accurate source of pricing data, as it is the actual source of quotes that insurance agents offer to their clients. Agents are forbidden from offering discounts by the anti-rebating laws, hence the premiums we report reflect actual transaction prices. For the purpose of testing the predictions of the model, the unique feature of Compulife, is that it reports the whole profile of future premiums faced by a buyer at the moment of underwriting. Thus, we observe the entire contract time profile, not just the starting premium.

The virtue of this data is that it is generated by using the actual pricing rule of dozens of insurance companies. We punch in the demographics and face value into the Compulife pricing software, and we obtain the premiums for all relevant future dates and contingencies. The advantage of this data for our empirical analysis is that, when we compare contracts, we literally fix all demographic characteristics and vary the contract profile.

We included in our sample insurers that satisfying a dual criterion of size and solvency. They must be in categories IX and above of A.M. Best for size (in terms of sales of term policies) and rating A or better in terms of solvency (according to A. M. Best). We chose these criteria to guarantee product homogeneity. We chose large sales companies to avoid companies that offer non-representative policies. 55 insurers satisfy the criteria.8

Table 2 presents descriptive statistics of the contracts in our sample. The table presents the mean premium and standard deviation by type of contract. The third and fourth columns concern the first year premium for a 40 year old male non-smoker who just passed the medical screening. The 5th and 6th columns report the present value of premiums for 20 years of coverage. When the contract is state contingent, because premiums depend on whether the consumer does or does not requalify, the present

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8 Twenty-one of the firms in our sample (the ones for which we were able to find sales figures) held 46.8% of the 2,937 billion dollars of in force face amount of term insurance in 1996 (Best’s Review July 1996). We do not have sales information for the rest of the companies in our sample, but clearly a large share of the market is covered.
value is computed under the assumption that the buyer never requalifies. As will be shown later, this is a useful benchmark because it allows a theoretically meaningful comparison of contracts. We use an 8% interest rate in computing present values.

Table 2 shows substantial variability in the present value of premiums, in particular, across types of contracts. We are going to use the variability across contract types to test the model. Price dispersion may seem inconsistent with competition. However, Winter (1981) found that, after controlling for contract characteristics, only a small fraction of the dispersion remains unexplained. He concluded that observed premiums are consistent with the hypothesis of competition. In the next Section we control for these policy characteristics.

<table>
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<tr>
<th>Contracts</th>
<th>Premium at age 40</th>
<th>PV 20 years of coverage</th>
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<tr>
<td></td>
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<td>Observations</td>
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<td>All Types</td>
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</tr>
<tr>
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</tr>
<tr>
<td>LT5</td>
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<td>14</td>
</tr>
<tr>
<td>Aggregate ART</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>S&amp;U ART</td>
<td></td>
<td>28</td>
</tr>
</tbody>
</table>

Data Source: *Compulife Quotation System* (July 1997). Contracts offered by the top 55 insurers in the US according to size and solvency criteria.

LTX=term policy with level premiums for X years.

Aggregate ART= annual renewable term policy with premiums that depend only on age.

S&U ART=annual renewable term with premiums that depend on age and time elapsed since last medical examination.

PV of the 20 years of coverage starting at age 40, and a 8% interest rate.

Table 2: Contract Descriptives

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*We purposely chose a high interest rate for two reasons: First, to account for both time preference and for the probability of surviving to a specific date. Second, as will later become clear, results are reinforced if the interest rate is lower. We experimented with other interest rates and our qualitative results remain unchanged.*
3 Theory

3.1 Model

Consider an economy with insurance buyers and insurance companies. Buyers have expected utility preferences that are time additive, and wish to insure a stream of income for their dependents. When considering a future period, a buyer has two distinct sources of utility. If he will be alive, and he consumes \( c \geq 0 \), his future utility is given by \( u(c) \). If, however, he will be dead, his future utility is given by the consumption of his dependents. In this case, if his dependents consume \( c \geq 0 \), his future utility is given by \( v(c) \). The functions \( u \) and \( v \) are both assumed to be strictly concave and twice differentiable.

There are two periods. In period 1 all agents have identical death probabilities \( p \). We can think of \( p \) as representing a specific health status in period 1. The model can be readily extended to treat several such categories. In period 1 there are 3 stages: in stage 1 insurance companies offer contracts. At stage 2 buyers choose a contract. At stage 3 uncertainty about death is resolved and consumption takes place. In period 2 there are 4 stages. In stage 0 uncertainty about the health status of each buyer is realized. A consumer with health status \( i \) dies with probability \( p_i \) in period 2. We order the health status so that \( p_1 < p_2 < \ldots < p_N \). We assume that \( p_1 \geq p \), i.e., health worsens over time. The probability of being in state \( i \) is denoted by \( \pi_i \). This uncertainty about the second period risk category creates reclassification risk, since it potentially leaves the buyer facing uncertain premiums in the second period. Information is symmetric: at the end of stage 0 all insurance companies observe the health status of all buyers. Stages 1 through 3 are the same as in the first period.

We assume that there is perfect competition between insurance companies.\(^{10}\) We also assume one-sided commitment: insurance companies can commit to future premiums whereas consumers freely choose between staying with the contract they chose in period 1 and switching to one of the contracts offered in period 2. Therefore, the set of feasible first period contracts is the set of unilateral contracts, i.e., those contracts that terminate the moment the buyer stops paying the premiums; there are no cash

\(^{10}\)The market for term life insurance is quite competitive: there are 400 competing companies (Life Insurance Factbook) and term insurance is increasingly viewed as a commodity (Record (1997)). There is a regulatory presence but regulation mainly pertains to financial solvency, not pricing. As Black and Skipper (1994) put it: “Life insurance rates for individual insurance are regulated only in a most indirect sense. It is felt that competition is an adequate regulator over any tendencies toward rate excessiveness”.

9
flows upon termination.\footnote{These are exactly the kind of contracts offered in the U.S. life insurance market. The contracts available in the life insurance market do not impose penalties on consumers who drop out of the contract. It would probably be impossible to enforce such penalties. As we will see later, insurance companies do commit to long term contracts. For more on institutional features of life insurance see Mc Gill (1967) or Daily (1989).}

A contract offered in the first period consists of a first period premium, $Q_1$, a first period face amount $F_1$, and a vector of premiums and face amounts $(Q^1_2, F^1_2), \ldots, (Q^N_2, F^N_2)$ indexed by the second period health status of an individual. A contract offered in the second period consists of a premium and face amount $(Q^i_2, F^i_2)$ indexed by the second period health status. Therefore, a first period contract is a long term contract whereas a second period contract is a short term (spot) contract.

The time line in figure 1 summarizes the model.

Lack of consumer commitment per se need not preclude the possibility of achieving full insurance. In a world with no other friction, all consumers would front-load sufficiently to guarantee that they have no incentive to drop out of the contract in the future. An implication of such a solution is that all consumers would be fully insured against reclassification risk. Furthermore, there would be no contract variety: all consumers would choose the same contract.

Explaining the existing variety of contracts, and obtaining predictions about them, requires an understanding of why most consumers are reluctant to fully front-load. There are several reasons that can make front-loading costly, implying that consumers will prefer to bear some of the premium risk. First, consumers may have heterogeneous
needs for life insurance depending on the future earning opportunities of their dependents, their age, and/or their life expectancy. For example, the spouse’s ability to find a job might be uncertain and different across buyers. A buyer who is unlikely to need insurance would be reluctant to front-load since front-loading would amount to transferring resources toward states where these resources are less likely to be needed. A second reason may be that consumers may differ in their beliefs about the probability of qualifying as healthy, independent of the actual risk they face. The more optimistic consumers are less likely to front-load. A third reason may be that capital markets are imperfect. If the borrowing rate is higher than the lending rate, front-loading is costly and may lead consumers to prefer to front-load less than the amount needed to guarantee full insurance. In their model of symmetric learning, Harris and Holmstrom (1982) use capital market imperfections to explore the consequence of workers’ inability to commit. For our purposes, any of the above alternative explanations for consumers heterogeneity will suffice to generate our predictions. To simplify, and be closer to the formulation of Harris and Holmstrom, we will use the idea of credit market imperfections and assume that capital markets are completely absent. Note that this assumption does not imply that consumers are constrained in their front-loading. Rather, the absence of capital markets introduces a trade-off between consumption smoothing and insurance against reclassification risk. More front-loading requires giving up current consumption.\footnote{Given the empirically observed magnitude of required front-loading, capital market imperfections may not be the only explanation. This is perhaps the less empirically satisfactory aspect of the model, but the alternative explanations generate the same predictions at the cost of a more complicated and less transparent model. For concreteness, and modeling simplicity, we concentrate on the assumption that is most standard in the literature.}

We capture consumer heterogeneity by assuming differences in the income process. If alive, the consumer receives an income of $y - g$ in the first period and $y + g$ in the second period, with $g \geq 0$. Thus, all consumers have the same permanent income, but different consumers have different income growth, as represented by the parameter $g$. If the buyer is dead, then his dependents receive no income except for the face amount of the insurance. Because of the absence of credit markets, individuals with higher $g$ are more tightly constrained. Heterogeneity in $g$ is what drives the different choice of contracts in our model.
### 3.2 Solving the Model

The approach we follow to obtain the set of equilibrium contracts is the following. In a competitive equilibrium, allocations must maximize consumers’ expected utility subject to a zero profit constraint and a set of no lapsation constraints that capture consumers’ inability to commit.\(^{13}\) Solving this constrained maximization problem delivers the set of premiums and face amounts that must be available to a consumer in a competitive market. However, there are several ways in which this set of premiums and face amounts can be made available to consumers. The constrained maximization problem below is constructed via fully contingent contracts that involve no lapsation. We later describe how to obtain the same allocation with non contingent contracts that are quite common in the life insurance market.

In a competitive equilibrium, premiums and face amounts that are fully contingent on the health state \(Q_1, F_1, (Q_2^1, F_2^1), \ldots, (Q_2^N, F_2^N)\) must maximize consumers’ expected utility\(^{14}\)

\[
pv(F_1) + (1-p)u(y_1 - g - Q_1) + (1-p)\sum_{i=1}^{N} \pi_i[p_iv(F_2^i) + (1-p_i)u(y_2 + g - Q_2^i)] \quad (1)
\]

Subject to the zero profit condition:

\[
(1-p)Q_1 - pF_1 + (1-p)\sum_{i=1}^{N} \pi_i[(1-p_i)Q_2^i - p_iF_2^i] = 0 \quad (2)
\]

and the no lapsation constraints:

\[
\text{for } i = 1, \ldots, N, \text{ and for all } \tilde{Q}_2^i, \tilde{F}_2^i \text{ such that } (1-p_i)\tilde{Q}_2^i - p_i\tilde{F}_2^i > 0,
\]

\[
p_i v(F_2^i) + (1-p_i)u(y_2 + g - Q_2^i) \geq p_i v(\tilde{F}_2^i) + (1-p_i)u(y_2 + g - \tilde{Q}_2^i) \quad (3)
\]

The constraint in equation (2) requires that insurance companies break even on average. This must hold under competition. The no-lapsation constraints defined by equation (3) are the additional constraints imposed by lack of consumer commitment. They require that, at every state in the second period, the buyer prefers staying in the long term contract than switching to a competing insurance company. In other words,

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\(^{13}\)Recall that lapsation means voluntary termination of coverage by the buyer.

\(^{14}\)Note that we use the standard formulation where the consumer pays the premium only in the case of no accident; thus, the premium decreases consumption only if the consumer is alive. It is easy to reformulate the problem so that the premium is paid in both states.
an equilibrium contract must be such that there does not exist another contract that is profitable and that offers the buyer higher utility in any state of period two.

We say that a consumer gets full event insurance in state $i$ of date 2 if

$$v'(F_2^i) = u'(y_2 + g - Q_2^i)$$  \quad (4)

Analogously, we say that a consumer gets full event insurance at date 1 if

$$v'(F_1) = u'(y_1 - g - Q_1)$$  \quad (5)

We call $Q_2^i(FI)$ the fair premium for full insurance in state $i$, namely, the premium that guarantees zero profits.

The following Proposition, which is proved in the Appendix, provides a characterization of equilibrium contracts.

**Proposition 1** In the equilibrium set of contracts:

(i) All consumers obtain full event insurance in period 1 and in all states of period 2.

(ii) For every $g$ there is an $s$ such that $Q_2^i = Q_2^s(FI)$ for $i = 1, \ldots, s - 1$, and $Q_2^i = Q_2^s$ for $i = s, \ldots, N$ where $Q_2^i < Q_2^s(FI)$ for $i = s + 1, \ldots, N$.

(iii) There is a $\hat{g}$ such that, if $g < \hat{g}$, then there is front-loading.

(iv) More front-loaded contracts provide more insurance against reclassification risk: contracts with higher $Q_1$ involve a lower $s$. Individuals with higher $g$ choose contracts with less front-loading.

Part (i) follows from the fact that, under competition, event insurance is offered at a fair rate, hence, buyers will choose to fully insure event risk.\textsuperscript{15}

Part (ii) says that there is a health state $s$ such that, for worse states than $s$, the premiums are capped at a common price which is cheaper than the spot rate for each of those states. In the optimal contract, consumers transfer income from the first period to the bad states in the second period. The reason why premiums in the bad states are all the same is the following: given that the no-lapsation constraints are non-binding in those states, transferring resources across these states is costless leading to an elimination of all variability in premiums at the optimum. If in contrast, the consumer is healthier than in state $s$, the premiums are actuarially fair. These are the states where the no-lapsation constraints are binding. In those states, buyers must be offered the same rates that they would be offered on the spot market.

\textsuperscript{15}Parts (ii) and (iii) of Proposition 1 are adaptations of Harris and Holmstrom (1982) to our environment. Part (i) was shown by De Garidel.
Part (iii) says that contracts are front-loaded as long as income does not increase too rapidly (see the remark below).

Part (iv) says that insurance companies should offer a menu of contracts differing in the trade-off between front-loading and reclassification risk. Less front-loaded contracts appeal to buyers with lower first period income (high $g$), namely consumers who find front-loading more costly. In our framework $g$ captures the marginal rate of substitution between a dollar today and a dollar in the future. Whatever the source of the imperfect substitution, different contracts are offered to cater to consumers with different willingness to front-load in exchange for different degrees of reclassification risk insurance.

Remark 1 Part (ii) of Proposition 1 allows for the extreme cases $s = N$ and $s = 1$. The first case is one where there is no insurance against reclassification risk, there is no cap on second period premiums, and no front-loading: the consumer pays the actuarially fair premiums in all states. This case arises when the cost of front-loading is high relative to the growth in the probabilities of death. In these circumstances, giving up first period consumption is too costly to accept even a moderate amount of front-loading.

If $s = 1$, there is full insurance against reclassification risk. This case arises if $p_1$ is much larger than $p$ and $g$ is small.

For intermediate ranges of changes in the death probabilities, and in costs of front-loading, there is some front-loading and only partial insurance against reclassification risk. For example, if $p_1 = p$, then for every value of $g$, in equilibrium the consumer chooses a contract that leaves him subject to some reclassification risk.

For $g=0$, the model predicts that premiums are upwardly rigid. This is a direct counterpart of the downwardly rigid wages in Harris and Homstrom. Remarkably, as shown in Section 4.1, the most front-loaded contracts have flat premiums. This matches the prediction of the model under the assumption that buyers have non declining income.

3.3 Contract Equivalence and Empirical Implementation of the Model

Proposition 1 obtains the equilibrium allocation via fully contingent contracts that involve no lapsation. However, as we saw in Section 2, both contingent and non-contingent contracts are common in the life insurance market. We now show that non
contingent contracts can also be optimal, we show how we account for lapsation, a common phenomenon in life insurance, and we discuss how we compute the present value of premiums for contingent contracts.

For a non contingent contract to be optimal, it must be possible for consumers to achieve the same utility in all states as with an optimal contingent one (as described in Proposition 1). Furthermore, the non contingent contracts must deliver the same profits in all states to insurance companies.

Consider an equilibrium state contingent contract \((Q_1, F_1), (Q_2^1, F_2^1), \ldots, (Q_N^N, F_N^N)\). By Proposition 1 there is a state \(s\) such that for \(i = s, \ldots, N\), the terms of the contract are independent of the state: \(Q_i^i = Q_s^s\) and \(F_i^i = F_s^s\). In states \(i = 1, \ldots, s - 1\), the premiums and face amounts equal those offered in the spot market (i.e., in those states the buyer pays the actuarially fair premium).

We now argue that the same allocation can be achieved via a non-contingent contract, with terms \((Q_1, F_1)\) and \((Q_2^2, F_2^2) = (Q_s^s, F_s^s)\). By construction the contingent and the non contingent contract are identical in the first period and in states \(i = s, \ldots, N\). In states \(i = 1, \ldots s - 1\) the contingent contract has better terms; however, in those states the consumer can replicate those terms by dropping out of the non contingent contract and purchasing spot contracts. Because by Proposition 1, in each state \(i = 1, \ldots s - 1\), the contingent contract has the same terms as a spot contract, the consumer obtains the same utility via the non contingent contract. Insurers are indifferent between selling the two kinds of contracts as well: in state \(s\) through \(N\) consumers stay in the contract under both contracts and the terms are exactly the same. In states 1 to \(s - 1\), the two alternative contracts induce different behavior by the consumer, but equal (zero) profits for the firms since in those states premiums in the state contingent contracts are actuarially fair. Thus, in those states, firms are indifferent between retaining and not retaining the consumers. This shows that the two ways of achieving the equilibrium allocation are equivalent.

This equivalence result will help us in two ways: First, by explaining within our model the existence of non contingent contracts in the life insurance market. Second, the result helps us compare contingent and non-contingent contracts. All we have to do is transform each contingent contract into its equivalent non-contingent contract, along the lines of the previous discussion. The importance of having comparable non-contingent contracts comes from the next proposition, which is at the core of our empirical analysis. It presents the main comparative statics across non-contingent contracts. Due to the equivalence result we will be able to apply it to all contracts.

**Proposition 2** Consider two contracts offered in the first period that are not contin-
gent on the health state in period 2. In equilibrium, the contract with the higher first period premium has a lower present value of premiums, it is chosen by consumers with lower income growth, and has lower lapsation (retains a healthier pool of consumers).

Proof: The contract with the higher first period premium must have a lower second period premium since otherwise no consumer would choose it. Thus, in the second period this contract will retain a healthier pool of consumers. This implies that the average cost of this contract (payments to dependents of deceased policy holders) is lower. Under competition this implies that the present value of the premiums must also be lower. The fact that the contract with the higher first period premium is chosen by consumers with lower income growth follows from Proposition 1.

Remark 2 The importance of Proposition 2 is that it provides a way to test the theory by comparing non contingent contracts that display different degrees of front-loading. The equivalence result discussed above provides a way to extend the comparison to the entire set of contracts by telling us how to evaluate contingent contracts. Whenever we compute the present value of premiums for a contingent contract, we do so by looking only at the non-requalifying states: in the terminology of the model we consider the portion of the contract \((Q_1, F_1), (Q_s^2, F_s^2)\), where \(s\) is the state obtained in Proposition 1. The resulting contract is exactly the non contingent contract that implements the same allocation (as discussed before Proposition 2). An example: for the S&U ART contract described in Table 1, this means computing the present value of the first row of the matrix. Note that, absent the equivalence result, we would not be able to compute the present value of premiums since we do not have data on requalifying probabilities; these probabilities depend on the underwriting stringency (the state \(s\) in terms of our model) for individual contracts. The model allows us to compare contracts even in the absence of such information.

To be consistent with the theory, in the empirical analysis of contingent contracts, we should consider requalification to be lapsation, i.e., we classify a consumer who requalifies to have started a new contract. This is consistent with industry practice, which treats requalification as a new contract, and it is the theoretically correct way to compare contracts. Of course, in our empirical analysis we make sure that the predictions are not an artifact of our definitions: we also confirm the predictions by looking only across contracts that are directly comparable.

Note that for generic values of the parameters, no consumer type is indifferent between lapsing and not lapsing. If the health type is between 1 and \(s−1\) the consumer
strictly prefers lapsing. If the type is between \( s \) and \( N \), then the consumer is strictly better off staying.\textsuperscript{16}

We reiterate that we focus on capital market imperfections because of simplicity. The key from our perspective, is that there are numerous sources of intertemporal frictions that can support the predictions of Proposition 2. As long as people learn about their health state and use that information in decision making, the predictions we are about to test are valid.

In the next section we look at the time profile of premiums of the various policies to test the implications of the model. In sum, the model predicts: 1. Optimal contracts involve front-loading. 2. Contracts with higher front-loading keep higher proportions of insureds in the long run, i.e., have lower lapsation. 3. Since better risk types have higher incentive to lapse any given contract, higher lapsation implies worse pools. 4. A worse pool (lower front-loading) translates into higher present value of premiums for a fixed period of coverage.

4 Testing the Implications of the Model

To test the model we use the variety of contracts offered. The different types of contracts are characterized by different premium profiles, or slopes (namely, steepness of premium increases over time). The slope of the premiums determines the extent of front-loading. The steeper the premiums, the less front-loaded the contract. We want to establish first the extent of front-loading of contracts offered, and then the relation between front-loading and lapsation, as well as with the quality of the insured pool.

4.1 Front-loading

Table 3 shows the yearly premiums paid, over 20 years, by a 40 year old purchasing half a million dollars of coverage under three different contracts. The numbers are averages over all contracts of each type in our sample. Column 1 is for aggregate ARTs. Column 3 is for a 20 year level term contracts (LT20). Columns 5 and 7 describe two extreme scenarios for S&U ARTs (recall from table 1 that the complete description of this type of contract is a matrix): in column 5 the buyer never satisfied the criterion for requalifying, in column 7 he was lucky and requalified year after year.

\textsuperscript{16}The non generic case occurs if in state \( s \) the no lapsation constraint is binding; in this event one type is indifferent.
Observe the substantial difference in payment profiles across contracts. By definition, premiums in LT20s are constant in nominal terms. Due to discounting and aging, the level term contract presents a high degree of front-loading. The first payment in the 20 year policies is 83% higher than in the yearly select contracts; this gap represents a lower bound on the magnitude of front-loading.

The initial over-payment creates consumer lock-in or commitment to the contract. When the insured reaches age 50, he cannot be lured by a S&U ART, since the remaining premiums are lower in LT20 contracts than the premiums he would pay in S&U ARTs (even if he were to keep requalifying as a select customer).

We now argue that even ARTs are front-loaded. To check this, in Table 3 we report the ratio of the yearly premium over the probability of death; the ratio was normalized to equal 100 at age 40.\textsuperscript{17} This ratio should be constant absent front-loading. In contrast, the ratio declines over time. For example, for a 40 year old and an aggregate ART policy the ratio halves within 4 years, and it keeps declining to below a third of its initial level. Hence, contracts do not break-even period by period.

More surprisingly, even S&U ARTs, obvious candidates for involving no long term insurance, involve some degree of front-loading. Column (6) confirms this. Absent front loading the ratio (column 6) should increase over time, since the denominator reflects the entire population while the numerator reflects the worsening pool that fails to requalify year after year. In contrast, the ratio mildly declines.\textsuperscript{18}

\textsuperscript{17}The death probabilities used for Table 3 are taken from select and ultimate tables compiled by the Individual Life Insurance Experience Committee. Select and ultimate tables reflect the mortality experience of insured individuals, namely, those that passed a medical examination, as a function of both age and time elapsed since they passed the medical. Reported numbers understate the extent of front-loading since most contracts do not retain the best draws. One caveat concerns the trend of decreased mortality. The mortality tables that we have refer to past populations whereas the contracts presumably reflect a decline in mortality. However, the declines in the ratios that we observe in Table 3 are too pronounced to be explained by a general improvement in mortality.

\textsuperscript{18}Another piece of evidence that ARTs involve front-loading, is that renewability options are costly. Some contracts offer longer periods of guaranteed renewability than others. If these contracts broke even period by period, then the option of renewing a contract an extra year would be costless to the insurer and under competition would be offered for free. In contrast, the option to renew a contract is priced. We compared an ART renewable for 10 years (Term 10 by NW Mutual) with another renewable to age of 70 (Term 70 by NW Mutual). The option to renew after 10 years makes the present value of the cost of the 10 years of insurance (under the second contract) 10% higher for a 35 year old individual, while 35% more expensive for a 50 year old. Hence, the renewability option has a positive price and is more expensive when it is more costly to provide. This is consistent with the idea that a lot more information about health status is revealed later on in life.
<table>
<thead>
<tr>
<th>Age</th>
<th>Aggregate ART</th>
<th>LT20</th>
<th>S&amp;U ART</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AvgPrm</td>
<td>Prm/Death</td>
<td>AvgPrm</td>
</tr>
<tr>
<td>40</td>
<td>645</td>
<td>100</td>
<td>866</td>
</tr>
<tr>
<td>42</td>
<td>739</td>
<td>60</td>
<td>866</td>
</tr>
<tr>
<td>44</td>
<td>852</td>
<td>50</td>
<td>866</td>
</tr>
<tr>
<td>46</td>
<td>1,000</td>
<td>44</td>
<td>866</td>
</tr>
<tr>
<td>48</td>
<td>1,184</td>
<td>39</td>
<td>866</td>
</tr>
<tr>
<td>50</td>
<td>1,395</td>
<td>37</td>
<td>866</td>
</tr>
<tr>
<td>52</td>
<td>1,611</td>
<td>34</td>
<td>866</td>
</tr>
<tr>
<td>54</td>
<td>1,877</td>
<td>30</td>
<td>866</td>
</tr>
<tr>
<td>56</td>
<td>2,223</td>
<td>27</td>
<td>866</td>
</tr>
<tr>
<td>58</td>
<td>2,746</td>
<td>27</td>
<td>866</td>
</tr>
</tbody>
</table>

AvgPrm = average premium of all policies of a specific type in our sample paid at different ages by a consumer who buys (qualifies for) insurance at age 40.

Prm/Death = average premiums divided by probability of death at each age. We use the 1985/90 select and ultimate actuarial table by the Society of Actuaries. Select and Ultimate tables reflect mortality experience for insured population who passed a medical. We are using death probabilities of a person passing the medical at age 40.

Prm/Death is rescaled to 100 at age 40.

NoRequal = premium profile of an S&U ART buyer who failed to requalify (show she is in good health) as good risk in later years.

Requal = premium profile of a buyer who requalified (passing a medical) year after year.

Note that on average the first year premium of aggregate ARTs is 36% higher than that of select contracts despite the fact that both are yearly contracts. This reflects the fact that in an aggregate contract the insurance company is offering a lower cap on future premiums in the event that the consumer is in poor health. The aggregate contract offers more insurance of reclassification risk, at the cost of higher initial payments.

To summarize, all the available contracts involve front-loading, as suggested by the theory. Let us contrast this finding with the alternative assumptions on commitment.
If consumers could commit, front-loading would not be necessary to achieve the efficient allocation. If front-loading is costly we would not observe it. At the other extreme, suppose that insurance companies cannot commit to future terms of the contract. Then front-loading would not provide any insurance against reclassification risk. Thus, in neither of these scenarios would we observe front loading.

4.2 The Negative Relation Between Front-loading and the Present Value of Premiums

We saw in the previous subsection that contracts differ in the extent of front-loading. We now show that there is a systematic relation between present value of the cost of coverage and the extent of front-loading along the lines of Proposition 2.

We look at the relation between the slope of the premiums and the present value of the cost of 20 years of coverage. To do this, we proxy the slope of the premium profile by the ratio of the first over the 11th premium, \( Q(1st)/Q(11th) \). Table 4 shows basic statistics for 40 year old policy holders. Note the wide range of premium slopes and present values.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std Div</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Q(1st)/Q(11th) )</td>
<td>0.43</td>
<td>0.31</td>
<td>0.11</td>
<td>1.00</td>
</tr>
<tr>
<td>( PV )</td>
<td>16,055</td>
<td>5,245</td>
<td>6,871</td>
<td>28,754</td>
</tr>
<tr>
<td>( \ln(PV) )</td>
<td>9.62</td>
<td>0.36</td>
<td>8.83</td>
<td>10.27</td>
</tr>
</tbody>
</table>

\( Q(1st)/Q(11th) \)= is the ratio of the first to the 11th premium, we use it to capture the slope of premiums.

\( PV \)= present value of the cost of 20 years of coverage at \( r=0.08 \).

Table 4: Contract Slopes and Cost of Coverage

A higher \( Q(1st)/Q(11th) \) ratio means that more is paid up-front. The prediction of the model is that contracts with a higher \( Q(1st)/Q(11th) \) should have lower present value of premiums. We now investigate whether the relation between slopes and present values is indeed negative in the data. We also ask how much of the variability in present values can be explained by contract slopes.

\(^{19}\)Recall that the present value is calculated conditional on the consumer not requalifying. We do not calculate the expected net present value over all possible states.
Dependent Variable log(PV) is the log of the present value (r=8%) of the cost to the consumer of 20 years of coverage starting at age 40. Convert=age until policy can be converted to another. Guarant=years premiums are guaranteed. Renew=last age the policy can be renewed. Spec Cond=special underwriting conditions, like “non-preferred risk”. Column (1) includes all the contracts in the sample. Column (2) excludes contracts slope as an explanatory variable. Column (3) includes all contracts but LT20s in the sample. Column (4) includes only LT5s and LT10s, column (5) includes only non-contingent contracts. Column (6) includes S&U ARTs under the assumption that individuals requalify every period for a rate reduction. t-statistics in parenthesis.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q(1st)/Q(11th)</td>
<td>-1.06</td>
<td>—</td>
<td>-1.35</td>
<td>-1.05</td>
<td>-0.73</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>(-16.79)</td>
<td>—</td>
<td>(-8.77)</td>
<td>(-4.84)</td>
<td>(-2.84)</td>
<td>(1.13)</td>
</tr>
<tr>
<td>Guarant</td>
<td>0.01</td>
<td>-0.02</td>
<td>0.01</td>
<td>0.004</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(2.95)</td>
<td>(-3.96)</td>
<td>(1.74)</td>
<td>(1.03)</td>
<td>(1.33)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Renew</td>
<td>-0.002</td>
<td>-0.003</td>
<td>-0.002</td>
<td>-0.001</td>
<td>0.001</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>(-1.22)</td>
<td>(-1.18)</td>
<td>(-1.00)</td>
<td>(-0.01)</td>
<td>(0.39)</td>
<td>(1.53)</td>
</tr>
<tr>
<td>Convert</td>
<td>0.01</td>
<td>0.01</td>
<td>.006</td>
<td>.007</td>
<td>0.004</td>
<td>-0.003</td>
</tr>
<tr>
<td></td>
<td>(3.19)</td>
<td>(2.85)</td>
<td>(3.41)</td>
<td>(2.73)</td>
<td>(1.56)</td>
<td>(-0.93)</td>
</tr>
<tr>
<td>Spec Cond</td>
<td>0.21</td>
<td>0.11</td>
<td>0.21</td>
<td>0.21</td>
<td>0.33</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>(3.22)</td>
<td>(0.97)</td>
<td>(3.14)</td>
<td>(1.83)</td>
<td>(3.28)</td>
<td>(2.31)</td>
</tr>
<tr>
<td></td>
<td>(62.1)</td>
<td>(33.3)</td>
<td>(53.5)</td>
<td>(36.7)</td>
<td>(29.7)</td>
<td>(16.7)</td>
</tr>
<tr>
<td>R²</td>
<td>74.4</td>
<td>16.6</td>
<td>56.1</td>
<td>44.9</td>
<td>53.8</td>
<td>32.0</td>
</tr>
<tr>
<td>N</td>
<td>125</td>
<td>125</td>
<td>100</td>
<td>57</td>
<td>41</td>
<td>28</td>
</tr>
</tbody>
</table>

Table 5: Regression: Cost of coverage on Slope of Premiums.

The first column of Table 5 presents the regression of the log of the present value of the premiums on the Q(1st)/Q(11th) ratio and other contract characteristics. The front-loading variable is highly significant; and it explains most of the variability in the present value of premiums. Excluding this variable from the regression drops the
R² from 74.4% to 16.6% (column 2). The effect is economically significant as well, one standard deviation increase in Q(1st)/Q(11th) translates into a 28% decline in the cost of coverage.

The third column presents a similar regression after omitting the LT20s from the sample. We do so to check whether these contracts, which have no variability in Q(1st)/Q(11th), were responsible for the negative relation between premiums and slope. The negative relation is still strong among the rest of the contracts as well. Columns 4 repeat the exercise for a sample of 5 and 10 year contracts. Column 5 includes only the non contingent contracts in the sample. The purpose of this column is to test the robustness of the results within non-contingent contracts. Remember that to compare contingent contracts we have to appeal to the equivalence result in section 3.3. One might thus wonder about the robustness of these results, once we only compare contracts that do not require such a theoretical interpretation. By comparing non contingent contracts we test Proposition 2 directly, without relying on the equivalence result. The negative relation is confirmed.

The sixth column presents a similar regression for requalifying ART contracts. The theory does not predict any relation between costs and slope for these contracts since Q(11th) just reflects the underwriting stringency, not the quality of the remaining pool. We present this regression as a control, to make sure there is nothing intrinsic to premiums creating the negative relation just reported. We find no statistically significant relation.

The same picture arises when we look at different ages. In the working paper (Hendel and Lizzeri (1999)) we compare contracts across ages. We also included fixed firm effects. The basic message remains the same: more front-loaded contracts have lower present value of premiums.

### 4.3 Front-loading and Lapsation

The role of front-loading as a device to provide more insurance depends on locking-in consumers. We now attempt to provide further corroboration for the theoretical prediction that less front loaded contracts suffer from more health related lapsation.

Table 6 presents lapsation data, from LIMRA’s Buyers Study (1996). LIMRA (Life Insurance Marketing Research Association, Inc.) is a research association of life insurance companies that collects data from its members for analysis and dissemination among the members themselves. This data is not ideal since it does not provide a complete break-down of lapsation by type of contract. It only allows us to contrast ARTs with term contracts of longer length (includes 2 to 30 year level contracts).
that ARTs are less front-loaded than longer term contracts.

The first two columns present lapsation as a percent of face amount. It confirms Proposition 2. Aside from the first year of the contract, where not much lock-in has occurred, longer contracts have lower lapsation, and a steeper decline in lapsation over time. A similar picture appears in the next two columns, that report lapsation as a percent of the number of policies.

The second part of the table separates lapsation by age groups. More health related information revelation is likely to occur in the 40-59 age-group than in the 20-39. As expected, we find that the difference in lapsation between ARTs and Term is bigger for the older group, namely, when most of the learning takes place.

<table>
<thead>
<tr>
<th>Contract Year</th>
<th>% of Face Amount</th>
<th>% of Policies</th>
<th>% of Face Amount</th>
<th>% of Face Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ART</td>
<td>Term</td>
<td>ART</td>
<td>Term</td>
</tr>
<tr>
<td>1</td>
<td>11.8</td>
<td>14.2</td>
<td>15.0</td>
<td>21.2</td>
</tr>
<tr>
<td>2</td>
<td>14.1</td>
<td>11.4</td>
<td>14.8</td>
<td>14.1</td>
</tr>
<tr>
<td>3-5</td>
<td>13.4</td>
<td>8.0</td>
<td>12.4</td>
<td>7.4</td>
</tr>
<tr>
<td>6-10</td>
<td>10.1</td>
<td>5.0</td>
<td>9.4</td>
<td>5.2</td>
</tr>
<tr>
<td>11+</td>
<td>7.0</td>
<td>3.9</td>
<td>6.5</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Data Source: LIMRA’s Long Term Ordinary Lapse Survey – United States (1996). Term includes all term level contracts, from 2 to 30 years of length.

Table 6: Lapsation by Age and Contract Type

4.4 Accidental Death Insurance: a Test Case

Accidental death insurance, which is a special type of life insurance contract, provides an ideal way to further test whether the main forces behind the model are responsible for the shape of the available contracts in the industry.

An accidental death insurance policy is essentially the same product as a term policy, with the exception that it only pays if death is accidental; it does not pay if death is due to illness. Accidental death rates are quite flat between the ages of 25 to 60, and firms are unlikely to learn much about the characteristics of the consumers, which we argued is the driving force behind our results. Thus, we expect the predictions of the model to have less bite in the Accidental insurance market. In other words there is no reason to predict that front-loading will be used to improve long-run insurance. We found that both the probability of an accident and premiums are flat between ages
25 to 60, namely, there is no front-loading. All the quotes available on the web are independent of age.

Thus, a very similar product which involves no learning about risk characteristics displays no front-loading and no relation between the present value of premiums and front-loading; this can be viewed as an experiment whereby removing the key assumption about learning makes the main theoretical predictions disappear.

5 Quantifying the Extent of Front Loading

For long term contracts to offer full insurance against reclassification risk, even the best risks must find staying with the contract less costly than buying, from that period on, the cheapest contract available on the market. Contracts, to be profitable, must front-load at least the gap between the cost of insuring the whole pool, and the cost of insuring the healthiest type.

Without information on individual insurers’ underwriting standards we cannot assess this gap precisely. However, we can provide bounds by looking at mortality experience from select and ultimate tables (see footnote 17). This table is particularly useful since it provides information on death probabilities for good risks and those that qualified as good risks in the past.

From the table we compute two things: i. the fair premiums a 40 year old would pay should he stay in the pool for 20 years, and ii. the premiums he would pay if he is in good health and he qualifies for a cheaper policy. The former approximates the fair premiums the whole pool pays throughout the 20 years of coverage, while the latter approximates the cost of a new policy for buyers in good health at different ages. The gap between these two figures proxies the level of front loading necessary to keep the best types in the pool.

The fair premiums a 40 year old, who today qualifies for insurance, would pay until age 60 have a present value (discounted at 8%) of $27.4 per $1000 of coverage. We also computed, at each age between 41 and 59, the present value of the remaining premiums under three different scenarios: (1) that the insured stays with the original contract, (2) that he qualifies for a new contract and pays fair premiums given his current good health and (3) that he qualifies for a new contract today and at every year until age 60.

By subtracting (2) from (1) we get a lower bound on the incentives to lapse at different ages, namely, a lower bound on the front-loading needed to keep the whole pool under the original policy. It is a lower bound for two reasons. First, because
it assumes that the buyer, in good health today, will not requalify in the future for further discounts. Second, insurers use different underwriting criteria, which means that some types can have access to better deals than those reflected by the S&U table. Such table represents the average health state of requalifying individual across many companies. On the other hand, by subtracting (3) from (1) we get an upper bound on the needed front-loading. This is an upper bound since the buyers assume that after requalifying today they will get further discounts in the future. The actual incentives to lapse are somewhere in the middle of these two figures.

A summary of these numbers is reported in Table 7. For example, the present value of the cost of insuring between age 45 and 60 the whole pool that qualified at 40 is $23.3. Good types who requalify for a new policy would pay only $20.1, while good types who stay in good health requalifying yearly for a new policy expect to pay $9.4. To keep the whole pool at age 45, a long term contract cannot charge more than $20.1 from that period on ($9.4 if we use the more stringent criterion defined by (3)). Hence, it should have front-loaded at least $3.2 (or $13.4) in the first 5 years of coverage. This means the first 5 premiums must have been at last 80% (or 33.5%) higher than actuarially fair.

We now compare the front-loading in observed contracts to the bounds that we just computed. To do this, we construct a hypothetical contract that mimics the most front loaded contract offered in the U.S., the LT20. This contract is constructed so that the present value of premiums is enough to cover the actuarial cost of the policy. The actuarial cost is computed on the basis of the death probability from the S&U table for the average qualifying 40 year old. This cost is $27.4. Thus, the yearly premium must be $2.8. The extent of front loading of this level term policy is reported in Table 7. The last column reports the accumulated present value of payments beyond the actuarially fair premiums. For instance, an insured paying $2.8 level premium yearly has paid $7.1 over and beyond the fair premiums by age 45.

Table 7 shows the front-loading of an LT20 falls within the predicted bounds. They are sufficiently front loaded to keep the whole pool in the long run according to the lower bound, or even the mean of the bounds.
Table 7: Quantifying Front Loading

Further evidence that 20 year level contracts are sufficiently front loaded comes from comparing the present value of premiums of actual contracts offered in the U.S. The present value of premiums, under competition, is a proxy for the actuarial costs. We compare the average present value of 20 years of premiums across all LT20s in our sample to the average across S&U ARTs under the assumption that the buyer requalifies year after year. Notice, that the requalifying S&U ART is an over-optimistic benchmarks to evaluate the cost of insuring the whole population qualifying at age 40, since it is based on a sequence of good draws rather then on the whole pool. The buyer of an S&U ART lucky to requalify yearly would end up paying (in present value) $7,932 for 20 years of coverage (average across policies in our sample). A buyer of an LT20 would end up paying 9,187$ (reported in Table 2). The small difference in cost of coverage between the two contracts (only 15%), suggests that 20 year level term contracts essentially keep the whole pool, eliminating reclassification risk. Most of the attainable gains from commitment are achieved by long term level-premium contracts.

The market share of LT20s is close to 10% (LIMRA Buyers’ Study). This suggests that, although the necessary front-load to obtain full insurance against reclassification risk is not that large, it is enough so that most buyers prefer to suffer some reclassification risk under alternative contracts that do not require as much front-loading.

<table>
<thead>
<tr>
<th>Ages</th>
<th>Cost of Coverage until age 60</th>
<th>FL Bounds:</th>
<th>LT20</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Staying</td>
<td>Req Once</td>
<td>Req Always</td>
</tr>
<tr>
<td>45</td>
<td>23.3</td>
<td>20.1</td>
<td>9.4</td>
</tr>
<tr>
<td>50</td>
<td>17.3</td>
<td>11.9</td>
<td>5.8</td>
</tr>
<tr>
<td>55</td>
<td>9.7</td>
<td>4.2</td>
<td>2.8</td>
</tr>
<tr>
<td>59</td>
<td>2.0</td>
<td>0.6</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Staying=cost of coverage from stated age until age 60 remaining with the contract initiated at age 40. 
Req=cost of coverage from stated age until age 60 in a new contract which draws good health types, either requalifying once or every year. 
FL Bounds=Lower and upper bounds are difference in cost of Staying and Req, once and always, respectively. 
FL observed=actual front loading of LT20s, i.e. accumulated past premiums beyond actuarial costs to date.
6 Alternative Explanations

In this section we explore and attempt to rule out alternative potential explanations for the empirical findings.

**Adverse Selection:** One possible concern is the presence of asymmetric information. Cawley and Philipson (1998) found no evidence of adverse selection in life insurance. They test for adverse selection by looking at the relation between the face amount and the unit price. If adverse selection was a serious issue one would expect a positive relation; this is not present in the data. This can be explained by the fact that buyers have to pass a medical examination and answer a detailed questionnaire. Misrepresentation or concealment of material information would render the policy void. Furthermore, insurance companies have an information clearing system. In practice there is of course an informational asymmetry, in the sense that the insurer learns the type of the insured only if the latter shows up for a medical examination. What matters for our purposes is that this asymmetry disappears (or becomes quantitatively unimportant) at the moment of underwriting (or renewing the contract).

Even absent asymmetric information about the current risk category, in the context of long term contracts there is another potential source of adverse selection. Buyers may have superior information about their living habits which influence future death probabilities. This is plausible. However, if this were an important force, more front-loaded contracts would attract buyers with worse future health who are seeking a lower cap on their future premiums. But then more front-loading would be associated with higher cost of coverage. We find the opposite.

Our discussion of adverse selection is only valid for term life insurance. There is evidence that annuity markets suffer from adverse selection (Brugiavini (1990) and Friedman and Warshawski (1990)). A key distinction with term contracts is that purchases of annuities do not require medical exams. The reason may be that this would give consumers the incentive to hide good information about their health, which is arguably much easier than hiding bad information (think about a non smoker showing up to the medical exam smoking a cigarette and coughing repeatedly).

**Fixed Underwriting Costs:** Underwriting involves fixed costs. Because more front-loaded contracts have lower lapsation, these fixed costs are incurred less frequently. This would explain the lower present value of premiums of more front-loaded contracts.

If this hypothesis were correct, then the savings from lower lapsation would decline

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20 See also our discussion of Dionne and Doherty (1994) in Section 7.
in the face amount of the policy, since the fixed –underwriting– costs would become relatively less important. Table 8 compares different levels of coverage, from 100,000$ to 10 million dollars, for all insurers in our sample that offer comparable ARTs and LT20s. For every company the same pattern arises. The ratio of present values (of 20 years of coverage) of an ART over a LT20 is larger than 1 and does not decline in face amount. Thus, fixed costs do not appear to adequately account for the observed relation between front loading and the present value of premiums.

**Cross Firm Differences in Underwriting Standards:** It is plausible that firms specialize in specific types of contracts, and that those firms offering more front-loaded contracts at the same time perform more strict underwriting. This would explain the relation between the present value of premiums and front loading. To rule out this explanation, we resort to within firms contract comparisons performed in two ways. First, we ran the regression in Table 5 with firm fixed effects and we found showing that results are unchanged from the previous analysis. Second, Table 8 confirms the relation between front-loading and cost of coverage holds for each company individually.

**Correlation Mortality-Income:** since mortality and income are negatively correlated, the lower cost of more front-loaded contracts could be caused by higher income consumers purchasing those contracts. This explanation can be ruled out by looking at Table 8. If income levels (through the correlation with mortality) were creating the link between front-loading and present value, then that relation should disappear as the face amount becomes large, since only the very rich will buy a 10 million policy regardless of the front-loading.
<table>
<thead>
<tr>
<th>Face Amount of Policy</th>
<th>Ratio of PV of ART to LT20 Premiums</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100K$</td>
</tr>
<tr>
<td>John Hancock Mutual</td>
<td>1.15</td>
</tr>
<tr>
<td>Lincoln National</td>
<td>1.87</td>
</tr>
<tr>
<td>Metropolitan</td>
<td>1.07</td>
</tr>
<tr>
<td>National</td>
<td>1.13</td>
</tr>
<tr>
<td>Northwestern</td>
<td>1.14</td>
</tr>
<tr>
<td>The Ohio State</td>
<td>1.05</td>
</tr>
<tr>
<td>Surety</td>
<td>1.39</td>
</tr>
<tr>
<td>USAA</td>
<td>1.18</td>
</tr>
<tr>
<td>First Colony</td>
<td>1.62</td>
</tr>
<tr>
<td>General American</td>
<td>2.22</td>
</tr>
<tr>
<td>Jackson National</td>
<td>2.21</td>
</tr>
<tr>
<td>Provident</td>
<td>2.27</td>
</tr>
<tr>
<td>Provident Mutual</td>
<td>1.75</td>
</tr>
<tr>
<td>ReliaStar</td>
<td>1.79</td>
</tr>
<tr>
<td>Life Company of Virginia</td>
<td>2.21</td>
</tr>
<tr>
<td>Transamerican</td>
<td>2.44</td>
</tr>
<tr>
<td>Travelers</td>
<td>1.74</td>
</tr>
<tr>
<td>USG</td>
<td>1.91</td>
</tr>
</tbody>
</table>

Note: it is reported the ratio between the present value of premiums for 20 years of coverage, starting at age 40 with r=8%, of an ART policy over that of a LT20. Included are all companies that offer comparable ARTs and LT20s. The first eight companies offer aggregate ART while the rest are S&U ARTs, explaining why the ratios are higher for the latter.

Table 8: Cost of coverage and Policy Size: ART vs. LT20

**Search costs:** One can think of consumers being heterogeneous in their propensity to search for new policies.\(^{21}\) A steep premium profile can be interpreted as an attempt to profit from consumers who do not search. Consumers who search drop their coverage, those that do not end up overpaying. This hypothesis can be incorporated into the

\(^{21}\)We already discussed price dispersion in Section 2.2.
model, and it would be consistent with some of the findings. However, it cannot be the major force behind the findings. First, under competition the positive profits in the long run from low search consumers has to be compensated by losses early in the contract. This contradicts the findings in Table 3, where we reported that front-loading is present in all contract types. Second, since insurance agents profit from replacing policies, they would have an incentive to inform consumers that they can save by requalifying. Finally, incentives to search increase in the face amount, hence, we would expect the negative relation between cost and slope to disappear as policy values increase. As we saw in Table 8 it does not.

7 Related Literature

There are few empirical papers on contract dynamics. Chiappori, P.A.; Salanie’, B.; and Valentin, J. (1998) test a model of wage dynamics using data from one large French firm. They find support for theories of learning with downward rigidity of wages. Murphy (1986) investigates a longitudinal sample of chief executive officers from more than 1000 firms and compares learning and incentives. His evidence is mixed. To our knowledge the only empirical work testing ideas of the theory of contract dynamics outside the labor market are Dionne and Doherty (1994) and Crocker and Moran (1998), the latter studies employee lock-in as a way to increase commitment to long term insurance, lock in makes it harder for good types to leave a firm.

Our model adapts the Harris and Holmstrom (1982) model of wage dynamics. In their model there is symmetric learning about workers’ ability (ability is public information and evolves stochastically over time), unilateral commitment (firms can commit to sequences of wage offers contingent on any public information but workers cannot commit to stay in the firm), and capital markets are absent. Since workers are risk averse, the first best allocation involves constant wages over time and information states. However, the equilibrium involves wages that are rigid downward and expected to increase over time as firms match offers made to those workers who are revealed to be of high ability. Furthermore, workers receive wages below their expected ability in the first few periods. This initial gap between wages and abilities is the counterpart of front-loading in our model. The wage rigidity is the counterpart of the cap on premiums in our model. The exact counterpart of wage rigidity is a second period cap on premiums equal to the first period premium. This premium rigidity occurs in our model only in the equilibrium contract designed for consumers whose income does not rise.
De Garidel (1998) was the first to adapt Harris and Holmstrom to an insurance setting. He discusses an environment where information is symmetric at the time of initial contracting. In the first period the accident history of an individual reveals information about his risk type. De Garidel considers two alternative scenarios. In one scenario, the accident history is only known to the consumer and to the original insurer. In the second scenario, firms share accident information so that accident history is public knowledge. Thus, the second scenario is one of symmetric learning, whereas the first one involves asymmetric learning, with the rivals of the original insurer possessing less information. De Garidel shows that it may be welfare decreasing to require information sharing.

Cochrane (1995) also discusses a similar issue. He looks at an environment where neither consumers nor insurance companies can commit to a long term contract and provides a scheme that achieves the efficient allocation by using a sequence of short term contracts and a health account that provides payments that cover future changes in premiums. In contrast, complete insurance of reclassification risk is not an equilibrium in our context. The reason for the contrast is that Cochrane makes an assumption on the relation between the growth in the present value of spot premiums and the growth of income that guarantees that the credit constraints are never operative. We characterize the equilibrium contracts for the cases where the credit constraints are binding.

Dionne and Doherty (1994) study contract dynamics, under asymmetric information about the probability of accidents. They assume that firms cannot commit not to renegotiate with consumers once information about types is revealed. They key implication of the renegotiation constraint is that equilibrium contracts, which involve pooling in the first period, are front-loaded. Our finding that contracts are front-loaded is consistent with this prediction. However, in their set up front-loading is associated with the proportion of bad types that pool. Hence, more front-loading means worse pools, which in turn translates into more expensive present value of premiums. We find the opposite, suggesting front-loading is not evidence of renegotiation problems in an asymmetric information environment.

8 Concluding Remarks

The contracts offered in the life insurance market fit the theoretical predictions of a model with symmetric learning and one-sided commitment. They are not in line with alternative assumption on commitment. They also cannot be explained by standard
asymmetric information explanations.

We found that the life insurance industry achieves consumer commitment to long term contracts by front loading premiums. Front-loading creates consumer lock in which in turn reduces reclassification risk.

The life insurance experience is in sharp contrast with the health insurance one where front-loaded contracts are not offered and reclassification risk is a major concern.

Understanding and quantifying the inefficiency from the lack of bilateral commitment in life insurance is of interest in light of the policy debate over health insurance. The health care market suffers from a variety of other problems. In contrast to the health insurance case, most households have access to life insurance. Hence, the ability of firms to commit to guarantee renewability seems to be enough to provide long term insurance. It is interesting to note that insurance companies offer guaranteed renewable contracts without the need of any regulatory imposition. Moreover, under some common term contracts consumers are subject to little or no reclassification risk.

It is of interest to understand what makes the performance of these two industries different. The goal would be to understand what health insurance features interact with the lack of consumer commitment to create inefficiencies not observed in the life insurance market.

There are several differences between these markets: First, while life insurance is about insuring an income stream, health insurance is about health care treatment. Thus, the amount needed to be front-loaded to generate long term insurance is proportional to income in the life insurance market while independent of income in the health insurance market. Hence, health insurance front-loading is likely to be unaffordable to low income households. Second, treatment cost risk is non-diversifiable, since it affects all patients (for more on this argument see Cutler (1992)). Finally, health insurance involves a quality of service, susceptible to moral hazard on the part of insurance companies (in particular, under managed care). Hence, consumers are likely to be more reluctant to lock-in to a health insurer, who later on can reduce quality.

An interesting connection exists between life insurance and some credit contracts (e.g., mortgages). Borrowers cannot easily commit not to pre-pay if interest rates drop. However there is an important difference: interest rate risk is aggregate risk that banks offering mortgages cannot easily diversify. In contrast, reclassification risk is idiosyncratic risk that is fully diversifiable. Thus, we expect more insurance against reclassification risk than of interest rate risk. Indeed, no more than a couple of “points” are front loaded in common mortgage contracts, only moderately reducing the present value of long run payments. This is in contrast with the life insurance case where there
is a wide range of front loading with a large impact on long run payments.

9 Appendix

Proof of Proposition 1

First note that we can replace the set of constraints (3) with the following, simpler, set of constraints:

\[(1 - p_i)Q_i^2 - p_iF_i^2 \leq 0 \text{ for } i = 1, \ldots, N\]  \hspace{1cm} (6)

To see this, note that if \((Q_1, F_1), (Q_1^1, F_1^1), \ldots, (Q_N^N, F_N^N)\) maximize (1) subject to (2) and (6), then there is no state \(i\), and no \((Q_i^2, F_i^2)\) that makes positive profits and gives buyers a higher utility in that state. Thus, (3) is satisfied. Conversely, suppose that \((Q_i^2, F_i^2)\) are such that (6) is violated. Then it is clear that (3) is violated as well since a competing insurance company can offer terms that are slightly better for buyers than \((Q_i^2, F_i^2)\) and that still make positive profits.

Let \(\mu\) be the Lagrange multiplier for the constraint in (2) and \(\lambda_i\) the Lagrange multiplier for the \(i\)th constraint in (6).

The first order conditions for an optimum are:

\[u'(y - g - Q_1) = \mu\]  \hspace{1cm} (7)

\[v'(F_1) = \mu\]  \hspace{1cm} (8)

\[-(1 - p)\pi_i u'(y + g - Q_i^1) + (1 - p)\pi_i \mu + \lambda_i = 0 \ \forall \ i\]  \hspace{1cm} (9)

\[(1 - p)\pi_i v'(F_i^2) - (1 - p)\pi_i \mu - \lambda_i = 0 \ \forall \ i\]  \hspace{1cm} (10)

\[((1 - p_i)Q_i^2 - p_iF_i^2)\lambda_i = 0 \ \forall \ i\]  \hspace{1cm} (11)

Part (i) follows from first combining equations (7) and (8) and then combining equations (9) and (10).

To prove part (ii), note first that equations (9) and (10) imply

\[F_i^2 = (u')^{-1}(u'(y + g - Q_i^2))\]  \hspace{1cm} (12)
If constraint \( i \) in equation (6) is binding, \((1-p_i)Q^i_2 = p_i F^i_2\). Substituting from equation (12) we obtain

\[(1-p_i)Q^i_2 = p_i (v')^{-1}(u'(y + g - Q^i_2))\] (13)

From equation (13), we see that, since \( u' \) and \( v' \) are decreasing functions, if \( i \) and \( j \) are two binding constraints with \( i > j \) (so that \( p_i > p_j \)), then \( Q^i_2 > Q^j_2 \).

Suppose now that constraint \( k \) in equation (6) is non-binding. Then equation (9) simplifies to:

\[u'(y + g - Q^k_2) = \mu\] (14)

Thus, if constraints \( k \) and \( l \) are non-binding, \( Q^k_2 = Q^l_2 \).

If in contrast, constraint \( i \) in equation (6) is binding,

\[u'(y + g - Q^k_2) = \mu + \frac{\lambda_i}{(1-p)\pi_i} < \mu\] (15)

Where the inequality holds because, if constraint \( i \) is binding, \( \lambda_i < 0 \).

Thus, if constraint \( i \) is binding and \( k \) is not, \( Q^i_2 < Q^k_2 \). We now want to show that if \( i \) is binding and \( k \) is not, then \( i < k \). Since \( k \) is not binding, substituting from equation (12) we obtain:

\[(1-p_k)Q^k_2 < p_k (v')^{-1}(u'(y + g - Q^k_2))\] (16)

Thus, \( Q^i_2 < Q^k_2 \) and \( p_i > p_k \) render equations (13) and (16) incompatible proving that indeed \( p_i < p_k \).

To prove part (iii), we need to show that the first period premium \( Q_1 \) must be larger than actuarially fair premium \( Q_1(FI) \). If any of the no lapsation constraints (6) is not binding, then \( Q_1 > Q_1(FI) \) is immediate from the zero profit condition for the insurance company (equation (2)).

Suppose instead that all the no lapsation constraints are binding. Substituting from equation (7) into equation (9), we obtain:

\[u'(y + g - Q^k_2) = u'(y - g - Q_1) + \frac{\lambda_i}{(1-p)\pi_i}\] (17)

Thus, \( Q_1 > Q^N_2(FI) - 2g \). This inequality clearly requires \( Q_1 > Q_1(FI) \) if \( g \) is small enough since \( p_N > p \).
Part (iv) is obvious: as $g$ increases, more and more of the no lapsation constraints become binding. This means that, as $g$ grows, $s$ becomes larger. When $s$ is larger, $Q_1$ declines.

10 Bibliography


Life Insurance Fact Book, American Council of Life Insurance, several issues.


Georges Dionne, forthcoming.