

Connecting Theory to Data in Analyzing Social Insurance*

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ABSTRACT

We survey the literature on social insurance, focusing on recent work that has connected theory to evidence to make quantitative statements about welfare. Our review contains two parts. We first discuss motives for government intervention in private insurance markets, focusing primarily on selection. We review the original theoretical arguments for government intervention in the presence of adverse selection, and describe how recent empirical work documenting the importance of preference heterogeneity and loading factors suggests refinements or reversals to the original theoretical conclusions. We then describe recent empirical work that seeks to test whether or not selection exists in insurance markets and to document the welfare costs of this selection and the welfare consequences of potential public policy interventions. In the second part of the paper, we review work on optimal social insurance policies. We discuss formulas for the optimal level of insurance benefits in terms of empirically estimable parameters. We then consider the consequences of relaxing the key assumptions underlying these formulas, such as allowing for fiscal externalities or behavioral biases. We also review recent work on other dimensions of optimal policy, such as mandated savings accounts and the optimal path of benefits. Finally, we discuss some of the major challenges that remain in understanding optimal social insurance policy.

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1 Introduction

Over the last century, social insurance – government intervention in providing insurance against adverse shocks to individuals – has emerged as one of the major functions of government in developed countries. Social insurance programs began by providing limited coverage for risks such as injury at work and unemployment (Fishback and Kantor 1998, Baicker, Goldin, and Katz 1998). Today, governments provide substantial insurance for a broad range of risks, including health (Medicare and Medicaid in the U.S.), disability and retirement (the Old Age, Survivors, and Disability insurance program), work injury (Workers Compensation), and unemployment (Unemployment Insurance).¹ In the United States, expenditures on social insurance have risen from less than 10 percent of the federal government’s budget in the early 1950s to almost 60 percent today and continue to grow rapidly (Gruber 2009). Social insurance expenditures are now a defining characteristic of modern developed economies. The fraction of GDP devoted to social insurance increases sharply with GDP per capita (Figure 1).

Academic research on social insurance policies has grown alongside the expansion of these programs. Research on social insurance has addressed two broad questions. First, when should the government intervene in private insurance markets? The standard set of rationales, includes consists of private market failures, income redistribution, and paternalism. More recently, a growing empirical literature has sought to quantify the importance of these motives for government intervention. Much of this literature has focused on one particular market failure that can provide a rationale for social insurance: adverse selection due to asymmetric information. Second, if the government chooses to intervene, what is the optimal way to do so? The key issue here is that expanding social insurance creates moral hazard by distorting incentives. The literature on optimal policies seeks to identify the policies that maximize welfare, trading off the distortionary costs of social insurance programs with the benefits they provide in reducing exposure to risk. This literature has analyzed several dimensions of social insurance policies, ranging from the optimal level of benefits to whether the optimal tools are provision of liquidity (e.g. via loans) or state-contingent transfers.

Research on each these two questions has traditionally been divided into two distinct methodological strands: a normative theoretical literature that focuses on welfare analysis and a positive empirical literature that documents the workings of private insurance markets or the impacts of social insurance programs. The limitation of this two-pronged approach is that the theoretical models do not by themselves offer quantitative answers to the key policy questions, while the descriptive empirical literature often has little to say about the welfare implications of its findings. For example, the rich theoretical literature on adverse selection has shown that private markets may provide too little insurance in the presence of asymmetric information. A more recent empirical literature has documented that adverse selection does in fact exist in many private insurance markets. However, the empirical techniques developed to identify the existence of selection do not,

¹See Social Security Administration (1997) for an excellent overview of modern social insurance programs in the United States. Krueger and Meyer (2002) also provide a description of many social insurance programs in the U.S., as well as a review of the empirical literature on their labor supply impacts.

by themselves, permit even qualitative comparisons across markets in which selection has been detected or where the welfare costs of this selection are likely to be larger, let alone making quantitative welfare statements. Similarly, a large theoretical literature has characterized the properties of optimal insurance contracts in the presence of moral hazard. In parallel, empirical work has documented the causal impacts of social insurance programs on a broad range of behaviors, ranging from job search to health expenditures. Again, however, the implications of estimates of parameters such as the elasticity of unemployment durations with respect to benefits for optimal policy were unclear from the initial empirical literature.

Over the past two decades, researchers have made considerable progress in connecting theoretical and empirical work on social insurance to make empirically grounded statements about welfare and optimal policy. For instance, recent work has shown how data on selection patterns in insurance markets can be used to quantify the welfare costs of adverse selection in models of asymmetric information. Similarly, researchers have developed new methods of mapping estimates of behavioral elasticities to statements about the optimal level of social insurance benefits.

In this survey, we provide an overview of some of the key advances in connecting theory to data in analyzing the welfare consequences of social insurance. In focusing on this goal, we deliberately do not provide a comprehensive survey of the literature on social insurance. We cover only a selected subset of the many theoretical studies that have advanced the literature. We also discuss only a small subset of the numerous empirical studies that have estimated relevant empirical parameters. Readers seeking a more detailed discussion of empirical evidence on behavioral responses to social insurance may refer to Krueger and Meyer (2002) and Cutler (2002).

We divide our review of the literature into two sections, corresponding to the two major questions discussed above. In Section 2, we discuss motives for government intervention in insurance markets. In Section 3, we discuss optimal policy design once the government has decided to intervene. We conclude in Section 4 by highlighting some of the broad challenges that remain in going from the work we review here to statements about optimal policy design.

2 Motivations for Social Insurance

Public finance analysis begins with the question of why the government might have a reason to intervene in a particular private market transaction. Only then can one move forward to consider potential forms of intervention and their consequences. Standard economic rationales for social insurance include redistribution, paternalism, and market failures (Diamond, 1977). Within this relatively broad remit our focus here is quite narrow. Following much of the recent literature, we concentrate on the potential role for social insurance in ameliorating one particular type of private market failure, namely selection. We return at the end of this section to briefly comment on other potential rationales for social insurance and some of the existing empirical work on them.

Modern theoretical work on adverse selection in insurance markets dates back to the seminal work of Akerlof (1970) and Rothschild and Stiglitz (1976) which introduced a key economic motivation for social insurance: the competitive private equilibrium may inefficiently under-provide

insurance, and there may be scope for welfare improving government intervention, perhaps even a Pareto improving intervention. Relative to the rich theoretical literature, for many years, empirical work on adverse selection in insurance markets lagged decidedly behind. Indeed, in awarding the 2001 Nobel Prize for the pioneering theoretical work on asymmetric information, the Nobel committee noted this paucity of empirical work (Bank of Sweden, 2001).

Over the last decade or so, empirical research had made considerable progress in developing tools to identify whether asymmetric information exists in a given insurance market, as well as to begin to quantify the welfare costs of this asymmetric information and the welfare consequences of alternative public policy interventions. Some of the findings of this empirical work have suggested important refinements to the initial theory. In particular, a growing body of evidence suggests that in addition to heterogeneity in risk type – which was the focus of the theoretical literature – heterogeneity in preferences – which the original theory assumed away – can be a quantitatively important determinant of demand for insurance. Once one allows for heterogeneity in preferences in addition to risk type, the competitive equilibrium may look very different and the optimal policy intervention is no longer a priori obvious.

To summarize and discuss this empirical literature, we begin by presenting a highly stylized model and graphical framework that allows us to review the basic results of the standard theory and to describe their sensitivity to incorporating several “real world” features of insurance markets. The graphical framework will then provide a lens through which we discuss the basic insights behind the existing empirical work aimed first at detecting whether selection exists and then at trying to quantify its welfare costs and the welfare consequences of alternative public policy interventions. We also briefly summarize some of the main findings of this empirical literature. Finally, we discuss some of the limitations to the work to date and a few of the important directions for further work.

2.1 Adverse Selection: Review of the basic theory

To illustrate the main conceptual ideas behind market failure and potential scope for welfare-improving government intervention and to link these ideas to related empirical work, we introduce a simplified model which is based on that presented in Einav, Finkelstein and Cullen (2010) and discussed further in Einav and Finkelstein (2011). We begin with the “textbook model” in which the qualitative results are unambiguous: adverse selection creates a welfare loss from sub-optimally low levels of insurance coverage, and public policy such as mandates can reach the efficient allocation and improve welfare. Even in this textbook case, however, the magnitudes of the welfare cost of adverse selection and the welfare gains from government intervention remain as empirical questions. Moreover, these qualitative results can be reversed with the introduction of either or both of two important features of actual insurance markets: (1) insurance loads, or administrative costs of providing insurance and (2) preference heterogeneity. When we allow for loads, whether or not mandates can produce welfare gains relative to the adversely selected market equilibrium is uncertain, since it is no longer necessarily efficient for all individuals to be insured in equilibrium. Once we allow for preference heterogeneity as well, the selection market equilibrium may involve

over-insurance rather than under-insurance. Given the qualitative as well as quantitative uncertainty of the impact of selection and of government intervention, these naturally become empirical questions.

2.1.1 A stylized model

Setup and notation. A population of individuals is allowed to choose from exactly two available insurance contracts, one that offers high coverage (contract H) and one that offers less coverage (contract L). To further simplify the exposition, assume that contract L is no insurance and is available for free, and that contract H is full insurance. These are merely normalizations and it is relatively straightforward to extend the analysis to partial coverage contracts or to more than two contracts (Einav, Finkelstein and Cullen 2010).

A key simplification is that we fix the contract space, although the price of insurance is determined endogenously. In other words, the set the contracts that insurance companies offer is determined exogenously, and the focus of the model is on how selection distorts the pricing of these existing contracts. The analysis is therefore in the spirit of Akerlof (1970) rather than Rothschild and Stiglitz (1976), who endogenize the level of coverage as well. This assumption greatly simplifies the analytical framework and makes it easier to both allow for multiple sources of heterogeneity across consumers and to illustrate some of the key insights and implications of selection models. However, it means that the analysis of the welfare consequences of selection or alternative possible government interventions is limited to the cost associated with inefficient pricing of a fixed set of contracts; it does not capture welfare loss that selection may create by distorting the set of contracts offered, which in some settings may be large. We return to this issue below.

Define the population by a distribution $G(\zeta)$, where ζ is a vector of consumer characteristics. For our initial discussion of the “textbook case”, we will assume that these consumer characteristics ζ include only characteristics relating to their risk factors; later, we will relax this assumption and explore the implications of allowing for preference heterogeneity.

Denote the (relative) price of contract H by p , and denote by $v^H(\zeta_i, p)$ and $v^L(\zeta_i)$ consumer i 's (with characteristics ζ_i) utility from buying contracts H and L , respectively. Although not essential, it is natural to assume that $v^H(\zeta_i, p)$ is strictly decreasing in p and that $v^H(\zeta_i, p = 0) > v^L(\zeta_i)$. Finally, denote the expected monetary cost associated with the insurable risk for individual i by $c(\zeta_i)$. For ease of exposition, we discuss the benchmark case in which there is no moral hazard; the cost c of insuring an individual does not depend on the contract chosen. Allowing for moral hazard does not fundamentally change the analysis, although it does complicate the presentation (Einav, Finkelstein and Cullen 2010). Of course, as we will discuss at length when we turn to the empirical work on selection in insurance markets, the potential presence of moral hazard as well as selection does pose important empirical challenges to the analysis of either one.

Demand for insurance. Assume that each individual makes a discrete choice of whether to buy insurance or not. Since we take as given that there are only two available contracts and their associated coverages, demand is only a function of the (relative) price p . Assume that firms cannot

offer different prices to different individuals. To the extent that firms can make prices depend on observed characteristics, one should think of the foregoing analysis as applied to a set of individuals that only vary in unobserved (or unpriced) characteristics. Assume that if individuals choose to buy insurance they buy it at the lowest price at which it is available, so it is sufficient to characterize demand for insurance as a function of the lowest price p .

Given the above assumptions, individual i chooses to buy insurance if and only if $v^H(\zeta_i, p) \geq v^L(\zeta_i)$. We can define $\pi(\zeta_i) \equiv \max \{p : v^H(\zeta_i, p) \geq v^L(\zeta_i)\}$, which is the highest price at which individual i is willing to buy insurance. Aggregate demand for insurance is therefore given by

$$D(p) = \int 1(\pi(\zeta) \geq p) dG(\zeta) = \Pr(\pi(\zeta_i) \geq p), \quad (1)$$

and we assume that the underlying primitives imply that $D(p)$ is strictly decreasing, continuous, and differentiable.

Supply and equilibrium. We consider $N \geq 2$ identical risk neutral insurance providers, who set prices in a Nash Equilibrium (a-la Bertrand). We further assume that when multiple firms set the same price, individuals who decide to purchase insurance at this price choose a firm randomly. For our initial discussion of the “textbook case”, we will assume that the only costs of providing contract H to individual i are the direct insurer claims $c(\zeta_i)$ that are paid out; later we will explore the implications of allowing for the possibility of loading factors, such as other administrative (production) costs of the insurance company.

The foregoing assumptions imply that the average (expected) cost curve in the market is given by

$$AC(p) = \frac{1}{D(p)} \int c(\zeta) 1(\pi(\zeta) \geq p) dG(\zeta) = E(c(\zeta) | \pi(\zeta) \geq p). \quad (2)$$

Note that the average cost curve is determined by the costs of the sample of individuals who endogenously choose contract H . The marginal (expected) cost curve in the market is given by

$$MC(p) = E(c(\zeta) | \pi(\zeta) = p). \quad (3)$$

In order to straightforwardly characterize equilibrium, we make two further simplifying assumptions. First, we assume that there exists a price \bar{p} such that $D(\bar{p}) > 0$ and $MC(p) < p$ for every $p > \bar{p}$. In words, we assume that it is profitable (and efficient, as we will see soon) to provide insurance to those with the highest willingness to pay for it. Second, we assume that if there exists \underline{p} such that $MC(\underline{p}) > \underline{p}$ then $MC(p) > p$ for all $p < \underline{p}$. That is, we assume that $MC(p)$ crosses the demand curve at most once. It is easy to verify that these assumptions guarantee the existence and uniqueness of equilibrium. In particular, the equilibrium is characterized by the lowest break-even price, that is:

$$p^* = \min \{p : p = AC(p)\}. \quad (4)$$

Measuring welfare. We measure consumer surplus by the certainty equivalent. The certainty equivalent of an uncertain outcome is the amount that would make an individual indifferent between

obtaining this amount for sure and obtaining the uncertain outcome. An outcome with a higher certainty equivalent therefore provides higher utility to the individual. This welfare measure is attractive as it can be measured in monetary units. Total surplus in the market is the sum of certainty equivalents for consumers and profits of firms. We ignore any income effects associated with price changes, which is equivalent to assuming the utility function exhibits constant absolute risk aversion (CARA).

Denote by $e^H(\zeta_i)$ and $e^L(\zeta_i)$ the certainty equivalent of consumer i from an allocation of contract H and L , respectively; under the assumption that all individuals are risk averse, the willingness to pay for insurance is given by $\pi(\zeta_i) = e^H(\zeta_i) - e^L(\zeta_i) > 0$. We can write consumer welfare as

$$CS = \int [(e^H(\zeta) - p) 1(\pi(\zeta) \geq p) + e^L(\zeta) 1(\pi(\zeta) < p)] dG(\zeta) \quad (5)$$

and producer welfare as

$$PS = \int (p - c(\zeta)) 1(\pi(\zeta) \geq p) dG(\zeta). \quad (6)$$

Total welfare will then be given by

$$TS = CS + PS = \int [(e^H(\zeta) - c(\zeta)) 1(\pi(\zeta) \geq p) + e^L(\zeta) 1(\pi(\zeta) < p)] dG(\zeta). \quad (7)$$

It is now easy to see that it is socially efficient for individual i to purchase insurance if and only if

$$\pi(\zeta_i) \geq c(\zeta_i). \quad (8)$$

In other words, in a first best allocation individual i purchases insurance if and only if his willingness to pay is at least as great as the expected social cost of providing to him the insurance.

2.1.2 The textbook case

Adverse selection equilibrium Figure 2 provides a graphical representation of the adverse selection insurance equilibrium that arises from the “textbook case” we have just outlined. The relative price (or cost) of contract H is on the vertical axis. Quantity (i.e. share of individuals in the market with contract H) is on the horizontal axis; the maximum possible quantity is denoted by Q_{max} . The demand curve denotes the relative demand for contract H . Likewise, the average cost (AC) curve and marginal cost (MC) curve denote the average and marginal *incremental* costs to the insurer from coverage with contract H relative to contract L .

Because individuals in this setting can choose only the contract or not, the market demand curve simply reflects the cumulative distribution of individuals’ willingness to pay for the contract. The difference between willingness to pay $\pi(\zeta)$ and $MC(\zeta)$ is the risk premium, and is positive for risk averse individuals.

Because of the “textbook” assumption that individuals are homogeneous in all features of their utility function – i.e. ζ_i includes only characteristics relating to one’s expected claims c_i – willingness to pay for insurance is increasing in risk type. This is the key feature of adverse selection: individuals who have the highest willingness to pay for insurance are those who, on average, have the highest

expected costs. This is represented in Figure 2 by drawing a downward sloping MC curve. That is, marginal cost is increasing in price and decreasing in quantity. As the price falls, the marginal individuals who select contract H have lower expected cost than infra-marginal individuals, leading to lower average costs.

The link between the demand and cost curve is arguably the most important distinction of insurance markets (or selection markets more generally) from traditional product markets. The shape of the cost curve is driven by the demand-side consumer selection. In most other contexts, the demand curve and the cost curve are independent objects; demand is determined by preferences and costs by the production technology. The distinguishing feature of selection markets is that the demand and cost curves are tightly linked since the individual's risk type not only affects demand but also directly determined cost.

As noted, the efficient allocation is to insure all individuals whose willingness to pay is at least as great as their expected cost of insuring them. In other words, in Figure 2, it is efficient to insure all individuals for whom demand exceeds marginal cost. In the textbook case, the risk premium is always positive, since by assumption all individuals are risk averse and there are no other market frictions. As a result, the demand curve is always above the MC curve and, as shown in figure 2, it is efficient for all individuals to be insured ($Q_{eff} = Q_{max}$). The welfare loss from not insuring a given individual is simply the risk premium of that individual, or the vertical difference between the demand and MC curves.

The essence of the private information problem is that firms cannot charge individuals based on their (privately known) marginal cost, but are instead restricted to charging a uniform price, which in equilibrium implies average cost pricing. Since average costs are always higher than marginal costs, adverse selection creates under-insurance, a familiar result first pointed out by Akerlof (1970). This under-insurance is illustrated in Figure 2. The equilibrium share of individuals who buy contract H is Q_{eqm} (where the AC curve intersects the demand curve), while the efficient number is $Q_{eff} > Q_{eqm}$; in general, the efficient allocation Q_{eff} is determined where the MC curve intersects the demand curve, which in the textbook case is never). The fundamental inefficiency created by adverse selection arises because the efficient allocation is determined by the relationship between *marginal* cost and demand, but the equilibrium allocation is determined by the relationship between *average* cost and demand.

The welfare loss due to adverse selection arises from the lost consumer surplus (the risk premium) of those individuals who remain inefficiently uninsured in the competitive equilibrium. In Figure 2, these are the individuals whose willingness to pay is less than the average cost of the insured population, P_{eqm} . Integrating over all these individuals' risk premia, the welfare loss from adverse selection is given by the area of the "dead-weight loss" trapezoid CDEF.

The amount of under-insurance generated by adverse selection, and its associated welfare loss, can vary greatly in this environment. As illustrated graphically in Einav and Finkelstein (2011), it is possible for the efficient allocation to be achieved despite a downward sloping marginal cost curve (as long as average costs always lie below demand), or it is possible to get complete unraveling of the private market, with no insurance in equilibrium, if average costs lie always above demand.

Public policy in the textbook case One can use the graphical framework in Figure 2 to evaluate not only the welfare consequences of the private market equilibrium insurance allocation but also the welfare consequences of common public policy interventions in insurance markets that alter the insurance allocation. The comparative advantage of the public sector over the private sector is that it can directly manipulate either the equilibrium quantity of insurance (through mandates) or the equilibrium price of insurance (through either tax/subsidy policy or regulation of insurance company pricing). We briefly discuss each in turn.

Mandates. The canonical solution to the inefficiency created by adverse selection is to mandate that everyone purchase insurance; this is emphasized as early as Akerlof (1970). In the textbook setting, mandates produce the efficient outcome in which everyone has insurance. However, the magnitude of the welfare benefit produced by an insurance purchase requirement can vary dramatically depending on the specifics of the market since, as noted, the amount of under-insurance produced by adverse selection in equilibrium can vary greatly.

Tax subsidies. Another commonly discussed policy remedy for adverse selection is to subsidize insurance coverage. Indeed, adverse selection in private health insurance markets is often cited as an economic rationale for the tax subsidy to employer provided health insurance, which is the single largest federal tax expenditure. We can again use Figure 2 to illustrate. Consider, for example, a lump sum subsidy toward the price of coverage. This would shift demand out, leading to a higher equilibrium quantity and less under-insurance. The gross welfare loss would still be associated with the area between the original (pre-subsidy) demand curve and the MC curve, and would therefore unambiguously decline with any positive subsidy. A large enough subsidy (greater than the line segment GE in Figure 2) would lead to the efficient outcome, with everybody insured.

Of course, the net welfare gain from public insurance subsidies will be lower than the gross welfare gain due to the marginal cost of the public funds that must be raised to finance the subsidy; this may be quite large since the subsidy must be paid on all the inframarginal consumers as well as the marginal ones. Given a non-zero social cost of public funds, the welfare maximizing subsidy would not attempt to achieve the efficient allocation. It is possible that the welfare maximizing subsidy could be zero. In other words, starting from the competitive allocation (point C), a marginal dollar of subsidy may not be welfare enhancing; although given the equilibrium distortion the welfare gain will be first order, the welfare cost of the subsidy is as well. Ultimately this is an empirical question and we return to it below.

Restrictions on characteristic-based pricing A final common form of public policy intervention is regulation that imposes restrictions on the characteristics of consumers over which firms can price discriminate. Some regulations require “community rates” that are uniform across all individuals, while others prohibit insurance companies from making prices contingent on certain observable risk factors, such as race or gender. For concreteness, consider the case of a regulation that prohibits pricing on the basis of gender. Recall that Figure 2 can be interpreted as applying

to a group of individuals who must be treated the same by the insurance company. When pricing based on gender is prohibited, males and females are pooled into the same market, with a variant of Figure 2 describing that market. When pricing on gender is allowed, there are now two distinct insurance markets – described by two distinct variants of Figure 2 – one for women and one for men, each of which can be analyzed separately. A central issue for welfare analysis is whether, when insurance companies are allowed to price on gender, consumers still have residual private information about their expected costs. If they do not, then the insurance market within each gender-specific segment of the market will exhibit a constant (flat) MC curve, and the equilibrium in each market will be efficient. In this case, policies that restrict pricing on gender are unambiguously welfare decreasing since they create adverse selection where none existed before. However, in the more likely case that individuals have some residual private information about their risk that is not captured by their gender, each gender-specific market segment would look qualitatively the same as Figure 2 (with downward sloping MC and AC curves). In such cases, the welfare implications of restricting pricing on gender could go in either direction; depending on the shape and position of the gender-specific demand and cost curves relative to the gender-pooled ones, the sum of the areas of the “deadweight loss” trapezoids in the gender-specific markets could be larger or smaller than the area of the single deadweight loss trapezoid in the gender-pooled market; Einav and Finkelstein (2011) discuss a numerical illustrative example in more detail.

Comment: Pareto improvements. It is important to note that while various policies may be able to increase efficiency or even produce the efficient outcome – such as mandates – they are not, in this environment, Pareto improving. Consider for concreteness the case of mandates. The insurance provider (be it the government or the private market) must break even in equilibrium, and therefore the cost of providing the insurance must be recouped. The total cost is equal to the market size (Q_{\max}) times the average cost of insurance provision to Q_{\max} individuals, which is given by point G. There are various potential financing mechanisms, but assuming, as seems reasonable, the government does not have observe all of the private information about an individual’s costs, the government – like the private sector – individuals based on their (privately known) marginal cost. Assume for simplicity the government uses average cost pricing, effectively issuing a lump sum tax on individuals equal to the average cost of insuring all individuals (given by the vertical distance at point G). Thus the efficient allocation is achieved and but everyone is not made strictly better off. Indeed, all those whose willingness to pay is less than G are made strictly worse off.

The inability for mandates to produce a Pareto-improvement are a direct consequence of the Akerloviaan modeling framework which has fixed the contract space. Some models that endogenize the contract offers are able to generate the possibility of Pareto-improving mandates (e.g. Wilson, 1977) or Pareto-improving tax-transfer schemes (Rothschild and Stiglitz, 1976). In the class of models with endogenous contracts, whether or not private information in this class of models generates an allocation that is constrained Pareto efficient or not varies with the modeling assumptions, as discussed in Crocker and Snow (1985).²

²All of the models discussed by Crocker and Snow (1985) assume that individuals differ only in their risk type.

2.1.3 Departures from the textbook environment: loads and preference heterogeneity

The qualitative findings of the textbook model are unambiguous. Under the textbook assumptions, private information about risk always produces under-insurance relative to the efficient outcome, and mandatory insurance coverage is always a welfare-improving policy intervention. Of course the quantitative implications concerning the extent of under-insurance in the private market equilibrium and the extent of the welfare gain from mandatory insurance coverage remain open empirical questions, even in the textbook environment.

We now discuss two departures from the textbook environment that can change even the qualitative findings of the model. Both are motivated by important features of actual insurance markets that have been emphasized recently in the empirical literature.

Production costs (loads) Consider first the supply-side assumption we made above that the only costs of providing insurance to an individual are the direct insurer claims that are paid out. Many insurance markets display evidence of non-trivial loading factors, including long-term care insurance (Brown and Finkelstein, 2007), annuity markets (Friedman and Warshawsky, 1990; Mitchell et al., 1999; Finkelstein and Poterba, 2002), health insurance (Newhouse, 2002), and automobile insurance (Chiappori et al., 2006). While these papers lack the data to distinguish between loading factors arising from administrative costs to the insurance company and those arising from market power (insurance company profits), it seems a reasonable assumption that it is not costless to “produce” insurance and run an insurance company.

We therefore relax the textbook assumption to allow for a loading factor on insurance, for example in the form of administrative costs associated with selling and servicing insurance, perhaps due to costs associated with advertising and marketing, or with verifying and processing claims. The key implication of such loads is that it is now not necessarily efficient to allocate insurance coverage to all individuals. Even if all individuals are risk averse, the additional cost of providing an individual with insurance may be greater than the risk premium for certain individuals, making it socially efficient to leave such individuals uninsured. This case is illustrated in Figure 3, which is similar to Figure 2, except that the cost curves are shifted upward reflecting the additional cost of insurance provision.

Figure 3 is drawn in a way that the MC curve crosses the demand curve “internally” (that is, at a quantity lower than Q_{\max}), at point E, which depicts the socially efficient insurance allocation. It is efficient to insure everyone to the left of point E (since demand exceeds marginal cost), but socially inefficient to insure anyone to the right of point E (since demand is less than marginal cost). In this situation, it’s efficient to keep $Q_{\max} - Q_{eff}$ individuals uninsured.

Implications for policy analysis The introduction of loads does not affect the basic analysis of adverse selection but it does have important implications for its standard public policy remedies. The competitive equilibrium is still determined by the zero profit condition, or the intersection

Allowing for preference heterogeneity as well presumably makes the potential for Pareto improvements more limited.

of the demand curve and the AC curve (point C in Figure 3), and in the presence of adverse selection (downward sloping MC curve) this leads to under-insurance relative to the social optimum ($Q_{eqm} < Q_{eff}$), and to a familiar dead-weight loss triangle CDE.

However, with insurance loads, the qualitative result in the textbook environment of an unambiguous welfare gain from mandatory coverage no longer obtains. As Figure 3 shows, while a mandate that everyone be insured “regains” the welfare loss associated with under-insurance (triangle CDE), it also leads to over-insurance by covering individuals whom it is socially inefficient to insure (that is, whose expected costs are above their willingness to pay). This latter effect leads to a welfare loss given by the area EGH in Figure 3. Therefore whether a mandate improves welfare over the competitive allocation depends on the relative sizes of triangles CDE and EGH; this in turn depends on the specific market’s demand and cost curves, and is therefore an empirical question.

Preference heterogeneity and the possibility of advantageous selection Our “textbook environment” – like the original seminal papers of Akerlof (1970) and Rothschild and Stiglitz (1976) – assumed that individuals varied only in their risk type. In practice, however, consumers of course may also vary in their preferences. Thus the vector of consumer characteristics ζ_i that affects both willingness to pay $\pi(\zeta_i)$ and expected costs $c(\zeta_i)$ may include consumer preferences as well as risk factors.

Indeed, recent empirical work has documented not only the existence of substantial preference heterogeneity over various types of insurance, but the substantively important role of this preference heterogeneity in determining demand. Standard expected utility theory suggests that risk aversion will be important for insurance demand. And indeed, recent empirical evidence suggests that heterogeneity in risk aversion may be as or more important than heterogeneity in risk type in explaining patterns of insurance demand in automobile insurance (Cohen and Einav, 2007) and in long-term care insurance (Finkelstein and McGarry, 2006). In other markets there is evidence of a role for other types of preferences. For example, in the Medigap market, heterogeneity in cognitive ability appears to be an important determinant of insurance demand (Fang, Keane and Silverman, 2008); in choosing annuity contracts, preferences for having wealth after death play an important role (Einav, Finkelstein and Schrimpf 2010); in annual health insurance markets, heterogeneity in switching costs can also play an important role in contract demand (Handel, 2011).

Such heterogeneity in preferences can have very important implications for analysis of selection markets. In particular, if preferences are sufficiently important determinants of demand for insurance and sufficiently negatively correlated with risk type, the market can exhibit what has come to be called “advantageous selection”. In our graphical framework, advantageous selection can be characterized by an *upward sloping* marginal cost curve, in contrast to adverse selection which is defined by a *downward sloping* marginal cost curve.³

³Allowing for preference heterogeneity can complicate the notion of efficiency since the the mapping from expected cost to willingness-to-pay need no longer be unique. In what follows, when we discuss the “efficient allocation” under preference heterogeneity we are referring to the constrained efficient allocation which is the one that maximizes social welfare subject to the constraint that price is the only instrument available for screening (see Einav, Finkelstein and

Equilibrium and public policy with advantageous selection Figure 4 provides a graphical representation of advantageous selection. We depict an upward sloping marginal cost curve (and consequently an upward sloping average cost curve). As price is lowered and more individuals opt into the market, the marginal individual opting in has higher expected cost than infra-marginal individuals. Note that preference heterogeneity is essential for generating these upward sloping cost curves. Without it, the clear comparative static of the model is that willingness to pay is higher for higher expected cost individuals; thus marginal costs must be upward sloping – the individuals with the highest willingness to pay are highest cost.⁴

Since the MC curve is upward sloping, the AC curve lies everywhere below it. If there were no insurance loads (as in the textbook situation), advantageous selection would not lead to any inefficiency; the MC and AC curves would always lie below the demand curve, and in equilibrium all individuals in the market would be covered, which would be efficient.

With insurance loads, however, advantageous selection generates the mirror image of the adverse selection case; it also leads to inefficiency, but this time due to *over-insurance* rather than *under-insurance*. This can be seen in Figure 4. The efficient allocation calls for providing insurance to all individuals whose expected cost is lower than their willingness to pay—that is, all those who are to the left of point E (where the MC curve intersects the demand curve) in Figure 4. Competitive equilibrium, as before, is determined by the intersection of the AC curve and the demand curve (point C in Figure 4). But since the AC curve now lies below the MC curve, equilibrium implies that too many individuals are provided insurance, leading to over-insurance: there are $Q_{eqm} - Q_{eff}$ individuals who are inefficiently provided insurance in equilibrium. These individuals value the insurance at less than their expected costs, but competitive forces make firms reduce the price in order to attract these individuals and at the same time attracting more profitable infra-marginal individuals. Intuitively, insurance providers have an additional incentive to reduce price, as the infra-marginal customers whom they acquire as a result are relatively good risks. This is not merely a theoretical possibility; Cutler, Finkelstein, and McGarry (2008) summarize some of the findings regarding the presence of adverse compared to advantageous selection in different insurance markets.

We can similarly characterize the welfare loss from this over-insurance. The resultant welfare loss is given by the shaded area CDE, and represents the excess of MC over willingness to pay for individuals whose willingness to pay exceeds the average costs of the insured population. Once again, the source of market inefficiency is that consumers vary in their marginal cost, but firms are restricted to uniform pricing.

From a public policy perspective, advantageous selection calls for the opposite solutions relative to the tools used to combat adverse selection. For example, given that advantageous selection produces “too much” insurance relative to the efficient outcome, public policies that tax existing insurance policies (and therefore raise P_{eqm} toward P_{eff}) or outlaw insurance coverage (mandate

Cullen 2010 for further discussion).

⁴Once one allows for preference heterogeneity, the marginal cost curve need not be monotone. However for simplicity and clarity we focus on the polar monotone cases.

no coverage) could be welfare-improving. Although there are certainly taxes levied on insurance policies, to our knowledge advantageous selection has not yet been invoked as a rationale in public policy discourse, perhaps reflecting the relative newness of both the theoretical work and empirical evidence. To our knowledge, advantageous selection was first discussed by Hemenway (1990), who termed it “propitious” selection. De Meza and Webb (2001) provide a theoretical treatment of advantageous selection and its implications for insurance coverage and public policy.

Advantageous selection provides a nice example of the interplay in the selection literature between theory and empirical work. Motivated by the seminal theoretical papers on adverse selection, empirical researchers set about developing ways to test whether or not adverse selection exists. Some of this empirical work in turn turned up examples of advantageous selection, which the original theory had precluded. This in turn suggested the need for important extensions to the theory.

2.2 Empirical Evidence on Selection

Over the last decade, empirical work on selection in insurance markets has gained considerable momentum, and a fairly extensive and active empirical literature on the topic has emerged. We discuss this literature using the graphical framework described in the previous section. We begin with work designed to test whether or not selection actually exists in a particular insurance market. Existence of selection is a natural and necessary condition for investigation of its welfare consequences and, not surprisingly, where empirical work started first. We then discuss more recent work designed to try to empirically quantify the welfare consequences of adverse selection or of alternative potential public policy interventions.

2.2.1 Testing for selection

Despite the age and influence of the seminal theory on selection in insurance markets, systematic empirical examination of whether or not selection exists in actual insurance markets is a surprisingly recent development. As made clear by the foregoing graphical framework, adverse selection is defined by a downward sloping marginal cost curve. Testing for adverse selection essentially requires testing whether the marginal cost curve is downward sloping. Making inferences about marginal individuals is difficult however. Not surprisingly, therefore, the initial empirical approaches focused on cases under which one could make inferences by comparing average rather than marginal individuals. We begin by discussing these “positive correlation tests”. We then move on to the “cost curve test” which has the advantage of being able to make inference about marginal individuals, but at the cost of higher data requirements.

Positive correlation test of asymmetric information The graphical depiction of adverse selection in Figure 2 (or Figure 3) suggests one way to examine whether adverse selection is present in a particular insurance market: compare the expected cost of those with insurance to the expected cost of those without (or compare those with more insurance to those with less insurance). If adverse

selection is present, the expected costs of those who select more insurance should be larger than the expected costs of those who select less insurance.

Figure 5 illustrates the basic intuition behind the test. Here we start with the adverse selection situation already depicted in Figure 3, denoting the AC curve shown in previous figures by AC^H to reflect the fact that it averages over those individuals with the higher coverage contract, H . We have also added one more line: the AC^L curve. The AC^L curve represents the average expected cost of those individuals who have the lower coverage contract L . That is, the AC^H curve is derived by averaging over the expected costs of those with H coverage (averaging “from the left”, starting at $Q = 0$) while the AC^L curve is produced by averaging over the expected costs of those with L coverage (averaging “from the right”, starting at $Q = Q_{max}$). A downward-sloping MC curve implies that AC^H is always above AC^L , with the average costs of those with H at Q_{max} equal to the average costs of those with L at $Q = 0$ (because both represent the average costs of the full population), and the marginal cost curve intersecting AC^H at $Q = 0$ and AC^L at $Q = Q_{max}$.

Thus, at any given insurance price, and in particular at the equilibrium price, adverse selection implies that the average cost of individuals with more insurance is higher than the average cost of those with less insurance, and the difference in these averages is given by line segment CF in Figure 5 (the thick arrowed line in the figure). This basic insight underlies the widely used “positive correlation” test for asymmetric information. The test measures the distance between point C (average costs of those who in equilibrium are insured) and point F (average costs of those who in equilibrium are not insured). The results are consistent with the existence of adverse selection if the average cost of the insured (point C) is statistically greater than those of the uninsured (point F).

Variants of this idea have been around for many years. For instance, Glied (2000) and Cutler & Zeckhauser (2000) summarize attempts to identify risk-based sorting in health insurance choice, where instead of directly comparing claims or “accidents” across individuals with different insurance coverage, the comparison is made over a particular individual characteristic thought to be associated with higher claims, such as age or chronic illness.

Chiappori and Salanie (2000) formalized this intuition and emphasized that the basic approach requires some refinement because it does not clearly differentiate, as economic theories do, between individual characteristics that are observable and those that are not. As a starting point, one must stratify on the consumer characteristics that determine the contract menu offered to each individual. That is, a proper implementation of the positive correlation test requires that we examine whether, among a set of individuals who are offered the same coverage options at identical prices, those who buy more insurance have higher expected costs than those who do not. In the absence of such conditioning, it is impossible to know whether a correlation arises due to demand (different individuals self select into different contracts) or supply (different individuals are offered the contracts at different prices by the insurance company). Only the former is evidence of selection. As a result, some of the most convincing tests are those carried out using insurance company data, where the researcher knows (rather than assumes) the full set of characteristics that the insurance company uses for pricing. Absent data on individually-customized prices, which is sometimes

difficult to obtain, one may instead try to flexibly control for all individual characteristics that affect pricing (Chiappori and Salanie, 2000).

Following on their paper, a veritable “cottage industry” has emerged that applies variants of this “positive correlation test” across a wide variety of settings. There is now a large literature studying how average costs vary across different coverage options in a broad range of insurance markets, including health, life, automobile, and homeowner insurance. The widespread application of the test in part reflects its relatively not-so-demanding data requirements. The test requires “only” that one observe the average expected costs of individuals (who are observationally identical to the firm) with different amounts of insurance coverage. As noted, the applicability of the test has been greatly enhanced by researchers’ increasing success in obtaining access to insurance company micro data that allows them to observe – and condition on – the full set of characteristics that determines the menu of contracts available to a given individual.

The results of this literature have been mixed. In some markets, researchers have found evidence consistent with adverse selection—that is, higher average costs for individuals with greater insurance coverage—while in others they have found evidence of advantageous selection—defined by a negative relationship between insurance coverage and average costs—or have been unable to reject the null of symmetric information, meaning no difference in average costs. Cohen and Siegelman (2010) provide a recent review of this “positive correlation” literature. We return at the end of this section to discussing the portions of that literature most relevant for thinking about social insurance programs.

A central limitation in interpreting the results of the positive correlation test is that it is a joint test of the presence of either adverse selection or moral hazard. In other words, even in the absence of selection (i.e. a flat marginal cost curve), moral hazard (loosely, an impact of the insurance contract on expected claims) can produce the same “positive correlation” property of those with more insurance having higher claims than those without. These two very different forms of asymmetric information have very different public policy implications. In particular, in contrast to the selection case where the social policy has a variety of instruments that we discussed above that are not available to the private sector and that may help ameliorate the consequences of selection, the social planner generally has no comparative advantage over the private sector in ameliorating moral hazard (i.e. in encouraging individuals to choose socially optimal behavior).⁵ Thus distinguishing between adverse selection and moral hazard is crucial.⁶

⁵There are, of course, important exceptions to this general statement. See for example Golosov and Tsyvinsky (2007).

⁶If one finds convincing evidence of a negative correlation between insurance coverage and expected claims, this is arguably more informative, as it is consistent with advantageous selection, even in the presence of moral hazard. This is the approach taken by Fang, Keane and Silverman (2008) who document a negative correlation between insurance and claims in the Medigap market, thus pointing to the existence of *advantageous selection* in this market. When a positive correlation is found however – as is the case in many of the papers reviewed by Cohen and Siegleman (2009) – further work is needed to determine whether the results are driven by adverse selection, or by moral hazard (perhaps combined even with advantageous selection). Another vexing case occurs when one is unable to reject the null of no correlation between insurance coverage and expected claims in the market, as in Chiappori and Salanie (2000) or

Cost curve test of selection Faced with the challenge of how to interpret results of the correlation test, researchers have taken a variety of approaches. One is to test for selection in insurance markets where moral hazard is arguably less of a concern, such as annuity markets. More generally, however, in insurance markets where the potential incentive effects of insurance seem harder to ignore, researchers have tried to use experimental or quasi-experimental variation in prices that consumers face to try to separate selection from moral hazard (see e.g. Abbring et al. 2003a,b, Adams et al., 2009, Cutler and Reber 1998, Einav, Finkelstein and Cullen 2010, Karlan and Zinman 2009).

Once again, the intuition for how pricing variation that is exogenous to demand (and hence by definition to costs since demand depends on expected costs) allows one to separate selection from moral hazard is easily seen in the graphical framework we outlined earlier. Imagine, for simplicity, an experiment that randomly varies the relative price at which the H contract is offered (relative to the L contract) to large pools of otherwise identical individuals. For each relative price, we would then observe the fraction of individuals who bought contract H , and the average realized costs of the individuals who bought contract H .⁷ We thus can trace out the demand curve as well as the average cost curve in e.g. Figure 3. From these two curves, the marginal cost curve is easily derived; marginal costs are simply the derivative of total cost with respect to quantity and total costs are the product of average costs and demand (quantity). The features of the marginal cost curve then provide direct evidence on the existence and nature of any selection. Specifically, a rejection of the null hypothesis of a constant marginal cost curve allows us to reject the null of no selection. Moreover, the sign of the slope of the estimated marginal cost curve informs us of the nature of any selection; a downward sloping marginal cost curve (i.e. a cost curve declining in quantity and increasing in price) indicates adverse selection, while an upward sloping curve indicates advantageous selection. Einav, Finkelstein and Cullen (2010) develop and discuss in more detail this “cost curve” test of selection.

Crucially, this “cost curve” test of selection is unaffected by the existence (or lack thereof) of moral hazard. To see this, recall that the AC curve is estimated using the sample of individuals who choose to buy contract H at a given price. As we vary price we vary this sample, but everyone in the sample always has the same coverage. Since by construction the coverage of individuals in the sample is fixed, the estimate of the slope of the cost curve (the test of selection) is not affected by moral hazard (which determines how costs are affected as coverage changes).⁸

Finkelstein and McGarry (2006). Such a finding is consistent with symmetric information or with the presence of offsetting advantageous selection and moral hazard. Even if moral hazard is ruled out, the inability to reject the null of no correlation could reflect the presence of multiple forms of private information acting in offsetting direction, as Finkelstein and McGarry (2006) find to be the case in the US market for long-term care insurance.

⁷When the L contract is no coverage, the average realized costs of individuals who bought contract H are simply the average claims paid out for people who have contract H . When the L contract involves some (lower) coverage amount, then we measure the average *incremental* claims for those with policy H , or, in other words, the average additional claims that insurance policy H would have to pay out beyond what policy L would pay out, for the accident occurrences of those who have policy H .

⁸Of course, it is possible that the moral hazard effect of insurance is greater for some individuals than others

Identifying price variation – which is the additional data element required by the “cost curve” test but not by the “positive correlation” test – is the key to distinguishing selection from moral hazard. Observing (via estimation) the marginal cost curve arguably addresses the key challenge for empirically analyzing selection in insurance markets which, as noted earlier, is to identify the marginal individuals.

2.2.2 Evidence of selection in social insurance settings

As noted earlier, there has recently been a lot of empirical work on detecting whether or not selection exists in particular insurance markets. We do not attempt a comprehensive review here.⁹ We focus instead on briefly characterizing the literature as it pertains to markets relevant for social insurance. Here we are fortunate that for the major social insurance programs as described at the outset – old age assistance and health insurance – there is fair amount of empirical work examining whether selection exists in these markets. Our reading of the evidence for these two markets is that there is overwhelming evidence that it does.

Annuities In return for an up-front lump sum premium, annuities provide the consumer with a survival contingent income stream. They therefore offer a way for a retiree facing stochastic mortality to increase welfare by spreading an accumulated stock of resources over a retirement period of uncertain length (Yaari, 1965; Davidoff, Diamond, and Brown 2005). Yet despite this theory, private annuity markets remain quite small, raising the possibility of market failure, among other possible explanations.

As a result, annuities have attracted a great deal of interest in discussions involving the design and reform of public pensions. Many of these public pension systems, including the current U.S. Social Security System, provide benefits in the form of mandatory, publicly provided annuities. A major economic rationale for this form of benefit provision is the potential for adverse selection to undermine the functioning of private annuity markets.

The issue of adverse selection in annuity markets received additional attention from the academic and policy discussions surrounding proposals to replace existing defined benefit Social Security programs with defined contribution systems in which individuals would accumulate assets in individual accounts. In such systems, a key question that emerges is how individuals would be able to draw down their asset balances during retirement; in particular, would individuals be mandated to annuitize their balances upon retirement or would they be allowed more flexibility in how to draw down their account balances, including the option of taking a lump-sum distribution or choosing to purchase private insurance.

and that, anticipating this, individuals whose behavior is more responsive to insurance may be more likely to buy insurance. We should still view this as selection, however, in the sense that individuals are selecting insurance on the basis of their anticipated behavioral response to it. Einav et al. (2011) provide empirical evidence of such “selection on moral hazard.”

⁹Cohen and Siegelman (2010) provide a recent review of much of the empirical work testing for selection in insurance markets.

A natural question that emerges from such considerations is whether or not adverse selection in fact exists in private annuity markets. Here, researchers have relied on the positive correlation test described above (see Figure 5) as a way of testing for selection in annuity markets. In the annuity context, higher risk (i.e. higher expected claim) individuals are ones who are longer lived than expected; adverse selection therefore is expected to generate a positive correlation between annuitization and survival.

Results from a number of studies all point to evidence of a positive correlation in annuity markets on both the extensive margin – individuals who purchase annuities tend to be longer lived than those who do not – and on the intensive margin – individuals who purchase annuity contracts with more insurance tend to be longer lived than those who purchase less. These findings obtain conditional on the characteristics of individuals used to price annuities, namely age and gender. The positive correlation finding has been documented in several countries including the United States (Mitchell et al., 1999), the United Kingdom (Finkelstein and Poterba 2002, 2004, and 2006) and in Japan (McCarthy and Mitchell 2003).

In the case of annuities, it may be reasonable to assume that annuitization does not induce large behavioral effects. Indeed, work in this literature tends to assume that moral hazard – an impact of income in the form of an annuity on life extension – is likely to be quantitatively negligible even though theoretically possible (see Philipson and Becker 1998). As a result, evidence of a positive correlation between annuitization and survival can be interpreted as clear evidence of adverse selection in this market (Finkelstein and Poterba, 2004).

Health insurance Cutler and Zeckhauser (2000) review a large literature that tends to find a positive correlation between insurance coverage and risk occurrence in health insurance. Conditional on the menu of contracts offered to them, individuals with more health insurance tend to have higher medical spending than individuals with less insurance. This literature provides a nice example of the substantive importance of conditioning on the observable characteristics of the individual that determine the menu of contracts offered to him, as emphasized by Chiappori and Salanie (2000). In particular, since employer offering of health insurance is such a major determinant of coverage, some of the most convincing implementations of the positive correlation test compare health insurance coverage and medical spending among individuals within the same employer, who therefore all face the same option set. Indeed, without such conditioning, one can get the opposite result suggesting that the insured have lower medical spending than the uninsured, driven by the difference in who is offered health insurance.

In the case of health insurance, the potential moral hazard effects are hard to ignore. There is compelling evidence – including results from randomized trials (Newhouse et al., 1993, Finkelstein and et., 2011) that health insurance has a causal effect of medical spending. As a result, the large body of evidence on the “positive correlation” property in health insurance suggests that asymmetric information exists in health insurance, but does not provide direct evidence of selection per se as distinct from moral hazard.

The task of trying to separate selection from treatment effects is greatly aided by the avail-

ability of variation in the offered contracts that is uncorrelated with demand. Arguably the most compelling evidence of adverse selection in health insurance markets comes from observing “death spirals” brought about by changes in the contract set. For example, Cutler and Reber (1998) examine the response to a change in health insurance pricing at Harvard University that required employees to pay more on the margin for more comprehensive coverage. The introduction of this pricing change was staggered over time across different employees. They document a death spiral dynamic whereby the pricing change produced a decline in enrollment in the more comprehensive plan that was particularly concentrated among lower cost (specifically, younger) employees, thereby prompting a further price increase in the more comprehensive plan to prevent it from losing money, which in turn prompted further exit by disproportionately younger individuals. More recently, Einav, Finkelstein and Cullen (2010) implemented the “cost curve” test for selection using data from a large firm and variation across employees within the firm in the relative price they faced for more comprehensive coverage; they estimated a downward sloping marginal cost curve, providing direct evidence of selection as distinct from moral hazard.

Thus in the market for acute medical insurance in the United States, there seems to be compelling evidence of the presence of adverse selection. As discussed, the most compelling evidence comes from adverse selection in employer provided health insurance within the firm, since this allows the researcher to control for what the consumer’s options are.

The findings in two other health insurance markets – specifically Medigap and long-term care insurance – are more mixed. While there is compelling evidence of private information in these markets, the evidence suggests that the resultant selection is advantageous rather than adverse (Fang, Keane and Silverman 2008; Finkelstein and McGarry 2006, Oster et al., 2010).

The rest: Disability insurance, unemployment insurance, worker’s compensation.

In contrast to the study of selection in annuity and health insurance markets there is, to our knowledge, a dearth of work on adverse selection in several settings where there are important social insurance programs including disability insurance, unemployment insurance and worker’s compensation. There has been considerable work on the moral hazard effects of these programs (see e.g. Krueger and Meyer 2002 for a review) and, as we turn to in the second half of this chapter, a recent burgeoning of work on the optimal level of public provision in these programs. Yet one of the central premises for the existence of these programs – the existence of adverse selection – remains to our knowledge unexplored. It would not be interesting, but not trivial, to try to test for the presence of selection in these markets. In order to test for selection on markets that basically do not exist – like private unemployment insurance or private worker’s compensation insurance – one would need to develop tests that – unlike the existing positive correlation or cost curve tests – do not require observing individual choices. In principle one could apply the positive correlation or cost curve test to the market for private disability insurance. Of course for all private markets where there are existing social insurance programs, one challenge is distinguishing between the selection that exists given the existing public policies and what the private market equilibrium would look like in the absence of any such policies. We return to this issue below.

2.2.3 Welfare consequences

Evidence that selection exists in a particular insurance market is necessary, but not sufficient for their to be potential welfare gains from government intervention in the market. As emphasized above, even in the “textbook case”, the magnitude of the welfare cost of adverse selection is uncertain, and in the limit could even be zero. Moreover, once we depart from the “textbook case” and allow for the possibility of loading factors and preference heterogeneity, whether there is scope for welfare improvement through government intervention – let alone what the welfare maximizing government policy is and what the magnitude of the potential welfare gains are – is theoretically uncertain (recall e.g. Figure 3). Ultimately, therefore, these are empirical questions. This has motivated recent empirical work to move beyond testing for asymmetric information to try to quantify the welfare distortions arising from asymmetric information and the potential impact of government policies such as mandates, pricing restrictions, and taxes.

A starting point for this literature is to note that the tests for asymmetric information described above are relatively uninformative about market efficiency or about the welfare impact of potential market interventions. In particular, markets or market segments that appear to be “more adversely selected” by the positive correlation metric – i.e. which there are larger differences between the expected costs of the insured and uninsured – are not necessarily ones in which there is a greater welfare cost imposed by that selection. In other words, without additional assumptions, comparisons of expected costs are not particularly informative about underlying efficiency costs (even abstracting from moral hazard). Einav and Finkelstein (2011) provide a graphical illustration of this point.

Intuitively, the “extent of adverse selection” is a statement about the shape of the cost curves in e.g. Figure 3 or 5. However, the welfare cost of adverse selection – i.e. the magnitude of the “deadweight loss triangle” CDE depends not only on the shape of the cost curve but also on that of the demand curve. Not surprisingly, therefore, knowledge of the demand curve allows one to pin down the welfare cost of adverse selection by identifying the efficient allocation and comparing it to alternative assumptions regarding the equilibrium allocation or the allocation induced by government policy.

This is the basis for the approach to estimating welfare developed and implemented by Einav, Finkelstein and Cullen (2010) who argue that the demand and cost curves shown in the prior figures are sufficient statistics for welfare analysis of equilibrium and non-equilibrium pricing of existing contracts. In other words, different underlying primitives (i.e. preferences and private information as summarized by ζ) have the same welfare implications if they generate the same demand and cost curves. As long as individuals’ revealed choices can be used for welfare analysis, the precise *source* of selection is not germane for analyzing the efficiency consequences of the resultant selection, or the welfare consequences of public policies that change the equilibrium price. As a result, the same identifying variation that is used to trace out the demand and cost curves for the “cost curve” test of selection, also provides the necessary estimates needed to estimate the welfare cost of adverse selection (triangle CDE in Figure 3) or the welfare consequences of government policy that would produce alternative allocations (such as mandates and subsidies).

This approach to estimating welfare is attractive in its transparency and relatedly, the ability to avoid making (often difficult to test) assumptions about consumer preferences or the nature of their ex ante information. Relatedly, it is relatively straightforward to implement in terms of data requirements. Data on costs and quantities in insurance markets are relatively easy to obtain – as evidenced by the widespread application of the “positive correlation” test which requires both of these data elements. The key additional data requirement is identifying price variation; while naturally more challenging to obtain, the near-ubiquitous regulation of insurance markets offers many potential opportunities.

However there are two important limitations to this approach, both of which can be addressed but at the cost of additional (and usually difficult to test) assumptions. First, as we noted above, the welfare analysis ignores any income effects associated with price changes and relies on the Marshallian (uncompensated) demand curve for welfare analysis. It is well known that welfare analysis off of the Marshallian demand curve can produce substantially different estimates than off of the Hicksian (compensated) demand curve (e.g. Hausman, 1981). It may be less of a concern when evaluating reasonably small changes in prices, but many public policy interventions would produce non-trivial price changes. To account for income effects one either needs to assume them away (by assuming constant absolute risk aversion (CARA)) or to impose more structure and specify a full model of primitives that underlies the demand function.

Second, the analysis of the welfare cost of adverse selection is limited to the cost associated with inefficient pricing of a fixed (and observed) set of contracts. It does not capture the welfare loss that adverse selection may create by distorting the set of contracts offered, which in many settings could be the primary welfare cost of adverse selection. More structure and assumptions are required to analyze the welfare effects of introducing contracts not observed in the data. Einav, Finkelstein and Levin (2010) provide more discussion of the various approaches researchers have taken. They distinguish broadly between two main types of approaches - modeling consumer valuation for particular insurance contracts as a function of consumer and contract characteristics, and modeling realized utility over different insurance plans directly as a function of individual characteristics (the ζ_i). The choice over the two involves a standard trade-off. The realized utility approach requires stronger assumptions about exactly why and how consumers derive value from insurance, but allows the researcher to use the resultant estimates to (at least in principle) examine counterfactual allocations that are much further from the insured data. (An additional attraction of this approach is that it recovers primitives that may be of inherent interest for other reasons, such as estimates of the distribution of risk aversion in the population.) The plan valuation approach requires weaker assumptions but commensurately limits the type of analysis one can do. An one extreme, the approach just described that Einav, Finkelstein and Cullen (2010) undertake recovers the willingness to pay for one health plan over another, but provides no information on the characteristics of the plan determining that valuation, so that inferences about contracts that are not observed in the data are not feasible. Other papers in this literature analyze valuation of contracts as a function of plan and individual characteristics, making some extrapolation to contracts not observed in principle feasible; examples in this vein include Carlin and Town (2010), Bundorf et al. (2011),

and Lustig (2011). Finally, papers that model realize utility directly as a function of individual primitives such as risk aversion and beliefs about risk type are able in principle to analyze choice and welfare over contracts that vary over dimensions over which one observes no heterogeneity in the data; the papers by Cardon and Hendel (2001), Cohen and Einav (2007), Einav, Finkelstein and Schrimpf (2010), and Einav, Finkelstein, Ryan, Schrimpf and Cullen (2011) are examples in this vein.

Estimates of welfare costs of selection Relative to the body of literature discussed earlier that tests where or not selection exists within a particular insurance market, there has been substantially less empirical work attempting to estimate the welfare cost of this selection and the welfare consequences of potential public policy interventions. Almost all of the empirical work has examined the welfare cost of selection in the health insurance market for acute medical expenses. To our knowledge these welfare questions have not been investigated empirically in other markets where asymmetric information has been detected – such as long term care insurance, Medigap or automobile insurance – nor in the social insurance areas where there testing literature has also not reached, such as unemployment insurance, disability insurance and worker’s compensation. These represent important gaps in the state of knowledge.

A striking feature of the literature to date is that the empirical estimates of the welfare cost of selection have consistently tended to be on the order of a few percent of premiums, which has bounded the potential welfare gains from public policy intervention. This is true both in the insurance markets for acute medical expenses where, as noted, most of the empirical work has focused (see e.g. Cutler and Reber (1998), Carlin and Towne (2010), Einav, Finkelstein and Cullen (2010), Bundorf, Levin and Mahoney 2011, Einav, Finkelstein, Ryan, Schrimpf and Cullen 2011, Handel 2011, Lustig 2011) and in the existing empirical work on the welfare cost of selection over the choice of annuity contract (Einav, Finkelstein and Schrimpf 2010). In interpreting these results, however, it is important to keep in mind that virtually all of these papers have studied the welfare cost of adverse selection that arises from inefficient pricing of a fixed (and observed) set of contracts and have not addressed the potentially much larger welfare losses that arise from selection limiting the set of contracts that are offered or, in the extreme, causing a market to unravel completely so that no contracts are offered; Lustig (2011) is a notable exception here. We return in the final section to describing some of the challenges in estimating the welfare costs of contracts not observed in the data.

Welfare consequences of public policy interventions Beyond estimating the welfare cost of selection, several papers within this literature have tried to examine the likely welfare consequences of alternative public policy interventions. A basic theme of this empirical work is that – as indicated by the stylized model we began with – the welfare consequences of “textbook” public policy interventions are not as straightforward as the simple theory suggests. This in turn highlights the importance of both existing and continued empirical work on these questions.

For example, work on mandatory insurance – perhaps the canonical public policy response

to selection - has either failed to find welfare improvements from the (limited) set of mandates considered (Einav, Finkelstein and Cullen 2010) or concluded that while the optimal mandate would be welfare improving, in a world with preference heterogeneity in addition to selection, it is difficult to determine without substantial effort which mandate would be welfare enhancing, and some may in fact be welfare reducing (Einav, Finkelstein and Schrimpf 2010).

Another focus of the literature has been on the welfare consequences of regulating what characteristics of consumers may be used in pricing insurance contracts. For example, Bundorf Levin and Mahoney (2011) emphasize that in the presence of heterogeneity in preferences for coverage that is not perfectly correlated with risk, uniform pricing of contracts across consumers of different risk types cannot induce efficient consumer choice and there is scope for welfare improvements through characteristic-based pricing, often known as “risk adjustment”; in practice, in their application, which uses data on employer-provided health insurance to several firms, they estimate that the welfare gains from feasible risk adjustment may be relatively modest.

Additional work on pricing regulation has focused on its impact for insurance coverage and government expenditures, rather than on welfare per se. For example, examinations of restrictions on characteristic-based pricing, such as community rating in the small group and non group health insurance markets which eliminates the option for insurance companies to charge observably different individuals different prices, have tended to find that such regulations can reduce coverage among lower risk individuals (e.g. Buchmueller and DiNardo 2002, Simon 2005, Bundorf and Simon 2006). Examining risk adjustment in Medicare Advantage plans, where the government is the insurer, Brown, Duggan, Kuziemko and Woolston (2011) conclude that more detailed pricing on consumer characteristics can, contrary to one’s simple intuition, exacerbate, rather than ameliorate, the selection problem as defined with respect to government expenditures.

Welfare consequences in a second best world Another interesting vein of this literature has investigated how adverse selection impacts welfare in a world with other existing imperfections. Lack of perfect competition is a natural additional imperfect. The framework that we began with, and much of the welfare analysis described, assumes that insurance firms are perfectly competitive. However, one can generalize the welfare analysis to any other *given* model of the insurance market, including models of imperfect competition, as long as one can solve for the equilibrium allocation. Lustig (2011), for example, examines the welfare cost of adverse selection in Medicare Advantage, allowing for imperfect competition on the supply side.

The assumed nature of the equilibrium can have interesting and non-trivial implications for welfare analysis. When selection is the only departure from the perfectly competitive neoclassical benchmark, eliminating private information is always welfare improving. This need not be the case when there are multiple frictions. For example, Starc (2010) discusses how, when firms have market power, moving from symmetric information to asymmetric information can improve consumer welfare. Intuitively, when firms have market power, prices are inefficiently high; adverse selection reduces the incentive for firms to mark up prices because the marginal consumers they lose when they raise prices have lower costs (and thus are higher profits) than the inframarginal ones that they

retain. In a similar spirit, Handel (2011) demonstrates how in the presence of adverse selection, switching costs that reduce consumer response to changes in plan pricing can be welfare increasing by blunting the selection pressures that would otherwise operate.

2.2.4 Directions for future work

A clear lesson from recent empirical work is that asymmetric information in insurance markets is more than just a theoretical possibility. A growing body of empirical work has documented the presence of adverse selection in several important areas of social insurance: acute health insurance and annuity markets. At the same time, this empirical work has suggested that designing the appropriate public policy response to this selection may be more challenging than the original simple theory suggested. The evidence of important heterogeneity in preferences as well as risk type in insurance markets – which the original theory abstracted from – has opened up the possibility that selection may be advantageous instead of adverse. And indeed, researchers have found evidence of advantageous selection in several private insurance markets, including the Medigap market for private insurance that supplements Medicare and long-term care insurance. With advantageous selection the public policy implications are the opposite of those for adverse selection, suggesting a welfare improving role for reducing (rather than increasing) insurance through taxation or restrictions on insurance purchases (rather than the traditional approaches to combatting adverse selection through subsidies and mandatory purchases). Moreover, even when selection is adverse, the existence of preference heterogeneity together with loading factors suggests that it is less a priori obvious what policy interventions would be welfare improving (let alone what the optimal intervention would be) than in the original textbook models. These theoretical ambiguities in turn underscore both the opportunities for and the value of empirical work examining the welfare consequences of selection and of potential public policy interventions in insurance markets.

As highlighted earlier, almost all of the empirical papers to date on welfare in insurance markets have taken the relatively narrow (albeit practical) approach of focusing on the welfare costs associated with the pricing distortions selection induces in insurance markets, and the welfare consequences of public policies that change the prices of existing contracts. In general, these papers have concluded that, defined in this way, the welfare costs of selection are relatively small. In two important respects, however, the existing work may be missing important potential welfare consequences of selection or of government intervention. These omissions highlight both the challenges and opportunities for further empirical work.

First, most of the existing empirical welfare analysis has abstracted from a potentially more significant welfare cost of selection that could arise from distortions in the set of contracts offered. Selection may result in certain types of coverage not being available, as in the classic Akerlof (1970) unraveling of a market, and the welfare costs of the disappearance of certain contracts is potentially much larger than the welfare costs of pricing distortions of the contracts that do exist. The ability to make empirically-based estimates of the welfare cost of selection via selection's effect on the set of contracts offered remains a very important area for future work. Empirical work is challenging

in markets that have almost or completely unraveled, yet it may be that these markets are precisely where the welfare costs of selection are largest; in other words, the “lampost problem” of empirical work gravitating to markets for which there are data and dimensions of coverage along which there is observed variation may be one reason that existing papers have found relatively small welfare losses.

A few recent papers have used calibration exercises to try to investigate the value of insurance in markets that virtually non-existent; examples include the market for annuities (Hosseini 2010), long term care insurance (Brown and Finkelstein 2008), and high deductible health insurance (Mahoney 2010). Such exercises require that the researchers make assumptions about the population distribution of certain primitives such as risk aversion and risk type, which are often based on estimates made in other, thicker, markets. In this respect, Hendren’s (2011) development of a method for characterizing the distribution of private information in a market where trade is not observed may represent an important step forward for more empirically-based estimates of non-existent (or virtually non-existent) markets. More work is needed in this area so that researchers may be equipped to examine the counterfactual functioning of private insurance markets that currently do not exist but where we have important social insurance programs such as unemployment insurance, worker’s compensation, and disability insurance.

Second, a related issue is that the existing empirical work has focused on testing for the presence of selection and examining its welfare consequences *given the existing public policies*, such as tax subsidies to employer provided health insurance or publicly provided annuities through Social Security. This raises the question of whether selection would exist –and what its welfare consequences would be – in the absence of these public programs or under very different public programs than we current have. These are important and largely uninvestigated issues.

Theoretically, it is not clear whether or when government intervention will create or exacerbate selection problems. For example, as discussed earlier, regulatory restrictions on the consumer characteristics insurance companies may use in setting pricing may potentially increase or decrease the welfare costs of selection in the private market. As another example, the impact of mandatory, partial social insurance (such as Medicare which covers some but not all medical expenses or Social Security which provides partial annuitization) on adverse selection in the residual private market for insurance is theoretically ambiguous; under different assumptions regarding the ability to offer exclusive contracts, Abel (1986) finds that partial public annuities provided by Social Security exacerbates adverse selection pressures in the residual private market while Eckstein et al. (1985) document a potential welfare enhancing role for partial public annuities. Empirically, we know little about whether the existing partial public insurance programs such as Medicare and Social Security have exacerbated or ameliorated adverse selection problems in the residual private markets for the elderly for health insurance (Medigap) and annuities; Finkelstein (2004) is a rare attempt to try to begin to examine such questions empirically. The recent introduction of Medicare Part D which covers some but not all prescription drug expenses may provide a fruitful opportunity for empirical work on this question.

2.3 Other potential motivations

Following much of the recent literature, we have concentrated our discussion above on only one potential rationale for social insurance, the amelioration of market failures, specifically those arising from asymmetric information. We have discussed selection and not moral hazard since, as previously noted, moral hazard is not in general not an area where the public sector has a comparative advantage over the private sector in redressing market failure. Our discussion has not touched on several other potential rationales for social insurance, including other potential market failures as well as optimization failures by individuals. We briefly summarize several of them here, noting that many are ripe for empirical work.

1. Some risks represent aggregate shocks for which the private insurance market's ability to diversify the risk cross-sectionally may be impaired. This may suggest a welfare-improving role for social insurance against such correlated risks as aggregate unemployment shocks, natural disasters, changes in population life expectancy or technological change in medicine. An interesting vein of this literature has investigated why such aggregate shocks cannot instead be effectively diversified – and thus insured – intertemporally through private capital markets; In the context of catastrophe risk (e.g. hurricanes and earthquakes), Froot (2001) discusses a variety of possible demand-side and supply-side explanations for why in practice the role of capital markets in reinsuring these risks appears to be limited and prices appear to be high; he also reviews the available evidence for each hypothesis. On the demand side, possible limitations include agency issues with insurance company managers who do not value protection for policyholders against extremely high losses if the protection does not avoid default by the firm, ex-post intervention by third parties such as the Federal Emergency Management Agency (FEMA) that substitute for insurance, and optimization failures. On the supply side, he discusses a variety of potential market failures including adverse selection and moral hazard, firm market power, capital market imperfections that restrict the supply of reinsurance, and high transaction costs.

2. Externalities from insurance represent another potential rationale for government intervention. One possibility is physical externalities, particularly in the case of health insurance which subsidizes the treatment or prevention of infectious disease.¹⁰ Another is the possibility of fiscal externalities stemming from the Samaritan's dilemma (Buchanan 1975). If an altruistic society will ex-post provide charitable assistance to those experiencing adverse events, this can reduce individuals' incentives to purchase insurance ex ante; Coate (1995) demonstrates that the optimal transfer policy therefore involves in-kind transfers of insurance to address the inefficient underinsurance that arises in response to unconditional transfers. There are important settings where ex post unconditional public transfers may deter ex ante insurance purchases including in the sphere of health insurance, natural disaster insurance, and insurance against terrorist attacks. In general we do not have a great deal of evidence on the empirical deterrance of ex ante purchases. Some

¹⁰Physical externalities may be substantial in some cases; in a developing country context, recent work has documented the enormous social returns in both the short and longer run to subsidized de-worming of children (Kremer and Miguel 2004, Baird et al., 2011).

work on this topic exists in health insurance where researchers have investigated the relationship between charity care and private insurance coverage (e.g. Herring 2005) or the role of bankruptcy protection in reducing demand for high deductible health insurance (Mahoney 2010). However this remains an important area for empirical work.

3. Incomplete contracts behind the Rawlsian veil of ignorance can provide a rationale for social insurance programs which redistribute within and/or across generations. Social insurance for risks behind the veil of ignorance is formally analogous to optimal taxation; see the chapter by Piketty and Saez in this volume for a review of this literature.

4. Optimization Failures. Another class of motivations for social insurance is a paternalistic motive premised on imperfect optimization in individual insurance purchases. There is considerable evidence that individuals do not adhere to the lifecycle expected utility model underlying traditional models of risk and insurance. For instance, demand for insurance that covers very small risks with high loads – such as toaster warranties, flight insurance, or homeowners insurance deductibles (e.g., Sydnor 2010) – implies levels of risk aversion that are inconsistent with expected utility theory (Rabin 1999). Barseghyan et al. (2011) argue that this excess demand for low deductibles is explained by misperceptions of loss probabilities or from loss aversion. The lack of demand for other types of insurance such as annuities is also difficult to explain in neoclassical models (e.g. Davidoff, Diamond, and Brown 2005).

There is also evidence that individuals make suboptimal choices in choosing not just the level but also the characteristics of insurance coverage. Abaluck and Gruber (2011) show that many individuals choose sub-optimal drug insurance plans in the Medicare Part D program given the risks they face. Kling et al. (2011) implement a field experiment which suggests that these suboptimal choices in drug insurance plans are due to “comparison frictions” – difficulty for consumers in using available information about plan features to make choices. These are just some examples from a vast literature in psychology and economics that has documented that individuals are prone to various biases such as impatience, loss aversion, overconfidence, and inattention.

The need to account for such biases is especially evident in dynamic models of temporary shocks such as unemployment. As we discuss below, unemployment shocks are quite costly as judged by ex-post measures of consumption-smoothing or liquidity effects. Given these costs, rational agents would build up buffer stocks to help cushion temporary shocks (Deaton 1991, Carroll 1997). But in practice, most individuals build very limited buffer stocks. The median job loser has less than \$200 in liquid assets at the beginning of his unemployment spell (Chetty 2008). Thus, it is difficult to reconcile the ex-post costs of shocks with optimizing behavior even in an environment without any private insurance markets, because self insurance would be adequate to smooth most temporary shocks.¹¹ Indeed, Lucas (1987) calculates that optimizing agents would pay less than 1% of lifetime consumption to entirely eliminate business cycle fluctuations even without any private insurance. Hence, the role for social insurance against temporary shocks is

¹¹The lack of such buffer stock savings is even more difficult to explain given that shocks such as unemployment generate long-lasting, possibly permanent earnings losses (von Wachter, Song, and Manchester 2009).

quite limited in optimizing models. This suggests that imperfect optimization must be an important motive for social insurance programs in practice. The chapter by Bernheim in this volume discusses welfare analysis in models with behavioral biases in detail; we briefly discuss recent work on optimal social insurance with agents who do not optimize perfectly in Section 3.3.5.

3 Design of Public Insurance programs

A large literature has analyzed the optimal government response to the failures in private insurance markets discussed above. The goal of this literature is to find the optimal system in terms of trading off protection against risk with minimizing moral hazard. In practice, this problem has several dimensions. Conditional on deciding to insure a risk such as unemployment, there are several policy choices to be made. What level of benefits should be paid? Should benefits rise or fall over an unemployment spell? Should the insurance plan be financed by taxing firms or workers?

The traditional approach to answering such policy questions is to identify a model's structural primitives and conduct welfare analysis by simulating alternative policies. In social insurance, Wolpin (1987), Hansen and İmrohorođlu (1992), Wang and Williamson (1996), and Hopenhayn and Nicolini (1997) are influential examples of such work. Lentz (2009) and Huggett and Parra (2010) provide recent state-of-the-art applications. While the structural approach is in principle the ideal method of analyzing policy, in practice it is difficult to fully identify all the primitives of complex dynamic models.

Because of this problem, recent studies have instead tackled the optimal policy problem using a "sufficient statistic" approach, which we focus on here. This approach seeks formulas for optimal policy that are a function of high-level empirically estimable elasticities and are relatively robust to changes in the underlying model of behavior. The advantage of this approach is that it offers results about optimal policy that do not rely on the strong assumptions made in structural studies for tractability and identification. The cost is that it can only be used to analyze marginal changes in policy, e.g. the impact of changing the level of benefits incrementally from its current observed level. See Chetty (2009) for a more detailed discussion of the advantages and disadvantages of the sufficient statistic approach.

We focus primarily on the case of unemployment insurance, which is the focus of most recent work on connecting theory to data in optimal social insurance. However, formal models of unemployment translate easily to other insurance programs such as workers compensation, disability, and catastrophic risks. We review evidence from various programs that can be used to apply the formulas derived below.

The largest body of research on social insurance has focused on identifying the optimal level of benefits. We organize our discussion of the optimal level of benefits into three subsections. First, we analyze a static model of insurance in which individuals live for a single period and face one risk. In this static model, it is straightforward to derive an intuitive condition for the optimal level of benefits that trades off the moral hazard costs with the benefits of smaller consumption fluctuations.

Second, we show that this condition for the optimal level of benefits can be written in terms of various empirically estimable parameters. We derive three representations of the formula discussed in recent work: consumption-smoothing benefits, moral hazard vs. liquidity effects, and changes in reservation wages. We discuss empirical evidence on each of these parameters and their implications for the optimal level of benefits.

Third, we analyze the implications of relaxing the assumptions made in the static model. Some of the assumptions are inconsequential. For instance, the formulas obtained from the static model carry over with minor modifications to more realistic dynamic models with endogenous savings, borrowing constraints, and persistent uncertainty. But other extensions to the model – in particular, introducing features such that total private surplus is not maximized by agents’ choices – have significant consequences. For example, if private markets provide insurance that also generates moral hazard, the simple formulas no longer apply because of “multiple dealing” externalities. Similarly, if agents do not maximize their expected utilities because of behavioral failures, the formulas again require modification.

After discussing the literature on the optimal level of benefits, we review recent work on three other aspects of optimal social insurance. First, we discuss recent work on helping agents smooth consumption using mandated savings accounts instead of tax-and-transfer systems. Next, we discuss imperfect takeup of social insurance programs and its implications for optimal policy. Finally, we review recent work on the optimal path of benefits in dynamic models. Unlike the work on the optimal level of benefits, this literature is primarily theoretical. We therefore present brief summaries of some of the key results in this literature and discuss ways in which theory could be connected to data to make further progress on these questions.

3.1 Optimal Benefit Level in a Static Model

Setup. The simplest model of insurance is static and has two states, high (h) and low (l). These states could reflect the risk of job loss (unemployment insurance), injury at work (Workers Compensation), or natural disasters (home insurance). Let w_h denote the individual’s income in the high state and $w_l < w_h$ income in the low state. Individuals enter the model with exogenously determined assets A . The government pays a benefit b in the low state that is financed by an actuarially fair tax $\tau(b) = \frac{1-e}{e}b$ in the high state. Let $c_h = A + w_h - \tau(b)$ denote consumption in the high state and $c_l = A + w_l + b$ denote consumption in the low state. Let $v(c)$ denote the agent’s utility as a function of consumption in the high state and $u(c)$ utility in the low state. This allows for the possibility that utility is state-dependent, e.g. agents may value consumption more when healthy. We assume that both u and v are smooth and strictly concave.

A critical feature of the optimal social insurance problem is moral hazard. If individuals’ behavior were not distorted by the provision of insurance, the planner would achieve the first best by setting b to perfectly smooth marginal utilities, $v'(c_h) = u'(c_l)$. We model moral hazard by assuming that the agent can control the probability of being in the bad state by exerting effort e at a cost $\psi(e)$. For instance, “effort” could reflect spending time to search for a job, taking

precautions to avoid injury, or locating a house away from areas prone to natural disasters. We choose units of e so that the probability of being in the high state is given by $e \in [0, 1]$.

Agent's Problem. The agent chooses effort e to maximize his expected utility:

$$\max_e V(e) = ev(c_h) + (1 - e)u(c_l) - \psi(e) \quad (9)$$

Importantly, we assume that the agent takes the tax and benefit levels offered by the government ($\tau(b)$, b) as fixed when solving this maximization problem. This assumption is a convenient analytical approximation to capture behavior in an economy with a large number of agents, in which the impact of any single agent's choice of e on the tax rate $\tau(b)$ is negligible.¹² The first order condition for the maximization problem in (9) is:

$$v(c_h) - u(c_l) = \psi'(e). \quad (10)$$

Intuitively, the level of e that maximizes $V(e)$ equates the marginal benefit of an extra unit of effort, given by the difference in utilities in the low and high states, with the marginal cost of exerting an extra unit of effort. Let $e(b)$ denote the agent's optimal choice of effort given a benefit level b .

Planner's Problem. The social planner's objective is to choose the benefit level b that maximizes the agent's expected utility, taking into account the agent's endogenous choice of effort:

$$\begin{aligned} \max_b W(b) &= ev(A + w_h - \tau(b)) + (1 - e)u(A + w_l + b) - \psi(e) \\ \text{s.t. } e &= e(b) \end{aligned} \quad (11)$$

Differentiating (11) and using the first-order condition for e in (10) gives

$$\begin{aligned} \frac{dW(b)}{db} &= (1 - e)u'(c_l) - \frac{d\tau}{db}ev'(c_h) \\ &= (1 - e)\left\{u'(c_l) - \left(1 + \frac{\varepsilon_{1-e,b}}{e}\right)v'(c_h)\right\} \end{aligned} \quad (12)$$

where $\varepsilon_{1-e,b} = \frac{d(1-e)}{db} \frac{b}{1-e}$ denotes the elasticity of the probability of being in the bad state (which can be measured as the unemployment rate, rate of health insurance claims, etc.) with respect to the benefit level.¹³ Notice that in this expression, the behavioral response $\varepsilon_{1-e,b}$ enters only via its impact on the government budget constraint $t(b)$. The direct impact of changes in e on the agent's private welfare is second-order because the agent has already set e at the optimum that maximizes

¹²Formally, consider an economy with $i = 1, \dots, N$ identical agents solving (9) and facing idiosyncratic risks. For each agent, the impact of changes in his own effort on $t(b)$ are proportional to $\frac{de}{db} \frac{1}{N}$. For the planner, the aggregate impact of changes in effort is $\sum_{i=1}^N \frac{1}{N} \frac{de}{db} = \frac{de}{db}$. As N grows large, the impact of agent i 's effort on $t(b)$ approaches 0 and can therefore be ignored when solving the private optimization problem in (9). However, the impact of changes in effort on the planner's problem in (11) are unaffected by N .

¹³This elasticity measures the *total* effect of an increase in benefits on e , taking into account the tax increase needed to finance the higher level of benefits.

his private welfare ($\frac{\partial W}{\partial e}(e(b)) = 0$). This envelope condition plays a critical role in generalizing (12) to richer, more realistic models, as we discuss in Section 3.3.1.

Equation (12) does not have a cardinal interpretation because it is scaled in utils. One natural cardinal metric is to normalize the welfare gain from a \$1 (balanced budget) increase in the size of the government insurance program by the welfare gain from raising the wage bill in the high state by \$1:

$$\begin{aligned} M_W(b) &= \frac{\frac{dW}{db}(b)/(1-e)}{\frac{dW}{dw_h}(b)/e} \\ &= \frac{u'(c_l) - v'(c_h)}{v'(c_h)} - \frac{\varepsilon_{1-e,b}}{e} \end{aligned} \quad (13)$$

The first term in (13) measures the gap in marginal utilities between the high and low states, which quantifies the welfare gain from transferring an additional dollar from the high to low state. The second term measures the net cost to the government of transferring this \$1 across states due to behavioral responses. The second term arises because the agent does not internalize the fiscal externality that he imposes on the government budget when changing his level of effort. This creates a wedge between the private return to effort and the social return to effort, generating a welfare loss.

At the optimal benefit level b^* , $M_W(b) = 0$ and hence

$$\frac{u'(c_l) - v'(c_h)}{v'(c_h)} = \frac{\varepsilon_{1-e,b}}{e} \quad (14)$$

This expression is a simple variant of Baily's (1978) classic formula for the optimal level of social insurance. It captures a simple – and, as we show below, quite robust – intuition about optimal policy: the optimal benefit level equates the marginal gains from a smoother consumption path with the marginal cost, measured by the behavioral response in effort. Note that (14) is a condition that must hold at the optimal benefit level b^* but is *not* an explicit formula for the level of benefits because all the parameters in (14) are endogenous to b .

Another way to write (14) is in terms of the replacement rate, $r = b/w_h$:

$$\frac{r}{1-r} = - \frac{u'(c_l) - v'(c_h)}{v'(c_h)} \frac{e}{\varepsilon_{1-e, w_h - b}} \quad (15)$$

where $\varepsilon_{1-e, w_h - b} = \frac{d(1-e)}{db} \frac{w_h - b}{1-e}$ denotes the elasticity of the probability of being in the bad state with respect to the net wage $w_h - b$. This formula bears a close resemblance to the inverse elasticity rules that are the hallmark of Ramsey formulas for optimal linear tax rates (Auerbach 1985). Indeed, the optimal social insurance problem is formally identical to an optimal Ramsey taxation problem (Chetty and Saez 2010). However, while such formulas are typically used as explicit formulas for optimal tax rates, equation (15) should not be used as an explicit formula for the optimal replacement rate r^* . The reason is again that the parameters on the right hand side are all functions of r . The very purpose of raising r is to reduce $\frac{u'(c_l) - v'(c_h)}{v'(c_h)}$. Moreover, the elasticity $\varepsilon_{1-e, w_h - b}$ may also vary with r because of liquidity effects (Chetty 2009), as we explain below. In

the optimal tax literature, there are preference specifications that generate constant elasticities and the marginal social value of funds is unaffected by changes in tax rates on goods that constitute a small share of government revenue. Neither of these assumptions applies in insurance models, which is why one can calculate the marginal welfare gains from changing r much more easily than calculating the optimal replacement rate r^* despite the similar appearance of the formulas.

Even in this static model, calculating the marginal welfare gain (13) empirically requires some work. The challenge is estimating the gap in marginal utilities $\frac{u'(c_l) - u'(c_h)}{u'(c_h)}$, which requires knowledge of the utility function as well as assets A and wage rates, which may be unobserved by the econometrician. We now discuss recent approaches to tackling this problem.

3.2 Sufficient Statistics Implementation

The modern literature on social insurance has developed three approaches to recover the marginal utility gap in (13): studying consumption fluctuations (Gruber 1997), liquidity and substitution effects in effort (Chetty 2008a), and reservation wages (Shimer and Werning 2007). We present simple derivations of each approach here and review some empirical evidence for the case of unemployment insurance in each context.

3.2.1 Consumption Smoothing

Gruber (1997) implements (13) under the assumption that utility is state independent, i.e. $v = u$. We first present Gruber's approach under this assumption and then show how it can be extended to allow for state-dependent utility. Taking a quadratic approximation to the utility function yields:

$$\frac{u'(c_l) - u'(c_h)}{u'(c_h)} = \gamma \frac{\Delta c}{c_h}(b) \quad (16)$$

where $\gamma = -\frac{u''(c_h)}{u'(c_h)}c_h$ is the coefficient of relative risk aversion evaluated at c_h and $\Delta c = c_h - c_l$. Gruber posits that the effect of UI benefits on consumption is linear:

$$\frac{\Delta c}{c_h}(b) = \alpha + \beta b \quad (17)$$

In this specification, α measures the consumption-drop that would occur absent government intervention while β measures the slope of the consumption function with respect to the benefit level. Putting this equation together with (16) and (13) yields the following expression for the marginal welfare gain from increasing the benefit level:

$$M_W(b) = (\alpha + \beta b)\gamma - \frac{\varepsilon_{1-e,b}}{e}. \quad (18)$$

In the context of unemployment insurance, implementing this formula empirically requires estimates of how consumption fluctuates around unemployment shocks (α, β), the curvature of the utility function γ , and the elasticity of unemployment rates with respect to the level of benefits. There are now extensive literatures estimating each of these parameters using an array of techniques; we briefly review some illustrative examples of quasi-experimental studies from this literature here.

Evidence on Consumption Smoothing. An early study by Hamermesh (1982) investigates the impacts of unemployment insurance on consumption using cross-sectional consumption data from the Consumer Expenditure Survey. Because Hamermesh does not have panel data, he cannot study changes in consumption around unemployment shocks. Instead, he compares individuals who are currently unemployed and receiving UI with those who are employed. He finds evidence that the marginal propensity to consume out of UI benefits is significantly higher than out of other sources of income, which he interprets as evidence supporting a consumption-smoothing role of UI.

Cochrane (1991) improves upon the analysis in Hamermesh (1982) by using panel data from the Panel Study of Income Dynamics (PSID). Using panel data, he studies how unemployment shocks affect within-household food consumption fluctuations. This is a significant advance over cross-household comparisons, which are likely to be plagued by omitted variable bias. Cochrane finds that unemployment shocks are imperfectly insured – i.e., $\alpha > 0$ in (17) – implying that there is a potential role for government intervention via unemployment insurance. However, Cochrane does not estimate the extent to which providing insurance through a UI system would affect consumption.¹⁴

Gruber (1997) exploits variation in UI benefit levels that is driven by state law changes to identify β using data on food consumption from the PSID. By controlling flexibly for cross-sectional determinants of the level of UI benefits (such as prior wage rates) and simulating UI benefits based on state laws, Gruber isolates variation in UI benefits that is plausibly orthogonal to other determinants of consumption. Gruber’s point estimates of (17) are $\alpha = 0.24$ and $\beta = -0.28$. These estimates show that UI plays a significant role in smoothing consumption, but a \$1 increase in UI translates into much less than a \$1 increase in consumption. Gruber’s estimates imply that consumption drops on average by 10% given existing UI replacement rates of approximately 50% of wages. In the absence of UI, consumption would drop by 24%.

Gruber’s approach has since become the benchmark quasi-experimental strategy for analyzing how social insurance affects consumption.¹⁵ For instance, Browning and Crossley (2001) implement a similar analysis using data on a broader set of consumption goods from Canada. They find that the average impact of increases in UI benefits on consumption is quite modest, but the impacts are especially large among a subset of households that are likely to be liquidity constrained. Gertler and Gruber (2002) show that severe health shocks have large effects on consumption using panel data from Indonesia and that buffering these shocks by reducing income fluctuations would significantly reduce consumption fluctuations.

While the evidence that has been accumulated clearly demonstrates that insurance markets

¹⁴Cochrane’s conclusion that insurance markets for unemployment are incomplete rests on the assumption that utility is not state-dependent. If utility is state-dependent, consumption may fall during unemployment spells simply because the marginal utility of consumption is lower when not working. Gruber’s (1997) approach provides more definitive evidence of incomplete insurance by using variation in UI benefit amounts rather than simply quantifying the size of consumption drops during unemployment.

¹⁵Another prominent approach is to analyze the impacts of income fluctuations on consumption using statistical decompositions of the income process into permanent and transitory components and examining the covariances of these components with consumption (see e.g., Blundell, Pistaferri, and Preston 2009). Jappelli and Pistaferri (2010) provide a comprehensive review of this work.

are incomplete – i.e., consumption does fall when individuals are hit with certain shocks – the consumption-smoothing role of social insurance programs is less clear. We can be confident given available evidence that $\alpha > 0$ for at least a subset of households, but we have very imprecise estimates of β . The estimates of β from Gruber (1997) have a confidence interval spanning $\beta = 0.08$ to 0.48. The imprecision and instability of estimates arises from the fact that consumption is very difficult to measure accurately due to noise and recall errors and is typically available for relatively small samples. Obtaining a more precise understanding of the consumption-smoothing benefits of insurance will likely require administrative data on consumption, e.g. from credit-card databases, scanner data, or value-added tax registers.

Empirical studies of consumption smoothing have focused on the impacts of shocks on consumption while unemployed or sick. We show below that the consumption drop from employment to unemployment is indeed what matters for calculating optimal unemployment benefit levels using (18). However, it is important to recognize that long-term impacts of temporary shocks on consumption may also be significant. von Wachter, Song, and Manchester (2009) show that unemployment shocks due to mass layoffs have large, permanent impacts on earnings. Given that consumption must converge to income in the long run for all workers except the few with substantial wealth before job loss, this result strongly suggests that even temporary unemployment shocks have long-lasting effects. If shocks have persistent impacts on consumption, the optimal insurance policy may not be just to provide benefits while agents are out of work, but rather a wage insurance system that insures long-lasting earnings losses, as proposed e.g. by Lalonde (2007).¹⁶ An interesting direction for further work would be to apply the methods reviewed here to analyze optimal wage insurance policies.

Evidence on Distortions in Behavior. The literature on measuring behavioral responses to social insurance programs – the impacts of unemployment insurance on unemployment durations, health insurance on health expenditures, disability insurance on labor force participation rates – has a long tradition that predates the theoretical work on social insurance discussed here. We have much more evidence on the distortions created by insurance programs than their consumption-smoothing benefits because of data availability. For instance, administrative data on unemployment durations must be collected in order to make UI payments, making it much easier to study the impacts of UI on durations than on consumption.

There are many excellent surveys of the literature on how social insurance affects behavior; see e.g. Krueger and Meyer (2002) for a review of work on how UI, DI, and Workers Compensation affect labor supply and Cutler and Zeckhauser (2000) or Cutler (2002) for a review on health insurance affects the demand for medical care. Here, we briefly discuss selected findings from the literature that have been used to inform theoretical calculations of optimal benefit levels using sufficient statistic formulas.

¹⁶To be clear, persistent wage shocks do not invalidate the use of temporary consumption drops to analyze optimal UI, because the observed consumption drop incorporates all future changes in income in an optimizing model (see Section 3.3.1). However, persistent wage shocks raise the possibility that the optimal insurance policy is not merely to provide benefits while the agent is out of work but also after he is re-employed.

In the context of unemployment, most studies have focused on measuring the impacts of increases in UI benefits on the duration of unemployment. The probability of being laid off could also respond to the level of benefits. The literature has focused less on this issue because UI benefits are typically at least partially experience rated, meaning that firms bear the unemployment insurance cost of laying off workers. In a perfectly experience rated system, changes in the level of benefits do not distort incentives to lay off workers. However, with imperfect experience rating, changes in the level of UI benefits can also affect unemployment rates by distorting firms' layoff decisions (Feldstein 1978, Blanchard and Tirole 2008). While studies such as Topel (1983) and Andersen and Meyer (1993) have documented significant effects of experience rating on firm layoffs, there is relatively little recent work on this issue. Analyzing whether social insurance programs affect the rate at which firms hire and lay off workers using modern quasi-experimental designs is a very promising area for further research.

The modern literature estimating the impact of UI on durations has adopted the hazard model specifications used by Meyer (1990). Meyer estimates semi-parametric models for the hazard of exiting unemployment as a function of UI benefits and other variables using administrative data on the duration of UI claims. He exploits variation in UI benefits coming from differential changes in benefits over time across states, as in Gruber (1997). Meyer finds that higher UI benefits reduce the hazard of exiting unemployment significantly, with an implied elasticity above 0.8 in most specifications.

Subsequent studies have obtained qualitatively similar results using a variety of different data sources. For instance, Lalive, van Ours, and Zweimuller (2006) use a regression-discontinuity design in administrative data from Austria and find that UI benefit increases significantly raise unemployment durations, although to a lesser extent than suggest by Meyer's estimates. Chetty (2008) estimates elasticities of approximately 0.5 using survey data from the Survey of Income and Program Participation. Landais, Michailat, and Saez (2011) replicate Meyer's analysis using his original dataset but show that including state by year effects and flexible controls for prior wages yields smaller elasticities, around 0.3. In general, the literature has settled on a consensus estimate of $\varepsilon_{1-e,b}$ for UI and unemployment durations of about 0.5 (Krueger and Meyer 2002).

Meyer (1990) and Katz and Meyer (1990) document a spike in hazard rates when unemployment benefits expire. This is typically viewed as *prima facie* evidence that UI distorts search behavior, as it suggests that people time their unemployment exits to coincide with the expiry of social assistance. This spike in unemployment exit hazards in the weeks prior to benefit exhaustion is now a well established empirical regularity; see Card, Chetty, and Weber (2007) for a review of this literature.

However, Card, Chetty, and Weber (2007) use data from Austria to show that the spike in *job-finding* rates when UI benefits expire is far smaller than the spike in unemployment exit rates. In Austria, as in most other European countries, individuals can stay on the UI system to receive job finding assistance and other benefits even after their benefits expire, but the majority of individuals choose to drop out of the UI system when their benefits end. Most of these individuals, however, remain unemployed even after they leave the UI system. In the U.S., individuals may choose not

to collect their last unemployment check because it is often a small leftover amount, which would create the appearance of a surge in hazard rates in the weeks before benefits expire. Because the margin relevant for calculating the efficiency costs of the UI system are time spent working rather than time spent on the UI system, this evidence suggests that the original sharp spikes documented in the literature likely overstate the degree of moral hazard created by UI. The more general lesson is that it is crucial to measure distortions in real economic choices rather than simply use measures that are well recorded in administrative databases.

Analogous behavioral responses have been documented for other social insurance programs beyond unemployment insurance. Meyer, Viscusi, and Durbin (1995) use differential changes in workers compensation benefits across states to show that higher benefit levels induce injured workers to stay out of work longer before returning to work. Gruber (2000) analyzes a disability insurance expansion in Canada that raised benefit levels for individuals in all provinces except Quebec. He finds that this benefit increase significantly reduced labor force participation rates for males ages 45-59, implying an elasticity of the non-participation rate with respect to DI benefits of 0.25. Maestas, Mullen, and Strand (2011) use random variation in assignment to disability insurance examiners to estimate that eligibility for DI reduces labor force participation rates for the marginal entrant to DI by approximately 20 percentage points, with significantly smaller effects for those with more severe impairments. In the context of health insurance, the RAND health insurance experiment (Manning et al. 1987) and Oregon health insurance lotteries (Finkelstein et al. 2011) have demonstrated that increases in consumer cost-sharing significantly reduce health care expenditures.

Evidence on Risk Aversion. Economists have estimated risk aversion using a broad array of techniques. The most direct and widely used method of estimating risk aversion is to assess preferences over gambles. Using empirical estimates of the distribution of risk and an expected utility model with a specific functional form for utility such as constant relative risk aversion, one can back out the value of γ implied by individuals choices over risky streams of income. Early work in asset pricing inferred risk aversion from portfolio choice and asset returns in standard asset pricing models (e.g., Mehra and Prescott 1985, Kocherlakota 1996). More recent work has used responses to hypothetical large-stake gambles (Barsky et. al. 1997), automobile insurance choices (Cohen and Einav 2006), risk-taking in game shows (Metrick 1995), and home insurance deductible choices (Sydnor 2010) to infer risk aversion. There is little consensus on the value of γ from this literature: the estimates range from 1 to well above 10 in the case of deductible choices and asset prices. One explanation of this discrepancy in estimates is that they reflect the behavior of different subgroups of the population. Barseghyan, Prince and Teitelbaum (2011) and Einav et al. (2012) test this explanation by examining the risk preferences of the same individuals in different domains of choice, such as health insurance deductibles and 401(k) portfolio allocations. While individuals' risk preferences are correlated across the domains, there is substantial heterogeneity in estimated risk aversion from each choice.

All of these estimates of risk aversion are based on ex-ante choices, which requires that individuals' subjective assessment of risks (e.g. the probability of a large fluctuation in stock prices)

and other parameters are consistent with the model assumed by the researcher. Chetty (2006a) proposes a different method of estimating γ that does not rely on subjective probabilities. He shows that expected utility models imply a direct connection between the curvature of the utility function over consumption and the impacts of wage changes on labor supply. Intuitively, if the utility function is very curved, individuals should become satiated with goods as their income rises, and should choose to work *less* as their wages rise. The fact that uncompensated wage increases almost always raise labor supply in practice implies an upper bound on the coefficient of relative risk aversion of approximately 1 without any assumptions about the structure of the utility function.¹⁷ Because this method of estimating risk aversion uses the same types of ex-post data used to measure $\varepsilon_{1-e,b}$ and $\frac{\Delta c}{c}$, it offers a more direct estimate of the curvature of utility that matters for evaluating the welfare cost of shocks.¹⁸

Unfortunately, even this ex-post measure of risk aversion varies significantly across contexts. Chetty and Szeidl (2007) develop a theoretical model of risk preferences in which individuals have “consumption commitments” – goods such as housing or fixed service contracts which can only be adjusted by paying fixed transaction costs. In this environment, individuals have amplified risk aversion over moderate-stake shocks because of their commitments. To understand the intuition, consider a two good model in which the agent spends half his income on housing (which can only be adjusted by paying a transaction cost) and half on food (which is freely adjustable). When facing a shock such as temporary job loss that forces them to reduce expenditure by say 10%, most individuals will rationally choose to bear the shock by cutting food consumption by 20% in order to avoid having to move out of their house. This concentrated reduction in food expenditures raises marginal utility sharply, amplifying risk aversion. Chetty and Szeidl confirm this prediction of the model in the PSID data used by Cochrane and Gruber: homeowners who become unemployed do not change housing consumption but cut back on food consumption significantly, while renters (who face lower adjustment costs), diversify the shocks more broadly by reducing consumption of both food and housing. Chetty and Szeidl’s analysis suggests that the value of γ relevant for shocks such as unemployment could be as high as $\gamma = 4$ because of fixed commitments. However, for large shocks such as permanent disability that induce households to abandon commitments, the relevant value of γ could be closer to 1.

Because of the tremendous uncertainty about the appropriate value of γ , researchers typically report welfare calculations for a range of values of γ . Gruber implements the formula in (18) using his own estimates of the consumption smoothing response and estimates of $\varepsilon_{1-e,b}$ from Meyer (1990). He finds that with a coefficient of relative risk aversion $\gamma < 2$, increasing the UI benefit level above the levels observed in his data (roughly 50% of the wage) would lead to substantial welfare losses. Extrapolating out of sample based on the assumption that $\varepsilon_{1-e,b}$ remains constant

¹⁷If utility is non-separable, one must bound the degree of complementarity between consumption and leisure in order to bound risk aversion using this method. Chetty uses the estimates of Cochrane (1991) and Gruber (1997) to place an upper bound on this complementarity parameter and shows that even at this upper bound, $\gamma < 1.25$.

¹⁸Conversely, however, this approach is less likely to yield accurate predictions about ex-ante choices in risky environments.

and the consumption function is given by (17), Gruber shows that it is difficult to justify having a positive level of UI benefits ($b^* > 0$) with risk aversion $\gamma < 2$ given his estimates of the consumption smoothing benefit of UI. With $\gamma = 4$, however, the optimal benefit level could be as large as 50%.

Estimating risk aversion accurately is particularly important because the size of the consumption drop $\frac{\Delta c}{c}$ is inversely related to γ , as shown by Chetty and Looney (2006). As a result, the welfare gains from insurance could be large even if consumption drops are small, as documented by Townsend (1994) and others in developing economies. Intuitively, highly risk averse households – e.g. those facing subsistence constraints – are likely to have very smooth consumption paths because they will go to any effort (e.g. by taking their children out of school in developing countries) in order to subsist. But these efforts to smooth consumption are very costly – i.e., $\psi(e)$ is highly convex. Chetty and Looney show that the marginal gains from insurance, given by $\gamma \frac{\Delta c}{c}$, could actually be larger than in economies with smoother consumption paths if that smoothness is driven by greater risk aversion.

State-Dependent Utility. When utility is state-dependent, the consumption-smoothing approach requires estimation of an additional parameter that measures the degree to which marginal utilities vary across states. With state-dependent utility, the quadratic approximation used above yields

$$\frac{u'(c_l) - v'(c_h)}{v'(c_h)} = \gamma_v \frac{\Delta c}{c} + \theta$$

where $\gamma_v = -\frac{v''(c_h)c_h}{v'(c_h)}$ denotes the coefficient of relative risk aversion in the employed state and $\theta = \frac{u'(c_l) - v'(c_l)}{v'(c_h)}$ measures the degree of state-dependence in marginal utilities. The parameter θ answers the question, “starting from equal consumption in the low and high states, how much would the agent pay to reallocate \$1 of consumption from the high state to the low state?” If utility is not state-dependent, the answer to this question would be $\theta = 0$. If the marginal utility of consumption is higher when the agent is in the low state, the willingness to pay is $\theta > 0$.¹⁹ The parameter θ directly enters the formula for $M_W(b)$ in (18) as an additive term. If $\theta > 0$, insurance has greater value because it is transferring resources to a state where money has more value at any given level of consumption.

Finkelstein, Luttmer and Notowigdo (2009) describe some possible approaches to estimating the value of θ . Broadly speaking, θ can be estimated based on either choice data that reveals individuals’ demand for moving resources across health state, or based on observed utility changes as state change. For example, one use of choice data would be to study how agents allocate consumption across states when they are perfectly insured. The extent to which agents voluntarily choose to have more or less consumption in the high or low state reveals the size of θ in this environment. This is most easily done in a setting in which individuals are fully insured and in which the state change is anticipated; Both of these are difficult to come by; most individuals are not perfectly insured in practice – if they were, there would be no reason for social insurance to begin with! – and it is rare to be able to observe anticipated state changes in data (e.g. anticipated health

¹⁹Technically, one must measure the willingness to pay in the high state, as $v'(c_h)$ appears in the denominator of θ .

events or unemployment spells). Absent this, one can try to focus on subgroups that are better insured and who are experiencing the state change. This requires assumptions about the degree of insurance one has and, since the life cycle budget constraint must be satisfied, inferring state dependence from the consumption fluctuations of individuals who experience different unexpected shocks (such as health events) requires strong assumptions about the nature of bequest motives. For example, Lillard and Weiss (1997) estimate a structural model of health shocks and use data on consumption trajectories to identify θ under the assumption that the marginal utility of bequests does not depend on health. Similarly, Low and Pistaferri (2011) estimate the impacts of disability shocks on consumption and use a structural model coupled with variation in the degree of insurance to identify θ . Both Lillard and Weiss (1997) and Low and Pistaferri (2011) estimate $\theta > 0$, i.e. positive state dependence for health and disability. Browning and Crossley’s (2001) finding that unemployment shocks have little impact on consumption for individuals with high levels of assets implies $\theta = 0$ for unemployment.

An alternative approach to identify state-dependence that does not require choice data from environments with full insurance is to use data on subjective well being. Intuitively, by estimating whether a cash grant has a larger impact on happiness in the low vs. high state, one can learn about θ . The challenge in implementing this approach is that subjective well being measures have no inherent cardinal interpretation, whereas θ is a cardinal parameter.²⁰ One must therefore choose a cardinal scale for happiness to estimate θ using data on subjective well being. One approach is to scale happiness so that one obtains estimates of the coefficient of relative risk aversion γ that match estimates from choice data. Finkelstein, Luttmer, and Notowidigdo (2008) implement such an approach and conclude based on survey data that $\theta < 0$, i.e. the marginal utility of consumption is higher when individuals are healthy. Unfortunately, because the range of plausible estimates for γ is so wide, the resulting range of estimates for θ is wide as well. In sum, there is currently little consensus in the literature on the sign of θ for social-insurance relevant states like unemployment, disability and sickness, let alone its magnitude in these contexts. We view this as an important but challenging area for future work.

Because optimal benefit calculations are highly sensitive to the assumed value of γ and θ , more recent studies have sought alternative techniques for recovering the gap in marginal utilities that do not require estimates of these parameters. We now turn to these alternative approaches.

3.2.2 Liquidity vs. Moral Hazard

Chetty (2008a) shows that the gap in marginal utilities in (13) can be inferred from the comparative statics of effort choice, yielding a formula for optimal benefits that does not require any data on consumption or risk preferences. Recall that the first order condition for effort in our static model is $\psi'(e) = v(c_h) - u(c_l)$. Now consider the effect of an exogenous cash grant (such as a severance

²⁰For instance, suppose giving an agent \$1,000 increases his reported happiness from 2 to 3 in the low state and 7 to 9 in the high state. One cannot identify θ without knowing whether an increase in happiness from 2 to 3 translates into a smaller or larger welfare gain than an increase in happiness from 7 to 9.

payment to job losers) on effort, holding fixed the tax τ :

$$\partial e / \partial A = \{v'(c_h) - u'(c_l)\} / \psi''(e) \leq 0 \quad (19)$$

The effect of increasing the benefit level on effort (again holding τ fixed) is:

$$\partial e / \partial b = -u'(c_l) / \psi''(e) \quad (20)$$

Finally, the effect of increasing the wage in the high state on effort is:

$$\partial e / \partial w_h = v'(c_h) / \psi''(e) \quad (21)$$

Combining (19) and (20), we see that the ratio of the “liquidity” effect ($\partial e / \partial A$) to the “substitution” effect ($\partial e / \partial w_h = \partial e / \partial A - \partial e / \partial b$) recovers the gap in marginal utilities:

$$\frac{u'(c_l) - v'(c_h)}{v'(c_h)} = \frac{-\partial e / \partial A}{\partial e / \partial A - \partial e / \partial b}$$

Plugging this expression into (13) yields the following expression for the welfare gain from increasing the benefit level:

$$M_W(b) = \frac{-\partial e / \partial A}{\partial e / \partial A - \partial e / \partial b} - \frac{\varepsilon_{1-e,b}}{e} \quad (22)$$

In this formula, the degree to which marginal utilities fluctuate across states is identified from the relative size of liquidity and moral hazard effects in the impact of benefit levels on effort.²¹ In a model with perfect consumption smoothing, the liquidity effect $\partial e / \partial A = 0$, because a cash grant raises $v(c_h)$ and $u(c_l)$ by the same amount. Note that unlike the consumption-smoothing method above, this approach does not require estimation of the degree of risk aversion or state-dependence in utility.²²

One intuition for the liquidity vs. moral hazard formula comes from familiar results from price theory. The impact of an increase in b on e can be decomposed into two terms, analogous to a Slutsky decomposition: $\partial e / \partial b = \partial e / \partial w_h + \partial e / \partial A$. The first term is a pure substitution (price) effect and arises from the distortion in marginal incentives created by the social insurance program. The second term is analogous to an income effect, and reflects the fact that higher benefits also raise agents’ cash-on-hand and thus reduce the supply of effort. The substitution effect is efficiency-reducing because it reflects second-best behavior arising from the wedge between private and social incentives. In contrast, the liquidity effect is efficiency *enhancing* because it allows the agent to choose a level of e that is closer to what he would choose with complete markets. The size of the

²¹A technical issue which arises in empirical implementation of (22) is that $\frac{\partial e}{\partial b}$ must be measured holding the tax t fixed, whereas the elasticity $\varepsilon_{1-e,b}$ must be measured while permitting t to vary. Instead of attempting to estimate both parameters, Chetty uses numerical simulations to show that the effect of a UI benefit increase on job finding rates is virtually identical whether or not UI taxes are held fixed. This is because the fraction of unemployed individuals is quite small, making UI tax rates very low.

²²If utility is not state dependent, one could infer the agent’s degree of risk aversion γ from the size of moral hazard vs. liquidity effects and the consumption drop: $\gamma = \frac{-\partial e / \partial A}{\partial e / \partial A - \partial e / \partial b} / (\Delta c / c)$. This restriction, which is closely related to the formula for risk aversion in Chetty (2006), could be evaluated empirically in future work.

liquidity effect measures the extent to which insurance markets are incomplete. The ratio of the liquidity effect to the distortionary substitution effect thus captures the marginal benefit of social insurance.

A more practical intuition for (22) is that it uses revealed preference to value the benefits of insurance. Consider an application to health insurance. The effect of a lump-sum cash grant on health care consumption reveals the extent to which health insurance permits the agent to attain a more socially desirable allocation. If the agent chooses to spend a lump-sum grant on buying a new car instead of purchasing more healthcare, we infer that the agent only spends more on health care when health insurance benefits are increased because of the price subsidy for doing so. In this case, health insurance simply creates inefficiency by distorting the private cost of health care below the social cost, implying $\frac{dW}{db} < 0$. In contrast, if the agent raises his health expenditures substantially even when he receives a non-distortionary lump sum cash grant, we infer that insurance permits him to make a more (socially) optimal choice, i.e. the choice he would make if insurance market failures could be alleviated without distorting incentives. The liquidity vs. moral hazard approach in (22) thus identifies the policy that is best from the libertarian criterion of correcting market failures as revealed by individual choice.

An important implication of (22) is that larger elasticities $\varepsilon_{1-e,b}$ do not necessarily mean that social insurance is less desirable, a point emphasized by Nyman (2003) in the context of health insurance. It matters whether a higher value of $\varepsilon_{1-e,b}$ comes from a larger liquidity ($-\frac{\partial e}{\partial A}$) or moral hazard ($\frac{\partial e}{\partial w_h}$) component. To the extent that it is the liquidity effect, insurance reduces the need for agents to make suboptimal choices they have insufficient ability to smooth consumption; if it is primarily the moral hazard effect, insurance is distorting incentives. For instance, the reductions in labor force participation caused by DI documented by Maestas, Mullen, and Strand (2011) may not be an undesirable effect. If DI helps individuals whose marginal product is lower than their disutility of work, this behavioral response is welfare-improving.

Evidence on Liquidity vs. Moral Hazard. The advantage of this formula relative to (18) is that it can be implemented purely using data on e (e.g., unemployment durations or health expenditures). Chetty (2008) implements (22) using survey data from the U.S. He estimates $\frac{\partial e}{\partial b}$ using data from the Survey of Income and Program Participation, following the specifications in Meyer (1990). Using the SIPP data, Chetty shows that individuals who have low levels of assets prior to job loss exhibit much higher levels of $\frac{\partial e}{\partial b}$ than those with higher levels of assets. This suggests that a significant part of the impact of UI benefits on durations may be driven by a liquidity effect. Chetty then estimates $\frac{\partial e}{\partial A}$ by studying the effects of lump-sum severance payments on unemployment durations using data from a survey of UI exhaustees conducted by Mathematica in collaboration with the Department of Labor. He finds that individuals who receive lump-sum severance payments have significantly longer unemployment durations, especially if they have low levels of assets prior to job loss. Using his estimates, Chetty calculates the welfare gain of raising the UI benefit level from the current replacement rate of approximately 50% of wages. He finds that the welfare gains from raising b are small but positive, suggesting that the current benefit level is slightly below but near the optimum.

Chetty’s (2008) analysis relies on cross-sectional variation across individuals in severance pay, and therefore rests on the strong identification assumption that severance recipients and non-recipients are comparable. More recent studies have documented similar results using research designs that make weaker assumptions. Card, Chetty, and Weber (2007) use a regression-discontinuity design that exploits a universal cutoff for severance pay eligibility based on job tenure in Austria. Using administrative data for the universe of job losers in Austria, they show individuals laid off just after the tenure cutoff – and receive 2 months of wages as a lump sum severance payment as a result – have unemployment durations that are about 10 days longer than individuals laid off just before the cutoff. They compare these liquidity effects to the impacts of UI benefit extensions using a similar RD design and show that the size of liquidity effects is large relative to the impact of benefit extensions, implying that many unemployed individuals are liquidity constrained. Centeno and Novo (2009) present evidence that liquidity-constrained households are more sensitive to UI benefit changes using a regression-discontinuity design in Portugal. Lalumia (2011) shows that individuals who happen to be laid off after they receive a tax refund (and have more cash-on-hand) have longer unemployment durations relative to individuals laid off at other times of the year.

There is less evidence on liquidity effects in other insurance programs because of the relatively recent development of these formulas and because researchers have not yet formulated quasi-experimental designs to estimate liquidity effects $\frac{\partial e}{\partial A}$ for many programs. One exception is Nyman (2003), who presents considerable anecdotal evidence and theoretical arguments suggesting that liquidity effects play a very important role in health insurance. The benefits of health insurance are extremely difficult to quantify, making the liquidity-based revealed preference approach particularly attractive in that context. Finding research designs to identify liquidity effects in health and other insurance programs is thus a very promising area for further work.

3.2.3 Reservation Wages

Shimer and Werning (2007) recover the gap in marginal utilities from the comparative statics of reservation wages instead of effort in a model of job search. They analyze a model in which the probability of finding a job, e , is determined by the agent’s decision to accept or reject a wage offer rather than by search effort. Wage offers are drawn from a distribution $F(w)$. If the agent rejects the job offer, he receives income of $w_l + b$ as in the baseline model above.²³

The agent rejects any net-of-tax wage offer $w - \tau$ below his outside option $w_l + b$. Therefore, $e = 1 - F(w_l + b + \tau)$ and the agent’s expected utility upon job loss is

$$W(b) = e\mathbb{E}[v(A + w - \tau)|w - \tau > w_l + b] + (1 - e)u(A + w_l + b)$$

Shimer and Werning’s insight is that $\frac{dW}{db}$ can be calculated using information on the agent’s reservation wage. Suppose we ask the agent what wage he would be willing to accept with certainty prior to the start of job search. Define the agent’s reservation wage prior to job search as the wage

²³Both formulas derived above continue to hold in this model with stochastic wages. Conversely, the Shimer and Werning formula also holds in a model with variable search intensity.

\bar{w}_0 that would make the agent indifferent about accepting a job immediately to avoid having to take a random draw from the wage offer distribution. The reservation wage \bar{w}_0 satisfies

$$v(A + \bar{w}_0 - \tau) = W(b)$$

The government's problem is to

$$\begin{aligned} \max W(b) &= \max v(A + \bar{w}_0 - \tau) \\ &\Rightarrow \max \bar{w}_0 - \tau \end{aligned} \tag{23}$$

Differentiating (23) gives the following formula for the marginal welfare gain of raising b :²⁴

$$M_W(b) = \frac{d\bar{w}_0}{db} - \frac{d\tau}{db} = \frac{d\bar{w}_0}{db} - \frac{1-e}{e} \left(1 + \frac{1}{e} \varepsilon_{1-e,b}\right) \tag{24}$$

In this formula, $\frac{d\bar{w}_0}{db}$ encodes the marginal value of insurance because the agent's reservation wage directly measures his expected value when unemployed. Intuitively, if agents can smooth marginal utilities perfectly across states, their reservation wage will depend purely on their expected income, and the marginal value of raising b by \$1 (holding fixed τ) is simply $(1 - e)$. But this marginal gain is outweighed by the cost of financing the extra dollar of benefits, which exceeds $1 - e$ because of the behavioral response $\varepsilon_{1-e,b}$. When marginal utilities fluctuate across states, agents value an increase in b at more than its actuarial cost, increasing the marginal value of public insurance. The extent to which agents value insurance can be captured by asking them how their valuation of being in the unemployed state varies with b , which is the parameter $\frac{d\bar{w}_0}{db}$. Like the liquidity vs. moral hazard method, this approach also does not require identification of state-dependence in utility or risk aversion.

An interesting implication of this result is that a higher sensitivity of reservation wages to benefits implies a *larger* value of social insurance, contrary to the intuition embodied in earlier empirical studies (e.g. Feldstein and Poterba 1984), which view the sensitivity of reservation wages to UI benefits as a distortion. This point, like the moral hazard vs. liquidity decomposition above, illustrates the importance of connecting empirical estimates to models in order to fully understand the implications of empirical findings for policy.

Evidence on Reservation Wages. A long literature has sought to measure unemployed worker's reservation wages; see Devine and Kiefer (1991) for a review of early work and Krueger and Mueller (2011) for recent evidence. While these studies have shown that reservation wages have predictive power for unemployment durations and the types of offers that workers accept, they have also documented significant problems with self-reported reservation wage measures. For instance, a large fraction of workers end up accepting jobs that pay below their reported reservation wage. Moreover, most jobs have many characteristics that matter beyond the wage rate, such as the

²⁴This corresponds to equation (12) in Shimer and Werning (2007), where the unemployment rate is $u = 1 - e$. The slight difference between the formulas (the $\frac{1}{1-u}$ factor in the denominator) arises because Shimer and Werning write the formula in terms of a partial-derivative-based elasticity. Here, $\varepsilon_{1-e,b}$ is the elasticity including the UI tax response needed to balance the budget; in Shimer and Werning's notation, it is holding the tax fixed.

nature of the work or commuting distance. A one-dimensional reservation wage measure does not incorporate these other dimensions. When jobs have multiple characteristics, in order to implement (24), one would ideally like to measure how reservation *utilities* for jobs vary with the benefit rate. Because such reservation utilities cannot be easily measured, it is difficult to estimate $\frac{d\bar{w}_0}{db}$ accurately.

Perhaps because of these measurement issues, there is relatively little evidence on the impact of UI benefits on reservation wages. Feldstein and Poterba (1984) use survey data from the Current Population Survey to estimate $\frac{d\bar{w}_0}{db}$ by studying how changes in UI benefit levels affect reported reservation wages. Their point estimates imply a substantial correlation between UI benefit levels and reservation wages. However, their specification does not isolate purely exogenous variation in UI benefits due to law changes, as in more recent work, raises concerns about omitted variable bias. Shimer and Werning implement (23) using an estimate of $\frac{d\bar{w}_0}{db}$ from Feldstein and Poterba (1984) and find a large, positive value for $M_W(b)$ at current benefit levels. They caution, however, that their exercise must be viewed as purely illustrative given the uncertainty in estimated $\frac{d\bar{w}_0}{db}$ and call for further work on estimating this parameter using alternative methods.

One alternative approach is to use data on actual wages obtained at the next job and back out the implied distribution of reservation wages. There are now a large set of studies using administrative panel data that study whether increasing UI benefits raises subsequent wage rates. Card, Chetty, and Weber (2007) use a regression discontinuity design in data from Austria to show that individuals eligible for 10 additional weeks of UI benefits take more time to find a job but do not have higher wages at their next job. Their estimates are sufficiently precise to rule out even a 1% increase in the wage rate at the upper bound of the 95% confidence interval. They also show that there are no detectable impacts on other observable job characteristics or on the number of years the worker spends at his next job, a summary measure of job match quality. Subsequent studies using similar RD designs have reached very similar conclusions. For instance, Lalive (2007) studies a 170 week benefit extension in Austria and shows that it has no impact on subsequent wages. van Ours and Vodopivec (2008) use a difference-in-difference approach using data from Slovenia and find that changes in benefit duration from 6 months to 3 months had no impact on subsequent earnings. These findings that ex-post observed wages are unaffected by benefit levels imply that reservation wages must be unaffected by benefit levels, i.e. $\frac{d\bar{w}_0}{db} = 0$.

How can UI have significant consumption-smoothing and liquidity benefits but little effect on ex-post wages? Lentz and Tranaes (2005), Chetty (2008), and Card, Chetty, and Weber (2007) develop pure search intensity models with borrowing constraints that generate these patterns. We present a stylized version of this model in Section 3.3.1 below. In these models, workers can control the amount of effort they spend searching for a job, but have a fixed wage rate. Such models can be viewed as an approximation to an environment in which the arrival rate of suitable job offers is relatively low, so the option value of waiting for a better offer is small and most workers take the first offer they receive. One puzzling feature of the data given this explanation is that there is tremendous heterogeneity in observed wage changes from the previous job to the new job across unemployed workers. Understanding how the variance of job offers can be reconciled with the lack

of mean impacts of UI benefits on reservation wages is an open question for future research.²⁵

In summary, there are now a variety of methods of calculating the welfare gains from increasing benefit levels in social insurance programs, but each of the methods yields different results because empirical evidence on many of the key parameters remains inadequate. Moreover, the three formulas discussed above are not an exhaustive list of potential approaches for connecting theory to data in analyzing optimal benefit levels for social insurance. There could be many other representations of the optimality condition in (13) that could be useful for applied work. The multiplicity of formulas for $M_W(b)$ is a general property of the sufficient-statistic approach (Chetty 2009). Because the positive model is not fully identified by the inputs to the formula, there are generally several representations of the formula for welfare gains. This flexibility allows researchers to use the representation most suitable for their applications given the available variation and data.

3.3 Generalizing the Static Model

The analysis above rests on a static model that makes several strong assumptions that are unlikely to hold in practice. Many of these assumptions turn out to have little impact on the formulas for optimal social insurance derived above, which is why these formulas have been widely applied. However, there are some assumptions that are more consequential and raise issues that remain unresolved. In this section, we consider the consequences of each of the main assumptions in turn. The general principle is that if agents' choices in the private sector maximize private surplus, then the formulas derived above continue to hold irrespective of the structure of the model. However, as soon as choices do not maximize private surplus – either because of externalities or imperfect optimization – the formulas no longer hold.

One important assumption that we do not relax below – not because it is inconsequential but rather because there is very limited normative work on this issue – is that wage rates and all other prices are fixed. That is, we do not consider the possibility that changes in social insurance policies will affect market clearing prices in general equilibrium. Acemoglu and Shimer (1999) analyze optimal unemployment insurance in an equilibrium search model with endogenous occupation choice and show that expanding UI can improve efficiency in this environment by encouraging more workers to take high-wage, high-risk jobs. There is no empirical evidence to date on the magnitude of such effects.²⁶ Perhaps an even greater challenge is that there are no results to date on how such empirical estimates could be connected to equilibrium models to make

²⁵One possibility is a model with impatient workers who wait to search for a job until they have no cash on hand. Such a model would generate significant liquidity effects but no impacts on ex-post wages, and would have very different welfare implications.

²⁶Rothstein (2010) and Chetty et al. (2011) present evidence that tax and transfer policies affect wage rates and the distribution of jobs in equilibrium. Rothstein shows that expansions of the Earned Income Tax Credit (EITC) depress wages for workers who are ineligible for the EITC, while Chetty et al. show that the tax schedule in Denmark affects even the earnings of workers unaffected by the tax incentives because of firm responses. The effects of social insurance on equilibrium outcomes could potentially be uncovered using a similar research design that focuses on groups whose incentives are not directly affected by the program.

quantitative statements about optimal policy.

3.3.1 Dynamics: Endogenous Savings and Borrowing Constraints

The most important limitation of the model analyzed above is that it does not incorporate dynamics. In dynamic models, agents can smooth consumption across periods and thus “self insure” part of the income fluctuations they face, potentially reducing the value of social insurance. In addition, social insurance distorts not just agents’ effort choices but also their consumption and savings decisions. Hubbard, Skinner, and Zeldes (1995) present simulation evidence suggesting that social insurance and means-tested transfer programs can substantially reduce savings rates. Engen and Gruber (2001) show that increases in UI benefits have small but significant effects on wealth accumulation prior to job loss among workers at risk of layoff. These intertemporal consumption smoothing and savings responses may be further complicated by borrowing constraints, generating buffer stock behavior as in Deaton (1991) or Carroll (1997).

Models that incorporate all of these features have been widely studied and are complex and difficult to solve analytically. Surprisingly, however, the three simple formulas for the marginal welfare gain from raising social insurance benefits derived above continue to hold in such models with small modifications. Because this result underpins much of the modern literature on connecting theory to data in analyzing optimal social insurance, we provide a simple proof here.

We analyze the optimal level of unemployment benefits in a dynamic job search model with borrowing constraints, following Lentz and Tranaes (2005) and Chetty (2008). For instructive purposes, we structure the analysis to parallel the steps for the static case in Section 4.1: (1) model setup, (2) characterizing the agent’s problem, (3) the planner’s problem, (4) deriving a condition for optimal benefits by exploiting envelope conditions, and (5) deriving empirically implementable sufficient statistic formulas.

Setup. The agent lives for T periods $\{0, \dots, T - 1\}$. The interest rate and the agent’s time discount rate are set to zero to simplify notation. The agent becomes (exogenously) unemployed at $t = 0$. An agent who enters a period t without a job first chooses search effort e_t . As in the static case, we normalize e_t to equal the probability of finding a job in the current period. Let $\psi(e_t)$ denote the cost of search effort, which is strictly increasing and convex. If search is successful, the agent begins working immediately in period t . All jobs last indefinitely once found.

We make two assumptions to simplify exposition: (1) the agent earns a fixed pre-tax wage of w when employed, eliminating reservation-wage choices and (2) assets prior to job loss (A_0) are exogenous, eliminating effects of UI benefits on savings behavior prior to job loss. Neither assumption affects the results below (Chetty 2008).

If the worker is unemployed in period t , he receives an unemployment benefit $b < w$. If the worker is employed in period t , he pays a tax τ . Let c_t^e denote the agent’s consumption in period t if a job is found in that period. Note that the agent will optimally set consumption at c_t^e for all $t' > t$ as well because he faces no uncertainty once he finds a job and therefore smooths consumption perfectly. If the agent fails to find a job in period t , he sets consumption to c_t^u . The agent then

enters period $t + 1$ unemployed and the problem repeats. Let $u(c_t)$ denote flow consumption utility when unemployed and $v(c_t)$ denote flow utility when employed.

Agent's Problem. We characterize the solution to the agent's problem using discrete-time dynamic programming. The value function for an individual who finds a job at the beginning of period t , conditional on beginning the period with assets A_t is

$$V_t(A_t) = \max_{A_{t+1} \geq L} v(A_t - A_{t+1} + w_t - \tau) + V_{t+1}(A_{t+1}). \quad (25)$$

where L is the borrowing constraint. The value function for an individual who fails to find a job at the beginning of period t and remains unemployed is

$$U_t(A_t) = \max_{A_{t+1} \geq L} u(A_t - A_{t+1} + b_t) + J_{t+1}(A_{t+1}) \quad (26)$$

where

$$J_t(A_t) = \max_{e_t} e_t V_t(A_t) + (1 - e_t) U_t(A_t) - \psi(e_t) \quad (27)$$

is the value of entering period t without a job with assets A_t .²⁷

An unemployed agent chooses e_t to maximize expected utility at the beginning of period t , given by (27). Optimal search intensity is determined by the first-order condition

$$\psi'(e_t) = V_t(A_t) - U_t(A_t). \quad (28)$$

The condition parallels (10) in the static model, except that the marginal value of search effort is given by the difference between the optimized present values of employment and unemployment in the dynamic model rather than the difference in flow utilities.

Planner's Problem. The social planner's objective is to choose the unemployment benefit level b that maximizes the agent's expected utility at time 0, $J_0(A_0; b, \tau)$, subject to balancing the government's budget. Let $D = \sum_{t=0}^{T-1} \prod_{j=0}^t (1 - e_j)$ denote the agent's expected unemployment duration. The planner's problem is:

$$\max_{b, \tau} J_0(A_0; b, \tau) \text{ s.t. } Db = (T - D)\tau \quad (29)$$

Differentiating J_0 w.r.t. b yields:

$$\frac{dJ_0}{db} = e_0 \frac{\partial V_0}{\partial b} + (1 - e_0) \frac{\partial U_0}{\partial b} - (e_0 \frac{\partial V_0}{\partial \tau} + (1 - e_0) \frac{\partial U_0}{\partial \tau}) \frac{d\tau}{db} \quad (30)$$

The key step in obtaining an empirically implementable representation of (30) is to exploit the envelope conditions for e_t , c_t^u , and c_t^e . These variables are all chosen to maximize the agent's expected utility at each stage of his dynamic program. Because changes in these variables do not

²⁷It is easy to show that V_t is concave because there is no uncertainty following re-employment; however, U_t could be convex. Lentz and Tranaes (2005) and Chetty (2008) report that non-concavity never arises in their simulations for a broad range of plausible parameters. Therefore, we assume that U_t is globally concave in the parameter space of interest and use first-order conditions to identify the optimal level of benefits.

have a first-order impact on utility, one can ignore the impacts of changes in b and τ on these choices when calculating the derivatives in (30). Hence, the only terms that appear in the derivatives are the marginal utilities in which b and τ directly appear. To characterize these terms, define the average marginal utility of consumption while unemployed as

$$\mathbb{E}u'(c_t^u) = \frac{1}{D} \sum_{t=0}^{T-1} \prod_{i=0}^t (1 - e_i) u'(c_t^u)$$

and the average marginal utility of consumption while employed as

$$\mathbb{E}v'(c_t^e) = \frac{1}{T-D} (e_0 T v'(c_0^e) + \sum_{t=1}^{T-1} [\prod_{i=1}^t (1 - e_{i-1})] e_t (T-t) v'(c_t^e)).$$

Some algebra yields:

$$\begin{aligned} e_0 \frac{\partial V_0}{\partial b} + (1 - e_0) \frac{\partial U_0}{\partial b} &= D \mathbb{E}u'(c_t^u) \\ e_0 \frac{\partial V_0}{\partial \tau} + (1 - e_0) \frac{\partial U_0}{\partial \tau} &= (T - D) \mathbb{E}v'(c_t^e) \end{aligned}$$

The government's budget constraint implies that $\frac{d\tau}{db} = \frac{D}{T-D} (1 + \frac{T}{T-D} \varepsilon_{D,b})$. Combining these expressions, it follows that

$$\frac{dJ_0}{db} = D \mathbb{E}u'(c_t^u) - D \mathbb{E}v'(c_t^e) (1 + \frac{T}{T-D} \varepsilon_{D,b})$$

As in the static model, we normalize the welfare gain from a \$1 increase in the size of the government insurance program by the welfare gain from raising the wage bill in the high state by \$1 to obtain

$$\begin{aligned} M_W(b) &= \frac{\frac{dJ_0}{db}(b)/D}{\frac{dJ_0}{dw}(b)/(T-D)} \\ &= \frac{1}{\mathbb{E}u'(c_t^e)} \left\{ \mathbb{E}u'(c_t^u) - \mathbb{E}v'(c_t^e) \left(1 + \frac{T}{T-D} \varepsilon_{D,b}\right) \right\} \\ &= \frac{\mathbb{E}u'(c_t^u) - \mathbb{E}v'(c_t^e)}{\mathbb{E}v'(c_t^e)} - \frac{1}{1 - D/T} \varepsilon_{D,b}. \end{aligned} \tag{31}$$

This expression coincides with the formula for $M_W(b)$ from the static model in (13) with two changes. First, the fraction of time spent unemployed is measured over the entire life of the agent (D/T) instead of in a single period. Correspondingly, the relevant elasticity is $\varepsilon_{D,b}$ rather than $\varepsilon_{1-e,b}$. Second, and more importantly, the gap in marginal utilities that enters the formula is the difference between the *average* marginal utility when employed and unemployed. This is because the average value of a marginal dollar of UI benefits depends upon the mean marginal utility across all the periods over which the agent is unemployed during his life. Similarly, the average cost of raising the UI tax depends upon the cost of losing \$1 during all the periods over which the agent is employed.

Sufficient Statistics Implementation. Equation (31) can be implemented using each of the three approaches described above with modifications to account for the fact that one must measure

the gap in average marginal utilities. To implement the consumption smoothing approach, one must estimate the *mean* consumption drop between periods when the agent is employed and unemployed, $\frac{\Delta \bar{c}}{\bar{c}^e} = \frac{\mathbb{E}c_t^u - \mathbb{E}c_t^e}{\mathbb{E}c_t^e}$, as the gap in expected marginal utilities when utility is not state-dependent is $\frac{\mathbb{E}u'(c_t^u) - \mathbb{E}u'(c_t^e)}{\mathbb{E}u'(c_t^e)} = \gamma \frac{\Delta \bar{c}}{\bar{c}^e}$. Identifying $\frac{\Delta \bar{c}}{\bar{c}^e}$ is conceptually analogous to identify $\frac{\Delta c}{c}$ in the static model. However, it may not directly correspond to the difference between consumption immediately before and after unemployment, as measured by Gruber (1997) and others, if consumption trends substantially over the lifecycle. The extent to which $\frac{\Delta \bar{c}}{\bar{c}^e}$ differs from estimates using Gruber's approach has not yet been investigated empirically and requires further work.

Similarly, to implement the liquidity vs. moral hazard approach, one must estimate the impacts of *annuities* to recover expected marginal utilities over the unemployment spell in a dynamic model. Again, this is conceptually no different than estimating the impact of lump sum cash grants, but may be harder to implement empirically. In practice, Chetty (2008) translates his estimates of the impacts of cash grants on unemployment durations into the impacts of annuities by making assumptions about discount rates. Finally, Shimer and Werning (2007) show that their reservation wage approach goes through in a dynamic model provided that utility has a CARA specification that eliminates income effects.

The general lesson from the analysis of the dynamic model is that one does not need to fully characterize all the margins through which agents may respond to shocks to calculate the marginal welfare gains of social insurance. Even in complex dynamic models, the calculation of welfare gains can be distilled to two parameters: the gap in average marginal utilities and the elasticity that enters the government's budget constraint $\varepsilon_{D,b}$. There is no need to identify additional structural parameters such as the tightness of the borrowing constraint (L) or the cost of job search ψ to calculate $\frac{dW}{db}$. Similarly, one can show that the formula in (31) is robust to a variety of other extensions as well. For example, Kaplan (2010) shows that many young unemployed workers move back in with their parents as a method of consumption smoothing. He shows that incorporating this margin of adjustment into a structural model has significant effects on consumption fluctuations and the benefits of unemployment insurance. However, this margin is automatically accounted for in the formulas derived above. Mathematically, the option to move back home is simply another choice variable for agents and thus has no impact on (31). Intuitively, optimizing agents account for the option to move back home in all their choices. Thus, empirically observed consumption patterns, liquidity effects, and reservation wages all already incorporate this margin.

Chetty (2006b) establishes the validity of (31) at its most general level by analyzing a dynamic model where transitions from the good state to the bad state follow an arbitrary stochastic process. Agents make J choices and are subject to M constraints. The choices could include variables such as reservation wages, savings behavior, spousal labor supply, or human capital investments. Chetty shows that (31) holds in this environment as long as agents' choices maximize private welfare.²⁸

²⁸A related point is that the same formula also holds in the context of other social insurance programs where the structure of the positive model differs. For instance, in the context of health insurance, one may choose the intensity of care *after* getting sick rather than controlling ex-ante effort. The formula in (31) holds in such a model with an appropriate redefinition of the average marginal utilities and the elasticity that enters the planner's budget constraint.

This is the critical assumption underlying (31). In the rest of this section, we discuss a series of important externalities that violate this assumption.

3.3.2 Externalities on Private Insurers

Public insurance is motivated by market failures of the types discussed in Section 2. However, most of the literature on optimal public insurance simply assumes that private markets do not provide any insurance against risks rather than modelling the underlying sources of the market failure. This assumption – which we made when deriving (31) above – is a convenient technical simplification but has important consequences for optimal social insurance.²⁹ If there is a formal market for private insurance, agents’ choices will no longer maximize *total* private surplus (including the agent and private insurer) because the private insurance contract will distort choices. As a result, marginal changes in agents’ choices will have fiscal externalities on private insurers. For example, suppose that part of health expenditures are covered by public insurance and part by private insurance. When the government raises health insurance benefits, agents will spend more on health care, and this increased expenditure will raise costs for *both* the government and the private insurer. This added fiscal externality on the private insurer is a first-order effect that reduces the marginal value of insurance and is not accounted for in (31).

Before discussing how these fiscal externalities affect optimal benefits, it is worth emphasizing that only private insurance contracts that generate moral hazard alter the formulas for optimal public insurance. Private insurance that does not generate moral hazard – such as informal insurance between relatives that is well monitored – has no impact on the original formula in (31). To see this, suppose that the agent can transfer $\$b_p$ between states at a cost $q(b_p)$, so that increasing consumption by b_p in the low state requires payment of a premium $\frac{1-\epsilon}{\epsilon}b_p + q(b_p)$ in the high state. As long as the level of b_p is chosen to maximize utility, it is simply another choice variable in Chetty’s (2006b) framework, and thus has no impact on the optimal social insurance formula. The effects of any such insurance arrangement are automatically embedded in the empirically observed consumption drop and other parameters that enter the formula.

There is relatively little work analyzing optimal social insurance with private insurance that induces moral hazard. Golosov and Tsyvinski (2007) analyze optimal government policy in a model in which agents can purchase insurance from multiple private providers. They rule out market failures due to adverse selection by assuming that agents can sign contracts before private information is revealed. However, the private market still does not achieve an efficient outcome because of a “multiple dealing” externality across firms, originally discussed by Pauly (1974). Intuitively, each firm does not take into account the fact that its provision of insurance distorts the agent’s behavior, thereby affecting other insurer’s budgets and leading to over-provision of insurance in the

Chetty (2006b) considers an example of “tenure review” that is formally analogous to this case.

²⁹One potential rationale for this approach is that private markets are essentially at a corner of providing zero insurance against certain risks (e.g. unemployment), and thus marginal changes in public insurance can be evaluated under the assumption that there is no private insurance. Unfortunately, this is not an accurate description of insurance markets in many important applications such as health.

decentralized private market equilibrium. Golosov and Tsyvinski show that the government can raise welfare by imposing a corrective tax that countervails the multiple dealing externality. They also show that the provision of public insurance partially crowds out private insurance and may reduce welfare because it leads to further over-provision of insurance. Using numerical calibrations, they demonstrate that these effects could be quite large quantitatively.

While these results demonstrate that endogenous private insurance could reduce the scope for government intervention in insurance markets, the implications of their analysis for optimal benefit levels in practice are less clear. Golosov and Tsyvinski rule out many of the rationales for publicly provided insurance we discussed above, such as adverse selection, by assumption. In addition, their numerical calibrations rest on strong assumptions about the structure of the underlying model that are not directly grounded in empirical evidence.

Chetty and Saez (2010) attempt to connect the theory to the data more explicitly by deriving formulas for optimal benefits in terms of empirically estimable parameters with endogenous private insurance. They first analyze a case in which agents are homogeneous and purchase insurance from a private firm. Because there is no market failure in this model, if agents in the private sector optimize perfectly, the marginal gain from government intervention is strictly negative (Kaplow 1991). When the private sector does not offer the optimal level of insurance – e.g., because of behavioral biases of the types discussed in Section 3.3.5 below – there is a potential role for government intervention. Chetty and Saez assume that the planner maximizes the agent’s true expected utility (which they assume is not state-dependent) and show that the marginal welfare gain from public insurance b can be expressed as

$$M_W(b) = (1 - r) \left[\frac{u'(c_l) - u'(c_h)}{u'(c_h)} - \frac{\varepsilon_{1-e,b}}{e} \frac{1 + b_p/b}{1 - r} \right] \quad (32)$$

where b_p is the private insurance benefit level in equilibrium and $r = -\frac{db_p}{db}$ measures the extent to which private insurance is crowded out by public insurance. When $b_p = 0$, this formula reduces to (13) with state-independent utility. When $b_p > 0$, two additional terms enter the formula. First, the marginal welfare gain is scaled down by $(1 - r)$ because \$1 more of public insurance raises total insurance $(b + b_p)$ by only $\$1 - r$. This effect rescales but does not change the sign $M_W(b)$ and thus does not affect the optimal public benefit level b^* . The second and more important effect of endogenous private insurance is captured by the added term $\frac{1+b_p/b}{1-r}$ that amplifies the elasticity. This term reflects the fiscal externality that expanding public insurance has on private insurers. When the agent reduces e in response to a \$1 increase in b , it not only has a cost to the government proportional to $\varepsilon_{1-e,b}$ but also a cost to the private insurer proportional to $\varepsilon_{1-e,b} b_p/b$. This externality effect reduces the optimal benefit level beyond what one would have calculated based on the formula in (31) that ignored private insurance.

Chetty and Saez implement (32) in the context of unemployment insurance and health insurance to illustrate their approach. For unemployment – where the only form of private insurance is severance pay – Chetty and Saez estimate $\frac{b_p}{b} = 0.2$ and $r = 0.14$ and using cross-state variation in UI benefits. Because the share of private UI benefits and crowdout effects are small, endogenous

private insurance has small effects on the optimal UI benefit level with plausible elasticities. For health, the share of private insurance is much larger ($\frac{b_p}{b} = 0.89$), as is the degree of crowdout. Cutler and Gruber (1996) estimate that a \$1 increase in public health insurance benefits reduces private insurance benefit levels by 50 cents, implying $r = 0.5$. As a result, accounting for endogenous private insurance reduces the marginal welfare gains of an aggregate health insurance expansion by more than an order of magnitude according to (32).

The shortcoming of the formula in (32) is that it is sensitive to the sources of private market failures. For instance, Chetty and Saez extend their baseline analysis to a case where there are heterogeneous agents who have private information about their risk types. This generates adverse selection and partial private insurance provision by the market. In this setting, the formula for $M_W(b)$ has additional terms relative to (32) because it has the added benefit of pooling risks across individuals of different types through a mandate. Hence, (32) is not a robust “sufficient statistic” formula because it is sensitive to the structure of the positive model. Developing formulas that are robust to the underlying sources of private market failures and can be implemented empirically is among the most important priorities for future research on social insurance.

3.3.3 Externalities on Government Budgets

Fiscal externalities can also arise when the government itself provides multiple types of social insurance or levies taxes. For instance, expansions in disability insurance may reduce the probability that a worker with a high disutility of work chooses to search for a job and claim unemployment insurance. A more general source of fiscal externalities is taxation. Any reduction in labor supply induced by social insurance programs will have a negative fiscal externality on the government by reducing income tax revenue.

It is useful to divide fiscal externalities into two categories. The first are mechanical externalities that arise because the choice insured by the program (e) directly affects other parts of the government’s budget, such as tax revenue. The second are indirect fiscal externalities that arise because of *other* behavioral responses unrelated to e itself. For instance, an increase in UI benefits may induce agents to save less, which would reduce revenue from capital gains taxes.

To see how such fiscal externalities affect (31), let us return to the static model and add an initial period, $t = 0$, in which the agent chooses how much to save, which we denote by A , before he faces the risk of unemployment. Let Z denote the agent’s wealth at the beginning of period 0, which we take as fixed. In period 0, consumption is given by $c_0 = X - A$. Let τ_A denote the tax levied on savings A (e.g. a capital gains tax) and τ_e denote an income tax levied on employed individuals. Tax revenue $R = \tau_A A + \tau_e e$ is rebated to the agent as a lump sum in the high state, so that $c_h = A + w_h - \tau(b) + R$.

The agent chooses effort e to maximize his expected utility taking the parameters of the tax system as fixed:

$$\max_{e,A} V(e, A) = v(Z - A) + ev(A + w_h - \tau(b) + R) + (1 - e)u(A + w_l + b) - \psi(e)$$

The social planner's objective is to choose the benefit level b that maximizes the agent's expected utility:

$$\begin{aligned} \max_b W(b) &= v(Z - A) + ev(A + w_h - \tau(b) + R) + (1 - e)u(A + w_l + b) - \psi(e) \\ \text{s.t. } e &= e(b) \text{ and } A = A(b) \text{ and } R = \tau_A A + \tau_e e \end{aligned}$$

Algebra analogous to that above yields:

$$M_W(b) = \frac{u'(c_l) - v'(c_h)}{v'(c_h)} - \frac{\varepsilon_{1-e,b}}{e} \left(1 + \frac{\tau_e}{b}\right) + \frac{1}{1-e} \frac{A}{b} \tau_A \varepsilon_{A,b}$$

This equation differs from the original formula in (13) in two ways. The first new term, $\frac{\tau_e}{b}$, reflects the mechanical externality arising from the fact that reductions in e reduce income tax revenue. The magnitude of this effect is proportional to $\frac{\varepsilon_{1-e,b}}{e}$. Accounting for this mechanical externality does not require estimating any additional parameters; one must simply take the income tax rate into account when calculating the impact of changes in e on the government budget. The second new term is proportional to $\tau_A \varepsilon_{A,b}$. This term reflects the indirect fiscal externality imposed by distorting the choice of savings A . Accounting for this indirect externality requires estimation of the additional elasticity $\varepsilon_{A,b}$, e.g. as in Engen and Gruber (2001).³⁰

Empirically, an important source of indirect fiscal externalities are behavioral responses that affect takeup of other social insurance programs. Autor and Duggan (2003) provide empirical evidence on the interaction between unemployment and disability insurance in the U.S. Using local employment shocks instrumented by industry shares, they show that more individuals exit the labor force and apply for DI when they are laid off when DI benefits are raised. As a result, unemployment rates rise less when disability insurance is expanded and, correspondingly, one would expect UI benefit payments to fall. Of course, the government also loses revenue by collecting fewer taxes from individuals who would have worked if the DI benefit level were lower.

Borghans, Gielen, and Luttmer (2011) quantify the magnitude of such fiscal externalities using administrative data from the Netherlands. They use a regression discontinuity design to show that reducing the generosity of DI benefits increases reliance on other forms of social insurance. They estimate that every \$1 saved in DI benefits via a benefit cut leads to approximately 50 cents of additional expenditure on other social insurance programs. Part of this cost is offset by increased tax revenue, but it is clear that accounting for such fiscal externalities is critical in designing optimal social insurance policy. More generally, one should ideally analyze social insurance and tax policies in a unified framework rather than optimizing each program (UI, DI, health insurance, etc.) separately.

³⁰Consistent with the results in section 3.3.1, the distortion in A has no impact on the formula if $\tau_A = 0$; it is only because savings are taxed that this behavioral response matters.

3.3.4 Other Externalities

Agents in the private sector may have direct non-pecuniary externalities on each other independent of the fiscal channels discussed above. In Section 2.3, we discussed how such externalities – such as the spread of contagious diseases – could provide a motivation for social insurance. In this section, we discuss how such externalities affect the optimal design of social insurance policies.

While any externality would affect (31), the literature on optimal social insurance has focused on two types of externalities in particular. The first are social multiplier effects, which refer to the idea that one individual's choices may affect the choices of those around him. For instance, an increase in disability benefits may induce some agents to stop working, which in turn may increase the value of leisure for their peers. The second are congestion externalities, which arise because of constraints that make one agent's behavior change the returns to effort for another agent. For instance, in the context of unemployment, agents compete for a limited number of positions when jobs are rationed. In this setting, changes in UI benefits can have different effects at the macroeconomic level relative to the microeconomic level.

Theoretical work on social multipliers effects and social insurance has shown that the aggregate effects of insurance on behavior could be significantly larger than microeconomic estimates of a single individual's behavioral responses to a change in his marginal incentives. For instance, Lindbeck, Nyberg, and Weibull (1999) present a benchmark model of how social norms about labor supply change the impacts of the welfare state on the economy. In their model, individuals' taste for work depends not only upon their private disutility of work but also the fraction of individuals who rely on social support rather than work to make a living. They demonstrate that in this environment, small changes in policy can lead to dramatic, discontinuous changes in the size of the welfare state by shifting the equilibrium. For instance, the macroeconomic effect of an increase in disability benefits on labor supply, ε^M , could be much larger than the microeconomic elasticity ε for any single individual. Intuitively, when social insurance benefits are increased, the direct effect on each agent's behavior is amplified by the feedback mechanism of the change in the norm. Lindbeck, Nyberg, and Weibull argue that these non-linear responses could explain why some developed countries (e.g. in Scandinavia) have much larger social insurance systems than others (such as the U.S.).

How do such social multipliers affect the formula for optimal benefits in (31)? If social multipliers affect behavioral responses but do not directly affect utility, (31) holds, but ε must be replaced by the macro elasticity ε^M . This is because the aggregate response ε^M is what determines how an increase in benefits affects the government budget. If the social externalities enter utility directly – e.g. if one agent not working increases the utility of leisure for others agents – then an additional term enters (31) to capture the impact of this externality on welfare, as the envelope conditions used to derive (31) do not take account of this effect.³¹

Empirical evidence lends support to the presence of such social multipliers. For instance, Lalive (2003) presents evidence that an extension of unemployment benefits to workers over age

³¹See Kroft (2008) for an analysis of optimal UI with social spillovers in takeup decisions.

50 in Austria affected the labor supply of their peers below age 50, although his results rely on relatively strong identification assumptions. Clark (2003) uses data on subjective well being from a panel of households in the United Kingdom and shows that unemployed individuals report higher levels of happiness when the local unemployment rate is higher, while employed individuals report lower levels of satisfaction. Bertrand, Luttmer, and Mullainathan (2000) show that individuals are more likely to take up welfare when living in neighborhoods with a large population of residents who speak their own language, suggesting that there are network effects in welfare takeup. A limitation of this analysis is that it relies purely on cross-neighborhood comparisons and thus rests on relatively strong identification assumptions. Chetty, Friedman, and Saez (2012) present evidence of social spillovers via learning using panel data. They show that individuals are more likely to *change* their earnings behavior in response to the incentives created the Earned Income Tax Credit in the U.S. when they move to a neighborhood where other individuals respond to the program. Unfortunately, none of these studies provide estimates of how the micro impacts of policy (ε) changes differ from their macro impacts (ε^M).

While social multiplier effects amplify elasticities and potentially reduce the optimal level of social insurance, congestion externalities have the opposite effect. Landais, Michaillat, and Saez (2012) analyze optimal unemployment insurance in a job search model with rationing. A standard matching function maps the number of vacancies and job openings to the equilibrium level of unemployment. They assume that wages are rigid, so that when the economy is hit by a negative productivity shock, jobs are rationed in the sense that the labor market does not clear even if workers exert arbitrarily high search effort. In this environment, job seekers have a negative search externality on each other: each individual tries to outrun his peers to find a job, leading to excess search effort via a standard rat-race mechanism. Landais, Michaillat, and Saez demonstrate that this externality has two effects on (31). First, it reduces the macro elasticity of unemployment with respect to the benefit rate relative to the micro elasticity. Again, it is the macro elasticity that enters (31) for the reasons described above. Second, the negative job search externality creates an added benefit from raising UI benefits, because when each individual searches less, he has a positive spillover effect on other job seekers. Because job rationing is more severe in recessions, Landais, Michaillat, and Saez conclude that the optimal level of UI benefits should be countercyclical. They show that the micro and macro elasticities along with the other parameters in (31) are sufficient statistics to calculate the optimal level of benefits in a relatively general environment.³²

Motivated by the question of whether unemployment benefits should vary over the business cycle, a recent empirical literature has investigated whether elasticities of unemployment durations with respect to benefit levels change in recessions. Most of the existing evidence uses identification strategies that are more likely to recover partial-equilibrium micro elasticities rather than general-equilibrium macro elasticities. This is because the need for a control group often makes it easier to identify partial equilibrium effects using quasi-experimental methods. Schmieder, von Wachter,

³²Landais, Michaillat, and Saez focus on benefits levels rather than the duration of benefits. However, the typical policy response to a recession is an extension in the duration of benefits rather than an increase in the level of benefits. Understanding why this is the case is an interesting open area for further work.

and Bender (2012) show that UI benefit extensions have smaller effects on unemployment exit hazards in recessions than in booms using data for Germany, implying that the moral hazard effect of UI is smaller at the micro level in recessions. Landais (2012) uses a regression kink design to show that changes in UI benefit levels have similar effects on unemployment durations in recessions and booms in the United States. Kroft and Notowidigdo (2011) present evidence that the moral hazard effects of changes in UI benefits are smaller in recessions, while the consumption smoothing benefits are roughly constant, although their estimates are somewhat imprecise due to a lack of power. Together, these findings suggest that the optimal level of benefits is likely to be somewhat higher in recessions even ignoring search externalities due to job rationing. The size of these externalities can be quantified by estimating the macro elasticity ε^M over the business cycle, which is an important challenge for future work.

3.3.5 Imperfect Optimization

Another important reason that agents' choices may not maximize total private surplus is failures of optimization. As we noted in Section 2.3 above, if agents optimized perfectly, we would observe very small consumption fluctuations $\frac{\Delta c}{c}$ for temporary shocks such as unemployment. Hence, (31) would imply that the welfare gains of social insurance are small. It is tempting to simply plug in a statistic such as the observed (large) values of $\frac{\Delta c}{c}$ and calculate the welfare gains of social insurance by applying (31) even if agents do not optimize. Unfortunately, (31) is not a valid formula for optimal benefits when agents do not optimize. This formula is valid only if agents optimize, and we know that if they optimized $\frac{\Delta c}{c}$ would not be large. Because a biased agent's choices do not maximize his own utility, the envelope conditions exploited to derive (31) no longer holds. Hence, one must modify the formulas to allow for imperfect optimization to obtain an internally consistent understanding of optimal social insurance.³³

At a broad level, there are two conceptual challenges in accounting for imperfect optimization. First, conducting welfare analysis requires recovering the individuals' true preferences, which is challenging when one cannot rely on the standard tools of revealed preference used above. One approach to solving this problem is to posit a structural model of behavioral failures, such as hyperbolic discounting (Laibson 1997), and estimate the parameters of that model to analyze optimal policy. Another approach, which is closer in spirit to the sufficient statistic methods we have focused on here, is to derive formulas for the welfare consequences of social insurance that do not rest on a specific positive model of optimization failures (Bernheim and Rangel 2009, Chetty, Looney, and Kroft 2009). The chapter by Bernheim in this volume discusses welfare analysis in behavioral models in greater detail. Second, from an empirical perspective, it is unclear how to systematically distinguish mistakes from unobserved attributes such as risk aversion or private information about expected losses under an insurance contract. While we are able to identify

³³This point illustrates a general weakness of the sufficient statistic approach, which is that the assumptions used to derive the formula are never explicitly tested because the parameters of the model are never fully identified. See Chetty (2009) for further discussion of these issues.

specific examples where we can reject the null of perfect optimization, it is less clear how we can quantify the degree to which individuals are biased, which is necessary for implementing corrective policies.

There is relatively little work on social insurance in behavioral models. DellaVigna and Paserman (2005) estimate a model of job search with impatient agents and show empirically that agents who are more impatient – as measured by variables that quantify tradeoffs between immediate and delayed payoffs – search less for jobs. In their model, increasing UI benefits would have additional costs because it would further reduce effort below the optimum. Fang and Silverman (2009) estimate a similar model of time inconsistency in the context of welfare program participation and estimate the model’s structural parameters. They then use their model to show that policies that limit the number of months for which individuals are eligible for social transfers could raise welfare. These papers are examples of the first approach to welfare analysis in behavioral models described above – positing a structural model and using it to analyze the welfare consequences of policy changes.

Spinnewijn (2011) is an example of the second approach to behavioral welfare analysis. He generalizes the sufficient statistic formulas for optimal benefit levels derived above to an environment in which agents are overoptimistic about their probability of finding a job. Spinnewijn shows that it is crucial to distinguish between two types of biases in beliefs: baseline bias, which is misestimating the probability of finding a job holding search effort fixed, and control bias, which is misestimating the impact of increased search effort on the probability of finding a job. Baseline bias has no impact on the formula in (31) because it does not affect the agent’s behavioral responses to benefit changes or his utility. In contrast, control bias introduces a new term in the formula that arises from the fact that the agent does not set e at its true optimum. As a result, changes in b have a first-order effect on utility by inducing changes in e . For instance, an agent who is control-pessimistic will undersupply effort in equilibrium, and increases in benefits will lower welfare by distorting e downward even further. Spinnewijn presents empirical evidence that agents are indeed control-pessimistic in practice, suggesting that calculations of optimal benefits based on the traditional formula in (31) will overstate the welfare gains of insurance.

The limitation of these papers is that each one characterizes the implications of a specific type of bias for policies. The challenge for research on social insurance in behavioral models is finding a framework that incorporates a broad set of biases yet offers empirically implementable results for optimal policy. Further work along these lines is a challenging but promising direction for future research.

3.4 Other Dimensions of Policy

While much of the literature connecting theory to data has focused on identifying the optimal level of social insurance benefits, there are many other important questions in the design of insurance programs. In this section, we briefly review three areas that have received attention in recent work: mandated savings accounts, increasing program takeup rates, and changing the path or duration

of benefits.

3.4.1 Mandated Savings Accounts

Our analysis thus far has focused exclusively on a social insurance system that transfers money from individuals in the high state to those in the low state via taxes and transfers. However, as we discussed above, there would be little need for social insurance against temporary shocks such as unemployment if individuals optimized and built up buffer stocks to smooth consumption fluctuations. Recent research has therefore analyzed policies that force individuals to maintain a buffer stock via mandated savings accounts rather than transferring resources across individuals. Intuitively, if the motive for social insurance benefits is undersaving, the optimal tool to correct this problem may be to mandate saving rather than provide state-contingent transfers.

Feldstein and Altman (1998) propose a system of UI savings accounts in which individuals are required to save a fraction of their wages in accounts designated to be used only in the event of unemployment spells. If they become unemployed, individuals would draw upon these accounts at standard benefit rates. If individuals run out of money in their savings account, they would automatically draw benefits from the state UI system, which would continue to be financed by a (smaller) payroll tax. Any remaining balance at the point of retirement would be refunded to the individual. The benefit of such a system is that individuals' incentives to search for a job while unemployed are not distorted by the provision of UI benefits, because each extra \$1 they use in UI benefits leaves them with \$1 less of wealth in retirement, provided that they do not fully deplete their savings account balance. Using data from the Panel Study of Income Dynamics, Feldstein and Altman show that less than half of UI benefits would be paid to individuals who hit the corner of a zero account balance, implying that incentives could potentially be improved for many people. Orszag and Snower (2002) present calibrations showing that the impacts of such a system on unemployment durations could be quite large.

Stiglitz and Yun (2005) present a more formal argument for the optimality of UI savings accounts. They analyze a model in which individuals pay money into a pension system that is taken as exogenous. They prove that permitting individuals to draw down these pension assets in the event of adverse shocks raises welfare if individuals are borrowing constrained. The intuition is that allowing individuals to borrow against retirement savings relaxes borrowing constraints and permits better consumption smoothing at a lower efficiency cost than state-contingent transfers.

An important limitation of existing theoretical work on optimal savings accounts is that they analyze models with agents who optimize perfectly. Mandated savings can only be justified if agents suffer from biases such as impatience, as the government is simply restricting the choice set available to agents. However, if agents are impatient, it is not clear that they will fully internalize the benefits of having more wealth in retirement if they draw less UI benefits when they are young. Hence, in a model that justifies mandated savings, such policies could well have efficiency costs similar to traditional social insurance systems. Countervailing this effect, there may be other biases – such as the increased salience of UI savings accounts relative to eligibility for UI benefits –

that may reduce distortions when agents do not optimize perfectly. Characterizing optimal savings account and benefit policies with imperfect optimization is therefore an important goal for future work.

Empirical evidence on the impacts of UI savings accounts is scarce because few governments have implemented such systems. Hartley, van Ours, and Vodopivec (2011) present suggestive evidence that a UI savings account program introduced in Chile reduced unemployment durations. Their analysis uses individuals who endogenously choose to opt into a traditional unemployment insurance program as a comparison group. Their conclusions therefore rest on stronger identification assumptions than most of the empirical studies discussed above. Further work using quasi-experimental designs to study the impacts of mandated savings accounts is needed to fully understand their impacts.

3.4.2 Imperfect Takeup

Another important dimension of social insurance policy is program participation. In the analysis above, we assumed that all individuals who are eligible for a social insurance program automatically participate in the program. In practice, takeup rates for most programs are often well below 100% (Currie 2006). For instance, only 75% of individuals eligible for UI actually receive UI benefits when laid off. Incomplete takeup raises two types of questions for optimal program design. First, should the government seek to increase takeup rates and if so what methods can be used to do so? Second, is the optimal level of benefits different when only some agents take up the benefit?

There are two competing views about whether it is socially desirable to raise takeup rates. In an environment where agents who do not take up benefits choose to do so rationally – e.g. because the hassle costs of signing up for the social insurance program outweigh the benefits of doing so – imperfect takeup could be socially desirable because it serves as a screening mechanism. Nichols and Zeckhauser (1982) analyze a stylized model in which implementing a hurdle to claim benefits raises social welfare by removing individuals who do not value the program highly from the pool of recipients. An alternative view is that individuals who do not takeup are uninformed or make optimization errors. In this environment, policies that increase takeup rates could raise welfare, because they may bring the individuals who would value social support most highly into the system. Which of these two views is correct is ultimately an empirical question.

Empirical evidence on the determinants of takeup provides evidence supporting both theories, suggesting that some mixture of the two mechanisms is at play. Anderson and Meyer (1997) present evidence that individuals are more likely to take up UI benefits when net benefit levels are higher. Black et al. (2003) present experimental evidence that individuals are more likely to drop out of the UI system when they receive a mailing announcing that they must attend a training program in order to remain eligible for benefits. The results support the rational model of takeup. In contrast, Ebenstein and Stange (2010) show that the shift from in-person to telephone registration for UI benefits, which significantly reduced the time costs of takeup, had no impact on UI takeup rates. Bhargava and Manoli (2011) present experimental evidence showing that simplifying tax

forms increases takeup of the Earned Income Tax Credit. These results support the behavioral model of takeup and suggest that simplification and outreach could raise takeup rates significantly. What remains unclear is the fraction of takeup that is explained by rational vs. behavioral factors, which is a key parameter for determining whether resources should be invested in increasing takeup rates.

How does incomplete takeup affect the optimal design of other parameters of the social insurance system? Kroft (2008) analyzes the optimal UI benefit level in a model with imperfect takeup. He generalizes the sufficient-statistic formulas derived above to a model with heterogeneous takeup costs and rational agents. The formula in (31) changes in two ways in this setting. First, $\mathbb{E}u'(c_t^u)$ must be computed for the subgroup of individuals who takes up benefits rather than all individuals in the low state. Second, the elasticity parameter that is relevant is the sum of the behavioral elasticity $\varepsilon_{1-e,b}$ and the takeup elasticity, as increases in benefit rates raise expenditures both through traditional margins and by raising the number of individuals claiming benefits. The lesson from this analysis is that accounting for endogenous takeup lowers the optimal benefit rate relative to computations that apply (31) to the subsample of individuals who take up benefits.

3.4.3 Path of Benefits

Most shocks have a variable time span. For instance, spells of work injury, disability, and unemployment all have uncertain durations. Although many health shocks are one-time events, there are some chronic conditions that generate expenditures over longer periods. In such settings, the social planner can choose not just the level of benefits but also its path. At an abstract level, one can choose a different benefit level b_t in each period t during which the individual is in the low state. In practice, many social insurance systems have one or two-tiered benefit systems, in which benefits are provided at a constant level for a finite duration and then reduced or completely eliminated (e.g., the termination of UI benefits at 6 months in the U.S.). Our preceding analysis has focused on identifying the optimal level of b under the assumption that $b_t = b$ for all t . In this section, we discuss the small but growing body of work that has sought to characterize the optimal path of benefits.

The fundamental tradeoff in setting the path of benefits, originally described by Shavell and Weiss (1979), is again between consumption-smoothing and moral hazard. Increasing benefits over time is desirable from a consumption smoothing perspective, as it provides the largest benefits to the agents who need it most. Intuitively, those who suffered from a long unemployment spells are likely to have depleted their assets and have a very high marginal utility of consumption. But increasing benefits over time is costly from an efficiency perspective, as it creates an incentive to “hold out” for higher benefits by prolonging one’s duration in the low state. Unfortunately, deriving formulas that map the relative magnitude of these two effects to quantitative predictions about the optimal path of b_t is challenging. The literature on the optimal path of benefits has thus been less successful in connecting theory to data because of the complexity of dynamic models and the high-dimensional nature of the problem. We therefore briefly describe some of the main

theoretical and empirical results that bear on this problem, highlighting the scope for further work deriving sufficient statistic formulas in this area.

Shavell and Weiss (1979) characterize the optimal path of a benefits in a discrete time model in which agents make consumption and search effort choices in each period. When agents cannot save or borrow, the optimal path of benefits is declining because an upward sloping benefit path does not provide a smoother consumption path but creates moral hazard. When agents can save or borrow, Shavell and Weiss show that the optimal path could be upward or downward sloping depending upon the structural parameters of the model. Hopenhayn and Nicolini (1997) extend Shavell and Weiss' analysis to allow for a wage tax after re-employment, but focus on the case with no saving or borrowing. They show that the optimal path of benefits is again declining in this environment, but that there is a significant welfare gain from levying a substantial tax upon re-employment.

Werning (2002) generalizes Hopenhayn and Nicolini's analysis to a case with hidden savings, i.e. a more realistic environment the planner can set benefit levels but cannot directly control consumption. Werning (2002) shows that when agents can save or borrow, optimal benefit levels may increase over time and are much lower in levels than those predicted by Hopenhayn and Nicolini's analysis.³⁴ Shavell and Weiss, Hopenhayn and Nicolini, and Werning all study models where agents have fixed wages and only choose search effort. Shimer and Werning (2008) analyze a standard reservation-wage model in which agents draw stochastic wage offers. They prove that the optimal path of benefits is constant ($b_t = b$) in a setting without liquidity constraints and CARA utility. Intuitively, under these assumptions, the agent's problem while unemployed is stationary because his attitudes toward risk and incentives to find a job do not change as he depletes his assets. As a result, the moral hazard costs and consumption-smoothing benefits of a steeper benefit profile perfectly cancel out, yielding a constant optimal benefit path. Shimer and Werning argue that in cases where agents do not have access to perfect capital markets, the optimal government policy is to provide loans and constant benefits.

While this result is a useful benchmark, the optimal path of benefits could differ substantially under alternative assumptions about the structure of the positive model. In practice, agents are highly liquidity constrained while unemployed and governments tend not to offer loans to such agents, perhaps because of moral hazard problems in debt repayment. Moreover, there could be significant non-stationarities in responses to incentives over a spell, due both to selection in an environment with heterogeneity and changes in the cost of effort. For instance, individuals who remain unemployed after 6 months could be relatively elastic types but may also have a hard time controlling the arrival rate of offers, driving $\varepsilon_{1-e,b}$ down over the course of an unemployment spell. Such forces eliminate the stationarity that drives Shimer and Werning's constant benefit result, as discussed in Shimer and Werning (2006). The quantitative magnitude of such effects is ultimately an empirical question whose answer could vary across environments and social insurance programs.

³⁴The very high optimal replacement rates predicted by Hopenhayn and Nicolini's model should essentially be interpreted as optimal *consumption* levels over the unemployment spell rather than optimal benefit levels.

The empirical literature, which also focuses primarily on unemployment insurance, shows that the path of benefits has significant effects on agents' behavior in a manner that is consistent-with forward-looking decisions. Card and Levine (2000) analyze the impacts of a 13 week extension in UI benefits in New Jersey on unemployment durations. Their estimates imply that this extension would have raised durations on the UI system by 1 week had individuals been eligible for the extension from the start of their spells. Card, Chetty, and Weber (2007) analyze a discontinuity in the Austrian UI benefit system based on work history that makes some individuals eligible for 20 weeks of benefits and others eligible for 30 weeks of benefits. Individuals eligible for 30 weeks of benefits have significantly lower job finding hazards even in the first five weeks of their unemployment spell, suggesting that the "holding out" moral hazard effect identified by Shavell and Weiss is indeed operative in the data. Lalive (2008) finds similar impacts of an age-based discontinuity in the Austrian unemployment system that varies eligibility much more dramatically, from 30 weeks to 209 weeks.

There is no evidence to date on the consumption-smoothing of extending benefits for a longer period due to the lack of high-frequency data on consumption. One approach to this problem may be to estimate liquidity effects at different points of a spell using variation in cash-on-hand from tax credits or other sources, as in Lalumia (2011). Investigating the path of asset decumulation and borrowing over the course of shocks would also shed light on the dynamic benefits of social insurance.

One approach for connecting the empirical evidence to theoretical models that make weaker assumptions may be to limit the set of benefit schedules that one considers. For instance, one could analyze two-parameter systems in which benefits are paid at a constant rate b and then terminated at some date T or systems in which benefits follow a linear path $b_t = \alpha + \beta t$. It may be possible to derive analytic formulas in terms of the elasticities estimated in the empirical literature for the optimal two-parameter system. Given that governments are unlikely to implement highly variable benefits over time, such simplifications of the problem might not be very restrictive from a practical perspective.

4 Challenges for Future Work

Our review of the literature indicates that modern methods of connecting theory to data are quite fruitful, but much remains to be learned before one can draw conclusions about social insurance policy from this work. We conclude by summarizing some of the main outstanding challenges.

First, there is a lack of empirical evidence on key parameters for many programs. In particular, most of the empirical work on selection in insurance markets, and particularly its welfare costs, has been concentrated in private health insurance markets, while most of the work on the optimal level of benefits has focused on unemployment insurance. A natural and presumably quite fruitful direction for further work is to apply the approaches surveyed here to other important areas of social insurance. A particularly important program that has received relatively little empirical attention on either of these questions is disability insurance.

Second, the majority of the research we reviewed has focused on models with perfectly optimizing agents. However, as we argued above, it is difficult to rationalize some social insurance programs such as unemployment insurance in an environment with forward-looking agents because intertemporal consumption smoothing (“self insurance”) is quantitatively a very good substitute for insurance against temporary shocks. An important challenge for future work is to understand the consequences of behavioral economics for optimal insurance. For instance, if large liquidity and consumption smoothing effects of unemployment insurance are driven by the fact that impatient workers postpone job search until they run out of cash, the gains from insurance may be much smaller than existing calculations suggest. Similarly, the optimal tools to correct behavioral biases may be very different from traditional insurance programs, which make state-contingent income transfers.

Third, most methods of connecting theory to data make restrictive assumptions that do not permit a full spectrum of general equilibrium responses. Results on measuring the welfare cost of selection have usually treated the offered contracts as fixed, and focused primarily on the distortions in prices created by selection. Likewise, formulas for optimal social insurance based on reduced-form elasticities all require that wage rates and other prices are unaffected by government policies. In practice, large-scale social insurance policies are likely to induce substantial supply-side responses, making it crucial to develop methods to account for such general equilibrium effects.

Fourth, and relatedly, the literature on optimal social insurance design we have reviewed has tended to focus on relatively specific design questions within the structure of existing programs, such as the optimal level of benefits given the existing time path of benefits or the optimal financing of benefits. It is generally silent on more global “optimal design” questions, such as those that would alter several features of a program simultaneously. One relatively under-studied design question is the choice of instrument used for government intervention. Governments can intervene in private insurance markets in at least three ways: direct public provision (e.g. Medicare, Social Security, and Unemployment Insurance), mandates on firms to provide insurance (e.g. Worker’s Compensation), and direct intervention in or regulation of private insurance markets (e.g. tax subsidies to employer provided health insurance or regulation of the allowable contracts and prices in the individual health insurance market). The optimal choice or combination of these instruments has not been well explored.

Fifth, the literature on motivations for social insurance and the optimal policy response are not yet well integrated. Existing empirical work on adverse selection analyzes selection and its consequences *given the existing public policies*, such as tax subsidies to employer provided health insurance or publicly provided annuities through Social Security. This raises the question of whether selection would exist –and what its welfare consequences would be – in the absence of these public programs or under very different public programs than we currently have. Understanding, both theoretically and empirically, how public insurance programs or policies affect the existence and nature of adverse selection in the residual private markets is therefore an important area for further work. Similarly, in the optimal policy literature, fiscal externalities on private insurers and other parts of the government budget such as tax revenue could significantly reduce the gains from

social insurance. Characterizing optimal public insurance in models that incorporate endogenous private market insurance failures is therefore essential to obtain a more precise understanding of the welfare consequences of social insurance.

Finally, a general conceptual challenge for the approaches we have discussed in this paper is that they are less informative about fundamental policy reforms, such as implementing universal health insurance, than local changes, such as changing copayment rates by 10%. This is because the reduced-form empirical estimates that the literature uses to make quantitative welfare predictions are identified using local variation around the currently observed environment. This makes it difficult to extrapolate out-of-sample to impacts of policies that have not been observed. The questions discussed above of how private markets would function in the absence of public insurance are one example of this problem. More generally, informing policy makers about significant reforms to social insurance programs will require a more global understanding of how these policies affect the economy. These issues are a fundamental challenge not just for the literature on social insurance but for empirical work more generally.

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Figure 1: Social Insurance vs. GDP Per Capita in 1996



Source: International Labour Organization

Note: Social Insurance statistics are from International Labour Organization (2000). Social insurance is defined as total expenditures on social security, disability insurance, unemployment insurance, insurance against work-related injuries, and government provided health insurance. GDP statistics are from the Penn World tables. GDP is measured in PPP-adjusted 1996 US dollars.

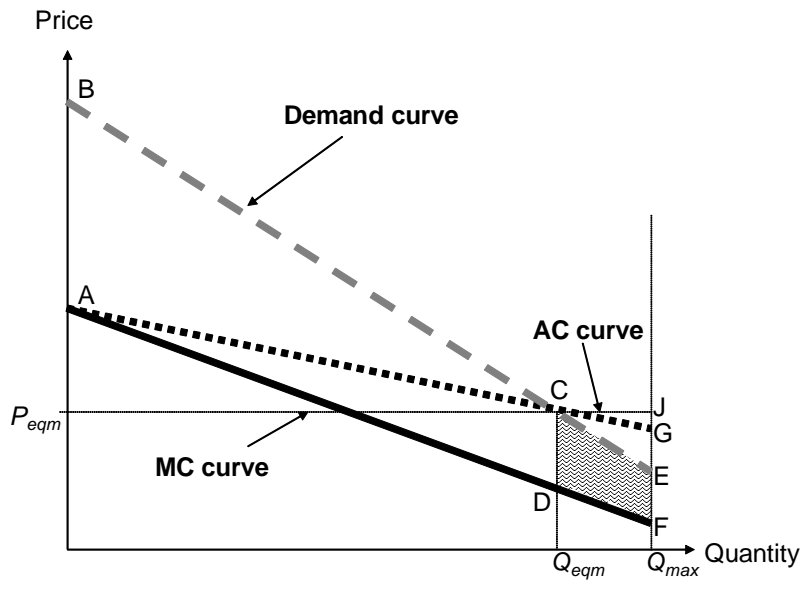


Figure 2: Adverse selection in the textbook setting

Source: Einav and Finkelstein (2011)

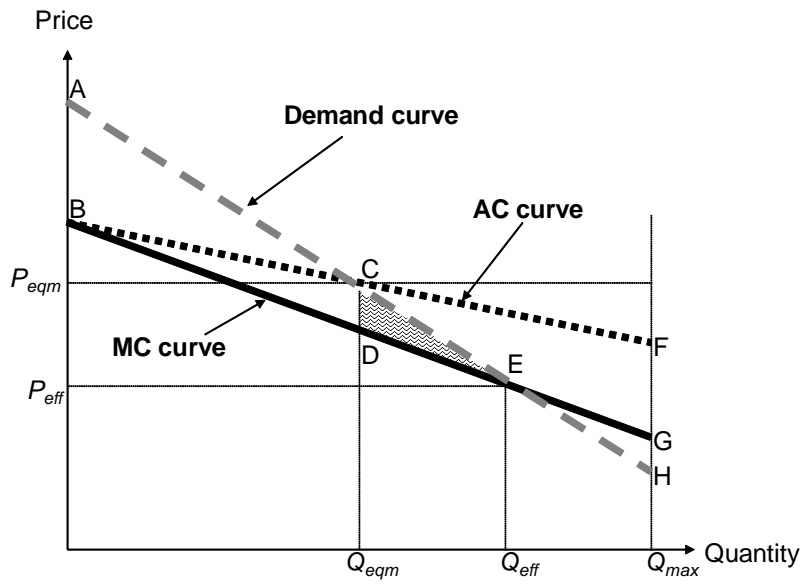


Figure 3: Adverse selection with additional costs of providing insurance

Source: Einav, Finkelstein and Cullen (2010)

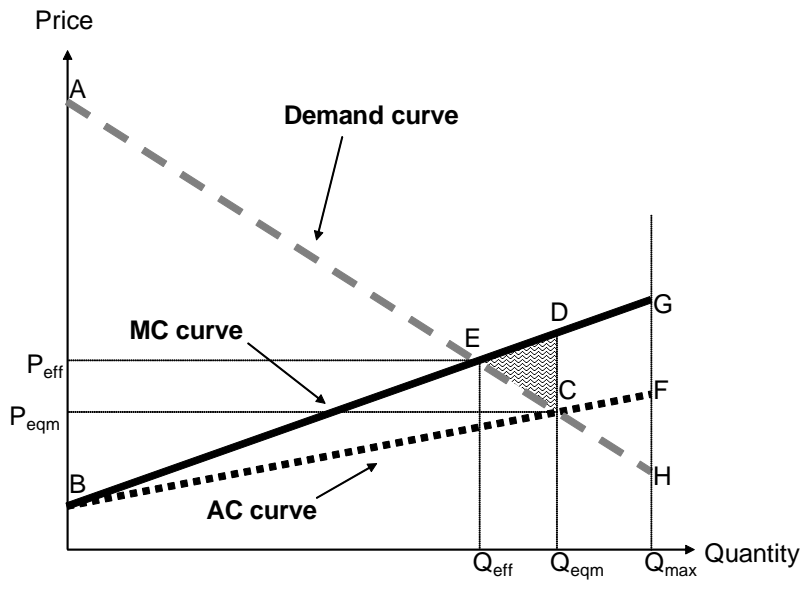


Figure 4: Advantageous Selection

Source: Einav, Finkelstein and Cullen (2010).

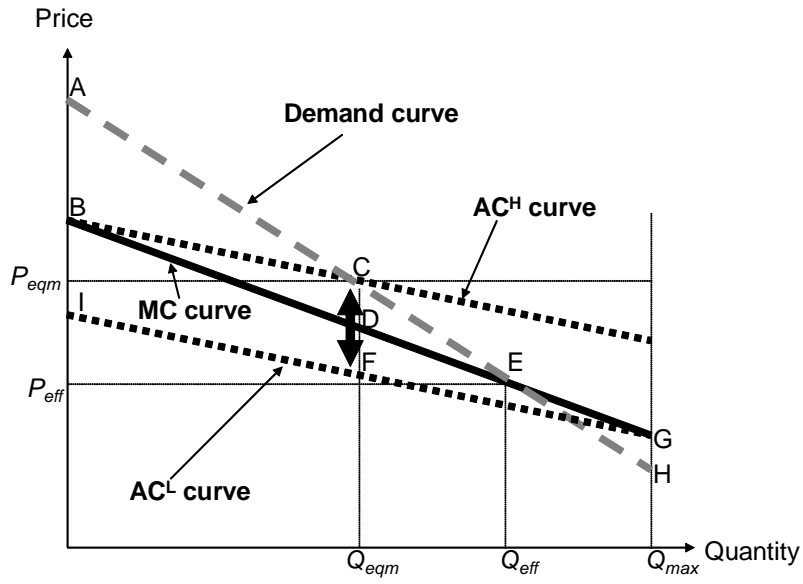


Figure 5: The “positive correlation” test for selection

Source: Einav and Finkeltein (2011).