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Individual Mandates in Insurance Markets with Asymmetrical Information

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Abstract

A Rothschild & Stiglitz (1976) model of a market for insurance is used in order to discuss how asymmetrical information can lead to a decrease in coverage in the market. A simple model of how an individual mandate that requires all individuals in a population to obtain insurance affects the market equilibrium is proposed. I show how such a mandate can give implications for the existence of a equilibrium, through a shift in the average risk in the population. The theoretical effect depends on the combinations of income and risk in the market, and is therefore inconclusive. Finally the Massachusetts health care reform is used as an example of how the models may be applied.

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I. Introduction

This thesis addresses the effect of an individual mandate as a means of preventing problems associated with asymmetrical information in markets for insurance. With "individual mandate", I am referring to a law that requires all individuals in a given population to obtain insurance, together with a punishment mechanism used for enforcing the law. The reason for introducing such a law could be that asymmetrical information between buyers and sellers has induced a market failure and an equilibrium that is not Pareto-optimal. In the case of an insurance market, asymmetrical information can mean that buyers have some private information about their own risk that cannot easily be obtained by the insurer. Such a situation can lead to the phenomenon known as *adverse selection*. I will primarily focus on how the insurance market equilibrium may be affected when an individual mandate is introduced.

1.1 Background: asymmetrical information and individual mandates

An important result from the economics of information is that, when asymmetrical information prevails, it will not be profitable for an insurer to offer all individuals in certain market a contract based on the average risk of the population as a whole. Because of the lower expected benefit of buying an insurance contract for individuals with relatively low risk, they are more likely to remain uninsured than individuals with relatively high-risk (See for example Varian, 1992, pp. 441-471). Eventually, the insurance pool would consist of an adverse selection of the population with a higher-than-average risk level. Hence, the insurer has overestimated the profitability of the market and will have to increase premiums in order to cover the increasing costs. This may in turn force even more low-risk individuals out of the insurance pool. Such a situation embodies the essential problem with adverse selection in insurance markets: a negative spiral caused by asymmetrical information leads to higher costs for buyers and eventually to a decrease in coverage.

Asymmetrical information between buyers and sellers becomes especially critical in situations in which the aggregate welfare costs market failures are high. An example of this could be the system constituting the American health insurance market, where low coverage rates and soaring costs have suggested a need for a fundamental reform (See for example Cutler, 1994 or Diamond, 1992). It is likely that such a reform needs to address more questions than just adverse selection problems associated with the private health insurance market. However, a way of increasing coverage by overcoming problems of asymmetrical information can be seen as an integral part.

A seemingly straightforward way to improve coverage and bring low-risk individuals back into the insurance pool would be for the state to simply make it binding by law for all individuals in the population to obtain insurance, and at the same time either deny access for uninsured individuals, or to introduce a punishment for disobeying this law. A reform based on a similar principle was launched in the United States in 2006, when the state of Massachusetts began implementing a law that would make health insurance mandatory for all individuals over the age of 18 (Hyman, 2007). For the first time in U.S. history, all of a state's residents were required by law to obtain health insurance or be subject to a penalty fee. This individual mandate was only one part of a broader health care reform program aiming to improve the rate of health insurance coverage in the population (Hyman, 2007). The reform also included a set of institutional innovations concerning the health insurance market, with the purpose of lower transaction costs associated with finding and buying an appropriate insurance plan. A third part of the reform was an employer mandate requiring all companies with 11 or more employees to help pay for health insurance (Haislmaier, 2006)[1].

An individual mandate like the one used in the Massachusetts health care reform may at first glance seem like an easy solution for improving insurance coverage in the population. But a problem with this strategy obviously arises if individuals still do not obtain insurance, even after it has been made mandatory. Such a situation can occur for example when there is a sufficiently high degree of uncertainty about the state's

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[1] I will briefly discuss these other parts of the reform in part four of this thesis.

credibility of punishing individuals who do not obtain insurance. Thus, the effectiveness of introducing a penalty fee for noncompliance will be limited by the state's ability to effectively collect this fee and also by the size of the fee itself. In other words, some individuals might prefer paying the price of not following the law to actually purchasing insurance, all depending on their own risk and income level.

In such a situation, the ameliorating effect on the adverse selection problem is likely to be small, and depending on the characteristics of the individuals who still do not buy insurance, the situation may even become worse. Put simply, making something binding by law does not necessarily make it happen. As an example, virtually all U.S. states require their drivers to possess auto insurance, and this mandate is also reinforced with sanctions in the form of penalty fees for uninsured drivers. Still, around 14% of the motorists in the U.S. remain uninsured (Hyman 2007).

The outcome of the Massachusetts health care reform can be regarded as very important due to its potential to influence future reform plans, possibly even on a national level. Given that an individual mandate plays an important role in the reform, inquiries about the effectiveness of such arrangements can also be regarded as important.

1.2 Purpose

The purpose of this thesis is to (1) use a theoretical model of the insurance market to show what types of equilibria that can occur, and how asymmetrical information affect these equilibria, (2) to analyze the potential effects of an individual mandate on the market equilibrium, and finally (3) to use the case of the Massachusetts health care reform in order to illustrate the results. Due to limitations in the availability of reliable first-hand data on this subject and the characteristics of the chosen topic, I will chiefly rely on a theoretical analysis.

1.3 Thesis overview

Part two of the thesis begins with a short discussion of problems associated with asymmetrical information. It is supposed to serve as an introduction the theories used in the later analysis. I will also discuss different kinds of proposed solutions to the problem, as well as different equilibrium concepts. Part two is also intended to be an overview of past research on the subject. In part three I will go into more detail of how adverse selection can be illustrated in the well-known Rothschild & Stiglitz (1976) model, and how the connection between an individual mandate and the existence of equilibrium can be modeled. In part four I will use the Massachusetts health care reform as an example of how the theories in part three can be applied. Part five concludes. This is not intended to be a thesis in healthcare economics, but rather in the economics of information and strategic interaction; I will therefore not go into depth with policy issues regarding health care systems in general.

II. Theory of asymmetrical information and adverse selection

This section will outline the underlying theories of asymmetrical information and adverse selection on which the further analysis is built. I will present the original formulations of the problem as well as some proposed equilibrium concepts. In order to understand the potential effects of an individual mandate on the market equilibrium, we first have to be familiar with both how adverse selection can occur and how equilibrium in the insurance market takes form. We will see that the models can be categorized into two distinct groups depending on whether it is the informed or the uninformed part that moves first. However, models in which the uninformed part moves first will be more applicable in our particular case.

2.1 Overview of the problem of adverse selection

The problem of adverse selection has been known for a long time. An early example is a phenomenon known as "Gresham's Law" (Kreps, 1990, p. 625), which can occur in an economy using gold coins as a medium of exchange. In order to understand how this phenomenon occurs, we assume that each individual coin can be shaved of a little bit of gold without it being easily detected. Also assume that the shaved coin still can be used for the purchase of goods and services at the same degree as the unshaved ones. This means that the shaved coin will be worth just as much in terms of other goods, even though the total value of the gold itself has obviously reduced (given that all other factors remain the same).

When people realize that they are in possession of a coin that has not yet been shaved, they will be less willing to use it for market transactions and instead keep it. The reason is obviously that the gold of the unshaved coins is worth more than the gold of the shaved coins, even though the value of the two different coins in terms of goods is the same. In money-market terms, the shaved coins are overvalued while the unshaved coins are undervalued. Eventually, when more and more individuals act in this way, all coins

circulating in the economy will be shaved ones. The mechanism creating such a situation has been summarized as "bad money drives out good" (see for example Rolnick & Weber, 1986).

A fundamental work on the theory of adverse selection is George Akerlof's (1970) classic paper "The Market for 'Lemons': Quality, Uncertainty and the Market Mechanism". Akerlof used the market for used cars in order to illustrate how asymmetrical information between buyers and sellers induces a market failure that drives high quality cars off the market. The object up for sale can be of two different levels of quality, not fully observable to the buyer—only the seller has information about whether the car is of high or low quality (i.e. whether the car is a "peach" or a "lemon"). The buyer will only be prepared to pay a price between his valuation of a high and low quality car. This valuation is in turn based on the probability that the particular object will be of either quality level (which in turn depends on the distribution of high and low quality cars in the market). If this weighted price is below the seller's valuation of a high quality car, he will only be willing to supply cars of low quality. When fewer high quality cars are supplied, the probability that any randomly chosen object will be of high quality decreases, and the buyers will adjust the price they are willing to pay accordingly. Eventually, high quality cars will be driven off the market so that it will consist of only low quality cars.

If perfect information prevailed, the problem of adverse selection would not occur; high quality objects would be sold for a higher equilibrium price and low quality objects would be sold for a lower equilibrium price. Similarly, if both seller and buyer were completely unaware of the objects' respective quality, the price would just be set according to the expected value of the car for both seller and buyer and the market would not necessarily break down in the same way as predicted when asymmetrical information is present. In other words, the acceptance price for the buyer and seller would just be a weighted average of their respective valuation of the different types. This underlines the important point made by Akerlof, that adverse selection stems from asymmetric

information rather than the absence of information. (For a thorough treatment of Akerlof's model, see Kreps [1990], for example.)

The model can also be applied in the case of an insurance market. The seller of insurance lacks complete information about the buyer's particular risk of accident. People with a relatively high risk of an accident will find the insurance offer a better deal than people with a relatively low risk of accident. This will lead to a situation in which the premium is based on the average risk of the population as a whole, while the actual insurance pool consists of an adverse selection of the population. Eventually, the insurance company will have to raise premiums to reflect the new average risk, which makes the individual "on the margin" of just buying an insurance to drop out of the insurance pool. In the context of the American health insurance market, Akerlof offered a theoretical reason for the lack of insurance coverage among the elderly prior to the Medicare[2] program: because the premium was set to reflect the average risk among the elderly, only the ones with higher-than-average risk bought insurance (Browne, 1992).

2.2 Equilibrium in markets with asymmetrical information: signaling

As indicated above, proposed solutions to the problem of adverse selection have been formulated both as models in which the informed part (the buyer of insurance) and the uninformed part (the seller for insurance) moves first. In the market for insurance, however, solutions in which the uninformed part moves first may seem like the more realistic alternative. After all, in the typical situation the insurer offers a contract and the buyer chose whether he or she will accept or reject the offer. Nevertheless, the other situation can provide insights also in the case of insurance and should therefore not be dismissed rashly.

Spence (1973) proposed a solution in which the informed part moves first. This solution concept has become known as *signaling*. The idea behind signaling is to give the part

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[2] Medicare is a U.S. health insurance program that provides health insurance coverage, generally for people of the age of 65 or over.

with private information an incentive to self-identify. Spence did not directly address the question of insurance markets, but was instead writing in the context of an employment market in which the potential employees are assumed to be of two different characteristic groups, each with different levels of productivity. Spence argued that high-ability individuals could distinguish themselves from low-ability ones through their choice of education. Before entering the employment market, each individual chooses a number of years to attend school in order to increase his or her productivity. For every level of education, a high-ability worker is worth more to the firm than a low-ability worker with the same education. The low-ability individuals have an incentive to try to appear as a high-ability individual in order to receive a better employment contract from the firm. While the firm cannot observe whether the potential employee is a high or low ability individual, it can observe his or her choice of years of schooling, and make interferences about the individual's capacity from that information (Kreps, 1990, pp. 625-654).

This model has two potential types of equilibria; the workers can either choose the same level of education—pooling equilibrium—or different levels of education—separating equilibrium. Assuming that it is more costly (in terms of effort) for the low-ability workers to achieve additional education, the solution for the high-ability workers is to choose a level of education that would not be desirable for the low-ability worker, and thereby distinguish himself as a high-ability worker. Put differently, the high-ability individual can exploit the fact that each additional year of schooling is more "painful" to the low-ability individual. The number of years chosen by the high-ability worker is the "signal" sent to the employer, making it possible for the latter to distinguish the potential employee from the lower-ability workers.

It is worth pointing out that in the Spence model, the number of years in school are not necessarily only beneficial in the sense that they might increase the potential employee's productivity, but also in that they serve as a signal to the employer; low productivity individuals are assumed to receive a higher degree of disutility from additional years of schooling. In game theoretic terms, this may be interpreted as a costly "war of attrition"

in which cost in terms of resources (effort) differs between the two different types of individuals (Powell, 1999).

In the context of a market for insurance, the insurance company usually makes the "first move"—hence, the Spence model may not seem as relevant. However, as we will see in section three, the important result is that that an equilibrium contract must lie just where the indifference curve of the low ability individual crosses the indifference curve of the high-ability worker and the wage line of the high ability worker (fair-odds line in the case of insurance) is indeed important.

2.3 Equilibrium in markets with asymmetric information: screening

Rothschild and Stiglitz (1976) proposed a rather different model of equilibrium in a market with adverse selection. They assumed a market for insurance in which the buyers have private information about their own probability of accident. Contrary to the case of Spence's signaling model, the uninformed part (in this particular case, the insurance company) moves first, and can offer the buyer different insurance contracts with different characteristics regarding premiums, deductibles and other benefits. As we will see in section three, all individuals are assumed to have the same state-independent, strictly concave and increasing von Neumann-Morgenstern utility function (for a treatment of von Neumann-Morgenstern utility, see for example Varian, 1992, pp. 172-194). Each individual makes a choice of which contract to purchase, based on his preferences and his private information about his own risk (i.e. his own probability of accident) (Browne, 1992).

Similarly to what we have seen in previous models, the problem of adverse selection arises, once again, when relatively healthy individuals choose not to buy insurance to the same extent as relatively risky individuals. If the insurance company continues offering the same contract, without knowing which customer is of either type, more people with a lower-than-average risk will drop out of the insurance pool and the insurer have to finance the increase in costs by higher premiums. This is exactly what we would expect

from the mechanisms behind the Akerlof model. However, Rothschild and Stiglitz offer a solution for the insurer. By offering a contract that is just on the margin of being preferred by the high-risk individual, the insurer can force the buyers to self-select the contract that is intended for them. In a way, this is essentially very similar to the case of signaling; in order to find the Nash equilibrium, we have to find a contract that gives no one an incentive to deviate from his or her strategy.

As we will see in part three, there is only one possible equilibrium in the Rothschild-Stiglitz model, and that is a separating equilibrium in which the high and low risk customers buy different insurance contracts (Browne, 1992). High-risk individuals are separated from low-risk individuals because their marginal benefit of extra coverage is greater (Riley, 1979). Another important result of the Rothschild-Stiglitz model is that a competitive insurance market can have no equilibrium at all. I will leave the more technical details of the Rothschild-Stiglitz model for part three, and discuss how an individual mandate can affect this existence of equilibrium.

2.4 Additional equilibrium concepts

Contributions to the Rothschild-Stiglitz model in cases in which there is an absence of equilibrium has been made by Riley (1979) and Wilson (1977). In the Rothschild-Stiglitz model, it is implicit in the concept of the equilibrium that if a new contract is added to the menu, nothing changes; the firms already offering contracts do not react in any way that would make profitable deviations unprofitable and restore equilibrium (Kreps, 1990, pp. 625-654). Riley (1979), suggested that there exists something called a *reactive equilibrium*. This is an equilibrium in which it must be possible for a firm to add a contract to the menu that will be strictly profitable and will not become strictly unprofitable if other firms add even more contracts.

Furthermore, the pooling equilibrium is broken when a new contract that only attracts low-risk individuals is added to the menu, and at the same time, the pooling contract remains to attract high-risk individuals. The new contract will be profitable as long as the

original pooling contract remains, because it will only be attractive to low-risk individuals. According to Riley, reactive equilibria always exist, and they correspond to the separating equilibrium found in the Rothschild-Stiglitz context (Kreps, 1990).

Contrary to the Rothschild-Stiglitz model, Wilson (1977) assumed a model in which firms have the foresight not to offer contracts that are profitable in the short run but will become unprofitable when other contracts are removed from the market. The resulting equilibrium is called *anticipatory equilibrium* (also known as a *Wilson E2* equilibrium [Browne, 1992]) and requires that it must be possible for a firm to add a contract that is strictly profitable and that does not become strictly unprofitable when unprofitable contracts from the original menu of contracts are removed by other firms (Kreps, 1990). This assumption makes it possible for the resulting equilibrium to be a pooling equilibrium, a result not possible in the Rothschild-Stiglitz model. A pooling equilibrium can occur when the costs of cross subsidization are less than the transaction costs of achieving a separating equilibrium (Browne, 1992).

Yet another model of equilibrium in an insurance market with asymmetrical information has been formulated by Miyazaki (1977). In this model, insurance companies are allowed to make losses on individual contracts as long as they break even on their total business. The equilibrium of the model will be a separating equilibrium allowing for a cross subsidization with wealth transfer from low to high-risk individuals (Browne, 1992). Intuitively, this means that the different risk types will buy different contracts and that the insurer will make losses on the contracts sold to high-risk individuals but earn profits on the contracts sold to low-risk individuals.

2.5 Appropriateness of the models in regarding health insurance

The major difference between the insurance market equilibria of Rothschild-Stiglitz, Riley and Wilson lies in their assumptions about the firms' possibilities to add and withdraw contracts offered on the market. If the insurance market is characterized by a strong regulatory mechanism that prohibits firms from withdrawing contracts once they

are offered, the assumptions of the Riley model might seem more plausible. However, if this regulatory mechanism instead works in a way that is more restrictive to the addition of contracts that may make existing contracts unprofitable, then the assumptions of the Wilson model may seem more appropriate (Kreps, 1990, pp. 625-654).

Common to all these models of market equilibrium is that the low risk individuals purchase less insurance than they would in a market free of asymmetrical information. However, in the separating equilibrium of the Rothschild-Stiglitz model, both the contracts purchased by the high and low risk individuals break even individually, while the other models suggests that there is an across risk class subsidization. As we have seen, this subsidization can either be in the form of a pooling (Wilson) or a separating (Miyazaki) equilibrium. In the former case, the different individuals buy the same contract, but the low risk individuals subsidize the high risk individuals, while in the latter case the earnings from the contracts purchased by the low risk individuals subsidizes the contracts purchased by the high risks. In other words, the subsidization differs from across individuals to across policies (Browne, 1992).

As noted earlier, adverse selection has the potential of making the free-market outcome inefficient in health insurance markets. Efficiency generally requires that different risk types end up with different contracts and that gains from contracts designed for low-risk individuals are used to subsidize contracts for high-risk individuals. When adverse selection enters the picture, such an equilibrium cannot be sustained in an unregulated market, because of the simple fact that firms would not sell loss-making contracts. Since high-risk individuals know this, they will have an incentive to try to "disguise" as low-risk individuals (analogous to the way low-ability workers tries to disguise as high-ability workers by their choice of education in the Spence signaling model). Hence, institutional arrangements designed to overcome adverse selection must also take into consideration that there can be no cross-subsidization between different contracts in a free market environment (Neudeck & Pdczeck, 1996).

Another important institutional characteristic of the private health insurance market model is that when an individual "chooses a contract", he in fact applies for a particular health insurance plan. This means that the insurance company may reject his application, and can be expected to do so whenever the contract is expected to be loss making. Thus, the individual will only reveal himself if the contract offered is not loss-making when chosen by high-risk individuals. (Neudeck & Pdczeck, 1996) Because the individual will only apply for a contracts intended for his type if he expects the application to be accepted, he has an incentive to imitate the behavior of the individuals in the other risk group (Grossman, 1979).

None of the discussed models can be said to be objectively better than the other. They all provide meaningful insights about how the insurance market works under slightly different circumstances. However, in order to choose an appropriate model for analyzing the effect of an individual mandate, we also have to pay attention to the simplicity of the model. In the upcoming section I will therefore focus on the most basic Rothschild & Stiglitz (1976) model, discuss how the existence of how a separating equilibrium depends on the average risk, and in turn, how an individual mandate can affect the average risk line. Nonetheless, I will briefly use the Wilson (1977) model to discuss how the results would play out in a pooling equilibrium.

III. A model of equilibrium in the insurance market

In the following section, the more technical part of the analysis will be carried out. Initially, I will present the underlying model of the insurance market on which the analysis is built: a Rothschild-Stiglitz (1976) insurance market model[3]. I will go into more detail with the results of the model already discussed in part two, mainly to examine which type of equilibrium that are possible. Thereafter, I will consider the case of an individual mandate and analyze the potential effects on the market equilibrium when the characteristics of the insurance buyers can vary in both risk and income. The main purpose is to illustrate the connection between the individual mandate and the average risk in the population, and how this average risk can affect the existence of a separating equilibrium.

3.1 A Rothschild-Stiglitz model of an insurance market with asymmetrical information

We start by considering a Rothschild-Stiglitz (1976) model of a market for insurance. Initially, we are assuming that each individual in the population has an income of size W and risks losing L if an accident occurs. The wealth-loss may seem more suitable when discussing property-insurance, but in the context of health insurance we can think of L as the costs of medical treatment. In order to insure himself from the loss associated with such an accident, the individual can buy an insurance contract described by the vector α $= (\alpha_1, \alpha_2')$. The contract is purchased for a premium α_1 and pays α_2' in the case of an accident.

After the individual has made his decision of whether to buy insurance or not and how much insurance to buy, two different "states of the world" can occur: "no accident" and "accident". Naturally, the probability that any of the states of the world will occur

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[3] For a review, see for example Mas-Colell et al., 1995, pp. 436-507

depends on the individuals' respective risk level (in the case of the health insurance market, this may be interpreted as the health status of the individual). Letting $\alpha_2 = \alpha_2' - \alpha_1$ be the net effect on income from a contract, the individual's income will be *(W, W – L)* in the two different states of the world respectively if he chooses not to purchase any insurance, and *(W - α_1, W – L + α_2)* if he choose to purchase an insurance contract.

Next, we assume that individuals and insurance companies can buy and sell insurance contracts on the market. By purchasing insurance, each individual seeks to alter his endowment of income between the two states of the world. Let $p \in [0,1]$ denote the probability that the "accident" state will occur for respective individual, and let W_1 and W_2 be the wealth in the "no accident" and "accident" states respectively. Further, we let *U( )* represent the utility of money function. We are assuming that all individuals have identical Von Neumann-Morgenstern utility functions, and that the utility functions are strictly concave and increasing. By the *expected utility theorem* (for a discussion of the expected utility theorem, see for example Varian, 1992, pp. 172-194), we obtain the following expected utility function:

(1) $$V(p, W_1, W_2) = (1 - p)U(W_1) + pU(W_2)$$

The individual will chose the contract that maximizes *V(p, α)*. It follows that the individual will buy positive amounts of insurance only if *V(p, α)* ≥ *V(p, 0)* = *V(p, W, W-L)*. Simply, that the utility of the insurance contract is greater or equal than the individual's utility without the contract. We are also assuming that individuals are risk-averse, or in other words that *V(p, α)* is quasi-concave (U'' < 0). The only thing that is assumed to differ between individuals is their risk of accident.

On the supply-side of the insurance market, we are assuming risk-neutral firms. This means that the firms will consider only the expected profit from selling an insurance contract. In other words, they will not consider the specific risks associated with selling particular contracts. It follows from the conditions facing the consumer, and the definitions above, that the expected profit for the insurance provider will be

(2) $$\pi(p,\alpha) = (1-p)\alpha_1 - p\alpha_2 = \alpha_1 - p(\alpha_1 + \alpha_2)$$

Any contract demanded by the consumers and expected to be profitable by the insurance company will be supplied. In the Rothschild-Stiglitz model, the equilibrium in a competitive insurance market is of Cournot-Nash type, consisting of a set of contracts, such that no contract has negative expected profits, and that no contract outside the equilibrium set has non-negative expected profits (Rothschild-Stiglitz, 1976). In other words, in equilibrium, neither buyer nor seller has any incentive to deviate from his or her strategy. This follows from the definition of a Nash Equilbrium (see for example Gibbons, 1992 or Myerson, 1978)

In the context of an insurance market, the analogous situation to the "lemons' market" of Akerlof (1970) occurs when the buyer and seller of insurance contracts have asymmetrical information about the probability that an accident will occur. In other words, the buyer of insurance has some private information about his own probability p of an accident to happen. As mentioned earlier, a crucial assumption is that each individual knows his or her own p while the insurance provider do not. This means that the insurance company cannot discriminate among its customers by picking the only the individuals with low risk.

The assumption that each individual knows his own probability of accident may seem strong in this particular context. And indeed, it might be wise to view this assumption with a bit of skepticism. How well do individuals really know their own risk level? Some studies have questioned the informed part's ability to accurately estimate his or her own risk (see for example Pauly, 1984 and Pauly, 1985). However, as far as the Rothschild-Stiglitz model goes, it is sufficient to assume that the agent has a *better estimation* of his own probability p than the principal does. Moreover, in the context of a health insurance market, it has been argued that the individual, with help from his physician, in fact has a

better estimate of his own health status than the insurer does[4] (Neudeck & Podczeck, 1996). Even though the insurance buyer's information surplus prevents the insurance company from discriminating among customers, the firm can use the customers' market behavior in order to make inferences about his particular characteristics. However, in this model, the insurer cannot get much valuable information about the customer only by observing what type of insurance contract he or she buys; if the customer ends up with the "wrong" kind of insurance policy from the insurers point of view (i.e. a risky individual purchases an insurance contract intended for individuals with relatively low risk), it is already too late to do something about it (Rothschild-Stiglitz, 1976). Obviously, the insurance company has to find another way to overcome the lack of information.

Before we look at how the insurance company can solve the situation with different types of customers, we consider a market where all customers have the same risk level, implying that there will be no problems of adverse selection. We note that point E in *figure 1* represents an example of the initial endowment of income between the two states of the world for an uninsured individual $(W_1^{\,o},\ W_2^{\,o})$. Note that the x-axis indicates the wealth in the case of no accident while the y-axis measures wealth in the accident state of the world. Because we are assuming that the individual will not over-insure himself, point E is located such that the individual's wealth is lesser in the case that an accident occurs than in the case that one does not occurs. The straight line EF represents the set of policies with zero expected profit for the insurance company, satisfying

(3) $\alpha_1(1-p) = \alpha_2 p$

This line is referred to as the "fair odds line". Equilibrium is denoted by α^* in *figure 1*, which is the contract maximizing the individual's utility $V(p,\ \alpha)$ and has zero expected profit. Due to the fact that the individual is risk-averse, equilibrium will occur at the intersection between the line equating income in the state of accident and no accident and the fair odds line (Rothschild & Stiglitz, 1976). We can easily visualize the result of

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[4] In other insurance markets, this relationship might, however, not be the case

Mossin (1968); if the insurance company offers actuarially fair premiums, the optimal strategy for the customer is to buy full insurance.
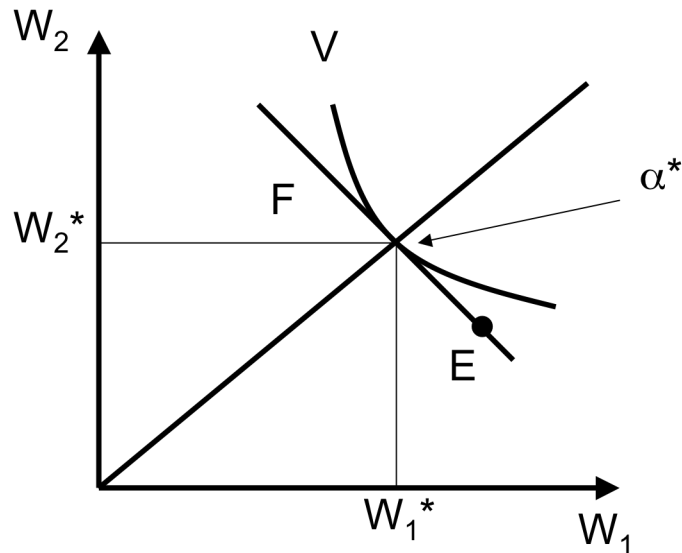

Figure 1 (After Rothschild & Stiglitz, 1976).

We will now move on to look at the problems associated with asymmetrical information and adverse selection discussed in part two. As noted, the core of the problem is that if premiums are set at actuarially fair rates based on the whole population, relatively healthy individuals will not buy to the same extent as relatively sick individuals. To show this, we are assuming that there are two different types of individuals, low-risk individuals with probability p^L and high-risk individuals with probability p^H, such that $p^H > p^L$. The fraction of high-risk individuals in the market is λ. Hence the average accident probability is $p = \lambda p^H + (1-\lambda) p^L$.

There are two possible candidate types of market equilibria; either both types purchase the same contract (pooling) or they purchase different (separating). However, as we will see, a central result derived from the Rothschild-Stiglitz (1976) model is that there cannot be a pooling equilibrium. Instead, in equilibrium, the high and low risk individuals must settle for different contracts. If the insurance company offers an average contract, the low-risk individuals will buy fewer units of coverage while the high-risk individuals will buy excess coverage so that the insurance company will loose money, which means that

profitability condition of the equilibrium will not hold. As a solution, the insurance company offers restricted policies in order to force the two different types of individuals to reveal their types by their choice of policy.

In *figure 2*, we can see that the contract that is meant for the low-risk individuals lies on the line *EL* while the high-risk individuals' contract lies on the line *EH*. *EL* and *EH* can be interpreted as the two types of individuals' respective fair odds lines. The difference in slope between the two fair odds lines is obviously due to the difference in probability between the two groups. The contract denoted by α^H in the figure gives full insurance and it is the contract preferred by the high-risk individual. This contract also corresponds to the full coverage equilibrium contract α^* in figure 1. Similarly, the contract β is preferred by the low-risk individual and gives full insurance. Even though both contracts give full insurance, they obviously have to differ in some aspects because of the difference in probability between the two groups.

From the figure, we can easily see that the high-risk individual has to pay a higher premium for full coverage; his wealth is in both states of the world smaller than the low-risk individual's. A problem arises when also the high-risk individuals will prefer contract β to α^H, due to the higher consumption possibilities it offers. In other words, they essentially get the same coverage for a smaller cost and can spend the remaining wealth on other goods and in that way increase utility. We know this because the contract β lies above the high-risk individual's indifference curve through α^H. Because the high risk individual clearly can be made better off by deviating and choose contract β instead of α^H, we know that (α^H, β) cannot be an equilibrium.

Figure 2 (After Rothschild & Stiglitz, 1976).

The solution proposed by Rothschild and Stiglitz is for the insurance company to offer two contracts that are *incentive compatible*, meaning that none of the two types have any incentive to deviate. It can be visualized in the following way: a necessary condition for a separating equilibrium is that the insurance company offers the low-risk individual a contract that does not attract the high-risk individuals, i.e. it must not be more attractive to the high-risk individuals than α^H. In terms of the figure, it cannot lie above the high-risk individuals indifference curve through α^H. From figure 2, we can easily see that such a condition will be met at the intersection between the line *EL* and the high-risk individual's indifference curve U^H. This constitutes the separating equilibrium, which is the only possible equilibrium contract for the low-risk individual in this model. This contract is denoted by α^L in figure 2. We realize that α^L is a Nash-equilibrium, because none of the individuals can be made better off by choosing another contract. We have now visualized the first result of Rothschild-Stiglitz (1976); the only possible equilibrium is a separating equilibrium such as (α^H, α^L) in figure 2. Note that the low-risk individual's indifference curve will always be steeper than the high-risk individual's at the point of intersection.

So far as the Rothschild-Stiglitz model goes, there cannot be a pooling equilibrium. The reason for this is that it simply will not be profitable to offer the same kind of contract to both types of customers. Assume that α^p is a potential pooling equilibrium and p^m is the probability associated with the insurance company's inference about the average risk in the market. Then $\pi(p, \alpha^p) < 0$ would imply negative profits for the insurer so that the profitability condition will not be met. Similarly, if $\pi(p, \alpha^p) > 0$, there will be a contract that offers strictly more consumption than α^p, which will induce the consumers to buy that contract instead. In both cases, one of the parts, either buyer or seller, can clearly make a profitable deviation from his strategy, so α^p cannot be an equilibrium (Rothschild & Stiglitz, 1976).

Also the other central result of the Rothschild-Stiglitz model mentioned in section two—a competitive insurance market may have no equilibrium at all—can be realized through an examination of the figure. Consider a situation in which contract γ in figure 2 is added to the menu of contracts. The contract γ lies above both the high and low risk individuals' indifference curves through α^L and will hence be preferred to (α^H, α^L) for both groups so that (α^H, α^L) will no longer be an equilibrium. However, γ will only be offered if it is profitable, that is, if the number of high-risk individuals in the market is sufficiently low compared to the number of low-risk individuals. The composition of types in the market can be shown using market fair odds lines. Examples of such lines are *EF* and *EF'* in figure 2. The slope of the market fair odds lines depends on the distribution of the different types of individuals in the population and will obviously increase if the ratio of low-risk individuals to high-risk individuals in the market increases. In case the market fair-odds line is given by *EF* in figure 2, γ will yield negative profit, and will not be offered. If the number of low risk-individuals increases so that the market fair-odds line changes to *EF'*, γ will be profitable and there will be no equilibrium in the market (we have already seen that (α^H, α^L) is the only possible equilibrium). Rothschild and Stiglitz (1976) characterize two conditions under which an equilibrium will not exist. If there is (1) relatively few high-risk individuals that have to be subsidized or when (2) the probability of accident of the two groups are not too different, the costs of pooling to the

low-risk individuals will be low and there will be no equilibrium. Similarly, if the costs of separating are high, there will also not be any equilibrium.

Hence the two main conclusions from Rothschild & Stiglitz (1976) can be summarized as follows:

(a)   The only possible equilibrium is a separating equilibrium. (Such as (α^H, α^L) in figure 2.)

(b)   The competitive insurance market may have no equilibrium at all.

3.2 Equilibrium with individual mandate

Now when we have become familiar with the mechanisms behind the Rothschild-Stiglitz model of the insurance market, we move on to consider an insurance market in which insurance has been made mandatory, but where some portion of the population still does not purchase insurance. As stated in section *3.1,* one conclusion from Rothschild & Stiglitz (1976) is that the competitive insurance market may have no equilibrium at all. As we saw, his might happen when the ratio of low-risk to high-risk individuals in the market is high enough to allow for an equilibrium-breaking contract γ to be profitable. Ignoring the contributions of Wilson (1977) for the moment, what effect can an individual mandate have on the profitability of an equilibrium-breaking contract and the existence of an equilibrium in the health insurance market?

Assume the state introduces a mandate, associated with a penalty fee F for noncompliance. However, there is a certain degree of uncertainty about whether or not the punishment will be carried out. In other words, how likely "cheaters" will be detected. Let $q \in [0,1]$ represent the probability that someone who does not purchase insurance will be detected and forced to pay the penalty fee. In other words, q represents the state's effectiveness in carrying out the punishment. We will make the strong assumption that individuals have a reasonable accurate perception of q. Several objections can be made against this assumption. Individuals may overestimate or

underestimate certain risks depending on the situation. An anecdotal example of this would be a person who is very afraid of the risk of a plane crash, but has no problem driving to the airport, even though the risk of a traffic accident may be significantly higher than the risk of a plane crash. However, this assumption will be necessary for the further analysis.

Moreover, we also assume that q is the same for all individuals in the market and that q cannot be affected by the actions of the buyers of insurance. It follows that qF represents the expected loss incurred only by the state's punishment mechanism alone. Even though qF is not *directly* depending each individuals own risk level p, or to the wealth level W, we will see that the changes in the size of qF will lead to different effects regarding insurance coverage in the population.

After the mandate has been introduced, each individual has to not only take his or her own risk level p into consideration, but also the risk of getting caught and being forced to pay F, when making a decision of whether to buy insurance or not. If the F is not set high enough, low-risk individuals will find the expected utility from not buying insurance greater than the expected utility from buying insurance and end up uninsured. This implies that the individuals that are willing to take the risk of not buying insurance will not be random in terms of their individual risk level.

In order to illustrate the effect of an individual mandate on the rate of coverage in the market in a simple way, we assume that all individuals can be ordered in a two-dimensional manner, with respect to both their individual risk p and income level W. An example of such an arrangement is visualized in *figure 3*, with income on the x-axis and individual risk on the y-axis. Individuals with a very high risk will find the insurance offer appealing almost regardless of their income; the expected loss is high enough to induce them to purchase insurance. These individuals will be located in the top part of the figure. Similarly, we assume that the higher W an individual has, the more inclined he or she will be to purchase insurance. This implies that we have to assume that the demand for insurance is increasing in W, i.e. that insurance contracts are normal goods.

This means that there exists a "cut-off line" separating the buyers from the non-buyers in the market. This line may be represented by the diagonal in figure 3, in which the group buying insurance consists of area B while the non-buyers are represented by area A. Obviously, the areas do not have to be equal, nor does the cut-off "line" necessarily have to look like a line. But for the sake of simplicity, we let figure 3 represent a very straightforward case in which A and B initially have the same size, and the cut-off line equals the diagonal. Note that when the penalty fee F varies in size, the areas A and B adjust accordingly; when the penalty fee increases, more people will be discouraged from trying to cheat the system and B will increase.
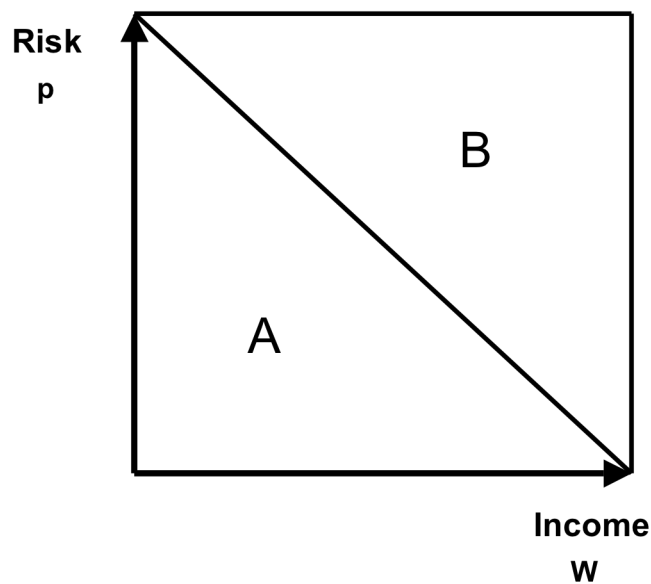

Risk

p

B

A

Income

w

Figure 3.

Given the assumptions above, variations in q and F have the potential to affect the existence of a separating equilibrium such as (α^H, α^L) in figure 2. This happens through a shift in the market fair odds that makes an equilibrium-breaking contract profitable. Starting from a situation in which there is at least some individuals in each of A and B of figure 3, a small increase in F will bring the individuals just on the margin of buying insurance into the pool of insured people. Area B will increase at the expense of area A.

When this happens, the average risk level in the population, on which the insurer bases his decision on whether a particular contract is profitable or not, will decrease. To realize this, we examine the equation for the slope of the average fair odds line and see that it is simply the average probability of no accident over the average probability of accident in the market:

(4) $$\frac{(1-p)}{p}$$

Intuitively, from the reasoning behind figure, the individuals on the margin of buying insurance have a low risk relative to group already purchasing insurance. Hence their contribution to the average risk will be a decrease in the average p. However, the effect is not entirely unambiguous. Depending on the shape of the cut-off line, the effect on p may be significantly reduced. For example, the "marginal group" (the group of individuals who enter the insured population due to a small raise in F), may have decided to purchase insurance due to an effect relating to their income rather than their individual risk. In such a situation, the market insurance line may remain nearly unchanged, and an equilibrium-breaking contract is still not profitable.

The fact that the cut off-line between buyers and non-buyers is affected by the expected loss from not buying insurance suggests that a change in q also would have the potential of altering the proportions of A and B, increase the slope of the market fair-odds line and thereby affect the existence of an equilibrium-breaking contract. Because q indicates how likely a person that does not obtain insurance will be detected, it is possible that the *method* by which the state tries to enforce the law has an effect on its size. For example, a system with random controls[5] might not have the same level of effectiveness as using some kind tax-law solution.

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[5] In the case of American traffic insurance, "random controls" would be a close description of how the control mechanism works; people who are inspected by the police have to show proof of insurance.

We have now seen that there is a possibility that a system based on a mandate with penalty fee can have an effect on the existence of a equilibrium-breaking contract. By making individuals with different combinations of income and risk-level enter and exit the insurance pool, the market fair-odds line adjust accordingly and affects the profitability of such a contract.

However, an important caveat must also be added to this observation. In this model, the market fair-odds line depends on the *relative* distribution of the different types of individuals in the population. Therefore, it may be possible that the market fair-odds line remains unchanged even though both F and q varies in size. First of all, simultaneous changes in F and q (which can be interpreted as if the state would change the level of the penalty fee at the same time as they change to a new way of collecting the fee) may of course cancel out each other and leave the market fair-odds line unchanged. Furthermore, as we have already noted, the shape of the cut-off line can vary considerably depending on the underlying characteristics of all individuals, not only the ones that are purchasing insurance. There is in other words a possibility that the changes that have come as a result in a change of both q and F affect groups A and B in a way that does not change the average probability and the market fair-odds line. It is in other words fair to say that under the assumptions above, the effect of an individual mandate on the existence of a Rothschild-Stiglitz separating equilibrium is in theory inconclusive.

3.3 The Possibility of Pooling Equilibria

If individual mandate has the potential to affect the existence of a separating equilibrium, would a pooling equilibrium be possible? With only the assumptions of Rothschild and Stiglitz (1976), we have seen that there cannot be a pooling equilibrium. However, if a new contract is added to the menu in the Rothschild-Stiglitz model, nothing else changes. Insurers already offering contracts do not react in any way that would make previously profitable deviations unprofitable, and restore equilibrium. As mentioned in section 2, in an anticipatory equilibrium it must be possible for an insurer to add a contract that is

strictly profitable even when unprofitable contracts are removed from the menu (Wilson 1977).

In this context, an attempt to break a pooling equilibrium such as α^p by offering a contract that attracts only low-risk individuals might not work. The new contract will make the pooling-equilibrium α^p unprofitable because it will now only attract high-risk individuals; nevertheless, if α^p is withdrawn, the high-risk individuals may instead choose the added contract. However, it is less hazardous to break a separating equilibrium with a pooling contract; the contract will attract both types of individuals and it is irrelevant if other contracts (now unused) are withdrawn; because the new contract already attracts both types of individuals, it does not matter if any of the other contracts are removed from the menu (Kreps, 1990). Hence, under the assumptions of Wilson (1977) an individual mandate would not affect the existence of equilbria in the insurance market. In this environment, an anticipatory equilibrium would always exist, regardless of how the cut-off line in figure 3 appears.

IV. Discussion: adverse selection, individual mandates, and the case of Massachusetts

How can the analysis of an insurance market with an individual mandate be related to the Massachusetts health care reform, and to what degree can the results be applied on a more general level? In an attempt to answer these questions, I will now look at some details concerning the Massachusetts case. Then I will try to put some of the reform's elements into the light of the results from part three. The main purpose with this section is to use the Massachusetts reform as an example of how theoretical model in part three can be applied.

4.1 The case of Massachusetts: a brief overview

The implementation of the Massachusetts health care reform began in 2006. One official goal of the reform was to cover at least 95% of the state's nearly 500,000 uninsured (roughly 10% of the population [Hyman, 2007]) within three years (Hyman, 2007). Apart from the individual mandate about which this thesis mainly is concerned, the reform can be divided into three distinct elements:

(1) An insurance "connector". The connector is an internet-based institutional arrangement with the purpose of making it easier for people to compare different insurance policies and choose the one that best fits their needs.

(2) An employer mandate aimed at companies with more than 10 employees. This employer mandate requires companies that do not make a "fair and reasonable"[6] contribution to the employees health insurance plans to pay a fee of around $300 per employee and year to the state.

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[6] The meaning of "fair and reasonable" was specified in the law, but I will not go into details with the employer mandate.

(3) Subsidies for the poorest individuals allowing for them to afford insurance (Hyman, 2007).

According to Mitt Romney (2006), the governor of Massachusetts at the time when the reform begun, the uninsured could be divided into three groups on the basis of their ability to pay for insurance. The first group was estimated to consist of about 100,000 individuals that were considered too poor to be able to afford insurance, but who also qualified for the partly federal Medicaid program. However, for some reason these people had not enrolled. A second group added up to about 200,000 individuals who were considered too poor to be able to afford health insurance on their own, but still not poor enough to qualify for Medicaid. Finally, another group adding up to around 200,000 individuals were estimated to be able to afford health insurance on their own but had nevertheless not bought it.

One major implication for the health care provider of having a large group of people uninsured is the free-riding problem that emerges because an individual without insurance cannot be denied emergency medical care. This means that a large group of uninsured will lead to large costs of uncompensated care that generally have to be financed through taxes. However, in Massachusetts, a specific fund had been set aside to cover these expenses. One idea behind the reform was to use this fund to finance the subsidies for the poorest individuals who could not afford insurance but did not qualify for Medicaid (Haislmaier, 2007).

The first group of uninsured is not primarily a problem caused by adverse selection and too high premiums—Mediaid could cover these individuals if they would enroll. A solution to how to cover these individuals might involve better information and so forth, but such discussions are beyond the scope of this thesis. The second group was to be given subsidies in order to afford insurance on their own. These relatively low-income individuals would not have bought insurance automatically just because it became mandatory—they could not simply afford it. The second group became the prime target of the individual mandate (Haislmaier, 2007).

4.2 Rate of coverage and adverse selection

To what degree can the lack of coverage prior to the reform be explained by adverse selection? Indeed, adverse selection may only be part of the explanation; there are many other plausible underlying reasons why these individuals remained uninsured. For example, it is possible that the uninsured group consisted of many young individuals who believed that they had little risk of getting seriously ill and therefore chose not to buy insurance. This view gains some support by Haislmaier (2006); Browne (1992) also suggests some reasons why people remain uninsured. For example, the risk-taking nature of some individuals, financial instability, and ignorance of the risks covered by health insurance may also lead to a significant decrease in coverage. For the insurance market, all these cases mean that individuals who are less likely to impose a significant cost to the insurance company leave the insurance pool, so that the insurance company is left with an above-average risk group of individuals from the population.

The notion that asymmetrical information leads to adverse selection problems and decreased coverage gains support in the empirical literature. Low risk customers have been shown to purchase less insurance in the car insurance market than high-risk customers (Dahlby, 1983), which is precisely what we could expect from the theoretical models examined in part two and three of this thesis. Furthermore, there has been significant evidence of adverse selection combined with a decrease in coverage in the market for dental insurance (Conrad et al., 1985). This may be especially interesting when analyzing the case of Massachusetts; there might be some institutional similarities between the health and dental insurance market.

In a study of the decline in private health insurance coverage in Australia between the years 1989 and 1995, Barrett and Conlon (2003) found that individuals' health status and health risk behaviors are significant determinants to whether or not they will purchase private health insurance. Perhaps even more interesting, the authors also show that the decline under the period 1989-1995 happened at the same time as an increased degree of

adverse selection in the market—in other words, at the same time as the difference in risk between the insured and uninsured increased.

Another empirical study of the effects of adverse selection on insurance coverage was based on health plan choices at Harvard University (Cutler & Reber, 1998). The authors compared the benefits gained by increased competition in the insurance market with the increased costs due to increased premiums. The results pointed to a somewhat ambiguous effect where the increased choice in insurance policies led to significant adverse selection and welfare loss, but that increased competition in the market reduced the premiums by between 5 and 8 percent (Cutler & Reber, 1998). Regarding choice in the insurance market, Cutler and Zeckhauser (1998) argued that an increased degree individual choice of health insurance plans may lead to a risk-based sorting across plans, which might lead to adverse selection and efficiency losses.

In sum, there seems to be a variety of studies justifying the notion of adverse selection as at least part of the explanation for the lack of coverage prior to the reform. This would suggest that focusing on overcoming problems associated with asymmetrical information would have the potential to increase coverage.

4.3 Individual mandate and sanctions

Finally, we turn to the question of how to analyze the effect of an individual mandate on the situation in Massachusetts prior to the reform using the models from part three. It is important to point out that much of this final discussion is rather speculative in terms of the combinations of risk and wealth among the uninsured. Once again, it is mainly intended as an example of how to apply the model in part three. In order to allow for a more accurate analysis, we would need some empirical data from this particular case.

In "technical" terms, the 500,000 uninsured can be said to make up group A in figure three. With some rough generalizations based on the Massachusetts numbers we could characterize the three sub-groups of uninsured as follows:

(a) Lowest income	20%
(b) Medium income	40%
(c) Higher income	40%

Where group (a) is the group that was covered by Medicaid, but had not enrolled, group (b) is the subsidy-targeted group and (c) the main target of the individual mandate. A fairly reasonable assumption would be that group (c) has a relatively low average risk; they could afford insurance on their own, but chose not to buy, so low risk could indeed be one explanation. In terms of figure 3, this would suggest that group (c) could be located in the lower right part of the figure with high income and low risk. Similarly, group (a) could be located close, and parallel to the y-axis. This is, of course, under the assumption that the risk level within group (a) is relatively evenly distributed, which may not necessarily be the case. Under the same assumption, group (b) could be located in the central part of the figure; the group could represent medium income with an evenly distributed risk. In this case, it is likely that the cut-off line would not look very much like a line.

What would the above example suggest in terms of the effect on the market fair-odds line? If group (a) did not enroll in Medicaid, and if there were no subsidies, the lion's share of the people switching over to being insured as a response to a small increase in q or F would consist of group (b). If the average risk within this group were greater than the average risk among the individuals buying insurance (group B in figure 3), there would be a possibility for the market insurance to make an equilibrium-breaking contract profitable.

However, as we know the effect depends on the size of q and F. The sanction against individuals who do not obtain insurance is a loss of personal income tax exemption. This amount has been estimated to around $220 for an individual and $440 for a family, which has also been estimated as below the cost of obtaining insurance in most cases (Hyman, 2007). Hence, we could consider this a relatively small F. Similarly, even though using

the loss of the personal tax exempt as a reasonable reliable method of enforcing the punishment, it only applies to individuals who file tax returns. In other words, it may be reasonable to assume that q in this case also is relatively low. All this put together would point to a relatively small effect on the market fair odds line.

V. Concluding remarks

A Rothschild-Stiglitz model of an insurance market with asymmetrical information has been used in order to show how asymmetrical information between buyers and sellers can lead to adverse selection problems manifesting in increasing premiums and a decrease in coverage. The main lessons from this model were that the only possible equilibrium is a separating equilibrium, and that there may be no equilibrium at all if an equilibrium-breaking contract is profitable. We saw how the profitability of such a contract depends on the ratio of high to low risk individuals in the market.

By using a two-dimensional scale of income and risk, I have discussed the connection between the introduction of an individual mandate in the insurance market, the penalty fee with which it is associated, and the means through which the penalty fee is collected on the one hand, and the average risk in the population (or the market fair-odds line) on the other. We also saw how an individual mandate and the enforcement mechanism can affect the existence of a Rothschild-Stiglitz separating equilibrium. However, it is also possible that the individual mandate has no effect at all on the existence of a separating equilibrium. It all depends on the composition of risk and income in the market, i.e. nature of the "cut-off line". In other words, the theoretical effect of an individual mandate on the existence of a Rothschild-Stiglitz separating equilibrium is inconclusive. I have also briefly discussed how the results would play out in a pooling, or anticipatory equilibria. In the context of the Wilson (1977) model, an individual mandate would not affect the existence of equilibria in the market.

The theoretical model, together with a series of empirical studies, suggests that adverse selection very well could be a considerable part of the explanation for the lack of coverage in Massachusetts prior to the reform. However, there are without doubt many other possible explanations. In a brief examination of the uninsured group, I hypothesized about how the case of Massachusetts would fit into the model connecting the mandate with the market fair odds line. The results are, however, again strongly dependent on the

risk vs. income characteristics in the insured group. To get an accurate picture of these characteristics, and to be able to say something more meaningful about this particular case, an empirical investigation would be needed. However, that is beyond the scope of this thesis.

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