Expanding Health Insurance with Mandate and Subsidy: Theory and Evidence from Massachusetts *

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Abstract

What is the desirable scope of social insurance, and what motivates governments to mandate and subsidize health insurance? This paper explores adverse selection and the societal burden of charity care as motivations for expanding health insurance. I show that expansions replacing charity care with tax-financed subsidies on premiums can improve welfare under adverse selection and progressive taxation. Exploiting the subsidy and penalty incentives in Massachusetts, I find that 60% of the pricing benefits are reductions in premiums, and the joint benefits on premiums and charity costs offset the fiscal cost of expansion. Redistribution can motivate further expansions subsidizing the low-income.

Keywords: health insurance, subsidy, penalty, adverse selection, charity care
JEL Codes: I11, I13, I18

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1 Introduction

Governments worldwide invest great amounts of resources in the health, education, and the well-being of citizens. To ensure the access to health services, universal health insurance has been implemented in 28 countries and is included in the United Nation's Sustainable Development Goals for the next decade (Desa *et al.*, 2016). Despite its growing appeal among policymakers, the welfare implications of universal insurance and the effectiveness of policies expanding health insurance are less well understood.

One argument for implementing universal insurance rests on the idea that access to healthcare is a basic human right. To provide universal healthcare, society may act as the last resort of insurance to cover the medical expenses of the uninsured. In the United States, for instance, coverage through charity care programs and the implicit coverage from bankruptcy laws alleviate the financial burden to the uninsured (Garthwaite *et al.* 2018; Mahoney 2015). While uninsured individuals are not denied access to healthcare or reimbursements, whether expanding enrollment in health insurance can improve upon the coverage through charity care is an open question in the literature.

A second argument for universal insurance is based on the adverse selection in health insurance (Akerlof 1970). Because premiums driven by high-cost enrollees price out low-cost individuals, expansions can reduce adverse selection and improve the pricing efficiency of insurance. However, the low demand among the uninsured limits the effectiveness of policies expanding health insurance (Finkelstein *et al.*, 2019). Nonetheless, when alternative forms of insurance exist, adverse selection has broader implications on the costs and prices beyond health insurance and may strengthen the motivation for insurance expansions through the substitution between programs.

This paper evaluates both motivations for the desirable scope of health insurance and for policies expanding health insurance. I first examine the case for a universal insurance mandate in a conceptual framework when the government can either enroll individuals in health insurance or provide charity care. I show that adverse selection alone presents only weak justifications for an insurance mandate, but expansions replacing charity care with tax-financed subsidies on premiums can improve welfare under adverse selection and progressive taxation. When higher incomes have lower risks, fully replacing charity care with subsidized health insurance maximizes welfare.

Although adverse selection and charity care potentially motivate an insurance mandate, I assess their empirical relevance in reforms where expansion is induced by policy incentives. Exploiting the insurance subsidy and penalty introduced in the 2006-2007 health reform in Massachusetts, I develop an empirical framework where the incentive effects on uptake, the change in the program risk pools, and the pricing implications for premiums and charity costs provide sufficient statistics that characterize the motivating benefits as well as the fiscal cost of expansion. The net benefit indicates the desirability of incremental expansions of health insurance using policy incentives.

The welfare framework relates the incentive effect on uptake to the pricing externality on premiums and charity costs. With adverse selection, expansion reduces the average enrollee cost in health insurance as well as the uninsured cost in charity care. The cost composition change results in lower charity care burdens and lower premiums according to the rating regulations. The fiscal externality is driven by the cost of marginal enrollees responing to policy. For subsidies, I also consider employment responses and the crowd-out of employer sponsored insurance (ESI) as additional sources of fiscal externality.

I estimate the incentive effects specific to the subsidies in Massachusetts focusing on non-elderly adults in the American Community Survey (ACS). I quantify subsidy generosity as a percent of premium and simulate the generosity from a pre-reform sample of individuals unaffected by the incentive (Currie and Gruber 1996a; Currie and Gruber 1996b). Across demographic groups, the simulated measure isolates generosity differences induced by the policy and pre-existing differences in incomes. Similar variations in the subsidy and rating regulations have been exploited to estimate insurance demand in the individual market (Tebaldi, 2017) and the incentive effect on uptake (Frean *et al.*, 2017).

I find that increasing the subsidy generosity by 10 percentage points (above the 70% baseline) increases uptake by 1.3 percentage points in 2008-2011, and by 1.8 percentage points in 2011. The largest increase occurs for younger individuals (below age 30). Employment reductions are indistinguishable from zero but increase in the near-elderly (55-64) where the coverage from ESI decreases with subsidy. In contrast, estimates based on the subsidy rates of enrollees are wrong-signed for the insurance uptake and indicate substantially larger disincentives on employment.

Based on the cost composition change induced by marginal enrollees (Finkelstein *et al.*, 2019), I calculate the pricing benefits when the subsidy or penalty is increased by one dollar. I find that 60% of the pricing benefits are reductions in health insurance premiums, with the remaining 40% accruing to payers of charity care. The joint benefit offsets the fiscal externality of expansion, implying a net benefit that is close to zero for a range of behavioral responses to policy. Thus, expansion improves welfare for enrollees in health insurance as well as payers of charity care, and omitting either benefit would drastically under-state the overall welfare of expansion.

As a means of redistribution, subsidy further improves welfare through the resource transfer to the low-income. With even small degrees of redistribution, benefits exceed costs and further expansions of subsidized insurance are desirable. In contrast, as uninsured individuals are more likely to be young and have low incomes, increasing the tax penalty reduces welfare due to the burden on the uninsured. Thus, while the current subsidy and penalty are close to the optimal in terms of balancing the pricing benefits against costs, redistribution could motivate further expansions of subsidized insurance whereas expansions through the tax penalty are less desirable.

Previous studies have separately identified the role of charity care for insurance demand in the subsidized market (Finkelstein *et al.*, 2019) and the impacts of selection on premiums in the individual market (Hackmann *et al.*, 2015). This paper shows that the mechanisms are fundamentally linked and jointly present motivations for policies expanding health insurance. In an empirical framework, I quantify the mechanisms exploiting the tax and subsidy incentives in Massachusetts. I show that evaluating the joint benefits on premiums and charity costs is critical for understanding the welfare impacts of expansion, and that redistribution could motivate further expansions subsidizing the low-income.

This paper more broadly relates to a recent literature exploring the rationales of universal insurance mandated by the government. Cabral *et al.* (2019) finds that standard market failures including adverse selection present only weak justifications for mandating workers' compensation insurance. For unemployment insurance, moral hazard limits the desirability of universal supplemental coverage above a minimum mandate (Landais *et al.*, 2021). For health insurance, this paper shows that universal insurance may ultimately involve redistribution preferences, but the pricing efficiency on premiums and charity costs can indicate very high insurance rates absent a mandate. Moreover, policy incentives should balance efficiency and redistribution in expansions of voluntary, choice-based insurance.

The remainder of the paper proceeds as follows. Section 2 introduces the Massachusetts health insurance reform. Section 3 proposes a conceptual framework to understand the desirability of an insurance mandate under adverse selection and charity care. Section 4 develops an empirical framework to evaluate the welfare impacts of the expansion in Massachusetts, followed by estimates of behavioral responses in Section 5 and pricing implications in Section 6. Section 7 interprets the welfare results. Section 8 concludes.

2 Massachusetts health insurance reform

Massachusetts enacted its comprehensive health reform law, Chapter 58 of the Acts of 2006, in April, 2006. The law aims to improve healthcare access in the state by implementing insurance mandates (in the form of tax penalties) on individuals and firms, subsidies on premiums to the low-income, and regulations of premiums and risk pools. The "threelegged stool" was also the basis of the national health reform under the Affordable Care Act (ACA). I detail each component next.

2.1 Mandate

The individual mandate requires that individuals above age eighteen must purchase health insurance or pay a tax penalty. When the penalty was first introduced in 2007, tax-filers without proof of insurance by December, 2007 were denied their personal income tax exemption. From 2008 onward, the tax penalty is linked to the premium of the cheapest plan available to the individual, adjusted by the number of uninsured months.

The employer mandate imposes penalties on firms that fail to sponsor health insurance for employees. The penalty amount is adjusted based on the cost of uninsured workers to the state's charity care program, and larger penalty applies when the uninsured generates particularly high costs of charity care (more than $50,000 annually). This is to ensure that the state budget mainly covers individuals unable to obtain private insurance from firms. In July, 2013, the state repealed the employer mandate.

2.2 Subsidized Insurance

The subsidy on premiums aims to alleviate the financial burden of health insurance on the low-income population. Previously, the state's Medicaid program, MassHealth, covers individuals with income below 133% federal poverty level (FPL).[1] No premium is charged for the Medicaid insurance. With Chapter 58, the state sponsored an insurance market, the Commonwealth Care (CommCare), where individuals below 300% FPL can purchase insurance at subsidized premium rates. Individuals with insurnace from employers are not eligible for subsidies.

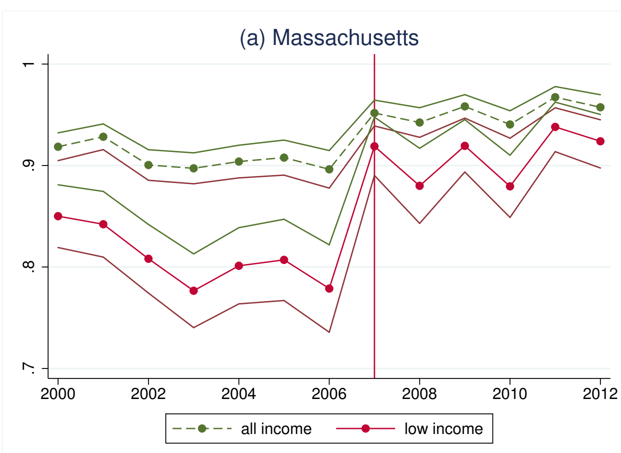
Enrollees in Commonwealth Care contribute an "affordable" amount towards the monthly premium cost of insurance. Premiums above the affordability limit are paid for

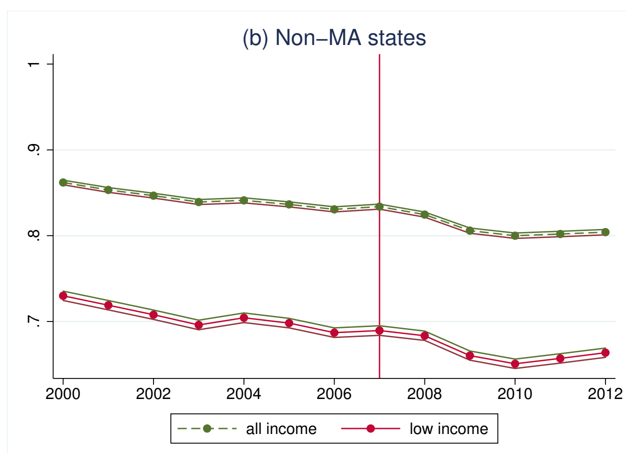
[1] Coverage is further restricted to individuals who are parents or caretakers of dependent children.

by the state. For individuals with income less than 150% FPL, affordability is zero, so that premiums are fully subsidized in this range. Above 150% FPL, in 2011, affordability is $39 per month in the 150-200% bracket, $77 per month in the 200-250% bracket, and $116 in the 250-300% bracket. Above 300% FPL, a separate program called the Commonwealth Choice offers unsubsidized insurance to high-income individuals.

The difference between enrollee cost (affordability) and the insurer price is the subsidy. Relative to the lowest premium price ($405 in 2011), subsidy is roughly 90% of premium in the 150-200% bracket, 80% in the 200-250% bracket, and 70% in the 250-300% bracket. Figure 1 illustrates the coverage gain in the low-income population in MA. While insurance rate was substantially lower below 300% FPL, the gap narrowed after the reform in MA but stayed constant in the rest of US.

Figure 1: Insurance coverage trends





Notes. Figure compares insurance coverage rates in Massachusetts (panel a) with the rest of US states (panel b), for the full population and the low-income group below 300% FPL. Insurance rates are derived for the 27-64 age group from the CPS March supplement, adjusted by the sampling weights for insurance. 95% confidence intervals are plotted around annual estimates.

2.3 Rating Regulation

The final piece of the law involves regulations on premiums. Before Chapter 58, premiums in MA can only differ based on enrollees' age and residential location and not by other factors such as health or demographics. Chapter 58 further requires that the maximum premium difference across age groups does not exceed a ratio of 2. In addition, Chapter 58 merged the risk pools of small-group and individual insurance in July 2007. After the merger, premiums of both insurance are regulated based on the combined risk pool.[2] In particular, the minimum medical loss ratio requires that insurers spend no less than 80% of the premium revenues on the claim costs of enrollees.

Table 1 summarizes the enrollment gains in Massachusetts in 2006-2008. Consistent with Figure 1, Commonwealth Care is the largest contributor to the insurance expansion from Chapter 58: of the 442,000 new enrollees by July 2008, around 40% received premium assistance from the program. Including the fully subsidized MassHealth program, more than half (68%) of new enrollees received some premium assistance from the state.

Table 1: Enrollment counts by source of insurance

	6/30/2006	12/31/2006	6/30/2007	12/31/2007	6/30/2008	diff. from 6/30/06
Private Group	4,274,000	4,338,000	4,378,000	4,406,000	4,421,000	147,000
Individual Purchase	40,000	39,000	36,000	65,000	80,000	40,000
MassHealth	705,000	741,000	732,000	765,000	785,000	80,000
Commonwealth Care	0	18,000	80,000	158,000	176,000	176,000
Total	5,020,000	5,136,000	5,226,000	5,394,000	5,462,000	442,000

Notes: Table summarizes administrative enrollment counts published in *Health Care in Massachusetts: Key Indicators, November 2008*. The report is accessible at http://archives.lib.state.ma.us/bitstream/handle/2452/36763/ocn232606916-2008-11.pdf?sequence=1&isAllowed=y. Only enrollment in the primary source of insurance included in the statistics.

2.4 Charity Care

Outside the main frame of Chapter 58, the state's Uncompensated Care Pool (UCP) is a safety net program that reimburses hospitals for treating uninsured individuals. UCP is

[2] Because previously the individual market was much smaller, the merger significantly reduced premiums of individual insurance without meaningfully increasing premiums of small-group insurance (Graves and Gruber, 2012).

important in the passage of Chapter 58 because a key motivation of the law was to reduce charity costs by expanding subsidized insurance, hence solving a "free-rider problem."[3] The problem originates from the 1986 Emergency Medical Treatment and Active Labor Act (EMTALA), which mandated hospital services to all individuals regardless of the ability to pay but did not stipulate reimbursement schemes for financing the costs. In Massachusetts, UCP reimburses hospitals through taxation on private sector revenues.[4]

Expecting reduced charity costs with the expansion of subsidized insurance, in 2005, Chapter 58 received permission from the federal government to redirect the UCP funding to subsidies on premiums in the Commonwealth Care. In 2011, charity costs totaled $496 million, decreasing by $243 million compared to the $739 million in 2005.

The remaining charity costs are financed through a mix of assessments, surcharges, and general revenues under the reformed charity care program called the Health Safety Net (HSN). Surcharges are service fees on the medical bills of enrollees, and assessments are taxation on hospital revenues. Both the surcharge and assessments are revised annually to finance the cost of charity care, and assessments are further adjusted across hospitals to alleviate the revenue loss of safety net hospitals. In 2011, surcharge fees and assessments each contribute $160 million to the program budget, with an additional $100 million appropriated from the general revenue.[5]

3 Conceptual Framework

Unlike health insurance, many insurance programs require mandatory participation from individuals and are universal by design. One typical example is unemployment insurance

[3] Subsidizing health insurance to reduce the high costs of charity care was cited as one of the reform rationales during the preparation of the law. See for instance https://www.npr.org/templates/story/story.php?storyId=5330854.

[4] In 2005, UCP was billed $701.8 million for hospital charity care and paid out $498.6 million according to the program report available at https://archives.lib.state.ma.us/handle/2452/47833.

[5] Source: the Health Safety Net program report, available at https://www.mass.gov/files/documents/2016/07/tp/hsn11-ar.pdf

(UI), which mandates firms and employees to contribute to the program trust fund and pays out benefits in the event of separation. In contrast, enrollment in health insurance in the US is voluntary and far from universal. To date, there remains substantial debate regarding the desirability of universal health insurance and the design of policy incentives to expand and finance insurance.

To understand the desirability of an insurance mandate, I develop a conceptual framework where the government can either enroll individuals in health insurance or cover their medical expenses through charity care. I focus on the case where premiums suffer from adverse selection in the risk pool and charity care is financed by private sector enrollees. I derive the implications for premiums and charity costs when expansion enrolls more individuals in health insurance.

3.1 Environment

Consider a unit mass of individuals with heterogeneous health type μ and labor productivity ν. The distribution of types follows the density $f(\nu,\mu)$.[6] $\mu \in [0,1]$ is the probability of staying healthy. With probability $1-\mu$, the individual experiences a health event and incurs medical cost M to restore health. The expected cost of type μ is $(1-\mu)M$.

Let $hi(\nu,\mu) \in \{0,1\}$ indicate the insurance coverage of type (ν,μ). The insurance requires premium $p(\nu,\mu)$ and fully covers the medical cost in the health event. Uninsured individuals are eligible for the charity care transfer $\Delta t(\nu,\mu)$ in the health event. $t(\nu,\mu)$ captures ex-ante transfers such as income taxation and subsidies on premiums prior to the realization of health states.

Let $e(\nu,\mu) \in [0,1]$ indicate the employment status of type (ν,μ), and $w(\nu)$ is labor income which differs by productivity $\nu \in [0,1]$. The opportunity cost of working is captured in $g(\frac{1}{\nu})$. With $g'(\cdot) > 0$ and $g''(\cdot) > 0$, the opportunity cost decreases (and decreases faster)

[6] The density $f(\nu,\mu)$ is a smooth function over the unit square $[0,1]^2$. The marginal distribution for each type is denoted $f(\nu,\cdot)$ and $f(\cdot,\mu)$, respectively. The correlation between types is unrestricted.

with productivity. I further assume that $g(1) = 0$ and $g(+\infty) = +\infty$, so that the highest productivity types always work and the lowest productivity types do not.

Absent insurance coverage, the expected utility of type (ν, μ) is

$$U(\nu, \mu|hi = 0) = \mu u(c_H(\nu, \mu)) + (1-\mu)u(c_S(\nu, \mu)) - e(\nu, \mu)g(\frac{1}{\nu}),$$

where consumption equals $c_H(\nu, \mu) = e(\nu, \mu) \cdot w(\nu) + t(\nu, \mu)$ in the healthy state and equals $c_S(\nu, \mu) = e(\nu, \mu) \cdot w(\nu) + t(\nu, \mu) + \Delta t(\nu, \mu) - M$ in the health event. Assuming that consumption is bounded away from zero with transfers, expected income $e(\nu, \mu) \cdot w + t(\nu, \mu) + (1-\mu)\Delta t(\nu, \mu)$ exceeds the cost of insurance $(1-\mu)M$. For risk-averse individuals, this implies that re-directing charity care $\Delta t(\nu, \mu)$ to subsidies on premiums in the ex-ante transfer $\bar{t}(\nu, \mu) = t(\nu, \mu) + (1-\mu)\Delta t(\nu, \mu)$ increases individual utility without raising the cost to the government. Thus, replacing charity care with subsidized insurance generally improves welfare with type-specific transfers. Under adverse selection, premiums respond to the average cost of enrollees and subsidies linked to premiums are less able to target individuals directly. I examine insurance expansions under these constraints next.

3.2 Charity Care and Subsidies on Premiums

Consider a government-sponsored insurance market where price discrimination based on health is prohibited. Premium p equals the average cost $\mathbb{E}[1-\mu|hi(\nu, \mu) = 1]M$. For simplicity, I assume that charity care does not require additional out-of-pocket costs in the health event for non-employed individuals, so that healthcare is fully subsidized for the low-income. Employees can access charity care after paying the premium price p, and those without proof of purchase pay the tax penalty equal to a fixed percent k of premium.

Let $e = Pr\{e(\nu, \mu) = 1\}$ indicate the employment share, $\lambda_{e,0}$ the uninsurance rate in workers, and $h_{e,0}^0$ the share of patients accessing charity care in uninsured workers. With similar notations for the non-employed $1-e$, the cost of charity care equals

$$UC = e\,\lambda_{e,0}\,h^0_{e,0}\,(M-p) + (1-e)\,\lambda_{1-e,0}\,h^0_{1-e,0}\,M\,.$$

Charity care is financed by the service surcharge collected from private sector enrollees. Assume that share t of the cost is financed by the surcharge fee on services, so that the medical bill increases by $\frac{t\,UC}{e\lambda_{e,1}h^0_{e,1}}$ in the health event. When the budget share t exceeds the patient share $h^0_{e,1}$ in health insurance, charity care places excess burden on patients. The remainder cost imposes a surcharge fee $\frac{(1-t)\,UC}{e\lambda_{e,1}h^1_{e,1}}$ per enrollee absent the health event.

Subsidies on premiums are financed by a tax on payroll and the penalty on the uninsured. The contribution of payroll is $(1-e)\,\lambda_{1-e,1}\,p - e\,k\,\lambda_{e,0}\,h^1_{e,0}\,p$ net of the revenue from penalty, and the implied tax rate per productivity unit is $\tau = \frac{(1-e)\,\lambda_{1-e,1} - e\,k\,\lambda_{e,0}\,h^1_{e,0}}{e\cdot\mathbb{E}[\nu\,|\,e(\nu,\mu)=1]}\,p$.

Given income $y(\nu,\mu)$, insurance purchase and taxation result in consumption $c^1_{e,1} = y(\nu,\mu) - p - \tau\,\nu - \frac{(1-t)\,UC}{e\lambda_{e,1}h^1_{e,1}}$ for insured workers absent the health event, and $c^0_{e,1} = y(\nu,\mu) - p - \tau\,\nu - \frac{t\,UC}{e\lambda_{e,1}h^0_{e,1}}$ for patients. If uninsured, the worker consumes $c^1_{e,0} = y(\nu,\mu) - \tau\,\nu - k\,p$ after paying the penalty, and consumes $c^0_{e,0} = y(\nu,\mu) - \tau\,\nu - p$ after paying the premium price in the health event.

3.3 Expanding Subsidized Insurance

I first focus on the expansion of subsidized insurance to the non-employed assuming mandatory insurance for workers ($\lambda_{e,0} = 0$). Let n_{1-e} indicate the marginal health type in subsidized insurance when lower health types with $\mu < n_{1-e}$ already enroll. Expanding insurance to cover health type n_{1-e} impacts welfare according to

$$\frac{\mathrm{d}W}{\mathrm{d}n_{1-e}} = e\sum_{l=0,1} h^l_{e,1}\,\mathbb{E}[u'(c_{e,1})]\cdot\mathbb{E}\left[\frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}\middle|\,e=1,h=l\right] + e\sum_{l=0,1} h^l_{e,1}\,Cov\left[u',\,\frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}\middle|\,e=1,h=l\right].$$

The first term gives the utility cost of expansion on workers. Because expansion replacing charity care does not increase the transfer to the non-employed, the resource cost of expansion $\sum_{l=0,1} h^l_{e,1}\,\mathbb{E}\left[\frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}\middle|e=1,h=l\right]$ is zero, so that the first term vanishes absent marginal utility differences across health states. However, because the service surcharge results in higher marginal utility in the health event, expansion impacts welfare through the increase in patient utility $\Delta u'_h\,\mathbb{E}\left[\frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}\middle|e=1,h=0\right]$, with $\Delta u'_h$ the difference in marginal utility, and through the tax incidence of subsidy $Cov\left[u',\frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}\middle|e=1,h\right]$.

The response in consumption $\frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}$ includes the increase in the subsidy burden ΔS and the reduction in charity costs based on the marginal enrollee cost MC.[7] Applying the consumption change, welfare depends on

$$\underbrace{h^0_{e,1}\Delta u'_h\left[\left(1-\frac{\mathbb{E}[\nu\,|\,e=1,h=0]}{\mathbb{E}[\nu\,|\,e=1]}\right)\Delta S+\left(\frac{t}{h^0_{e,1}}-1\right)MC\right]}_{\text{patient burden}}\underbrace{-\sum_{l=0,1}\frac{Cov[u',\nu\,|\,e=1,h=l]\cdot h^l_{e,1}}{\mathbb{E}[\nu\,|\,e=1]}\Delta S}_{\text{tax incidence of subsidy}},$$

with $\left(1-\frac{\mathbb{E}[\nu|e=1,h=0]}{\mathbb{E}[\nu|e=1]}\right)\Delta S$ the relative subsidy burden on workers in the health event. When subsidy places smaller burdens on patients $\left(\frac{\mathbb{E}[\nu|e=1,h=0]}{\mathbb{E}[\nu|e=1]}<1\right)$ in addition to reducing the burden of charity care $\left(\frac{t}{h^0_{e,1}}>1\right)$, expansion of subsidized insurance increases welfare for patients. Moreover, when the subsidy burden is smaller on individuals with higher marginal utility, expansion further improves welfare through progressive taxation. Overall welfare thus satisfies the following proposition

Proposition 1. *Assume that workers receive mandatory insurance from employers. Under the condition that*

(1) worker productivity increases with health: $Cov[\nu,\mu\,|\,e=1]>0$,

(2) tax burden decreases with marginal utility: $Cov[u',\nu\,|\,e=1,h]<0$,

enrolling uninsured individuals in subsidized insurance always improves welfare, and subsidized universal insurance maximizes welfare.

[7] ΔS includes the direct cost of marginal enrollees and the reduction in infra-marginal costs through premiums. Appendix A provides detailed derivation of welfare.

The first condition is equivalent to $\frac{\mathbb{E}[\nu|e=1,h=0]}{\mathbb{E}[\nu|e=1]} < 1$, which ensures that the subsidy places smaller burdens on patients compared to an average worker. The second condition ensures that subsidy is financed by progressive taxation. Together, the conditions ensure that replacing charity care with tax-financed subsidies increases welfare for each marginal health type n_{1-e}, so that subsidized universal insurance maximizes welfare.

3.4 Universal Health Insurance with Penalty

I then examine the case for universal insurance when workers not enrolled in health insurance are subject to a penalty. Unlike subsidized expansion, in the unsubsidized population, expansion reduces utility for marginal enrollees paying the full premium price but benefits infra-marginal enrollees through reduced adverse selection in premiums. With universal insurance, utility necessarily decreases on the ultra-health margin where $\mu = 1$. I focus on this limiting case and highlight the trade-offs between marginal and infra-marginal enrollees in the following proposition

Proposition 2. *Expanding insurance to the ultra-health margin impacts welfare through*

(1) *marginal utility loss:* $MP = \mathbb{E}[u(c^1_{e,1}) - u(c^1_{e,0})|e=1,\mu=1]$,
where $c^1_{e,0} - c^1_{e,1} = (1-k)p$ *is the net cost of insurance for* $\mu = 1$

(2) *benefits to enrollees:* $IB = \mathbb{E}[u'|e=1](1-k)p$,

(3) *tax incidence of subsidy:* $TS = -\frac{Cov[u',\nu|e=1]}{\mathbb{E}[\nu|e=1]}\left(k + \frac{e}{e_{\mu=1}} - 1\right)p$,
with $e_{\mu=1}$ *the employment share on the ultra-health margin*

Universal insurance thus trades-off marginal utility with infra-marginal benefits with the welfare impact

$$\left.\frac{\mathrm{d}W}{\mathrm{d}n}\right|_{n=1} \propto MP + IB + TS.$$

The proposition states that universal insurance involves transfers from the ultra-health margin to infra-marginal enrollees. The net benefit is generally ambiguous when marginal utility differs. In addition, expansion on net increases the subsidy transfers when the cost of new enrollees exceeds the infra-marginal reduction through premiums. This is the case when the share eligible for subsidy is higher on the ultra-margin, or $\frac{e}{e_{\mu=1}} > 1$. When financed through payroll, the additional transfers $\left(k + \frac{e}{e_{\mu=1}} - 1\right)p$ impact welfare through the tax incidence across worker productivity in the term TS. Overall welfare thus depends on the utility trade-offs across risk types and the redistribution in the tax base across workers.

Taken together, adverse selection alone does not present strong motivations for an insurance mandate in the unsubsidized market, but expansions of subsidized insurance replacing charity care can improve welfare under adverse selection and progressive taxation, in which case universal insurance may be desirable as a result of redistribution across individuals. Turning to the insurance expansion in Massachusetts, I quantify the motivations in an empirical setting where expansion is induced by tax and subsidy incentives. I introduce the empirical framework next.

4 Incremental Expansion in Massachusetts

Guided by the theoretical analysis, I develop an empirical framework to evaluate the welfare impacts of the expansion in Massachusetts. The framework formulates the benefits on premiums and charity costs as well as the fiscal cost of expansion using individual responses to policy. I present key elements of the framework below.

4.1 Setting

Consider the life-cycle problem of individuals with different health μ and productivity ν. In the beginning of period t, individuals choose employment $e_t \in \{0, 1\}$ and health insurance $hi_t \in \{0, 1, 2\}$, where $hi_t = 0$ indicates uninsurance, $hi_t = 1$ employer sponsored insurance (ESI), and $hi_t = 2$ individual insurance. Individuals are then subject to a health shock and $h_t = 0$ indicates those experiencing a health event. The period utility is

$$U(c_{i,j,t}) = \mu\, u(c^1_{i,j,t}) + (1-\mu)\, u(c^0_{i,j,t}) - 1_{\{e_t=1\}}\, g\left(\frac{1}{\nu}\right), \tag{1}$$

where $c^l_{i,j,t}$ is consumption in health state $h_t = l$ and $g\left(\frac{1}{\nu}\right)$ the disutility from foregone leisure.

In a stationary dynamic setting, a new cohort of (ν, μ) individuals is born each period. The life-cycle utility for the cohort born in period 0 is $\mathcal{U} = \int_0^\infty U(c_{i,j,t})S(t)\,dt$, where $S(t) = \exp\{-\int_0^t \Lambda(h_\tau)\,d\tau\}$ is the survival probability with Λ the mortality hazard given previous health shocks.[8] Individuals maximize life-cycle utility subject to the budget constraint

$$\begin{aligned}\dot{A}_{i,j,t}(h_t) = y_t(A_t, e_t) & \overbrace{-1_{\{e_t=1\}}\,\tau_{pb} - 1_{\{e_t=1,\, hi_t=1\}}\,\tau_{pr}}^{\text{insurance transfers}} \overbrace{-1_{\{hi_t=2\}}\,(1-\lambda_p)\,p}^{\text{subsidized premium}} \overbrace{-1_{\{hi_t=0\}}\,k\,p}^{\text{penalty}} \\ & \underbrace{-1_{\{hi_t=0,\, h_t=0\}}\,(1-g\,n)\,M}_{\text{uninsured out-of-pocket cost}} \quad \underbrace{-1_{\{hi_t>0,\, h_t=0\}}\,[(1-n)\,M + uc_p]}_{\text{enrollee out-of-pocket cost and surcharge}} \; -c_{i,j,t}(h_t),\end{aligned} \tag{2}$$

where income y_t generated by asset A_t and employment e_t is subject to insurance transfers τ_{pb} and τ_{pr}, subsidy or penalty based on insurance choice, and out-of-pocket costs in the health event. Individuals then choose saving $\dot{A}_{i,j,t}$ to determine consumption $c_{i,j,t}$ in period t and health state h_t.

In the cross section, the equilibrium insurance rate and premium price determine the charity costs and insurance transfers financed by the government. Let e indicate the size of workers and λ_j the size choosing insurance j each period. Given premium p, public

[8] From stationarity, the size of age-t individuals born in period 0, $\int_{(\nu,\mu)} S(t)\,dF(\nu,\mu)$, is also the size of age-t individuals in the cross section. Government thus implements life-cycle transfers through cross-sectional transfers each period. Without loss of generality, I normalize the population size each period $\int_{(\nu,\mu)}\int_0^\infty S(t)\,dt\,dF(\nu,\mu)$ to unity.

transfer τ_{pb} satisfies the balanced budget

$$\lambda_1 \tau_{ESI} p + \lambda_2 \lambda_p p = \lambda_0 k p + e \tau_{pb}, \tag{3}$$

where the government subsidizes ESI at rate τ_{ESI} and subsidizes individual insurance at rate λ_p. The subsidies are financed from the tax revenue $e\tau_{pb}$ and penalty $\lambda_0 k p$. Firms finance ESI through the private transfer τ_{pr} from employees as follows

$$\lambda_1 (1 - \tau_{ESI}) p = e \lambda_{e,1} \tau_{pr}, \tag{4}$$

where $\lambda_{e,1}$ is the share of workers with ESI.

I assume that insurance covers n percent of the medical cost M in the health event, so that the expected cost is $(1-\mu) n M$ for health type μ. Let $r(\lambda_0) = h^0_{>0} n M$ indicate the average enrollee cost when the uninsured size is λ_0, and $h^0_{>0} = \mathbb{E}[1_{\{h_t=0\}} | hi_t > 0]$ is the patient share in health insurance. Applying an administrative load β above costs, premium equals

$$p = (1+\beta) r(\lambda_0), \tag{5}$$

and β is capped at 25% in Massachusetts.

The charity care program covers cost $g n M$, where g allows for different spending levels in charity care compared to health insurance.[9] In the health event, uninsured individuals are charged $(1 - g n) M$, and enrollees are charged $(1-n) M$ plus a service surcharge uc_p. The surcharge fees finance fraction α of the charity cost

$$\alpha \lambda^0_0 g n M = \lambda^0_{>0} uc_p, \tag{6}$$

where λ^0_0 ($\lambda^0_{>0}$) is the size of uninsured (insured) patients. The remaining cost, $(1-\alpha) \lambda^0_0 g n M$, is borne by hospitals as revenue loss.

[9] $g \leq 1$ indicates greater spending in health insurance potentially from additional benefits.

4.2 Welfare

The government provides policy incentives $\mathbf{K} = (\lambda_p, k)$ to increase the insurance uptake. With the expansion, the government seeks to reduce the social burden of charity care and to increase individual utility. I thus consider the following social welfare function

$$W = \zeta\, V - (1-\alpha)\, \lambda_0^0\, g\, n\, M\,, \tag{7}$$

where $V = \int_{(\nu,\mu)} \mathcal{U}\, dF(\nu,\mu)$ is the sum of individual utility each period and $(1-\alpha)\,\lambda_0^0\, g\, n\, M$ the uncompensated costs borne by hospitals. ζ normalizes utility to private sector revenues using the marginal utility of workers.

Assuming individual optimization, marginal enrollees responding to policy incentives are indifferent with the uptake. On the infra-margin, expansion generates externality on premiums and charity costs and generates fiscal externality on the government budget. The welfare impact of policy-induced expansion can be summarized as follows

Proposition 3. *An increase in policy spending $d\mathbf{K}p$ impacts welfare through*

1. *beneficiary utility* $\frac{\mathrm{d}W_B}{\mathrm{d}\mathbf{K}p} = \lambda_2\, \omega_{\cdot 2} \frac{\mathrm{d}\lambda_p}{\mathrm{d}\mathbf{K}} - \lambda_0\, \omega_{\cdot 0} \frac{\mathrm{d}k}{\mathrm{d}\mathbf{K}}$
2. *premium payment* $\frac{\mathrm{d}W_P}{\mathrm{d}\mathbf{K}p} = -\frac{\mathrm{d}\log p}{\mathrm{d}\mathbf{K}} \left[e\frac{\tau_{pb}}{p} + e\lambda_{e,1}\omega_{1,1}\frac{\tau_{pr}}{p} + \lambda_0\omega_{\cdot 0}k + \lambda_2\omega_{\cdot 2}(1-\lambda_p) \right]$
3. *charity care burden* $\frac{\mathrm{d}W_{UC}}{\mathrm{d}\mathbf{K}p} = -\lambda^0_{>0}\, \omega^0_{\cdot>0} \frac{\mathrm{d}uc_p}{\mathrm{d}\mathbf{K}p} - (1-\alpha)\, \frac{\mathrm{d}\lambda_0^0}{\mathrm{d}\mathbf{K}p} g\, n\, M$
4. *fiscal cost* $\frac{\mathrm{d}W_C}{\mathrm{d}\mathbf{K}p} = -e\frac{\mathrm{d}\tau_{pb}}{\mathrm{d}\mathbf{K}p} - e\lambda_{e,1}\, \omega_{11} \frac{\mathrm{d}\tau_{pr}}{\mathrm{d}\mathbf{K}p}$

where $\omega^l_{i,j} = U'(\overline{c^l_{i,j}})/U'(\overline{c_{1\cdot}})$ is the welfare weight of individuals with employment i, insurance j, and health state l. The overall welfare impact is

$$\frac{\mathrm{d}W}{\mathrm{d}\mathbf{K}p} = \frac{\mathrm{d}W_B}{\mathrm{d}\mathbf{K}p} + \frac{\mathrm{d}W_P}{\mathrm{d}\mathbf{K}p} + \frac{\mathrm{d}W_{UC}}{\mathrm{d}\mathbf{K}p} + \frac{\mathrm{d}W_C}{\mathrm{d}\mathbf{K}p}\,. \tag{8}$$

Proposition 3 formulates welfare in terms of the impacts on beneficiaries, premium, charity cost, and the fiscal cost. Additional policy spending increases beneficiary utility by $\frac{\mathrm{d}W_B}{\mathrm{d}\lambda_p p} = \lambda_2 \omega_{\cdot 2}$ with the subsidy dollar, and reduces utility by $\frac{\mathrm{d}W_B}{\mathrm{d}kp} = -\lambda_0 \omega_{\cdot 0}$ with penalty. The impact on premium is $\frac{\mathrm{d}\log p}{\mathrm{d}\mathbf{K}} = \frac{\varepsilon_{r,\lambda_0}}{\lambda_0} \frac{\mathrm{d}\lambda_0}{\mathrm{d}\mathbf{K}}$, where $\varepsilon_{r,\lambda_0}$ is the cost elasticity in health insurance to the expansion. With adverse selection, expansion reduces premiums and in addition reduces the subsidy and ESI transfers linked to premiums, the cost of penalty on the uninsured, and the price of subsidized premium for enrollees. The welfare benefit is given by

$$\frac{\mathrm{d}W_P}{\mathrm{d}\mathbf{K}p} = -\frac{\mathrm{d}\log p}{\mathrm{d}\mathbf{K}} \Big[\underbrace{e\frac{\tau_{pb}}{p} + e\lambda_{e,1}\omega_{1,1}\frac{\tau_{pr}}{p}}_{\text{subsidy and ESI transfers}} + \underbrace{\lambda_0 \omega_{\cdot 0} k}_{\text{penalty}} + \underbrace{\lambda_2 \omega_{\cdot 2}(1-\lambda_p)}_{\text{enrollee cost}} \Big]. \tag{9}$$

With adverse selection, the average cost of the uninsured also decreases with expansion. Let $\varepsilon_{ri,\lambda_0}$ indicate the elasticity of the uninsured cost ri. For policy-induced expansion $\frac{\mathrm{d}\lambda_0}{\mathrm{d}\mathbf{K}}$, service surcharge responds according to $\frac{\mathrm{d}uc_p}{\mathrm{d}\mathbf{K}} = \alpha\, g\, \frac{ri}{\lambda^0_{>0}} \left(\frac{1}{\lambda_{>0}} + \varepsilon_{ri,\lambda_0} - \varepsilon_{r,\lambda_0} \right) \frac{\mathrm{d}\lambda_0}{\mathrm{d}\mathbf{K}}$, which increases with the cost elasticity $\varepsilon_{ri,\lambda_0}$ and the burden per patient $\frac{ri}{\lambda^0_{>0}}$. Including the reduction in hospital uncompensated costs, the benefit to payers of charity care is

$$\frac{\mathrm{d}W_{UC}}{\mathrm{d}\mathbf{K}p} = \underbrace{-\omega^0_{\cdot >0}\, \alpha\, g\, \frac{ri}{p} \left(\frac{1}{\lambda_{>0}} + \overbrace{\varepsilon_{ri,\lambda_0} - \varepsilon_{r,\lambda_0}}^{\text{cost difference}} \right)}_{\text{service surcharge}} \frac{\mathrm{d}\lambda_0}{\mathrm{d}\mathbf{K}} - \underbrace{(1-\alpha)\, g\, \frac{ri}{p} \left(1 + \varepsilon_{ri,\lambda_0}\right)}_{\text{hospital assessment}} \frac{\mathrm{d}\lambda_0}{\mathrm{d}\mathbf{K}}. \tag{10}$$

For the fiscal costs, financing the subsidy dollar through worker taxation reduces welfare by $-e\frac{\mathrm{d}\tau_{pb}}{\mathrm{d}\lambda_p p} = -\lambda_2 + (\lambda_p + k)\frac{\mathrm{d}\lambda_0}{\mathrm{d}\lambda_p} + (\lambda_p - \tau_{ESI})\frac{\mathrm{d}\lambda_1}{\mathrm{d}\lambda_p} - \frac{\tau_{pb}}{p}\frac{\mathrm{d}e}{\mathrm{d}\lambda_p}$. This amount includes the mechanic transfer to enrollees λ_2 and the fiscal externality from new enrollees $\frac{\mathrm{d}\lambda_0}{\mathrm{d}\lambda_p}$ and ESI crowd-out $\frac{\mathrm{d}\lambda_1}{\mathrm{d}\lambda_p}$. The crowd-out affects welfare through the subsidy increase $\lambda_p - \lambda_{ESI}$ and the adjustment in the transfer burden per worker $(1-\tau_{ESI})\frac{\mathrm{d}e\lambda_{e,1}}{\mathrm{d}\lambda_p}$. $\frac{\tau_{pb}}{e}\frac{\mathrm{d}e}{\mathrm{d}\lambda_p}$ is the adjustment in the tax burden from employment $\frac{\mathrm{d}e}{\mathrm{d}\lambda_p}$. The total fiscal cost is thus

$$\frac{\mathrm{d}W_C}{\mathrm{d}\lambda_p\, p} = -\lambda_2 + \overbrace{(\lambda_p + k)\frac{\mathrm{d}\lambda_0}{\mathrm{d}\lambda_p}}^{\text{new enrollees}} + \overbrace{\Big[\underbrace{\lambda_p - \tau_{ESI}}_{\text{crowd-out}} \underbrace{-\omega_{1,1}(1-\tau_{ESI})\Big]\frac{\mathrm{d}\lambda_1}{\mathrm{d}\lambda_p}}_{\text{reduced private transfer}} + \underbrace{\frac{\lambda_1\omega_{1,1}}{e\lambda_{e,1}}(1-\tau_{ESI})\frac{\mathrm{d}e\lambda_{e,1}}{\mathrm{d}\lambda_p}}_{\text{transfer burden per worker}}}^{\text{response in ESI}}$$
$$+ \frac{\tau_{pb}}{p}\frac{\mathrm{d}e}{\mathrm{d}\lambda_p}. \tag{11}$$

I show detailed derivation in Appendix B. Overall welfare thus depends on the transfer values to enrollees, the externality on premiums and charity costs, and the fiscal cost to the government. The net benefit indicates the desirability of further expansion using policy. I discuss model assumptions and alternative mechanisms affecting welfare below.

4.3 Model Discussion

Charity Costs. I assume that the government maintains a balanced budget for charity care and the subsidies on premiums, so that the surcharge burden on patients would respond to the charity costs of the uninsured given subsidized expansions. In Massachusetts, the surcharge decreased from 2.90% of services in 2005 to 1.87% in 2013. For a service cost of $9,656 per hospital admission, expansion lowered surcharge payments by $36 per admission.[10] In addition, hospital uncompensated costs decrease in states expanding health insurance to the low-income (Dranove *et al.* 2016; Blavin 2016), consistent with drops in the revenue loss immediately to hospitals.

In Massachusetts, the service surcharge covers only one-third of the charity costs. With a low program budget, hospitals may seek private payments from insurers to cover the costs uncompensated by the government. To allow for cost-shifting, I deviate from the

[10]The hospital expense per inpatient day is $2,414 in 2011 in Massachusetts (source: Kaiser Family Foundation, https://www.kff.org/state-category/health-costs-budgets/hospital-inpatient-day-expenses/). Assuming a 4-day inpatient stay, the reduction in service surcharge is $4 \cdot \$2,414 \cdot (2.90\% - 1.87\%) \cdot 36\% = \$35.80$ per hospital admission under a 36% budget share.

program budget and calculate welfare when charity costs are borne by different private payers. As I show in Section 7.3, alternative incidences of charity costs yield similar impacts on welfare as the program budget (equation 10).

Private Insurance. Expansions are more costly if spending on subsidized insurance replaces private insurance by firms. Because subsidizing enrollees previously in ESI does not improve the insurance risk pool or reduce charity costs, crowd-out does not increase the pricing benefits but impacts costs through the substitution with private transfers in equation 11. In particular, higher subsidy in the individual insurance compared to ESI increases the costs, and the loss of workers in ESI reduces welfare due to the additional transfer burden on workers.

Empirically, expansions of public insurance often lead to some extent of crowd-out of private insurance (Gruber and Simon, 2008), although evidence of significant crowd-out is not strong in recent reforms under an employer mandate (Sommers *et al.* 2014; Sommers *et al.* 2018; Frean *et al.* 2017). Across sub-groups, subsidy may induce younger individuals to sort into jobs without ESI (Aizawa, 2019) while inducing early retirement in old age (Wood, 2019), implying that subsidy will likely impact the ESI burden on workers. In Massachusetts, I examine ESI crowd-out jointly with employment to quantify the expansion impacts on private insurance.

Individual Optimization. A key assumption of the empirical framework is that individuals optimally choose health insurance but do not internalize the pricing implications on premiums and charity care. To improve welfare, the government offers financial incentives to expand health insurance. The policy environment lends itself to the sufficient statistics approach which characterizes welfare using individual responses to policy.

Optimization also implies that marginal enrollees responding to policy are indifferent with the uptake. For welfare, this implies that private benefits of insurance given prices are fully internalized in choices. Due to the complexity of insurance contracts and insurance choice, realistic deviations from optimization may arise due to cognitive and behavioral biases of individuals (Handel and Kolstad 2015; Handel *et al.* 2019). To the extent that enrollment would have increased utility based on a normative measure, policies increasing uptake also benefit marginal enrollees by improving their choices. These benefits are not included in the empirical framework.

5 Estimation

The key statistics in the empirical framework are the incentive effects of policy on insurance and employment choice. These responses determine the pricing externality in equation 9 to 11. I turn to the estimation of these empirical quantities next.

5.1 Subsidy Rate

Subsidy in Massachusetts ensures that premiums paid by enrollees do not exceed an affordability limit. Regulations on premiums prohibit price discrimination within rating communities defined by enrollee age and county. Given the market price charged by insurers, subsidy rate as a percent of premium equals

$$subs = 1 - \frac{affordability}{market\_price}, \tag{12}$$

which is the discount provided by policy. I detail the construction of $subs$ next.

Numerator: affordability. Affordability starts from zero for individuals with income below 150% FPL and increases discretely with income at 200%, 250%, and 300% FPL. The income cut-offs are displayed in the Schedule HC Worksheets and Tables prepared by the state government to help tax filers determine the affordability, subsidy, and penalty amounts applicable to their income and insurance status. Figure 2 shows the affordability schedule and the market premium price printed in the 2011 Worksheets and Tables. The cut-off at 150% FPL corresponds to an annual income of $16,344 for single individuals and a family income of $22,068 for married couples. Above 300% FPL, insurance is deemed affordable and subsidy no longer applies.

Denominator: market price. The right panel of Figure 2 shows the cheapest premium price across counties and enrollee age in 2011. Across ages, premium is nearly twice as high for the oldest group (55+) compared to young adults (age 27-29).[11] Across locations, premiums are higher in the Berkshire-Franklin-Hampshire counties, where the monthly premium for single adults in age 40-44 is $316. These prices further differ over years. For instance, premiums in the Berkshire-Franklin-Hampshire counties are the lowest across regions in 2010 and rank middle in 2009.[12]

Subsidy Rate in ACS. I construct subsidy rates for 132,360 Massachusetts individuals of age 27-64 in the 2008-2011 American Community Survey (ACS). Because adult children living with parents are not claimed as dependents, I construct family units for each generation in co-residing households (Ruggles *et al.*, 2018) and assign affordability to family members based on incomes. I assign the market premium price to individuals based on age and location across public use micro-data areas (PUMAs). In Massachusetts, 52 PUMAs divide up 14 counties, with 7 intersecting multiple counties. For these PUMAs, I follow Frean *et al.* (2017) and assign the average premium price weighted by population shares to individuals.[13]

Appendix Table C1 summarizes the subsidy rate in Massachusetts. About one quarter of the state population does not have ESI and hence qualifies for subsidized insurance. The eligible individuals are more likely to be young adults with lower education and income. The average subsidy rate is 68% (69% excluding the uninsured), implying an expected

[11] Younger individuals below age 26 are eligible for dependent coverage from parents' insurance. I exclude this group from the analysis.

[12] The 2009 Worksheets and Tables is available at https://www.mass.gov/doc/hc-instrpdf/download, and the 2010 document is available at https://www.mass.gov/doc/sched-hc-worksheetspdf.

[13] The split of PUMA population across counties is detailed in http://usa.ipums.org/usa/volii/2000pumas.shtml. The weighting affects premiums in 7 PUMAs or 14% of the state population. As I show in the robustness analysis, results are not sensitive to dropping the border PUMAs or subsuming them into counties with the largest population share.

Figure 2: 2011 Schedule HC Worksheets and Tables, Affordability and Premiums

Table 3: Affordability

Individual or Married Filing Separately (no dependents)		
a. Federal adjusted gross income		b. Monthly premium
From	To	
$ 0	$16,344	$ 0
$16,345	$21,780	$ 39
$21,781	$27,228	$ 77
$27,229	$32,676	$116
$32,677	$39,215	$175
$39,216	$44,443	$235
$44,444	$54,900	$354
$54,901	Any individual with an annual income over $54,900 is deemed to be able to afford health insurance.	

Married Filing Jointly with no dependents or Head of Household/ Married Filing Separately with one dependent		
a. Federal adjusted gross income		b. Monthly premium
From	To	
$ 0	$22,068	$ 0
$22,069	$29,424	$ 78
$29,425	$36,780	$154
$36,781	$44,136	$232
$44,137	$55,113	$315
$55,114	$65,611	$422
$65,612	$86,607	$589
$86,608	Any couple with an annual income over $86,607 is deemed to be able to afford health insurance.	

Married Filing Jointly with one or more dependents or Head of Household/Married Filing Separately with two or more dependents		
a. Federal adjusted gross income		b. Monthly premium
From	To	
$ 0	$ 27,804	$ 0
$27,805	$ 37,068	$ 78
$37,069	$ 46,332	$154
$46,333	$ 55,596	$232
$55,597	$ 73,688	$373
$73,689	$ 94,742	$586
$94,743	$115,796	$849
$115,797	Any family with an annual income over $115,796 is deemed to be able to afford health insurance.	

Table 4: Premiums

Region 1. Berkshire, Franklin and Hampshire Counties			
Age	Individual[1]	Married couple[2] (no dependents)	Family[3]
0–26	$164	$328	$ 846
27–29	$258	$516	$ 875
30–34	$270	$540	$ 887
35–39	$291	$582	$ 887
40–44	$316	$632	$ 922
45–49	$372	$744	$1,011
50–54	$455	$910	$1,137
55+	$455	$910	$1,173

Region 2. Bristol, Essex, Hampden, Middlesex, Norfolk, Suffolk and Worcester Counties			
Age	Individual[1]	Married couple[2] (no dependents)	Family[3]
0–26	$165	$330	$ 719
27–29	$238	$476	$ 719
30–34	$241	$482	$ 860
35–39	$266	$532	$ 899
40–44	$282	$564	$ 952
45–49	$319	$638	$1,061
50–54	$404	$808	$1,255
55+	$416	$832	$1,305

Region 3. Barnstable, Dukes, Nantucket and Plymouth Counties			
Age	Individual[1]	Married couple[2] (no dependents)	Family[3]
0–26	$164	$328	$ 709
27–29	$229	$458	$ 724
30–34	$229	$458	$ 910
35–39	$261	$522	$ 932
40–44	$297	$594	$ 959
45–49	$328	$656	$1,050
50–54	$384	$768	$1,238
55+	$396	$792	$1,269

1. Includes married filing separately (no dependents).
2. Rates for a married couple are based on the combined monthly premium cost of individual plans for each spouse, rather than the cost of a two-person (or self plus spouse) plan.
3. Head of household or married couple with dependent(s).

WS-3

Notes. Figure shows a screenshot of the 2011 Schedule HC Worksheets and Tables in Massachusetts. Table on the left panel shows the affordability amount across incomes. Table on the right panel shows the market premium rates across counties. Affordability is zero below 150% FPL, or $16,344 in annual income for single adults and $22,068 in family income for married couples. Subsidy is not applicable above 300% FPL. The full Worksheets and Tables for 2011 is available at https://www.mass.gov/lists/dor-health-care-forms.

premium cost that is one-third of the market price with subsidy.

5.2 Empirical Strategy

I estimate the incentive effects of subsidy exploiting variations in affordability and the premium differences across rating communities. Building on the subsidy measure $subs$, I compare choices across individuals exposed to the same market price in the denominator but eligible for different affordability amounts due to the differences in incomes. The strategy comparing subsidy differences given premiums has been successfully implemented in Frean *et al.* (2017), Jaffe and Shepard (2018), and Tebaldi (2017) to study the subsidized individual market.

There are several challenges to applying the strategy. First, the means-tested subsidy schedule may induce individuals to reduce incomes to qualify for higher subsidy. The endogenous choice of subsidy rates can bias estimates through reverse causality.

In addition, unobserved factors affecting choices could be correlated with income and the subsidy rate of enrollees. For instance, differences in education and labor market conditions affect both insurance coverage and income, and failing to account for these differences would lead to omitted variable biases in the estimates. Moreover, measurement errors in the subsidy rate introduce attenuation bias to the estimates.

To overcome the challenges, I simulate subsidy rates applying the premiums and subsidy schedules in 2008-2011 Massachusetts to the national sample of individuals in the 2005-2006 ACS. Using a national pre-reform sample ensures that the simulated rates do not capture behavioral responses to incentives. I detail the simulation next.

5.3 Simulated Instrument

I simulate two generosity measures and use them as instruments for the subsidy rate $subs$. I construct the first instrument, $subiv$, as follows

$$subiv_{dapt} = 1 - \frac{1}{|\mathbb{N}_{da}|} \sum_{i \in \mathbb{N}_{da}} \frac{affordability_{it}}{market\_price_{apt}},$$

where the subsidy rates are first calculated for each individual i based on her income, age a, and the market premium price in PUMA p and year t. I then average the individual rates by demographics d and age a to generate $subiv_{dapt}$. The instrument thus quantifies the subsidy generosity induced by policy and pre-existing differences in incomes across groups. In contrast to the subsidy rate of Massachusetts enrollees, the simulated instrument parametrizes policy incentives without also measuring the behavioral responses to policy.

I include 144 demographic groups in d to capture the substantial variations in subsidy across gender, race, ethnicity, education, marital and parenthood status (Appendix Table C2).[14] For instance, subsidy rate is 98% for African American single mothers in age 30-34 without high school diploma, and less than 10% for college-educated White males in the same age who are married without children.

Despite the variations, causal interpretation relies on the assumption that outcomes would have trended similarly across demographics absent the subsidy. If confounding changes correlated with policy have differential impacts across demographics, then the instrument is invalid. To assess the extent of omitted variable bias, I construct a second instrument

$$sublean_{apt} = 1 - \frac{1}{|\mathbb{N}_{a}|} \sum_{i \in \mathbb{N}_{a}} \frac{affordability_{it}}{market\_price_{apt}},$$

where individual rates are averaged simply by age a. Compared to $sublean$, the additional demographic variation in the main instrument $subiv$ allows for over-identification tests

[14] I use gender, race (White, Black, other), Hispanic origin, education (high school drop-out, high school, some college), marital and parenthood status to generate demographic groups in d.

based on the variation. I focus on the main instrument $subiv$ to estimate the policy impacts and use both instruments to conduct model specification tests.

5.4 Econometric Model

I assign simulated generosity to Massachusetts individuals across rating community apt and demographics d. The outcome of interest is insurance and employment choice y_{iapt}, which depends on subsidy generosity $subiv_{dapt}$ in the reduced form as follows

$$\begin{aligned} y_{iapt} &= \beta \cdot subiv_{d(i)apt} + \chi_1 \cdot incb_{d(i)} + \rho_a + \phi_p + \tau_t + \rho_{b(a)} \cdot \phi_{r(p)} \cdot \tau_t + \rho_{b(a)} \cdot \phi_{r(p)} \cdot incb_{d(i)} \\ &\quad + \phi_{r(p)} \cdot \tau_t \cdot incb_{d(i)} + \rho_{b(a)} \cdot \tau_t \cdot incb_{d(i)} + \phi_{r(p)} \cdot \tau_t \cdot X_{d(i)} + \gamma \cdot UE_{d(i)apt} + \epsilon_{iapt}, \end{aligned} \quad (13)$$

where I control for the main effects of age ρ_a, PUMA ϕ_p, year t, and the income $incb_{d(i)}$ of demographic d derived from the simulation sample. I include community fixed effects $\rho_{b(a)} \cdot \phi_{r(p)} \cdot \tau_t$ to control for premiums and include additional interactions to flexibly control for income differences across demographics, location, and over time.[15]

I further control for unemployment rates at the same level of the instrument in $\gamma \cdot UE_{d(i)apt}$. To do so, I include age-specific unemployment rate $UE_{b(a)t}$ as well as interactions with demographic characteristics $X_{d(i)}$ across region-year $\phi_{r(p)} \cdot \tau_t$. These controls allow macroeconomic shocks to differentially impact demographics across insurance markets, which importantly accounts for the impacts of the recession in 2008-2009. Less aggressive controls of unemployment rates yield similar estimates.

Table 2 shows the first-stage prediction. In a basic specification with main effects and demographic controls, the simple instrument $sublean$ is a good predictor of the subsidy rate, but including $subiv$ significantly improves statistical power when additional controls and unemployment rates are added. With full controls (column 4), $subiv$ strongly predicts subsidy rate with an F-statistic above 600. I turn to the reduced-form results and

[15] I control for differences across age bands $b(a)$ and ten rating regions $r(p)$ in the interactions. The main effects control for integer ages in ρ_a and PUMAs in ϕ_p.

two-stage-least-square (TSLS) estimates next.

Table 2: First-stage prediction by simulated instruments

	(I)	(II)	(III)	(IV)
subiv		0.92***	0.88***	0.89***
		(0.034)	(0.037)	(0.037)
sublean	0.90**	0.22	-1.76	
	(0.42)	(0.42)	(1.46)	
region-year FE	Y	Y	Y	
region-year-age FE				Y
UE			Y	Y
F-statistic	4.63	379.71	289.48	580.22
R^2	0.27	0.29	0.29	0.29
N	132,360	132,360	132,360	132,360

*** $p < 0.01$ ** $p < 0.05$ * $p < 0.10$

Notes: Table summarizes the first-stage prediction of subsidy rate *subs* from simulated instruments *subiv* and *sublean*. All specifications include main effects of PUMA, year, age, and income, as well as region-year effects and demographic controls. Column 3 and 4 includes controls of unemployment rates (UE) at the same level of the instrument *subiv*. Column 4 further includes three-way interaction terms as in equation 13, and the rating community fixed effects by region-year-age fully absorb the simple instrument *sublean*. Robust standard errors clustered at the level of PUMA in the parenthesis.

5.5 Results

Table 3 estimates equation 13 for insurance and employment outcomes. In Panel A, estimates based on the endogenous subsidy measure indicate lower insurance rates for more subsidized individuals. In contrast, simulated generosity capturing policy variations indicates a positive and significant impact on uptake. In Panel B, increasing the subsidy by ten percentage points increases uptake by 1.3 percentage points, with slightly larger increases estimated by TSLS in Panel C. Across age groups, young adults are the most responsive to subsidy, increasing uptake by 1.9 percentage points (Appendix Table C3).

The employment effects of subsidy are not distinguishable from zero in Table 3. Increasing subsidy generosity by ten percentage points, for instance, reduces participation by less than 1 percentage point, with similar null effects across years in 2008-2011. Across age groups, subsidy reduces participation in the near-elderly and increases employment in prime age (Appendix Table C3), but the overall impact on employment is not significant.

Column 4-5 examines ESI coverage jointly with employment. Across ages, crowd-out is larger for younger individuals less likely to obtain ESI and for the early-elderly existing the labor market (Appendix Table C3). These patterns are consistent with the "retirement-lock" of ESI (Wood 2019; Duggan *et al.* 2021) and increased sorting of young workers to subsidized insurance (Aizawa, 2019). Overall, increasing subsidy by ten percentage points decreases ESI and employment jointly by 1.7 percentage points, and decreases ESI and non-employment jointly by 3.5 percentage points (Table 3).

5.6 Robustness

I report p-values from over-identification tests in Panel C of Table 3. For all outcomes, simulated instruments are uncorrelated with unobserved factors in the error term, lending support to the specification in equation 13. In Appendix Table C4, I examine alternative specifications without unemployment controls. I find larger reductions in ESI (column 4) compared to Table 3, but the instruments are potentially correlated with economic shocks directly impacting ESI and employment. Thus, controlling for the recession could be important for estimating the ESI crowd-out in response to subsidy.

I examine alternative subsidy measures in the border PUMAs in Appendix Table C5. Instead of using premiums weighted across regions (Panel A), calculating subsidy based on premiums in the largest share region gives very similar estimates (Panel B). Dropping the border PUMAs, which affects 14% of the state population, also has very little impact on the estimates (Panel C). Overall, the effects of subsidy are not sensitive to premiums in the border PUMAs.

To assess the significance of policy impacts, I conduct randomization tests using the 50 non-MA states as placebos. In these states, I generate premiums across random rating

Table 3: Effects of subsidy generosity on insurance and employment

	(I) Any Insurance	(II) Employed	(III) In Labor Force	(IV) ESI + Employed	(V) ESI + Not Employed
			Panel A: OLS		
$subs$	-0.071***	-0.41***	-0.31***	-0.55***	0.046***
	(0.003)	(0.007)	(0.007)	(0.007)	(0.004)
R^2	0.082	0.21	0.19	0.29	0.054
			Panel B: Reduced Form		
$subiv$	0.13***	0.010	-0.003	-0.17***	-0.35***
	(0.024)	(0.053)	(0.045)	(0.056)	(0.024)
R^2	0.070	0.090	0.10	0.13	0.054
2008	0.051	-0.008	0.014	-0.17*	-0.39***
	(0.049)	(0.087)	(0.084)	(0.093)	(0.042)
2009	0.11***	0.056	-0.008	-0.14*	-0.39***
	(0.040)	(0.080)	(0.062)	(0.081)	(0.042)
2010	0.15***	-0.001	-0.003	-0.19***	-0.32***
	(0.036)	(0.064)	(0.057)	(0.066)	(0.035)
2011	0.18***	-0.003	-0.011	-0.16*	-0.32***
	(0.045)	(0.081)	(0.072)	(0.083)	(0.034)
			Panel C: Over-Identified TSLS		
$\widehat{subs}$	0.14***	0.012	-0.003	-0.19***	-0.39***
	(0.028)	(0.059)	(0.050)	(0.058)	(0.030)
F-statistic	289.48	289.48	289.48	289.48	289.48
p-value	0.32	0.43	0.54	0.81	0.44
y mean	0.95	0.77	0.83	0.81	0.10
N	132,360	132,360	132,360	132,360	132,360

*** $p < 0.01$ ** $p < 0.05$ * $p < 0.10$

Notes: Table estimates the effects of subsidy generosity on insurance and employment outcomes. Panel A shows OLS estimates using endogenous subsidy rate $subs$. Panel B shows reduced-form estimates using simulated generosity $subiv$ and separate estimates across years. Both panels apply the full specification in equation 13. Panel C estimates over-identified two-stage-least-square (TSLS) estimates using instruments $sublean$ and $subiv$. The specification controls for region-year fixed effects instead of rating community fixed effects by region-year-age. First-stage F-statistic and p-values from over-identification tests are reported. Robust standard errors clustered at the level of PUMA in the parenthesis.

communities by age, year, and PUMA, and generate affordability differences over income assigning simulated generosity randomly to demographics. Appendix Figure D1 shows estimates of equation 13 in placebo states and in Massachusetts. Effects on insurance uptake and ESI are highly significant at 95% level in Massachusetts, whereas employment responses are not distinguishable from placebo effects occurring by chance.

6 Calculation

Based on the incentive effects, I calculate the benefits on premiums and charity costs of a marginal increase in policy. I quantify the welfare weights associated with the benefits using consumption data. I detail the calculation of fiscal costs incorporating ESI and employment responses in Section 7.3.

Subsidy. I calculate the cost composition change in the subsidized market based on the cost curve derived in Finkelstein *et al.* (2019). Adjusted to the 150% FPL income, the average cost of enrollees is \$334 and marginal cost decreases from \$203 to \$148 between the 20th and the 6th percentile of WTP in 2011,[16] and further decreases to \$141.4 at the lowest WTP observed in sample. Expanding subsidized insurance by 0.1% of the state population thus reduces average cost by $\frac{\$334 \cdot 95\% + \$148 \cdot 0.1\%}{95\% + 0.1\%} - \$334 = -\$0.20$, where 95% is the state insurance rate. In terms of elasticity, the expansion reduces average cost by $\varepsilon_{r,\lambda_0} = \frac{\mathrm{d}r}{\mathrm{d}\lambda_0} \cdot \frac{\lambda_0}{r} = \frac{\$0.20}{0.1\%} \frac{5\%}{\$334} = 0.03$ for one percent reduction of uninsurance.

Given the cost elasticity, expansion through subsidy λ_p impacts premium according to

$$\frac{\mathrm{d}p}{\mathrm{d}\lambda_p} = \varepsilon_{r,\lambda_0} \frac{r}{\lambda_0} (1 + \beta) \frac{\mathrm{d}\lambda_0}{\mathrm{d}\lambda_p} = 0.03 \cdot \frac{\$334}{5\%} \cdot (1 + 25\%) \cdot (-0.18) = -\$45.1$$

under the maximum administrative load $\beta = 25\%$.[17] Linked to the benchmark premium

[16] The corresponding enrollment share is 80% to 94% of eligible individuals (Appendix Table 7, Finkelstein *et al.* 2019). Under linear extrapolation, the slope of the cost curve is -\$392.9 above 80% enrollment in subsidized insurance, and the lowest WTP type has marginal cost \$124.4.

[17] Compared to the average premium price (\$422 in 2011), administrative load is 26% above the average

(\$417.5), an additional dollar of subsidy reduces premium by $\frac{\mathrm{d}p}{\mathrm{d}\lambda_p p} = \frac{\$45.1}{\$417.5} = -0.11$.

To derive the average cost of uninsured individuals in the state, I linearly extrapolate the cost curve assuming common slopes for costs in the subsidized and unsubsidized market.[18] In specifics, marginal cost in the unsubsidized market is \$137 at the lowest WTP in sample. From linear extrapolation, the average cost of uninsured individuals is \$130.7 in the unsubsidized market and \$136.2 in the subsidized market. With 73% of the uninsured eligible for subsidy, the average cost of uninsured individuals (5% of the state population) is $ri = 73\% \cdot \$136.2 + 27\% \cdot \$130.7 = \$134.7$, which is greater than the average cost to the charity care program (\$117.1).[19] This implies a spending difference $g = \frac{\$117.1}{\$134.7} = 0.9$ between programs.

Enrolling 0.1% of the state population in subsidized insurance thus reduces the uninsured average cost by $\frac{\$134.7 \cdot 5\% - \$148 \cdot 0.1\%}{5\% - 0.1\%} - \$134.7 = -\$0.27$, or by $\varepsilon_{ri,\lambda_0} = \frac{\$0.27}{0.1\%} \frac{5\%}{\$134.7} = 0.10$ per one percent reduction of uninsurance. Given the cost elasticity, expansion through subsidy λ_p reduces the surcharge fee on patients according to

$$\begin{aligned}\frac{\mathrm{d}uc_p}{\mathrm{d}\lambda_p} &= \frac{\alpha\, g}{1-\lambda_0} \frac{ri(\lambda_0)}{h^0_{>0}} \left[\frac{1}{1-\lambda_0} + \varepsilon_{ri,\lambda_0} - \varepsilon_{r,\lambda_0} \right] \frac{\mathrm{d}\lambda_0}{\mathrm{d}\lambda_p} \\ &= \frac{36\% \cdot 0.9}{95\%} \frac{\$134.7}{12.6\%} \left[\frac{1}{95\%} + 0.10 - 0.03 \right] (-0.18) = -\$73.7,\end{aligned}$$

where $\alpha = 36\%$ is the budget share of service surcharge and $h^0_{>0} = 12.6\%$ is the hospital utilization rate.[20] Increasing the subsidy by one dollar thus reduces the surcharge fee

enrollee cost. In the calculation, I use premium $p = (1 + 25\%) \cdot \$334 = \$417.5$ as the benchmark premium linked to policy.

[18]The common slope assumption is invoked to analyze the combined individual market in Hackmann *et al.* (2015). Here, I assume that the lowest WTP types have the same cost in both markets (\$124.4), and impose common slope in the last segment of cost curves describing uninsured individuals in both markets. I thus use the assumption specifically for linear extrapolation out of sample.

[19]From the Health Safety Net program report (https://www.mass.gov/files/documents/2016/07/tp/hsn11-ar.pdf), hospital charity care totals \$440 million in 2011, with 63% spent on uninsured individuals (without primary or bridge insurance) and 90% on non-elderly adults in age 19-64. Average monthly spending is \$117.1, or $\$440m \cdot 63\% \cdot 90\%$ spending divided by $12 \cdot 177{,}535$ uninsured months.

[20]In 2011, surcharge payments provide \$160 million to the HSN budget, covering 36% of the hospital charity cost (\$440 million). From state reports on health cost trends, hospital discharge rate is 126 per 1000 resident in Massachusetts in 2011 (source https://www.mass.gov/doc/2019-cost-trends-report-chartpack).

by $\frac{\mathrm{d}uc_p}{\mathrm{d}\lambda_p p} = \frac{-\$73.7}{\$417.5} = -0.18$. Moreover, hospital revenue loss decreases by $(1-\alpha)g\frac{ri}{p}(1+\varepsilon_{ri,\lambda_0})\frac{\mathrm{d}\lambda_0}{\mathrm{d}\lambda_p} = 64\% \cdot 0.9 \cdot \frac{\$134.7}{\$417.5} \cdot (1+0.10) \cdot (-0.18) = -0.04$.

Penalty. I quantify the incentive effect of penalty using the regression discontinuity (RD) evidence from Lurie *et al.* (2021). Above the income cut-off of penalty (138% FPL) under the Affordable Care Act (ACA), uninsured months decrease by 0.08 for a \$21 increase in penalty.[21] On an annual basis, the increase in uptake is $\frac{0.08/12}{\$21/\$417.5} = 0.13$ per penalty percent linked to premium. In Massachusetts, purely based on the increase in unsubsidized insurance (2.3%) after the reform, the incentive on uptake is around $\frac{2.3\%}{\$101/\$417.5} = 0.10$ per penalty percent for a \$101 penalty.[22] I focus on the RD estimate in the calculation.

With 73% of the uninsured eligible for subsidy, the cost of marginal enrollees responding to penalty is $73\% \cdot \$148 + 27\% \cdot \$137 = \$145.0$, Expanding insurance by 0.1% of the population reduces the average cost in health insurance by $\frac{\$334 \cdot 95\% + \$145.0 \cdot 0.1\%}{95\% + 0.1\%} - \$334 = -\$0.20$, or by $\varepsilon^k_{r,\lambda_0} = \frac{\$0.20}{0.1\%} \cdot \frac{5\%}{334} = 0.03$ per one percent reduction of uninsurance. The expansion reduces uninsured costs by $\frac{\$134.7 \cdot 5\% - \$145.0 \cdot 0.1\%}{5\% - 0.1\%} - \$134.7 = -\$0.21$, implying elasticity $\varepsilon^k_{ri,\lambda_0} = \frac{\$0.21}{0.1\%} \cdot \frac{5\%}{\$134.7} = 0.08$ per one percent reduction of uninsurance.

The benefit of increased penalty on premium is

$$\frac{\mathrm{d}p}{\mathrm{d}k} = \varepsilon^k_{r,\lambda_0}\frac{r}{\lambda_0}(1+\beta)\frac{\mathrm{d}\lambda_0}{\mathrm{d}k} = 0.03 \cdot \frac{\$334}{5\%} \cdot (1+25\%) \cdot (-0.13) = -\$32.6,$$

with an additional penalty dollar reducing premium by $\frac{\mathrm{d}p}{\mathrm{d}k\,p} = \frac{-\$32.6}{\$417.5} = -0.08$. The benefit

[21] The 0.08 reduction is reported in Table 3 of Lurie *et al.* (2021) based on verified enrollment data in the tax return.

[22] According to the Key Indicator (http://archives.lib.state.ma.us/bitstream/handle/2452/112747/ocn232606916-2011-05.pdf), enrollment in unsubsidized insurance increased by 77,330 between 2006 and 2010, or by 2.3% of the age 19-64 population in Massachusetts.

on the service surcharge is

$$\frac{\mathrm{d}uc_p}{\mathrm{d}k} = \frac{\alpha\, g}{1-\lambda_0}\,\frac{ri(\lambda_0)}{h^0_{>0}}\left[\frac{1}{1-\lambda_0} + \varepsilon^k_{ri,\lambda_0} - \varepsilon^k_{r,\lambda_0}\right]\frac{\mathrm{d}\lambda_0}{\mathrm{d}k}$$
$$= \frac{36\%\cdot 0.9}{95\%}\,\frac{\$134.7}{12.6\%}\left[\frac{1}{95\%} + 0.08 - 0.03\right](-0.13) = -\$52.3,$$

with the additional penalty dollar reducing the surcharge by $\frac{-\$52.3}{\$417.5} = -0.13$. The penalty reduces the revenue loss of hospitals by $(1-\alpha)\, g\,\frac{ri}{p}\,(1+\varepsilon^k_{ri,\lambda_0})\,\frac{\mathrm{d}\lambda_0}{\mathrm{d}k} = -0.03$.

Consumption. – I assume that the state utility exhibits constant relative risk aversion (CRRA) over consumption, so that marginal utility equals $u'(c^l_{ij}) = \left(c^l_{ij}\right)^{-\gamma}$ for employment i, insurance j, and health state l. I normalize welfare by the marginal value of labor earnings, so that welfare weights across groups are functions of consumption ratios given γ.[23]

I measure consumption in Massachusetts using the 2011 panel of the Consumer Expenditure Survey (CEX). I determine insurance choice from expenditures on premiums and classify health states based on expenses on hospital services. Appendix Table C6 summarizes non-medical consumption across groups. The consumption ratios imply welfare weight $1.03^{-\gamma}$ on ESI sponsors, $0.64^{-\gamma}$ on subsidized enrollees, $0.58^{-\gamma}$ on the uninsured, and $0.77^{-\gamma}$ on patients subject to the surcharge.

7 Welfare

7.1 Subsidy

I apply the empirical results to quantify the welfare impacts of subsidy summarized in Proposition 3. As a benchmark, I consider the special case where $\gamma = 0$, so that marginal utility is constant across individuals and the transfer value of policy is zero. In this case,

[23] Welfare weights are $\zeta^l_{ij} = \left(\overline{c^l_{ij}}/\overline{c_{1\cdot}}\right)^{-\gamma}$ with $\overline{c^l_{ij}}$ the average consumption in group i-j-l.

welfare calculates the cost-effectiveness of subsidy at reducing premiums and the societal burden of charity care. Further expansions are desirable if individual WTP for subsidies exceeds the fiscal cost.

Table 4: Welfare impacts of subsidies on premiums

	$\frac{dW_B}{d\lambda_p p}$	$\frac{dW_P}{d\lambda_p p}$	$\frac{dW_{UC}}{d\lambda_p p}$	$\frac{dW_C}{d\lambda_p p}$				$\frac{dW}{d\lambda_p p}$
				transfer	marginals	ESI+work	total	
$\gamma = 0$	0.24	0.10	0.06	-0.24	-0.15	-0.02	-0.42	-0.02
$\gamma = 1$	0.38	0.10	0.06	-0.24	-0.15	-0.03	-0.42	0.12
$\gamma = 2$	0.59	0.11	0.07	-0.24	-0.15	-0.04	-0.43	0.34
$\gamma = 3$	0.92	0.12	0.08	-0.24	-0.15	-0.04	-0.44	0.68

Notes: Table calculates the welfare impacts of a dollar increase in subsidy based on Proposition 3. Subsidy percent is 76% of the benchmark premium for eligible individuals ($\lambda_p = 0.76$). Increasing the subsidy by one dollar affects welfare through the transfer to recipients $\frac{dW_B}{d\lambda_p p}$, benefits on premium $\frac{dW_P}{d\lambda_p p}$ and charity cost $\frac{dW_{UC}}{d\lambda_p p}$, and the fiscal cost $\frac{dW_C}{d\lambda_p p}$. γ accounts for redistribution adjusting the welfare weights of individuals.

Table 4 summarizes the welfare impacts. The fiscal cost of increasing the subsidy by one dollar is \$0.40, of which \$0.24 is paid to current recipients and \$0.17 to new enrollees. ESI crowd-out and employment responses have very small impacts on costs. The subsidy dollar reduces premium by $\frac{dp}{d\lambda_p p} = \$0.11$, which improves welfare by $\$0.11 \cdot 95\% = \$0.10$ for the 95% enrolled in health insurance. Charity costs internalized by individuals improve welfare by \$0.06, and the surcharge burden on patients accounts for roughly $36\% \cdot \$0.06 = \$0.02$ of the benefit. The pricing benefits nearly offset the fiscal externality, implying that current subsidies are close to the optimal for reducing premiums and charity costs in the state. In addition to improving pricing efficiency, subsidies also serve redistribution purposes when directed towards low-income individuals. I consider different transfer values of subsidy through the parameter γ. Higher transfer values substantially increase the benefits to subsidized enrollees, offsetting the fiscal externality for low values of γ around 1. The benefit on charity costs further increases as expansion reduces the excess burden on patients. Overall, benefits exceed costs with even small degrees of redistribution captured in $\gamma > 0$.

7.2 Mandate penalty

Table 5 summarizes the welfare impacts of mandate penalty. In Massachusetts, penalty owed by the 5% uninsured is around 10% of the benchmark premium. Increasing the penalty by one dollar raises revenue by \$0.05. New enrollees increase the subsidy cost by \$0.11, on net increasing the spending by \$0.06. The pricing benefit on premiums and charity costs increases welfare by \$0.11, which is smaller than that of subsidy due to a smaller impact on uptake. Overall, larger penalty has nearly zero impact on welfare, suggesting that the current amount optimally balances the benefits of expansion with costs.

Including redistribution concerns, because the uninsured are more likely to be young and have low incomes (Appendix Table C1), increasing the penalty significantly reduces welfare compared to raising the revenue through taxation on workers, whereas the benefits on prices increase less with redistribution. The burden on the uninsured thus trades-off the pricing benefits and pushes for reducing the penalty with redistribution.

Table 5: Welfare impacts of mandate penalty

	$\frac{dW_B}{dkp}$	$\frac{dW_P}{dkp}$	$\frac{dW_{UC}}{dkp}$	$\frac{dW_C}{dkp}$			$\frac{dW}{dkp}$
				revenue	marginals	total	
$\gamma = 0$	-0.05	0.07	0.04	0.05	-0.11	-0.06	0
$\gamma = 1$	-0.09	0.08	0.05	0.05	-0.11	-0.06	-0.03
$\gamma = 2$	-0.15	0.08	0.05	0.05	-0.11	-0.06	-0.08
$\gamma = 3$	-0.26	0.08	0.06	0.05	-0.11	-0.06	-0.17

Notes: Table calculates the welfare impacts of a dollar increase in penalty based on Proposition 3. Penalty percent is 10% of the benchmark premium for uninsured individuals ($k = 10\%$). Increasing the penalty by one dollar affects welfare through the payment by the uninsured $\frac{dW_B}{dkp}$, benefits on premium $\frac{dW_P}{d\lambda_p p}$ and charity cost $\frac{dW_{UC}}{d\lambda_p p}$, and the fiscal cost $\frac{dW_C}{d\lambda_p p}$. γ accounts for redistribution adjusting the welfare weights of individuals.

7.3 Robustness

For robustness checks, I calculate fiscal costs applying alternative estimates of employment and ESI responses from the literature. I also consider different incidences of charity care for the pricing benefits. These calculations yield very similar results on welfare.

Employment Effects. In Table 4, employment responses to subsidy have very small impacts on the fiscal costs. Of the \$0.42 cost implied by an additional subsidy dollar, less then \$0.01 is driven by employment reduction. In the ACA, expansions of Medicaid insurance also have limited impacts on employment (Duggan *et al.* 2019; Leung and Mas 2016). These estimates alleviate the concern that subsidized expansion could meaningfully reduce the workforce and worsen the fiscal condition of government (CBO, 2014).

Nonetheless, significant employment responses have been detected in some states despite very small effects on average. These larger estimates suggest that gaining Medicaid eligibility could lead to a 4.6 to 5.3 percentage point reduction in employment (Garthwaite *et al.* 2014; Dague *et al.* 2017). Allowing for these effects, I set $\frac{\mathrm{d}e}{\mathrm{d}\lambda_p} = -0.050$ and re-calculate welfare in Appendix Table C7. The employment reduction increases the fiscal cost by \$0.02, or by less than 15% of the spending on new enrollees responding to subsidy. This suggests that the welfare impact of employment is not substantial compared to the impacts of insurance uptake. Applying the reduction in labor supply ($\frac{\mathrm{d}e}{\mathrm{d}\lambda_p} = -0.011$ from Table 3) gives similarly small costs of employment. Taken together, the employment effect of subsidy is not a significant factor in the welfare trade-offs of expansions.

ESI Crowd-Out. Switching from ESI to subsidized insurance increases the fiscal cost if subsidy is more generous than the tax exemption of ESI. In Massachusetts, purchasing ESI on the pre-tax basis reduces premium by 25% for enrollees.[24] Compared to the subsidy (76% of benchmark premium), ESI crowd-out increases the subsidy cost by

[24]The average income of workers enrolled in ESI is \$70,117 (median \$53,000) in Massachusetts. Purchasing ESI on a pre-tax basis exempts premium from the 25% federal income tax applicable in this range.

$(\lambda_p - \tau_{ESI}) \frac{\mathrm{d}\lambda_1}{\mathrm{d}\lambda_p} = (0.76 - 0.25) \cdot (-0.48) = -\$0.24$ while reducing the private transfer from ESI sponsors by \$0.22. The net increase in spending is a modest \$0.02 from the crowd-out.

The crowd-out in Massachusetts is lower than the average estimate suggesting $\frac{\mathrm{d}\lambda_1}{\mathrm{d}\lambda_p} = -0.60$ from previous Medicaid expansions (Gruber and Simon, 2008). Applying the average estimate increases the expansion cost by \$0.01, whereas assuming a zero crowd-out reduces the expansion cost by \$0.02 (Appendix Table C8), in which case subsidy is optimal at the current level. Based on the results, ESI crowd-out slightly reduces the efficiency of subsidized expansion, but redistribution would still indicate further expansions subsidizing the low-income.

Charity Costs. To allow for hospital cost shifts when reimbursement from the charity care program is low, I consider different incidences of charity costs on private payers. For charity costs fully financed by patients, subsidized expansion reduces the surcharge burden and improves welfare by an additional \$0.02-\$0.05 depending on redistribution (Appendix Table C9). Alternatively, charity costs financed through a tax on premiums result in similar benefits on welfare as the statutory budget.

Cost shifts have similarly small impacts in expansions through the mandate penalty (Appendix Table C10). Increasing the cost share on patients increases welfare by \$0.02-\$0.03, and charity costs fully financed by premiums yield nearly identical estimates on welfare. Different incidences on private payers would thus imply similar benefits of expansions on charity costs.

The benefit also depends on the spending differences between health insurance and charity care. In Massachusetts, $g = 0.9$ is consistent with an 11% increase in spending with health insurance. Much larger increases (43% with $g = 0.7$) still result in a \$0.05 reduction in charity costs with subsidy and a \$0.02 reduction with penalty (Appendix Table C11 and C12). Despite the wide range of spending differences, overall welfare is comparable to the main results with $g = 0.9$.

7.4 Discussion

The welfare calculations reveal that adverse selection and charity costs both present important motivations for expansion. Over 60% of the pricing benefits are reductions in health insurance premiums, with the rest accruing to patients and hospitals as reduced charity costs. While the reform was intended to reduce by the state's charity costs, expansion ultimately benefited the majority of the state population enrolled in health insurance as well as payers of charity care. In particular, the pricing benefits are larger in subsidized expansions due to the larger response in uptake.

The fiscal cost of expansion reflects the cost of covering marginal enrollees in subsidized insurance. Perhaps not very surprisingly, above the 95% insurance rate, further expansions require fiscal costs that roughly offset the benefits on premiums and charity care, resulting in a net benefit that is close to zero across a range of estimates. Thus, incremental expansions through either subsidy or penalty are unlikely to be cost-effective in terms of balancing the pricing benefits against costs.

However, expansions are desirable when subsidy provides a means of redistribution to the low-income. Incorporating redistribution preferences significantly increases the transfer benefit to recipients, whereas the pricing benefits to enrollees and patients increase less with redistribution. In contrast, redistribution worsens the penalty costs on the uninsured and reduces welfare in expansions of penalty. Taken together, implementing universal insurance with subsidy may be desirable when redistribution provides a sufficiently strong motivation that offsets the expansion costs.

8 Conclusion

The insurance expansion of Chapter 58 in Massachusetts is a landmark legislature with far-reaching implications for health insurance in the US. The key elements of the reform, namely the coverage mandate, subsidies on premiums, and rating regulations, provide the blueprint for the Affordable Care Act, a national reform which expanded Medicaid in 39 states and enrolls over 11 million individuals in the subsidized Exchange in 2020. Building on the ACA, in March 2021, the American Rescue Plan Act (ARPA) introduced further incentives for states to expand Medicaid and increased the subsidies to Exchange enrollees and previously ineligible individuals.

This paper analyzes adverse selection and the societal burden of charity care as motivations for expanding health insurance. I show that adverse selection alone does not provide strong motivations for a mandate, but expansions replacing charity care with tax-financed subsidies on premiums can improve welfare under adverse selection and progressive taxation. For policies expanding insurance using taxes and subsidies, the welfare implications depend on the strength and incidence of the motivating benefits relative to the expansion costs.

I quantify the welfare impacts of the insurance subsidy and penalty in Massachusetts. Increasing either policy incentives generates substantial benefits on enrollees in health insurance as well as individuals financing the charity care, and the joint benefit offsets the fiscal externality of expansion. Importantly, omitting either benefit would drastically under-state the overall welfare of expansion. Moreover, redistribution could motivate further expansions of subsidized insurance, whereas increasing the tax penalty would reduce welfare due to the excess burden on the uninsured.

While these results have direct implications for states with mandate penalty on the uninsured and the ongoing expansion of subsidized insurance, they also inform the desirable scope of social insurance under the presence of implicit or informal safety net available to the uninsured. The nature of selection between programs and the implications for prices and spending are important considerations in the design of social insurance.

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Appendix

A Appendix Proofs

A.1 Basic Trade-Offs

I first consider the argument for universal health insurance when charity care is not available to the uninsured. The government subsidizes health insurance premium at rate λ_p for the non-employed, and finances the subsidies from a linear tax on payroll. In simple settings where insurance is fully subsidized for the non-employed, the implied tax burden on worker ν is $\tau = \frac{(1-e)\cdot\lambda_{1-e,1}}{e\,\mathbb{E}[\nu|e(\nu,\mu)=1]}p$. Given income $y(\nu, \mu)$, insurance purchase and taxation result in consumption $c_{e,1} = y(\nu,\mu) - p - \tau\,\nu$. Absent insurance, consumption is $c^1_{e,0} = c_{e,1} + p$ in the healthy state and $c^0_{e,1} = c_{e,1} + p - M$ in the health event. Providing insurance to health types $\mu \leq n$ implies welfare

$$\begin{aligned} W = & \int_0^n \int_{\chi(\mu)}^1 u(c_{e,1})\mathrm{d}F(\nu,\mu) + \int_n^1 \int_{\chi(\mu)}^1 \mu\, u(c_{e,1}+p)\mathrm{d}F(\nu,\mu) \\ & + \int_n^1 \int_{\chi(\mu)}^1 (1-\mu)\, u(c_{e,1}+p-M)\mathrm{d}F(\nu,\mu) + \int_0^n \int_0^{\chi(\mu)} \mathrm{d}F(\nu,\mu)\cdot u(A) \\ & + \int_n^1 \int_0^{\chi(\mu)} \mu\,\mathrm{d}F(\nu,\mu)\cdot u(A) + \int_n^1 \int_0^{\chi(\mu)} (1-\mu)\,\mathrm{d}F(\nu,\mu)\cdot u(A-M) \\ & - \int_0^1 \int_{\chi(\mu)}^1 g\left(\frac{1}{\nu}\right)\mathrm{d}F(\nu,\mu) \end{aligned} \tag{A1}$$

where productivity types above an arbitrary cut-off $\chi(\mu)$ are employed. Premium p equals the expected cost of enrollees $M\gamma$ with $\gamma = \mathbb{E}[1-\mu|hi(\nu, \mu) = 1]$. An incremental expansion of insurance above health type n reduces premium by

$$\left.\frac{dp}{dn}\right|_n = -M\,\frac{\gamma - (1-n)}{i}\int_0^1 f(\nu,n)d\nu, \tag{A2}$$

where $i = e\,\lambda_{e,1} + (1-e)\,\lambda_{1-e,1}$ is the population insurance rate. For universal insurance, expansion covering the ultra-health margin reduces premium by $\frac{\mathrm{d}p}{\mathrm{d}n}\Big|_{n=1} = -p\int_0^1 f(\nu,1)d\nu$, and the reduction exactly offsets the premium cost on the ultra-margin. Thus, universal insurance implies transfers from the ultra- to the infra-margin, and the desirability of universal insurance would generally depend on the utility differences across risk types.

In addition, when subsidies are financed by a tax on payroll, expansion further impacts welfare through the incidence of subsidy across productivity. When the share eligible for subsidy is higher on the ultra-margin ($\frac{e}{e_{\mu=1}} > 1$), expansion on net increases the subsidy transfers due to higher costs to new enrollees compared wit infra-marginal reductions through premiums. The additional costs are distributed across productivity and impacts welfare through the correlation with marginal utility. The overall impact on welfare is

$$\frac{dW}{dn}\Big|_{n=1} \propto \underbrace{-\mathbb{E}[\Delta u\,|\,e=1,\mu=1] + p\cdot\mathbb{E}[u'\,|\,e=1]}_{\text{marginal vs. infra-marginal enrollees}} \underbrace{-\frac{Cov[u',\nu\,|\,e=1]}{\mathbb{E}[\nu\,|\,e=1]}\left(\frac{e}{e_{\mu=1}}-1\right)p}_{\text{tax incidence of subsidy}}, \tag{A3}$$

where $\Delta u = u(c_{e,1}+p) - u(c_{e,1})$ is the utility cost of premium for $\mu = 1$. $p\,\mathbb{E}[u'|e=1]$ is the infra-marginal benefit resulting from lower premiums. The third term gives the tax incidence of subsidy. With progressive taxation, the subsidy increase $\left(\frac{e}{e_{\mu=1}}-1\right)p$ imposes smaller burdens on individuals with higher marginal utility, which further improves welfare through the redistribution across workers.

Thus, expansion achieving universal insurance is desirable if the benefits to infra-marginal enrollees and the redistribution through taxes offset the marginal utility loss. The net benefit is indeterminate as a result of the trade-off. However, when society already provides charity care to the uninsured, expanding subsidized insurance can improve welfare by reducing the charity care burden on private sector patients in health insurance. I derive Proposition 1 regarding subsidized expansion replacing charity care next.

A.2 Expanding Subsidized Insurance

Following the setting in Section 3.2, I consider expansions of subsidized insurance when workers are enrolled in mandatory insurance from employers. Expanding subsidized insurance to cover marginal health types n_{1-e} impacts welfare according to

$$\frac{\mathrm{d}W}{\mathrm{d}n_{1-e}} = e\sum_{l=0,1} h^l_{e,1}\,\mathbb{E}[u'(c_{e,1})]\cdot\mathbb{E}\left[\frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}\middle| e=1, h=l\right] + e\sum_{l=0,1} h^l_{e,1}\,Cov\left[u', \frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}\middle| e=1, h=l\right].$$

Because subsidies replacing charity care do not increase the transfer to the non-employed, the resource cost of the expansion is zero

$$\sum_{l=0,1} h^l_{e,1}\,\mathbb{E}\left[\frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}\middle| e=1, h=l\right] = 0.$$

Thus, if marginal utility does not differ across health states, employees in health insurance would be indifferent between providing charity care and subsidized insurance to the non-employed. However, with charity care, the service surcharge results in higher marginal utility in the health event, and expansion replacing charity care increases welfare for patients according to $e\,h^0_{e,1}\,\Delta u'_h\cdot\mathbb{E}\left[\frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}\middle| e=1, h=0\right]$, where $\Delta u'_h$ is the marginal utility increase in the health event. The welfare impact can be written as

$$\frac{\mathrm{d}W}{\mathrm{d}n_{1-e}} = e\,h^0_{e,1}\,\Delta u'_h\cdot\mathbb{E}\left[\frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}\middle| e=1, h=0\right] + e\sum_{l=0,1} h^l_{e,1}\,Cov\left[u', \frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}\middle| e=1, h=l\right]. \quad \text{(A4)}$$

In the first term, the consumption response $\frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}$ for patients operates through changes in the subsidy transfer linked to premiums and reductions in the service surcharge based on the cost of marginal enrollees. Let $s(n_{1-e}) = \int_0^{\chi(n_{1-e})} f(\nu, n_{1-e})\,d\nu$ indicate the size of subsidized enrollees on health margin n_{1-e}. The subsidy cost of new enrollees is $p\cdot s(n_{1-e})$, and the infra-marginal reduction in premiums and subsidies is $(1-e)\lambda_{1-e,1}\frac{\mathrm{d}p}{\mathrm{d}n_{1-e}} = -(1-e)\lambda_{1-e,1}M\frac{\gamma-(1-n_{1-e})}{i}\cdot s(n_{1-e})$. On net, expansion increases subsidy by $\Delta S = p - (1 -$

$e)\lambda_{1-e,1} M \frac{\gamma-(1-n_{1-e})}{i}$ multiplied by the expansion size $s(n_{1-e})$. Let $MC = M(1-n_{1-e})$ indicate the marginal cost of new enrollees. With premium $p = M\gamma$, the subsidy increase simplifies to $\Delta S = \frac{e}{i}p + (1-\frac{e}{i})MC$, an average of premium and marginal cost weighted by the worker share in health insurance. Furthermore, expansion reduces the surcharge burden by the marginal enrollee cost MC adjust by the budget share t. The consumption impact on patients is therefore

$$\mathbb{E}\left[\frac{\mathrm{d}c_{e,1}}{\mathrm{d}n_{1-e}}\middle| e=1, h=0\right] = \left[\left(1 - \frac{\mathbb{E}[\nu|e=1, h=0]}{\mathbb{E}[\nu|e=1]}\right)\Delta S + \left(\frac{t}{h^0_{e,1}} - 1\right) MC\right]\frac{s(n_{1-e})}{e}. \tag{A5}$$

Applying the consumption change to equation A4 and factoring out the expansion size $s(n_{1-e})$, welfare depends on

$$\underbrace{h^0_{e,1}\Delta u'_h \left[\left(1 - \frac{\mathbb{E}[\nu|e=1, h=0]}{\mathbb{E}[\nu|e=1]}\right)\Delta S + \left(\frac{t}{h^0_{e,1}} - 1\right)MC\right]}_{\text{patient burden}} \underbrace{- \sum_{l=0,1} \frac{Cov[u', \nu|e=1, h=l]\cdot h^l_{e,1}}{\mathbb{E}[\nu|e=1]}\Delta S,}_{\text{tax incidence of subsidy}}$$

with $\left(1 - \frac{\mathbb{E}[\nu|e=1,h=0]}{\mathbb{E}[\nu|e=1]}\right)\Delta S$ the relative subsidy burden on workers in the health event. When subsidy imposes smaller burdens on patients $\left(\frac{\mathbb{E}[\nu|e=1,h=0]}{\mathbb{E}[\nu|e=1]} < 1\right)$ in addition to reducing the burden of charity care $\left(\frac{t}{h^0_{e,1}} > 1\right)$, expansion replacing charity care increases welfare for patients. Moreover, when the burden of subsidy is smaller on individuals with higher marginal utility, expansion further improves welfare through progressive taxation.

To derive Proposition 1, note that the condition $\frac{\mathbb{E}[\nu|e=1,h=0]}{\mathbb{E}[\nu|e=1]} < 1$ is equivalent to a positive correlation $Cov[\nu, \mu|e=1]$ between productivity and the health type of workers. The condition $Cov[u', \nu|e=1, h] < 0$ implies that subsidies are financed with progressive taxation decreasing in marginal utility. Together, the conditions ensure that replacing charity care with tax-financed subsidies increases welfare for each marginal health type n_{1-e}, so that subsidized universal insurance maximizes welfare.

A.3 Universal Health Insurance with Penalty

To arrive at the welfare effects summarized in Proposition 2, note that expanding insurance to the ultra-health margin increases welfare by

$$\left.\frac{dW}{dn}\right|_{n=1} = \underbrace{\int_{\chi(1)}^{1} u(c_{e,1}) f(\nu,1) d\nu - \int_{\chi(1)}^{1} u(c_{e,0}) f(\nu,1) d\nu}_{\text{marginal utility}} + \underbrace{e \cdot \mathbb{E}\left[u'(c_{e,1}) \frac{dc_{e,1}}{dn} \middle| e=1\right]}_{\text{infra-marginal benefits}}, \quad \text{(A6)}$$

where the first two terms give the utility cost of insurance for the healthiest individuals. The consumption difference $c_{e,1} - c_{e,0} = -(1-k)p$ is the premium cost net of penalty. On the infra-margin, expansion reduces premium and improves utility according to the term $e \cdot \mathbb{E}\left[u'(c_{e,1}) \frac{dc_{e,1}}{dn} \middle| e=1\right]$, which is a sum of consumption benefit $e \cdot \mathbb{E}[u'(c_{e,1})]\mathbb{E}\left[\frac{dc_{e,1}}{dn} \middle| e=1\right]$ and incidence $e \cdot Cov\left[u'(c_{e,1}), \frac{dc_{e,1}}{dn} \middle| e=1\right]$.[25]

The consumption response equals

$$\left.\frac{dc_{e,1}}{dn}\right|_{n=1} = \int_0^1 f(\nu,1) d\nu \left[1 - \frac{\nu}{\mathbb{E}[\nu | e=1]}\left[1 - \frac{e_{\mu=1}}{e}(1-k)\right]\right] p, \quad \text{(A7)}$$

where the first term in the square bracket is the premium reduction from the expansion. The second term, $\frac{\nu}{\mathbb{E}[\nu|e=1]}\left[1 - \frac{e_{\mu=1}}{e}(1-k)\right]$, accounts for the increase in the subsidy burden on productivity type ν. The increase is smaller with larger employment share on the ultra-margin ($\frac{e_{\mu=1}}{e}$) and smaller revenue loss from foregone penalty. Total consumption increases for workers according to $e \cdot \mathbb{E}\left[\frac{dc_{e,1}}{dn} \middle| e=1\right] = p(1-k)\int_{\chi(1)}^1 f(\nu,1) d\nu$, which is the resource transfer from the ultra-margin to the infra-margin.

Applying equation A7, the incidence term $e \cdot Cov\left[u'(c_{e,1}), \frac{dc_{e,1}}{dn} \middle| e=1\right]$ can be shown to equal $-\frac{Cov[u',\nu|e=1]}{\mathbb{E}[\nu|e=1]}\left(k + \frac{e}{e_{\mu=1}} - 1\right)p \cdot \int_{\chi(1)}^1 f(\nu,1) d\nu$. The term $\left(k + \frac{e}{e_{\mu=1}} - 1\right)p$ captures the increase in subsidy transfers when the cost of marginal enrollees exceeds the infra-marginal reduction through premiums, with the net increase proportional to $\frac{e}{e_{\mu=1}} - 1$.

[25] Because consumption does not further differ across health states when universal health insurance fully replaces charity care, I omit the superscript for health state in the derivation.

Including the lost revenue from penalty, the subsidy burden on workers adjusts and impacts welfare through the correlation with marginal utility $Cov[u', v|e=1]$. The infra-marginal benefit in equation A6 thus equals

$$e \cdot \mathbb{E}\left[u'(c_{e,1})\frac{\mathrm{d}c_{e,1}}{\mathrm{d}n}\middle|e=1\right] = \left[p(1-k) - \frac{Cov[u', v|e=1]}{\mathbb{E}[v|e=1]}\left(k + \frac{e}{e_{\mu=1}} - 1\right)p\right]\int_{\chi(1)}^{1} f(v,1)\,dv. \tag{A8}$$

From equation A6 and A8, normalized by the size of unsubsidized enrollees on the ultra-health margin $\int_{\chi(1)}^{1} f(v,1)\,dv$, expansion impacts welfare according to

$$\frac{\mathrm{d}W}{\mathrm{d}n}\bigg|_{n=1} \propto \underbrace{\mathbb{E}[u(c_{e,1}^{1}) - u(c_{e,0}^{1})|e=1, \mu=1]}_{\text{marginal utility loss } (MP)} + \underbrace{\mathbb{E}[u'|e=1](1-k)p}_{\text{benefits to enrollees } (IB)} \underbrace{- \frac{Cov[u', v|e=1]}{\mathbb{E}[v|e=1]}\left(k + \frac{e}{e_{\mu=1}} - 1\right)p}_{\text{tax incidence of subsidy } (TS)}, \tag{A9}$$

which sums over marginal utility loss MP, enrollee benefit IB, and the tax incidence of subsidy TS as in Proposition 2. Universal insurance thus trades-off the marginal utility loss against the infra-marginal benefits through premiums and the redistribution across workers. When marginal utility differs, infra-marginal benefits do not necessarily offset the utility loss, and universal insurance may not be desirable due to the trade-off.

B Insurance Expansion In An Empirical Framework

Let $\mathcal{U} = \int_0^\infty U(c_{i,j,t})S(t)\,dt$ indicate the life-cycle utility of type (v, μ) borne in period t, with $S(t)$ the survival probability after time t. From stationarity, $\mathcal{U}$ is the utility of type (v, μ) individuals in each period, with $S(t)$ the size of age-t individuals. Across types, $V = \int_{(v,\mu)} \mathcal{U}\,dF(v,\mu)$ is the sum of individual utility each period. Increasing policy **K** affects utility V according to

$$\frac{\mathrm{d}V}{\mathrm{d}\mathbf{K}} = \int_{(\nu,\mu)} \int_0^\infty U' \frac{\mathrm{d}c_{i,j,t}}{\mathrm{d}\mathbf{K}} S(t)\, dt\, dF(\nu,\mu), \tag{B1}$$

where U is the period utility in equation 1. Assuming that individuals optimally choose employment i and insurance j, marginal enrollees following a policy increase $d\mathbf{K}$ are indifferent with the uptake. On the infra-margin, expansion creates externality on prices through the program risk pools and impacts consumption $c_{i,j,t}$ through the individual budget constraint. Evaluated by the marginal utility of individuals bearing the externality, the welfare impact can be written as

$$\begin{aligned}\frac{\mathrm{d}V}{\mathrm{d}\mathbf{K}} \approx & -\frac{\mathrm{d}\tau_{pb}}{\mathrm{d}\mathbf{K}} \cdot e \cdot U'(\overline{c_{1\cdot}}) - \frac{\mathrm{d}\tau_{pr}}{\mathrm{d}\mathbf{K}} \cdot e\, \lambda_{e,1} \cdot U'(\overline{c_{11}}) \\ & - \frac{\mathrm{d}(1-\lambda_p)p}{\mathrm{d}\mathbf{K}} \cdot \lambda_2 \cdot U'(\overline{c_{\cdot 2}}) - \frac{\mathrm{d}kp}{\mathrm{d}\mathbf{K}} \cdot \lambda_0 \cdot U'(\overline{c_{\cdot 0}}) \\ & - \frac{\mathrm{d}uc_p}{\mathrm{d}\mathbf{K}} \cdot \lambda_{>0}^0 \cdot U'(\overline{c_{\cdot >0}^0}),\end{aligned} \tag{B2}$$

where $\overline{c_{i,j}^l}$ is the average consumption given choice (i,j) and in health state l.[26]

The pricing externality terms are derived from differentiating the program budget and premium (equation 3 to 6) with respect to a small policy increase $d\mathbf{K}$. In addition to individual utility, expansion benefits hospitals through reduced revenue loss from charity care, captured in $-(1-\alpha)\frac{\mathrm{d}\lambda_0^0}{\mathrm{d}\mathbf{K}} g\, n M$.

[26]To illustrate the derivation, consider the externality on the public transfer which affects worker utility according to

$$-\frac{\mathrm{d}\tau_{pb}}{\mathrm{d}\mathbf{K}} \underbrace{\int_{(\nu,\mu)} \int_0^\infty 1_{\{e_t=1\}} U' S(t)\, dt\, dF(\nu,\mu)}_{\mathcal{V}_e},$$

where $\mathcal{V}_e$ evaluates the tax burden on workers. Normalizing by the population size $L = \int_{(\nu,\mu)} \int_0^\infty S(t)\, dt\, dF(\nu,\mu)$, the valuation $\mathcal{V}_e$ can be written as $L \cdot \mathbb{E}_{(t,\nu,\mu)}[1_{\{e=1\}} U']$, where $\mathbb{E}_{(t,\nu,\mu)}$ averages across population shares by type (ν,μ) and age t. Using e to indicate the size of workers, the welfare impact simplifies to $-\frac{d\tau_{pb}}{d\mathbf{K}} e\, \mathbb{E}_{(t,\nu,\mu)}[U'|e = 1]$, which is approximately $-\frac{d\tau_{pb}}{d\mathbf{K}} e\, U'(\overline{c_{1\cdot}})$ ignoring third-order derivatives.

Welfare. The total impact of policy **K** on welfare $W = \zeta V - (1-\alpha)\lambda_0^0 g n M$ is given by

$$\frac{dW}{d\mathbf{K}} = \zeta \frac{dV}{d\mathbf{K}} - (1-\alpha)\frac{d\lambda_0^0}{d\mathbf{K}} g n M, \tag{B3}$$

where $\zeta = 1/U'(\overline{c_{1\cdot}})$ normalizes individual utility V to private sector revenues using the marginal utility of workers. Applying equation B2, welfare can be formulated as impacting the beneficiary utility, premiums, charity costs, and the fiscal cost of expansion. I detail the derivation next.

B.1 Expanding Insurance with Subsidy

Proposition 3 states that increasing the policy spending $\mathbf{K}p$ impacts welfare according to

$$\frac{dW}{d\mathbf{K}p} = \frac{dW_B}{d\mathbf{K}p} + \frac{dW_P}{d\mathbf{K}p} + \frac{dW_{UC}}{d\mathbf{K}p} + \frac{dW_C}{d\mathbf{K}p}. \tag{B4}$$

Here I formulate each term for an increase in the subsidy on premium.

Beneficiaries. An additional subsidy dollar raises beneficiary utility by $-\lambda_2\omega_{\cdot 2}\frac{d(1-\lambda_p)p}{d\lambda_p p} = \lambda_2\omega_{\cdot 2} - \lambda_2\omega_{\cdot 2}(1-\lambda_p)\frac{d\log p}{d\lambda_p}$, where $\lambda_2\omega_{\cdot 2}$ is the benefit to subsidized enrollees and $\frac{d\log p}{dp}$ is the reduction in premiums from the cost composition change in health insurance. I characterize the premium benefits separately. The benefit of subsidy to recipients is given by

$$\frac{dW_B}{d\lambda_p p} = \lambda_2\,\omega_{\cdot 2}. \tag{B5}$$

Premiums. The subsidy dollar expands insurance by $-\frac{d\lambda_0}{d\lambda_p p}$ and reduces premium by $\frac{d\log p}{d\lambda_p} = \frac{\varepsilon_{r,\lambda_0}}{\lambda_0}\frac{d\lambda_0}{d\lambda_p}$, where $\varepsilon_{r,\lambda_0}$ is the cost elasticity with respect to the expansion. The price change reduces payments for subsidized enrollees, workers providing ESI transfers, taxpayers financing the subsidies, and the uninsured subject to the mandate penalty. The total benefit on premiums is given by

$$\frac{\mathrm{d}W_P}{\mathrm{d}\lambda_p\, p} = -\frac{\mathrm{d}\log p}{\mathrm{d}\lambda_p}\Big[e\frac{\tau_{pb}}{p} + e\lambda_{e,1}\omega_{1,1}\frac{\tau_{pr}}{p} + \lambda_0\omega_{.0}k + \lambda_2\omega_{.2}(1-\lambda_p)\Big]. \tag{B6}$$

Charity Costs. The subsidy dollar reduces the revenue loss of hospitals by $(1-\alpha)\frac{\mathrm{d}\lambda_0^0}{\mathrm{d}\lambda_p\, p}\, g\, n M$, and reduces the service surcharge uc_p on patients in health insurance. From equation 6, the surcharge can be written as $uc_p = \alpha\, g\, \frac{\lambda_0}{\lambda_{>0}}\frac{ri(\lambda_0)}{r(\lambda_0)}\, nM$, where $ri(\lambda_0) = h_0^0\, nM$ is the cost of the uninsured in health insurance and $r(\lambda_0) = h_{>0}^0\, nM$ the cost of enrollees. Expansion reduces uc_p by $\frac{\mathrm{d}uc_p}{\mathrm{d}\lambda_p\, p} = \alpha\, g\, \frac{ri}{\lambda_{>0}^0}\left(\frac{1}{\lambda_{>0}} + \varepsilon_{ri,\lambda_0} - \varepsilon_{r,\lambda_0}\right)\frac{\mathrm{d}\lambda_0}{\mathrm{d}\lambda_p\, p}$, where $\varepsilon_{ri,\lambda_0}$ is the cost elasticity of the uninsured and $\frac{ri}{\lambda_{>0}^0}$ the burden per patient. Total reduction in charity care $\frac{\mathrm{d}W_{UC}}{\mathrm{d}\lambda_p\, p} = -\lambda_{>0}^0\, \omega_{.>0}^0\, \frac{\mathrm{d}uc_p}{\mathrm{d}\lambda_p\, p} - (1-\alpha)\frac{\mathrm{d}\lambda_0^0}{\mathrm{d}\lambda_p\, p}\, g\, nM$ can be written as

$$\frac{\mathrm{d}W_{UC}}{\mathrm{d}\lambda_p\, p} = -\omega_{.>0}^0\, \alpha\, g\, \frac{ri}{p}\left(\frac{1}{\lambda_{>0}} + \varepsilon_{ri,\lambda_0} - \varepsilon_{r,\lambda_0}\right)\frac{\mathrm{d}\lambda_0}{\mathrm{d}\lambda_p} - (1-\alpha)\, g\, \frac{ri}{p}\left(1 + \varepsilon_{ri,\lambda_0}\right)\frac{\mathrm{d}\lambda_0}{\mathrm{d}\lambda_p}. \tag{B7}$$

Fiscal Cost. Financing the subsidy dollar increases worker taxation and reduces welfare by $-e\,\frac{\mathrm{d}\tau_{pb}}{\mathrm{d}\lambda_p\, p} = -\lambda_2 + (\lambda_p + k)\frac{\mathrm{d}\lambda_0}{\mathrm{d}\lambda_p} + (\lambda_p - \tau_{ESI})\frac{\mathrm{d}\lambda_1}{\mathrm{d}\lambda_p} - \frac{\tau_{pb}}{p}\frac{\mathrm{d}e}{\mathrm{d}\lambda_p}$. This effect includes the mechanic cost λ_2 and the fiscal externality due to uptake $\frac{\mathrm{d}\lambda_0}{\mathrm{d}\lambda_p}$ and the ESI crowd-out $\frac{\mathrm{d}\lambda_1}{\mathrm{d}\lambda_p}$. The term $\frac{\tau_{pb}}{e}\frac{\mathrm{d}e}{\mathrm{d}\lambda_p}$ accounts for the employment responses affecting the tax base. Including the responses in private transfer $\frac{\mathrm{d}\tau_{pr}}{\mathrm{d}\lambda_p\, p}$, the fiscal impact of a subsidy dollar is given by

$$\begin{aligned}\frac{\mathrm{d}W_C}{\mathrm{d}\lambda_p\, p} = &-\lambda_2 + (\lambda_p + k)\frac{\mathrm{d}\lambda_0}{\mathrm{d}\lambda_p} + \Big[\lambda_p - \tau_{ESI} - \omega_{1,1}(1-\tau_{ESI})\Big]\frac{\mathrm{d}\lambda_1}{\mathrm{d}\lambda_p} \\ &+ (1-\tau_{ESI})\frac{\lambda_1\omega_{1,1}}{e\lambda_{e,1}}\frac{\mathrm{d}e\lambda_{e,1}}{\mathrm{d}\lambda_p} + \frac{\tau_{pb}}{p}\frac{\mathrm{d}e}{\mathrm{d}\lambda_p}.\end{aligned} \tag{B8}$$

B.2 Expanding Insurance with Penalty

Similarly, the welfare impact of a dollar increase in penalty is given by

$$\frac{\mathrm{d}W}{\mathrm{d}kp} = \frac{\mathrm{d}W_B}{\mathrm{d}kp} + \frac{\mathrm{d}W_P}{\mathrm{d}kp} + \frac{\mathrm{d}W_{UC}}{\mathrm{d}kp} + \frac{\mathrm{d}W_C}{\mathrm{d}kp}. \tag{B9}$$

I characterize each component next.

Beneficiaries. A dollar increase in penalty reduces utility by $-\lambda_0\,\omega_{\cdot 0}$ for the uninsured, affecting welfare by

$$\frac{\mathrm{d}W_B}{\mathrm{d}kp} = -\lambda_0\,\omega_{\cdot 0}. \tag{B10}$$

Premiums. The increase in penalty expands insurance by $-\frac{\mathrm{d}\lambda_0}{\mathrm{d}k}$ and reduces premiums according to $\frac{\mathrm{d}\log p}{\mathrm{d}k} = \frac{\varepsilon^k_{r,\lambda_0}}{\lambda_0}\frac{\mathrm{d}\lambda_0}{\mathrm{d}k}$, where $\varepsilon^k_{r,\lambda_0}$ is the cost elasticity when expansion is induced by the mandate penalty. The price change affects payments by subsidized enrollees, ESI sponsors, taxpayers, and the uninsured. The total welfare impact on premiums is

$$\frac{\mathrm{d}W_P}{\mathrm{d}kp} = -\frac{\mathrm{d}\log p}{\mathrm{d}k}\left[e\frac{\tau_{pb}}{p} + e\lambda_{e,1}\omega_{1,1}\frac{\tau_{pr}}{p} + \lambda_0\omega_{\cdot 0}k + \lambda_2\omega_{\cdot 2}(1-\lambda_p)\right]. \tag{B11}$$

Charity Costs. The penalty reduces the revenue loss of hospitals by $-(1-\alpha)\frac{\mathrm{d}\lambda^0_{>0}}{\mathrm{d}kp}g\,n\,M = -(1-\alpha)\,g\,\frac{ri}{p}\,(1+\varepsilon^k_{ri,\lambda_0})\frac{\mathrm{d}\lambda_0}{\mathrm{d}k}$, and reduces the patient surcharge by $\frac{\mathrm{d}uc_p}{\mathrm{d}kp} = \alpha\,g\,\frac{ri}{\lambda^0_{>0}}\left(\frac{1}{\lambda_{>0}} + \varepsilon^k_{ri,\lambda_0} - \varepsilon^k_{r,\lambda_0}\right)\frac{\mathrm{d}\lambda_0}{\mathrm{d}kp}$. The welfare benefit is

$$\frac{\mathrm{d}W_{UC}}{\mathrm{d}kp} = -\omega^0_{\cdot>0}\,\alpha\,g\,\frac{ri}{p}\left(\frac{1}{\lambda_{>0}} + \varepsilon^k_{ri,\lambda_0} - \varepsilon^k_{r,\lambda_0}\right)\frac{\mathrm{d}\lambda_0}{\mathrm{d}k} - (1-\alpha)\,g\,\frac{ri}{p}\left(1+\varepsilon^k_{ri,\lambda_0}\right)\frac{\mathrm{d}\lambda_0}{\mathrm{d}k}. \tag{B12}$$

Fiscal Cost. Increasing the penalty reduces the taxation on workers by $-e\frac{\mathrm{d}\tau_{pb}}{\mathrm{d}kp} = \lambda_0 + (\lambda_p + k)\frac{\mathrm{d}\lambda_0}{\mathrm{d}k} + \frac{\tau_{pb}}{p}\frac{\mathrm{d}e}{\mathrm{d}k}$, where λ_0 is the revenue from the penalty increase and $(\lambda_p+k)\frac{\mathrm{d}\lambda_0}{\mathrm{d}k}$ is the fiscal externality of new enrollees. I assume that the penalty does not affect employment or coverage from ESI. The fiscal cost of penalty is thus

$$\frac{\mathrm{d}W_C}{\mathrm{d}k\,p} = \lambda_0 + (\lambda_p + k)\frac{\mathrm{d}\lambda_0}{\mathrm{d}k}. \tag{B13}$$

C Appendix Tables

Table C1: Summary statistics, estimation sample

	Full Sample N=132,360		No ESI N=30,389		No Insurance N=5,141	
	mean	s.e.	mean	s.e.	mean	s.e.
Demographics						
Age	45.39	0.034	44.81	0.074	41.87	0.17
Female	0.52	0.002	0.52	0.003	0.37	0.008
Race						
White	0.83	0.001	0.73	0.003	0.70	0.008
Black	0.061	0.001	0.095	0.002	0.10	0.005
other	0.11	0.001	0.18	0.003	0.20	0.007
Hispanic	0.080	0.001	0.16	0.003	0.19	0.007
Education						
less than high school	0.072	0.001	0.18	0.003	0.18	0.007
high school	0.30	0.002	0.41	0.003	0.45	0.008
some college	0.62	0.002	0.41	0.003	0.36	0.008
Married	0.60	0.002	0.39	0.003	0.33	0.008
Dependent Children	0.38	0.002	0.32	0.003	0.23	0.007
Insurance						
Any Insurance	0.95	0.001	0.80	0.003	0	–
ESI	0.74	0.002	0	–	0	–
Employment						
Employed	0.77	0.001	0.51	0.003	0.64	0.008
In Labor Force	0.83	0.001	0.64	0.003	0.83	0.006
Employed + ESI	0.64	0.002	0	–	0	–
Not Employed + ESI	0.10	0.001	0	–	0	–
Income (% FPL)	500.91	0.66	383.61	1.27	371.38	2.79
Subsidy Rate	0.29	0.001	0.68	0.003	0.62	0.007
Simulated Subsidy Rate	0.31	0.001	0.46	0.002	0.46	0.003

Notes: Table summarizes the demographics, insurance, employment, and subsidies for 132,360 Massachusetts individuals in age 27-64 sampled in the American Community Survey (ACS) in 2008-2011. ACS sampling weights applied. Subsidy rates are calculated based on policy rules and incomes (in % FPL) in tax-filing units. Simulated subsidy rates are calculated from a pre-reform national sample of individuals. See the main text for details of the subsidy rates.

Table C2: Differences in subsidy across demographics

	subsidy rate *subs*		simulated *subiv*	
	mean	s.e.	mean	s.e.
Age				
27-29	0.40	0.006	0.42	0.003
30-34	0.33	0.004	0.36	0.002
35-39	0.30	0.004	0.33	0.002
40-44	0.28	0.004	0.31	0.002
45-49	0.26	0.003	0.28	0.002
50-54	0.26	0.004	0.27	0.002
55-64	0.27	0.003	0.30	0.001
Male	0.27	0.002	0.29	0.001
Female	0.31	0.002	0.33	0.001
Race				
White	0.25	0.001	0.28	0.001
Black	0.50	0.007	0.49	0.003
Other	0.46	0.005	0.46	0.002
Hispanic	0.59	0.006	0.58	0.003
Non-Hispanic	0.26	0.001	0.29	0.001
Education				
Less than high school	0.69	0.006	0.72	0.002
High school	0.41	0.003	0.43	0.001
Some college	0.18	0.002	0.21	0.001
Married	0.18	0.001	0.21	0.001
Not Married	0.46	0.003	0.47	0.001
Dependent Children	0.28	0.002	0.31	0.001
No Dependent Children	0.30	0.002	0.32	0.001

Notes: Table summarizes the subsidy rate *subs* and the instrument *subiv* across demographic groups in the estimation sample. The simulated instrument *subiv* applies subsidy policies to a pre-reform national sample of individuals and quantifies generosity exploiting income differences by demographics. *subs* indicates subsidy rates based on observed incomes in Massachusetts. ACS sampling weights applied in the statistics.

Table C3: Effects of subsidy generosity across age groups

	(I) Any Insurance	(II) Employed	(III) In Labor Force	(IV) ESI + Employed	(V) ESI + Not Employed
27-29	0.19**	0	0.075	-0.37***	-0.33***
	(0.071)	(0.12)	(0.093)	(0.12)	(0.048)
30-24	0.12**	0.015	0.085	-0.19*	-0.38***
	(0.054)	(0.068)	(0.063)	(0.10)	(0.035)
35-39	0.10**	0.18**	0.20***	-0.072	-0.42***
	(0.040)	(0.082)	(0.073)	(0.087)	(0.041)
40-44	0.16***	0.14*	0.11	0.001	-0.41***
	(0.047)	(0.075)	(0.069)	(0.065)	(0.039)
45-49	0.12***	0.066	0.045	-0.18**	-0.27***
	(0.027)	(0.072)	(0.059)	(0.075)	(0.032)
50-54	0.13***	-0.071	-0.14***	-0.26***	-0.24***
	(0.028)	(0.061)	(0.051)	(0.059)	(0.039)
55-64	0.11***	-0.19***	-0.25***	-0.16**	-0.42***
	(0.026)	(0.069)	(0.055)	(0.064)	(0.036)
y mean	0.95	0.77	0.83	0.64	0.10
R^2	0.070	0.091	0.10	0.13	0.054
N	132,360	132,360	132,360	132,360	132,360

*** $p < 0.01$ ** $p < 0.05$ * $p < 0.10$

Notes: Table estimates the effect of subsidy generosity across age groups, interacting instrument *subiv* with age group indicators in the reduced-form specification in equation 13. Robust standard errors clustered at the level of PUMA in the parenthesis.

Table C4: Effects of subsidy generosity without controlling for unemployment rates

	(I) Any Insurance	(II) Employed	(III) In Labor Force	(IV) ESI + Employed	(V) ESI + Not Employed
			Panel A: OLS		
subs	-0.071***	-0.41***	-0.30***	-0.55***	0.045***
	(0.003)	(0.007)	(0.007)	(0.007)	(0.004)
R^2	0.065	0.20	0.18	0.29	0.052
			Panel B: TSLS estimates, instrument *sublean*		
$\widehat{subs}$	0.20	-0.69	-0.29	-1.30*	-0.30
	(0.34)	(0.49)	(0.42)	(0.68)	(0.41)
F-statistic	4.63	4.63	4.63	4.63	4.63
			Panel C: TSLS estimates, instrument *subiv*		
$\widehat{subs}$	0.11***	-0.081	-0.054	-0.33***	-0.31***
	(0.027)	(0.050)	(0.043)	(0.047)	(0.026)
F-statistic	722.78	722.78	722.78	722.78	722.78
			Panel D: Over-Identified TSLS		
$\widehat{subs}$	0.11***	-0.081	-0.054	-0.34***	-0.31***
	(0.027)	(0.050)	(0.043)	(0.047)	(0.026)
F-statistic	379.71	379.71	379.71	379.71	379.71
p-value	0.79	0.18	0.57	0.053	0.97
y mean	0.95	0.77	0.83	0.64	0.10

*** $p < 0.01$ ** $p < 0.05$ * $p < 0.10$

Notes: Table estimates the effect of subsidy using the endogenous rate *subs* in Panel A, instrument *sublean* in Panel B, instrument *subiv* in Panel C, and both instruments in Panel D. The specification controls for the main effects of PUMA, year, age and income, as well as demographic variables and region-year fixed effects. The specification does not include any controls of unemployment rates. In Panel D, p-values from over-identification tests are reported in addition to the first-stage F-statistics. Robust standard errors clustered at the level of PUMA in the parenthesis.

Table C5: Robustness analysis: border PUMAs

	(I) Any Insurance	(II) Employed	(III) In Labor Force	(IV) ESI + Employed	(V) ESI + Not Employed
			Panel A: main results		
subiv	0.13***	0.010	-0.003	-0.17***	-0.35***
	(0.024)	(0.053)	(0.045)	(0.056)	(0.024)
R^2	0.070	0.090	0.10	0.13	0.054
			Panel B: assign border PUMAs to the dominant region		
subiv	0.12***	0.005	-0.009	-0.18***	-0.35***
	(0.023)	(0.053)	(0.046)	(0.058)	(0.024)
R^2	0.061	0.088	0.10	0.13	0.053
			Panel C: dropping the border PUMAs		
subiv	0.12***	0.020	0.017	-0.17***	-0.35***
	(0.026)	(0.060)	(0.049)	(0.061)	(0.026)
R^2	0.062	0.088	0.10	0.13	0.053

*** $p < 0.01$ ** $p < 0.05$ * $p < 0.10$

Notes: Table show estimates applying different premiums to PUMAs intersecting multiple rating regions. Panel A assigns the average premium weighted by region population shares to the border PUMA. Panel B assigns border PUMAs to regions with the largest population share. Panel C drops the border PUMA (affecting 14% of the state population) from the analysis. Robust standard errors clustered at the level of PUMAs in the parenthesis.

Table C6: Non-medical consumption

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
	$\overline{c_{1\cdot}}$	$\overline{c_{11}}$	$\overline{c_{\cdot 2}}$	$\overline{c_{\cdot>0}}$	$\overline{c^0_{\cdot>0}}$	$\overline{c_{\cdot 0}}$	$\overline{c}$
mean	43.21	44.38	27.57	39.43	33.16	24.95	38.51
	(2.78)	(3.05)	(6.12)	(2.53)	(6.93)	(6.50)	(2.41)
ratio (vs. $\overline{c_{1\cdot}}$)	1	1.03	0.64	0.91	0.77	0.58	0.89
N	284	238	50	323	18	22	345

Notes: Table summarizes quarterly non-medical consumption expenditures (in thousands of dollars) for Massachusetts individuals in the 2011 Consumer Expenditure Survey. Standard error of mean estimates in the parenthesis.

Table C7: Welfare impacts of premium subsidy, alternative employment effects

	$\frac{dW_B}{d\lambda_p p}$	$\frac{dW_P}{d\lambda_p p}$	$\frac{dW_{UC}}{d\lambda_p p}$	$\frac{dW_C}{d\lambda_p p}$			$\frac{dW}{d\lambda_p p}$		
				$\frac{de}{d\lambda_p} = -0.003$	$= -0.011$	$= -0.050$	$\frac{de}{d\lambda_p} = -0.003$	$= -0.011$	$= -0.050$
$\gamma = 0$	0.24	0.10	0.06	-0.42	-0.42	-0.44	-0.02	-0.02	-0.04
$\gamma = 1$	0.38	0.10	0.06	-0.42	-0.42	-0.44	0.12	0.11	0.10
$\gamma = 2$	0.59	0.11	0.07	-0.43	-0.44	-0.46	0.34	0.33	0.31
$\gamma = 3$	0.92	0.12	0.08	-0.44	-0.44	-0.46	0.68	0.67	0.66

Notes: Table summarizes welfare for an additional dollar of subsidy assuming different employment responses $\frac{de}{d\lambda_p}$ in the calculation of fiscal costs. The main result uses a reduction of 0.003 estimated in Massachusetts. Here, I calculate welfare for alternative responses using the participation reduction in Massachusetts ($\frac{de}{d\lambda_p} = -0.011$) and the larger estimates ($\frac{de}{d\lambda_p} = -0.050$) from the literature.

Table C8: Welfare impacts of premium subsidy, alternative ESI crowd-out

	$\frac{dW_B}{d\lambda_p p}$	$\frac{dW_P}{d\lambda_p p}$	$\frac{dW_{UC}}{d\lambda_p p}$	$\frac{dW_C}{d\lambda_p p}$			$\frac{dW}{d\lambda_p p}$		
				$\frac{d\lambda_1}{d\lambda_p} = -0.48$	$= -0.60$	$= 0$	$\frac{d\lambda_1}{d\lambda_p} = -0.48$	$= -0.60$	$= 0$
$\gamma = 0$	0.24	0.10	0.06	-0.42	-0.42	-0.40	-0.02	-0.02	0
$\gamma = 1$	0.38	0.10	0.06	-0.42	-0.43	-0.40	0.12	0.12	0.15
$\gamma = 2$	0.59	0.11	0.07	-0.43	-0.44	-0.40	0.34	0.33	0.37
$\gamma = 3$	0.92	0.12	0.08	-0.44	-0.45	-0.40	0.68	0.68	0.72

Notes: Table summarizes welfare for an additional dollar of subsidy assuming different ESI crowd-out in $\frac{d\lambda_1}{d\lambda_p}$. The main result applies a crowd-out of -0.48 (with one-third of the effect driven by workers) based on the estimate in Massachusetts. Alternatively, I calculate costs and welfare applying the average crowd-out (-0.60) in previous Medicaid expansions and a zero crowd-out in the table.

Table C9: Welfare impacts of subsidy, alternative incidence of charity cost

	$\frac{\mathrm{d}W_B}{\mathrm{d}\lambda_p p}$	$\frac{\mathrm{d}W_P}{\mathrm{d}\lambda_p p}$	$\frac{\mathrm{d}W_{UC}}{\mathrm{d}\lambda_p p}$			$\frac{\mathrm{d}W_C}{\mathrm{d}\lambda_p p}$	$\frac{\mathrm{d}W}{\mathrm{d}\lambda_p p}$		
			$\alpha = 36\%$	$= 100\%$	premium tax		$\alpha = 36\%$	$= 100\%$	premium tax
$\gamma = 0$	0.24	0.10	0.06	0.06	0.06	-0.42	-0.02	-0.02	-0.02
$\gamma = 1$	0.38	0.10	0.06	0.08	0.07	-0.42	0.12	0.13	0.12
$\gamma = 2$	0.59	0.11	0.07	0.10	0.07	-0.43	0.34	0.36	0.34
$\gamma = 3$	0.92	0.12	0.08	0.13	0.08	-0.44	0.68	0.72	0.68

Notes: Table summarizes welfare for an additional dollar of subsidy under alternative incidences of charity costs. $\alpha = 36\%$ is the share financed by the service surcharge according to the program budget. Alternatively, I consider complete cost shifts to private payers assuming that charity care is either fully financed by patients ($\alpha = 100\%$) or financed by enrollees through a premium tax $\tau_p = g\,\frac{\lambda_0 ri}{1-\lambda_0}$, in which case the reduction in charity costs improves welfare by $\frac{\mathrm{d}W_{UC}}{\mathrm{d}\lambda_p p} = \omega_{\cdot>0}\, g\,\frac{ri}{p}\left[\frac{1}{1-\lambda_0} + \varepsilon_{ri,\lambda_0}\right]\frac{\mathrm{d}\lambda_0}{\mathrm{d}\lambda_p}$.

Table C10: Welfare impacts of penalty, alternative incidence of charity cost

	$\frac{dW_B}{dkp}$	$\frac{dW_P}{dkp}$	$\frac{dW_{UC}}{dkp}$			$\frac{dW_C}{dkp}$	$\frac{dW}{dkp}$		
			$\alpha = 36\%$	$= 100\%$	premium tax		$\alpha = 36\%$	$= 100\%$	premium tax
$\gamma = 0$	-0.05	0.07	0.04	0.04	0.04	-0.06	0	0	0
$\gamma = 1$	-0.09	0.08	0.05	0.05	0.05	-0.06	-0.03	-0.02	-0.03
$\gamma = 2$	-0.15	0.08	0.05	0.07	0.05	-0.06	-0.08	-0.06	-0.08
$\gamma = 3$	-0.26	0.08	0.06	0.09	0.06	-0.06	-0.17	-0.14	-0.18

Notes: Table summarizes welfare for an additional dollar of penalty under alternative incidences of charity costs. $\alpha = 36\%$ is the share financed by the service surcharge according to the program budget. Alternatively, I consider complete cost shifts to private payers assuming that charity care is either fully financed by patients ($\alpha = 100\%$) or financed by enrollees through a premium tax $\tau_p = g\,\frac{\lambda_0 ri}{1-\lambda_0}$, in which case the reduction in charity costs improves welfare by $\frac{dW_{UC}}{dkp} = \omega_{\cdot>0}\, g\,\frac{ri}{p}\left[\frac{1}{1-\lambda_0} + \varepsilon_{ri,\lambda_0}\right]\frac{d\lambda_0}{dk}$.

Table C11: Welfare impacts of subsidy, differences in spending

	$\frac{dW_B}{d\lambda_p p}$	$\frac{dW_P}{d\lambda_p p}$	$\frac{dW_{UC}}{d\lambda_p p}$			$\frac{dW_C}{d\lambda_p p}$	$\frac{dW}{d\lambda_p p}$		
			$g = 0.9$	$= 0.7$	$= 1.1$		$g = 0.9$	$= 0.7$	$= 1.1$
$\gamma = 0$	0.24	0.10	0.06	0.05	0.07	-0.42	-0.02	-0.03	-0.01
$\gamma = 1$	0.38	0.10	0.06	0.05	0.08	-0.42	0.12	0.10	0.13
$\gamma = 2$	0.59	0.11	0.07	0.06	0.09	-0.43	0.34	0.32	0.35
$\gamma = 3$	0.92	0.12	0.08	0.06	0.10	-0.44	0.68	0.66	0.70

Notes: Table summarizes welfare for an additional dollar of subsidy assuming different spending levels in health insurance and charity care. $g = 0.9$ is calibrated for Massachusetts from a 11% spending increase with health insurance. $g = 0.7$ allows for a spending increase of 43%, and $g = 1.1$ allows for lower spending in health insurance compared to charity care.

Table C12: Welfare impacts of penalty, differences in spending

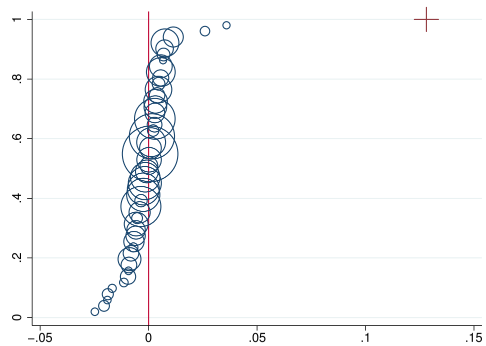
	$\frac{dW_B}{dkp}$	$\frac{dW_P}{dkp}$	$\frac{dW_{UC}}{dkp}$			$\frac{dW_C}{dkp}$	$\frac{dW}{dkp}$		
			$g = 0.9$	$= 0.7$	$= 1.1$		$g = 0.9$	$= 0.7$	$= 1.1$
$\gamma = 0$	-0.05	0.07	0.04	0.03	0.05	-0.06	0	0	0.01
$\gamma = 1$	-0.09	0.08	0.05	0.04	0.06	-0.06	-0.03	-0.04	-0.02
$\gamma = 2$	-0.15	0.08	0.05	0.04	0.06	-0.06	-0.08	-0.09	-0.07
$\gamma = 3$	-0.26	0.08	0.06	0.05	0.07	-0.06	-0.17	-0.19	-0.16

Notes: Table summarizes welfare for an additional dollar of subsidy assuming different spending levels in health insurance and charity care. $g = 0.9$ is calibrated for Massachusetts from a 11% spending increase with health insurance. $g = 0.7$ allows for a spending increase of 43%, and $g = 1.1$ allows for lower spending in health insurance compared to charity care.

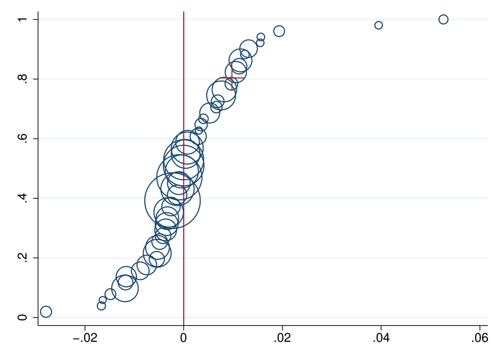
D Appendix Figures

Figure D1: Randomization tests across states

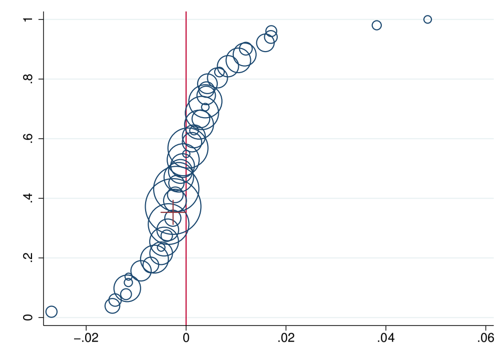
(a) Any Insurance



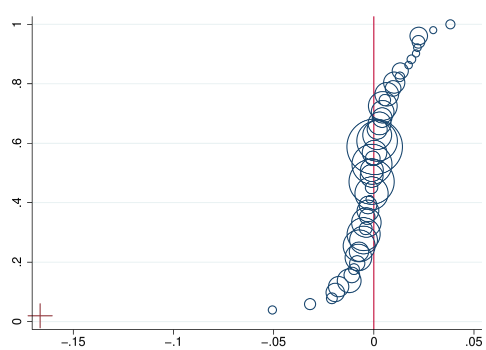
(b) Employed



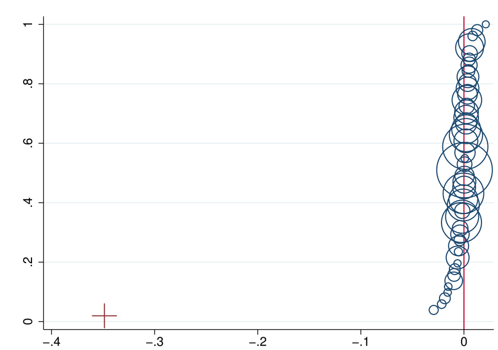
(c) In Labor Force



(d) ESI + Employed



(e) ESI + Not Employed



Notes. Figure plots the empirical cumulative distribution of estimates from non-MA states and Massachusetts (marked with a plus). In non-MA states, I generate premiums across random rating communities by age, year, and PUMA, and generate affordability differences over income by assigning simulated generosity randomly to demographics. I then estimate equation 13 in the placebo states and in Massachusetts. The circles indicate the sample size in each state.