Government Involvement in a Mandated Insurance Market: The Case of Workers' Compensation Insurance

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Abstract

I exploit the formation of public options in workers' compensation insurance in the 1990s to study how public options impact insurer competition and underwriting performance. In doing so, I provide insight on the debate about the merits of public options. I find that the introduction of public options increased market concentration overall, with public options gaining significant market share. Underwriting profitability improved following the formation of public options, but this was largely driven by simultaneous cuts in legislated benefit levels, rather than the public options themselves. I also document that, while public options tend to charge higher prices than their private competitors, they may help to stabilize private insurer loss experiences and encourage market segmentation.

Keywords: workers' compensation, public options, insurance markets, social insurance

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1 Introduction

Workers' compensation insurance pays benefits when a worker is injured or becomes ill from work-related conditions, providing medical coverage and a portion of lost income. Each state in the US has a workers' compensation system, setting its own benefit levels and regulating its own insurance market. Workers' compensation insurance markets in the US are unique - among other lines of insurance - in that some states feature public options operating as standalone, active competitors with the private market.[1] This is the first paper to provide empirical evidence as to the role of creating a public option in the US workers' compensation insurance market, where some public options have existed for more than a century and others were formed within the last 30 years.

There is notable variation in the structure of workers' compensation insurance markets across the US. In some states, the government is the only seller; in others, only privately-owned insurers sell coverage. Yet, in other states, there is a mixture of these two approaches via a public option (also known as a "state fund") that competes with private insurers. Currently, 28 states and DC have private-only settings; four states use government monopoly designs. In the 18 states that use public options, their role is notable: they paid nearly $5 billion in workers' compensation benefits in 2021 (Welch et al., 2024). Over time, many states have changed their market involvement via the public option, by either creating one for the first time or privatizing a currently-operating one. After documenting historical market statuses in each state, I focus on several new public option formations in the 1990s.

In each year between 1984 and 1991, the workers' compensation line of insurance was unprofitable (Thomason et al., 2001). While the profitability issues were largely national, only a subset of states elected to form a public option in response. The motivation for forming public options is traditionally tied to market failures.[2] With states making unique

[1] Importantly, these public options compete for non-residual risks. A residual risk, by contrast, is an employer deemed too risky to price adequately by the private market. Generally, this employer ends up in the residual market, which allocates losses (in excess of premiums) to private insurers (usually based on market share).

[2] Government involvement in US insurance markets began with workers' compensation (Greene, 1976). As Greene (1976) laid out, the rationale for government involvement in insurance comes from residual market needs, convenience, compulsory purchase, efficiency goals, or collateral social purposes. The justification for

public option choices in the face of market failures, the ultimate guiding question here is: was forming public options a "good" decision and, if so, for which stakeholder(s)? I provide insight on this broad question by investigating three research questions. First, how did the creation of public options affect the degree of concentration in workers' compensation insurance markets? Second, did the underwriting profitability of private insurers improve after the introduction of the public option and can any improvements be attributed to the public option specifically? Third, in terms of the role public options play in the market: do they encourage market segmentation or stabilize private insurer loss experiences? The answers to these questions inform various arguments about whether ultimate formation was beneficial.

To answer these questions, I use detailed, insurer-level data from the National Association of Insurance Commissioners (NAIC) spanning 1988-2020, supplemented with state-level benefit and payroll data from the US Census Bureau's County Business Patterns series, the *Social Security Bulletin*, and the National Academy of Social Insurance. Throughout, I use states that maintained consistently private-only markets (i.e., no public option) as the comparison for states that formed new public options. In both sets of states, the market structure before forming a public option was the same. The ideal experiment would be a comparison between private-only states and public option states, where the formation of the public option was the only policy lever. In reality, however, many states cut legislated benefits for all workers around the same time. To deal with this confound, I match new public option states to private-only states based on the magnitude of the cuts to benefit levels in the same year as public option formation. This allows me to compare matched and unmatched results to better isolate the impact of the public option.

To serve the first research question, I study concentration using the Herfindahl-Hirschman Index (HHI), which increases when the market is more concentrated. A public option may decrease concentration and encourage competition if it serves an exclusively residual market role (in a place with a limited residual market) or by cutting down on excessive private insurer

workers' compensation competitive public options is typically efficiency related or due to affordability and availability issues (Thomason et al., 2001).

profits (Greene, 1976; Atkinson and Stiglitz, 1980; Polyakova, 2016; Atal et al., 2024). On the other hand, concentration may grow with diminished competition for many reasons, including if the public option operates at a competitive advantage, receives preferential political treatment, or takes on residual risks in states with large residual markets (Greene, 1976; Butler and Worrall, 1986; Shleifer, 1998).

Before public option creation, I document that public option states experienced elevated concentration levels relative to private-only markets. After formation, public options lead to a large increase in concentration, never returning to the levels of the private-only counterfactual. The results indicate that the gap in HHI between public option and private-only states grew - on average - by about 100% after formation, with most new public options taking significant market share. While some of this market share may have come from residual risks in the years just after formation, I provide evidence that this is not an adequate explanation in the long term. In particular, the high concentration levels that developed just after formation have largely increased over time, including through 2020, as residual markets have shrunk in most states across the US. The results are unchanged by matching on simultaneous legislated benefit cuts and are not explained by changes in insurer entry. With no changes to entry, elevated market concentration forces private insurers to compete over smaller market shares. In the competition for these smaller market shares, I show that public options do not increase private insurer concentration.

To study the second research question, I measure underwriting profitability using the loss ratio (i.e., how much an insurer pays out in losses relative to what it earns in premiums). Before the formation of public options, statewide average loss ratios were significantly higher (more than ten percentage points higher) in public option states than in private-only states. In fact, they were above one for several years, an unsustainable proposition for insurers who are operating at a loss before including their operating expenses. After the public options joined the market, however, statewide underwriting profitability improved dramatically, with loss ratios falling by about 20%.

Were these improvements in underwriting profitability the result of public options or caused instead by other market changes at the same time? Given changes in legislated benefit levels that were prevalent during the formation period, I match public option and private market states on the relative benefit cuts in the year of formation. Doing so erases much of the loss ratio improvement. This implies that the public option did not meaningfully affect average loss ratios by itself. Moving from an unmatched to a matched analysis, the loss ratio improvement coefficients become 50% smaller and almost all lose statistical significance. Yet, the results are broadly still negative, indicative of some lingering loss ratio improvements after matching. To explore some rationales for this, I show that differential trends toward safer industries in public option states and the shifting of comparably worse risks to the public option (improving private insurer experiences) do not explain the improvement in loss ratios. Price reductions, however, that are much smaller than legislated benefit cuts in public option states (i.e., price reductions more than 50% smaller than benefit reductions), even after matching, tend to explain improvements in average loss ratios in the long-term.

With public options being related to distinct increases in concentration and little direct improvement in insurer underwriting profitability, the continued role of these public options comes into focus. From the consumer's perspective (the employer, in this case), one rationalization of a public option's continued role is to keep prices down. To get at this point, I propose a new standardized price measure in workers' compensation insurance. I measure price as direct premiums written per dollar of insured payroll. This measure mitigates traditional insurance economics issues with observing the product of price and quantity (premiums) but not the individual elements. Price can then be calculated for the entire market, or specific to private insurers or public options.

I find that public options in new public option states charge very similar, and almost always slightly higher, prices relative to their private insurer counterparts. This does not suggest that public options serve to raise prices, however. One possible interpretation is that the public option allows some segmentation in the market. In this case, public op-

tions underwrite employers in higher risk industries (and charge them as such, using robust experience-rating, as is common in workers' compensation) and allow the private market to charge lower prices on average. These higher risk industry policies do not need to be "residual" risks for this to be true.[3] From the perspective of private insurers, one other role of a public option could be improving market stability (i.e., variability in loss ratios at the insurer level). I provide some evidence that public options improve stability on average in the years just after formation, but it is not true in every state.

This study contributes to the literature in a few important ways. Naturally, it adds to the literature on workers' compensation, both in terms of policy and insurance markets. My analysis lends insight, for the first time, into the ramifications of pulling the public option policy lever in workers' compensation. This is especially relevant with recent work suggesting no rationales for workers' compensation coverage mandates using the optional coverage setting in Texas (Cabral et al., 2022). If states consider moving to Texas' market design in the future, an important element to consider would be the public option, which covered 41% of the Texas market in 2022 (TDI, 2024). In the literature on workers' compensation insurance markets, this is the first study to apply causal inference strategies to learn about public options. There has been ample research on these markets over time, but it has focused on settings without public options (for example: Carroll (1993); Danzon and Harrington (1998, 2001); Harrington and Danzon (2000)), the cost efficiency differences between private and public insurers (for example: Butler and Worrall (1986); Thomason et al. (2001)), the moral hazard effects of benefits (for example: Meyer et al. (1995)), or spillovers between voluntary and residual markets (Kwon and Grace, 1996).

This paper also contributes to the literature on insurance markets beyond just workers' compensation; this is the first study to empirically estimate the effect of a public option in US insurance markets. Public options have been widely studied in other US contexts, most

[3]In fact, if public options charge higher prices and maintain lower loss ratios than the private market (which I show to be true), then the higher risks I refer to may not be "residual" at all. If they were, prices would not be able to match risk perfectly (hence the push out of the traditional market into the residual market).

popularly in education.[4] They have also been studied in the context of off-street parking in Philadelphia (Caskey, 2010), household finance and mortgages (Levitin and Wachter, 2013), prisons and garbage collection (Hart et al., 1997), and nursing homes (Amirkhanyan et al., 2008). There has been a focus on the role of public options in insurance markets outside of the US, however, including health insurance in Germany (Polyakova, 2016), pharmacies in Chile (Atal et al., 2024), and, in Sweden, ambulance systems (Knutsson and Tyrefors, 2022) and elderly care centers (Bergman et al., 2016).

In US insurance markets, researchers have generally focused on understanding what a public option could do in the health insurance context (Cebul et al., 2011; Miller and Yeo, 2019; Craig, 2022), including using "Medicare-for-All" (Shepard et al., 2020), or on certain state-based arrangements that use "public option plans."[5] Ultimately, these plans fall short of the competitive public option design present in workers' compensation, where there is no public-private coordination.[6] While workers' compensation insurance and health insurance are different products among various dimensions, they are also similar in that they are largely employer-provided, highly regulated, and payers of medical expenses. With these similarities, this paper may lend insight to creating a public option in health insurance markets.

This paper also contributes to the literature on pricing in US insurance markets, specifically residual markets and workers' compensation, as most workers' compensation public options are "insurers of last resort." There is a literature studying residual market mechanisms in other property-casualty insurance markets, including auto insurance (for just a few examples, see: Bajtelsmit and Bouzouita (1998); Browne and Wells (1999); Grace et al. (2013)) and property insurance (Dumm et al. (2013) and Born et al. (2021) provide reviews of the related work). It has also been discussed in the health context (Finkelstein, 2004). In

[4] Dinerstein and Smith (2021) present new evidence and review prior work.

[5] For instance, Washington recently implemented an approach where private insurers could sell a "public option plan" with regulated features (Sen et al., 2022). Colorado took a similar approach, running "public option plans" through private insurers and mandating that private carriers offer one (Kumar and Adashi, 2023). Nevada is set to implement a similar approach by 2026.

[6] There has been ample attention paid to public versus private provision of insurance in Medicare (Curto et al., 2019). That setting also differs from workers' compensation insurance, given the public-private coordination; my analysis below focuses on public options in active competition, not coordination, with the private market.

workers' compensation, legislated benefit levels are constant across employers within a state, and coverage is nearly universal. I make use of these institutional features and combine several data sources to produce a unit price (i.e., per $1 of payroll).[7] This unit price measure is new to the workers' compensation space (Carroll and Kaestner, 1995; Kwon and Grace, 1996; Thomason et al., 2001; Danzon and Harrington, 2001) and allows me to provide prices specific to public options as "insurers of last resort," contributing to the residual market literature broadly.[8]

The remainder of the paper is organized as follows. Section 2 describes the institutional background of workers' compensation. Section 3 describes the data, while Section 4 provides a descriptive explanation of what occurred at times of public option formation. A discussion of simultaneous legislated benefit cuts follows in Section 5, which also presents the empirical methodology. Sections 6, 7, 8, and 9 present results, discuss prices and mechanisms, consider roles for public options in insurance markets, and conclude, respectively.

2 Institutional Background

Workers' compensation provides almost guaranteed payment to employees for injuries at work (thus, it is an occupational disability program).[9] Yet, it is also the exclusive remedy available to employees (employees cannot sue their employers), functioning as a strict liability system. As long as an employee injury satisfies a few conditions (harm caused by an accident arising out of, and in the course of, employment), they will be paid for some lost income and all covered medical expenses. Without the workers' compensation system, typical negligence rules would apply, whereby the employer and employee must resolve the issue in court (or settle out of court), with more risk – both in who wins and how much is paid. Coverage for workers' compensation is provided by the employer for its employees; workers' compensation

[7] In most insurance contexts, premiums are observed but are a function of two unobservables: price and quantity. In workers' compensation, legislated benefit levels and universal coverage allow for a more well-known quantity space. The measure I propose also takes into consideration several issues with traditional insurance price proxies (i.e., based on the loss ratio) in workers' compensation (Thomason et al., 2001).

[8] The price measure I propose is an extension of Carroll and Kaestner (1995) using premiums per non-agricultural employee. Their price measure was not differentiated between private and public option insurers.

[9] Non-occupational injuries or illnesses may end up in workers' compensation claims, however. Smith (1990) presents the prevalence of increased claims on Mondays as evidence of concealment and delayed treatment.

is not a product available for employees to purchase directly. Benefits are prescribed by the state, so each firm is purchasing the same amount of coverage per employee.

In the early 1900s, several debates surfaced about how to best operationalize workers' compensation programs; one of those debates centered around how to best provide workers' compensation coverage. Meaning, should it be provided with government involvement, either in competition with the private market or in a monopoly arrangement? This debate featured disagreements between organized labor (desiring state monopolies), insurers (desiring no state involvement), and cautious employers (not wanting poor state control to lead to higher costs and adverse selection issues). These disagreements led to heterogeneity across states that still exists today (Clayman, 1959; Weinstein, 1967; Fishback and Kantor, 1996, 1998).

2.1 Workers' Compensation Insurance Marketplaces

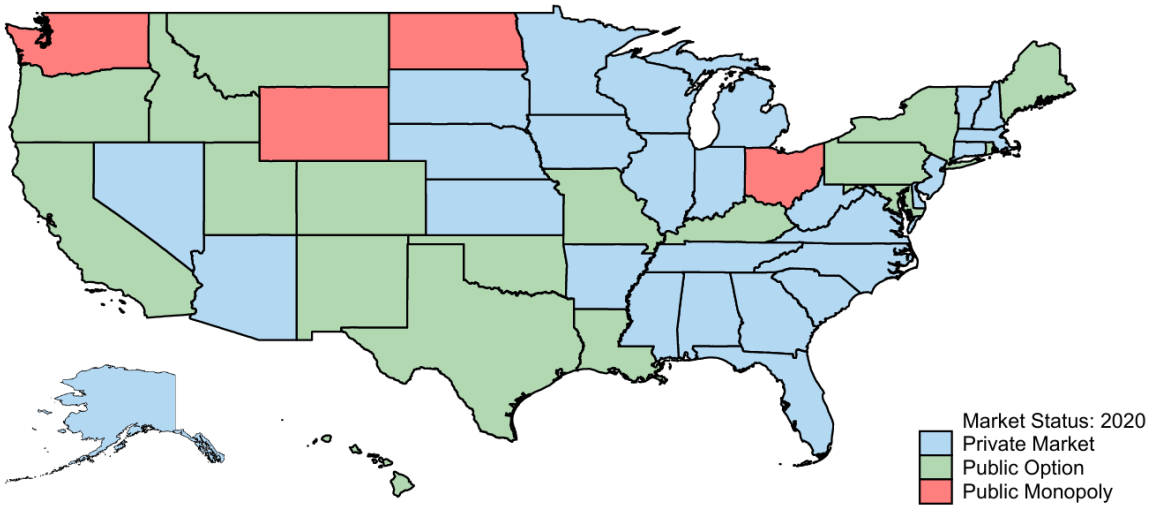
The structure of the workers' compensation insurance marketplace varies from state to state (and over time, as will be described below). With coverage mandated in virtually every state, employers can either purchase insurance or arrange certified self-insurance (where it is permitted). Within the insurance path, there are three broad categories that define the US workers' compensation insurance market: 1) private market states, 2) public option states, and 3) public monopoly states. Figure 1 provides the state of the US marketplace in 2020, the last year of my data.[10]

In private market states, the only source of coverage for employers comes via private insurers. In these settings, the government maintains a residual market mechanism (often a residual pool) to reinforce compulsory coverage for those employers who cannot get coverage on their own. There are 28 states plus DC in this category. As a second category, 18 states utilize a public option marketplace. In these settings, the marketplace is similar to a private market but where an active competitor is the public option insurer, which was created by the government and typically operates like a mutual insurance company. Finally, there are four monopoly states, wherein the only source of coverage is via the government.[11]

[10]This map also applies through 2024, given there have been no market changes since 2020.

[11]All public option and private market states allow for employers to arrange self-insurance. Among public

Figure 1: Workers' Compensation Market Structure in 2020



Notes: This figure displays workers' compensation insurance market structure as of 2020. Sources: National Academy of Social Insurance annual reports and author's own statutory & policy research.

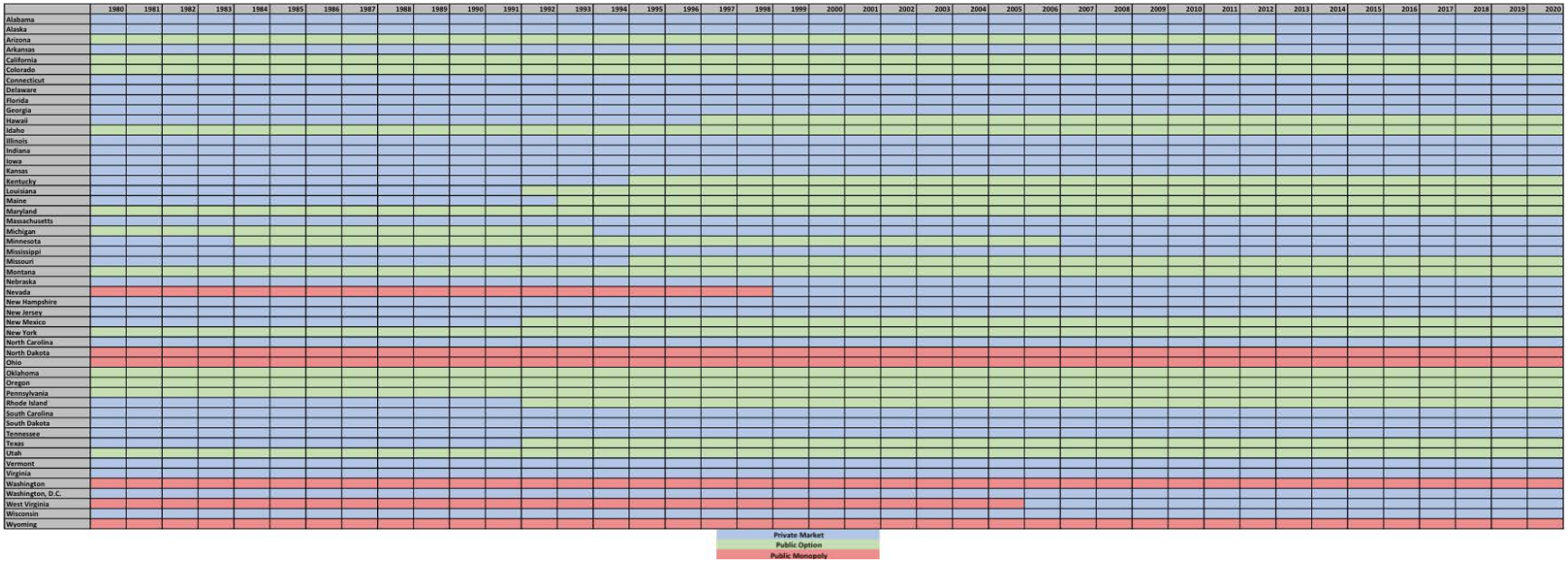
There is additional variation in public option states, most notably related to residual market responsibilities and federal tax payments. Four of the eighteen states with a public option - Idaho, Missouri, New Mexico, and Oregon - do not require that the public option accept all risks. Meaning, the public option does not serve as the residual market mechanism. In the other fourteen states with public options, the public option serves as the residual market. Within those fourteen states, two - Maine and Utah - no longer exempt the public option from federal taxation. While this means that these states are no longer classified as public option states strictly by the National Academy of Social Insurance, the forthcoming analysis does not use Utah and will focus on Maine's public option while it was still exempt (before 2007).

2.2 Changes to Market Structures Over Time

While Figure 1 provides a snapshot of the cross-sectional variation in state workers' compensation insurance markets in a single year, Figure 2 provides a mapping of state

monopoly states, North Dakota and Wyoming do not allow self-insurance; Ohio and Washington do.

Figure 2: Workers' Compensation Market Structure Changes, 1980-2020



Notes: This figure displays workers' compensation insurance market structures from 1980 through 2020. Blue corresponds to private market states, while green corresponds to public option states and red to public monopoly states. Sources: National Academy of Social Insurance annual reports and author's own statutory & policy research.

marketplaces over time, from 1980 through 2020. The color discontinuities depict structural changes to the marketplace. For instance, Nevada went from a public monopoly (in red) to a private market (in blue) in 1999. The same happened in West Virginia in 2007. This graphic not only helps identify the time of changes, but it highlights just how much variation there is across the US, by state and over time. It is also noteworthy that many states did not make changes. In total, nine states created a public option over this time period: Minnesota (1984), Louisiana (1992), New Mexico (1992), Rhode Island (1992), Texas (1992), Maine (1993), Kentucky (1995), Missouri (1995), and Hawaii (1997). While Minnesota had completely privatized its public option by 2008, the other eight states continue to have public options.[12]

2.3 Public Option Relevance

Among the eight states that created a new public option without reversal, most of which I use as the main set of focus states in this paper, public options have maintained a large role in the market over time. Figure 3 shows the market share of the new public options from the year of introduction through 2020. Market share is defined as the percent of total direct premiums in the workers' compensation market written by the public option.

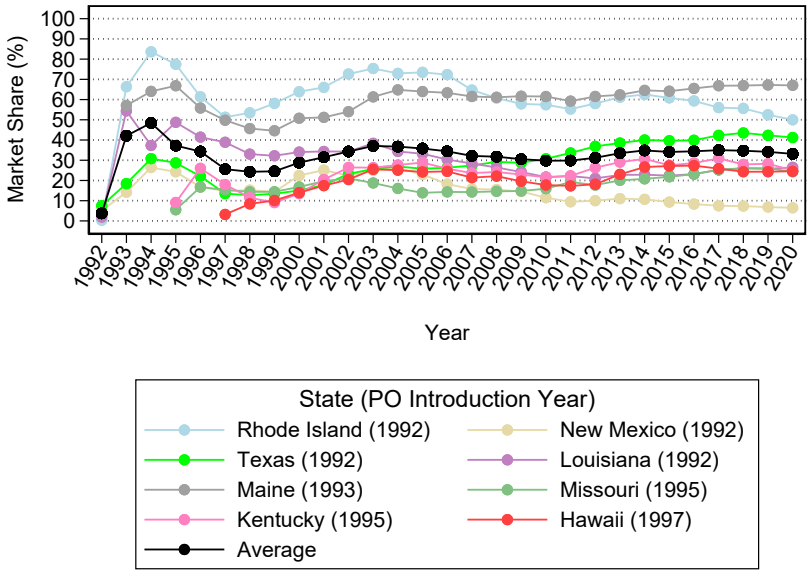
After a slow first year or two after formation, public options eventually develop a notable presence that lasts through the 20-year anniversaries of their formations. Every new public option experienced market shares of at least 10% within two years of forming. Over time, the market share of these public options persisted: market shares exceeded 20% in all but one of the new public option states in 2020. In three states, public option market share was more than 40%, with the average above 30%.

3 Data

This paper employs data from numerous sources. I first use detailed, insurer-level data aggregated to the state level to assess the effect of public option formation on concentration and loss ratios. Then, I use a panel of state payroll figures and payer-level data on workers' compensation benefits paid to match states on benefit levels and to construct a price measure.

[12]Michigan and Arizona also privatized their public options during the study period - Michigan in 1994 and Arizona in 2013. Missouri plans to do so in 2025.

Figure 3: Public Option Market (PO) Share by State



Notes: This figure displays the market share of each public option based on the portion of direct premiums written in the state, as given by the colors in the key along with their years of commencement. The average market share across the eight new public options is also provided over time. Sources: NAIC 1992-2020.

3.1 Insurer Data by State, Line of Business, and Year

I utilize data from the National Association of Insurance Commissioners (NAIC) over the 1988-2020 period. The data provide information on the losses and premiums of each insurer, by state and year, in the workers' compensation line. The public options that I investigate in this study started reporting data to the NAIC in the year of their formation.[13]

3.2 Benefits and Payroll Data

Data on workers' compensation benefits paid come from the *Social Security Bulletin* (SSB) for the years 1988 to 1993 and from the National Academy of Social Insurance for the years 1994 to 2020. Both of these sources are largely available publicly.[14] For each year and each state, I identify the amount of workers' compensation payments made by 1) private

[13]There are two exceptions to this, but I located public option financial information in those two cases from (gracious) industry contacts.

[14]The following reports provide the data: Nelson (1992, 1993); Schmulowitz (1995); Mont et al. (2002); Sengupta et al. (2005, 2010, 2013, 2014); Sengupta and Baldwin (2015); Baldwin and McLaren (2016); McLaren and Baldwin (2017); McLaren et al. (2018); Weiss et al. (2019); Murphy et al. (2020, 2021); Murphy and Wolf (2022).

insurance carriers, 2) public options (state funds), and 3) self-insured employers. These total benefits paid numbers include medical and lost income benefits. Generally speaking, these data validate the discontinuities in Figure 2.[15]

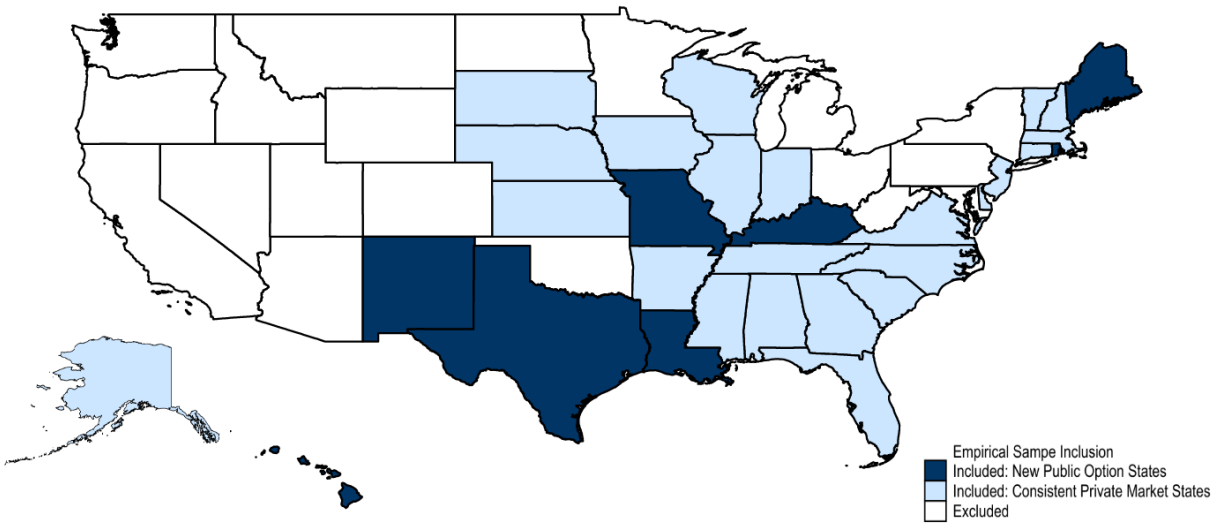
Annual employment, payroll, and firm (number of reporting units) data at the industry-state level come from the Census' County Business Patterns (CBP) series. With the available data, I need to assume all payroll is covered by workers' compensation, which is largely true except for various small firm exemptions around the US. I cannot explicitly say how much of the CBP payroll is "covered," though I can cite that more than 97% of payroll and employment was covered by workers' compensation in 2015 (BLS, 2015; SSA, 2017). This number is very stable, with the most recent estimate suggesting 97.5% of all non-federal jobs reported via unemployment insurance filings were covered in 2021 (Welch et al., 2024).

4 Public Option Formation

In this section, I investigate raw trends in market concentration and insurer underwriting profitability before and after the formation of the public option. In Section 5 below, I describe a stacked event study approach that formally tests for pre-trends and applies multi-level fixed effects. Figure 4 shows the 32 states (including DC) in my sample. The public option states are depicted in dark blue. I only include the eight states that formed a public option in the 1990s. The comparison states, shown in light blue, are the states with a private market throughout the sample period. This is the useful comparison for this exercise given both groups had the same, private-only structure before new public options were formed. The sample does not include the nineteen states that (1) had a public monopoly (four), (2) had a public option throughout the entire sample period (ten), or (3) made other changes to their market structure (e.g., privatizing a public option or monopoly; five states did so).

[15]The SSB publications mistakenly suggest public options in New Mexico and Rhode Island did not begin paying benefits when they actually did, so those two states are dropped from estimates that rely on benefits paid data. Hawaii was cited as having a public option in 1992 and 1993 despite the public option not being created until 1997 (Schmulowitz, 1995). This was an error not acknowledged by the SSB publications (as they ended with the 1993 year), but the Hawaii government noted in a separate report that these were from the state Special Compensation Fund (Pang et al., 1993). Following the National Academy of Social Insurance's process, I allocate state fund benefits paid in 1992 and 1993 to private carriers and self-insured employers based on their respective percentages of total benefits paid.

Figure 4: Empirical Sample Inclusion



Notes: This figure displays state-level inclusion in the main empirical sample, as described in the text. States with no color are excluded; states with color are included (light blue states are consistently private market states; dark blue states are new public option states).

4.1 Market Competition: Concentration

The first outcome of interest focuses on the level of insurer concentration in each state marketplace. To measure concentration, I use the Herfindahl-Hirschman Index or HHI. The HHI is the sum of the squared market share of each insurer in a state.[16] A higher HHI value means that more employers in the state are getting their insurance from fewer insurers.

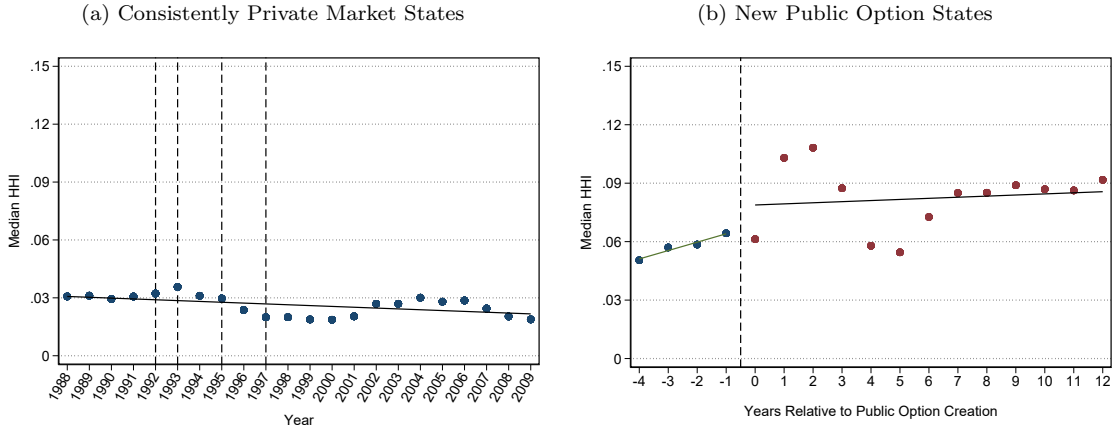
Figure 5 presents trends in the median HHI value among the states that consistently used a private market in panel (a) and new public option states in panel (b).[17] From panel (a), median HHI reaches a maximum of 0.036 in 1993 and a minimum of 0.019 in 2000. The small range documents the stability of insurer concentration in states with consistently

[16]This setup excludes insurers who report negative direct premiums written (DPW) in the workers' compensation line, though the results are robust to including those firms. Appendix Table A.1 shows that less than 6% of insurer-year observations report negative DPW in workers' compensation. This table also compares negative versus non-negative firm-year observations. Appendix Table A.2 places firms into ever negative and never negative groups to provide comparisons. As is clear from those comparisons, negative DPW firm-year observations tend to come from smaller stock insurers.

[17]Appendix Figure A.1 uses the same setup but graphs means rather than medians. Using means, these trend differences are even more stark after a public option is formed.

private markets.[18] The picture in panel (b), however, is quite different. Two things become immediately clear. First, the median HHI increases by about 30% across the pre-period, from 0.050 four years before formation ($t = -4$) to 0.064 in year $t = -1$. Second, while there is no noticeable shock to the median HHI when the public option joins the market at $t = 0$, median HHI values jump to 0.103 and 0.108 in years $t = 1$ and $t = 2$, respectively. This value in year $t = 2$ is more than double what it was at $t = -4$ (and nearly four times higher than in their private-only counterparts). While median HHI falls to 0.055 in year $t = 5$, it appears new public option states only become increasingly more concentrated in the long run, with a median HHI of 0.092 by year $t = 12$. As Figure 3 showed earlier, these trends in median HHI align well with the increasing relevance of public options.

Figure 5: Trends in Concentration (HHI) - Medians



Notes: This figure displays median HHIs for consistently private market states in panel (a) and new public option states in panel (b), across calendar time (year) and event time, respectively. A linear trend line is drawn through all points in panel (a) and drawn separately in panel (b) before and after public option formation (at time = 0). Vertical lines in panel (a) indicate public option creation years. Sources: NAIC 1988-2020.

4.2 Underwriting Profitability: Loss Ratios

To investigate insurer underwriting profitability, I use the loss ratio, which is direct losses incurred over direct premiums earned. Each element is first aggregated across all insurers

[18] Note that panel (a) runs from 1988 (four years before the first public option was formed) through 2009 (twelve years after the last one was formed). This is intended to roughly mimic the event time in panel (b) for new public option states, given there is no "event" for states without a public option. For clarity, the four formation years are marked with vertical, dashed lines.

in a state in a given year. Loss ratios are one of the few measures of performance that can be built back to 1988 using the NAIC data, and they provide insight as to the underwriting performance of an insurer (i.e., the success of the insurer at predicting losses, charging premiums, and paying claims). Of course, this is an imperfect measure: it does not account for expenses nor investment returns.[19] Loss ratios are a measure of performance in the sense that, from an insurer's perspective, a lower loss ratio implies greater profitability. For instance, a loss ratio over one is not sustainable because, even without expenses included, the insurer is exhibiting issues matching their prices and quantities sold (premiums) to losses. This is especially true at the state level.

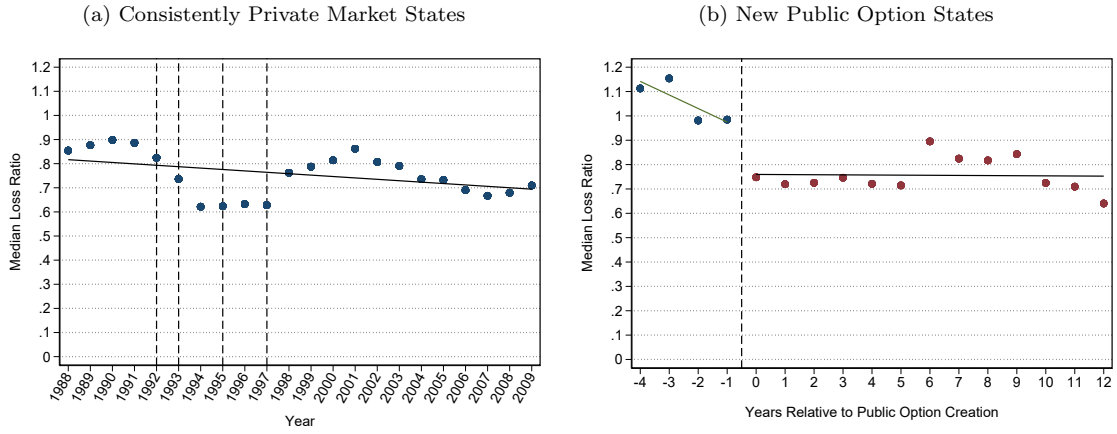
Figure 6 presents the raw trends in the median loss ratio among consistent private-only states in panel (a) and new public option states in panel (b).[20] Loss ratios are decreasing in similar periods for both groups of states, which tends to be driven by having larger, faster decreases in losses paid (or expected to be paid) than premiums earned (see Figure A.3). In panel (a), the median loss ratio drops from a high of 0.899 (i.e., insurers were paying \$0.90 in losses for every \$1 collected in premiums) in 1990 to 0.622 by 1994. The median loss ratio then increased to 0.862 in 2001 before steadily decreasing to 0.710 by 2009.

Panel (b) shows that median loss ratios were much higher in the pre-formation period for states that adopted a new public option than at any point for consistently private states, ranging from 1.113 in year $t = -4$ to 0.985 in year $t = -1$. At the time of formation, there was an immediate drop, with a median loss ratio in year $t = 0$ of 0.748. Median loss ratios were fairly stable over the remainder of the period, before closing at 0.640. At first glance, it appears that public options were aligned with a steep improvement in the insurer experience via the loss ratio, given the nearly 25% drop at time $t = 0$. Yet, in consistently private-only states in panel (a), there were also improvements in the loss ratio around the

[19] Expenses and net investment gains are only available since 1991 and are provided at the insurer level (which would require assumptions about how to allocate among the states and lines in which an insurer writes business).

[20] Trends in mean loss ratios can be seen in Appendix Figure A.2, and trends in the means of each loss ratio component can be found in Appendix Figure A.3.

Figure 6: Trends in Loss Ratios - Medians



Notes: This figure displays median loss ratios for consistently private market states in panel (a) and new public options states in panel (b), across calendar time (year) and event time, respectively. A linear trend line is drawn through all points in panel (a) and drawn separately in panel (b) before and after formation (at time = 0). Vertical lines in panel (a) indicate public option creation years. Sources: NAIC 1988-2020.

same time, which are seemingly independent from public option formations. These patterns are indicative of other legislative activity in states that never created a public option, which could also be relevant for public option states.

5 Legislated Benefit Levels & Empirical Methodology

From the mid-1980s to the early 1990s, over half of states enacted legislation that cut workers' compensation benefits (Thomason et al., 2001). These changes, while constant across all insurers in a state and year, present challenges for comparisons between new public option states and consistently private-only states. This is especially true with a main outcome like loss ratios. Changes in benefits that are comparably larger in new public option states may have an out-sized influence on loss ratios if prices do not respond in the same fashion. Below, I discuss the landscape of legislated benefit levels at the time of public option creation and then present the methodology I use to assess the impact of public options.

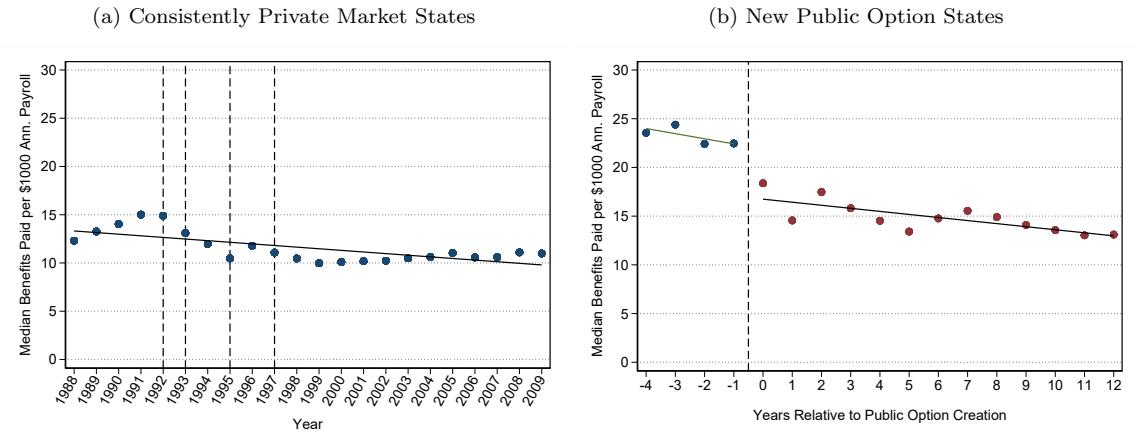
5.1 Workers' Compensation Benefits Paid

To track legislated benefit levels, I make use of the total workers' compensation benefits paid and payroll data described above. Due to data issues discussed earlier, two public option states are dropped from this setup (New Mexico and Rhode Island). These benefits paid data

track with legislated benefit changes, both broadly across the US and in specific states.[21]

There were large benefit cuts in both public option states and private market states, but the magnitude of the cuts was greater in the public option states. Figure 7 plots the median of total workers' compensation benefits paid per $1,000 of annual payroll.[22] Panel (a) focuses on private market states. From 1988 to 1991, benefits paid increased from $12 to $15. Benefits then fell from 1992 through 1995, before stabilizing between 1998-2009. Panel (b) focuses on new public option states. Before formation, benefits paid ranged from $23 to $25. After formation, however, benefits paid ranged from $18 to $13. From $t = -1$ to $t = 0$, benefits paid dropped from $23 per $1,000 of annual payroll to $18 (20%). The evidence in panel (b) suggests that the formation of public options coincided with changes in legislated benefit levels, which may contaminate inferences about the impact of public options.

Figure 7: Trends in Benefits Paid - Medians



Notes: This figure displays median workers' compensation benefits paid per $1,000 of annual payroll within consistent private market states in panel (a) and new public option states in panel (b), across calendar time (year) and event time, respectively. A linear trend line is drawn through all points in panel (a) and drawn separately in panel (b) before and after formation (at time = 0). Vertical lines in panel (a) indicate public option creation years. Sources: CBP, SSB, and the National Academy of Social Insurance 1988-2020.

[21] Appendix Figures A.4 and A.5 show the benefits paid measure for the six new public option states and then the remainder of states (except the two that were dropped), respectively. Generally, benefit cuts are evident across the US, in line with Thomason et al. (2001). More specific to a few states with larger benefit cuts, however, legislative activity can be lined up with noticeable shocks in the benefits paid data, such as in Alaska (1988 revisions to the Workers' Compensation Act), Massachusetts (Chapter 398 of the Acts of 1991), and Montana (Berreth, 1992). This enhances trust in these data as tracking legislated benefit levels.

[22] Appendix Figure A.6 does the same for means. Appendix Figure A.7 shows each new public option state's total benefits paid amount over time, graphed against the private market average for reference.

5.2 Empirical Methodology

To address the potential contamination, I match public option states with private market states based on the percentage reduction in benefits paid in the year that a public option is formed. I then use a stacked event study estimator to average over the more isolated, higher quality comparisons post-matching to provide an estimate of the public option's effect in the market. First, I describe the general stacked event study methodology; then I discuss the matching process and what it can achieve.

5.2.1 Stacked Event Study Estimator

The stacked event study design employs difference-in-difference techniques, following work by Deshpande and Li (2019), Cengiz et al. (2019), Butters et al. (2022), and Wing et al. (2024). Typically, when treatment time varies, concerns mount for the traditional two-way fixed effects estimator (Goodman-Bacon, 2021); the stacked event study framework avoids problematic ("forbidden") comparisons that come from allowing treatment time to vary without ensuring clean controls (that themselves do not move in and out of treatment). This setup is beneficial because it allows for pre-trend testing and the ability to study how contemporaneous effects develop over time.

The general framework for this type of setting is as follows:

$$\mathrm{Y}_{s,t,k} = \alpha + \sum_{r=-4, r\neq -1}^{12} \beta_r(PublicOption_s * 1(RelTime_{t,k} = r)) + \gamma_{s,k} + \lambda_{t,k} + \epsilon_{s,t,k}, \qquad (1)$$

where the outcome, at least in the main specifications, is either the HHI or loss ratio in state s, year t, and stack k. The $PublicOption_s$ dummy variable indicates whether a state is a new public option or consistent private-only observation, which is interacted with the $RelTime_{t,k}$ indicators. These relative time indicators track the years before and after public option creation (at $r = 0$), where t tracks the year and k defines the stack's creation year. The event study framework, then, comes through the β_r terms, looking as far back as four

years prior to a change and as far forward as twelve years after a change (given Maine created a public option in 1993 but then made changes to it in 2007, with a buffer for anticipatory effects). The interpretation of the estimates represents the difference between the two types of states at a given time, relative to the difference in the year before public option creation.

In Equation 1 above, there are six stacks: one for each new public option state and its matched comparators from among the consistently private market group. Ultimately, stacks are mini experiments and the stacked event study specification works across all of them to identify effects in relative time. The specification includes both state-stack and year-stack fixed effects. Clustering is done at the state-by-stack level, which is especially important with repeat observations among the consistently private group.[23]

5.2.2 "Matching" on Legislated Benefit Cuts

I match public option states with private market states using the magnitude of the change in legislated benefit levels at the same time as public option formation. Table 1 below describes the matching by documenting - for each new public option state and its matched comparators - percentage decreases in benefits in the year of public option formation (with levels), along with statewide average loss ratios and payroll sizes in the year before formation. With a small sample of states to start, similarity of states on non-matched dimensions (like benefit levels, payroll, and loss ratios) is more difficult to achieve. As expected, new public option states tend to have both higher benefit levels (before and after) and higher loss ratios in the year before formation. The comparison of payroll is more mixed, given variation within the matched comparator group in several instances.

To investigate the matching procedure, I apply the stacked event study estimator - on the matched and unmatched samples - with benefits paid as the outcome.[24] Figure 8 provides those results. Panel (a) shows that using all consistently private states as the comparator

[23]Each stack has the same number of treated observations, so weighting is not needed (Wing et al., 2024).

[24]Raw estimates of each public option state's benefit levels over time are compared to the private market average (without matching) in Appendix Figure A.7. Appendix Figure A.8 focuses on benefits paid trends over time, after matching.

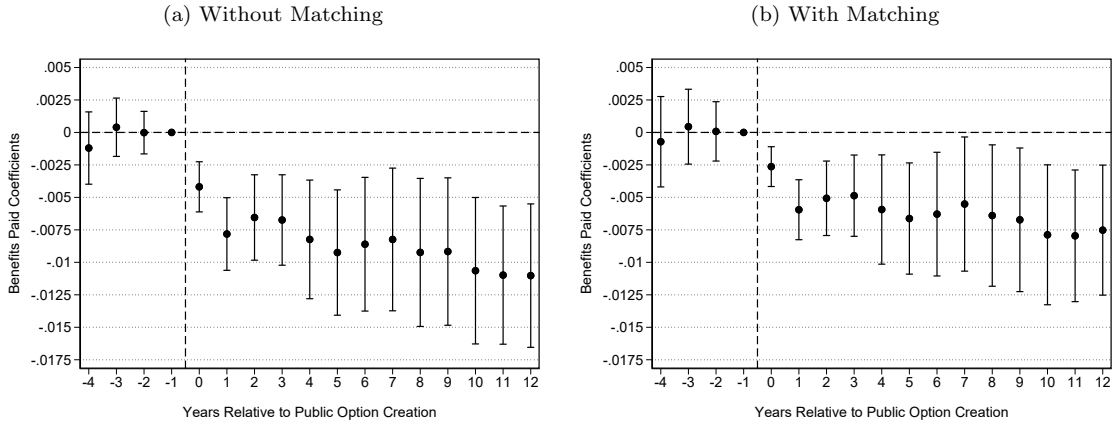
Table 1: Matching Exercise

Public Option State	Formation Year	Matched Comparison States	Benefits Paid, Year Before	Benefits Paid, Year Of	% Change in Benefits Paid	Statewide Average Loss Ratios, Year Before	Statewide Total Payroll, Year Before
Louisiana	1992	(5): Arkansas, Florida,	T: $21.0	T: $18.3	T: -12.9%	T: 0.96	T: $26,711,019
		Indiana, Massachusetts, Wisconsin	C: $16.4	C: $14.6	C: -10.6%	C: 0.90	C: $52,232,873
Texas	1992	(4): Arkansas, Florida,	T: $24.0	T: $18.4	T: -23.3%	T: 0.80	T: $136,202,165
		Massachusetts, Wisconsin	C: $18.4	C: $15.9	C: -11.3%	C: 0.96	C: $53,749,127
Maine	1993	(2): Massachusetts,	T: $50.1	T: $38.3	T: -23.6%	T: 1.10	T: $8,888,975
		Mississippi	C: $17.3	C: $14.4	C: -21.7%	C: 0.72	C: $42,754,122
Missouri	1995	(7): Connecticut, Florida, Illinois, Indiana,	T: $15.7	T: $13.7	T: -12.7%	T: 0.68	T: $50,161,688
		Kansas, New Hampshire, Virginia	C: $14.5	C: $12.6	C: -12.6%	C: 0.68	C: $62,375,379
Kentucky	1995	(5): Georgia, Massachusetts, Nebraska,	T: $20.6	T: $16.6	T: -19.4%	T: 1.01	T: $28,324,513
		North Carolina, Tennessee	C: $10.7	C: $8.7	C: -19.2%	C: 0.60	C: $54,061,563
Hawaii	1997	(2): South Dakota,	T: $27.4	T: $22.8	T: -16.7%	T: 0.70	T: $10,954,149
		Tennessee	C: $12.8	C: $10.8	C: -15.8%	C: 0.63	C: $30,259,467

Notes: This table documents the matching exercise described in the text. "T" refers to the value in the public option state; "C" refers to the average value among the matched comparators. Benefits paid columns are per $1,000 of annual payroll. Payroll column is in thousands of US dollars. Sources: CBP, SSB, National Academy of Social Insurance, and NAIC 1991-1998.

group leaves large residual benefit reductions in new public option states post-formation. Given a baseline difference in year $t = -1$ of roughly \$0.008 per \$1 of payroll, the coefficients indicate large reductions in benefit levels that largely erased the difference (with coefficients ranging between -\$0.0075 and -\$0.011 from years $t = 1$ through $t = 12$).

Figure 8: Stacked Event Study Results - Benefits Paid



Notes: This figure displays point estimates from estimating Equation 1 using annual benefits paid per \$1 of payroll as the outcome for two specifications: unmatched in panel (a) and matched in panel (b). The graphs use 90% confidence intervals. Sources: CBP, SSB, and the National Academy of Social Insurance 1988-2020.

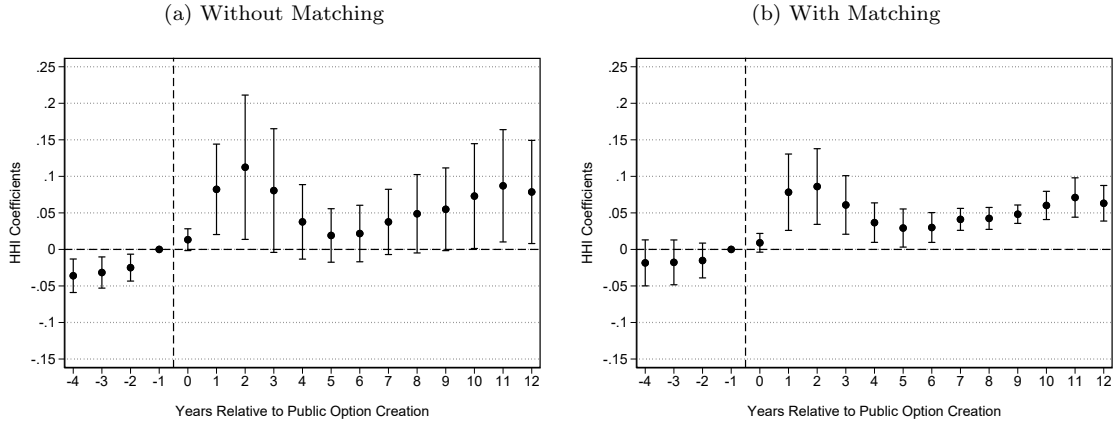
Panel (b), using the matched group, substantially reduces the size of the point estimates across the sample period. When comparing the point estimates at a given time between panels (a) and (b), there is a 20-40% reduction in magnitude from the unmatched size in each of the post-formation periods. This is indicative of the role matching plays in making states more similar. Yet, the matching is not perfect in that panel (b) shows statistically significant benefits paid changes in public option states over their matched comparators. Thus, the loss ratio (and, potentially, HHI) results may continue to be explained by larger reductions in benefits levels for public option states. Though, any meaningful difference in results from matching are quantifying the role benefits legislation plays and identifying something closer to the public option's *unique* effect than if there were no matching.[25]

[25]Future iterations of this work aim to employ a synthetic control design, which will better isolate the public option's impact.

6 Results

Below, I provide stacked event study results for the two main outcomes of the paper: HHI and loss ratios. Using Equation 1, I provide the main results in both unmatched and matched form.[26] Figure 9 presents the results of the stacked event study for HHI. Panel (a) presents the unmatched results, while panel (b) presents the matched results. Both panels present very similar findings, indicating that the main driver of the HHI effects are the public option itself, not simultaneous benefit changes. While the coefficient magnitudes do not change much from panel (a) to panel (b), the standard errors do. This is indicative of the power of matching, which also helps with comparability in the pre-period (with statistically insignificant pre-period coefficients).

Figure 9: Stacked Event Study Results - HHI



Notes: This figure displays point estimates from estimating Equation 1 using statewide HHI as the outcome for two specifications: unmatched in panel (a) and matched in panel (b). The graphs use 90% confidence intervals. Sources: NAIC 1988-2020.

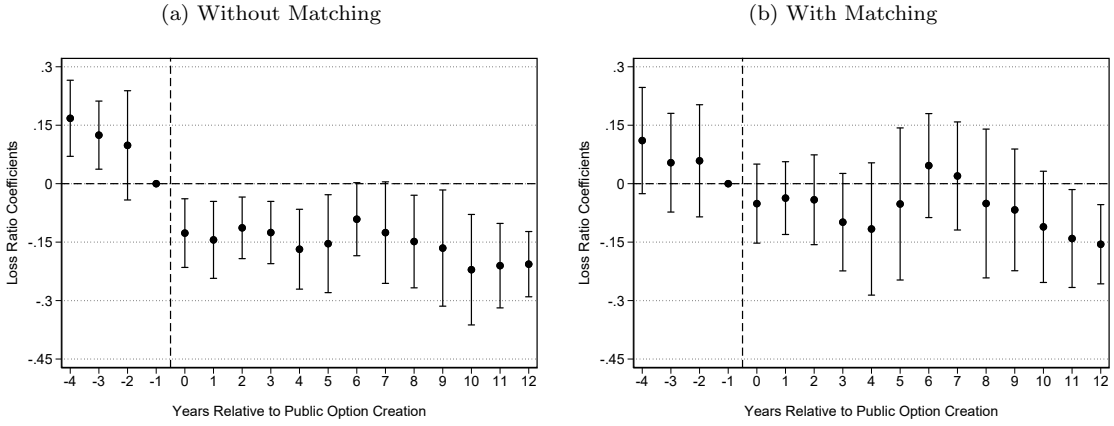
Focusing on the matched results, it is clear that the public option is responsible for significantly increasing the concentration of the workers' compensation insurance markets in the states in which they were formed. Increases in the concentration gap between new public option states and matched consistently private states are statistically significant in each post-formation period, with the exception of the year of formation. Across the pre-

[26] In the unmatched results, weights of each stack - of which there are four (1992, 1993, 1995, and 1997) - are based on the percentage of new public option states in each stack, as per Wing et al. (2024).

formation period, the average HHI coefficient is -0.017. In the post-formation period, the average HHI coefficient is 0.05, ranging from 0.086 in year $t = 2$ to 0.029 in year $t = 5$. With the baseline HHI gap between the two states at about 0.05, these effects are also economically relevant, with increases ranging from 58-172% at the minimum and maximum post-formation coefficients. Using a back of the envelope calculation of $(1/HHI)$ to approximate the number of equally-sized insurers in the market (given HHI falls between 0 and 1), the baseline gap in HHI of 0.05 (on a comparator mean of roughly 0.05) suggests that there were about 10 fewer insurers competing in new public option states relative to their comparators before formation. After formation, that number ranges from a low of 12 fewer insurers in year $t = 5$ to a high of 15 fewer insurers in year $t = 2$.

Figure 10 presents the results for loss ratios. When looking just at the unmatched results in panel (a), the effects seem similar to what would have been expected from the descriptive evidence presented earlier. Namely, it appears that new public option states were related to improved insurer loss ratio experiences in both economically and statistically relevant ways. Pre-trends, however, are statistically different from zero, which speaks to the concern about other changes around this time that may be driving the results.

Figure 10: Stacked Event Study Results - Loss Ratios



Notes: This figure displays point estimates from estimating Equation 1 using statewide average loss ratios as the outcome for two specifications: unmatched in panel (a) and matched in panel (b). The graphs use 90% confidence intervals. Sources: NAIC 1988-2020.

Addressing major legislated benefit level changes through matching, as in panel (b), eliminates the statistically significant pre-trends (and the associated coefficients decrease by an average of 42.9% across the pre-period). The matched results in the post-formation period, however, largely suggest a disappearance of the improvements in loss ratios. While confidence intervals tend to be larger, every coefficient has shifted toward zero. Using the coefficients from the loss ratio estimates between the two panels, there is a drop in magnitude of more than 50% in most periods coming from this closer match on benefit reductions. In fact, the average of the post-formation coefficients from panel (a) is -0.1438, while the average in panel (b) is -0.0658. On a baseline gap in loss ratios in the year before formation of about 0.10, these averages are important. Panel (a) would indicate that new public option states surpassed the profitability gap to be more profitable than private market states. Panel (b) suggests that the gap was closed but not erased. In fact, all coefficients in panel (a) suggest reductions in the loss ratio gap of at or more than 0.10; the same is only true in the long-term in panel (b). Thus, while benefit reduction disparities were not reduced to zero, moving toward a world where the public option is more isolated as a policy lever shows that the public option had little distinct effect on statewide average loss ratios.

7 Mechanisms & Measuring Price

In this section, I explore potential explanations for the results presented above. I start with the HHI results, where I find that public options lead to more concentrated markets. Concentration may increase with the formation of a public option if: (a) the public option absorbs the "bad risks" in the market, increasing its market share while allowing the private market to compete for the remaining risks; or (b) the public option grabs market share by offering insurance below the competitive market price, which may lead to insurer exits.

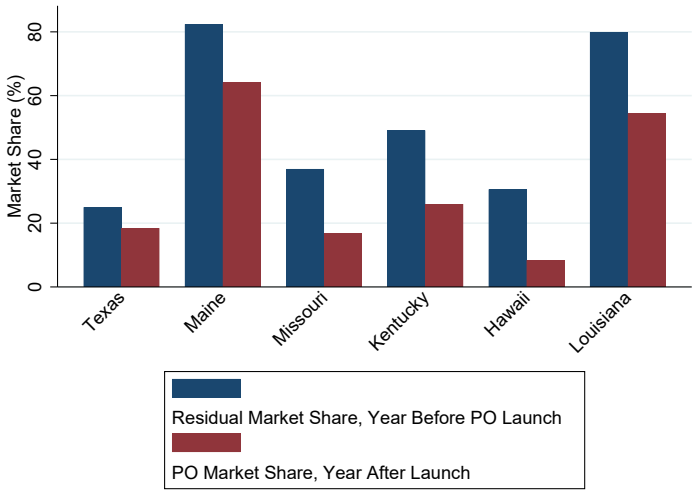
Then, I move to the loss ratio results. As shown above, a large part of the explanation for the loss ratio results that could have initially been attributed to the public option was actually coming from differences in legislated benefit level cuts. Yet, the loss ratio coefficients are still broadly negative, even if not statistically different from zero (though they are in

later years). This could be explained in several ways: a) the additional disparity in legislated benefit cuts (due to imperfect matching) sufficiently outweighs changes in prices; b) shifting residual risks to the public option (raising its loss ratios) reduces private insurer loss ratios; c) the public option gains market share and outperforms the private market, shifting statewide underwriting profitability with the performance of the public option; and/or d) public option states saw differential shifts in industry mix away from unsafe industries.

7.1 Ceding "Bad Risks" to the Public Option

I first investigate whether the public option absorbs the "bad risks" in the market. To do so, I compare residual market share before the formation of the public option to public option market share after formation. The results, in Figure 11, show that the market share of the residual market in the year before the formation of the public option is always greater than the market share of the public option in the year after formation.[27] The evidence indicates that, if the residual market represents the "bad risks" in the market, then the public option does not take all the "bad" risks. The public option market shares do not reflect such a shift.

Figure 11: Residual Market Share Before vs. Public Option Market Share After

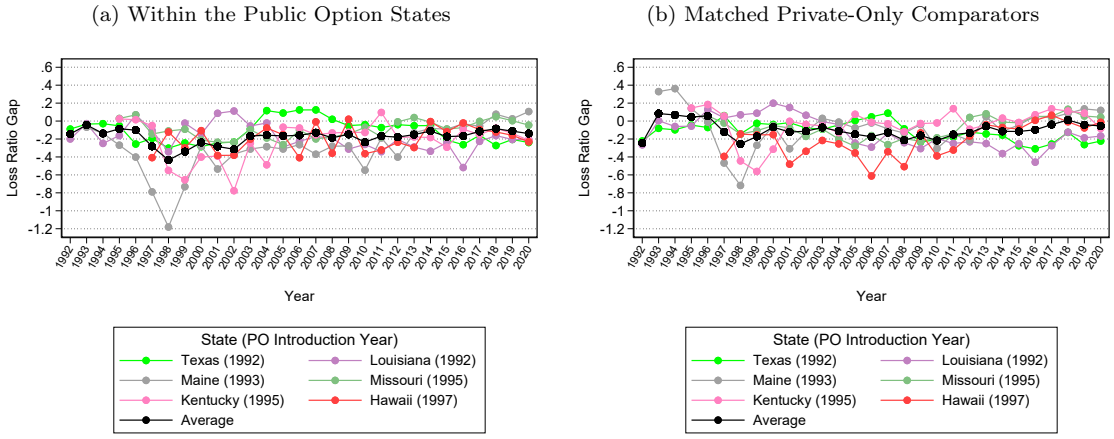


Notes: This figure displays residual market shares in the year before the public option (PO) launched, compared to the PO's market share in the year after launch. Sources: NAIC 1992-1998, Thomason et al. (2001), Buhro (2011), and NCCI (2000).

[27] For comparison, Appendix Figure A.9 shows residual market shares around formation time for each set of matched comparator private-only states.

Another way to investigate whether the public option absorbs the "bad" risks is to investigate the performance of the public option relative to the private market. If the public option accepts a large proportion of the "bad" risks, and these risks are residual in the sense that they cannot be priced properly for their risk level, then its underwriting performance ought to be lower than the performance of the private market. Figure 12 plots the gap between the loss ratio of the public option and the average statewide loss ratio of the private market (i.e., $LossRatio_{PublicOption} - LossRatio_{Private}$).[28] Panel (a) compares the public option loss ratio with the statewide average loss ratio of the private insurers in the public option's state. The loss ratios of public options, across all states and nearly every year, are consistently below that of their private market competitors.

Figure 12: Loss Ratio Gaps - Public Options vs. the Private Market



Notes: This figure displays the gaps between the loss ratios of the public option and the private market over time. The private market is defined as all private insurers in the public option's state in panel (a), and the matched group of private-only comparators in panel (b). Sources: NAIC 1992-2020.

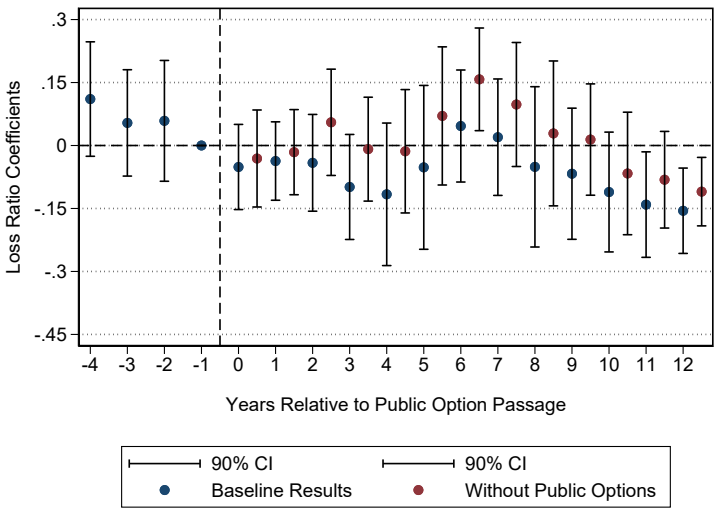
The comparison in panel (a) is especially relevant because it is within a legislated benefit regime, wherein each insurer faces the same legislated benefit levels (and was exposed to the same changes over time). While there is some variability in public option loss ratios year-over-year (which is common at the firm-level in many lines of insurance), the average gap is negative in every year. In many years, the magnitudes are large - and not just in Maine

[28] Appendix Figure A.10 depicts the baseline average loss ratios for each public option over time, for reference.

where there may be an outlier in public option financial reporting in 1998. Even a 20% gap in the loss ratio is quite large economically. When compared to the private market average in the matched comparator states via panel (b), the picture is largely the same but with a few additional positive gap patterns. This comparison is weaker than panel (a), given that the matched comparator states exist under different legislated benefit regimes over time.

The evidence from Figure 12 suggests that enhanced underwriting profitability and increased concentration may not come from the public option purely accepting worse risks, unless they are able to charge sufficiently high prices to reflect risk levels. It is clearer that they can't be accepting purely residual risks, unless the public option has different price-setting experiences relative to the private market. Additional evidence supports this idea. Figure 13 duplicates the main, matched event study results for loss ratios, with (like Figure 10) and without the public options included. Results indicate that after the first few years, not including the public option further nullifies the loss ratio effect (even making the coefficient statistically significant and positive in one year), further verifying that the public option performance is as good as, and likely better than, the private market.

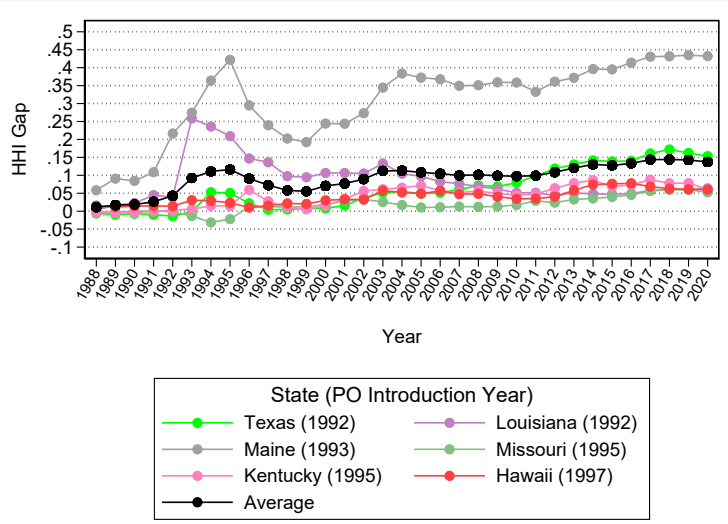
Figure 13: Loss Ratio Results With(out) Public Options



Notes: This figure displays point estimates from estimating Equation 1 with respect to loss ratios. The graph uses 90% confidence intervals. Blue dots duplicate panel (b) of Figure 10, while red dots repeat that analysis after dropping the public options, which only affects the period after formation (time ≥ 0). Sources: NAIC 1988-2020.

Beyond outperforming the private market in terms of loss ratios and not simply taking all of the residual market share, one final way to get at the point about whether public options take bad risks is to look at long-term trends in concentration measures. Figure 14 shows the gap in HHI between new public option states and their matched private-only comparators (i.e., $HHI_{PublicOptionStates} - HHI_{PrivateMarketMatch}$).[29] As is clear, public option states are consistently more concentrated than their matched private comparators. Over a set of more recent years (2012-2020), this is inconsistent with public options holding primarily residual risks. While national residual market shares never exceed 10% across these years, Figure 3 above shows that public option market shares never fall below 20% in all six states of the main sample over the same time span.[30]

Figure 14: HHI Gap - New Public Option States vs. Matched Private Market States



Notes: This figure displays the gap in HHI between new public option states and matched private market comparators over time. Sources: NAIC 1988-2020.

If public options face the same pricing frictions as private market insurers, then "bad" risks may not be synonymous with residual risks, given a comparably unsafe employer may be a "bad" risk but can be priced properly for that risk level (and, hence, not a residual

[29] Appendix Figure A.11 displays HHI over the entire panel, 1988-2020.

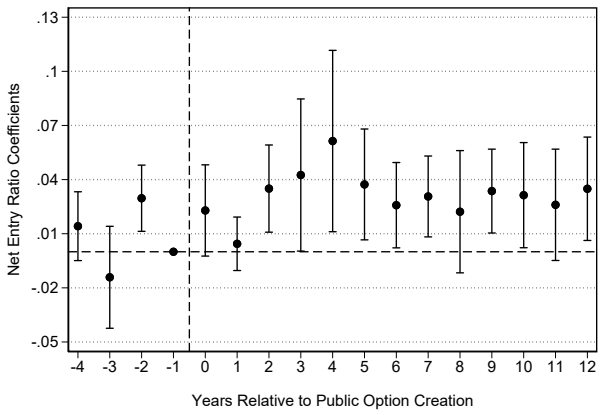
[30] Appendix Figure A.12 displays the national residual market share of all states (26) which the National Council on Compensation Insurance (NCCI) services over the 2012-2020 period.

risk). The evidence above suggests that the shifting of some (not all) "bad" risks (including residual) to the public option could be a sufficient explanation for the concentration results in the years just after formation. Yet, in later years, the public option accepting residual risks is a less compelling explanation, given 1) the national shift downward in residual market sizes that was not matched with a downward shift in public option market share; and 2) the inability for residual risks to be priced properly would lead to a mismatch in premiums and losses that would be reflected by lower underwriting profitability for public options (which is not the observed pattern). The public option accepting higher risk employers that it can price properly, however, is a compelling explanation, in both the near and long term.

7.2 Entries and Exits

I next explore whether the introduction of a public option changes the entry and exit of private insurers. Figure 15 shows the net entry ratio, which is $(N_{Entries} - N_{Exits})/N_{Insurers}$, around public option formation. The results suggest that, if anything, entries exceed exits. While these results are unlikely to be causal, the findings indicate that the introduction of a public option is not associated with private insurers exiting the marketplace.

Figure 15: Net Entry Ratio

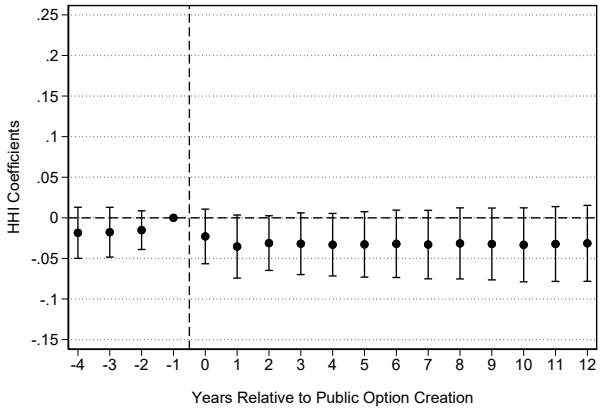


Notes: This figure displays point estimates from estimating Equation 1 with respect to the net entry ratio. The graph uses 90% confidence intervals. Sources: NAIC 1988-2020.

As shown in Figure 3, public options take a lot of market share, both immediately and over time, driving up the HHI. If the public option did not force more insurer exits, does it

affect competition among private insurers? Figure 16 studies this question using the private market HHI (where the scale from Figure 9 is retained for comparison). The private market HHI is a recalculation of the HHI, after removing the premium written by public options. The results suggest that the public option, while leading to more concentrated markets overall, did not lead to more concentrated markets among the set of their private competitors.[31]

Figure 16: HHI Results, Private Insurers



Notes: This figure displays point estimates from estimating Equation 1 using statewide HHI among private insurers as the outcome. The graph uses 90% confidence intervals. Sources: NAIC 1988-2020.

7.3 Changes in Statutory Benefits and Price Dynamics

One potential explanation for the fall in loss ratios after the introduction of the public option (even if they were statistically insignificant) is that public option states experience larger benefit reductions relative to prices than private market states. To provide evidence for this explanation, I develop a price measure and compare it to benefit reductions. I measure the price of workers' compensation insurance as direct premiums written per dollar of insured payroll. Direct premiums written represent all the premiums insurers receive in the state to provide workers' compensation coverage. Since premiums are revenue ($Price * Quantity$), I divide premiums by total insured payroll to obtain a measure of price per \$1 of payroll.[32]

[31] Appendix Figure A.13 provides additional evidence on this point. While median market shares for private insurers increased over time, this was largely a function of greater competition, given mean market shares - and the market share of the top ten private insurers - dropped after public option formations.

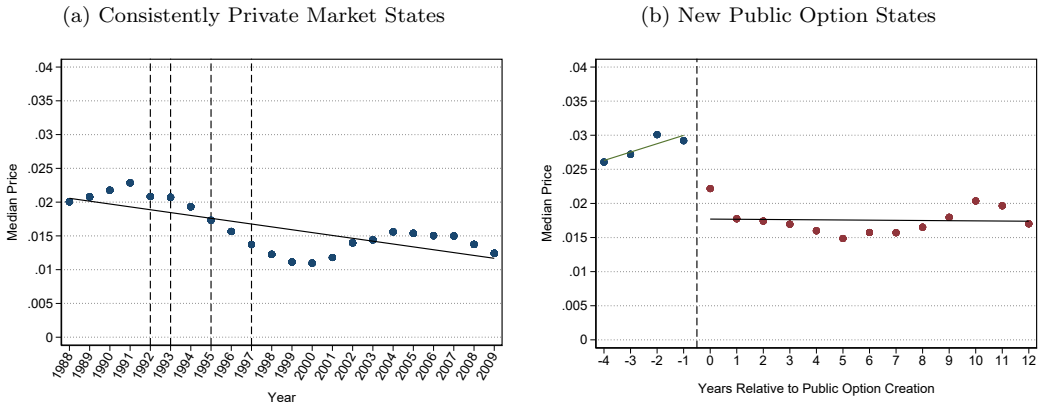
[32] All dollar values are adjusted to 2020 US dollars using the consumer price index.

Total insured payroll is a good a proxy for the quantity of coverage, as workers' compensation insurance is required in virtually every state. Reducing total payroll by the amount of payroll that is plausibly self-insured (using the portion of benefits paid by self-insured employers), I define insured payroll as follows:

$$\text{InsuredPayroll}_{s,t} = TotalPayroll_{s,t} * (1 - \frac{SelfInsuredBenefitsPaid_{s,t}}{TotalBenefitsPaid_{s,t}}). \quad (2)$$

Figure 17 shows the median price of workers' compensation insurance per $1 of payroll over the sample period.[33] Panels (a) and (b) show the price trend for private market states and public option states, respectively. In private market states, median price trends downward over the sample period. After peaking at $0.023 per $1 of payroll in 1991, median price steadily declines, reaching a low of $0.011 in 2000 before closing at $0.012. For public option states, median prices rise substantially over the pre-formation period, from $0.026 per $1 of payroll to about $0.030 (18%). After formation, median prices fall to $0.022 in year $t = 0$, which is a drop of 27%. Median prices then decrease to a minimum of $0.015 in year $t = 5$ before reaching a maximum of $0.020 in year $t = 10$.

Figure 17: Trends in Price - Medians

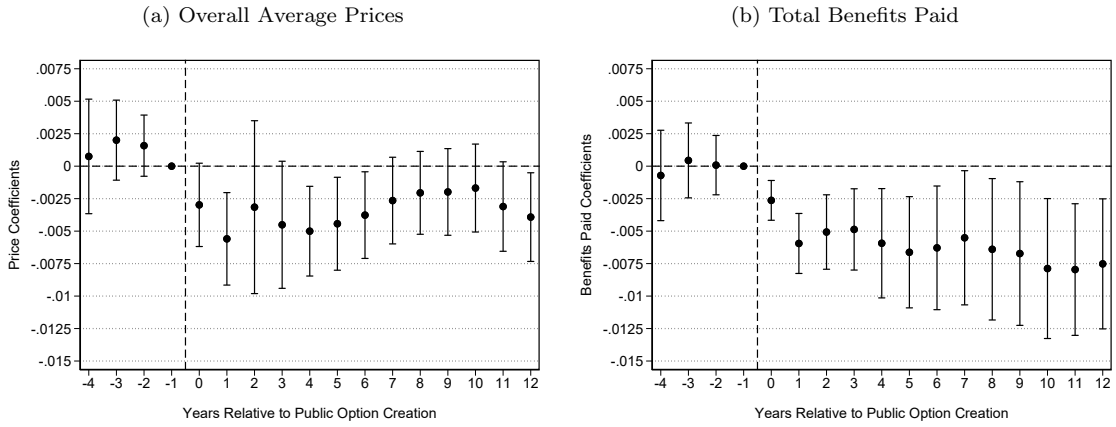


Notes: This figure displays median workers' compensation insurance price per $1 of annual payroll within consistent private market states in panel (a) and new public option states in panel (b), across calendar time (year) and event time, respectively. A linear trend line is drawn through all points in panel (a) and drawn separately in panel (b) before and after formation (at time = 0). Vertical lines in panel (a) indicate public option creation years. Sources: NAIC, CBP, SSB, and the National Academy of Social Insurance 1988-2020.

[33] Appendix Figure A.14 does the same for the mean price.

To address differential changes in the two groups of states, I estimate a stacked event study using the matched sample. Panel (a) of Figure 18 presents the event study results for price. For comparison, panel (b) shows the results for benefits paid per $1 of annual payroll (also shown in Figure 8, though with an altered vertical axis for the sake of comparison).[34] Panel (a) indicates that the baseline gap in prices between public option states and matched private market states was reduced by an average (across all post-formation periods) of $0.003 per $1 of payroll after the public option entered the market, with some variation over time. Panel (b) suggests that the average reduction in the benefits paid gap over the post-formation period was $0.006. This indicates that benefits fell by a greater magnitude than prices. Since benefit payments reflect insurer losses, the results suggest that the observed decline in the loss ratios (the ratio of losses to premiums) after the introduction of the public option may be due to prices not falling as much as losses.

Figure 18: Stacked Event Study Results - Price and Benefits Paid



Notes: This figure displays point estimates from estimating Equation 1 with two outcomes: price in panel (a) and annual benefits paid in panel (b). All outcomes are per $1 of annual payroll. These graphs use 90% confidence intervals. Sources: NAIC, CBP, SSB, and the National Academy of Social Insurance 1988-2020.

[34] Appendix Figure A.15 presents matched event study results for the self-insured percentage of benefits paid, adjusted prices (factoring out dividends), and dividends paid per $1,000 of annual payroll. Though imprecise, there is a general trend toward more self-insured benefits paid in new public option states over time. Adjusted prices are consistent with unadjusted prices, and there were little dividend changes.

7.4 Changes in Industry Mix

If new public option states experience a differential change in their industry mix away from dangerous work, this could also explain loss ratio improvement patterns. Figure 19 studies this dynamic and tests for changes in the percentage of a state's payroll coming from six key industry groups: mining, manufacturing, agriculture/fisheries/forestry, wholesale trade, retail trade, and construction. I use only these six industries because the industries are largely consistent across the CBP data series switching from Standard Industrial Classification (SIC) to North American Industry Classification System (NAICS) codes in 1998. These six categories make up between 40-60% of total payroll in a given state.[35] The results here, while noisy in some industries, largely indicate that industry mix is unlikely to explain the results. While there were some small decreases in mining, there were much larger increases in manufacturing and some increases in construction.[36] There was little change in wholesale and retail trade, and in agriculture, fisheries, and forestry.

8 Role of the Public Option

Public options lead to substantially more concentrated markets by gaining significant market share. At the same time, the public option has little distinct effect on statewide average loss ratios. The public option seems to, however, have stronger underwriting profitability than its private market competitors in most states and in most years. This begs the question: what is the role of the public option in these marketplaces? I proffer two suggestions, and then provide evidence in support. Both suggestions are deserving of future research.

One role a public option could play is to either keep prices low or encourage market segmentation. A natural step is to ask about the prices specific to public options relative to the rest of the market.[37] To better assess the difference in prices, I analyze the price gap in Figure 20 (i.e., $Price_{PublicOption} - Price_{Private}$). The price gaps in this figure indicate that

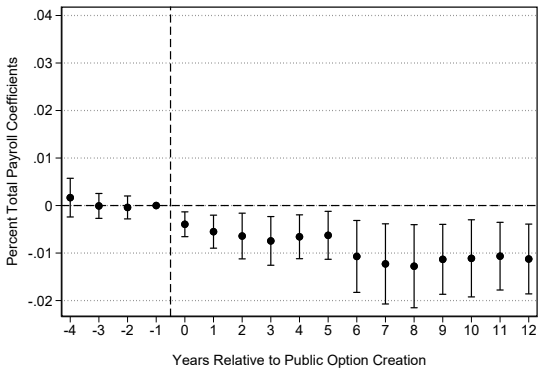
[35] Appendix Figure A.16 shows the portion of total payroll captured, including the notable drop in 1998 as the NAICS codes are more granular than SIC codes.

[36] In 2022, the incidence rate of nonfatal injuries and illnesses in manufacturing exceeded that of mining (BLS, 2023). This suggests the net effect of these transitions may be small.

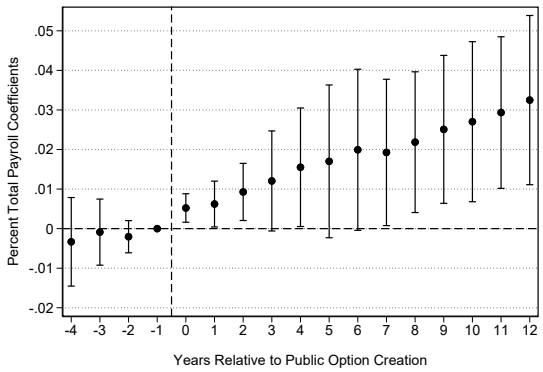
[37] Using the price measure I suggested in the prior section, Appendix Figure A.17 documents public option prices over time, outside of the first year of operation (which was characterized by overly high prices).

Figure 19: Stacked Event Study Results - Industry Mix

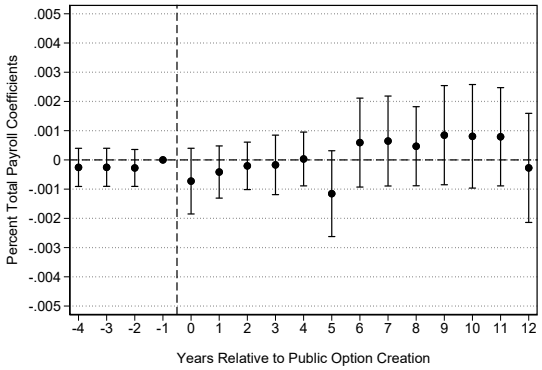
(a) Mining



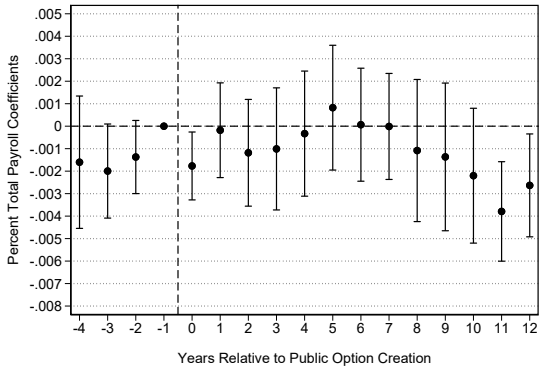
(b) Manufacturing



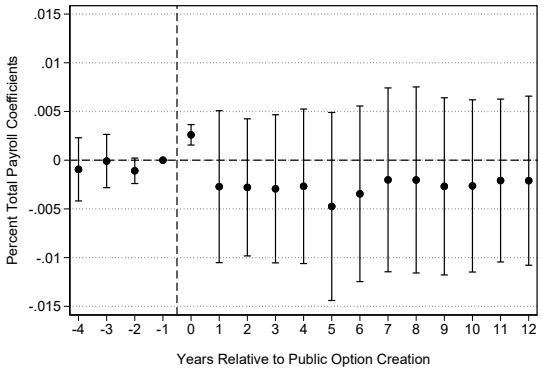
(c) Agriculture, Fisheries, and Forestry



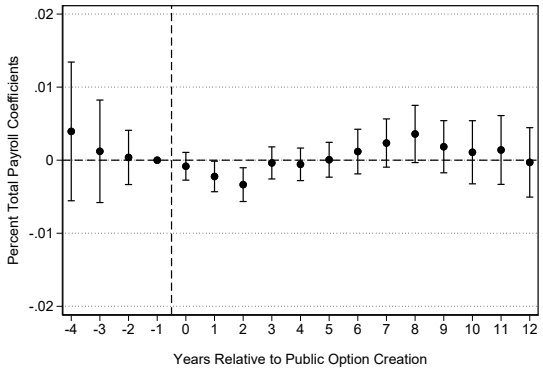
(d) Wholesale Trade



(e) Retail Trade



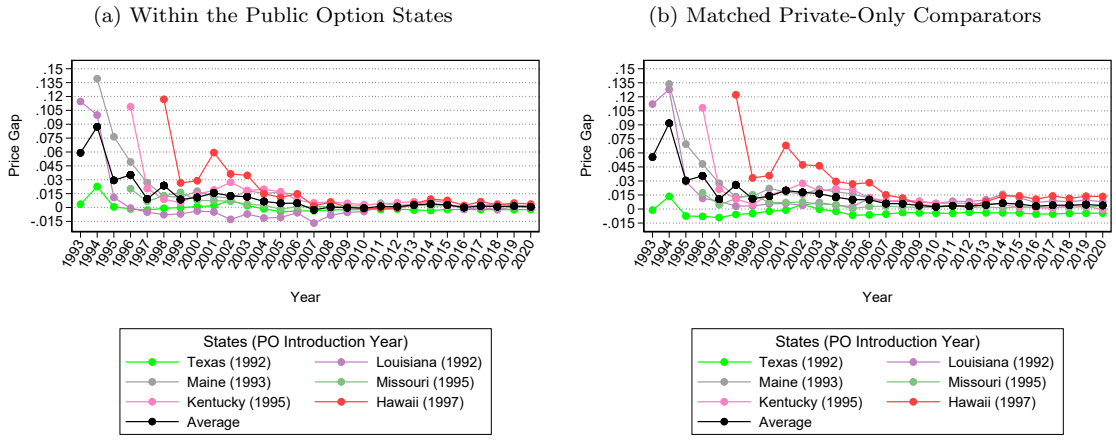
(f) Construction



Notes: This figure displays point estimates from estimating Equation 1 with the outcome as the percentage of a state's total payroll coming from the industry named in each sub-figure title. The graphs use 90% confidence intervals. Note the unique axis values, given the different baselines in each industry. Sources: CBP 1988-2020.

public options tend to charge roughly similar, and often slightly higher, prices relative to their private market counterparts, either from their home state in panel (a) or the matched private-only sample in panel (b).[38]

Figure 20: Price Gaps - Public Options vs. the Private Market



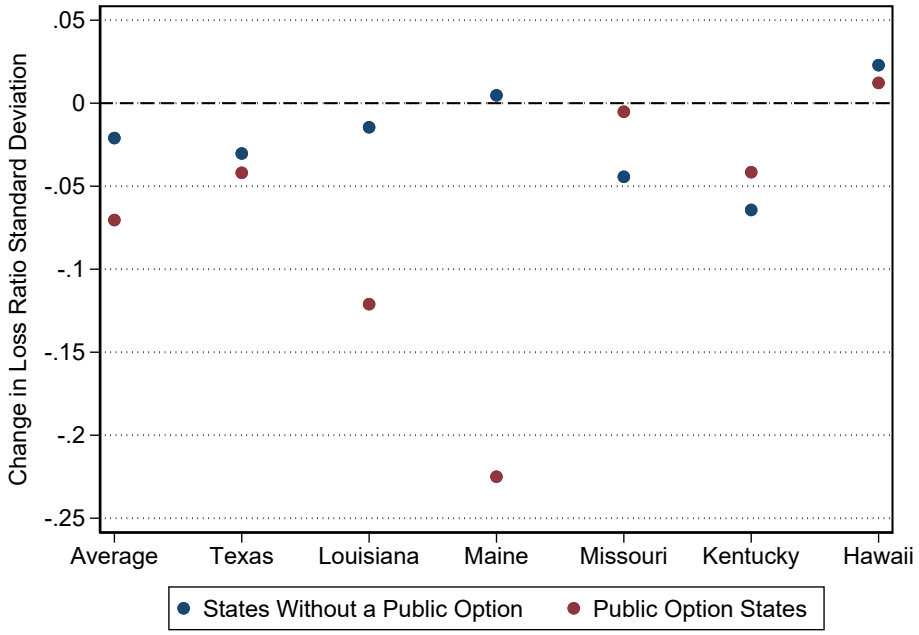
Notes: This figure displays the gaps between the public option price and the private market price over time. The private market is defined as all private insurers in the public option's state in panel (a), and the matched group of private-only comparators in panel (b). Sources: NAIC, CBP, SSB, and the National Academy of Social Insurance 1988-2020.

One way for public options to gain the market share they have is to charge systematically lower prices. The evidence above suggests that is not the case. This does not mean that the public option is not serving the role of keeping prices down, however, given that workers' compensation is highly experience rated. Thus, they may charge higher prices because they tend to underwrite higher risk industries (even if these are not "residual" risks). This could be seen as evidence of market segmentation in public option states. Regarding the HHI results discussed above, these price gaps support the notion that public options may have accepted largely residual risks at first, given it appears they could charge higher prices. Future research would be wise to consider, however, why the following items persist together in recent years: positive price gaps, high public option market share, and small roles (nationally) for residual markets.

[38]This is clear through about 2008, when it becomes more challenging to clearly see the gaps. Appendix Figure A.18 zooms in on the 2008-2020 period to show that this pattern in positive gaps (higher prices for the public option) persists, though they are smaller in magnitude.

A separate role the public option could play in the market is to stabilize the underwriting performance of private market insurers. To investigate market stability around the introduction of the public option, I compare the standard deviation of firm-level loss ratios in a state in the three years before and after the formation of the public option. Figure 21 presents the result using insurers who operated for the entire three year period before or after formation (i.e., not allowing entering/exiting insurers to affect the results).[39] Firm-level loss ratios outside of the 10th and 90th percentiles are dropped.

Figure 21: Firm-Level Stability in Loss Ratios



Notes: This figure displays the change in the standard deviation of firm-level loss ratios between the three years before public option formation and the three years after (including the year of formation) among private insurers in matched private-only states (blue dots) and states with a new public option (red dots). States are grouped by their reference public option (x-axis), along with the average of the gaps across all six categories on the far left. This graph drops firm-level loss ratios outside of the 10/90 percentiles, and only firms operating in all three years before or all three years after are used. Sources: NAIC 1989-1999.

In the graph, the blue dot within each grouping represents the change in loss ratio standard deviation (i.e., $SD_{After} - SD_{Before}$) in matched private market comparator states (i.e., matched to the new public option state given on the x-axis); the red dots show the differ-

[39] Appendix Figure A.19 uses all firms, regardless of entry/exit behavior, and the results are broadly consistent. Though, the changes are smaller, likely given the increased variability for new or exiting firms.

ence among private insurers in new public option states. Arguably, the blue dots provide an estimate of the improved stability (a negative change is an improvement) that comes from benefit reductions and the red dots would provide a more focused benefit of the public option. The average of the six gaps among each group is graphed on the far left.

The results from this exercise suggest, on average, public options may have played a role in stabilizing the loss ratio experience of private insurers within their home state. Public option states experienced a drop in loss ratio standard deviation of 0.07, while private market states experienced a drop of 0.02. For the state-specific results, four of the six show a similar relationship to the average. In two states (Missouri and Kentucky), the improvement in firm-level loss ratio variability was larger in matched states without a public option than among private insurers in the public option states.

There could be several explanations for these patterns, many of which are beyond the scope of this paper. Differential benefits paid experiences after matching, for example, could play a role if there were magnitude differences that persisted. Figure A.8 shows some of those differences, but they do not appear to clearly tell a story with the stability estimates. Another possibility is additional market changes, like shifts to open competition (rather than administered pricing, which allowed very little pre-contract price competition) around the same time as public option formation. Using tracking from Thomason et al. (2001), this also appears to explain little of the pattern.[40]

9 Conclusion

Public options are often discussed as policy tools in US insurance markets, especially in the health context. Despite the attention, however, there exists no empirical evidence of the impact on US insurance markets when public options are formed. In this paper, I provide (to my knowledge) the first empirical evidence as to the effect of a standalone, competitive

[40] Maine, Texas, and Missouri moved to open competition in the year around public option formation. Louisiana, Hawaii, and Kentucky had been operating in an open competition setting for at least four years before formation. While matched comparator states could also have changed regimes, and sometimes did, there appears to be little role there. For example, Louisiana and Texas share the same set of matched comparators (4), except that Louisiana has a fifth matched state, Indiana (which did not make a pricing change around formation time). Yet, Texas and Louisiana have quite different stability results.

public option in US insurance markets by utilizing the workers' compensation arena.

In workers' compensation insurance markets, several states created public options between 1992 and 1997. I leverage these changes to study the development of concentration and underwriting profitability in new public option states relative to states that have a market made up of only private carriers. First, I document that concentration significantly increased after the public option entered the market. In testing various mechanisms, I provide evidence that public options accepting residual risks may explain their large market share (and increased concentration levels overall) in the years just after formation. This explanation is not as compelling in more recent years. Despite the increased concentration, private insurers tend to continue entering the concentrated market in competition over smaller market shares, making increased exits an insufficient explanation.

Second, I show that insurer underwriting profitability appeared positively affected by the public option. After matching on simultaneous legislated benefit changes, however, there is little room for a standalone effect of a public option on average loss ratios. Any improvements in underwriting profitability that exist (even if not statistically significant) seem to be driven by the fact that the matching is imperfect: new public option states made larger benefit cuts on average than matched private-only states. Thus, performance tended to improve differentially because price drops did not match the severity of benefit cuts.

This work has important policy ramifications in workers' compensation insurance debates. Two states have recently changed their public option rules, with Arizona completely privatizing its public option in 2013 and Missouri having just passed legislation to do so by 2025. In addition, by laying out two rationales for continued public option market involvement (despite large market shares and high levels of profitability), this work outlines important areas for future work related to a public option's ability to manage market prices and stabilize private insurer performance.

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Appendix Tables and Figures

Intended for online-only publication.

Table A.1: Comparing Non-Negative DPW Firm-Years to Negative DPW Firm-Years

	(1) Non-Negative	(2) Negative
Member of Group	0.92	0.96
	(0.27)	(0.20)
Stock Insurer	0.86	0.92
	(0.35)	(0.27)
Mutual Insurer	0.11	0.07
	(0.31)	(0.25)
Magnitude of Negative ($1000s)	0.00	-266.99
	(0.00)	(1450.54)
Direct Premiums Earned ($1000s)	4792.06	-112.99
	(23542.25)	(1640.76)
Dividends ($1000s)	143.46	13.02
	(2712.35)	(335.86)
Direct Losses Paid ($1000s)	2659.60	981.28
	(14003.95)	(6214.04)
LAEs Paid ($1000s)	268.10	108.65
	(1564.76)	(773.28)
Direct Premiums Written ($1000s)	4848.97	-266.99
	(23711.46)	(1450.54)
N	437905	27578

Notes: Depicted are sample averages across variables (rows) and negative direct premiums written (DPW) status (columns). Standard deviations are in parentheses. "LAEs" refer to loss adjustment expenses. Dollar amounts in 2020 US dollars. Source: NAIC 1988-2020.

Table A.2: Comparing (N)ever Negative Firms

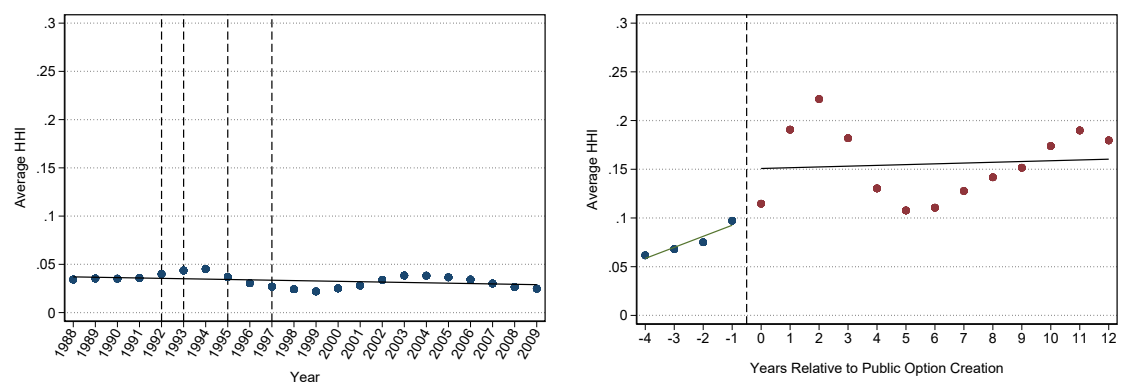
	(1) Non-Negative	(2) Negative
Member of Group	0.89	0.96
	(0.31)	(0.21)
Stock Insurer	0.82	0.90
	(0.38)	(0.30)
Mutual Insurer	0.13	0.08
	(0.34)	(0.27)
Magnitude of Negative ($1000s)	0.00	-29.37
	(0.00)	(488.32)
Direct Premiums Earned ($1000s)	6675.36	2634.84
	(30669.98)	(12812.70)
Dividends ($1000s)	213.66	69.63
	(3700.53)	(1119.49)
Direct Losses Paid ($1000s)	3612.94	1668.64
	(18586.72)	(7260.79)
LAEs Paid ($1000s)	351.40	179.92
	(1979.47)	(1001.44)
Direct Premiums Written ($1000s)	6764.11	2639.22
	(30860.66)	(12959.98)
Avg. of Neg. DPW Firm-State-Years when Negative	.	-262.91
	(.)	(1021.70)
Avg. of Neg. DPW Firm-State-Years when Positive	.	3063.39
	(.)	(9657.79)
N	235070	230413

Notes: Depicted are sample averages across variables (rows) and (n)ever negative direct premiums written (DPW) status (columns). Standard deviations are in parentheses. "LAEs" refer to loss adjustment expenses. Dollar amounts in 2020 US dollars. Source: NAIC 1988-2020.

Figure A.1: Trends in Concentration (HHI) - Means

(a) Consistently Private Market States

(b) New Public Option States

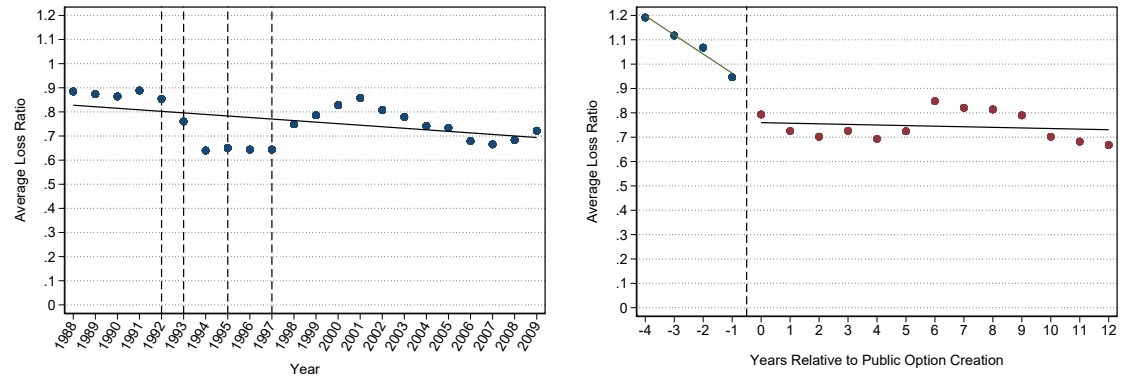


Notes: This figure displays average HHIs in consistently private market states in panel (a) and new public option states (b), across calendar time (year) and event time, respectively. A linear trend line is drawn through all points in panel (a) and drawn separately in panel (b) before and after public option formation (at time = 0). Vertical lines in panel (a) indicate public option formation years. Sources: NAIC 1988-2020.

Figure A.2: Trends in Loss Ratios - Means

(a) Consistently Private Market States

(b) New Public Option States

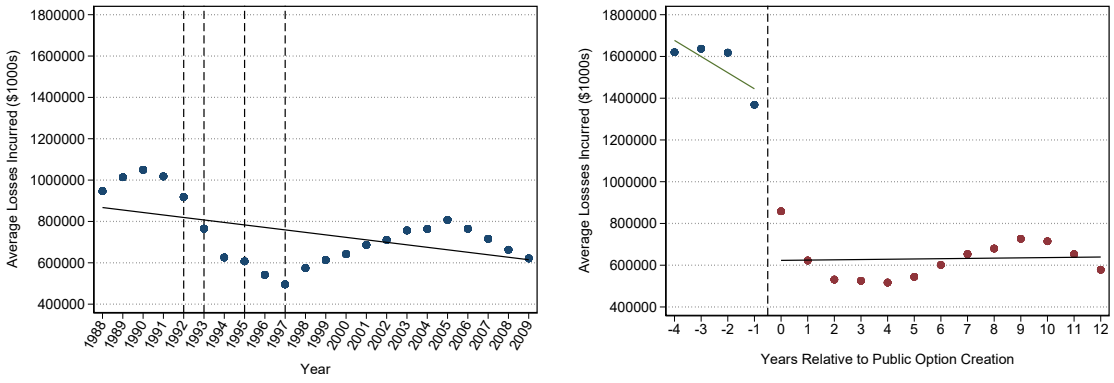


Notes: This figure displays mean loss ratios for consistently private market states in panel (a) and new public options states in panel (b), across calendar time (year) and event time, respectively. A linear trend line is drawn through all points in panel (a) and drawn separately in panel (b) before and after formation (at time = 0). Vertical lines in panel (a) indicate public option formation years. Sources: NAIC 1988-2020.

Figure A.3: Trends in Loss Ratio Elements - Means

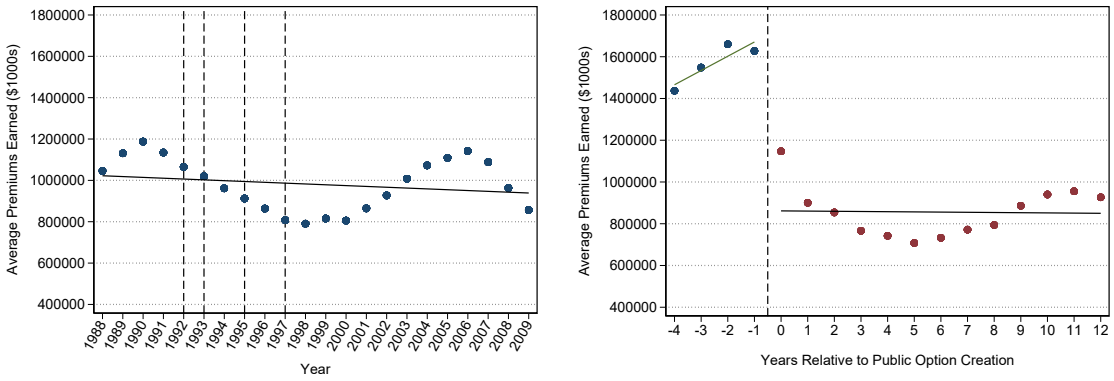
(a) Losses Incurred: Private Market States

(b) Losses Incurred: Public Option States



(c) Premiums Earned: Private Market States

(d) Premiums Earned: Public Option States

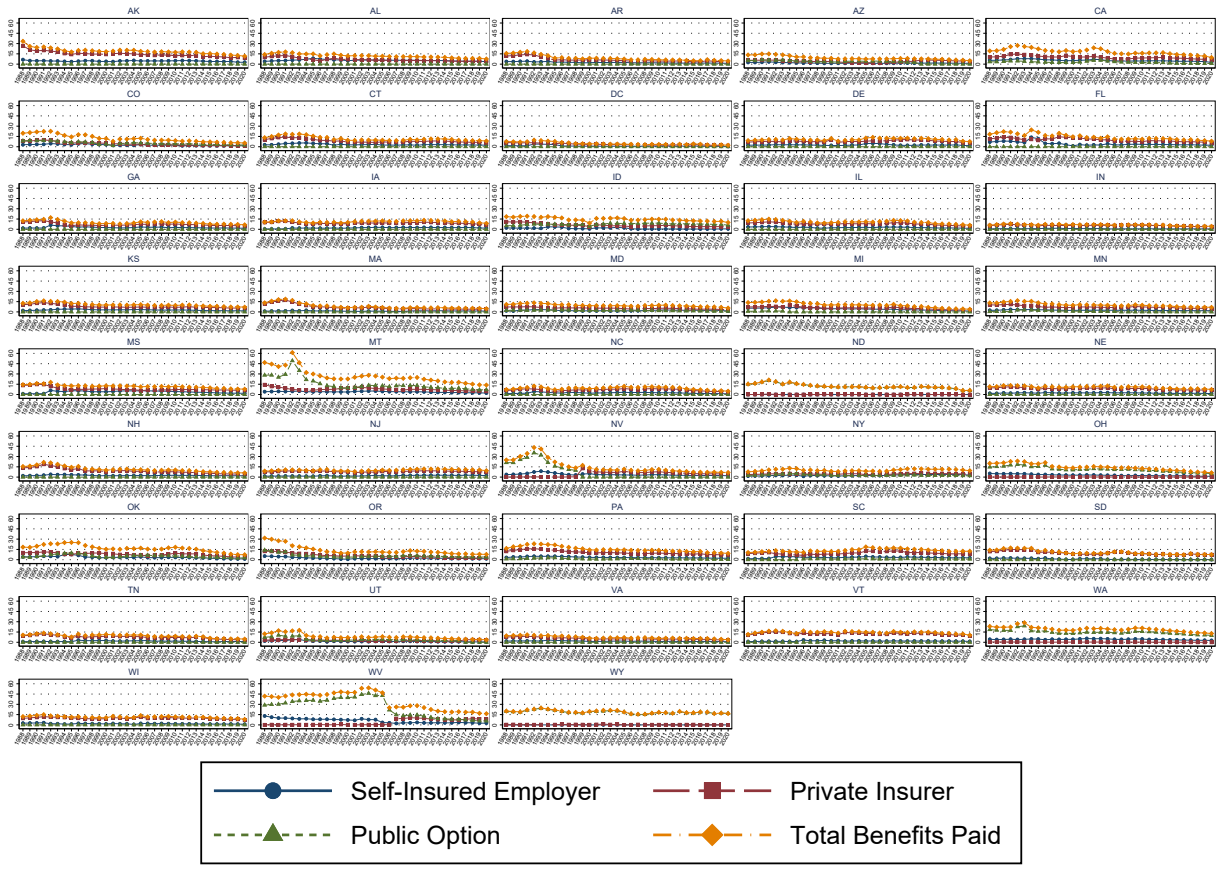


Notes: This figure displays average losses incurred and premiums earned in private market states - in panels (a) and (c) - and new public option states - in panels (b) and (d) - across calendar time (year) and event time, respectively. A linear trend line is drawn through all points in panels (a) and (c) and drawn separately in panels (b) and (d) for public option states before and after formation (at time = 0). Vertical lines in panels (a) and (c) indicate public option formation years. Sources: NAIC 1988-2020.

Figure A.4: Trends in Benefits Paid, New Public Option States

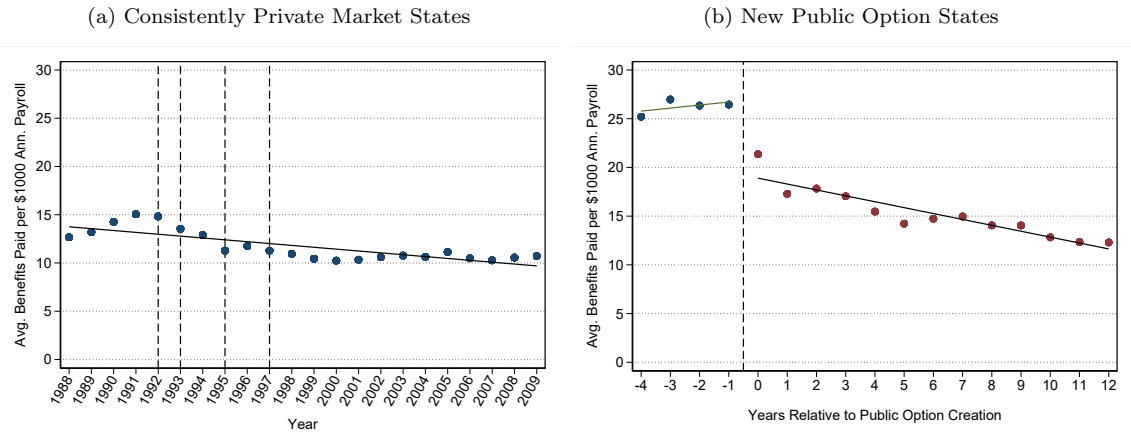
Notes: This figure displays workers' compensation benefits paid per $1,000 of annual payroll within each state over time. Benefits paid by self-insured employers are given by the blue (circle) lines; private insurer benefits paid are given by the red (square) lines. Public option benefits paid are given by the green (triangle) lines, and total benefits paid across all sources are given by the orange (diamond) lines. Sources: CBP, SSB, and the National Academy of Social Insurance 1988-2020.

Figure A.5: Trends in Benefits Paid, Other States



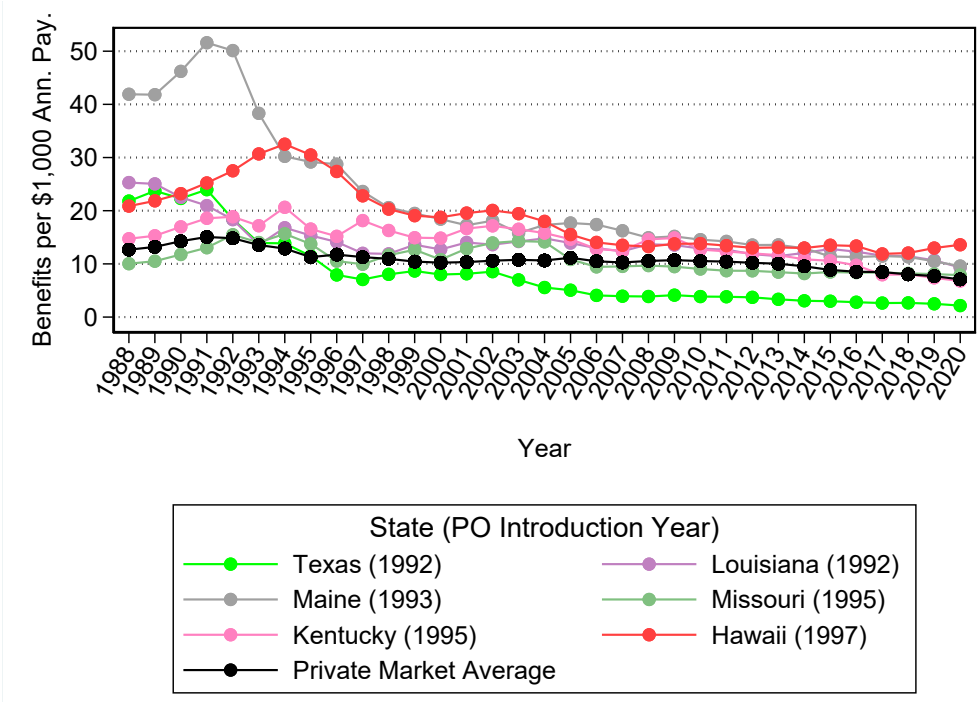
Notes: This figure displays workers' compensation benefits paid per $1,000 of annual payroll within each state over time. Benefits paid by self-insured employers are given by the blue (circle) lines; private insurer benefits paid are given by the red (square) lines. Public option benefits paid are given by the green (triangle) lines, and total benefits paid across all sources are given by the orange (diamond) lines. Sources: CBP, SSB, and the National Academy of Social Insurance 1988-2020.

Figure A.6: Trends in Benefits Paid - Means



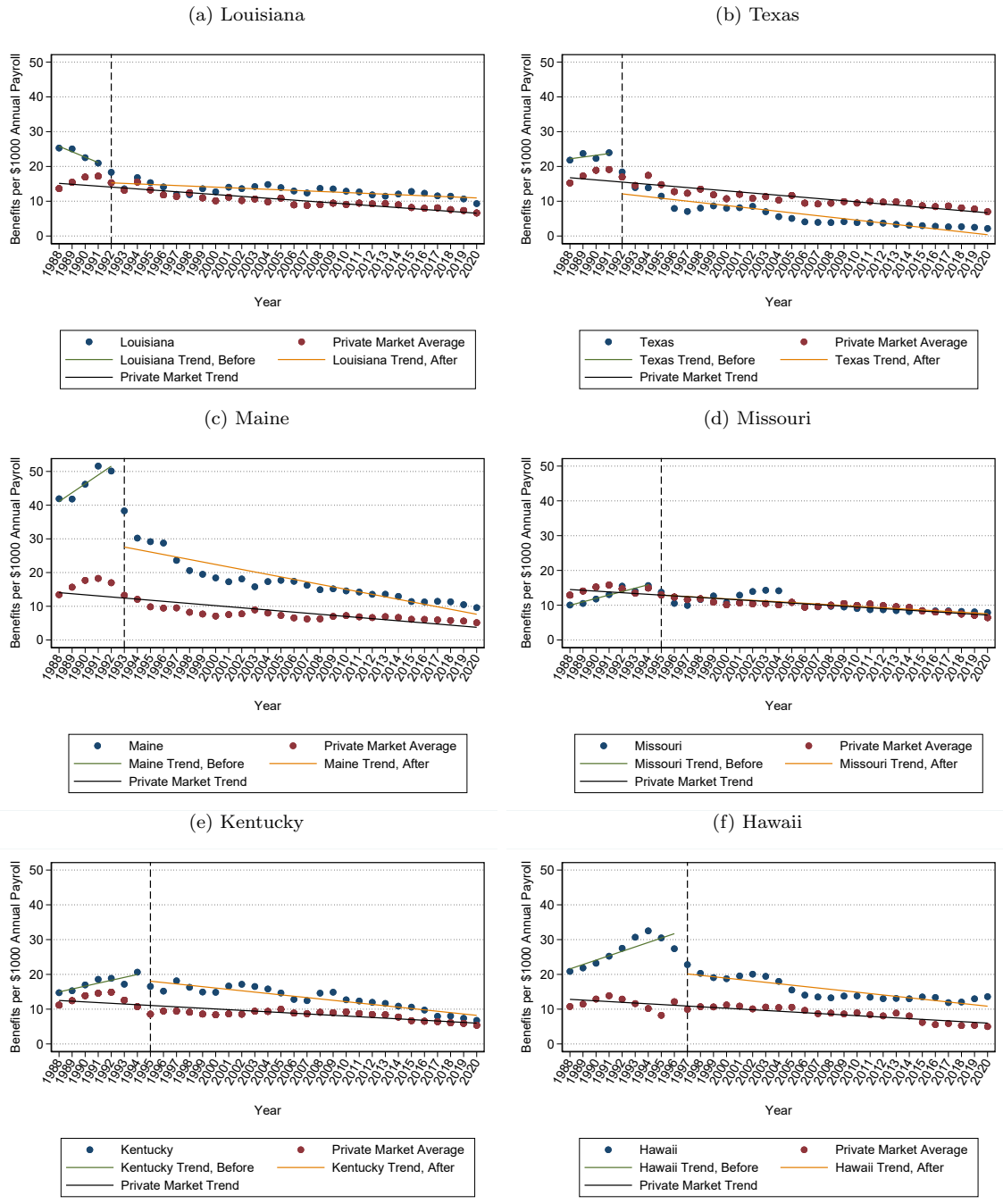
Notes: This figure displays mean workers' compensation benefits paid per $1,000 of annual payroll within consistent private market states in panel (a) and new public option states in panel (b), across calendar time (year) and event time, respectively. A linear trend line is drawn through all points in panel (a) and drawn separately in panel (b) before and after formation (at time = 0). Vertical lines in panel (a) indicate public option creation years. Sources: CBP, SSB, and the National Academy of Social Insurance 1988-2020.

Figure A.7: Trends in Benefits Paid, Public Option States vs. Private Market Average



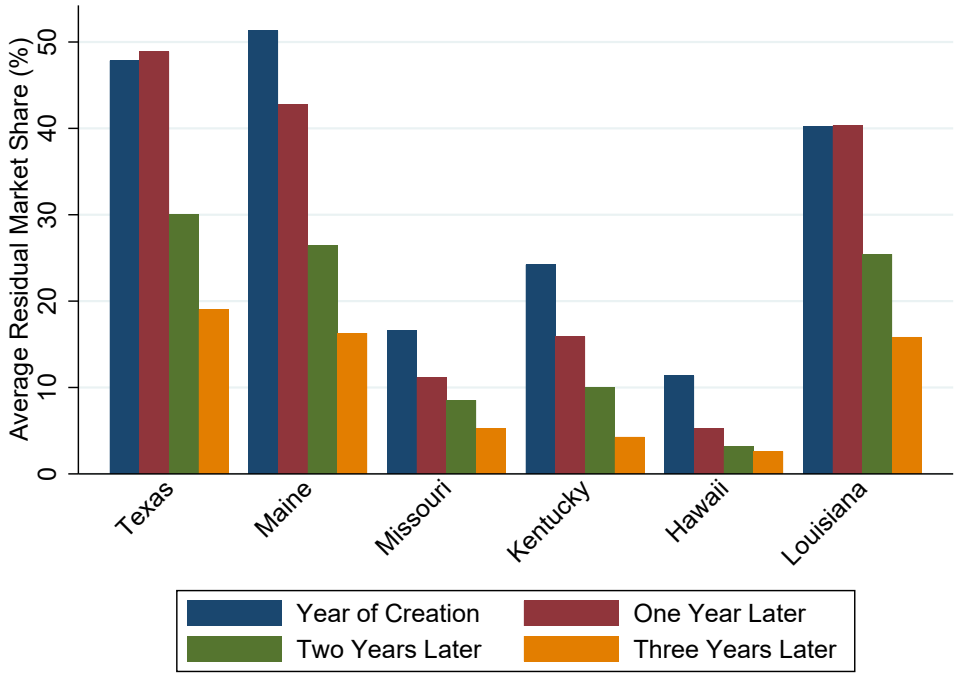
Notes: This figure displays workers' compensation benefits paid per $1,000 of annual payroll within each new public option state over time, compared to the average among the consistently private market states. Sources: CBP, SSB, and the National Academy of Social Insurance 1988-2020.

Figure A.8: Trends in Benefits Paid, Post-Match



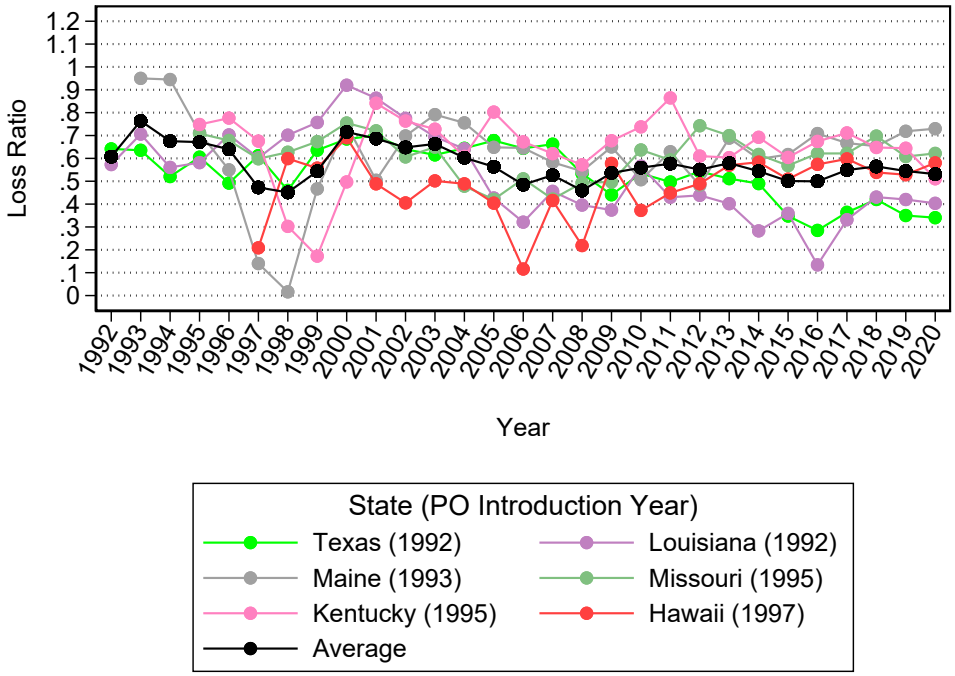
Notes: This figure displays benefits paid levels per $1,000 of annual payroll in each public option state (given by the panel title) compared to its matched comparison states from the private-only subset. Blue dots represent benefits paid in the public option state, with a green trend line before formation and an orange trend line after formation. Red dots represent the matched comparator average benefits paid levels, connected with a black trend line. Sources: CBP, SSB, and the National Academy of Social Insurance 1988-2020.

Figure A.9: Private-Only Residual Markets Before and After Public Option Formation



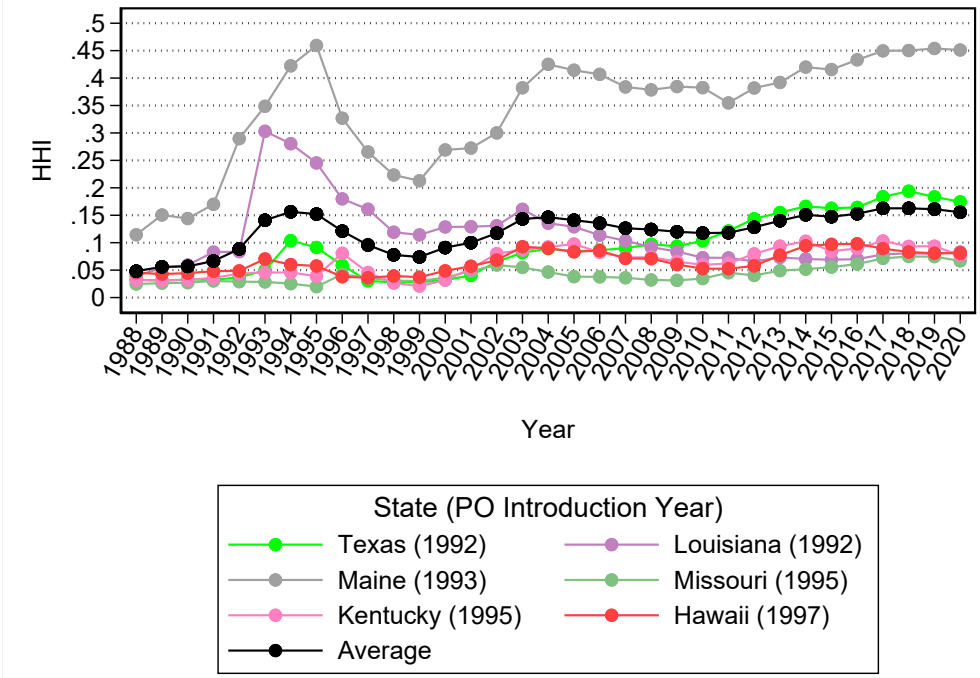
Notes: This figure displays residual market shares in consistently private market states matched to each new public option state (given by x-axis labels) in the year the public option launched, and then for each of the three years after. Only two matched private market states aren't included: Wisconsin and Florida (after 1995). Sources: Thomason et al. (2001), Buhro (2011), and NCCI (2000).

Figure A.10: Public Option Loss Ratios Over Time



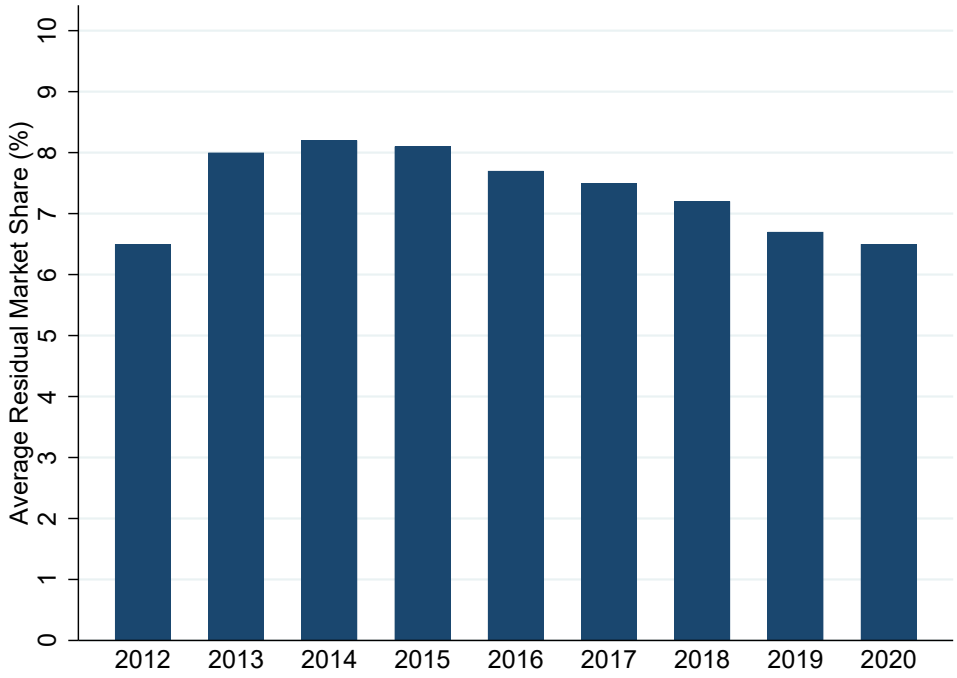
Notes: This figure displays the loss ratios of each public option over time, along with the average among the public options. Sources: NAIC 1992-2020.

Figure A.11: Public Option States - HHIs Over Time



Notes: This figure displays HHI measures in each public option state, and the running average, across time. Sources: NAIC 1988-2020.

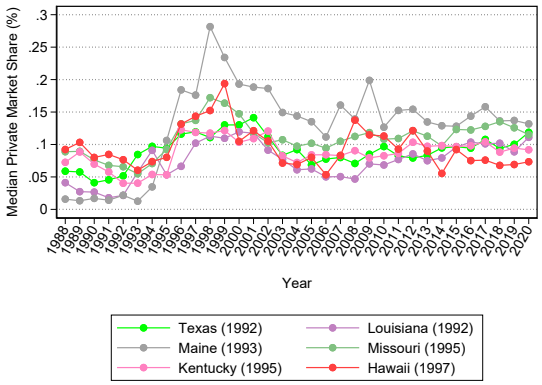
Figure A.12: Recent Residual Market Shares



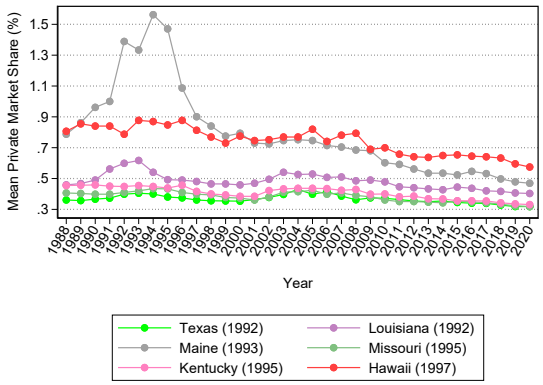
Notes: This figure displays the percentage of direct premiums written by the residual market in NCCI states over time. Sources: NCCI (2016) and NCCI (2020).

Figure A.13: Private Market Competition

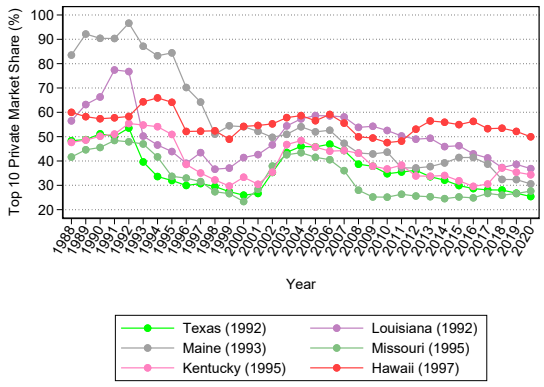
(a) Median Private Insurer Market Share



(b) Mean Private Insurer Market Share

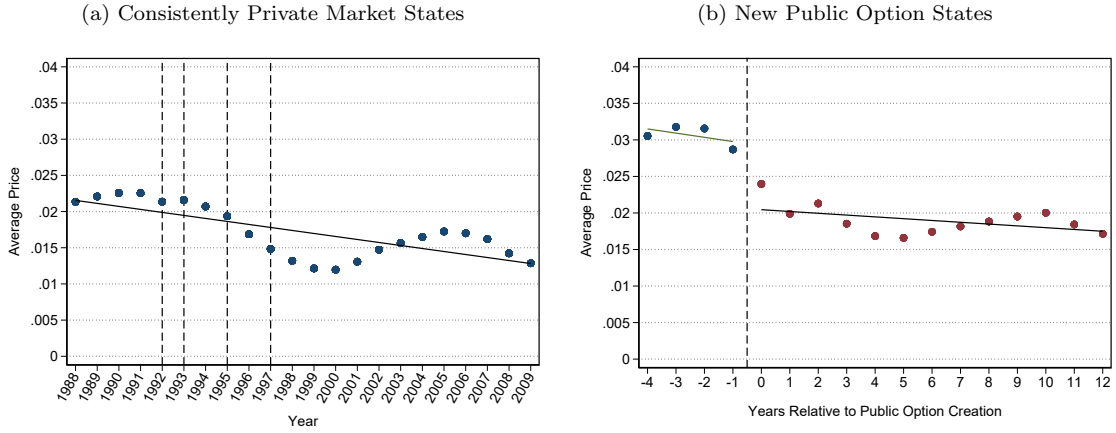


(c) Market Share of Top 10 Private Insurers



Notes: This figure displays market shares among private insurers in new public option states, after removing the public option's portion of premiums written. Panel (a) displays the median private insurer market share. Panel (b) does the same but for the mean, and panel (c) sums the market shares of the top 10 private insurers. Note the different vertical axis labels in each depiction, given the stark level differences (though all are in percentages). Sources: NAIC 1988-2020.

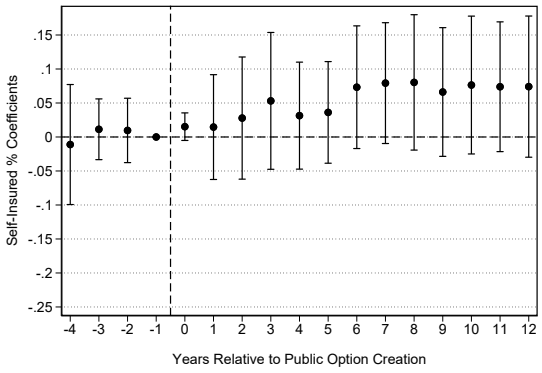
Figure A.14: Trends in Price - Means



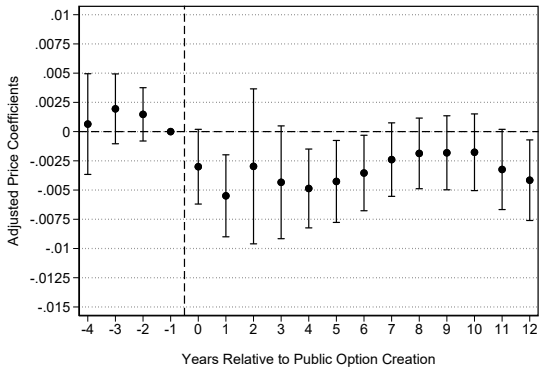
Notes: This figure displays mean workers' compensation insurance price per $1 of annual payroll within consistent private market states in panel (a) and new public option states in panel (b), across calendar time (year) and event time, respectively. A linear trend line is drawn through all points in panel (a) and drawn separately in panel (b) before and after formation (at time = 0). Vertical lines in panel (a) indicate public option creation years. Sources: NAIC, CBP, SSB, and the National Academy of Social Insurance 1988-2020.

Figure A.15: Stacked Event Study Results - Self-Insured Benefits, Adjusted Price, Dividends

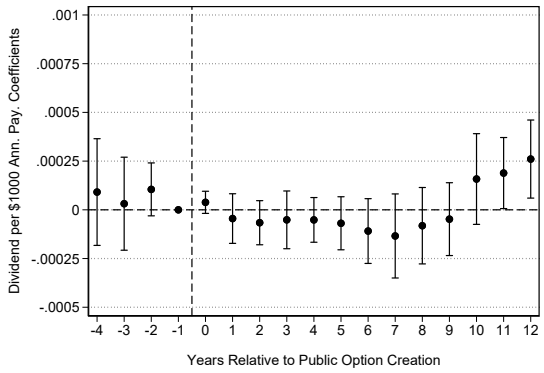
(a) Self-Insured Percentage of Benefits Paid



(b) Adjusted Prices

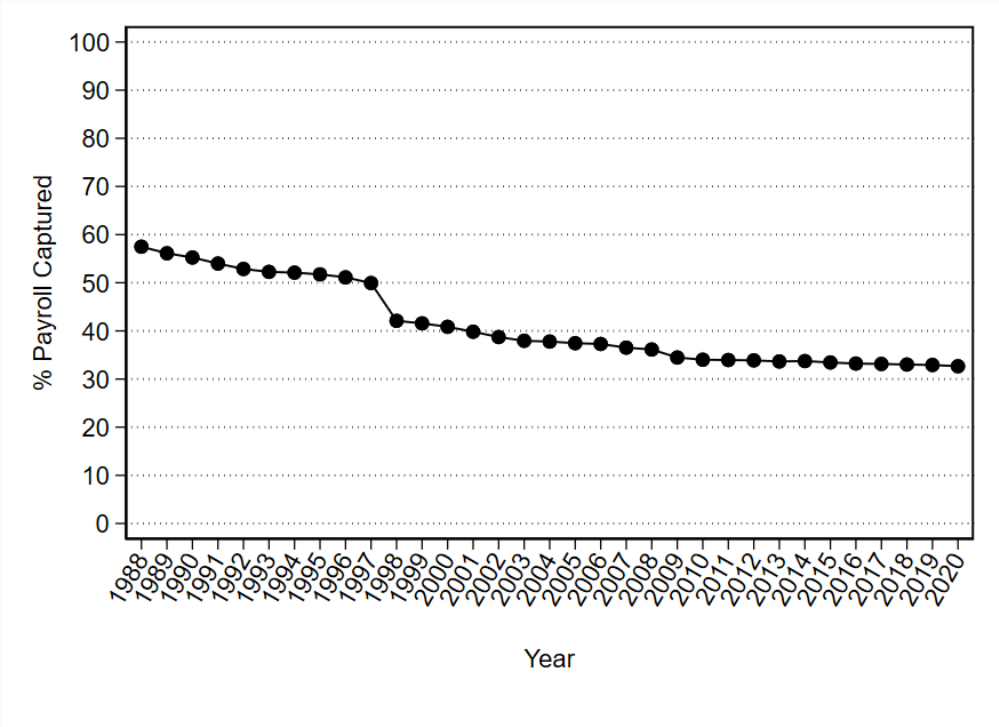


(c) Dividends Paid



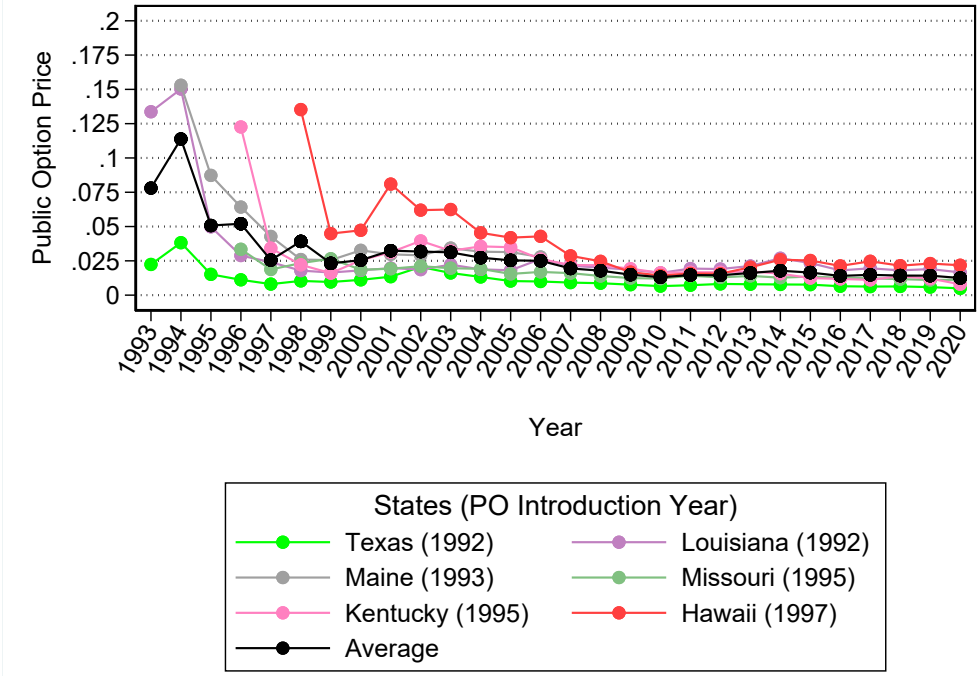
Notes: This figure displays point estimates from estimating Equation 1 with three outcomes: self-insured percentage of total benefits paid in panel (a), prices adjusted for dividends paid in panel (b), and dividends paid per $1,000 of annual payroll in panel (c). The graphs use 90% confidence intervals. Note the unique vertical axis values, given the different outcomes being graphed in each. Sources: NAIC, CBP, SSB, and the National Academy of Social Insurance 1988-2020.

Figure A.16: Payroll Captured



Notes: This figure shows how much of total payroll, on average, is captured by the six broad categories from Figure 19 over time. Sources: CBP 1988-2020.

Figure A.17: Public Option Prices

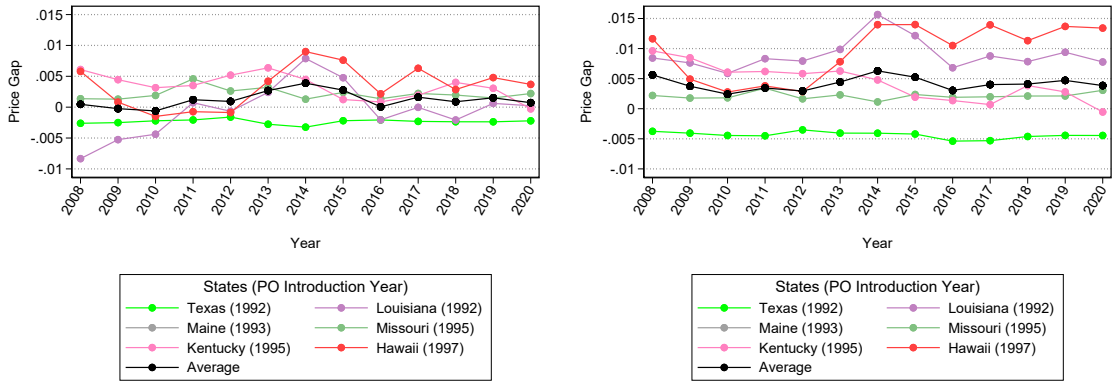


Notes: This figure displays workers' compensation insurance price per $1 of annual payroll for public options over time, along with the average public option price among the six new public option states. Sources: NAIC, CBP, SSB, and the National Academy of Social Insurance 1993-2020.

Figure A.18: Price Gaps, 2008-2020 - Public Options vs. the Private Market

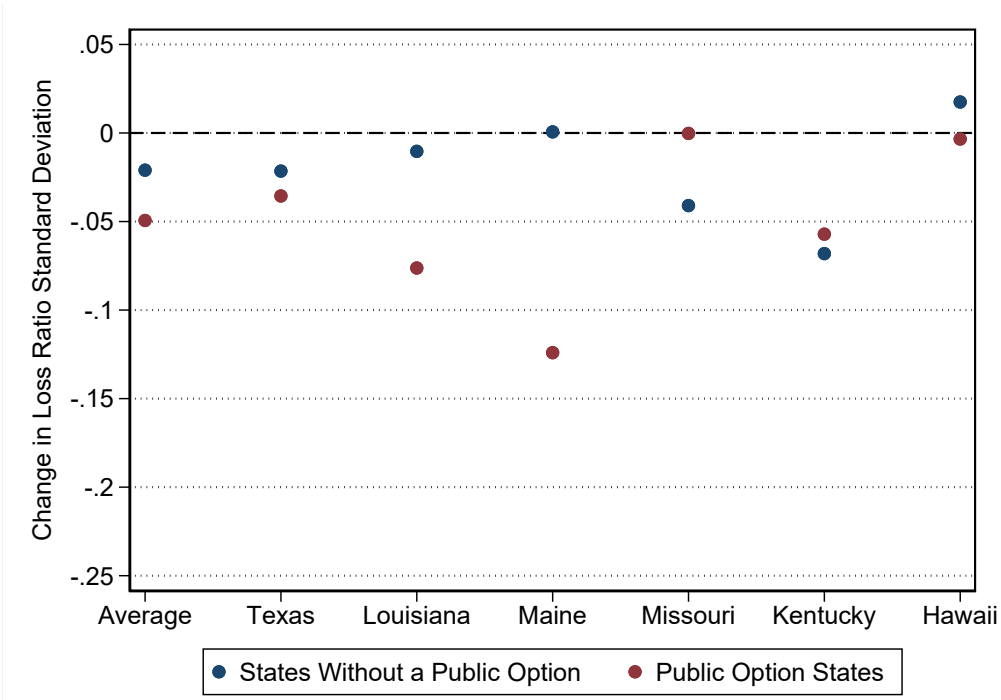
(a) Within the Public Option States

(b) Matched Private-Only Comparators



Notes: This figure displays the gaps between the public option price and the private market price over time, specific to the 2008-2020 period. The private market is defined as all private insurers in the public option's state in panel (a) and the matched group of private-only comparators in panel (b). Sources: NAIC, CBP, SSB, and the National Academy of Social Insurance 2008-2020.

Figure A.19: Firm-Level Stability in Loss Ratios



Notes: This figure displays the change in the standard deviation of firm-level loss ratios between the three years before public option formation and the three years after (including the year of formation) among private insurers in matched private-only states (blue dots) and states with a new public option (red dots). States are grouped by their reference public option (x-axis), along with the average of the gaps across all six categories on the far left. This graph drops firm-level loss ratios outside of the 10/90 percentiles. Sources: NAIC 1989-1999.