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Physician payments under health care reform☆

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ABSTRACT

This study examines the impact of major health insurance reform on payments made in the health care sector. We study the prices of services paid to physicians in the privately insured market during the Massachusetts health care reform. The reform increased the number of insured individuals as well as introduced an online marketplace where insurers compete. We estimate that, over the reform period, physician payments increased at least 11 percentage points relative to control areas. Payment increases began around the time legislation passed the House and Senate—the period in which their was a high probability of the bill eventually becoming law. This result is consistent with fixed-duration payment contracts being negotiated in anticipation of future demand and competition.

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1. Introduction

The primary goals of the 2006 Massachusetts health care reform were to expand the number of individuals with health insurance coverage and increase the degree of competition in the insurance marketplace. The expansion focused on using financial incentives to spur enrollment in the private insurance market. The key elements of the legislation included an individual insurance mandate, employer requirements to provide insurance, the creation of a subsidized insurance program to low-income individuals, and the introduction of a health insurance exchange. The reform has been quite successful in its goal, with the percentage of individuals without insurance falling from 6.4 in June of 2006 to 1.9 in 2010 (Massachusetts Division of Health Care Finance and Policy (DHCFP), 2011).[1]

The reform in Massachusetts served as a model for the 2010 national health-care reform legislation, known as the Affordable Care Act (ACA). Both the Congressional Budget Office (CBO) and the Center for Medicare and Medicaid Services (CMS) project that over 30 million more individuals will have insurance in the United States over the next decade as a result of the reform.[2] Examining the case of Massachusetts may therefore give important insights about the impact of national reform. Recent studies have looked at the causal impact of the Massachusetts reform on a wide array of variables including healthcare demand (Kolstad and Kowalski, 2012; Long et al., 2012) and the place of service (i.e., emergency room or physician office, Miller, 2012a). The finding that the reform affected service utilization is in line with a vast empirical literature that documents the effect of insurance coverage on utilization (e.g., Manning et al., 1987; Finkelstein, 2007; Finkelstein et al., 2012). However, distinct from prior expansions in public insurance, where prices are fixed by regulators (i.e., Medicare and Medicaid), both the

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[1] Estimates vary on the effect of the reform. For example, Long et al. (2012) find that the uninsured rate fell from 13.4 to 5.8 percent.

[2] Survey evidence from Krueger and Kuziemko (2013) suggest that 35 million uninsured individuals would gain insurance.

ACA and the reforms in Massachusetts rely more heavily on the private sector. Consequently, these reforms may not only affect utilization, but may also have an impact on equilibrium prices, including insurance premiums and payments to health care providers.

This paper focuses specifically on the effect of insurance expansion on payments to providers. Since health care accounts for about 18 percent of nominal GDP, even a relatively small price increase to providers would increase the nominal expenditures devoted to the health sector and also affect national measures of inflation and output. Prices are also important signals that affect the long-run market entry decisions and also short-run decisions on the quantity and types of services offered to patients.[3] Theoretically, the mechanisms by which the reform might impact provider fees are straightforward. First, the reform led more than 400,000 previously uninsured individuals to obtain health insurance, causing a substantial increase in the demand for health care (Kolstad and Kowalski, 2012; Miller, 2012b; Long et al., 2012). To match demand, insurers may need to adjust physician payments in order to maintain their current physician network or to draw new physicians into their network. Second, the new health insurance exchange, known as the Massachusetts Connector, likely increased the degree of competition among insurers (Ericson and Starc, 2012). Dunn and Shapiro (2013) and Dafny et al. (2012) show that a higher degree of competition in the insurance market raises payments to physicians. While theory would suggest that expansion would likely lead to higher prices, the magnitude and timing of the effect is unclear. For instance, there is the possibility that physician capacity was sufficient to accommodate expansion at existing rates. Ultimately, the effect of the reform on prices must be measured empirically.

In this study, we focus on the impact of the Massachusetts reform on payments to physicians. There are two reasons for focusing on physician prices. First, relative to how other payments are set in the healthcare industry, physician payment contracts are usually quite simple. Prices are based on fees for specific procedures defined by Current Procedural Terminology (CPT) codes. For example, there are distinct CPT codes for office visits that last 15 min and those that last 30 min.[4] This is in contrast to how prices are negotiated for inpatient hospital services where the definition of a service is more complex and the pricing methodology may change dramatically depending on the specific contract between each insurer and provider (see Reinhardt, 2006).[5] A second reason for focusing on physician prices is that the number of physicians is quite large reducing the chance that the price changes are caused by a single provider's negotiating practices.

Prior studies measuring the impact of Massachusetts reform have relied on two different sources of variation to conduct difference-in-difference analysis: across-state variation and across-county variation. We apply both approaches, obtaining two distinct estimates of the effect on physician prices. Specifically, one approach uses across-state variation to identify the relative change in Massachusetts prices around the time of the reform, relative to comparable states, as applied in Kolstad and Kowalski (2012). To obtain comparable control states, we apply the synthetic control approach of Abadie et al. (2010).[6] The second approach exploits variation in the pre-reform uninsured rates in the county, as applied by Miller (2012a).[7] This analysis adds another layer of variation—the uninsured rate of the county—under the presumption that providers and insurers residing in those counties with higher uninsured rates should have anticipated a higher impact of the reform on insurance coverage than those counties with already near-full coverage.

Unlike prior studies of the reform, our analysis assesses the timing of the impact of the reform. In examining price impacts of the reform, tracking the timing is important since key industry characteristics suggest that a response to the reform should be expected *prior* to implementation. First, price negotiations between physician firms and insurers take place rather sporadically—anywhere from annually to every five years. Since prices are essentially "stuck" for a fixed duration of time, it is likely that insurers set prices based on expectations of future demand and competition over the contract period. Strategically, insurers need to negotiate contracts with a enough time remaining to advertise their provider networks to consumers.[8] Additional dynamic considerations arise from the large switching costs in health insurance markets that lock individuals into a plan (Ericson, 2011; Handel, 2013; Nosal, 2013). In industries with high switching costs, firms that do not respond immediately to expected changes in market conditions risk substantial profit loss in future periods (Klemperer, 1995; Farrell and Klemperer, 2007).[9]

Both our across-state and across-county analysis lead to a similar conclusion. Relative to control states and counties, we find that prices are significantly higher post-reform, relative to the pre-reform period. Overall, our estimates imply that at least one-sixth of overall physician service price growth in Massachusetts was directly attributable to the reform itself. The timing of the price increase occurs around the time the health care legislation passed the house and senate—the period in which their was a high probability of the bill being signed. This timing is consistent with recent microeconometric studies in other industries that show price changes in response to anticipated changes in the competitive environment. For example, Goolsbee and Syverson (2008) show that rival airlines set prices in anticipation of Southwest Airline's entry in a market; and Tenn and Wendling (2013) show that generic drug manufacturers reduce prices in anticipation of potential entry by other generic firms.[10]

It is important to highlight a few caveats of this study. First, this study assesses the impact of the reform on payments made to physicians from insurers, not the impact of the reform on insurance premiums or out-of-pocket costs that are charged to employers

[3] Clemens and Gottlieb (2013) find supply motives associated with physician payment increases, indicating the payments may also affect the quantity and types of services provided to patients.

[4] Due to the thousands of CPT codes in existence, physicians usually negotiate the prices of all CPT codes at once based on a fee schedule—for example, all prices set relative to Medicare prices (see Clemens and Gottlieb, 2014.

[5] For example, inpatient hospital contracts may be based on a discount off of charges, a per diem rate, or price based on the diagnosis code (i.e., DRG code) of the patient.

[6] Our state-level analysis is based on a variation of the classical Fisher permutation test—similar to a recent paper by Buchmueller et al. (2011). Similar results are found using alternative difference-in-difference approaches at the state level.

[7] This approach is also applied in Finkelstein (2007) looking at the effects from the introduction of Medicare.

[8] The first major components of the legislation aimed at people with lower incomes went into effect in October 1, 2006 and January 1, 2007.

[9] In other words, "anticipated future changes in market conditions will have immediate effects on prices in markets with switching costs" (Klemperer, 1995). The expansion of insurance to the uninsured likely provided a key opportunity for insurers with low market share to expand, since uninsured individuals arguably have no switching costs.

[10] Kwoka and Shumilkina (2010) show that prices fall in airline markets when potential competitors are eliminated after a merger. Anticipatory effects are not confined to prices. For instance, Goetz and Shapiro (2012) find that airlines preemptively codeshare when a route is threatened, while Ellison and Ellison (2011) find that pharmaceutical firms make strategic investments to deter future entry. It is interesting to note that forward-looking price setting models have been commonplace in the macroeconomics literature for some time (e.g., see Gali and Gertler (1999).

and enrollees. Given the reform induced expansion in the private insurance market, ultimately changing the competitive landscape, it is possible that no medical-care price increases were passed onto consumers.[11] In fact, Graves and Gruber (2012) find that the reforms had no effect on group premiums in Massachusetts relative to other states, and led to a reduction in premiums in the non-group market. Second, our study assess the prices of services provided by physicians in an office setting. We make no definitive assessment about pharmaceutical prices or payments made to hospitals in an inpatient setting. Third, we analyze the prices of physicians services in the privately insured market, which accounts for more than 80 percent of the Massachusetts non-Medicare insured population. Our data does not include Medicare or Medicaid prices or prices charged to the uninsured. Furthermore, we likely do not see prices paid by plans in the subsidized insurance exchange. The overall impact of the reform would be partly offset if subsidized plans pay physicians less generously than other plans, or previously uninsured patients pay lower prices after the reform. Furthermore, we cannot rule out the possibility that our dataset may include some selection bias if a large number of consumers left their employer-provided insurance to purchase insurance on the new insurance exchange. Finally, the results in this study should not be treated as a normative statement regarding the merits of the reform. To fully evaluate the success of a reform, policymakers must weigh the potential benefits of the reform, such as expanded coverage, improved health outcomes, and a more competitive insurance market, against the associated cost.

2. Massachusetts health-care reform

2.1. Timeline of events

Health-care reform efforts in Massachusetts began in early 2003 with the inauguration of Mitt Romney as governor. Upon taking office, Romney's staff immediately began consulting with policy experts and academics to figure out ways to cover the uninsured. By May 2004, a preliminary insurance coverage plan was created by Romney's health and human services secretary, who privately circulated a 29-page white paper outlining a plan to increase coverage by expanding the Medicaid program and imposing individual and employer mandates. In hindsight, the plan described in this white paper looked very similar to the actual legislation that was eventually enacted two years later.[12]

Romney did not fully advertise his ideas concerning health insurance reform to the general public until November 2004, when he wrote an editorial in *The Boston Globe* outlining his ideas concerning a health insurance overhaul. The editorial explicitly came out against an insurance mandate.[13] Romney instead focused on how the state could lower health care costs via offering health insurance with larger deductibles and smaller benefits.[14]

Seven months later in June 2005, in contrast to the views expressed in his prior editorial, Romney stated his support for an insurance mandate. Specifically, in a keynote address at an event organized by the Blue Cross Blue Shield of Massachusetts Foundation, he discussed that his plan would require all residents to have some form of health insurance or agree to pay their health care expenditures out of pocket.[15] Romney touted the individual mandate as the "the ultimate conservative idea."

The next important milestone occurred later that year, in November 2005, when the Massachusetts House and Senate each passed separate health insurance reform bills. Both bills included an individual mandate, although the Senate bill was less comprehensive, in that it did not include expanded subsidized coverage or an employer assessment (Bebinger, 2012). It took a few months of negotiations between both sides of the legislature on an employer assessment until a compromise was finally reached in April 2006. The Massachusetts legislation made national headlines and eventually served as a benchmark for national health care reform under the ACA of 2010.

2.2. The three-legged stool design

Similar to the ACA of 2010, the Massachusetts 2006 legislation was based on a three-legged stool design (Gruber, 2011). The first leg included private insurance market reforms. These aimed to limit price discriminating against individuals with pre-existing conditions, guarantee issuance and renewal of insurance, and prohibit medical underwriting (McDonough et al., 2008). To increase the availability and transparency of health insurance, an exchange was created, called the Commonwealth Health Insurance Connector.

The second leg of the stool aimed to keep the market from unraveling. For instance, with guaranteed issuance and limits on pre-existing conditions, healthy individuals may find it in their interest to wait to obtain health insurance until they finally need health care. For this reason, part of the reform consisted of an insurance mandate, which required individuals over the age of 18 to purchase insurance or pay a penalty.

The third leg of the stool represented government subsidies to allow low-income individuals access to the insurance market. Specifically, Massachusetts created the Commonwealth Care Health Insurance Program (CommCare), which would be sold on the Massachusetts Connector. This program gave eligible people with incomes below 150 percent of the poverty level insurance coverage without any premium. Eligible households with incomes between 150 and 300 percent of the poverty line paid premiums for CommCare based on a gradient. It is important to note that the Massachusetts Connector also served as a marketplace for nonsubsidized plans known as Commonwealth Choice plans. These plans are designed for uninsured individuals who are not eligible for Medicaid or CommCare and must meet certain standards for quality and value before given a seal of approval.

[11] Graves and Gruber (2012) find that the reforms had no effect on average premiums in Massachusetts relative to other states. DHCFP (2011) reports profit margins for insurers falling post reform. Dafny et al. (2012) shows a strong relationship between premiums and insurer concentration. A full accounting of consumer welfare would also need to consider the gains for those that receive insurance who previously had none.

[12] The paper was released to the public in January 2006.

[13] The second paragraph of the editorial read, "Next year I am committed to working with the Legislature to pass a comprehensive, market-based reform program for healthcare. It will not be a government-mandated universal coverage "pay or play" scheme nor a single payer system. It will not require new taxes. What it will do is restrain the growth in healthcare costs and change how we provide healthcare for those who receive it at taxpayer expense. And, it can lead to every citizen in Massachusetts having health coverage. I call it Commonwealth Care."

[14] Romney writes later in the editorial: "Insurers tell us they can develop plans costing less than half of today's standard rate of $500 for an individual. These plans still provide primary, preventative, specialty, and catastrophic care. The cost could be lower with higher deductibles and more restrictions. New York introduced a program in which private insurers offer rates as low as $140 a month. We can have a similarly affordable program in Massachusetts: Commonwealth Care Basic."

[15] See *The Boston Globe* June 22, 2005 article by Scott Greenberger http://www.boston.com/news/local/articles/2005/06/22/romney_eyes_penalties_for_those_lacking_insurance.

The reform also included a number of other ordinances. For example, to expand coverage, the legislation encouraged employers to offer insurance. This was done by imposing a penalty ($295 per worker) to firms with eleven or more full-time equivalent employees who do not make "fair and reasonable" contributions to employee health insurance costs. The reform also implemented a minimal-credible coverage (MCC) mandate. The MCC included a number of requirements including maximum deductibles, maximum out-of-pocket spending, coverage for ambulatory services, diagnostic imaging, emergency care, maternity care, medical/surgical care, mental health care, prescription drugs, and radiation therapy. The mandate also required that preventative services be provided before deductibles.

2.3. Impact of the reform

Estimates vary on the exact effect of the reform on coverage, although the consensus is that the impact was quite large. The Massachusetts DHCFP estimated that insurance enrollment increased by 411,722 individuals between June 2006 and 2010—a 4.5 percentage point increase in coverage. Other studies find that the increase in coverage was considerably larger. For instance, Kolstad and Kowalski (2012) perform a difference-in-differences estimation and find that insurance coverage increased by approximately 6 percentage points due to the reform. Long et al. (2009) perform a similar difference-in-differences estimation and find a 6.6 percentage point increase in coverage.[16] Miller (2012a) shows that the insurance coverage increase mainly occurred in 2007, while Kolstad and Kowalski (2012) find that it occurred in 2008. Coverage expansion from the reform was a result of both an increase in coverage from public insurance programs and employer-sponsored insurance (ESI). Both Kolstad and Kowalski (2012) and Long et al. (2009) find that approximately half of the increase in insurance coverage was a take-up of employer-sponsored insurance.[17] By 2011, the Massachusetts Connector had a membership of 158,174 individuals (Raymond, 2011). This is approximately 2.5 percent of Massachusetts' covered population. About 40 thousand of these individuals were Commonwealth Choice members—that is, individuals who purchased non-subsidized coverage.

A few recent studies have found that the increase in insurance coverage led to an increase in health-care demand. Long et al. (2012) find that the overall percentage of people who visited a general doctor in the last 12 months increased by 2.1 percentage points between 2006 and 2010, and the percent who visited a specialist increased even more, 3.7 percentage points.[18] Miller (2012b) also finds a significant increase in doctors visits.

The increase in the demand for services does not appear to have led to movements of physicians into the Massachusetts market. In Table 1 we report the number and geographic movement of doctors in the United States from the SK&A database. The database spans 2005–2008 and includes information on the name, location, and specialty of physicians (see Dunn and Shapiro, 2013 for more information about the SK&A database).[19] Table 1 provides counts for those physicians who were in the database all four years, which allows us to measure the geographic movement of physicians who practiced in Massachusetts before the reform took place.[20] The numbers show that there was little movement of physicians into or out of Massachusetts during the reform.[21] We also examined physician market concentration before and after the reform using the SK&A data and found little change over the reform period.[22] We consulted with Partners Healthcare, a large health system in Massachusetts, who informed us that although provider consolidation has increased in recent years, there was not a lot of consolidation occurring around the reform period.

Overall, health-care expenditures and premiums grew during the 2000s in Massachusetts. The DHCFP reports that private spending per enrollee grew 15.5 percent between 2006 and 2008, with physician services accounting for approximately 40 percent of this growth. Spending per capita on physician services in the privately insured market grew 8.4 percent between 2006 and 2007 and then 9.8 percent between 2007 and 2008. Spending on physician services then increased 11.8 percent between 2008 and 2009. Most spending growth was attributed to growth in service prices. Premiums also grew, although not as rapidly as medical-care spending, implying that insurance carriers' medical loss ratios were rising. Premiums grew 5–10 percent annually between 2007 and 2009, while the medical loss ratio increased from 88 percent to 91 percent.

2.4. Physician service prices and the reform

Prices for physician services in private insurance markets are set through negotiations between insurers and physician groups. Both sides may gain from contracting and agreeing on rates before marketing insurance plans. Those physicians who agree to a contract are placed in-network, where enrollees may visit a physician at a lower out-of-pocket cost than out-of-network physicians. Physicians gain access to enrollees in the insurer's plan, while the insurer is more likely to attract enrollees if the network contains a broad, high-quality physician network. Each side may attempt to gain leverage and more favorable rates by threatening to not contract with the other party. Contract durations vary by the health care provider and the insurance firm. For instance, contracts between large health systems and commercial payers are typically negotiated every three years, sometimes up to every five years, whereas contracts between smaller practices and insurers are typically set on an auto-renewing annual basis with provisions that allow either party to terminate the contract.

[16] Long et al. (2012) look at the Massachusetts Health Reform Survey (MHRS) and find that the insurance coverage rate increased from 86.6 percent in 2006 to 94.2 percent in 2010—an increase of 7.6 percentage points.

[17] The DHCFP reports that the percentage of Massachusetts employers offering ESI increased from 70 percent in 2005 to 77 percent in 2010. Long et al. (2012) find that the percent of residents with ESI increased from 64.4 percent in 2006 to 68.0 percent in 2010. In 2010, approximately 91 percent of employees worked for a firm that sponsored insurance.

[18] The evidence thus far indicates that the reform has not had an effect on access to care. Gruber (2011), for instance, cites a survey from the Massachusetts Medical Society that found average wait times remained constant over the course of the reform. Long and Stockley (2010), who examine the Massachusetts Health Reform Survey, find that barriers to getting care, either because the physician was not accepting new patients or not accepting their health insurance, remained high throughout the reform—approximately 20 percent of patients over the reform period had trouble finding a doctor. Long (2010) explains that problems with individuals finding the care they need were exacerbated in the years immediately following the reform and then eventually improved.

[19] As noted in our previous work, this data is very noisy concerning consolidation in a time-series dimension. However, it is comprehensive in terms of individual physician counts.

[20] This also allows us to control for the fact that the size of the SK&A sample grew over their sample period.

[21] We also observe relatively little movement in the share of doctors across states when looking at county data from the American Medical Association.

[22] We assessed the 80-min market boundary fixed-travel time HHI (FTHHI) constructed in Dunn and Shapiro (2013). The county-population weighted state concentration shows that the FTHHI was 0.063 in 2005, 0.060 in 2006, 0.058 in 2007 and 0.054 in 2008.

Table 1
Physician geographic movement before, during, and after reform.

	2005h1	2005h2	2006h1	2006h2	2007h1	2007h2	2008h1	2008h2
CT	2510	2505	2507	2508	2505	2504	2503	2501
MA	4288	4299	4297	4293	4300	4305	4303	4297
ME	855	858	858	859	860	859	859	856
NH	793	795	804	809	810	803	805	809
RI	771	769	771	772	770	770	768	768
VT	503	509	506	504	505	505	508	507
OTHER	151,652	151,637	151,629	151,627	151,622	151,626	151,626	151,634
Total	161,372	161,372	161,372	161,372	161,372	161,372	161,372	161,372

Notes: This table reports the number of physicians in the SK&A physician database during the 2005–2008 period. Physicians who entered or left the data mid-sample are not reported. The sample includes internists, family doctors, general practitioners, pediatricians, cardiologists, orthopedists, endocrinologists, gynecologists, gastroenterologists, and vascular surgeons.

There are at least two reasons why service prices could be affected by the Massachusetts reform. The first reason is related to insurance demand. The individual and employer mandate increased the number of insured by over 400,000 individuals. To match the increased demand, an insurer may be enticed to draw new physicians into its network with higher fees. This effect could potentially be larger in areas with a high number of uninsured individuals.

The second reason is related to the competitive environment in the insurance market. All else equal, more competition between insurers acts to raise physician payments (Dunn and Shapiro, 2013). The expanded enrollment and the exchange may have acted to increase competition by bringing in new entrants from the managed Medicaid market[23] as well as by lowering consumer search costs.[24] Besides competing on premiums, insurers compete in terms of the size of their physician networks. For instance, the Massachusetts Connector allows the shopper to search for plans that include a specific physician. All else equal, higher payments encourage physicians to stay in (or join) a network which maintains (or increases) the insurer's network size. These competitive effects might be especially true in areas of Massachusetts where consumers are more apt to use the Connector.

It is important keep in mind the possibility that the reform had no effect on service prices. In particular, physicians may have sufficient capacity or may be able to adjust practice patterns, allowing them to see more patients at pre-reform rates. The ambiguity of the theoretical prediction elevates the importance of testing the effect empirically.

3. MarketScan® data

The MarketScan® database used in this analysis tracks insurance claims from physicians using a nationwide convenience sample of patients.[25] The data span 2003 through 2010 and include payments in an office setting to cardiologists, orthopedists, internists, gastroenterologists, gynecologists, endocrinologists, and family practice physicians. The data include health claims from employers and insurance carriers throughout the entire United States; all claims have been paid and adjudicated. Geographic information is provided about the patient's county of residence and physician's county of practice. Although the MarketScan® database is a convenience sample, Dunn et al. (2012) show that data are actually quite representative of actual health-care spending.

Each observation in the data corresponds to a service line item in an "explanation of benefits" form. We use MarketScan's payment variable, which is defined as the total gross payment to a provider for a specific service. Each service line represents the Current Procedural Terminology (CPT) code including any modifiers performed on the patient. For instance, the most common CPT code is 99213, which represents a 15-min established-patient office visit. The payment of each service line represents the amount of dollars eligible for payment after applying pricing guidelines such as fee schedules and discounts, and before applying deductibles and copayments. For our analysis, we kept only those CPT codes where there existed at least 100 observations per quarter in Massachusetts. This left 33 CPT codes, which make up 66 percent of all physician office spending in MarketScan® in New England. Typically, providers negotiate all procedures from a percentage off of a base fee schedule, for example, 20 percent above Medicare rates.[26] A summary of the MarketScan® sample used in this study is shown in Table 2.

MarketScan® includes a variable called "provider ID," which is an encrypted identification number of the health-care provider. This variable may represent a single physician, a group of physicians, or the hospital employing the physician. The important information for our study is that this variable keeps track of a given health-care provider over time. This allows us to control for new health-care providers spuriously entering or leaving the MarketScan® sample.[27] To keep the sample balanced in this regard, we keep only those provider IDs that are in the data at least six consecutive years. This step removed only 3 percent of the observations in the data, leaving about 100,000 provider IDs in the United States and 1757 in Massachusetts. We show that the results are robust to a range of provider ID cutoffs.

MarketScan® also indicates the type of insurance plan the claim was made under, which allows us to ignore episodes in which a capitation payment was made.[28] The bottom portion of Table 2 compares the types of spending in Massachusetts to the entire

[23] Plans such as Network Health, Neighborhood Health Plan, and Healthnet, entered the non-Medicaid market by going on the exchange to serve individuals required to get commercial insurance or individuals obtaining subsidized insurance.

[24] The Connector allows consumers to compare the prices and benefits of different plans on a single web page. Studies have shown that, more generally, the internet increases competitiveness. For example, Brown and Goolsbee (2002) find that in the life insurance industry, an increase in the share of individuals using the Internet reduces insurance premiums. Dafny et al. (2012) and Dunn and Shapiro (2013) show that decreased insurer market power increases physician income and payments.

[25] This paper uses the Commercial Claims and Encounters Database portion of the MarketScan® Databases, which includes records at the encounter level.

[26] See Clemens and Gottlieb (2013).

[27] Since this variable is created by clients of Truven Health, there may be a single physician or physician firm (i.e., group) with multiple provider IDs, if the same physician is in the data provided by multiple sets of clients. The ID variable should therefore not be used to track statistics on the number of physicians in a market.

[28] Approximately 3 percent of our sample are capitated episodes. These observations are likely to include closed HMO systems such as Kaiser-Permanente patients.

Table 2
MarketScan® sample.

	U.S. (excl. MA)	New England (excl. MA)	Massachusetts
Number of procedures	33	33	33
Number of provider IDs	98,988	3988	1757
Observations	209,212,900	3,311,833	1,741,223
Average patient age	43.4	43.5	42.8
Percent spending by plan type			
PPO	62.7%	42.9%	20.1%
HMO	13.2%	17.0%	51.8%
POS	11.5%	27.0%	19.4%
Other	12.6%	13.1%	8.7%
Percent spending by procedure			
15 min est. E/M (99213)	32.7%	33.1%	30.7%
25 min est. E/M (99214)	23.8%	20.0%	24.1%
Comprehensive E/M (99396)	6.6%	14.8%	10.9%
30 min new E/M (99203)	4.0%	3.0%	2.4%
40 min est. E/M (99215)	3.9%	1.7%	3.3%
Remaining	29.0%	27.4 %	28.6%

United States and New England.[29] An apparent disparity in Massachusetts is its low share of PPO spending and high share of HMO spending. We verified this with HealthLeaders-InterStudy (HLIS), which shows similar HMO market shares and verifies that this is likely representative.[30] Nevertheless, speaking with insurance companies in Massachusetts leads us to believe that the distinction between plan types has blurred over the past couple of decades. That is, there are many HMO plans with low restrictions and PPO plans with high restrictions. The cutoff in the distinction between these types of plans likely varies regionally.

4. State-level analysis

Our state-level analysis examines overall physician service price growth in Massachusetts over certain periods of time during the course of the health care reform. For instance, a simple difference-in-differences estimate would compare Massachusetts price growth before and after the reform relative to the difference in growth rates of non-Massachusetts states before and after the reform. We take a more flexible approach by breaking the sample into three period periods. We characterize a lead-up period, which begins in 2004q4, the quarter in which Governor Romney wrote the *The Boston Globe* editorial, and extends to the quarter the reform was implemented, 2006q2. The two periods around the lead-up period we simply refer to as the pre- and post-reform periods.[31]

As noted by Moulton (1990), statistical inference is not straightforward in this setting. Due to the focus on a single state, the standard asymptotic assumptions under a clustering framework do not hold. To address this issue we use a variation of the Fisher permutation test, similar to that performed in Buchmueller et al. (2011).

4.1. Service price growth by state

Our exercise begins by obtaining price-growth estimates for each state by running a simple fixed-effects regression for each state plus the District of Columbia. Each regression tracks price growth at the service level or claim-line level, where each observation corresponds to a specific service provided to an individual. Specifically, the service level observation corresponds to a specific service performed on an individual, where the service is specific to a CPT code, plan-type (e.g., HMO, PPO, etc.), and physician ID. Since physician contracts with different insurers are specific to each CPT code, we include CPT code-plan-type-physician ID triple fixed effect to isolate the price change of a specific contract with a provider.[32] Given the fixed effects to control for each physicians average contract, we capture the state-level changes in price by including state-time fixed effects. That is, we run the regression:

$$\ln(P_{jnt}) = \sum_{s} \sum_{t=2003:Q2}^{t=2010:Q4} [\gamma_{st} \cdot \mathbf{1}(\text{STATE} = s) \cdot \mathbf{1}(\text{Time}_t) + \delta_t \cdot \mathbf{1}(\text{Time}_t)] + \sum_{jc} [\alpha_{jc} \cdot \mathbf{1}(\text{Service}_{jc})] + \varepsilon_{jnt} \quad (1)$$

where j indicates a CPT code-physician ID-plan triple,[33] t indicates the time, and n indicates the specific service level of treatment for a patient.[34] Growth rates can then be calculated from the γ_{ts} estimates.[35] We can then treat the other 50 estimates of price growth as the sampling distribution for general price growth over any two periods of time t_1 and t_2. Accordingly, the test statistic for the null hypothesis that Massachusetts price growth during a

[29] New England states include Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. Results did not change when we excluded Vermont from our sample. Vermont passed the Health Care Affordability Acts in 2006, which aimed to increase insurance enrollment, but did not include an insurance mandate nor a penalty to firms for not providing employer sponsored insurance. See Deprez et al. (2010).

[30] HLIS reports an average HMO market penetration of 49.3 percent in Massachusetts and 27.9 percent in the United States from 2004 to 2008. PPO market penetration was 36 percent in Massachusetts and 61.3 percent in the United States. In our main empirical specification, we include the type of plan in the fixed effect. Results were quantitatively similar without plan type included.

[31] We conduct a more sensitive test of the specific timing of the reform when we conduct the across-county analysis.

[32] Some physicians are reported as operating in different counties, which may reflect their presence at different physician offices. To capture potential differences in contracting across offices, we actually include a quadruple fixed effect that is by CPT code-physician ID-county-plan type.

[33] The physician-plan-CPT triple fixed effect was chosen because this level corresponds to how bargaining takes place (see Clemens and Gottlieb, 2014).

[34] The regressions are weighted by the average price of the CPT code over the entire sample—as would be done in a Tornqvist index. This gives less weight to lower value services. The county is included as an additional fixed effect for those physicians that practice in multiple counties. That is, for those physicians that practice in multiple counties, the fixed effect included in the specification is a CPT code-physician ID-county-plan quadruple.

[35] For example, the cumulative growth between 2003q1 and 2010q4 is $\exp(\gamma_{2010q4}) - 1$.

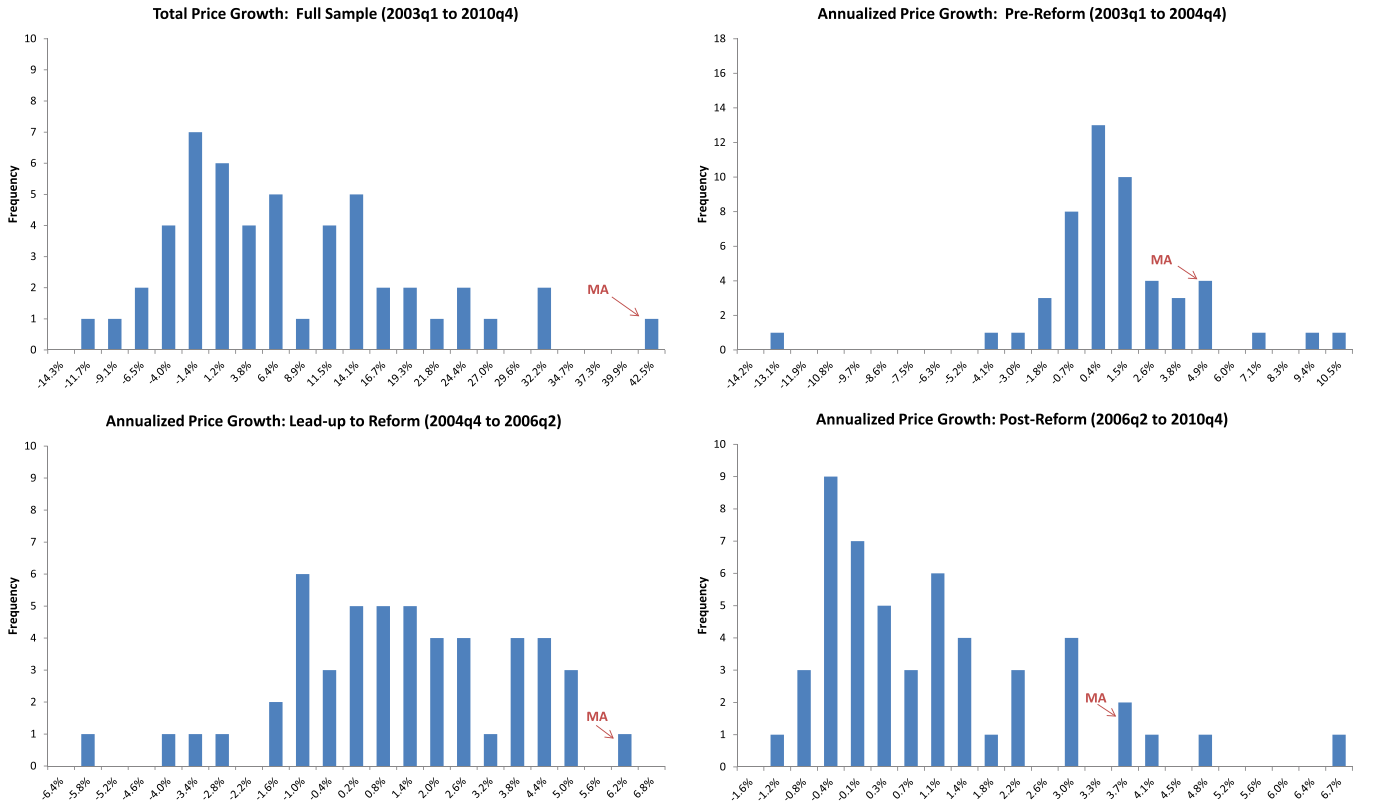

Fig. 1. Physician service price growth by state. *Notes*: Histogram of physician service price growth by state relative to the U.S. average price growth. Massachusetts value in the histogram is marked. Growth estimates are taken from the estimates γ_{st} taken from running regression (1). This regression includes 209,212,900 observations. The histograms are not centered at zero growth because prices in some large states (e.g., Texas) grew well below average.

specific period of time is no different than that any other state can be obtained by computing the percentile that it falls in the entire distribution. Since there are 50 "placebo" estimates, if Massachusetts is ranked second from the top or bottom of the distribution, we can infer that its price growth is statistically significant at the 10 percent level. Statistical significance at the 5 percent level requires it be ranked first.

Each panel in Fig. 1 consists of a histogram of price-growth rates of the 51 states. Note that our regression estimate γ_{st} measures price growth for each state relative to the national average—for instance, a price growth rate of 5 percent means that prices grew 5 percentage points faster than the U.S. average.[36] The top-left panel depicts the cumulative growth rate between 2003q1 and 2010q4. The other three panels report annualized growth rates during the three specific time periods outlined above.

The top left panel shows that physician prices in Massachusetts grew more than in any other state over the 2003q1–2010q4 period—representing significance at the 5 percent level. Prices in Massachusetts grew 49 percentage points faster than overall U.S. prices during this period.[37] For comparison, the states with the next highest price growth are New Hampshire (37 percent), North Dakota (36 percent), and Oregon (28 percent). Relative to the five other New England states, prices in Massachusetts grew 28 percentage points faster.

The other three panels show that, on an annualized basis, Massachusetts is in the upper tail of the distribution in terms of price growth during all three time periods. However, it is only in the lead-up period that Massachusetts had the highest overall growth. Specifically, relative to average U.S. growth, Massachusetts prices grew 5 percent per year during the pre-reform period, 6.4 percent per year during the lead-up period, and 3.7 percent per year in the post-reform period.[38]

4.2. Synthetic-control analysis

As a second exercise, we perform an extension of the above analysis by applying the synthetic control approach of Abadie et al. (2010). As explained by these authors, a synthetic control state can be constructed as a weighted average of the available control units—the other 49 states and the District of Columbia. Applying this technique, it follows that a synthetic measure of γ_t can be constructed for Massachusetts, γ_t^{synth}—the price level of a synthetic state that resembles Massachusetts prior to the reform. To do so requires using a set of predictor variables.[39] Our predictor variables are the percent of the population over age 65, the uninsured rate, median household income, median house value, median rent, percent of population with a college degree, population density, the unemployment rate, percent of spending that is HMO (from MarketScan), percent of spending that is PPO (from MarketScan), the number of university hospitals per capita, and the pre-reform

[36] Note that the histogram is not centered at zero growth because prices in some large states (e.g., Texas) grew well below average.

[37] This is a total of 69 percent growth in payments over the 2003–2010 period.

[38] As Kolstad and Kowalski (2012) refer to 2006q2–2007q2 as the implementation period, we also examined a post-implementation period, 2007q2–2010q4. The growth rates in the post-implementation period looked very similar to the overall post-reform period.

[39] In the following analysis we have dropped the s subscript on γ for ease of notation.

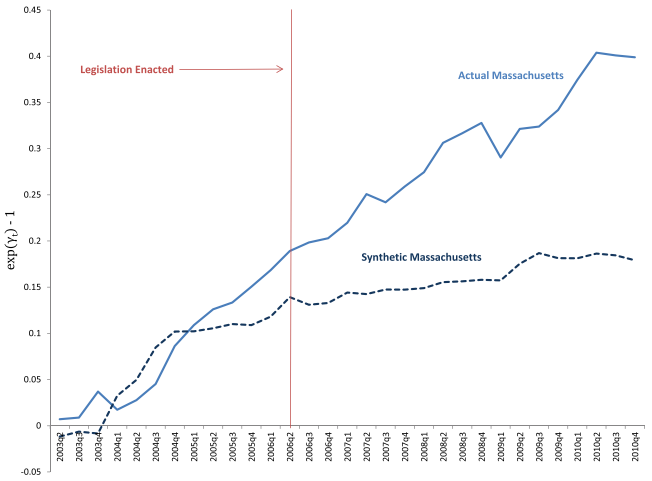

Fig. 2. Physician payment levels: actual versus synthetic Massachusetts. *Notes*: Physician payment levels of actual and synthetic Massachusetts. The actual Massachusetts price level is calculated from the estimate of $\gamma_{s=MA,t}$ from regression (1). Synthetic Massachusetts price level is constructed by applying the synthetic control approach of Abadie et al. (2010).

estimates of γ_t.[40] Means of these predictor variables and state weights for Massachusetts are available in Appendix. The synthetic control for Massachusetts was determined to be a convex combination of Rhode Island, New Hampshire, Illinois and Alaska. Results were generally robust to a range of predictor variables.[41]

We plot price growth of synthetic Massachusetts along with the price growth of actual Massachusetts in Fig. 2. The plots highlight that actual Massachusetts price growth was similar to its synthetic counterpart for most of the pre-reform period. It is not until the lead-up period that Massachusetts prices start surpassing the synthetic state's price growth.

In order to examine the statistical significance of this result we perform another permutation test.[42] Our empirical exercise is performed as follows. For each quarter, t, we construct a measure of the gap between the synthetic control price level and the actual price level: $\gamma_t^{gap} = \gamma_t - \gamma_t^{synth}$. For the case of Massachusetts, this creates a series, γ_t^{gap}, which is designed to track how its price level differs from what would have happened if health care reform had not happened. By looking at the change in γ_t^{gap} between any two time periods, we can see how Massachusetts prices grew relative to its synthetic control over that time period. For statistical inference, we create a distribution of growth rates of γ_t^{gap} in which to compare the Massachusetts value of γ_t^{gap}. We do so by repeating this synthetic control exercise once for each of the other 50 states. That is for each state, we create its own synthetic control, and subsequently its own measure of γ_t^{gap}. In total, we create 51 series of γ_t^{gap}—one series for Massachusetts, and 50 placebo series. This allows us to form a distribution of relative growths in the variable γ_t^{gap} between any two periods t_1 and t_2.

Fig. 3 displays the results of this exercise. Similar to what was suggested in Fig. 1, the analysis using the synthetic control shows statistically significant price growth during the lead-up period. Massachusetts lies at the top of the distribution in terms of growth over the entire sample period, however, in terms of specific time periods, it is only during the lead-up period that Massachusetts price growth was considerably larger than its synthetic control. During the lead-up period, Massachusetts prices grew 4.3 percentage points (on annualized basis) faster than its synthetic control. The results of this exercise imply that the reform had a total effect on prices as large as 21 percent. A large portion of which stemmed from price growth occurring in the lead-up period.

The results in the section are consistent with a story where services prices were negotiated up in anticipation of health care reform. Indeed, during the lead-up period there was extensive news coverage and political speeches about the reform. As price negotiations are based on lengthy contracts, anywhere from one to five years in length, insurers were likely taking this into account when setting fee schedules.

As with any reduced-form analysis, there are some drawbacks to this analysis. Notably, identification of the difference-in-differences estimator at the state level rests mainly on a comparison in growth rates between time periods. To strengthen our identification in this regard, we next exploit variation within Massachusetts at the county level. Specifically, we run a triple difference-in-differences estimator by exploiting the fact that the reform should have had a stronger impact in those counties with higher rates of uninsured.

5. County-level analysis

In our county-level analysis, we estimate whether the impact of the Massachusetts insurance reform was caused by the increase, or expected increase, in insurance coverage the reform would generate. To do so, we implement an identification technique similar to Finkelstein (2007) and Miller (2012a). Both Finkelstein and Miller exploited the fact that certain geographic areas should, ex ante, be more affected by policy reform than others based on their pre-reform insurance coverage rates. In the setting of the Massachusetts reform, counties in Massachusetts with low rates of insurance coverage have the most coverage to gain by an insurance mandate. Health care providers and insurers located in low insurance coverage counties should therefore expect to be impacted more by the health insurance reform than those counties that already had high insurance coverage.[43] For instance, individuals who use the Connector are more apt to live in counties with high uninsured rates.

Table 3 shows insurance coverage statistics for the non-elderly, taken from the U.S. Census Small Area Health Insurance Estimates (SAHIE) for the largest nine counties in Massachusetts.[44] The 2005 uninsured rate level varied among these counties from 9.5 percent in Norfolk and Worcester counties to 15.4 and 12.2 percent in Suffolk and Middlesex counties, respectively. As explained by Miller (2012a), those counties with higher uninsured rates before the reform was implemented experienced proportionally larger increases in coverage during the reform. For example, Suffolk County experienced an 8.4 percent increase in insurance coverage while, Worcester County experienced a 4.9 percent increase.

The pre-reform level of insurance is used in our price regression to follow the approach employed by Miller (2012a), which also uses the 2005 uninsured rate to evaluate the impact of the reform at the county level. The advantage of using the pre-reform

[40] We use $\gamma_{2004:1}$, $\gamma_{2005:1}$, and $\gamma_{2006:1}$.

[41] As a robustness exercise we created synthetic controls without including any γ_t as a predictor variable. These results are available in Appendix.

[42] See Clemens (2013) for a nice overview on statistical inference in the context of a synthetic control.

[43] Dunn and Shapiro (2013) show that the physician market may be as small as a 20-min driving radius.

[44] To keep the table smaller we do not depict statistics for Dukes, Nantucket, Franklin, Hampshire, and Barnstable counties which together represent 7 percent of Massachusetts's population. All counties were used in our estimation.

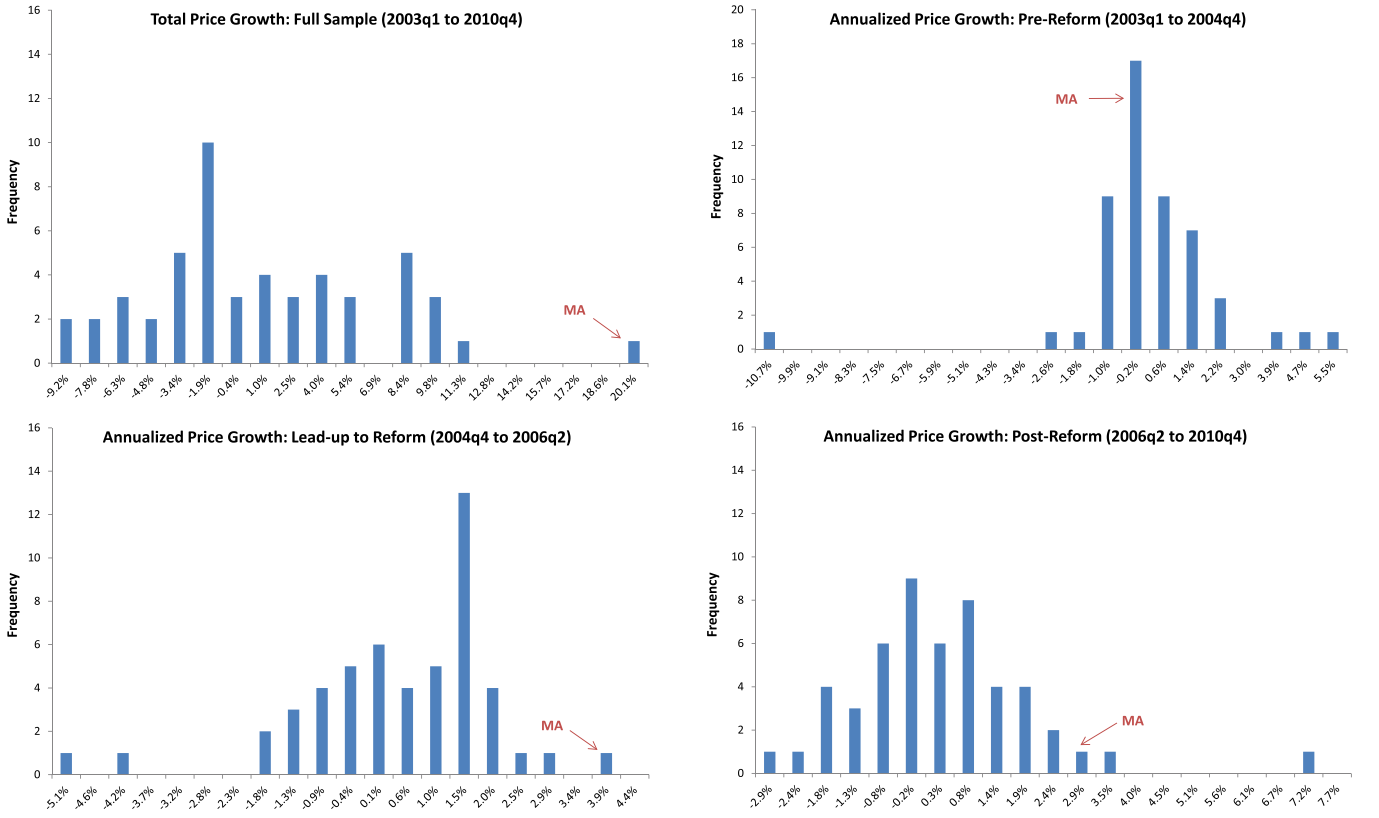

Fig. 3. Physician service price growth by state: relative to synthetic control. *Notes*: Histogram of physician service price growth by state relative to each state's synthetic control. For example, the cumulative growth between 2003q1 and 2010q4 is $\exp(\gamma^{gap}_{2010q4}) - 1$, while annualized growth in the lead-up period is $\exp(\gamma^{gap}_{2006q2} - \gamma^{gap}_{2004q4})^{(1/1.5)} - 1$. Massachusetts value in the histogram is marked.

level of insurance is that it is likely an exogenous measure of the effect of the reform, while the actual change may be affected by other county level economic factors. However, the effect of the pre-reform uninsured rate does not precisely measure the share of the population gaining coverage due to the reform because the insurance coverage post-reform is not 100 percent. To translate the effect of the uninsured rate prior to the reform into a price effect from the reform, we measure the statistical relationship between the rate of insurance to the change in the insurance coverage. The regression of the change in coverage on the 2005 uninsured rate produces a statistically significant coefficient of 0.61 and an R^2 of 0.76. This results in a one-standard deviation band of 0.48–0.74. This means that the reform caused the uninsured rate to fall between about 50 and 75 percent from its 2005 level. In other words, a Massachusetts county with a 1 percent higher uninsured rate than another Massachusetts county could rationally expect to see between a 0.50 and 0.75 percentage point larger increase in its insurance coverage rate. This leads to an exogenous causal interpretation because the reform had an expected differential impact across markets depending on the pre-reform size of the uninsured population.

5.1. Assessing the timing of the reform's impact

We run a triple difference-in-differences estimation by interacting the 2005 insurance level with Massachusetts-specific time dummies. Kolstad and Kowalski (2012) and Miller (2012a) show that, prior to 2006, the uninsured rate in Massachusetts was fairly steady, and then in 2007 and 2008 it took a steep fall. This implies that there was an exogenous increase in insurance coverage after 2005 attributable to the reform. The difference-in-differences regression takes the form:

$$\begin{aligned} ln(P_{jnct}) = \sum_{t=2003:Q2}^{t=2010:Q4} & [\lambda_t \cdot \text{Uninsured2005}_c \cdot \mathbf{1}(\text{MA}) \cdot \mathbf{1}(\text{Time}_t) \\ & + \gamma_{1,t} \cdot \mathbf{1}(\text{MA}) \cdot \mathbf{1}(\text{Time}_t) + \gamma_{2,t} \cdot \text{Uninsured2005}_c \\ & \cdot \mathbf{1}(\text{Time}_t) + \delta_t \cdot \mathbf{1}(\text{Time}_t)] + \sum_{jc} [\alpha_{jc} \cdot \mathbf{1}(\text{Service}_{jc})] \\ & + \sum_{s} [\alpha_s \cdot \mathbf{1}(\text{State}_s) \cdot \text{Time}_t] + X_n\beta + Y_{ct}\theta + \varepsilon_{jnct}, \end{aligned} \tag{2}$$

Table 3
County statistics.

	Suffolk	Middlesex	Norfolk	Worcester	Essex	Plymouth	Bristol	Hampden	Berkshire
2005 uninsured rate	15.4	12.2	9.5	9.5	12.6	10.0	10.0	11.5	10.7
Δ Coverage Rate 2005–2009	8.4	7.6	6.2	4.9	7.8	5.6	4.4	6.3	6.0
Percent of MA Spending in MarketScan	30.3	28.7	11.5	7.5	7.3	4.5	3.6	3.2	1.6

Notes: "Δ Coverage Rate" represents the percent increase in insurance coverage between 2005 and 2009 taken from the U.S. Census Small Area Health Insurance Estimates (SAHIE). Not included in this table are Dukes, Nantucket, Franklin, Hampshire, and Barnstable counties with 0.0, 0.0, 0.1, 0.7, and 1.0 percent of Massachusetts spending, respectively.

where n represents a specific service used for treating a patient, and j represents three characteristics of the service—CPT code plus modifier (k), provider ID(i), and health insurance type (l). It follows that P_{jnct} is the price of service j paid to a provider who resides in county c and providing a service line level of treatment to patient n in year-quarter t. Including service fixed effects, $\mathbf{1}(\text{Service}_{jc})$, isolates variation over time in the payment to a specific provider, procedure and type of plan (i.e., HMO, PPO, POS, etc.). We include the county, c, as a characteristic in the fixed effect to account for the fact that the provider may move geographic areas. The variable $\mathbf{1}(\text{MA})$ is a dummy variable representing a service provided by a physician located in Massachusetts. The variable labeled Uninsured2005_c measures the 2005 uninsured rate in county c—shown in Table 3 for Massachusetts. We weight observations in the regression by a proxy for the service's relative value units (RVUs). Our proxy is the average price of the CPT code over the entire U.S. sample—the same as that used in Dunn et al. (2012). We show that our main result does not depend on weighting. Standard errors are clustered by county to account for spatial correlation between counties and time-series correlation in the error terms.[45]

The specification includes a number of controls. The 2005 uninsured level variables are interacted with the time dummies, $\text{Uninsured2005}_c \cdot \mathbf{1}(\text{Time}_t)$, to control for any time-varying unobservable characteristics attributable to the 2005 uninsured rate level in the county. The vector Y_{ct} represents the county-level unemployment rate and median income in period t, and the vector X_n represents demographic variables including patient n's age and gender. Importantly, the coefficients on these control variables are estimated using variation in the entire sample—prices in the states other than Massachusetts. Estimating specification (2) on the New England states implies that we are removing any time-varying component attributable to the 2005 uninsured level or income level, that is common to all counties in New England.[46] Finally, the Massachusetts time dummies, $\mathbf{1}(\text{MA}) \cdot \mathbf{1}(\text{Time}_t)$, control for time-varying unobservable factors common to all counties in Massachusetts, while the main time dummies, $\mathbf{1}(\text{Time}_t)$, control for time-varying unobservable variables common to all states. Since these main time dummies control only for aggregate time factors, we include state-specific time trends, $\mathbf{1}(\text{State}_s) \cdot \text{Time}_t$, in our specification.[47]

Pertinent to this analysis are the λ_t estimates—the coefficients on the interactions of the 2005 uninsured rate in county c, time dummies, and a Massachusetts time dummy. These coefficients track the difference in the pattern of prices over time within Massachusetts that are attributable to different 2005 uninsured rate levels in the county. More specifically, since each 1 percentage point difference in the 2005 uninsured rate level translates into a 0.50–0.75 expected percentage point increase in coverage, the λ_t coefficients can be interpreted as the impact of an expected 0.50–0.75 percentage point increase in insurance coverage on the log price level in period t relative to the base period, 2003q1.

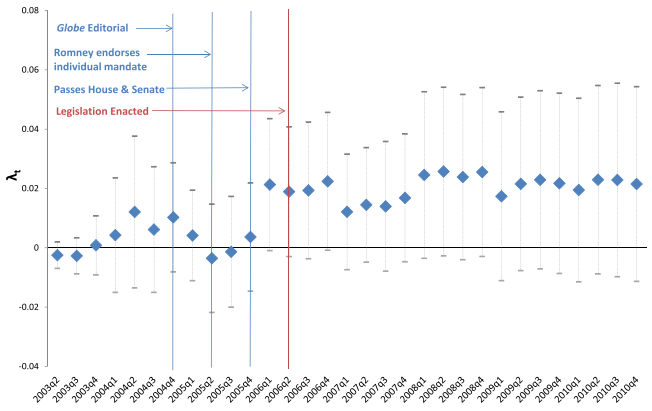

Fig. 4. County-level analysis: estimates of λ_t. *Notes*: Estimates and 95-percent confidence intervals using the sample of New England states in the MarketScan data. Each diamond represents the coefficient λ_t in specification (2). Standard errors are clustered by county. Coefficients are in column 1 of the table in Appendix B. Regression includes 5,053,056 observations.

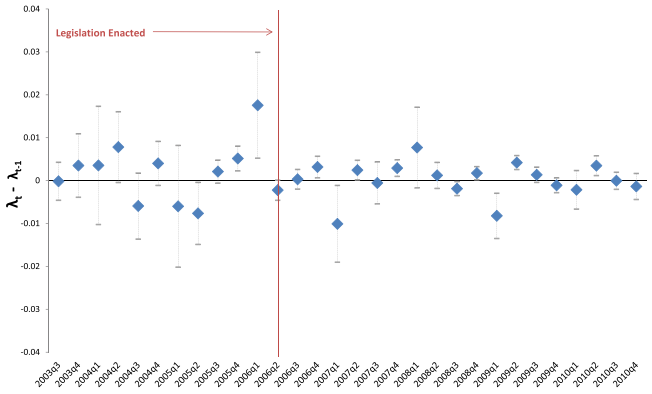

Fig. 5. County-level analysis: estimates of $\Delta\lambda_t = \lambda_t - \lambda_{t-1}$. *Notes*: Estimates and 95-percent confidence intervals using the sample of New England states in the MarketScan data. Each diamond represents the change in λ_t (i.e., the coefficient λ_t minus the coefficient λ_{t-1} in specification (2)). Standard errors are clustered by county. Regression includes 5,053,056 observations.

Estimates of λ_t are shown in Fig. 4. To track how these estimates align with the sequence of events leading up to the Massachusetts reform, we depict four major event indicators as vertical lines. The first line indicates the beginning of the pre-reform period, 2004q4, when Romney published *The Boston Globe*, editorial. The other three lines indicate when Romney publicly endorsed the individual insurance mandate (2005q2), the date health insurance reform passed the Massachusetts House and Senate separately (2005q4), and the date the legislation was finally enacted (2006q2).

The pattern of the λ_t's shows a a clear level shift that occurs in the first quarter of 2006—the quarter immediately after the passage of the legislation in the House and Senate, but before the bill's final enactment in the second quarter of 2006 (April). This pattern is consistent with prices being negotiated up in anticipation of the reform eventually being enacted. Given Romney's previous public support of the bill, it is certainly plausible that insurers set payment rates in such an anticipatory fashion.

We next examine the statistical significance of this shift in λ_t between 2005q4 and 2006q1. To do so, we calculate the change in λ_t, that is λ_t minus λ_{t-1}, between each period in the sample. A plot of the changes in λ_t are depicted in Fig. 5. The largest quarterly change in λ_t occurs between 2005q4 and 2006q1 where λ increases

[45] For robustness purposes, we also clustered at the state level which produced smaller standard errors. This indicates that errors are spatially correlated at the county level, but there is likely negative correlation in the errors between counties. A similar approach of estimating at the micro level, and controlling for potential correlations across geography and time was taken by Kolstad and Kowalski (2012).

[46] Estimates on the sample of Northeast states are available in Appendix.

[47] The inclusion of state-time trends have proven critical in some difference-in-differences analysis, as demonstrated by Besley and Burgess (2004) looking at the effects of labor regulations on businesses in Indian states. Our results are similar without state-time trends, although their inclusion appears to reduce our standard errors slightly.

by 0.0175. This change in λ_t is statistically significant at the one percent level. To put the magnitude of this change in context, the next highest increase was 0.007 and not statistically significant from zero.[48]

In Appendix B, we perform a few robustness exercises. First, we estimate our model on the sample of Northeast states, which includes the sample of New England states plus New York, New Jersey, Maryland, Pennsylvania, and Delaware. Second, we include trends specific to the 2005 uninsured rate in the Massachusetts' counties. These specifications show a similar level shift in prices, although the persistence of the effect is somewhat sensitive to the specification. Namely, including Massachusetts-specific trends to the sample of Northeast states implies that the shift in prices was transitory from trend. It is not clear whether to include these types of trends in our analysis since they may include effects due to expectations of the reform.

5.2. Measuring the total implied impact of the reform

Our analysis indicates that a level shift in payments occurred in 2006q1. To estimate the total implied level shift, we run a model that takes the following form:

$$\begin{aligned}\ln(P_{jnct}) = {} & POST_{2006q1} \cdot \text{Uninsured2005}_c \cdot \mathbf{1}(\text{MA}) \cdot \mathbf{1}(\text{Time}_t \geq 2006q1) \\ & + \sum_{t=2003:Q2}^{t=2010:Q4} [\gamma_{1,t} \cdot \mathbf{1}(\text{MA}) \cdot \mathbf{1}(\text{Time}_t) + \gamma_{2,t} \\ & \cdot \text{Uninsured2005}_c \cdot \mathbf{1}(\text{Time}_t) + \delta_t \cdot \mathbf{1}(\text{Time}_t)] \\ & + \sum_{jc} [\alpha_{jc} \cdot \mathbf{1}(\text{Service}_{jc})] + \sum_{s} [\alpha_s \cdot \mathbf{1}(\text{State}_s) \cdot \text{Time}_t] \\ & + X_n\beta + Y_{ct}\theta + \varepsilon_{jnct}. \end{aligned} \quad (3)$$

which replaces the flexibly estimated coefficients of λ_t with the post-period coefficient $POST_{2006q1}$. Specifically, $POST_{2006q1}$ can be interpreted as the impact of the pre-reform uninsurance coverage, Uninsured2005_c, on the log price level in the post-period, defined as $t \geq 2006q1$, relative to the pre-period, defined as $t < 2006q1$. Note that if the estimate $POST_{2006q1}$ is statistically significantly different than zero, we can reject the null hypothesis that there is no break in the level of λ_t in period 2006q1. Our estimate of $POST_{2006q1}$ was 0.0171 and statistically significant at the one percent level.

We can use the estimate of $POST_{2006q1}$ to measure the effect of an expected increase in insurance coverage attributable to the reform. Recall, that to translate the effect of the Uninsured2005_c into an actual price effect, we need to know the relationship between Uninsured2005_c and the actual change in coverage. Estimates, discussed previously, show that a one percentage point in the uninsured rate prior to the reform, is related to a 0.61 percentage point increase in insurance coverage post reform. Therefore, multiplying the estimate of $POST_{2006q1}$ by (1/0.61) translates the estimate into the impact of a 1 percent expected increase in coverage. To measure the expected impact of the entire reform, we would then further multiply this figure by the total number of percentage points the reform was expected to increase the insurance coverage rate. We use the 4.5 percentage point estimate from the DHCFP. It follows that:

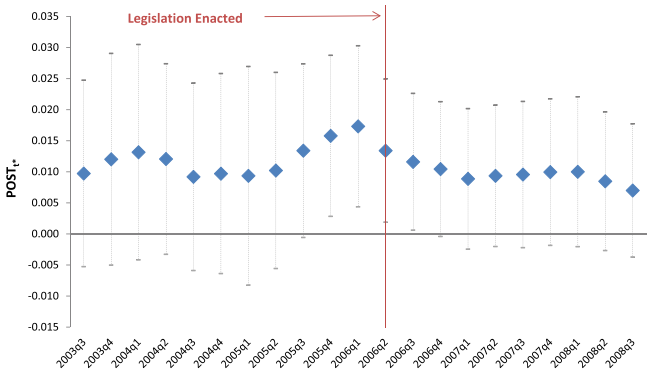

Fig. 6. County-level analysis: alternative estimates of post period. *Notes*: Estimates and 95-percent confidence intervals using the New England MarketScan data. Each diamond represents the coefficient $POST_{t^*}$ estimated from a single regression of specification (5). The regression is run 21 times, once for each $t^* \in [2003q3, 2008q3]$. Each regression includes 5,053,056 observations. Standard errors are clustered by county. The date of the reform is marked by the red line. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Impact of Expected Insurance Increase

$$= \left[\exp\left(\frac{1}{0.61} \cdot 4.5 \cdot POST_{2006q1}\right) - 1\right] = 13.4 \,\text{percent} \quad (4)$$

where $POST_{2006q1} = 0.0171$. Because overall prices in Massachusetts grew 69 percent (49 percentage points above the U.S. average) between 2003 and 2010, this estimate means that approximately one-fifth of the price growth in Massachusetts between 2003 and 2010 is directly attributable to the expected insurance increase of the reform. The 95 percent confidence interval for the 0.61 coefficient relating pre-reform uninsurance to the change in coverage ranged from 0.50 to 0.75. Based on this interval, the expected impact of the reform ranges between 10.8 percent and 16.6 percent.

The county-level estimate is smaller than the estimate found in the state-level analysis which showed the total effect of the reform on physician payments was 21 percent. We believe the difference between the state- and county-level analysis is due to three reasons. First, the SAHIE are imputed by the Census and therefore likely include measurement error. This may act to attenuate the county-level estimates, pushing them towards zero. Second, the estimates in the county-level regression isolate variation solely stemming from variation in uninsured rates. This specification will not pick up variation that effects all counties equally, for example, the minimum credible coverage requirements which created minimum quality standards for all plans. There is evidence that the reform caused administrative costs to rise (Staiger et al., 2011) which may also have affected all counties more or less the same. Finally, the 13.4 estimate above is a conservative estimate. If, for example, we assumed that the reform caused a 7.6 percentage point increase in the reform (Long et al., 2012) the estimated impact of insurance increase would be 23.7 percent.

5.3. Robustness analysis

To assess the robustness of this result, we undertake a falsification exercise that investigates the timing of the post period. We create 20 placebo estimates of the post dummy coefficient by running specification (3) on alternative dates for the

[48] Interesting to note is that the confidence bands are wider in the first quarter of each year. This is likely due to the fact that contracts are usually set to begin in the beginning of each calendar year (see Clemens et al., 2014), and there is likely dispersion in these payment adjustments.

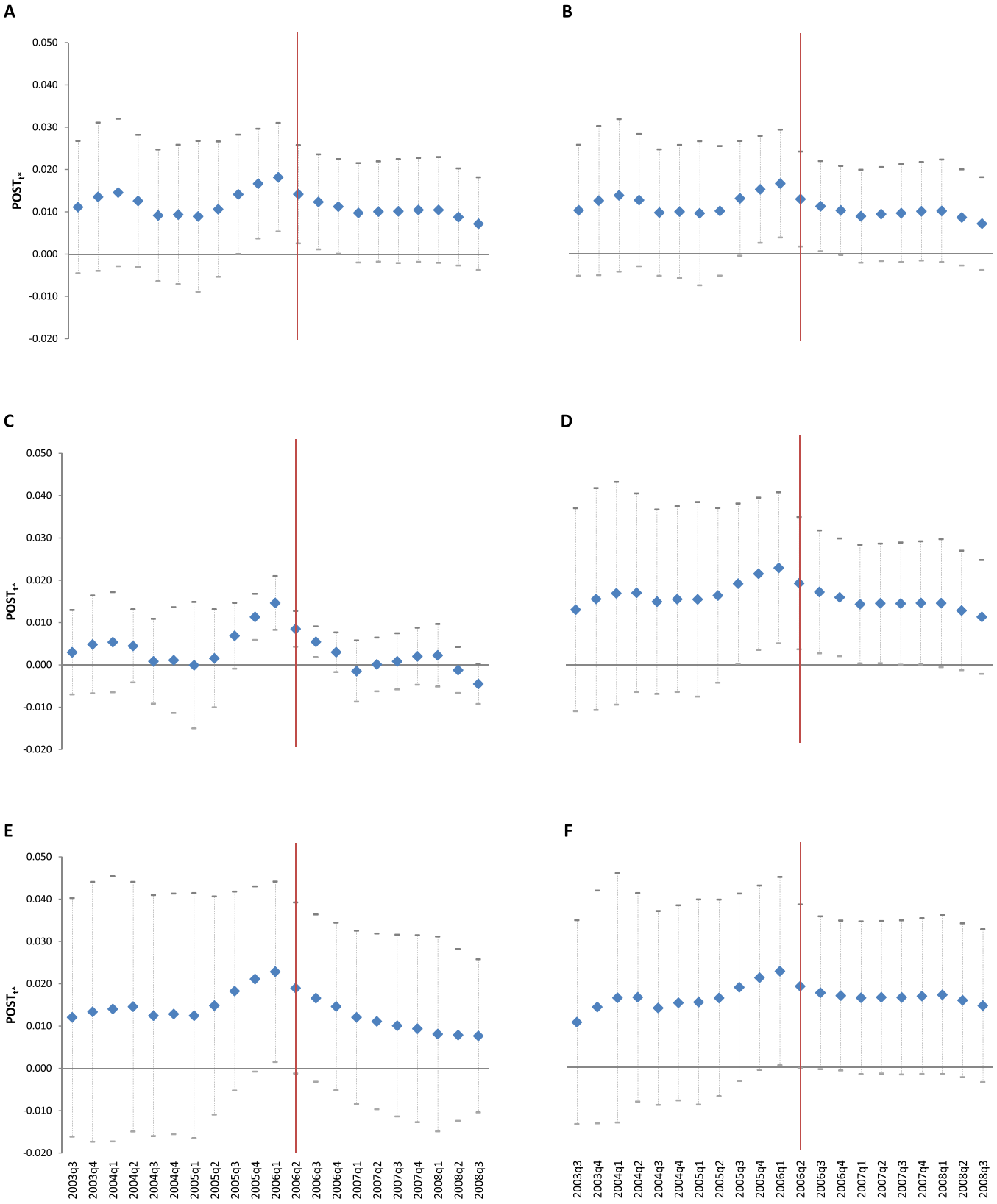

Fig. 7. County-level analysis: falsification exercises under different specifications. *Notes*: Estimates and 95-percent confidence intervals using the New England MarketScan data. Each diamond represents the coefficient $POST_{t^*}$ estimated from a single regression of specification (5). The regression is run 21 times, once for each $t^* \in$ [2003q3, 2008q3]. Standard errors are clustered by county. The date of the reform is marked by the red line. Panel A: provider ID in sample all 8 years. Panel B: no provider ID restrictions. Panel C: includes Massachusetts-specific uninsured-rate trends. Panel D: separate provider ID-CPT and plan fixed effects. Panel E: separate CPT and plan fixed effects (no provider ID fixed effects). Panel F: no state-time trends and no weighting by RVU. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

post period. Specifically, we run the following regression 21 times:k

$$\ln(P_{jnct}) = POST_{t^*} \cdot \text{Uninsured2005}_c \cdot \mathbf{1}(\text{MA}) \cdot \mathbf{1}(\text{Time}_t \geq t^*) + \sum_{t=2003:Q2}^{t=2010:Q4} [\gamma_{1,t} \cdot \mathbf{1}(\text{MA}) \cdot \mathbf{1}(\text{Time}_t) + \gamma_{2,t} \cdot \text{Uninsured2005}_c \cdot \mathbf{1}(\text{Time}_t) + \delta_t \cdot \mathbf{1}(\text{Time}_t)] + \sum_{jc} [\alpha_{jc} \cdot \mathbf{1}(\text{Service}_{jc})] + \sum_{s} [\alpha_s \cdot \mathbf{1}(\text{State}_s) \cdot \text{Time}_t] + X_n\beta + Y_{ct}\theta + \varepsilon_{jnct}. \quad (5)$$

once for each $t^* \in [2003q3, 2008q3]$, then collect the corresponding $POST_{t^*}$'s and standard errors. Estimates of $POST_{t^*}$ are plotted in Fig. 6. The estimate of $POST_{t^*}$ is statistically insignificant at the 5 percent level until t^* reaches 2005q4. The estimate reaches a global maximum of 0.017 in 2006q1 with a corresponding p-value of 0.009, and then becomes statistically insignificant. This exercise shows that of all the time periods between 2003q3 and 2008q3, the shift in pricing, captured by λ_t, most likely occurred in 2006q1. This break in λ_t occurs over a year after Romney's editorial, but one quarter *before* the insurance reform legislation was enacted in 2006q2. Specifically, this period corresponds to the period between when the legislation passed the Massachusetts House and Senate separately and the actual enactment of the reform.

We investigated the robustness of this falsification exercise by repeating it under a number of alternative specifications. Fig. 7 shows the estimates of $POST_{t^*}$ under six alternative specifications. To address concern that our provider ID threshold (being in the sample at least six years) is either too strict or too narrow, we ran a specification where the provider ID is in the sample all eight years of the sample (panel A) and another specification where there is no restriction (panel B).

Also, there may be a concern that trends specific to counties within Massachusetts are driving the results. For instance, counties with higher uninsured rates may have higher trend price growth. To address this issue, we include Massachusetts county uninsured-rate time trends (panel C). It is likely problematic to include these types of trends in the specification because they may be greatly influenced by the actual effects of the reform, due to the inclusion of a lengthy post period in the analysis. That is, these trends may include effects attributable to the reform itself. Despite the potential problem of including these trends, we still find a significant price jump just prior to the reform. This robustness check shows that the price increase that occurs immediately prior to the reform cannot be attributed to trend.

Another concern is that our definition of the service, defined as a CPT-physician-plan triple, may be an overly strict definition of a service. We relax this assumption by using different types of fixed effects. Panel D shows results where we split the CPT-physician-plan fixed effect into separate plan type fixed effects and CPT-physician fixed effects. In panel E, we ignore the physician ID characteristic and include only CPT and plan type fixed effects.

Finally, it is possible that our results are being driven by other aspects of our specification. In particular, there may be concern that our results are sensitive to the weights we have chosen or sensitive to the inclusion of state-time trends. To test the robustness of our results along these dimensions, in panel F, we remove observation weights and state-time trends from the regression.

In all of these specifications, the largest estimate of $POST_{t^*}$ and p-value are obtained when t^* is set to 2006q1. We should note that we performed other robustness exercises and obtained similar results. For instance, we also obtained similar results when we ran specifications that controlled for the health of the population. It is important to reiterate that our data are from employers and the commercially insured population and likely do not include the subsidized Connector market. Thus, the results obtained here are likely not attributable to a mechanical change attributable to Medicaid managed care plans switching to the Connector, but rather a change in payments in the existing insurance market. However, this does not limit the possibility of some selection bias in the payments that are observed in our dataset.

6. Conclusion

Our study confirms that there was likely a reaction in physician prices in anticipation of health insurance reform in Massachusetts. Service prices rose by at least 10.8 percent, mainly in the period after the reform passed the House and Senate separately. This is consistent with insurers and physicians negotiating prices in a forward-looking manner, in anticipation of the implementation of the reform.

This study does not explicitly identify the mechanism by which prices were raised. That is, it is not clear whether demand or competitive concerns caused prices to rise in anticipation of the reform. However, the available data from the DHCFP suggest that competitive concerns in the insurance market may have played an important role. The DHCFP reports that premiums grew less rapidly than expenditures, while the medical loss ratio increased. In addition, despite our finding of a price increase, Graves and Gruber (2012) find that the reforms had no effect on group premiums in Massachusetts, and even led to lower premiums in the non-group market, relative to other states. While this result may be due some confounding factors, such as the minimum credible coverage requirement, it does suggest that service price increases may not have been passed on to consumers, which is consistent with a more competitive insurance market post-reform. Furthermore, our conversations with Massachusetts health care providers and insurers leads us to believe that there was at least a perceived increase in the degree of competition in the insurance market stemming from the exchange.

In terms of implications for the ACA, our results imply that there may be price effects and they could occur before implementation. A major caveat, however, is that there are important differences between the ACA and the Massachusetts reform in terms of implementation. The Massachusetts Connector opened almost immediately after enactment, in October 2006. Similarly, the individual mandate in Massachusetts went into effect for the 2006 tax year. By contrast, the ACA implies that the insurance exchanges and individual mandate take effect in October 2013 and January 2014, respectively—years after the March 2010 enactment. It is not clear how a policy lag of this length would have affected anticipation and the results in this study.

While this study highlights an important consequence of the reform in Massachusetts, the results should not be treated as a normative statement regarding the merits of the reform. To fully evaluate the success of a reform, policymakers must weigh the benefits of the reform, such as expanded coverage and additional competition in the insurance market, against the associated cost. The analysis presented in this paper provides information with regards to medical-care prices, allowing for more accurately shaped policies in this regard.

Appendix A. Synthetic control analysis

See Tables 4 and 5, Fig. 8.

Table 4
Synthetic Massachusetts.

State	Weight	State	Weight	State	Weight	State	Weight
Alabama	0	Montana	0	Illinois	0.339	South Carolina	0
Alaska	0.103	Nebraska	0	Indiana	0	South Dakota	0
Arizona	0	Nevada	0	Iowa	0	Tennessee	0
Arkansas	0	New Hampshire	0.180	Kansas	0	Texas	0
California	0	New Jersey	0	Kentucky	0	Utah	0
Colorado	0	New Mexico	0	Louisiana	0	Vermont	0
Connecticut	0	New York	0	Maine	0	Virginia	0
Delaware	0	North Carolina	0	Maryland	0	Washington	0
DC	0	North Dakota	0	Michigan	0	West Virginia	0
Florida	0	Ohio	0	Minnesota	0	Wisconsin	0
Georgia	0	Oklahoma	0	Mississippi	0	Wyoming	0
Hawaii	0	Oregon	0	Missouri	0		
Idaho	0	Pennsylvania	0	Rhode Island	0.378		

Table 5
Massachusetts predictor means.

Variables	Real	Synthetic
Percent of population over 65	0.133	0.120
Uninsurance rate	0.115	0.269
Median household income ($)	55,344	51,072
Unemployment rate	0.027	0.028
Percent of spending HMO	0.314	0.131
Percent of spending PPO	0.180	0.543
University hospitals per capita	7.04E−06	4.56E−06
Median house value	191,981	137,177
Median rent	699.868	617.473
Perc. of pop. with college degree	0.221	0.168
Population density (persons per sq. mile)	831	528
$\gamma_{2004:1}$	0.017	0.032
$\gamma_{2005:1}$	0.103	0.097
$\gamma_{2006:1}$	0.156	0.112

Notes: All variables except lagged γ_t are averaged for the 2003q1–2006q1 period. PPO and HMO spending are calculated from MarketScan. Other variables we obtained from the Area Resource File.

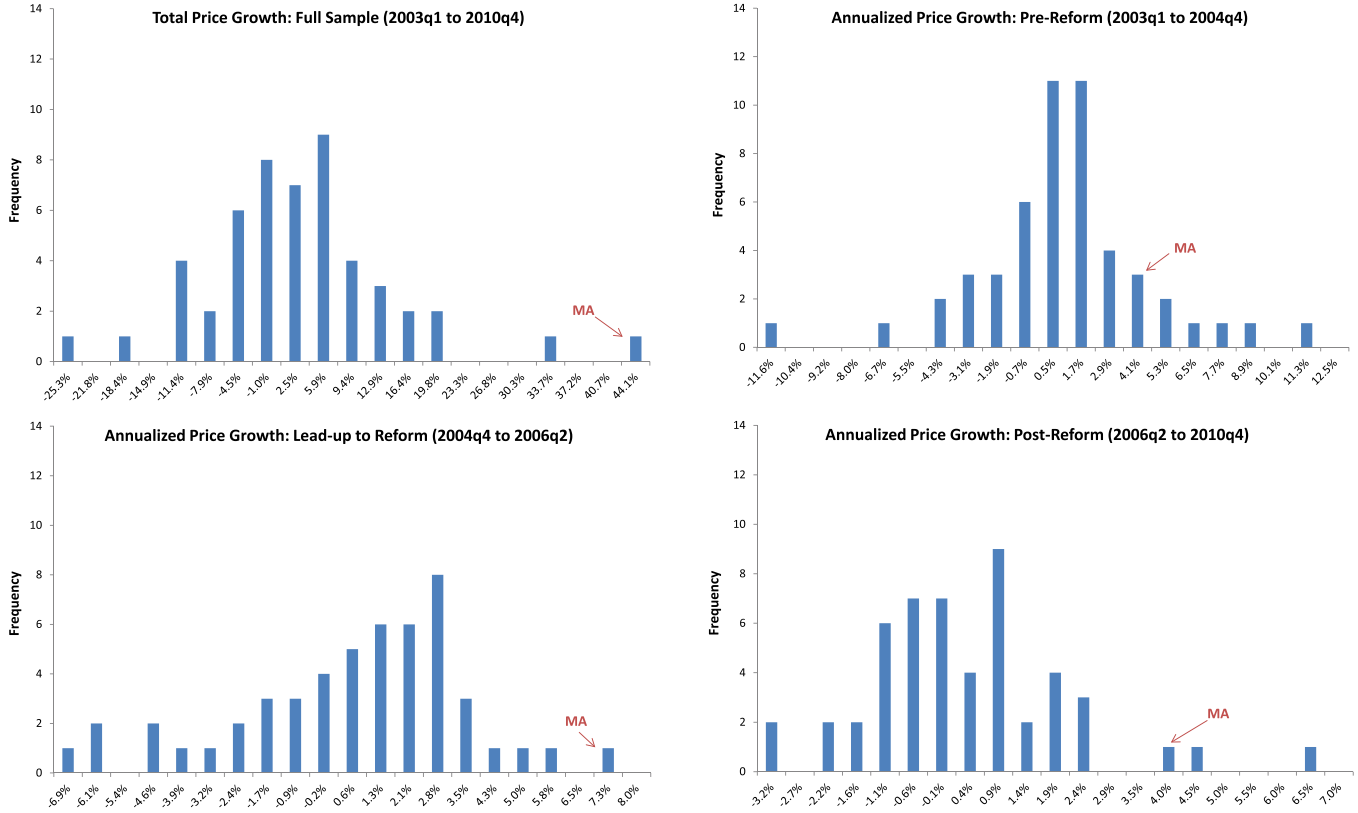

Fig. 8. Physician service price growth by state: relative to synthetic control (no pre-reform γ_t in predictor set). *Notes*: Histogram of physician service price growth by state relative to each state's synthetic control. For example, the cumulative growth between 2003q1 and 2010q4 is $\exp(\gamma^{gap}_{2010q4}) - 1$. Massachusetts value in the histogram is marked.

Appendix B. Robustness: estimates of λ_t

We perform a few robustness exercises. First, we estimate our model on the sample of Northeast states, which includes the sample of New England states plus New York, New Jersey, Maryland, Pennsylvania, and Delaware. This sample includes 37,493,340 observations. Second, we include trends specific to the 2005 uninsured rate in the county (i.e., trend · $Uninsured2005_c$) as well as specific to Massachusetts (i.e., trend · $Uninsured2005_c \cdot \mathbf{1}$(MA). We perform two specifications that include this type of trend. One specification estimates this trend using the entire sample period, the other specification estimates the trend on the pre-reform period (Fig. 9).

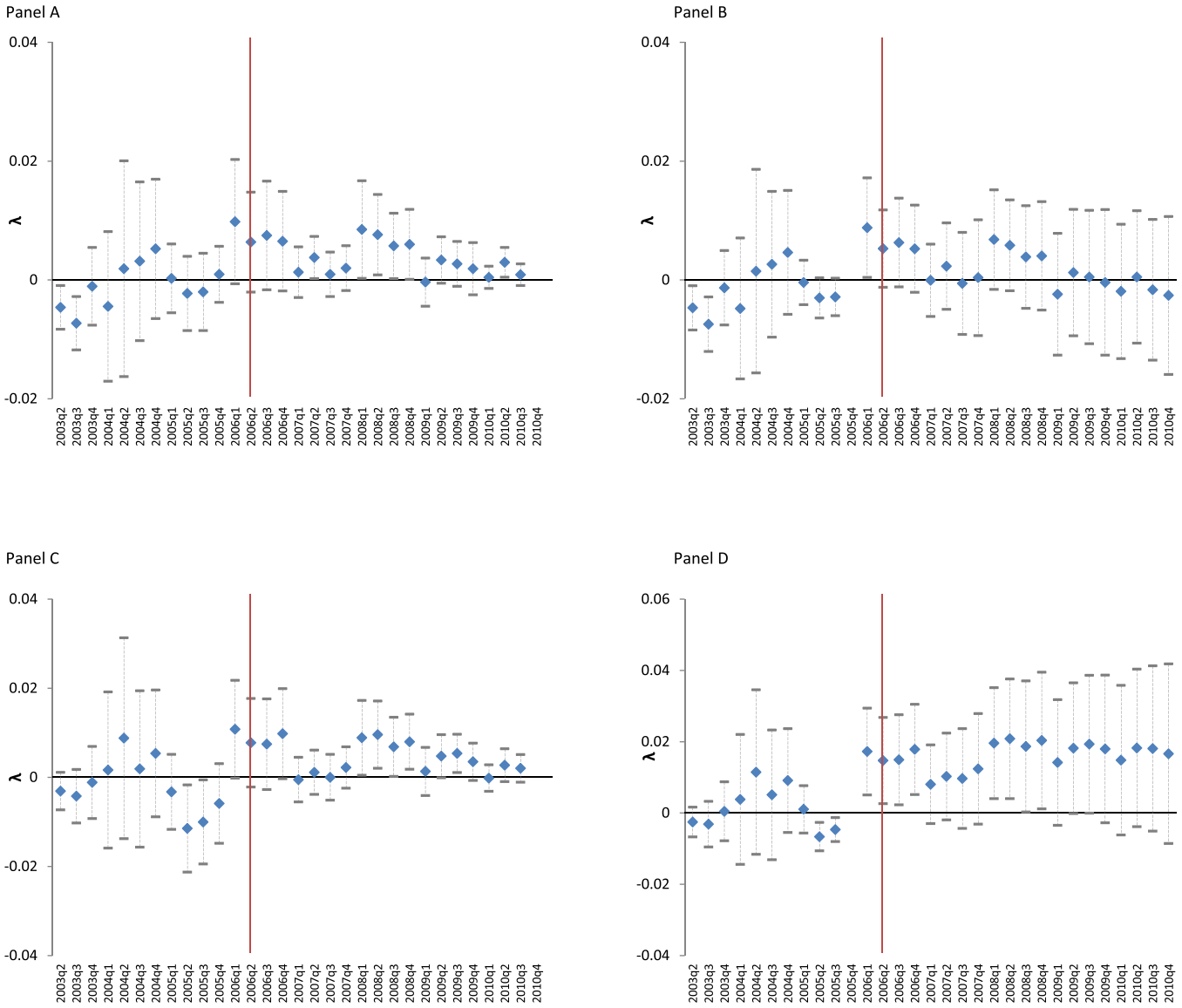

Fig. 9. Robustness: estimates of λ_t including Massachusetts uninsured rate trends. *Notes*: Estimates and 95-percent confidence intervals. Panels A and B using the Northeast MarketScan data (37,493,340 observations), Panels C and D using the New England MarketScan data (5,029,835 observations). Panels A and C include Massachusetts-specific uninsured-rate trends over the entire sample period. Panels B and D include Massachusetts-specific uninsured-rate trends estimated over the pre-reform period. Estimates and standard errors are reported in the table above.

	New England sample			Northeast sample		
2003q2	−0.002	−0.003	−0.003	−0.004*	−0.005**	−0.005**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
2003q3	−0.003	−0.004	−0.003	−0.005**	−0.007***	−0.007***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
2003q4	0.001	−0.001	0.000	0.002	−0.001	−0.001
	(0.005)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
2004q1	0.004	0.002	0.004	−0.000	−0.004	−0.005
	(0.010)	(0.009)	(0.009)	(0.008)	(0.006)	(0.006)
2004q2	0.012	0.009	0.011	0.007	0.002	0.001
	(0.013)	(0.011)	(0.012)	(0.011)	(0.009)	(0.009)
2004q3	0.006	0.002	0.005	0.009	0.003	0.003
	(0.011)	(0.009)	(0.009)	(0.009)	(0.007)	(0.006)
2004q4	0.010	0.005	0.009	0.012	0.005	0.005
	(0.010)	(0.007)	(0.007)	(0.008)	(0.006)	(0.005)
2005q1	0.002	−0.003	0.001	0.009	0.000	−0.000
	(0.007)	(0.004)	(0.003)	(0.006)	(0.003)	(0.002)
2005q2	−0.005	−0.011**	−0.007***	0.007	−0.002	−0.003*
	(0.009)	(0.005)	(0.002)	(0.007)	(0.003)	(0.002)
2005q3	−0.003	−0.010**	−0.005***	0.008	−0.002	−0.003*
	(0.009)	(0.005)	(0.002)	(0.007)	(0.003)	(0.002)
2005q4	0.002	−0.006		0.012*	0.001	
	(0.009)	(0.005)		(0.007)	(0.002)	
2006q1	0.019*	0.011*	0.017***	0.022**	0.010*	0.009**
	(0.011)	(0.006)	(0.006)	(0.010)	(0.005)	(0.004)
2006q2	0.017	0.008	0.015**	0.020**	0.006	0.005
	(0.011)	(0.005)	(0.006)	(0.010)	(0.004)	(0.003)
2006q3	0.017	0.007	0.015**	0.022**	0.007	0.006*
	(0.011)	(0.005)	(0.006)	(0.010)	(0.005)	(0.004)
2006q4	0.020*	0.010*	0.018***	0.022**	0.007	0.005
	(0.012)	(0.005)	(0.006)	(0.010)	(0.004)	(0.004)
2007q1	0.010	−0.001	0.008	0.018**	0.001	−0.000
	(0.010)	(0.003)	(0.006)	(0.008)	(0.002)	(0.003)
2007q2	0.013	0.001	0.010*	0.021***	0.004**	0.002
	(0.010)	(0.003)	(0.006)	(0.008)	(0.002)	(0.004)
2007q3	0.012	−0.000	0.010	0.020**	0.001	−0.001
	(0.011)	(0.003)	(0.007)	(0.008)	(0.002)	(0.004)
2007q4	0.015	0.002	0.012	0.022***	0.002	0.000
	(0.011)	(0.002)	(0.008)	(0.008)	(0.002)	(0.005)
2008q1	0.023	0.009**	0.020**	0.029**	0.008**	0.007
	(0.014)	(0.004)	(0.008)	(0.012)	(0.004)	(0.004)
2008q2	0.024*	0.010**	0.021**	0.029**	0.008**	0.006
	(0.014)	(0.004)	(0.009)	(0.012)	(0.003)	(0.004)
2008q3	0.022	0.007**	0.019**	0.028**	0.006**	0.004
	(0.014)	(0.003)	(0.009)	(0.011)	(0.003)	(0.004)
2008q4	0.024*	0.008**	0.020**	0.030**	0.006**	0.004
	(0.014)	(0.003)	(0.010)	(0.012)	(0.003)	(0.005)
2009q1	0.018	0.001	0.014	0.024**	−0.000	−0.002
	(0.014)	(0.003)	(0.009)	(0.011)	(0.002)	(0.005)
2009q2	0.022	0.005*	0.018*	0.029**	0.003*	0.001
	(0.015)	(0.002)	(0.009)	(0.012)	(0.002)	(0.005)
2009q3	0.023	0.005**	0.019*	0.030**	0.003	0.000
	(0.015)	(0.002)	(0.010)	(0.012)	(0.002)	(0.006)
2009q4	0.022	0.003	0.018*	0.030**	0.002	−0.000
	(0.015)	(0.002)	(0.011)	(0.012)	(0.002)	(0.006)
2010q1	0.019	−0.000	0.015	0.029**	0.000	−0.002
	(0.015)	(0.002)	(0.011)	(0.013)	(0.001)	(0.006)
2010q2	0.023	0.003	0.018	0.033**	0.003**	0.000
	(0.016)	(0.002)	(0.011)	(0.014)	(0.001)	(0.006)
2010q3	0.023	0.002	0.018	0.032**	0.001	−0.002
	(0.016)	(0.002)	(0.012)	(0.014)	(0.001)	(0.006)
2010q4	0.021		0.017	0.032**		−0.003
	(0.016)		(0.013)	(0.014)		(0.007)
trend * Uninsured2005		0.000	0.001		0.000	0.000
		(0.000)	(0.001)		(0.000)	(0.000)
trend * Uninsured2005 * MA		0.001	0.000		0.001**	0.001*
		(0.001)	(0.001)		(0.000)	(0.001)
Full sample period uninsurance trends		X			X	
Pre-2006 uninsurance trends			X			X

*, **, *** correspond to 0.1, 0.05, and 0.01 respectively.

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