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Does Universal Occupational Licensing Recognition Improve Patient Access? Evidence from Healthcare Utilization
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ABSTRACT

Optimizing state and regional physician labor supply has been an important policy issue in healthcare in the United States. One of the proposed solutions has been the universal licensing recognition (ULR), which allows out-of-state physicians to provide healthcare services without relicensing and increases the local labor supply of physicians. There has been no empirical analysis of the effect of such regulatory relaxation on the local labor supply and subsequent improvements of consumer welfare. In this study, we use the Behavioral Risk Factor Surveillance System to investigate the effect of universal reciprocity of physician licenses on healthcare utilization, and use data from IPUMS-USA, IPUMS-CPS, and the Doctors and Clinicians National Downloadable File from the Centers for Medicare & Medicaid Services to examine the changes in the local labor supply of physicians through interstate migration and out-of-state practices. Our results show that adopting the ULR significantly raises the proportion of individuals accessing healthcare, particularly among older individuals, and reduces the proportion of individuals not getting healthcare services because of costs. We provide empirical evidence that these effects are from the universal reciprocity of physician licenses, instead of unknown factors related to the ULR. We also show that the positive effect of the ULR on healthcare utilization is closely related to the increase in out-of-state practitioners to include temporary and telehealth physicians, by showing no changes in interstate migration of physicians and an increase in out-of-state practices. The adoption of ULR may allow for a more efficient regional distribution of physicians and result in greater access to healthcare.

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1 Introduction

Optimizing state and regional physician labor supply is a significant issue in healthcare and thereby in the economy (Kirch and Petelle, 2017). Because of changes in the demographic composition of the U.S. population, there is expected to be a significant increase in the number of regions that will have a lower than anticipated number of physicians (Zhang et al., 2020). Although it does not raise the overall physician labor supply, one of the ways to optimize the geographic distribution of physicians is to allow interstate reciprocity of physician licenses; this regulatory relaxation allows out-of-state practitioners to practice with their current licenses issued in another state. However, because healthcare is a heavily regulated industry, interstate reciprocity was not considered until the early 2010s, which has restricted labor supply and potentially limited consumer welfare in many U.S. states (Holen, 1965; Kleiner, 2000; Johnson and Kleiner, 2020).

Universal licensing recognition (ULR) is a comprehensive policy reform that waives out-of-state licensed workers' re-licensure (i.e., universal reciprocity of out-of-state licenses for selected occupations). Recent studies show its positive impact on local labor supply (Bae and Timmons, 2023; Deyo and Plemmons, 2022). However, its impact on specific sectors of consumer welfare, such as healthcare utilization, has not been analyzed. Furthermore, similar, preexisting policy reforms, such as the Interstate Medical Licensing Compact (IMLC), make measuring the impact of the ULR more complex.

In this study, we evaluate the impact of the ULR on healthcare utilization separately from the IMLC's by measuring the effect on healthcare utilization among the states that passed the IMLC before adopting the ULR. We mainly use the Behavioral Risk Factor Surveillance System (BRFSS) to examine the changes in state-level healthcare utilization and medical cost measures. We also use data from the IPUMS-ACS, IPUMS-CPS, and the Doctors and Clinicians National

Downloadable File from the Centers for Medicare & Medicaid Services (CMS) to examine the changes in physician labor supply from interstate migration and out-of-state practices.

Our study provides two significant contributions to the literature on the economics of occupational licensing. First, this is the first study that provides theoretical and empirical evidence of how the ULR improves consumer welfare. Previous studies suggest the outcomes, including improvements in consumer welfare, are based largely on economic theory. The ULR is known to be a more comprehensive regulatory relaxation than preexisting policy reforms (e.g., the IMLC). Our study shows that the ULR increased consumer welfare for a specific service that is large, essential, and costly.

Second, this study adds to the literature by providing theoretical and empirical evidence that regulatory relaxation can contribute to improving consumer welfare by increasing the state or local labor supply. Although labor market regulations are needed to protect consumers from incompetent or unscrupulous service providers and to maintain the quality of services, some of the regulations may be overly restrictive, leading to a reduction in the labor supply, access to healthcare, and potentially, consumer welfare. Thus, this regulatory relaxation may raise consumer welfare by increasing access, without deteriorating the service quality or increasing malpractice costs. Both theoretical and empirical evidence shows that the relaxation of licensing can improve consumer welfare by raising the local labor supply if the work-related requirements, such as the scope of practice and qualification exams, are substantially equivalent across the states.

To preview our findings, we first provide two theoretical models explaining physicians' labor market and the market for healthcare services. The first is a partial equilibrium model that explains how the adoption of out-of-state license reciprocity increases the local labor supply by increasing out-of-state practices but not migration in the industry that imposes non-compete agreements during employment. Then, we develop a general equilibrium model whose implication is that the increase in local labor supply increases consumer welfare by raising the availability and reducing the cost of healthcare services. We also provide the approximation of the increase in consumer welfare due to the adoption of the out-of-state license reciprocity, showing that the magnitude of this increase depends on the proportion of physicians who are licensed from non-IMLC states.

Then, in empirical analyses, we show that adopting universal reciprocity of physician licenses raises the proportion of individuals who have personal doctors or healthcare providers, especially for older individuals, and reduces the proportion of individuals who did not see doctors because of costs. We also provide empirical evidence that the residency requirement of the ULR limits the effect of regulatory relaxation and the increase in the local labor supply of physicians is through out-of-state practices instead of interstate migration, suggesting that universal reciprocity's positive effect for healthcare utilization is closely correlated with the increase in temporary out-of-state practitioners, but not with interstate migration. Using falsification tests, we validate that the positive impact of the ULR on healthcare utilization is from the universal reciprocity of physician licenses. Overall, our study shows that the ULR is a comprehensive regulatory relaxation that optimizes regional labor supply and can improve consumer welfare, which is consistent with the theoretical predictions and previous literature on the reduction of occupational licensure regulations.

The remainder of this paper is organized as follows. In Section 2, we present a background of occupational licensure research over the last decade as well as the literature review on the influence of regulatory relief for occupational licensure. In Section 3, we provide two theoretical models explaining physicians' decision-making process between staying, migrating, and starting out-of-state practices and how the adoption of out-of-state license reciprocity increases consumer welfare. In Section 4, we provide a detailed explanation of the data, sample selection, variables, and estimation procedures. In Section 5, we outline the results from the analyses and provide the implications of the results. In the final section, we summarize the findings and policy implications and provide a discussion of limitations and suggestions for future studies.

2 Background on Relaxing Occupational Licensure Regulations

Licensing influences the labor market through shifting out the labor market demand curve or restricting labor supply (Kleiner, 2016; Carollo et al., 2025). The academic literature has examined both the demand and supply implications of the labor market effects of licensing. For instance, Kleiner and Krueger (2013) find that licensing generates around a 15% wage premium while not significantly reducing wage dispersion for licensed workers; this number climbs to 23% when licensing is interacted with union membership. Gittleman et al. (2018) find a lower wage premium of around 5%, using Survey of Income and Program Participation (SIPP) data over a more recent time period a somewhat different set of questions from the ones asked in other surveys. They also conclude that licensing is associated with higher probabilities of being employed and receiving health insurance from employers. By estimating market share ratios, Blair and Chung (2022) show that licensing reduces equilibrium labor supply by an average of 17% to 27%. Similarly, Kleiner and Soltas (2023) find that licensing raises wages and hours but reduces employment by a similar percentage.

The supply restriction effects of occupational licensing requirements on employment and earnings are well documented, both at the national level and within specific occupations (Kleiner 2016; Oh and Kleiner, 2025; Bae et al., 2025). From theory, occupational licensing restrictions limit labor supply, produce a wage premium for licensed workers, and increase prices for consumers (Kleiner et al., 2016). Previous studies show that stricter re-licensure processes increase the economic rent of pre-existing healthcare practitioners and reduce the service quality, leading to deteriorating consumer welfare (Kugler and Sauer, 2005; Peterson et al., 2014). By contrast, the influence of relaxing occupational licensing policies in the healthcare sector has resulted in a reduction in prices, with no effect on the quality of services (Kleiner et al., 2016).

Over the last decade, there have been multiple efforts to introduce reciprocity of out-of-state occupational licenses. The Interstate Licensure Compact (ILC) is one of the earlier policy reforms that allows out-of-state licensed workers from the ILC member states to practice without a time-consuming re-licensure process (and thereby achieves reciprocity of out-of-state licenses). Since state-specific occupational licensure discourages the interstate mobility of licensed workers (Johnson and Kleiner, 2020), the interstate reciprocity of out-of-state licenses, in theory, increases the interstate mobility of licensed workers, leading to an increase in local labor supply. Previous studies provide empirical evidence that the ILC increased the local labor supply, reduced labor costs, improved the quality of services, and ultimately increased consumer welfare (Apgar, 2022; Kim et al., 2023).

Specifically for physicians, the Interstate Medical Licensure Compact (IMLC) was introduced and adopted to raise the local labor supply of physicians by waiving state-specific re-licensure processes for those who attained their physician licenses from the IMLC member states (Steinbrook, 2014). Healthcare practitioners, economists, and policymakers expected that this compact would increase the regional labor supply of healthcare practitioners and access to healthcare by increasing the interstate mobility of physicians, including interstate relocation and out-of-state practices (Chaudhry et al., 2015). Multiple studies provide empirical evidence that this compact raised the interstate mobility of these workers, increased the regional labor supply of nurses and the out-of-state practices of physicians, and improved the quality of healthcare services (e.g., Deyo and Hughes, 2019; Deyo et al., 2024; Livanos, 2020; Shakya et al., 2022). However, this reciprocity is limited to the physicians who attained their licenses from the IMLC member states. In other words, physician licenses from non-member states are not eligible for interstate reciprocity, although the Interstate Medical Licensing Compact board recognizes that approximately 80% of U.S. physicians meet the IMLC's reciprocity requirements (Adashi et al., 2021).

From the late 2010s onward, an increasing number of states adopted the Universal Licensing Recognition (ULR), a recent policy reform that allows out-of-state licensed workers in selected occupations to practice without having to go through state-specific re-licensure. The ULR is a similar policy reform as the ILC in that it relaxes the licensure regulation by adopting reciprocity of out-of-state licenses. However, the ULR is a more comprehensive regulatory reduction than the ILC since it adopts "universal[1] reciprocity" for the selected licensed occupations, regardless of the states of licensure, as long as licensees' qualifications meet the reciprocity requirements, such as similar scope of practice, substantially equivalent education and experience, and, sometimes, in-state residency (Timmons and Norris, 2023; Norris, 2024; Shakya et al., 2024).

Previous studies provide theoretical and empirical evidence that the ULR increased the local labor supply of licensed occupations and reduced service costs, suggesting that the ULR has a clear effect on increasing the local labor supply (Deyo and Plemmons, 2022; Bae and Timmons,

[1] The term "universal" refers to its comprehensiveness. Universal reciprocity refers to the recognition of out-of-state licenses regardless of the state of issuance. This recognition sometimes includes licenses issued in Canada. For instance, Montana and South Dakota include physician licenses obtained by passing the qualification exams and completing a residency program from the U.S. or Canada for reciprocity. Thus, this is a more comprehensive reciprocity than the ILC, because the ILC recognizes only the licenses issued from the ILC member states.

2023). Economic theory suggests that an increase in the labor supply reduces labor costs and improves the quality of services, leading to improved consumer welfare. This implies that the increase in the local labor supply of physicians due to universal reciprocity of out-of-state licenses will lead to the reduction of healthcare costs, improvement in the quality of services, and ultimately the increase in healthcare utilization among the states that adopted the universal reciprocity of physician licenses.

However, it is not clear whether the ULR is effective in this respect, because the IMLC was already adopted to achieve a similar goal: reciprocity of out-of-state licenses. Furthermore, adopting the ULR does not always mean that all occupational licenses become subject to universal reciprocity, because this reciprocity is for selected occupations only. This implies that some of the states that adopted the ULR did not adopt the universal reciprocity of physician licenses. For instance, Iowa, Utah, and Wyoming are the states that adopted the ULR but did not adopt universal reciprocity for physician licenses. This study accounts for these issues to estimate the effect of the ULR on healthcare utilization. More information about the similarities and differences between the ULR and ILC is provided in Table 1.

In addition, it is not clear whether the increase in local labor supply is due to the increased interstate migration or out-of-state practices—that is, providing healthcare services by traveling and/or telehealth. While the studies that examine general licensed workers show an increase in interstate migration after reductions in regulations (e.g. Deyo and Plemmons, 2022; Bae and Timmons, 2023), studies that focused on physicians do not show an increase in interstate migration, only in out-of-state practices (e.g. Deyo et al., 2024; Fannin, 2020). These findings imply that physicians do not migrate but use out-of-state practices after the regulatory relaxation. This may be due to the prevalence of non-compete agreements, which restrict physicians from practicing more than their contracted work hours within the region. Non-compete agreements prohibit physicians from working in other hospitals located within a certain distance (e.g., 50 miles or 100 miles) from their employer hospitals during and after their employment (Robeznieks, 2023). Because these agreements limit physicians from working more than the contracted hours in their regions, out-of-state practice is the only way they can increase their work hours as well as their earnings and utility. Through the development of theoretical models and implementation of econometric analyses, this study also validates whether the positive impact of the ULR on healthcare utilization is due to the increase in interstate migration or the increase in out-of-state practices.

3 Theoretical Models

In this section, we present two models. The first model is a partial equilibrium model of physicians, explaining how the ULR raises local labor supply by increasing out-of-state practices. The second model is a general equilibrium model of healthcare service producers and consumers, explaining how the increase in the out-of-state practitioners improves consumer welfare. Using these two models, we show how the adoption of the ULR improves consumer welfare among the states that previously adopted the IMLC.

3.1 A Simple Partial Equilibrium Model of Physicians: Stay, Migrate, or Open Out-of-State Practices

This is a simple partial equilibrium model that is an adaptation of Johnson and Kleiner's (2020) model explaining the role of occupational licensing on interstate migration. Physicians choose whether to (1) stay in the current labor market, (2) migrate to a new labor market, and (3) start out-of-state practices.

In this model, we assume that physicians are perfectly certain about the earnings from the current market (w_s) and from the potential migration destination (w_m) as well as the earnings from out-of-state practices (w_t). Note that $w_t \geq w_m$, as employers generally pay more to traveling physicians than local physicians to attract more physicians to work in their hospitals (Cross et al., 2024). For example, in the U.S., traveling physicians, often called "locum tenens physicians," travel to various hospitals and across state lines according to hospital and patient demands. For the physicians providing telehealth services, assume that $w_t = w_m$, as the Telehealth Coverage and Payment Parity Act imposes the same payment rate for telehealth services and in-person healthcare services (H.R.4480., 2021; Deyo et al., 2024).

Costs are involved in choosing between migration and starting out-of-state practices. For simplicity, we assume that there is no cost related to the loss of human capital from the current labor market and the accumulation of human capital from new labor markets, as the scope of practice of physicians is potentially the same between the current and potential labor markets. The cost of migration is denoted by c_m. It is composed of the cost of re-licensure ($c_{relicense}$), a relocation cost that is covered by potential employers (c_{move}), and other relocation time and monetary costs that are paid by the physician (c_{self}), and there are no costs of public policy frictions:

$$c_m = c_{relicense} + c_{move} + c_{self}.$$

The cost of re-licensure includes monetary cost, time, and effort to complete the re-licensure processes, as well as the opportunity costs related to re-licensure processes, such as potential monetary and human capital gain from healthcare practices. The costs paid by the physician, c_{self}, can also be seen as a disutility of migration, as it discounts the utility costs. Similarly, c_t is the travel cost to work as a traveling doctor, which is composed of the cost of re-licensure ($c_{relicense}$) and the travel expenses that are covered by potential employers (c_{travel}):

$$c_t = c_{relicense} + c_{travel}.$$

Since c_{move} and c_{travel} are assumed to be covered by employers (i.e., hospitals in potential destinations), these costs are zero for the physicians. Note that $c_{move} > c_{travel}$, which implies that the employers choose whether to pay a higher fixed cost (c_{move}) with lower variable costs (w_m) to employ migrated physicians or to pay a lower fixed cost (c_{travel}) with higher variable costs (w_t) to employ traveling physicians. In addition, c_{travel} is zero if a physician provides telehealth services, as they provide healthcare services without physically traveling to different locations. Also note that $c_{relicense}$ is zero if a potential destination adopted the IMLC or ULR (i.e., re-licensure is not required to practice).

The prevalence of non-compete agreements[2] for physicians implies that working more than normal hours can be done only by starting out-of-state practices. If physicians decide to start out-of-state practices, they can reduce a fraction of their work hours from the current labor market by $T_s \geq 0$ and spend a fraction of their work hours in the hospital(s) at potential destinations by $T_t > 0$. Note that $(1 - T_s) + T_t \geq 1$, which indicates that these physicians can work more than the hours stipulated in their initial contract, which the non-compete agreements restrict them from doing in their local or new labor markets during employment. This is the unique component of this model that explains physicians' decisions; while most licensed occupations do not impose non-compete agreements that geographically restrict licensed workers' intensive margin of labor, a significant proportion of physicians sign these agreements.

[2] A recent report from the American Medical Association (AMA) in 2023 shows that non-compete clauses affect between 37% and 45% of physicians in the U.S., restricting them from practicing in nearby hospitals. See https://www.ama-assn.org/medical-residents/transition-resident-attending/ama-backs-effort-ban-many-physician-noncompete.

In addition, physicians are subject to idiosyncratic preference shocks ε_s, ε_m, and ε_t, which tilt preferences toward staying, migrating, and traveling, respectively, and these preference shocks are dispersed at the scale of γ, which follows standard Gumbel distributions, independently of each other and identically distributed across groups. There is an increasing function of work hours, δ_{time}, which represents the disutility from working longer than normal hours, where $\delta_{time} > 0$ if $(1 - T_s) + T_t > 1$. Note that δ_{time} for telehealth physicians is significantly smaller than for traveling doctors working for the same hours, as providing telehealth services does not require travel to different states.

Then, the utilities of staying (U_s), migrating (U_m), and starting out-of-state practices (U_t) are given by the following expressions:

$$U_s = w_s + \gamma\varepsilon_s$$

$$U_m = w_m - c_{relicense} - c_{self} + \gamma\varepsilon_m \quad (1)$$

$$U_t = (1 - T_s)w_s + T_t w_t - c_{relicense} - \delta_{time} + \gamma\varepsilon_t.$$

3.1.1 Before Adopting Reciprocity of Out-of-State Licenses

Before the reciprocity of out-of-state licenses is adopted, $c_{relicense} > 0$ and is large enough to discourage physicians from migrating or starting out-of-state practices. In other words, $U_s > U_m$ and $U_s > U_t$. Assume that the preference shocks ε_s, ε_m, and ε_t are zero at means; then, these can be expressed as

$$U_s > U_m$$

$$\Rightarrow w_s > w_m - c_{relicense} - c_{self}$$

$$\Rightarrow c_{relicense} + c_{self} > w_m - w_s,$$

which implies that physicians stay rather than migrate, because the costs of migration paid by them are greater than the marginal earnings from migration ($w_m - w_s$), and

$$U_s > U_t$$

$$\Rightarrow w_s > (1 - T_s)w_s + T_t w_t - c_{relicense} - \delta_{time}$$

$$\Rightarrow c_{relicense} + \delta_{time} > T_t w_t - T_s w_s,$$

which implies that physicians stay rather than start out-of-state practices, because the sum of the re-licensure cost and disutility from working longer is greater than the marginal earnings from starting out-of-state practices ($T_t w_t - T_s w_s$).

3.1.2 After Adopting Reciprocity of Out-of-State Licenses

Adopting the reciprocity of out-of-state licenses—that is, measures like the IMLC and ULR—removes the cost of re-licensure (i.e., $c_{relicense} = 0$), making migration and out-of-state practices more attractive. Yet, physicians prefer starting out-of-state practices more than migrating to potential labor markets if $U_t > U_m$. In other words, removal of the re-licensure cost raises the utility of starting out-of-state practices more than that of migrating or staying; that is, $U_t > U_s$ and $U_t > U_m$. Again, assume that the preference shocks ε_s, ε_m, and ε_t are zero at means. Then, these can be expressed as

$$U_t > U_s$$

$$\Rightarrow (1 - T_s)w_s + T_t w_t - \delta_{time} > w_s$$

$$\Rightarrow T_t w_t - T_s w_s > \delta_{time},$$

which implies that physicians start out-of-state practices rather than stay, because the marginal earnings from starting out-of-state practices ($T_t w_t - T_s w_s$) are greater than the disutility of working longer than normal hours (i.e., the disutility of starting out-of-state practices), and

$$U_t > U_m$$

$$\Rightarrow (1 - T_s)w_s + T_t w_t - \delta_{time} > w_m - c_{self}$$

$$\Rightarrow (1 - T_s)w_s + T_t w_t - w_m > \delta_{time} - c_{self},$$

which implies that physicians travel rather than migrate, because the difference in earnings between starting out-of-state practices ($(1 - T_s)w_s + T_t w_t$) and migrating (w_m) is greater than the difference between the disutility from working longer than normal hours and the cost of migration. Since c_{self} can be seen as a disutility of migration and is likely to be greater than the disutility of working more than normal hours (δ_{time}), the right-hand side of the above inequality is likely to be negative. This implies that physicians are likely to prefer starting out-of-state practices more than migrating if the earnings from traveling are greater than the earnings from migrating.

3.1.3 Change in the Rate of Starting Out-of-State Practice

Physicians make decisions by choosing the option that returns the highest utility. As explained in the previous subsection, physicians choose to stay before the reciprocity of out-of-state licenses is adopted and choose to start out-of-state practices after it is adopted. Using the assumptions and the properties of Gumbel distribution, we can first calculate the (log) rate of starting out-of-state practices (OSP) before adopting the reciprocity of out-of-state licenses:

$$\log\left(OSP_{Before}\right) = \frac{1}{\gamma}[(1 - T_s)w_s + T_t w_t - c_{relicense} - \delta_{time} - w_s]$$

$$= \frac{1}{\gamma}[T_t w_t - T_s w_s - c_{relicense} - \delta_{time}] .$$

If a physician's license is eligible for reciprocity,[3] then the log rate is

$$\log\left(OSP_{After}\right) = \frac{1}{\gamma}[(1 - T_s)w_s + T_t w_t - \delta_{time} - w_s] = \frac{1}{\gamma}[T_t w_t - T_s w_s - \delta_{time}].$$

Suppose α is the proportion of physicians starting out-of-state practices who were licensed from the IMLC states. Then, we can write the changes in the rate of starting out-of-state practices for the IMLC states after adopting the universal reciprocity of physician licenses as

[3] This is the case if (1) a physician was licensed from the IMLC member state and decided to travel to another IMLC state to practice, or (2) a physician decided to start out-of-state practices in the states that adopted the universal reciprocity of physician licenses.

$$\Delta \log(OSP) = \frac{1}{\gamma}[T_t w_t - T_s w_s - \delta_{time}] - \alpha\frac{1}{\gamma}[T_t w_t - T_s w_s - \delta_{time}]$$

$$-(1-\alpha)\frac{1}{\gamma}[T_t w_t - T_s w_s - c_{relicense} - \delta_{time}] = \frac{1}{\gamma}(1-\alpha)c_{relicense} > 0. \quad (2)$$

The above inequality implies that the change in log rate of starting out-of-state practices is higher if the cost of re-licensure is higher and/or the proportion of physicians licensed from the IMLC states is smaller.

3.1.4 Theoretical Implications

This model provides several implications. First, physicians are not willing to migrate before and after the adoption of the reciprocity of physician licenses; instead, they prefer staying before and starting out-of-state practices after its adoption. While the disutility from migrating (c_{self}) is likely to be greater than that from traveling (δ_{time}), starting out-of-state practices is likely to return higher utility than migrating, as $w_t \geq w_m$ and total work hours after starting out-of-state practices $(1 - T_s) + T_t \geq 1$.

Second, there is still an increase in the local labor supply of physicians after the adoption of the IMLC, and the magnitude of this increase changes by the proportion of physicians who are licensed from non-IMLC states $(1 - \alpha)$. As Equation (2) shows, the positive change in the log rate of starting out-of-state practices implies that there is still room to increase the local labor supply by adopting the ULR. We provide empirical evidence of these implications in the following sections.

Lastly, extending the implications of this model, prohibition of non-compete agreements during employment will significantly raise the intensive margin of local labor supply of physicians and reduce physicians traveling to different states to practice. Unlike other licensed occupations, physicians did not experience a significant change in their migration rate after adopting reciprocity for out-of-state licenses. Our model itself cannot explain why physicians do not migrate but instead travel, because our model assumes that the non-compete agreements restrict physicians from working longer than normal hours in their current or potential labor markets during employment unless they start out-of-state practices. In other words, non-compete agreements restrict the intensive margin of labor supply when they work in one labor market only.

Repealing these agreements allows U_t to explain the utility of out-of-main-job practices (i.e., all the practices outside physicians' main jobs that their normal work hours are spent in), with zero cost of re-licensure, regardless of the state's adoption of the IMLC and ULR. In addition, the reduced travel costs of in-state traveling physicians, covered by potential in-state employers, will increase local employers' preference for local physicians over out-of-state physicians and migrated physicians, reducing physicians' out-of-state travel rate. However, it is unknown whether there will be changes in out-of-state telehealth services since the cost of travel is zero for providing telehealth services; this will depend on consumers' preference between in-person and telehealth services.

3.2 Production of Healthcare Services and Consumer Welfare

This is a simple general equilibrium model explaining how consumer welfare increases as the out-of-state practices increase after adopting the reciprocity of physician licenses. Our model is of a market for goods and services where there is a representative producer and a representative consumer. The representative producer tries to maximize its profit by choosing the number of out-of-state physicians to employ, given the condition that its local labor supply of physicians is fixed. The representative consumer tries to maximize their utility by choosing the quantity of healthcare services to consume given their budget for utilizing these services. We capture the change in consumer welfare by deriving how the utility of the representative consumer changes with respect to the change in the number of out-of-state physicians employed by the representative producer.

3.2.1 Producer's Problem

The representative producer tries to maximize its profit Π by choosing and employing the number of out-of-state physicians starting out-of-state practices for this producer, denoted by n_t. As physician shortage is a prevalent issue in the U.S. healthcare market, assume that the number of local physicians, denoted by n_s, is fixed. In other words, local physicians are at full employment, and therefore their employment cannot be increased. For simplicity, assume that there are no migrated physicians; this assumption is consistent with our theoretical implications from the previous subsection and previous studies showing that regulatory relaxation on licensing requirements does not increase the interstate migration of physicians (Deyo et al., 2024; Fannin, 2020). Assume that the production of healthcare services is based on n_s and n_t with the constant elasticity of substitution (CES), where σ denotes the elasticity of substitution. Then, the production of healthcare services can be expressed as

$$AL = A\left[(1-\lambda)n_s^{\frac{\sigma-1}{\sigma}} + \lambda T_t n_t^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \quad (3)$$

where A is the production constant, λ is the share parameter, and T_t is the fraction of hours that out-of-state physicians spend working for this producer (the same parameter from the partial equilibrium model in Section 5.1). To employ local and out-of-state physicians for normal work hours, the producer pays w_s and w_t, respectively. Since out-of-state physicians work a fraction of hours, denoted by T_t, the wage these physicians receive is $T_t w_t$. In addition, for simplicity, assume that the cost of travel, subsidizing out-of-state physicians' travel, is zero; as telehealth services are more prevalent, the cost of providing out-of-state practices goes down significantly.

Statement. The producer maximizes its profit by choosing the number of out-of-state physicians to employ:

$$\max_{n_t} \Pi = \max_{n_t} PAL - (w_s n_s + T_t w_t n_t)$$

$$\text{s.t. } L = \left[(1-\lambda) n_s^{\frac{\sigma-1}{\sigma}} + \lambda T_t n_t^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{4}$$

where P is the price of healthcare services.

3.2.2 Consumer's Problem

The representative consumer of healthcare services tries to maximize their individual utility by choosing the quantity of healthcare services to consume, denoted by q, given the probability of the needs for healthcare services (ρ), the price of these services (P), and the budget for utilizing these services (B) which is dispersed at the scale of η.

Statement. A consumer maximizes their utility by choosing the quantity of healthcare services to consume:

$$\max_q U_c(q) \text{ s.t. } \rho P q \leq \eta B, \tag{5}$$

where $\frac{\partial U_c(q)}{\partial q} > 0$, implying that increasing the consumption of healthcare services increases consumer utility.

We can express the quantity of healthcare services as a demand for healthcare services that is a function of the price and budget for utilizing these services, denoted by $q(P, B)$. Note that $\frac{\partial q(P,B)}{\partial P} < 0$, which implies that the quantity demanded for healthcare services decreases as the price of these services increases. The first-order conditions above imply that

$$\frac{\partial U_c(q)}{\partial P} < 0 \tag{6}$$

as $\frac{\partial U_c(q)}{\partial P} = \frac{\partial U_c(q)}{\partial q} \frac{\partial q(P,B)}{\partial P}$.

3.2.3 Equilibrium and Implications of the Model

Definition. Given the number of local physicians employed n_s, the consumer's budget for healthcare utilization B, and parameters $\{A, \sigma, \lambda, \rho, \eta, T_t\}$, an equilibrium is defined by the endogenous quantities n_t and q such that:

1. Producer's optimization behavior: A representative producer choosing n_t solves Equation (4).

2. Consumer's optimization behavior: A representative consumer choosing q solves Equation (5).

3. Market clears: The price of healthcare services P is such that the healthcare market clears: $AL = \rho q$.

We now present two equilibrium relationships, which together compose the system of equations that we solve to obtain comparative statics. The derivations of these equations are provided in Appendix A. First, Equation (3) implies that the marginal product of out-of-state physicians is positive:

$$\frac{\partial L}{\partial n_t} = \lambda T_t \left(\frac{L}{n_t}\right)^{1/\sigma} > 0. \tag{7}$$

This means that the quantity of healthcare services produced increases as more out-of-state physicians are employed. Second, Equation (4) implies that the price of healthcare services at equilibrium is a function of w_t, n_t, and L:

$$P^* = \frac{w_t}{A\lambda}\left(\frac{n_t}{L}\right)^{1/\sigma}. \tag{8}$$

Given the consumer's and producer's problems as well as the equilibrium relationships, we summarize three corollaries explaining how the price of healthcare services and wages for out-of-state physicians change. Proofs and derivations of equations are provided in Appendix A.

Corollary 1. The change in the price of healthcare services with respect to the change in the production of healthcare services is negative:

$$\frac{\partial P}{\partial L} = -\frac{1}{A\sigma\lambda L}\left(\frac{n_t}{L}\right)^{1/\sigma} < 0. \tag{9}$$

This corollary shows that the price of healthcare services decreases as more healthcare services are produced.

Corollary 2. Given Equations (7) and (9), the price of healthcare services decreases as more out-of-state physicians are employed by the representative producer:

$$\frac{\partial P}{\partial n_t} = \frac{\partial P}{\partial L}\frac{\partial L}{\partial n_t} = -\frac{T_t}{A\sigma L} < 0. \tag{10}$$

This corollary shows that the price of healthcare decreases as more out-of-state physicians are employed by the representative producer.

Corollary 3. Given Equations (8) and (10), the wage of out-of-state physicians decreases as more out-of-state physicians are employed. In other words,

$$\frac{\partial w_t}{\partial n_t} = \frac{\partial w_t}{\partial P}\frac{\partial P}{\partial n_t} = -\frac{\lambda T_t L^{1-\sigma}}{{n_t}^{\sigma}} < 0. \tag{11}$$

This corollary shows that the increase in physician labor supply after adopting the reciprocity of out-of-state licenses reduces the economic rent of occupational licensing, which is created by the labor supply restriction effect of occupational licensing.

We now analyze the change in consumer welfare after reciprocity for out-of-state licenses is adopted. We define the increase in consumer welfare as the increase in the utility of the representative consumer of healthcare services. As shown in Equations (5) and (6) and their first-order conditions, consumer welfare increases as the consumption of healthcare services increases or the price of the services decreases.

Given the corollaries and the first-order conditions, we explain how the increase in the employment of out-of-state physicians increases consumer welfare. Proofs and derivations of equations are provided in Appendix A.

Theorem 1. Suppose a representative producer tries to maximize its profits by choosing and employing the number of out-of-state physicians to employ. At the same time, a representative consumer of healthcare services tries to maximize their utility by choosing the quantity of healthcare services to consume. Adoption of reciprocity of out-of-state physician licenses significantly reduces the cost of employing these physicians as well as the disutility of starting out-of-state practices, allowing the producer to employ these physicians at a significantly lower cost. Then, adopting the reciprocity of out-of-state physician licenses increases consumer welfare in the healthcare services market:

$$\frac{\partial U_c}{\partial n_t} = \frac{\partial U_c}{\partial P}\frac{\partial P}{\partial n_t} > 0. \tag{12}$$

This theorem shows that consumer welfare increases when more out-of-state physicians are employed and start practicing in the representative consumer's local market, because the increase in physician labor supply due to the increase in out-of-state practices reduces the price of healthcare services, leading to an increase in the utility of the consumer.

In Section 3.1.3, we show that the log rate of starting out-of-state practice among the state that previously adopted the IMLC and then adopt the ULR is $\frac{1}{\gamma}(1-\alpha)c_{relicense}$, showing that there is still a room to increase the local labor supply of physicians among these states. The approximation of the change in consumer welfare in these states is

$$\frac{\partial U_c}{\partial n_t}\left[n_t^1 e^{\frac{1}{\gamma}(1-\alpha)c_{relicense}}\right] > 0, \tag{13}$$

which implies that adoption of the ULR among the states that previously adopted the IMLC also increases consumer welfare. In summary, this model predicts that consumer welfare increases as a result of the increase in local labor supply of physicians via increasing out-of-state practices. In the next sections, we present the empirical model and econometric analyses to show that the predictions from the model can be supported by an analysis of data on the issue.

4 Data and Methods

4.1 Healthcare Utilization Measures

We mainly use the Behavioral Risk Factor Surveillance System (BRFSS) for the years 2018 through 2023. The BRFSS, publicly available from the Centers for Disease Control and Prevention (CDC), is an annual cross-sectional telephone survey that provides abundant health-related information, such as healthcare utilization, health outcomes, and health-related behaviors, on a nationally representative sample of Americans aged 18 and older. The benefit of using the BRFSS is that the survey provides both the state of residency and month of survey of each respondent; this is particularly important for distinguishing the time before and after the adoption of the ULR in each state.

We first select the sample of respondents aged between 25 and 64. We specifically select this age group because Medicare eligibility and receipt, which occur at age 65 or older, significantly increase healthcare utilization and possibly distort the effect of the ULR (Card et al., 2008); as a robustness check, we conduct a separate analysis using the sample of respondents with ages 65 through 79. Then, the respondent-level healthcare utilization measures are shrunk into state-half-year cells; each cell provides the proportion of respondents in each state who utilized the corresponding healthcare services during the given 6-month period. For the analysis by age group, we follow the same procedure but using a subset of respondents based on their ages: ages between 25 and 44 (younger population) and ages between 45 and 64 (older population). By examining the changes in this proportion before and after the implementation of the ULR, we can validate the effect of the ULR on healthcare utilization.

Although the BRFSS provides numerous useful measures of healthcare utilization, the majority of the measures cannot be used, because the survey questions for the corresponding measures are asked only for specific groups of respondents based on their age and sex. For instance, the question on the time since last sigmoidoscopy or colonoscopy was asked of respondents who are aged 50 or older. Similarly, the question on the time since last mammogram was asked to women only. This leads to having an insufficient number of respondents to accurately obtain the proportion of respondents that received corresponding healthcare services. In addition, some of the questions are asked biennially (e.g., time since last dental checkup), which limits the possibility of using an event study design to measure the pre- and post-treatment effects in each time interval.

Therefore, we carefully selected three variables whose questions in the survey remained relatively similar across all survey years and were asked to all the survey respondents. First, "having one or more personal doctors or healthcare providers" is a measure that captures whether a respondent has a personal doctor or healthcare provider. Although the change in the wording of this survey question in 2021 led to an increase in the proportion of respondents who have personal doctors or healthcare providers, this increase was observed at a similar rate across all states (Hest, 2022).[4] In Appendix B, we provide the difference in the proportions of respondents who have one or more personal doctors or healthcare providers from the BRFSS 2020 and 2021, separately by ULR adoption status; this table shows that the difference in the change in this proportion between the states that adopted and did not adopt the ULR is only 0.3 percentage point. Therefore, this change can be controlled by using time fixed effects of the event study design. Second, "could not

[4] For more information about the survey question and changes in the responses, check the SHADAC's blog: https://www.shadac.org/news/brfss-potential-break-series-usual-source-care.

see a doctor because of cost" is a measure that captures whether a respondent experienced not seeing a doctor because of high healthcare costs. Lastly, "received routine health checkups within a year" is a measure that captures whether a respondent received a routine health checkup within a year. The complete survey questions from the questionnaire are provided in Appendix C.

These variables are particularly useful given the period because these measures are not critically influenced by COVID-19: a potential confounder of the impact of this relaxation of regulations by raising the needs of medical doctors for COVID-19 diagnosis and patient care. These measures were shrunk into state-half-year cells, and the final data are composed of state-level panel data that have a set of healthcare utilization variables. We choose the half-year time interval because the sizes of the denominator for subgroup analyses are not sufficient to accurately obtain the proportions for monthly and quarterly time interval.

4.2 Physician Local Labor Supply Measures

We use three data sets to investigate the changes in local labor supply before and after adopting the ULR. Using the IPUMS-USA and IPUMS-CPS 2018–2023, we obtain two measures that examine the changes in the interstate migration of physicians (Flood et al., 2023; Ruggles et al., 2023). First, from both IPUMS-USA and IPUMS-CPS, we obtain the proportion of physicians using the state of residency, calculated by dividing the total number of physicians living in the corresponding state by the state's population. Second, from the IPUMS-USA, we obtain the proportion of physicians using the state variable for the primary place of work, calculated by dividing the total number of physicians working in the corresponding state by the state's population. Note that the variable that indicates the primary place of work is provided in IPUMS-USA only. These measures are useful in examining the changes in the level of interstate migration after the ULR was adopted, which are used in previous studies examining interstate migration issues (e.g., Johnson and Kleiner, 2020; Bae and Timmons, 2023). Third, from the IPUMS-CPS, we obtain the proportions of self-employed physicians and employed physicians (i.e., physicians employed by hospitals), as migration patterns may differ by their employment types.

The IPUMS-CPS offers monthly survey data that provides the month in which the survey was conducted, and therefore we obtain the proportion of physician measures by shrinking the respondent-level data into state-year cells; each cell provides the proportion of physicians in each state during the given one-year period. However, since IPUMS-USA is an annual survey without months of survey, the proportion of physician measures are shrunk into state-year. More information about the variables for obtaining these measures is provided in Appendix D.

Another data set we use is the Doctors and Clinicians National Downloadable File 2018–2023 from the Centers for Medicare & Medicaid Services (CMS). It provides information on where each clinician and physician works. Using each physician's unique identification, the National Provider Identifier (NPI), we obtain two measures indicating physicians' out-of-state practice statuses. The first measure is the status of whether a physician works in two or more states. The second measure is the status of whether a physician works in two or more states, at least one of which did not adopt the IMLC at the time of observation. The second measure is particularly important because our partial equilibrium model explains that the additional gain of local labor supply is from the reciprocity of physician licenses from non-IMLC states (see Equation (2)). As we did with the other measures, we shrink these statuses into proportions, presenting the proportions of physicians working in two or more states in given time periods.

4.3 Treatment and Control Groups

In this study, we use the event study framework to estimate the reduced-form effect of the ULR. We carefully select the treatment and control groups that allow us to make a parallel trend assumption. To do so, we group the states that adopted the IMLC in the same year, so that it is plausible to assume that the healthcare utilization trends of treatment and control group states are parallel before the ULR was adopted. Appendix E shows the trends of healthcare utilization measures during the survey periods, showing parallel trends before the ULR's adoption.

The first wave of IMLC adoption occurred in 2015, when 11 states adopted it (see Table 2). Out of these 11 states, six states adopted the ULR: Idaho, Iowa, Montana, South Dakota, Utah, and Wyoming. However, three states – Iowa, Utah, and Wyoming – did not include physician occupations in the list of occupations for universal reciprocity. In other words, the other three states – Idaho, Montana, and South Dakota – are the states that adopted the universal reciprocity of physician licenses; these 3 states are chosen as a treatment group, and the other 8 states are chosen as a control group for the baseline analysis, named the "2015 Cohort." Note that the states that adopted the universal reciprocity of physician licenses impose the same rules and requirements for physicians with the Medical Doctor (MD) degree and those with the Doctor of Osteopathic Medicine (DO) degree.

We also conduct a set of falsification tests to examine whether the estimated effects are from the universal reciprocity of physician licenses or other, unknown factors related to the ULR. First, we conduct the same analyses by adding the three states that adopted the ULR but did not include physician occupations in the universal reciprocity (Iowa, Utah, and Wyoming) in the treatment group. In other words, we create a counterfactual treatment group. Second, we conduct the same analyses using the baseline treatment group (Idaho, Montana, and South Dakota) and the three counterfactual treatment group states (Iowa, Utah, and Wyoming) as the control group. This does not only allow measuring the effect of the universal reciprocity of physician licenses but also allows comparing the states that are geographically close and have similar characteristics; in the baseline control group, there are three other states (Illinois, Minnesota, and Wisconsin) that are significantly more urbanized than the treatment group states, and another two states (Alabama and West Virginia) are geographically distant from the treatment group states.

The second wave of IMLC adoption occurred in 2016, when six states adopted it, named the "2016 Cohort." Out of these six states, five states adopted the ULR. However, one state – Colorado – excluded physician occupations from the list of occupations for universal reciprocity, and three states – Arizona, Kansas, and Mississippi – added residency requirements for universal reciprocity of physician licenses. For a robustness check, despite the residency requirement, four states that included physician occupations to the list of occupations for universal reciprocity – Arizona, Kansas, Mississippi, and New Hampshire – are chosen as a treatment group, and the two other states – Connecticut and Colorado – are chosen as a control group. This robustness check provides results on the outcomes of the ULR when the residency requirement – restricting out-of-state practices – is imposed. Table 2 shows the list of states that are being used as treatment and control groups in this study. Table 3 provides descriptive statistics of the sociodemographic characteristics of respondents from January to June of 2018 (the initial wave of the final data) by their states' ULR adoption status and the year of adoption of the IMLC.

4.4 Estimation Procedure

For the estimation, we mainly use a Callaway-Sant'Anna (2021) staggered difference-in-difference model. There are two reasons we chose this method. First, because we expect that the impact of this policy reform is introduced gradually, and therefore an event study design is more appropriate to capture the change in the magnitude of the effect over time. Second, the ordinary event study design is limited in accounting for so-called 'non-parallel outcome dynamics' that lead to biased and inconsistent estimates (Goodman-Bacon, 2021). Callaway-Sant'Anna staggered difference-in-difference (CSDID) allows us to account for these issues so that we can obtain the causal measures that present the effect of this policy reform on healthcare utilization. The estimation model is

$$Y_{st} = \alpha + \mathbf{ULR}_{st}\boldsymbol{\beta} + s + t + \varepsilon_{st}, \tag{14}$$

where s and t are the state and time fixed effects, respectively, Y_{st} is the proportion of respondents living in state s in time t who received corresponding healthcare service or had medical cost issues, or the proportion of physicians from the population in state s in time t, and $\mathbf{ULR}_{st}$ is the vector of event study regressors capturing the time since the ULR was adopted, including both pre- and post-treatment. We present the results of four pre-treatment waves (two years) and nine post-treatment waves (four years and six months). As a robustness check, we also use other staggered DID approaches based on Borusyak et al. (2024) and Wooldridge (2021).

5 Results

5.1 Healthcare Utilization Among the States That Adopted IMLC in 2015

Figure 1 shows the results from the CSDID of Equation (14), using data from the states that adopted the IMLC in 2015. There are three sub-figures. The first sub-figure, in the upper left corner of the figure, shows the result using "having personal doctors or healthcare providers (Personal Doctor)" as an outcome. This sub-figure shows that the proportion of respondents having one or more personal doctors or healthcare providers significantly increased among the states that adopted universal reciprocity of physician licenses starting at Time 0. Furthermore, since Time 0, the magnitude of the estimated effects increases for the first two and half years after the treatment; this result implies that the effect of the ULR gradually increases.

The second sub-figure, in the upper right corner of the figure, shows the result using "could not see a doctor because of cost (Cost Issue)" as an outcome. This sub-figure shows that the proportion of respondents not seeing a doctor because of the cost significantly decreased among the states that adopted universal reciprocity of physician licenses, which is in effect starting at Time 0. The last sub-figure, in the lower left corner of the figure, shows the result using "received routine health checkups within a year (Routine Check within 1 Year)" as an outcome. Although the estimated effects since Time 0 are positive, these effects are not statistically significant.

Overall, the results from the first two sub-figures provide clear evidence that access to healthcare increased and the medical cost issues decreased after the universal reciprocity of physician licenses was adopted, implying a positive impact of regulatory relief on consumer welfare. Note that the estimated effects present the increase in healthcare utilization and reduction in cost issues among the treatment group, instead of the control group. The figures in Appendix E show parallel trends before the earliest treatment was given (in this case for Montana, which adopted the ULR in March 2019), and then the magnitudes of the effects grow as more states in the treatment group adopted the ULR.

5.2 Analyses by Age Group, 2015 Cohort

Figures 2 and 3 show the results from the CSDID of Equation (14), using the healthcare utilization measures that were generated from selected respondents according to their ages: ages between 25 and 44 (Figure 2) and ages between 45 and 64 (Figure 3). The sub-figures in Figure 2 show unclear effects of the universal reciprocity of physician licenses. For instance, the first sub-figure shows that the treatment effects are positive and statistically significant since Time 0 and Time -2. On the other hand, the top right sub-figure shows that the effects are not statistically significant across all time periods. The last sub-figure shows that the estimated effects are statistically significant since Time 7 and Time -3. These results do not provide clear evidence of the effect of universal reciprocity of physician licenses on healthcare utilization among younger populations.

On the other hand, the first sub-figure in Figure 3 provides clear evidence of the effect of universal reciprocity of physician licenses on healthcare utilization; the difference in the proportion of respondents having personal doctors or healthcare providers is not statistically significant before adopting universal reciprocity of physician licenses, and then it became statistically significant after adopting this type of reciprocity. However, the other sub-figures do not provide clear evidence. The second sub-figure shows that the treatment effects are negative and statistically significant since Time 0 and Time -2. The last sub-figure shows that the treatment effects are not statistically significant across all time.

Overall, these results suggest that the effect of universal reciprocity of physician licenses on having personal doctors or healthcare providers is statistically significant across all post-treatment time points for older respondents (aged between 45 and 64) who need more healthcare services than younger respondents (aged between 25 and 44). The results from the robustness check using the measures generated from respondents aged 65 and older are provided in Section 5.5, which are consistent with this result. Healthcare services become more and more essential as people age, and these results are consistent with the growth of healthcare services demand by age.

5.3 Changes in Local Labor Supply: Interstate Migration Versus Out-of-State Practices

Figures 4 and 5 show the results from the CSDID of Equation (14) using the proportion of physicians from the population measures of the 2015 cohort from the IPUMS-USA and IPUMS-CPS, respectively. The two sub-figures in Figure 4 illustrate the changes in the proportion of physicians from the population. The proportions are calculated using physicians' state of residency and the state where physicians' workplaces are located. Both sub-figures show that the ULR has no statistically significant effect on the interstate migration of physicians. The three sub-figures in Figure 5 also present similar results. These results are consistent with our theoretical predictions; the adoption of the ULR does not increase the interstate migration of physicians.

On the other hand, Figure 6 presents meaningful results related to the changes in local labor supply. The top left sub-figure in Figure 6 illustrates the changes in the proportion of physicians who work in two or more states (i.e., the proportion of out-of-state practices). The estimated effects of the ULR on out-of-state practices are positive and statistically significant in the 7th and 8th waves. The more important part is the bottom sub-figure, which illustrates the changes in the proportion of physicians working in two or more states where at least one or more of these states are non-IMLC states. This measure indicates the changes in the inflow of physicians from non-IMLC states via out-of-state practices. The estimated effects of adopting the ULR are overall positive. In addition, these effects are positive and statistically significant in the 3rd, 4th, and 7th waves, implying that local labor supply of physicians increased among the states that adopted the ULR through the increase in out-of-state practices that were delivered by the physicians who are potentially licensed from non-IMLC states. In summary, Figures 4, 5, and 6 clearly illustrate that adopting the ULR increases the local labor supply by increasing out-of-state practices; however, doing so does not increase interstate migrations.

5.4 Robustness Check: Residency Requirement Limits the Effect of ULR?

Figure 7 shows the results from the CSDID of Equation (14) using data from the states that adopted the IMLC in 2016; three out of four states that adopted the ULR imposed residency requirements. None of the three sub-figures show a clear effect of the universal reciprocity of physician licenses. Compared with the results from the 2015 cohort, these results suggest that residency requirement for the reciprocity of occupational licenses works as a barrier to improving consumer welfare. The results and implications from Sections 5.1 and 5.3 show that the increase in local labor supply, which raises consumer welfare in theory and practice, is limited among the 2016 cohort because physicians do not migrate but operate out-of-state practices. Since the residency requirement does not allow out-of-state physicians to operate out-of-state practices, the local labor supply of physicians, and therefore consumer welfare, does not increase. In other words, the residency requirement is a regulatory barrier that prohibits out-of-state licensed workers from practicing without relocation, limiting the effect of such regulatory relaxations.

5.5 Falsification Test: Universal Reciprocity or Unknown Factors Related to ULR?

Figure 8 shows the results from the CSDID of Equation (14) using counterfactual treatment group. The data are composed of measures from the states that adopted the IMLC in 2015, but the states that adopted the ULR without extending universal reciprocity to physicians are also included in the treatment group. In other words, we include these states in the treatment group to create a counterfactual treatment group. Obtaining the treatment effect using the states that passed the ULR, regardless of including physician occupations in the list of occupations for universal reciprocity, reveals whether the effect of the ULR on healthcare utilization was from the universal reciprocity of physician licenses or unknown effects from the ULR.

There are four sub-figures: two sub-figures on the left show the effects of ULR using the true treatment group (i.e., the three states that adopted the universal reciprocity of physician licenses), and the two sub-figures on the right show the effects using the counterfactual treatment group. We exclude the sub-figures for “Routine Check within 1 Year” because the estimations using both true and counterfactual treatment groups produce results that are not statistically significant. The sub-figures in the top row use “having personal doctors or healthcare providers”

(Personal Doctor) as an outcome, and the sub-figures in the bottom row used "could not see a doctor because of cost" (Cost Issue) as an outcome. The results in these sub-figures illustrate that the estimated effects of the ULR are statistically significant only if we use the true treatment group; the results using the counterfactual treatment groups are not statistically significant. Note that the statistically significant estimate in Time 8 in the sub-figure in the upper right corner was obtained from one state (Montana) that adopted the ULR in 2019: the state that did not exclude physician licenses from the list of occupations with universal reciprocity.

Figure 9 shows the results from another CSDID of Equation (14) using the states that adopted the universal reciprocity of physician licenses as the treatment group and the states that adopted the ULR but did not adopt the universal reciprocity of physician license as the control group. In other words, all the states in this analysis adopted the IMLC in 2015 and adopted the ULR, yet only the treatment group states adopted the universal reciprocity of physician licenses. Note that the states in treatment and control groups here are geographically close, which implies that this analysis also controls for geographical variations. The results clearly show that after the adoption of the universal reciprocity of physician licenses, there is an increased proportion of respondents with personal doctors and a reduced proportion of respondents not seeing a doctor because of the cost after. In summary, the results in Figures 8 and 9 reveal that the positive impacts of the ULR on consumer welfare are due to the universal reciprocity of physician licenses instead of other, unknown factors related to the ULR.

5.6 Robustness Check: Healthcare Utilization Among Older Populations (Age 65 and over)

The sample we use for the baseline analysis and most of the robustness checks excludes the respondents aged 65 and older because of the potential distortion of healthcare utilization due to Medicare eligibility and receipt; Card et al. (2008) shows a drastic increase in the healthcare utilization at age 65, which implies that Medicare eligibility and receipt significantly change the level of healthcare utilization of U.S. older adults. However, this is an important population to study because of its high demand for healthcare services and relatively lower concern about healthcare costs, which are substantially covered by Medicare. Although these characteristics make this population different from our baseline populations (i.e., individuals between the ages of 25 and 64), analyzing the outcomes from this population still provides important implications.

In theory, universal reciprocity of physician licenses that leads to increasing the local labor supply of physicians will significantly benefit this population, leading to increasing healthcare utilization. However, this population would only partially or not significantly benefit if this universal reciprocity eased the cost burden, since their healthcare costs are already substantially covered by Medicare. In other words, for individuals aged 65 and older, the effect of the ULR on healthcare utilization will be positive and large while that on the cost issue will be relatively small.

To test whether this is true, as a robustness check, we conduct the same analysis, using the data of this population separately. Because the BRFSS topcodes the value of the age variable at 80, we cannot determine the true age of the respondents whose ages are shown to be 80 in the data. Thus, we use the respondents whose ages are between 65 and 79. We use the 2015 cohort for this analysis.

Figure 10 shows the results from the CSDID of Equation (14) using the data of respondents aged between 65 and 79. The top left sub-figure shows the result using "having personal doctors or healthcare providers" (Personal Doctor) as an outcome. This sub-figure clearly shows an increase in the proportion of respondents who have one or more personal doctors after the ULR was adopted. However, the other two sub-figures do not show a statistically significant effect of the ULR. This implies that there is no significant change in the proportion of respondents with cost issues, which is consistent with our predictions.

These results provide clear evidence that the adoption of the ULR increased access to healthcare for these older respondents while their concern about medical costs did not significantly change. Although only one measure (Personal Doctor) is statistically significant, these results provide evidence that the adoption of the ULR increased the consumer welfare of this population, a result that is also consistent with our theoretical model.

5.7 Robustness Check: Effect of ULR during Medicaid Expansions

The Affordable Care Act of 2010 included a Medicaid expansion. Many U.S. states extended their Medicaid eligibility to individuals with incomes up to 138% (or higher among some states) of the federal poverty level (FPL). This expansion allowed more individuals, especially those with lower income, to obtain health insurance, leading to increased access to healthcare services (Sommers et al., 2012; Courtemanche et al., 2017; Mazurenko et al., 2018; Borgschulte and Vogler, 2020). However, the timing of Medicaid expansion varies by state; while some states expanded before or during the first wave of expansion in 2014, other states either did not expand or expanded in 2019 or later. For instance, Utah, one of the states in the control group of 2015 cohort, expanded in January 2020, which is in the middle of our study period. This means that there can be a variation in healthcare utilization due to Medicaid expansion. Furthermore, some states' expansion encompasses larger groups of individuals by raising the FPL threshold for the households with children or pregnant women. For instance, Illinois expanded Medicaid eligibility for adults under 65 up to 138% of the FPL, yet that for households with children is up to 147%, and that for the households with pregnant women is up to 213%, with coverage extended for 12 months after birth. This means that healthcare utilization can vary also by the characteristics of households: household annual income, number of family members, and presence of child and pregnant women.

Thus, considering the impact of Medicaid expansion is needed to measure the true effect of universal reciprocity of physician licenses on healthcare utilization. However, the BRFSS 2018–2023 is limited in directly accounting for Medicaid expansions, because of the change in the survey question on primary source of healthcare coverage. While the response rates of the survey question on primary source of healthcare coverage in the BRFSS 2018–2020 are below 15%, those in the BRFSS 2021–2023 are above 95%. This is due to the BRFSS's re-engineering of the survey and its questions, which led to a change in the response rates for some of the questions. Note that the wording of the survey question on primary sources of healthcare coverage did not change, but its place in the order of questions in the survey did. Since the survey response rates are drastically different between the two time periods, using this coverage measure to take Medicaid expansion into account would not provide accurate answers.

Thus, we select the sample of respondents who are not affected by Medicaid expansion. Since the majority of the states in the 2015 cohort have Medicaid eligibility thresholds of 138% of the FPL regardless of having children or pregnant women in the household, we first choose the states in this cohort that have the maximum of 138% thresholds for Medicaid eligibility. This step drops Alabama,[5] Iowa, Illinois, Minnesota, and Wisconsin. Then, we select the respondents whose household annual income is above the 150% FPL, considering the number of family members in the household; we choose the households with one to five family members, covering approximately 90% of the households in 2015 cohort states. The BRFSS provides household

[5] While Alabama's Medicaid eligibility is up to 138% of the FPL for adults, that for the households with children or pregnant women is up to 146%, with a 12-month extension for 12 months after birth. Although 146% FPL is below 150% FPL, we exclude Alabama from the sample to create more homogeneous sample.

income measures in categories, and we use these categorical measures to determine and drop the respondents whose households fall below 150% FPL. More information on sample selection is provided in Appendix F. Then, we lastly select the respondents who are covered by health insurance; this is a binary measure that has a response rate over 95% across all survey periods, meaning that it was not significantly affected by the survey re-engineering in 2021.

The final sample of respondents are those living in the states in 2015 cohort with the Medicaid eligibility below 138% FPL, whose households are above 150% FPL and covered by some form of health insurance. In other words, these respondents are not affected by the Medicaid expansions before and after. Using the data of these respondents, we obtain the state-half-year healthcare utilization measures.

Figure 11 shows the shows the results from the CSDID of Equation (14) using the data of respondents aged between 25 and 64 and are not affected by Medicaid expansions. The results are consistent with our findings in the baseline analysis: an increase in the proportion of respondents having one or more personal doctors or healthcare providers, and a reduction in the proportion of respondents not seeing a doctor because of the cost. Although these results do not explain how the ULR improved the welfare of economically vulnerable populations in the healthcare market due to data limitations, they provide consistent and clear evidence that adopting the universal reciprocity of physician licenses increases consumer welfare in the healthcare market.

5.8 Robustness Check: Estimations Using Other Staggered Difference-in-Difference Approaches

To ensure our empirical results, we conduct another robustness check by using recent econometric methods that deal with event study designs. Wang et al. (2024) classify some of the recent staggered difference-in-difference methods into three groups based on how non-parallel outcome dynamics are dealt with: group-time estimator approach, imputation approach, and regression approach. CSDID is classified as a group-time estimator approach. The methods that are classified as an imputation approach include the ones used in Borusyak et al. (2024) and Liu et al. (2024), using not-yet-treated observations to impute counterfactual outcomes for each treated unit in the absence of treatment. The methods that are classified as a regression approach include those in Sun and Abraham (2021), Cengiz et al. (2019), and Wooldridge (2021, 2023), running a regression with event study regressors interacted with group indicators and/or time periods.

We first conduct a Bacon decomposition (Goodman-Bacon, 2021) to distinguish the overall treatment effect and the effects from different treatment timing. Table 4 provides the results, showing that both effects are in the same direction across all healthcare utilization measures. Then, we choose one method for each approach – Borusyak et al. (2024) for an imputation approach and Wooldridge (2021) for a regression approach – to obtain the results on how healthcare utilization changes after adopting the ULR. Figure 12 shows the results from using other staggered difference-in-difference estimations of Equation (14). The sub-figures on the left are the results using the imputation approach. All three sub-figures are consistent with our findings from the baseline analysis and robustness checks, and notably, the estimated effects are at higher levels of significance.

On the other hand, the results using the regression approach, shown in the sub-figures on the right, are slightly different from our previous findings; the estimated effects using the cost issue as a dependent variable (the middle figure) are not statistically significant. However, surprisingly, the result in the bottom sub-figures, measuring the estimated effect of the ULR on utilizing routine health checkup, is positive and statistically significant after the treatment. In summary, all these results are consistent with our predictions that adopting the universal reciprocity of physician licenses increases healthcare utilization.

6 Conclusions

We examine how the recent policy reform on relaxing the licensure regulations may improve consumer welfare, by evaluating the impact of universal reciprocity of physician licenses on healthcare utilization. We first provide a partial equilibrium model explaining how after reciprocity of out-of-state licenses is adopted, non-compete agreements make physicians prefer starting out-of-state practices over migrating within employment contracts. Then, we provide a general equilibrium model explaining how the ULR improves consumer welfare in the healthcare market. Then, we use public data to estimate the change in access to healthcare, interstate migration, and out-of-state practices before and after adopting the universal reciprocity of physician licenses.

The results from these estimates are consistent with our theoretical models; the universal reciprocity of physician licenses significantly raises the proportion of respondents accessing healthcare, particularly among older respondents, and reduces the proportion of respondents not getting healthcare services because of cost considerations. We also examine how the residency requirements of the ULR change the outcomes, using a subset of states that adopted the IMLC in 2016. We show that the positive effect of the ULR on healthcare utilization is not observed among the states that adopt universal reciprocity but impose residency requirements. Plus, the analysis of the change in the local labor supply of physicians confirms that there is no statistically significant change in the interstate migration of physicians. However, there is an increase in out-of-state practices, particularly by the physicians from non-IMLC states, among the states that adopted the ULR. These results imply that the universal reciprocity of physician licenses has a significant role in the decision-making process for doctors who are considering out-of-state practices, but not in interstate migration. Lastly, we use a counterfactual treatment group to validate whether the positive effect of the ULR on healthcare utilization is due to the universal reciprocity of physician licenses or unknown factors associated with the ULR. Our results clearly reveal that the positive effect is due to universal reciprocity.

The main rationales for occupational licensing are to protect the health and safety of consumers and to ensure a sufficiently high level of product or service quality (Kleiner, 2015). According to this perspective, by making would-be practitioners undergo specific training, pass exams, and complete other requirements, licensing protects the public from fraudulent, disreputable, and unqualified service providers. Nevertheless, by making it more difficult to enter an occupation across state lines, licensing can affect employment in licensed occupations, wages of licensed workers, and the prices for their services, and it can reduce workers' economic opportunities more broadly. Further, if these policies result in an inability to achieve regional, state, or local equilibrium, policies that reduce these barriers could enhance both consumer and worker welfare in healthcare.

Although our study reveals the influence of the ULR on healthcare utilization by developing theoretical models and utilizing a relevant data set and method, there are limitations. First, the outcome variable "received routine health checkups within a year" is somewhat limited in reflecting the changes in healthcare utilization in the short term. The routine medical checkup comprises various types of medical examinations with different suggested cycles. For instance, for men aged between 40 and 64, a blood pressure check is recommended at least once every year, while a colonoscopy is recommended every five years (Davidson et al., 2021; Whelton et al., 2022).

Furthermore, these recommendations also vary by age and sex.[6] The outcome variable for routine medical checkups used in this study may account for a shorter interval of time (one year) than it should have, depending on the types of checkups and the age of respondents (National Institute of Health, 2023). However, the majority of states adopted the ULR in 2020 and 2021. This fact suggests that the current availability of data cannot take the long-term effect of universal reciprocity of physician licenses into account. Also, while we show the reduction in the proportion of individuals having experience in not seeing a doctor because of cost issues, this study does not show the actual cost reduction due to the ULR; the BRFSS does not provide the data on actual healthcare expenses. In addition, for the same reason, this study does not show the influence of the ULR on the change in service quality.

Therefore, future research should extend our findings to obtain the long-term effects of universal reciprocity by utilizing upcoming data sets. Also, future research can utilize other healthcare data sets to examine the influence of the ULR on actual healthcare cost and service quality, especially the outcomes among economically vulnerable populations that could not be included in this study, owing to data limitation. Plus, the recent ongoing debates on prohibiting non-compete agreements for physicians should be studied to see whether repealing these agreements would increase the in-state traveling physicians and reduce the out-of-state practices. Lastly, it would be fruitful to examine the change in consumer welfare from different occupational sectors, as the ULR includes various occupations. Nevertheless, our analysis adds to the role that changes in statutes affecting physicians' ability to practice can enhance patient well-being and consumer welfare.

[6] For more information about government's recommendations on routine medical checkups by age and sex, check the NIH's webpage: https://medlineplus.gov/ency/article/002125.htm.

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Table 1. Comparison Between Interstate Licensure Compact and Universal Licensing Recognition

	Interstate Licensure Compact (ILC)	Universal Licensing Recognition (ULR)

Similarity	• Reciprocity of occupational licenses for certain occupations.
	  ○ "Reciprocity" means giving out-of-state licensed workers "right to practice" without going through the state-specific re-licensure processes.
	• There are separate compacts for each occupation that administer the matters for corresponding occupations. For instance, the Interstate Medical Licensure Compact administers the matters related to physician licenses, while the Nurse Licensure Compact administers the matters related to nurse licenses.
	  ○ Therefore, some of the occupational licenses are eligible for reciprocity while others are not, depending on whether the corresponding state is in the compact for corresponding occupations or not.
		• Reciprocity of occupational licenses for selected occupations.
		  ○ "Reciprocity" means giving out-of-state licensed workers "right to practice" without going through the state-specific re-licensure processes.
		• The occupations for recognition are selected at the time of adopting the ULR; other occupations can be added later via amendments.
		  ○ Therefore, some of the occupational licenses are eligible for reciprocity while others are not, depending on whether the corresponding occupation is included for the ULR or not.

Difference	• Only the licenses that are issued by the member states are eligible for reciprocity (less comprehensive than ULR).	• Licenses that are issued by any U.S. state qualify for reciprocity (more comprehensive than ILC). ○ Some states (e.g., Montana and South Dakota) also adopt reciprocity for the licenses issued from Canada.

Table 2. Universal Licensing Recognition and Interstate Medical Licensure Compact Status of U.S. States

State		IMLC			ULR					
Name		FIPS	Year	Month	ULR Adopted	Bill Number	Year	Month	Residency Required	Physician License Excluded
Idaho	ID	16	2015	3	Yes	SB 1351	2020	7		
Montana	MT	30	2015	4	Yes	HB 105	2019	3		
South Dakota	SD	46	2015	3	Yes	HB 1077	2021	2		
Iowa	IA	19	2015	7	Yes	HF 2627	2020	6		Yes
Utah	UT	49	2015	3	Yes	SB 23	2020	5		Yes
Wyoming	WY	56	2015	2	Yes	SF 18	2021	7		Yes
Alabama	AL	1	2015	5	No					
Illinois	IL	17	2015	7	No					
Minnesota	MN	27	2015	5	No					
Wisconsin	WI	55	2015	12	No					
West Virginia	WV	54	2015	3	No					
Arizona	AZ	4	2016	5	Yes	HB 2569	2019	4	Yes	
Kansas	KS	20	2016	5	Yes	HB 2066	2021	7	Yes	
Mississippi	MS	28	2016	5	Yes	HB 1263	2021	7	Yes	
New Hampshire	NH	33	2016	5	Yes	SB 382	2022	8		
Connecticut	CT	9	2016	5	No					
Colorado	CO	8	2016	6	Yes	HB 1326	2021	1		Yes

Note: Some states adopted the IMLC before 2015 or after 2016, yet there are not enough states that passed the ULR in the same year, which is a necessary condition for the parallel trend assumption. Plus, among the states that did not pass the IMLC before 2023, we have only two states that passed the ULR (New Jersey is an exception because it passed the ULR in 2018, which is too early in our study's time frame). Thus, it does not seem plausible to use data from states that are not on this list.

Table 3. Descriptive Statistics of States' Healthcare Utilization and Demographic Characteristics

	IMLC in 2015				IMLC in 2016			
Passed ULR	No		Yes		No		Yes	
	Prop/Mean	SD	Prop/Mean	SD	Prop/Mean	SD	Prop/Mean	SD
Healthcare Utilization Measures								
Personal Doctor	.792	.406	.752	.432	.884	.320	.784	.411
Cost Issue	.126	.331	.121	.326	.096	.294	.143	.351
Routine Check Within 1 Year	.749	.433	.705	.456	.793	.405	.732	.443
Sociodemographic Characteristics								
Women	.522	.500	.510	.500	.537	.499	.539	.499
Age	47.5	11.5	47.0	11.6	49.4	10.6	47.8	11.5
Race and Ethnicity								
NH White	.806	.396	.841	.366	.744	.437	.743	.437
NH Black	.091	.288	.011	.104	.093	.290	.096	.294
NH Others	.055	.229	.082	.274	.074	.262	.064	.244
Hispanic	.048	.214	.066	.249	.090	.286	.098	.298
Level of Education								
Less than HS and HS Graduate	.300	.458	.315	.465	.266	.442	.312	.463
Some College or Higher	.698	.459	.682	.466	.729	.444	.685	.464
MSA	.658	.474	.395	.489	.944	.231	.618	.486
Has Health Insurance	.911	.285	.889	.314	.942	.233	.879	.326

Note: Prop - proportion; SD - standard deviation; NH - non-Hispanic; HS - high school; MSA - metropolitan statistical area. The above descriptive statistics are from the BRFSS 2018, January–June.

Table 4. Bacon Decomposition, 2015 Cohort, Age 25–64 (*N* = 132)

	Two-Way Fixed Effects			Bacon Decomposition			
				Timing Groups		Never Treated vs Treated	
	EST	SE	p	Beta	Total Weight	Beta	Total Weight
Personal Doctor	.055	.007	.000	.031	.088	.057	.912
Cost Issue	-.006	.005	.198	-.012	.088	-.006	.912
Routine Check	.019	.007	.005	.006	.088	.020	.912

Note: The results above are generated using a Bacon decomposition (Goodman-Bacon, 2021) to distinguish the directions, magnitudes, and weights of the overall treatment effect and the effects from different treatment timing.

Figure 1. Impact of Universal Licensing Recognition on Healthcare Utilization, 2015 Cohort, Age 25–64 ($N = 132$)

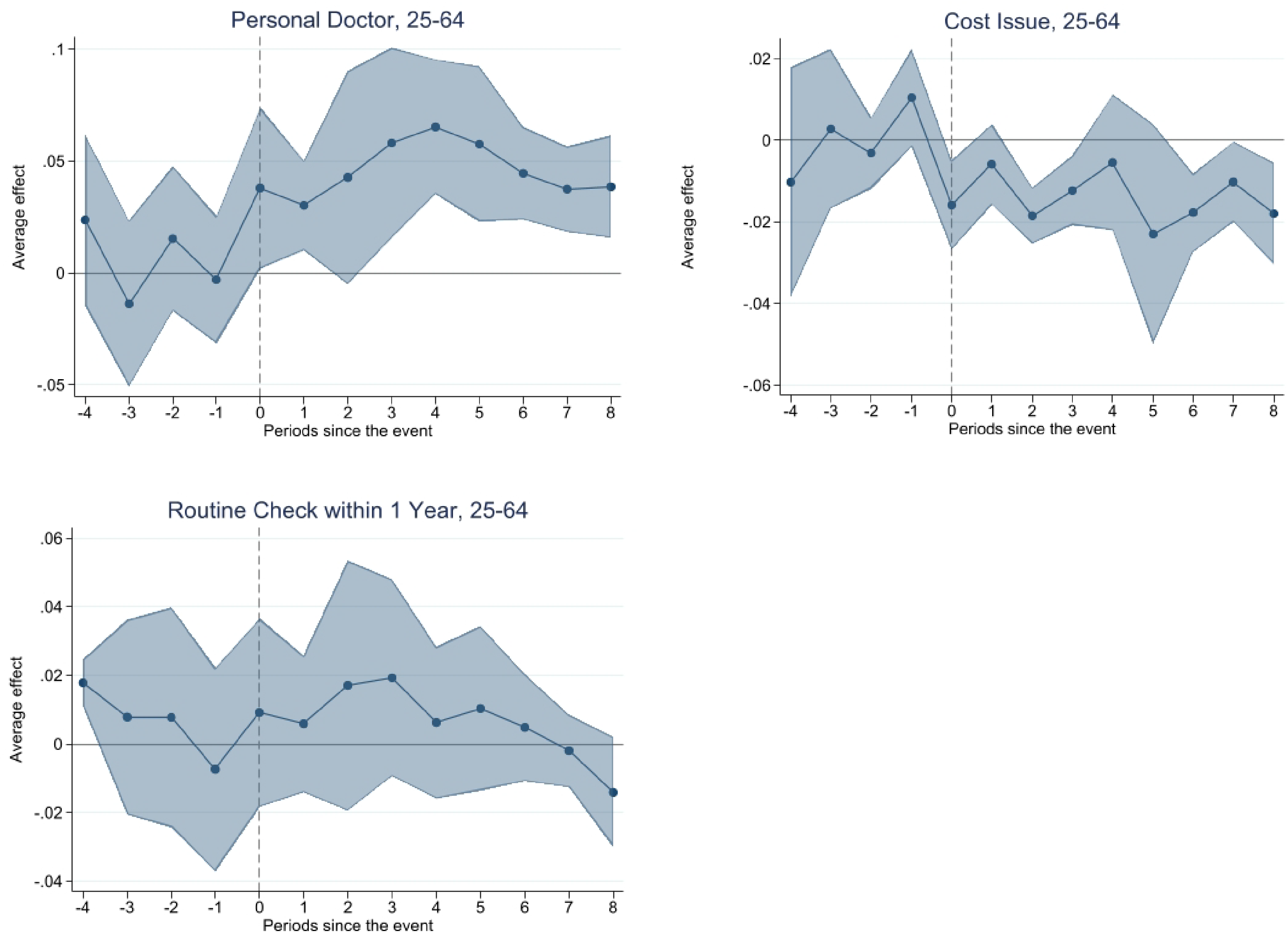


Figure 2. Impact of Universal Licensing Recognition on Healthcare Utilization, 2015 Cohort, Age 25–44 (*N* = 132)

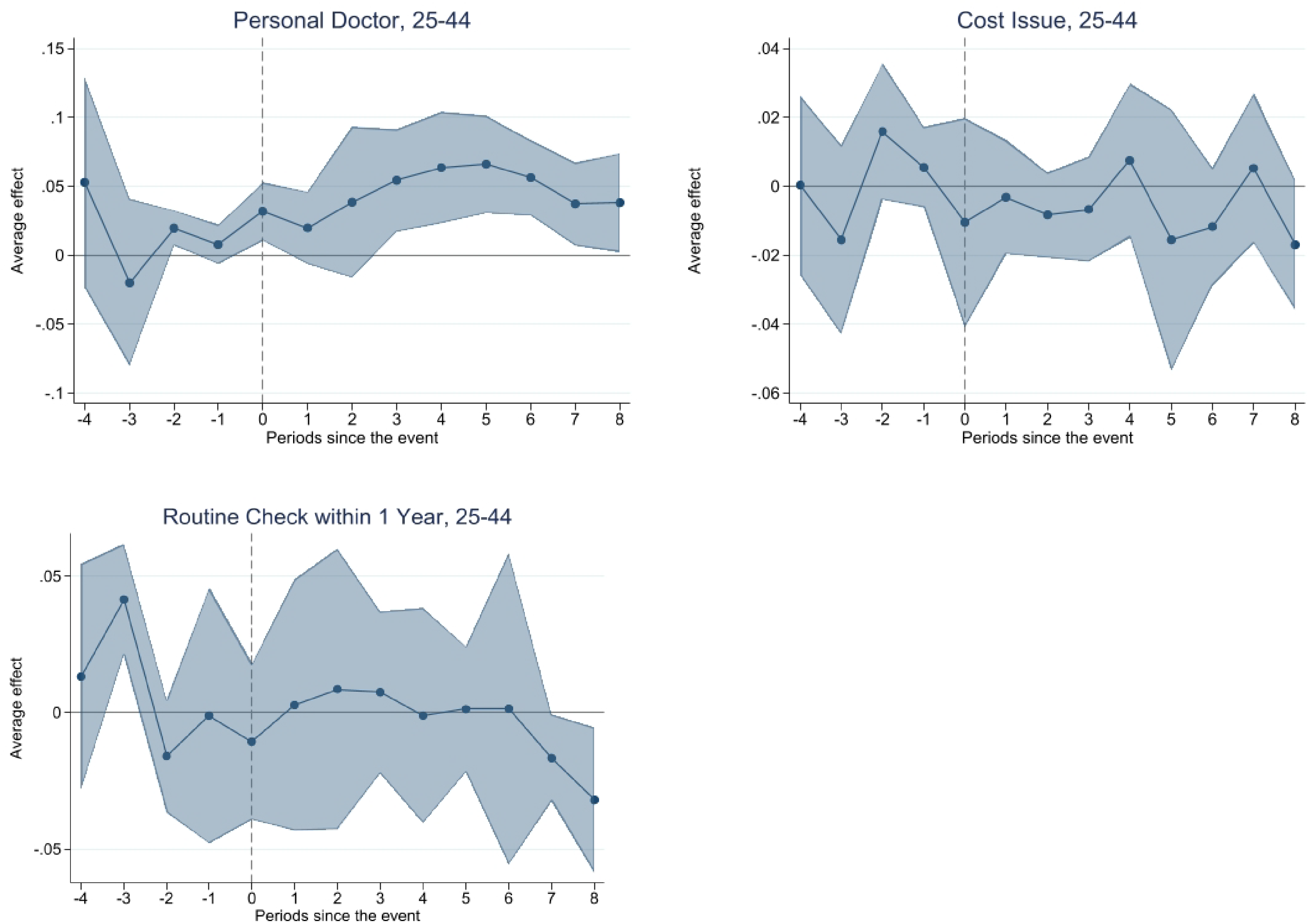


Figure 3. Impact of Universal Licensing Recognition on Healthcare Utilization, 2015 Cohort, Age 45–64 (*N* = 132)

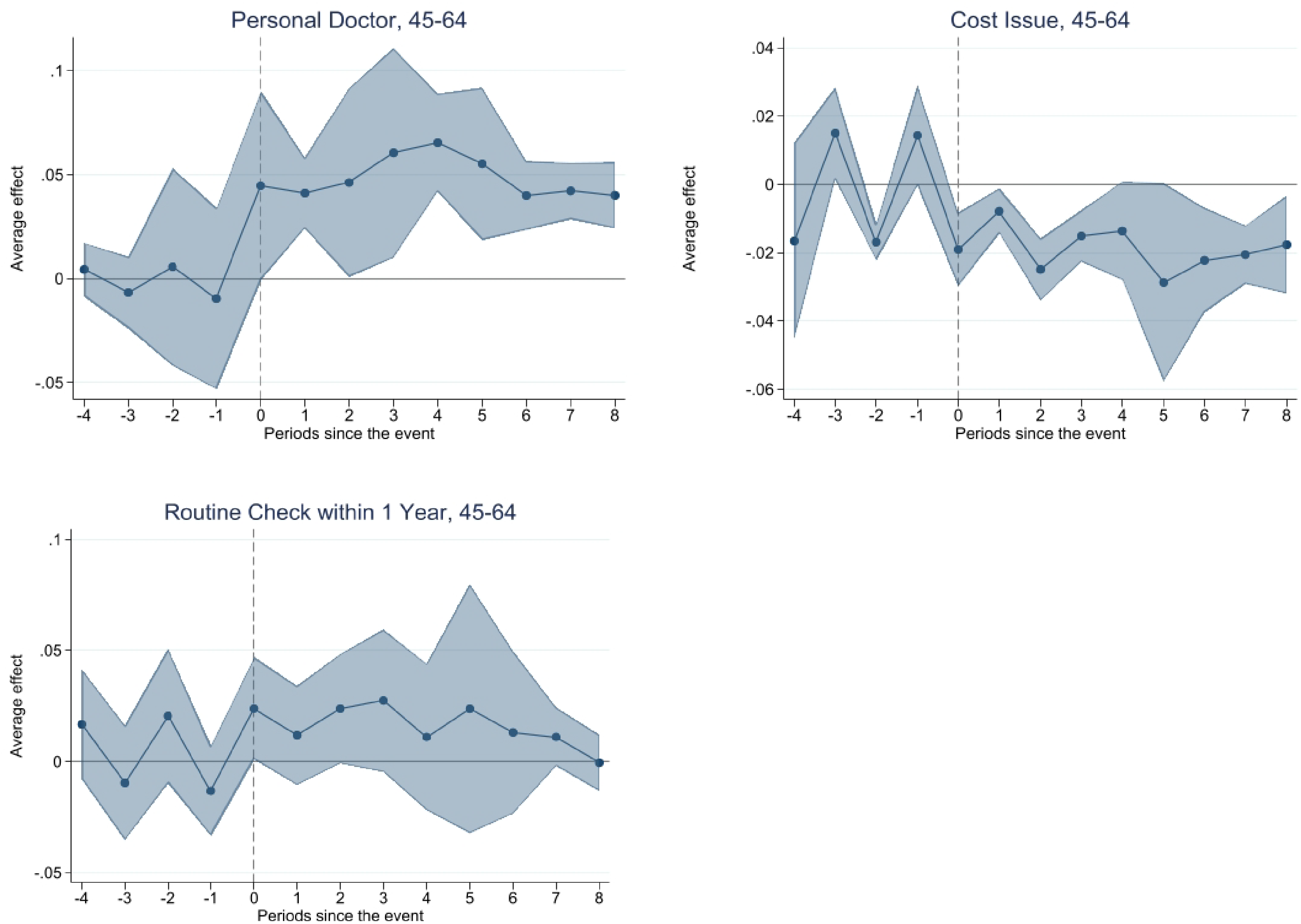
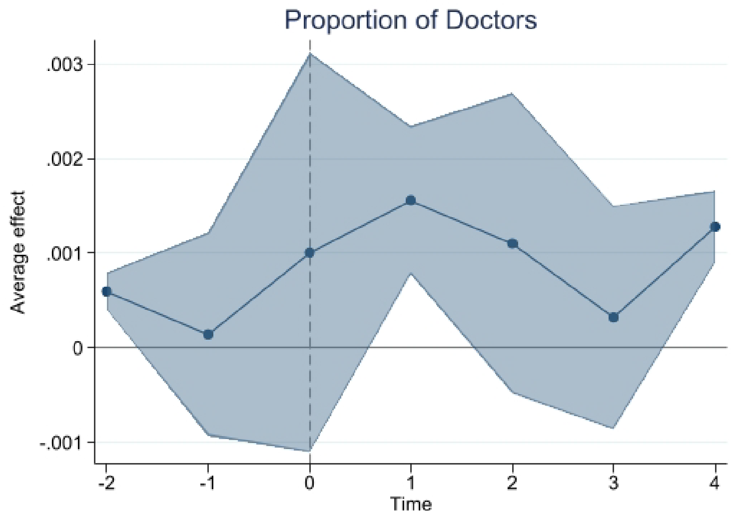
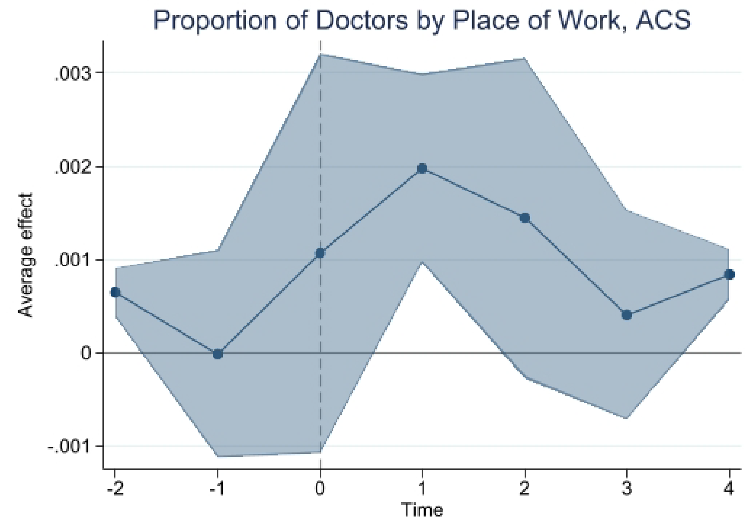


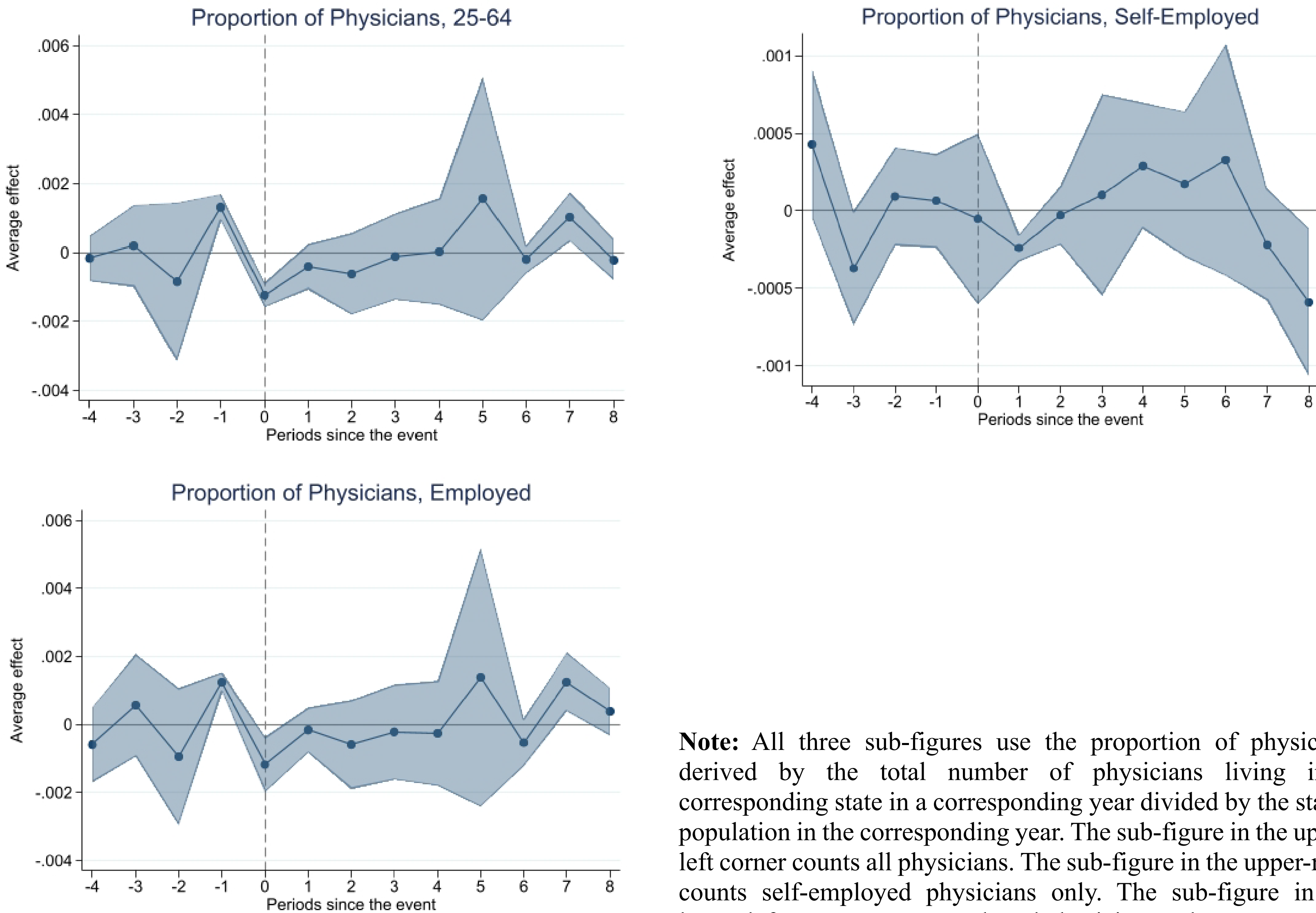
Figure 4. Interstate Migration of Physicians, IPUMS-USA, 2015 Cohort ($N = 66$)





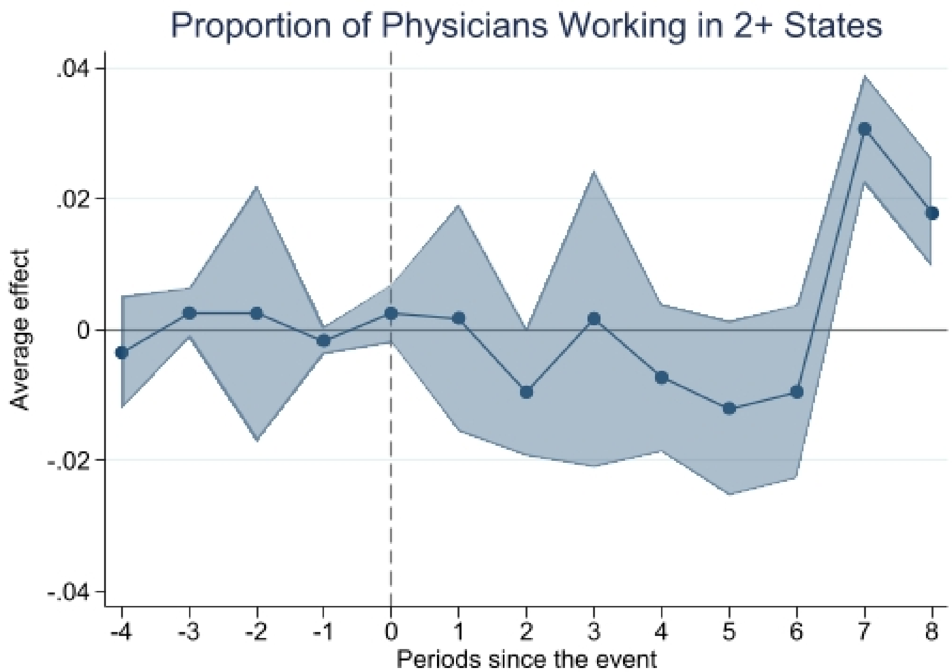
Note: The sub-figure on the left used the proportion of physicians derived by the total number of physicians living in a corresponding state in a corresponding year divided by the state's population in the corresponding year. The sub-figure on the right used the proportion of physicians derived by the total number of physicians working in a corresponding state in a corresponding year divided by the state's population in the corresponding year.

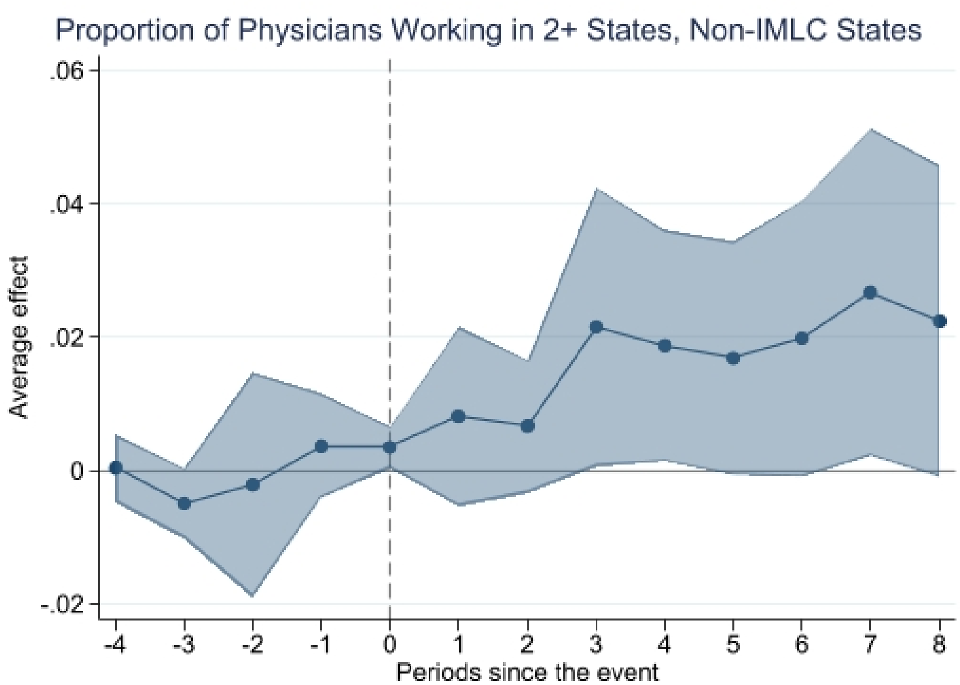
Figure 5. Interstate Migration of Physicians, IPUMS-CPS, 2015 Cohort (*N* = 132)



Note: All three sub-figures use the proportion of physicians derived by the total number of physicians living in a corresponding state in a corresponding year divided by the state's population in the corresponding year. The sub-figure in the upper-left corner counts all physicians. The sub-figure in the upper-right counts self-employed physicians only. The sub-figure in the lower-left corner counts employed physicians only.

Figure 6. Out-of-State Practices, CMS National Downloadable File, 2015 Cohort (*N* = 132)





Note: The first sub-figure (at the top) uses the proportion of physicians who work in two or more states. The second sub-figure (at the bottom) uses the proportion of physicians who work in two or more states where at least one of these states is a non-IMLC state.

Figure 7. Impact of Universal Licensing Recognition on Healthcare Utilization, 2016 Cohort, Age 25–64 (*N* = 72)

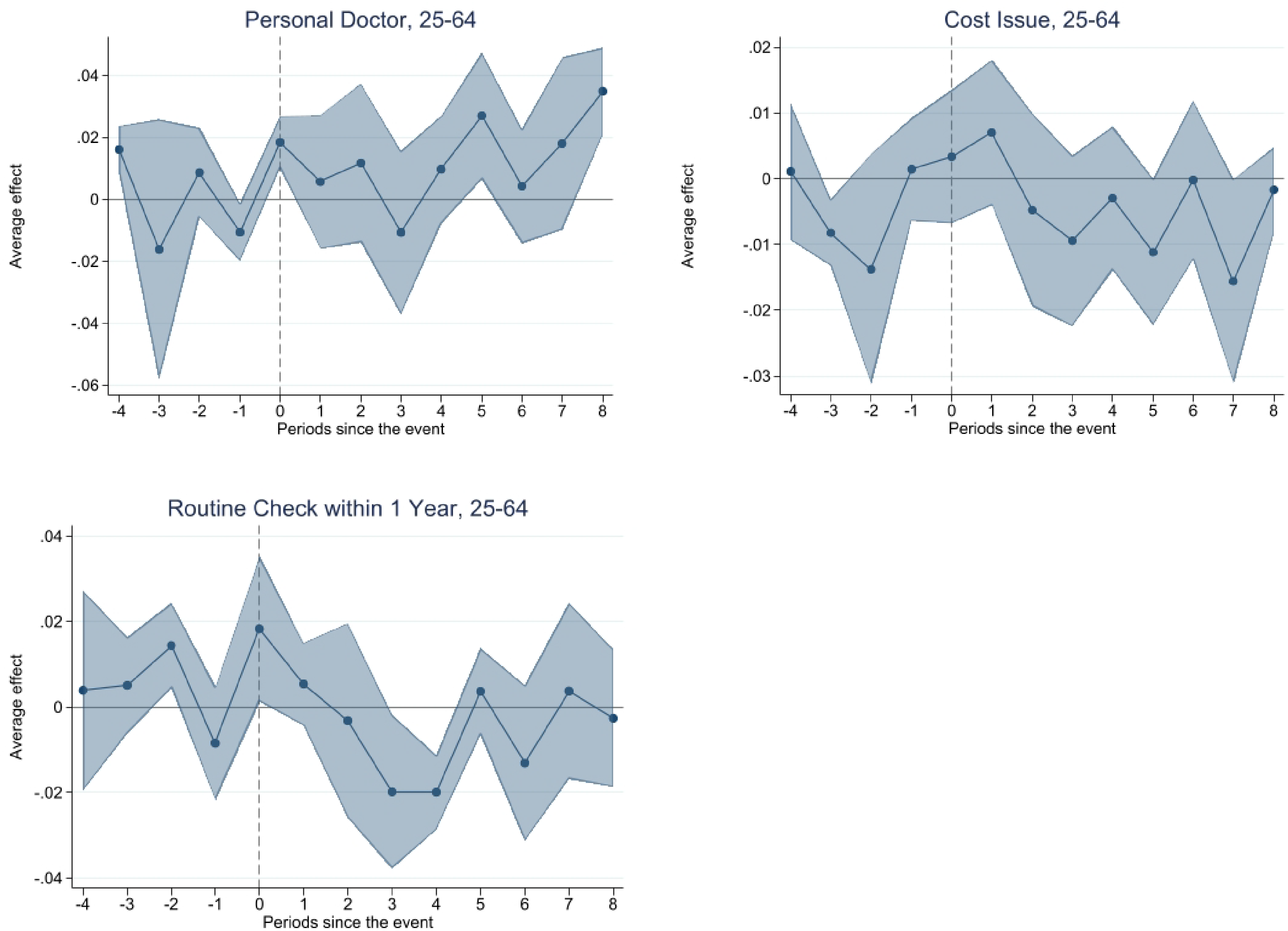


Figure 8. Measuring Effect of Universal Reciprocity of Physician Licenses Using Counterfactual Treatment Group (N = 132)

True Model | **Counterfactual Model**

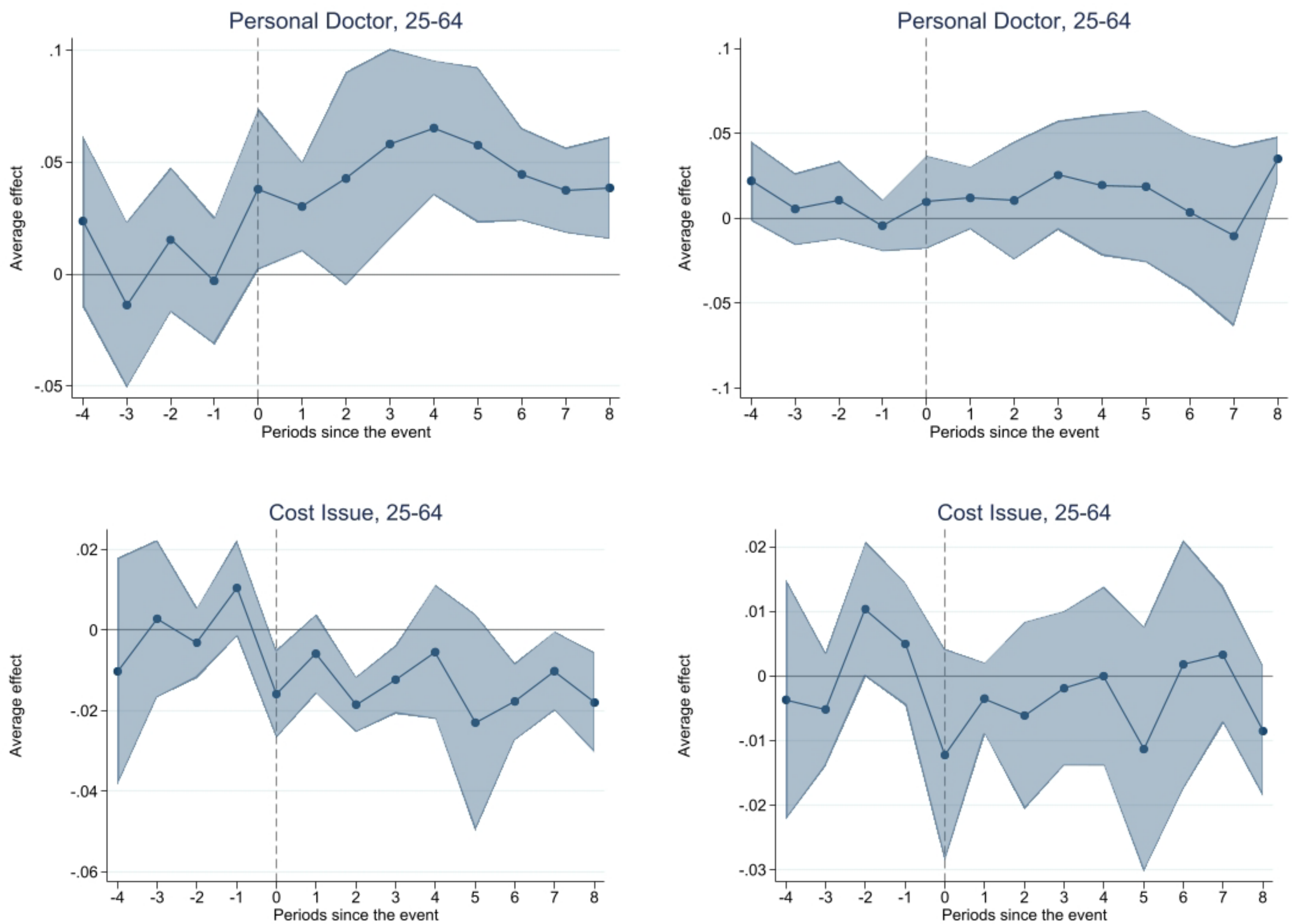


Figure 9. Measuring Effect of Interstate Reciprocity of Physician Licenses Using ULR States Only (*N* = 132)

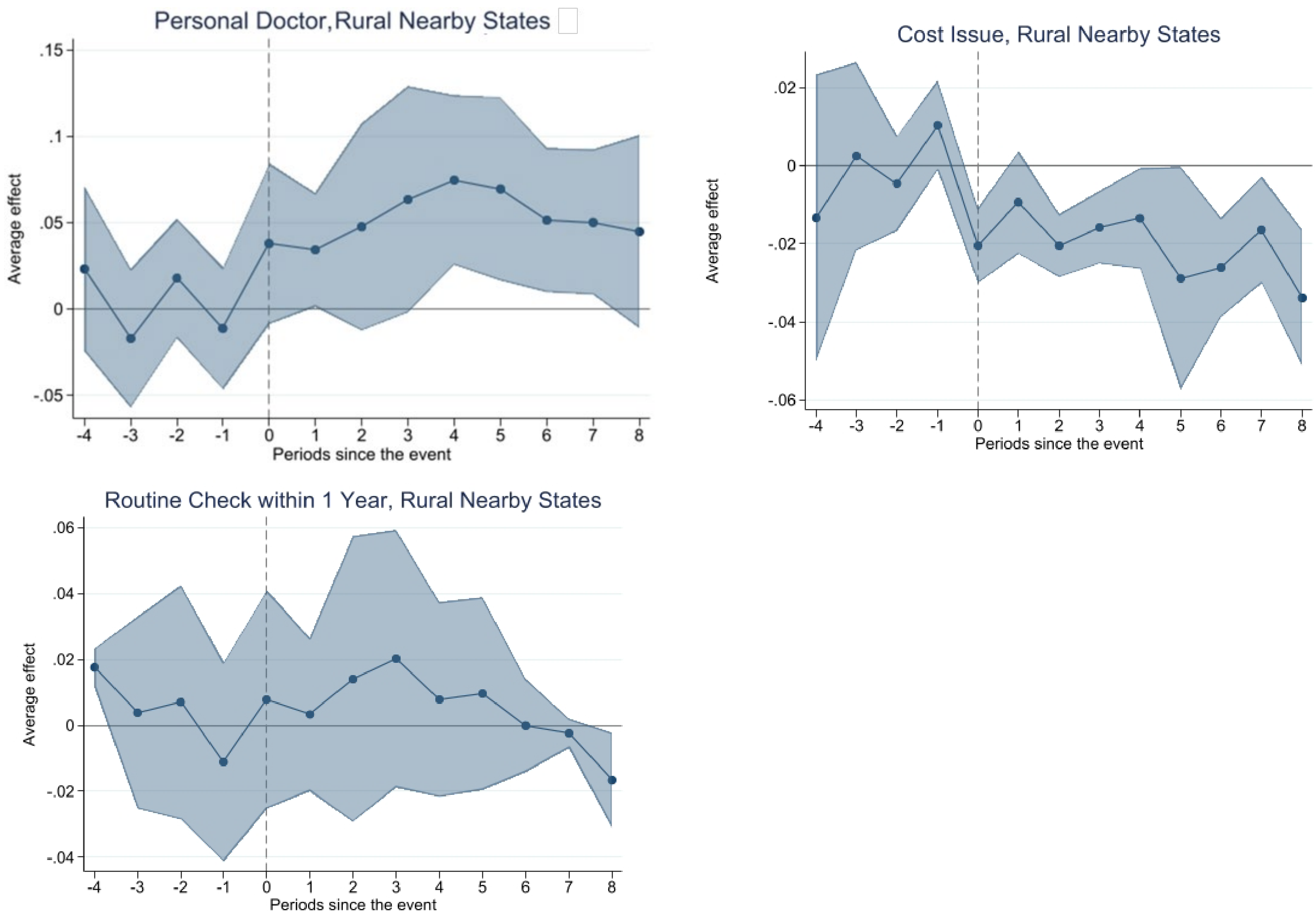


Figure 10. Impact of Universal Licensing Recognition on Healthcare Utilization, 2015 Cohort, Age 65–79 (*N* = 132)

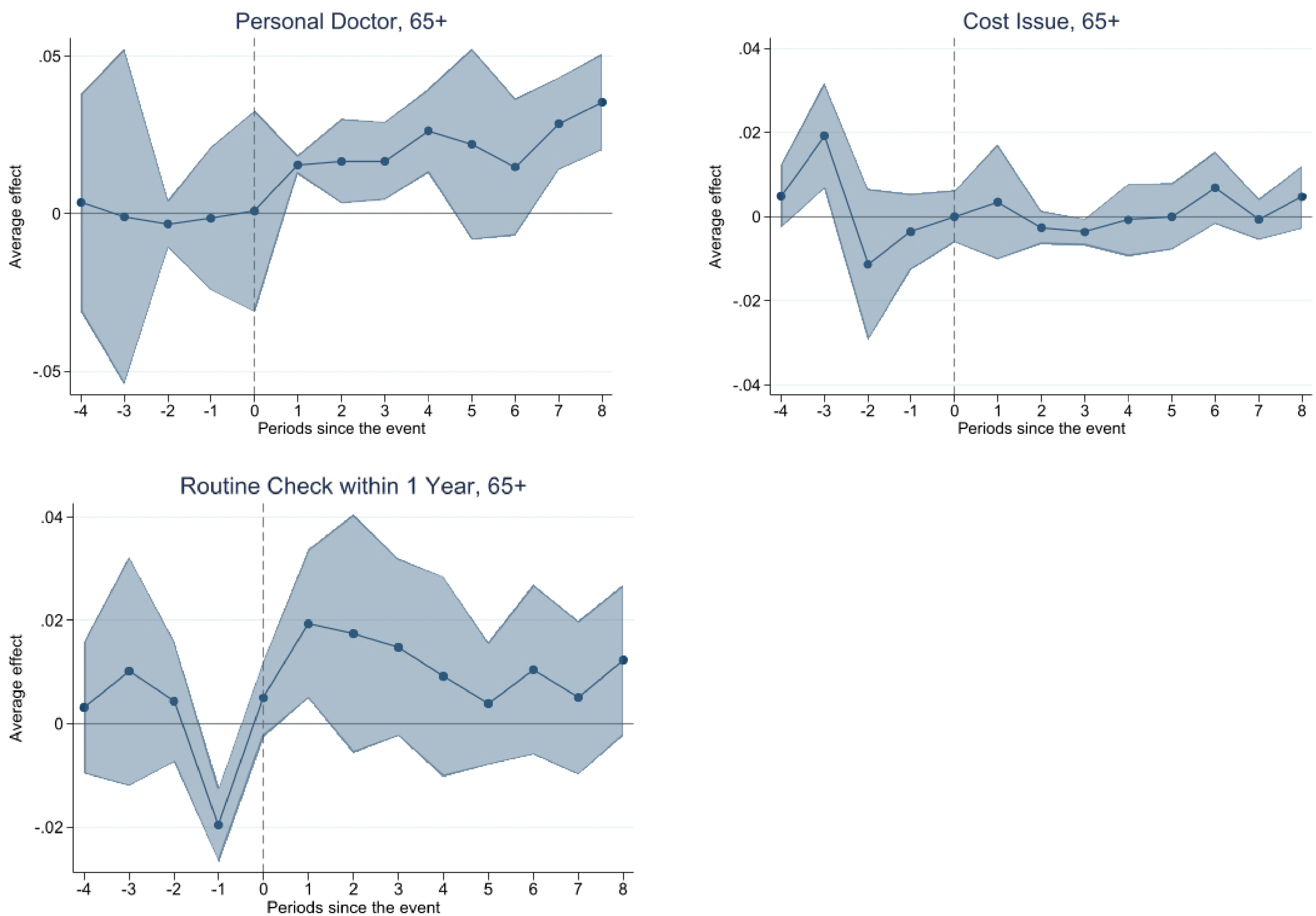


Figure 11. Measuring Effects from Respondents Not Affected by Medicaid Expansion, 2015 Cohort, Age 25–64 (*N* = 72)

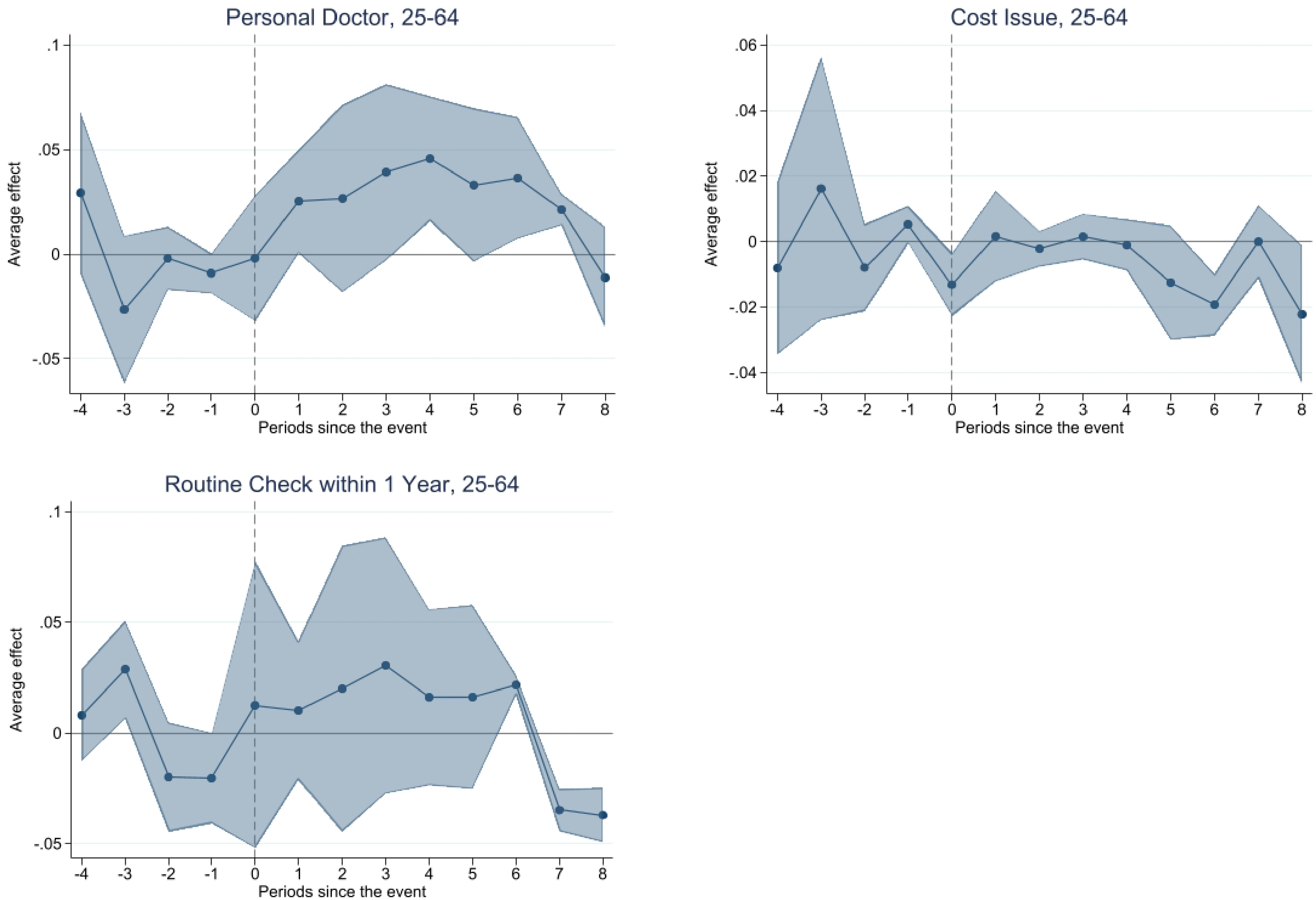


Figure 12. Use of Different Staggered Difference-in-Difference Approaches, 2015 Cohort, Age 25–64 (N = 132)

Borusyak et al. (2024)	Wooldridge (2021)

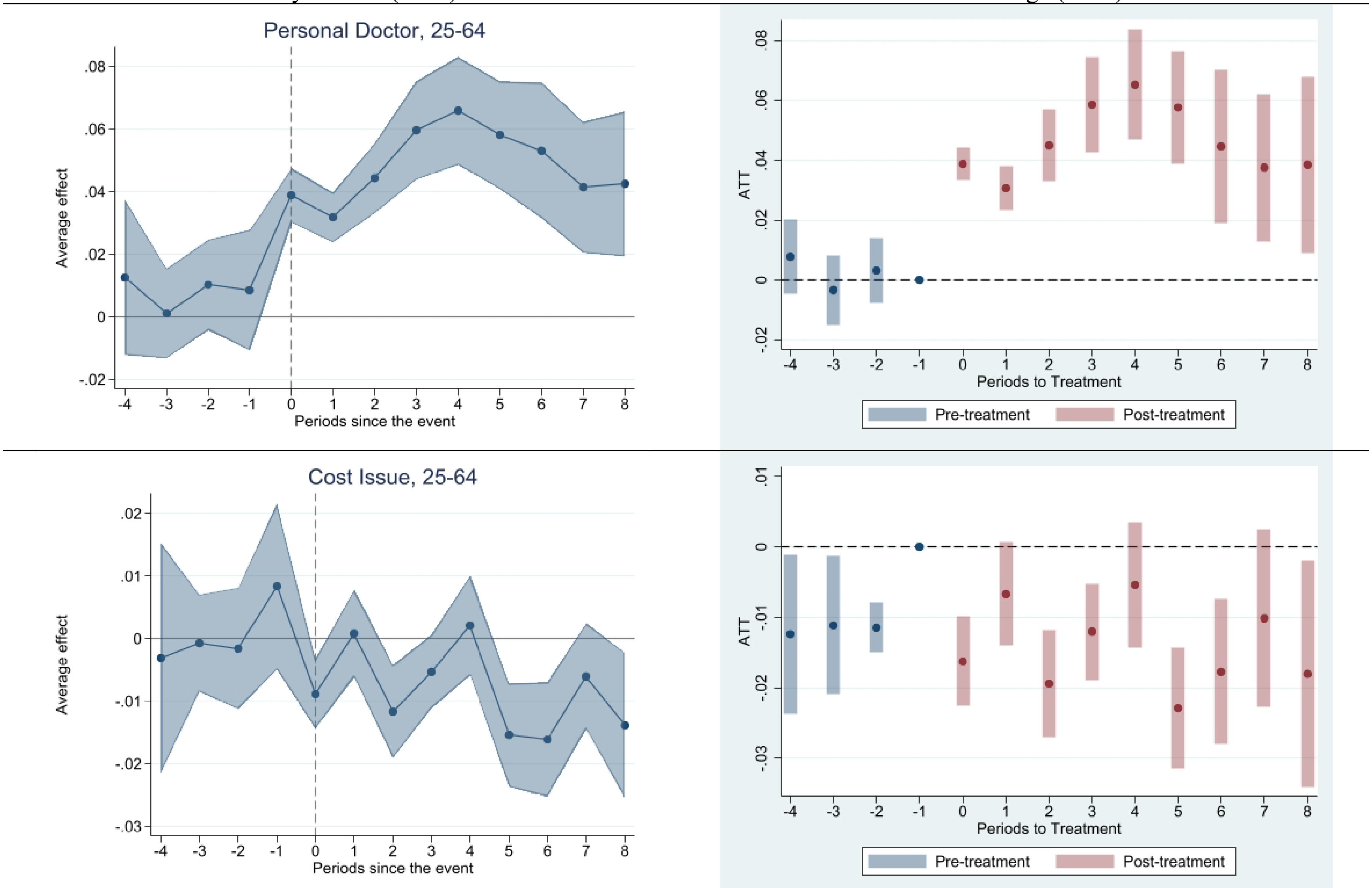
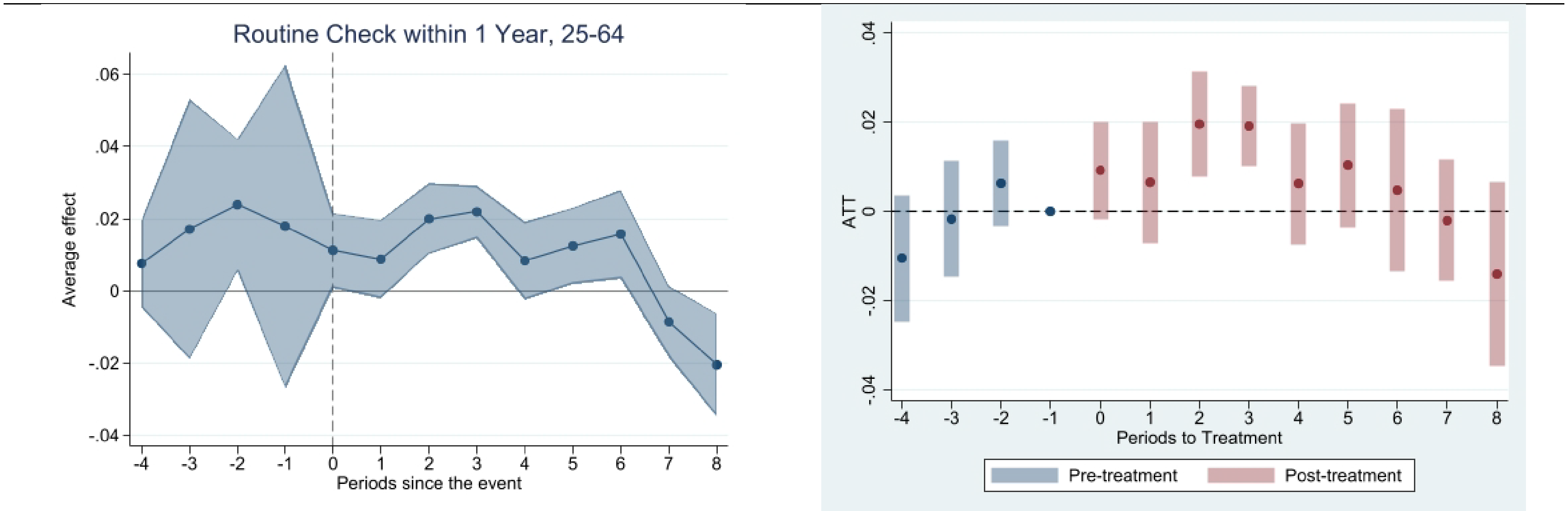


Figure 12 Continued



Appendix A. Derivations and Proofs of Equilibria and First-Order Conditions

A.1 Derivation of Equation (7)

Given the production function, Equation (3), the marginal product of out-of-state physicians is

$$\frac{\partial L}{\partial n_t} = \left(\frac{\sigma}{\sigma-1}\right)\left[(1-\lambda)n_s^{\frac{\sigma-1}{\sigma}} + \lambda T_t n_t^{\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}} (\lambda T_t)\left(\frac{\sigma-1}{\sigma}\right) n_t^{-\frac{1}{\sigma}},$$

where $\left[(1-\lambda)n_s^{\frac{\sigma-1}{\sigma}} + \lambda T_t n_t^{\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}} = L^{1/\sigma}$. Therefore,

$$\frac{\partial L}{\partial n_t} = \left(\frac{\sigma}{\sigma-1}\right) L^{1/\sigma}(\lambda T_t)\left(\frac{\sigma-1}{\sigma}\right) n_t^{-\frac{1}{\sigma}} = \lambda T_t \left(\frac{L}{n_t}\right)^{1/\sigma} > 0.$$

A.2 Derivation of Equation (8)

Given the profit maximization problem, Equation (4), the marginal revenue and marginal cost are

$$MR = PA\left(\frac{\lambda T_t}{n_t^{1/\sigma}}\right)\left[(1-\lambda)n_s^{\frac{\sigma-1}{\sigma}} + \lambda T_t n_t^{\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}},$$

$$MC = T_t w_t,$$

where $\left[(1-\lambda)n_s^{\frac{\sigma-1}{\sigma}} + \lambda T_t n_t^{\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}} = L^{1/\sigma}$. Therefore,

$$MR = PA\left(\frac{\lambda T_t}{n_t^{1/\sigma}}\right) L^{1/\sigma}.$$

At equilibrium, $MR = MC$:

$$PA(\lambda T_t)\left(\frac{L}{n_t}\right)^{\frac{1}{\sigma}} = T_t w_t.$$

Solve for P; then,

$$P^* = \frac{w_t}{A\lambda}\left(\frac{n_t}{L}\right)^{1/\sigma}.$$

A.3 Derivation of Equation (9)

Given the function of price of healthcare services, Equation (8), we can derive the derivative of the price with respect to the production of healthcare services:

$$\frac{\partial P}{\partial L} = \frac{w_t}{A\lambda} {n_t}^{1/\sigma} \left(-\frac{1}{\sigma}\right) L^{\frac{-1-\sigma}{\sigma}} = -\frac{1}{A\sigma\lambda L}\left(\frac{n_t}{L}\right)^{\frac{1}{\sigma}} < 0.$$

A.4 Derivation of Equation (10)

Equation (7) shows that the quantity of healthcare services produced increases as more out-of-state physicians are employed. On the other hand, Equation (9) shows that the price of healthcare services decreases as more healthcare services are produced. Then, the change in the price of healthcare services when more out-of-state physicians are employed can be expressed as

$$\frac{\partial P}{\partial n_t} = \frac{\partial P}{\partial L}\frac{\partial L}{\partial n_t} = \left[\lambda T_t \left(\frac{L}{n_t}\right)^{1/\sigma}\right]\left[-\frac{1}{A\sigma\lambda L}\left(\frac{n_t}{L}\right)^{1/\sigma}\right] = -\frac{T_t}{A\sigma L} < 0.$$

A.5 Derivation of Equation (11)

Equation (8) shows that the price is a function of a wage of out-of-state physicians, number of out-of-state physicians, and the labor productivity. This can be re-written by solving for w_t:

$$w_t = A\lambda P \left(\frac{L}{n_t}\right)^{1/\sigma}.$$

Given the above equation, we can calculate the change in the wage of out-of-state physicians with respect to the price of healthcare services:

$$\frac{\partial w_t}{\partial P} = A\lambda \left(\frac{L}{n_t}\right)^{1/\sigma}.$$

Equation (10) shows that the price of healthcare services decreases as more out-of-state physicians are employed by the representative producer. Therefore,

$$\frac{\partial w_t}{\partial n_t} = \frac{\partial w_t}{\partial P}\frac{\partial P}{\partial n_t} = \left[A\lambda\left(\frac{L}{n_t}\right)^{1/\sigma}\right]\left[-\frac{T_t}{A\sigma L}\right] = -\frac{\lambda T_t L^{1-\sigma}}{n_t{}^{\sigma}} < 0.$$

A.6 Proof of Inequality (12)

Equation (6) shows that the utility of a representative consumer decreases when the price of healthcare services increases. Similarly, Equation (10) shows that the price of healthcare services decreases as more out-of-state physicians are employed by the representative producer. Then, the change in the utility of a representative consumer when the representative producer employs more out-of-state physicians can be expressed as

$$\frac{\partial U_c}{\partial n_t} = \frac{\partial U_c}{\partial P}\frac{\partial P}{\partial n_t} = \frac{\partial U_c}{\partial P}\left(-\frac{T_t}{A\sigma L}\right),$$

where $\frac{\partial U_c(q)}{\partial P} < 0$ and $-\frac{T_t}{A\sigma L} < 0$. Therefore, $\frac{\partial U_c}{\partial n_t} > 0$.

A.7 Derivation and Proof of Inequality (13)

Equation (12) shows that the utility of a representative consumer increases when the number of out-of-state physicians increases. Suppose the number of out-of-state physicians before the adoption of the ULR is n_t^1 and that after the adoption is n_t^2, where $n_t^2 > n_t^1 > 0$[7]. Equation (2) shows the change in the log rate of out-of-state practices ($\Delta\log(OSP)$) that is equal to $\frac{1}{\gamma}(1-\alpha)c_{relicense}$. This can be expressed as

$$\Delta\log(OSP) = \frac{1}{\gamma}(1-\alpha)c_{relicense} = \log\left(\frac{n_t^2 - n_t^1}{n_t^1}\right) > 0,$$

[7] The employers in the states that adopted the IMLC before adopting the ULR can employ out-of-state physicians who attained their licenses from the IMLC member states. Furthermore, among the states that did not adopt any of the regulatory relaxation, there are physicians who have two or more physician licenses from multiple states.

which means $n_t^2 - n_t^1 = n_t^1 e^{\frac{1}{\gamma}(1-\alpha)c_{relicense}}$. The change in the utility of a representative consumer (i.e., consumer welfare) after adopting the ULR is

$$\Delta U = \int_{n_t^1}^{n_t^2} \frac{\partial U_c}{\partial n_t} \partial n_t = \lim_{N \to \infty} \sum_{i=1}^{N} \frac{\partial U_c}{\partial n_t} \frac{n_t^2 - n_t^1}{N} > 0.$$

The approximation of the change in consumer welfare can be expressed as

$$\Delta U_{Approximation} = \frac{\partial U_c}{\partial n_t}(n_t^2 - n_t^1) = \frac{\partial U_c}{\partial n_t}\left[n_t^1 e^{\frac{1}{\gamma}(1-\alpha)c_{relicense}}\right] > 0.$$

Appendix B. Comparison of Measures Between 2020 and 2021: Personal Doctor

	No ULR		ULR	
Year	Mean	SD	Mean	SD
2020	.802	.047	.782	.057
2021	.862	.039	.845	.043
Diff (2021-2020)	.060		.063	

Note: The above descriptive statistics show the proportion of respondents who have one or more personal doctors or healthcare providers in 2020 and 2021, separately by the ULR adoption status: the states that adopted the ULR are included in the group "ULR," and those that did not adopt the ULR are included in the group "No ULR."

Appendix C. Operationalization of Survey Questions, Behavioral Risk Factor Surveillance System (BRFSS)

Outcome Variable	Question from the Survey	Response Choices	Operationalization
Personal Doctor	[BRFSS 2018–2020] "Do you have one person you think of as your personal doctor or health care provider?" [BRFSS 2021–2023] "Do you have one person (or group of doctors) that you think of as your personal health care provider?"	1 – Yes, only one 2 – More than one 3 – No 7 – Don't know / Not sure 9 – Refused	= "Yes" if Response = {1,2} = "No" if Response = {3}
Cost Issue	[BRFSS 2018–2023] "Was there a time in the past 12 months when you needed to see a doctor but could not because you could not afford it?"	1 – Yes 2 – No 7 – Don't know / Not sure 9 – Refused	= "Yes" if Response = {1} = "No" if Response = {2}
Routine Check Within 1 Year	[BRFSS 2018–2023] "About how long has it been since you last visited a doctor for a routine checkup?"	1 – Within past year (any time < 12 months ago) 2 – Within past 2 years (1 year but < 2 years ago) 3 – Within past 5 years (2 year but < 5 years ago) 4 – 5 or more years ago 7 – Don't know / Not Sure 8 – Never 9 – Refused	=" Yes" if Response = {1} = "No" if Response = {2,3,4,8}

Note: BRFSS – Behavioral Risk Factor Surveillance System. There was a change in the wording of the survey question for "Personal Doctor" in 2021; therefore, we provide both question texts in this table.

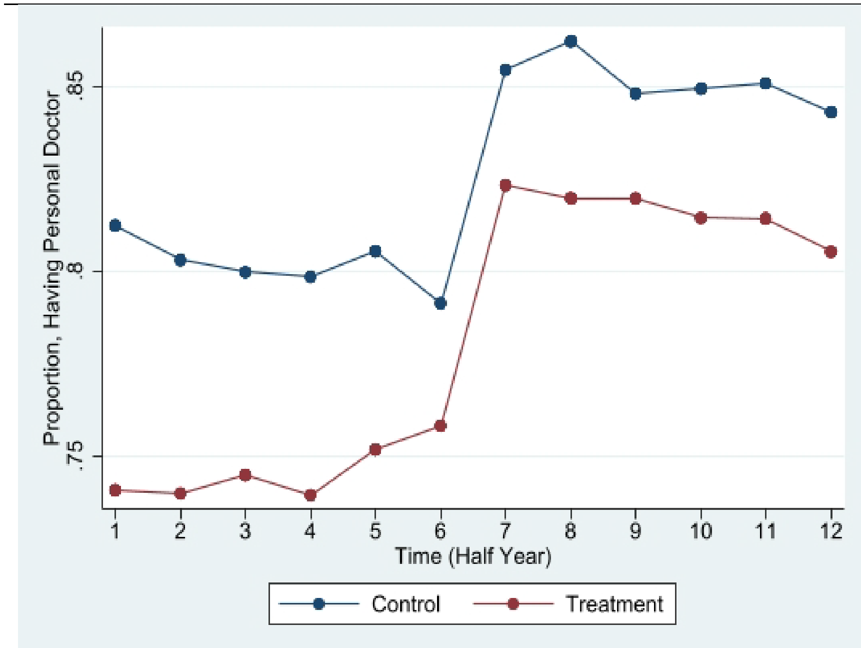
Appendix D. Operationalization of Survey Questions, IPUMS-USA and IPUMS-CPS

Outcome Variable	Description	Response Choices	Operationalization
State of Residency	[Both IPUMS-USA and IPUMS-CPS] The state in which the household was located, using the Federal Information Professing Standards (FIPS) coding scheme.	FIPS Code (e.g. 01 – Alabama, 02 – Alaska, etc.)	= FIPS Code if $1 \leq FIPS \leq 56$ where FIPS 1 = Alabama and FIPS 56 = Wyoming
Primary Place of Work	[IPUMS-USA only] The state in which the respondent's primary workplace was located. If the person worked abroad, this is also indicated.	FIPS Code (e.g. 01 – Alabama, 02 – Alaska, etc.)	= FIPS Code if $1 \leq FIPS \leq 56$ where FIPS 1 = Alabama and FIPS 56 = Wyoming

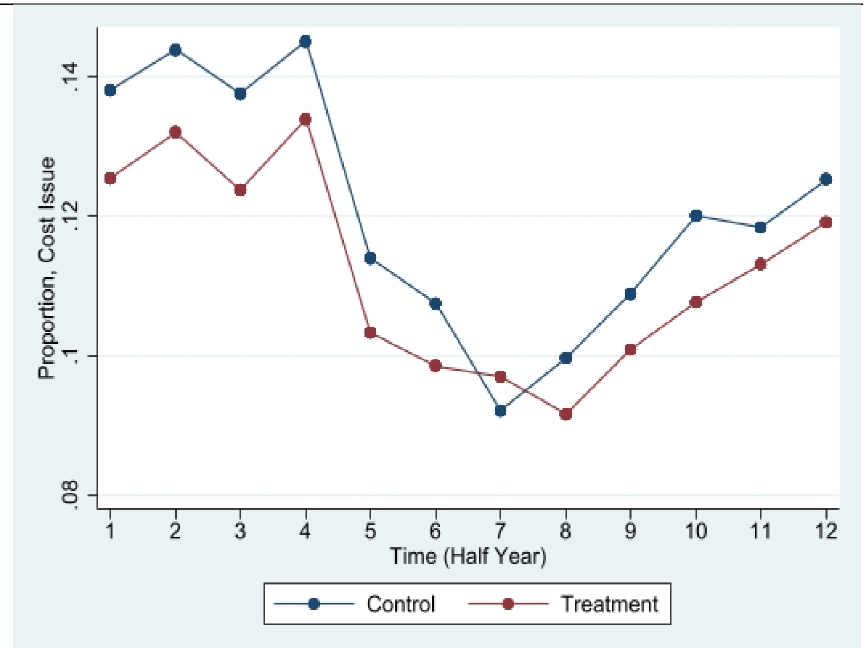
Note: IPUMS: Integrated Public Use Microdata Series; IPUMS-USA: American Community Survey integrated in IPUMS system; CPS: Current Population Survey.

Appendix E. Changes in Healthcare Utilization Measures Over Time (*N* = 132)

Having Personal Doctors or Healthcare Providers, 2018–2023

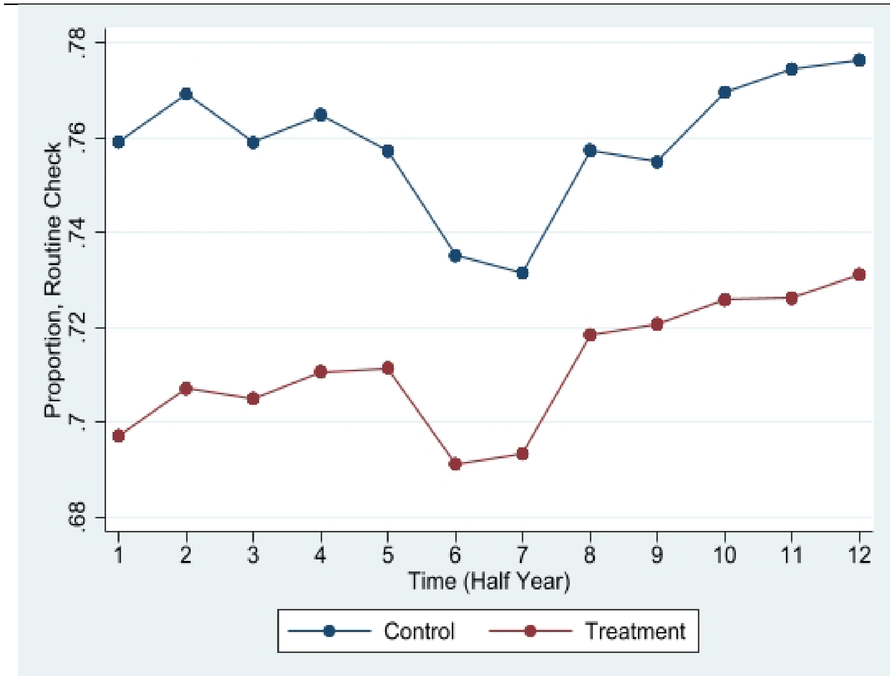


Could Not See a Doctor Because of Cost, 2018–2023



Appendix E Continued

Received Routine Health Checkups Within a Year, 2018–2023



Note: The first treatment (i.e., adopting the ULR) was in Time 3 (first half of 2019). The wording for the question "having one or more personal doctors or healthcare providers" was changed in the BRFSS 2021, which led to the increase in the proportion of respondents with personal doctors or healthcare providers across all the states in the U.S. Yet, this increase was observed at a similar rate across all states, and therefore this can be controlled by the use of time fixed effects in staggered difference-in-difference methods. For more information about the survey question and changes in the responses, check SHADAC's blog: https://www.shadac.org/news/brfss-potential-break-series-usual-source-care.

Appendix F. 150% Federal Poverty Level – Determining Respondents Not Being Affected by Medicaid Expansions

F.1 150% Federal Poverty Level, 2018–2023

Family Size	Year					
	2018	2019	2020	2021	2022	2023
1	$18,210	$18,735	$19,140	$19,320	$20,385	$21,870
2	$24,690	$25,365	$25,860	$26,130	$27,465	$29,580
3	$31,260	$32,000	$32,580	$32,940	$34,545	$37,290
4	$37,740	$38,625	$39,300	$39,750	$41,625	$45,000
5	$44,220	$45,225	$45,780	$39,750	$49,050	$52,710

Note: Family size is operationalized by adding total number of adults and total number of children in the household.

F.2 Operationalization of Respondents with the Federal Poverty Level > 150%

Because the BRFSS does not provide the continuous measures of annual household income, only categorical income measures, we identify the respondents whose household income exceeds 150% of the Federal Poverty Level (FPL) by using these categorical measures. The income levels above 150% in each year by family size are provided in Appendix A. Note that the BRFSS added three more income categories in 2021, three upper-level categories ($100,000 to $150,000, $150,000 to $200,000, and $200,000 or more).

The annual household income categories in the BRFSS 2018–2020 are (1) less than $10,000, (2) $10,000–$15,000, (3) $15,000–$20,000, (4) $20,000–$25,000 (5) $25,000–$35,000, (6) $35,000–$50,000, (7) $50,000–$75,000, and (8) $75,000 and more. The annual household income categories in the BRFSS 2021-2023 are (1) less than $10,000, (2) $10,000–$15,000, (3) $15,000–$20,000, (4) $20,000–$25,000, (5) $25,000–$35,000, (6) $35,000–$50,000, (7) $50,000–$75,000, and (8) $75,000–$100,000, (9) $100,000–$150,000, (10) $150,000–$200,000, and (11) $200,000 or more. For more information, check the BRFSS's codebook.

1. Year 2018

- Family Size = 1, 150% FPL = $18,210: if household income level > $20,000 (Category 4)
- Family Size = 2, 150% FPL = $24,690: if household income level > $25,000 (Category 5)
- Family Size = 3, 150% FPL = $31,260: if household income level > $35,000 (Category 6)
- Family Size = 4, 150% FPL = $37,740: if household income level > $50,000 (Category 7)
- Family Size = 5, 150% FPL = $44,220: if household income level > $50,000 (Category 7)

2. Year 2019

- Family Size = 1, 150% FPL = $18,735: if household income level > $20,000 (Category 4)
- Family Size = 2, 150% FPL = $25,365: if household income level > $35,000 (Category 6)
- Family Size = 3, 150% FPL = $32,000: if household income level > $35,000 (Category 6)
- Family Size = 4, 150% FPL = $38,625: if household income level > $50,000 (Category 7)
- Family Size = 5, 150% FPL = $45,225: if household income level > $50,000 (Category 7)

3. Year 2020

- Family Size = 1, 150% FPL = $19,140: if household income level > $20,000 (Category 4)
- Family Size = 2, 150% FPL = $25,860: if household income level > $35,000 (Category 6)
- Family Size = 3, 150% FPL = $32,580: if household income level > $35,000 (Category 6)
- Family Size = 4, 150% FPL = $39,300: if household income level > $50,000 (Category 7)
- Family Size = 5, 150% FPL = $45,780: if household income level > $50,000 (Category 7)

4. Year 2021

- Family Size = 1, 150% FPL = $19,320: if household income level > $20,000 (Category 4)
- Family Size = 2, 150% FPL = $26,130: if household income level > $35,000 (Category 6)
- Family Size = 3, 150% FPL = $32,940: if household income level > $35,000 (Category 6)
- Family Size = 4, 150% FPL = $39,750: if household income level > $50,000 (Category 7)

- Family Size = 5, 150% FPL = $39,750: if household income level > $50,000 (Category 7)

5. Year 2022

- Family Size = 1, 150% FPL = $20,385: if household income level > $25,000 (Category 5)

- Family Size = 2, 150% FPL = $27,465: if household income level > $35,000 (Category 6)

- Family Size = 3, 150% FPL = $34,545: if household income level > $35,000 (Category 6)

- Family Size = 4, 150% FPL = $41,625: if household income level > $50,000 (Category 7)

- Family Size = 5, 150% FPL = $49,050: if household income level > $50,000 (Category 7)

6. Year 2023

- Family Size = 1, 150% FPL = $21,870: if household income level > $25,000 (Category 5)

- Family Size = 2, 150% FPL = $29,580: if household income level > $35,000 (Category 6)

- Family Size = 3, 150% FPL = $37,290: if household income level > $50,000 (Category 7)

- Family Size = 4, 150% FPL = $45,000: if household income level > $50,000 (Category 7)

- Family Size = 5, 150% FPL = $52,710: if household income level > $75,000 (Category 8)