Assessing the impact of supply-side abortion regulations in the United States

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Abstract

Abortion rates are at historic lows in the United States while restrictive abortion policies increase contemporaneously, prompting questions about how much of the decline in abortion is attributable to decreased need versus decreased access. State-level abortion restrictions encompass a mix of "demand-side" policies that have a theoretically direct effect on women, and "supply-side" policies (often collectively referred to as targeted regulation of abortion providers (TRAP) laws), which may require providers to adhere to a state's regulatory guidelines for ambulatory surgical centers (ASCs) or secure admitting privileges at a nearby hospital. Supply side restrictions may become serious barriers to continued service provision, particularly in rural areas and locations where hospitals are unlikely to extend admitting privileges to abortion providers.

Despite the recent popularity of TRAP laws, evidence is lacking on their impact on abortion rates and related outcomes. In the **first manuscript**, I present a systematic review of literature on supply-side abortion policies and women's health outcomes. This review yielded two key findings: first, there is little rigorous quantitative evidence on this relationship, and second, certain TRAP laws – specifically admitting privilege and ASC requirements – may be associated with a decrease in abortion rates, but existing evidence does not permit consensus on the overall impact.

The paucity of evidence on TRAP laws is likely due in large part to a lack of high-quality, longitudinal data on policy shifts: while several cross-sectional data sources exist, these sources do not provide information on policy changes over time. The **second manuscript** in this thesis describes the compilation of a longitudinal database of supply-side shifts. These data feed directly

into the **third manuscript**, where I conduct a difference-in-differences analysis to assess the average causal effect of two specific TRAP laws (ASC and admitting privilege laws) on abortion rates. My findings do not suggest a meaningful effect of the enforcement of either policy on abortion rates.

The **fourth manuscript** explicitly examines the association between TRAP enforcement and provider availability. This relationship is often assumed to be strong, but given contemporary abortion trends there is likely some level of provider loss that is attributable to decreased need for abortion. I attempt to disentangle these phenomena and quantify the excess decline associated with TRAP enforcement. Using provider data from two periods (2008 to 2010 and 2011 to 2014) and the aforementioned policy data, I find that TRAP enforcement was associated with an excess clinic decline of roughly 15% as of 2014. While I could not conclude that this change was statistically different from zero, this analysis offers preliminary evidence of the average impact of TRAP enforcement on clinic and provider availability.

In sum, the collective findings presented in this work offer important new information on the effect of TRAP laws on provider availability and abortion rates at the state level, as well as the data and replication files to facilitate additional research in this area.

Abrégé

Les taux d'avortement atteignent des niveaux historiquement bas aux États-Unis alors que les politiques d'avortement restrictives augmentent simultanément, incitant des questions sur la façon dont une grande partie de la baisse de l'avortement est attribuable à une diminution par rapport à un besoin réduit par rapport à un accès réduit. Les restrictions à l'avortement au niveau de l'État englobent une combinaison de politiques «axées sur la demande» qui ont un effet théoriquement direct sur les femmes, et de la politique du « côté de l'offre » (souvent désignées collectivement sous le nom de réglementation ciblée des fournisseurs de services d'avortement des lois (TRAP)), qui peuvent exiger que les fournisseurs doivent conformer aux directives réglementaires pour les centres de chirurgie ambulatoire d'un État (ASCs) ou d'obtenir des privilèges d'admission dans un hôpital voisin. Des restrictions secondaires d'approvisionnement peuvent devenir de graves obstacles à la prestation de services continus, en particulier dans les zones rurales et les endroits où les hôpitaux ne sont pas susceptibles d'accorder des privilèges aux fournisseurs d'admission à l'avortement.

Malgré la popularité récente des lois TRAP, il manque des preuves sur leur impact sur les taux d'avortement et les résultats connexes. Dans le **premier manuscrit**, je présente une revue systématique de la littérature sur les politiques d'avortement du côté de l'offre et les résultats de santé des femmes. Cette revue a donné deux résultats clés: premièrement, il y a peu de preuves quantitatives rigoureuses sur cette relation, et deuxièmement, certaines lois TRAP - admettant spécifiquement le privilège et les exigences ASC - peuvent être associées à une diminution des taux d'avortement, mais les données existantes ne permettent pas un consensus sur l'impact global.

Le manque de preuves sur les lois TRAP est probablement dû en grande partie à un manque de haute qualité, des données longitudinales sur les changements de politique: tandis que plusieurs sources de données transversales existent, ces sources ne fournissent pas d'informations sur les changements de politique au fil du temps. Le **deuxième manuscrit** dans cette thèse décrit la compilation d'une base de données longitudinale de l'évolution de l'offre. Le flux de données est mentionné directement dans le **troisième manuscrit**, où je conduis une analyse de la différence des différences à fin d'évaluer l'effet causal moyen de deux lois TRAP spécifiques (ASC et d'admettre des lois sur les privilèges) sur les taux d'avortement. Mes conclusions ne suggèrent pas un effet significatif de l'application de l'une ou l'autre politique sur les taux d'avortement.

Le **quatrième manuscrit** examine explicitement l'association entre l'application du TRAP et la disponibilité du fournisseur. Cette relation est souvent supposée être forte, mais donné les tendances de l'avortement contemporain il y a probablement un certain niveau de perte de fournisseur qui est attribuable à une diminution de besoin pour l'avortement. J'essaie de démêler ces phénomènes et de quantifier la baisse excessive associée à l'application de la TRAP. L'utilisation des données du fournisseur de deux périodes (2008 à 2011 et 2011 à 2014) et les données politiques mentionnées ci-dessus, je trouve que l'application TRAP a été associée à une baisse excessive de la clinique d'environ 15% à partir de 2014. Bien que je ne puisse pas conclure que ce changement était statistiquement différent de zéro, cette analyse offre une preuve préliminaire de l'impact moyen de l'application de la loi TRAP sur la disponibilité des cliniques et des fournisseurs.

En résumé, les conclusions collectives présentées dans ce travail offrent des informations importantes sur l'effet des lois TRAP sur la disponibilité des fournisseurs et des taux d'avortement au niveau de l'Etat, ainsi que les données et les fichiers de réplication pour faciliter la recherche supplémentaire dans ce domaine.

List of abbreviations

US	United States
TRAP	Targeted regulation of abortion providers
D & E	Dilation and evacuation
SEP	Socioeconomic position
LARC	Long-acting reversible contraception
LMP	Last menstrual period
ASC	Ambulatory surgical center
DD	Difference-in-differences
OLS	Ordinary least squares
CI	Confidence interval
HB2	House Bill 2
GEE	Generalized estimating equations

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Contribution of authors

The individual manuscripts that constitute this thesis are listed below. The data used in the analyses come either from publicly-available sources (outlined in greater detail in manuscripts 3 and 4) or from my own policy data collection process (summarized in manuscript 2). I developed the research questions and study design for all of these papers with the support of my supervisor, Dr. Sam Harper. I was solely responsible for merging the data, completing the analyses, and generating the draft versions of the manuscripts.

Dr. Harper provided indispensable guidance from the protocol development stage onward. In particular, he helped me refine my research questions and build suitable analysis plans for manuscripts 3 and 4. He also encouraged the development of manuscript 2, which describes the policy data collection process. Dr. Harper reviewed all of the manuscripts in detail and provided valuable feedback.

My committee members (Dr. Erin Strumpf and Dr. Rachel Jones) also provided technical and substantive support. Dr. Strumpf (McGill University) reviewed and commented on manuscript 3 in full, and she offered methodological guidance for manuscripts 3 and 4. Dr. Jones (Guttmacher Institute) supported this project with valuable content-area knowledge that ultimately led to the redesign of the analysis presented in manuscript 4. She offered insightful comments on the initial research protocol, and she also provided key guidance on various aspects of manuscripts 3 and 4.

Manuscript 1: **Austin N**, Harper S. Assessing the impact of TRAP laws on abortion and women's health in the USA: a systematic review. BMJ Sex Reprod Health. 2018 Apr 1;44(2):128-34.

Manuscript 2: **Austin N**, Harper S. "If you build it…": Constructing a longitudinal database of supply-side shifts in abortion policy. Currently being prepared for submission to *Health Affairs*.

Manuscript 3: **Austin N**, Harper S. Quantifying the impact of TRAP laws on US abortion rates: A multi-state assessment. Currently being prepared for submission to the *American Journal of Public Health*.

Manuscript 4: **Austin N**, Harper S. Is TRAP enforcement associated with an excess change in abortion providers? Currently being prepared for submission to *Perspectives on Sexual and Reproductive Health*.

Statement of originality

I attest that the work presented herein is my own, and represents an original and timely contribution to the area of reproductive health policy evaluation. My supervisor and committee members provided indispensable guidance throughout the research process, but the overarching research questions and analyses reflected in this series of manuscripts are of my own design, and were motivated by important gaps in existing research on the health impact of TRAP laws.

In addition to generating new policy data to facilitate future analyses (manuscript 2), this work enhances the existing scholarship on TRAP laws in two important ways. First, there was a lack of consensus on whether these laws impact abortion rates. I elucidated this knowledge gap in manuscript 1, and aimed to address it in manuscript 3. Second, the extent to which these policies impact provider availability - above and beyond expected changes in provider availability linked to decreased need for abortion - was previously unknown. I explicitly address this research question in manuscript 4.

1. Introduction

Abortion rates in the United States are at historic lows (1), but there is little consensus on why this decline has occurred. While it is likely that women no longer need as many abortions due to improved access to contraception, another possibility is that women can no longer access abortion services; this could reflect changes in clinic availability and other potential barriers. As these two drivers may have very different health and social repercussions, the question of access has emerged as a central theme in contemporary abortion debates.

The US reproductive health policy climate varies substantially from state to state, and many states have enacted and/or enforced policies[1] that complicate or restrict access to information and services. Abortion restrictions are not new: states began to enact these laws following the seminal Supreme Court decisions in Roe v. Wade (2), which marked the federal legalization of abortion, and Planned Parenthood v. Casey (3), which effectively gave states the freedom to restrict abortion as long as the restrictions did not constitute an undue burden to abortion-seeking women. However, the recent increase in state-level abortion restrictions is unprecedented (4, 5), and many of the restrictions enacted recently impose burdensome requirements on clinics and providers (5).

These supply-side policies (often collectively referred to as targeted regulation of abortion providers (TRAP) laws) do not apply to abortion-seeking women, but to abortion providers and

[1] I use the terms "law" and "policy" interchangeably throughout this thesis, but I acknowledge that there is a formal distinction between the two: while laws formally encode rules that serve to regulate the actions of people/institutions (and often involve penalties for noncompliance), policies can exist independently or as a consequence of law(s). To be clear, the focus of this work is on laws (proposed and passed by state legislators), and any policies that exist as a direct consequence of these laws.

facilities. Common TRAP laws require clinics to be located within a specified radius of a hospital, require clinics to convert to, and function as, ambulatory surgical centers (ASCs), and require providers to secure admitting privileges at a nearby hospital. These regulations may become major barriers in rural areas and locations where hospitals are unlikely to extend admitting privileges to abortion providers. Striking evidence from Texas (6) following the enactment and partial enforcement of a particularly severe set of TRAP laws in 2013 suggested that these laws may have an impact on abortion rates and a drastic effect on provider availability. However, despite the recent popularity of TRAP laws, little is known about their impact in other states (or their average impact over time).

A key barrier to a clearer understanding of the impact of TRAP laws is a lack of data on policy shifts. Consequently, most existing work evaluates policy exposure in a single state and/or over a short period of time, and much of this work is descriptive (6, 7). Without detailed state-level information on the enforcement of new laws, it is not possible to quantify the causal effects of exposure: we can estimate the association between TRAP laws and related outcomes, but we cannot determine the extent to which these laws directly influence the outcomes. Furthermore, while literature reviews exist on common demand-side policies (8-10), the available evidence on TRAP laws had not previously been synthesized. The research presented in this thesis aims to address the data limitations and resulting knowledge gaps in the existing scholarship on TRAP laws.

1.1. Research objectives

My overarching goal was to produce current, relevant evidence on the impact of TRAP laws on health and service availability. My specific research objectives were to:

1. Systematically review and summarize the current evidence on TRAP laws and women's health;
2. Compile a rich, longitudinal data set on state-level policy shifts;
3. Assess the average causal effect of TRAP laws on abortion rates (beyond a single-state or pre/post analysis); and
4. Assess whether the enforcement of TRAP laws contributed to an excess decline in abortion clinics and providers from 2011-2014.

1.2 Structure

This thesis contains 8 chapters. In chapter 1, I introduce the overarching rationale for this work and present my research objectives. In chapter 2, I present contextual information on abortion policy and abortion trends in the United States. In chapter 3, I provide a brief overview of the data and analytical methods I use to address each of my research questions. In chapter 4, I present a recently published systematic review on TRAP laws and women's health outcomes. In chapter 5, I describe my TRAP policy data collection process and the resulting policy database. In chapter 6, I use these data to analyze the impact of TRAP laws on abortion rates from 1991 to 2014. In chapter 7, I analyze the association between TRAP laws and excess changes in clinic/provider availability over two periods. In chapter 8, I summarize my results and offer suggestions for future research based on my collective findings.

2. Literature review

This chapter provides contextual information on recent trends in abortion rates, abortion policies, and barriers to research in order to conceptually frame the subsequent research objectives. One component of this thesis (manuscript 1) is a systematic review of quantitative literature on the impact of TRAP laws on women's health outcomes. I touch briefly on that literature here, but focus on the broader body of literature on abortion and restrictive policymaking in the US.

2.1 Abortion in the United States

Induced abortion (hereafter "abortion") is a medical procedure performed with the intention of ending an ongoing pregnancy. The procedure may be surgical – typically via aspiration or dilation and evacuation (D&E) – or medical, through a combination of mifepristone and misoprostol. Surgical and medical abortions are efficacious and exceedingly safe, carrying lower risks of mortality and morbidity than childbirth and many outpatient procedures, although the risk of complications increases slightly with gestational age (11-13). The majority of all US abortions occur within the first trimester of pregnancy (≤12 weeks gestation), most often in abortion clinics (1).[2]

[2] Other types of abortion providers include nonspecialized clinics, private physicians' officer, and hospitals (1); I use the terms "clinics" and "providers" interchangeably throughout this review and the first three manuscripts, but I differentiate between them in manuscript 4.

Recent estimates indicate that nearly a quarter of all US women are expected to obtain an abortion in their childbearing years (14), which is perhaps unsurprising as approximately half of all pregnancies in the US are unintended (15). However, these estimates are not consistent across all sociodemographic groups: for example, young women and women of low socioeconomic position (SEP) have a much higher likelihood of both unintended pregnancy and abortion (15, 16). As of 2014, abortion rates were highest among women aged 20 to 24 (28/1,000 women), followed by women aged 25 to 29 (22.8 /1,000 women) (14). Abortion rates also vary considerably by race and marital status: the rate among black women in 2014 (27.1/1,000 women) was higher than women of other races, and rates were higher among unmarried/cohabitating women (31/1,000 women) than among married women or unmarried women living alone (5.5/1,000 and 16.9/1,000, respectively) (14).

Although abortion remains quite common in the US, abortion rates have been steadily declining over time. The US Centers for Disease Control (CDC) estimates that the national abortion rate peaked in the early 1980s at 29.3 abortions per 1,000 women aged 15-44 (16). As of 2014, however, the Guttmacher Institute (a research organization that monitors reproductive health policy and associated trends in the US) reported that this rate reached an all-time low of 14.6/1,000 women (1). From 2008 to 2014 alone, the national abortion rate fell by 25% and rates fell across every subgroup of women defined by the researchers (though the magnitude of change was heterogeneous by group) (14). **Figure 2.1** illustrates abortion trends from 1991 to 2014, grouping states into their respective Census divisions, and **Figure 2.2** illustrates the boundaries of the Census divisions. With few exceptions (for example, Delaware in the South Atlantic region), state

and regional abortion rates have been declining monotonically for many years, driving a striking national trend.

Figure 2.1: Abortion trends by state/Census division

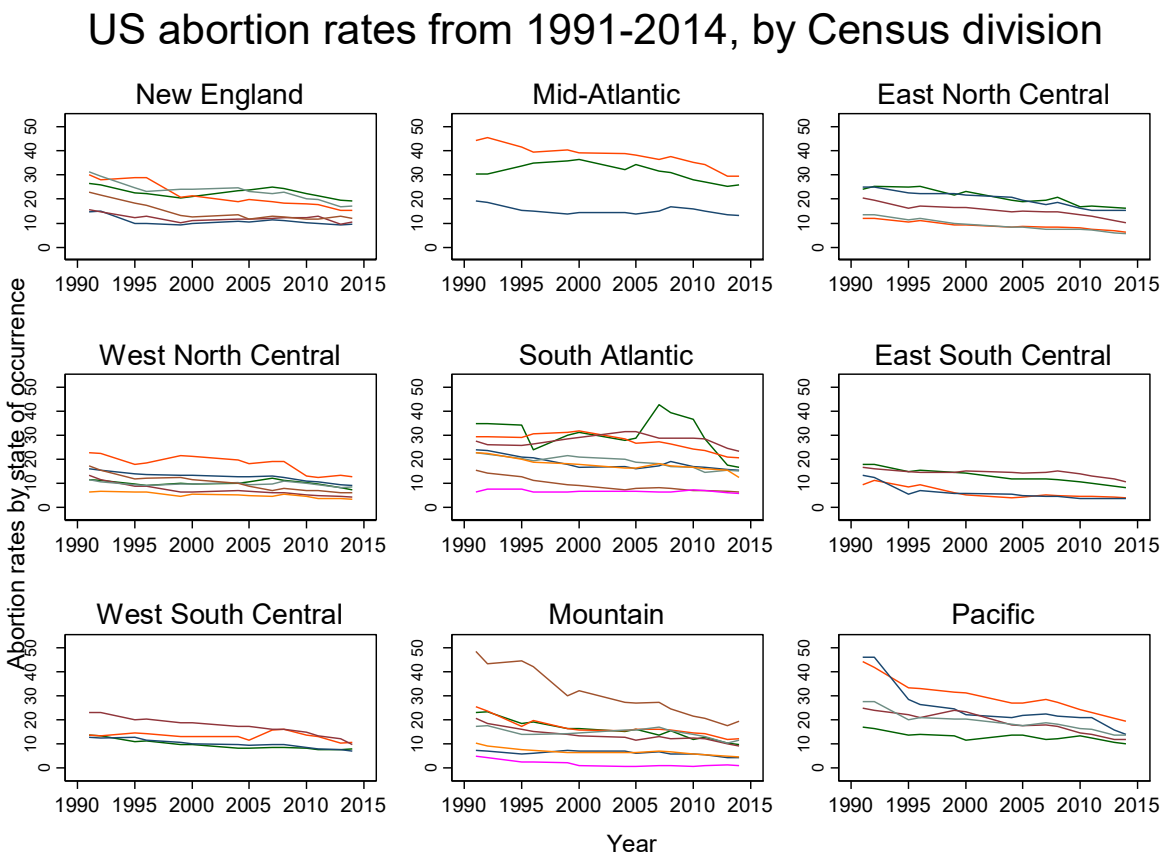
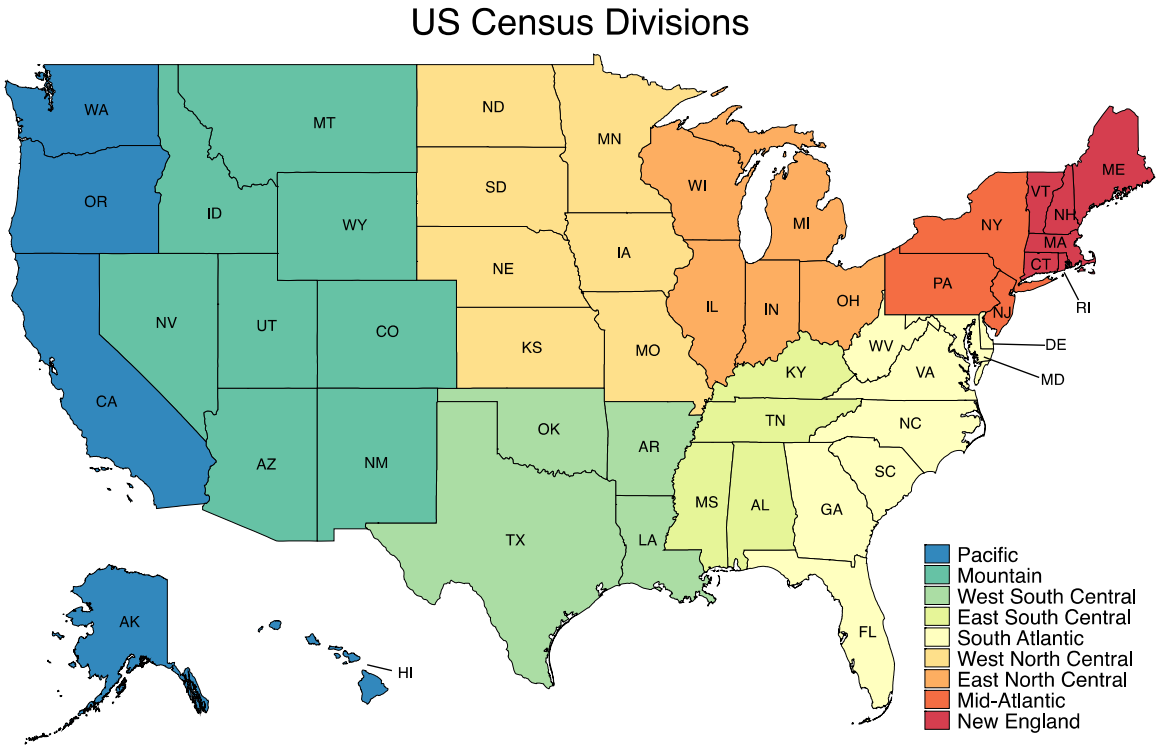


Figure 2.2: Map of US Census divisions



The precise cause of the decline in abortion remains unknown, but several factors likely contribute jointly to these trends, including temporal shifts in family size preferences and economic conditions (17). A key potential contributor, in light of the high unintended pregnancy rate in the US, is contraception. Forms of long-acting reversible contraception (LARC) became more accessible for many women in recent years (17-19), and uptake followed accordingly: estimates indicate that rates of LARC use increased from 8.5% in 2009 to 11.6% in 2012 (20). LARC methods may have a notable effect on reducing the number of unintended pregnancies (and consequently, abortions) in the US. A study from Iowa, which expanded access to LARC in the early 2000s, reported that the odds of abortion decreased as LARC use increased (OR=.96; 95%

CI: .94-.97), even in light of a simultaneous increase in access to abortion (17). These findings suggest that changes in abortion over the observation period may have been largely attributable to contraception.

A related contemporaneous shift that likely has an impact on abortion trends is the remarkable decline in adolescent and teen pregnancy in the US (21, 22). LARC use is less common among teens than adult women, but evidence suggests that the improved use of other forms of contraception – particularly barrier and hormonal methods – drove the majority of the decline in teen pregnancy from 1995 to 2002 (23). Because the vast majority of teen pregnancies are unintended (15), declines in teen pregnancy have a notable effect on the overall distribution of women obtaining abortions: for example, in 2008, 18% of all abortions were performed on teens and adolescents, but this figure decreased to 12% as of 2014 (14).

Finally, changes in access to abortion are also a suspected driver of declining abortion rates. While differential rates of decline in abortion across sociodemographic groups may be associated with differences in contraception access, they may also be attributable to the presence of state-level abortion restrictions, which are often easier to overcome for women of higher SEP (14). In the sections that follow, I describe the different types of abortion policies in the US, and the ways in which these policies may impact access to care.

2.2 Abortion legality and policy trends

Abortion was legalized at the federal level in the US in 1973. However, states have considerable control over the extent to which women can easily access services, in large part because federal

funds cannot be used to pay for abortion. States' legislative power over abortion service accessibility is theoretically bounded by the "undue burden" standard (3), which allows states to impose restrictions on abortion as long as these restrictions do not place an undue burden on women, effectively opening the door to various types of state-level restrictive policies. As a result, the reproductive health policy climate varies substantially from state to state. Whereas some states prioritize preventive initiatives like widespread contraception access and publicly funded family planning services, many others opt to restrict access to information and services, despite consistent evidence that preventive initiatives have a positive impact on women's health and socioeconomic outcomes (24-26).

Just as the decline in abortion is unprecedented, so too is the recent rise in state-level abortion restrictions. The number of restrictive policies enacted from 2011 to 2014 surpassed the number enacted in the preceding decade (27), and nearly a third of all the restrictive policies enacted since abortion was first federally legalized in 1973 were enacted between 2010 and 2016 (5). As of 2014, over half of all states had four or more restrictions in place simultaneously (compared to 13 states in 2000), leading the Guttmacher Institute to classify these 27 states as "hostile" toward abortion (27).

There are several types of abortion restrictions, and some are more onerous than others. Given the scope of these policies, it is useful and substantively important to distinguish between restrictions targeting supply and demand, respectively (28). Policies geared toward reducing abortion demand have a theoretically direct effect on women and include, but are not limited to, mandatory pre-abortion ultrasound, parental notification/consent requirements, waiting periods, and pre-abortion

counselling. States also vary widely in their gestational limits for abortion, with many states prohibiting abortion after 20 weeks post-fertilization (or 22 weeks after a woman's last menstrual period (LMP)) due to scientifically unsupported arguments surrounding fetal pain (29). Demand-side policies are often implemented in order to ensure "informed consent" prior to abortion; however, none of these policies are medically necessary, some compromise physicians' autonomy in providing optimal care to their patients, and many introduce financial and time-related barriers to women seeking care (30, 31).

Supply-side policies, in contrast, apply directly to abortion providers and facilities. Key supply-side policies are often collectively referred to as targeted regulation of abortion providers (TRAP) laws, and consist of facility and physician/staff requirements unique to abortion providers. In addition to imposing often superfluous regulations on factors such as waiting room temperature and groundskeeping standards (32), many common TRAP laws require clinics to be located within a specified radius of a hospital and/or adhere to the state's regulations for ambulatory surgical centers (ASCs), which often entails costly renovations and equipment purchases. These laws may also require providers to secure admitting privileges at a nearby hospital. As such, TRAP laws may become major barriers in rural areas and locations where hospitals are unlikely to extend admitting privileges to abortion providers.

Despite the documented safety of abortion, abortion provision and abortion facilities in the US are regulated to a far greater extent than other office-based interventions (33). It is therefore unsurprising that many of the recently enacted abortion restrictions in the US are TRAP laws specifically designed to hinder the capacity of abortion clinics (5). TRAP laws are therefore

interesting for several reasons: first, they are a relatively recent policy trend, unlike some of the more common demand-side laws (like parental involvement policies (34)) that have been widespread for many years. Second, TRAP laws gained popularity very quickly among states seeking to regulate access to abortion, leading to a spike in policy enactment and enforcement in the late 2000s. Third, TRAP laws appear – at least in some situations (6) – to have the capacity to close providers, which may subsequently alter women's experiences obtaining abortion (7), or their ability to obtain an abortion at all.

2.3 Existing evidence of policy impact

The decline in US abortion rates predates the majority of state-level abortion restrictions, so policy factors are not the sole driver of changes in abortion. However, certain policies may contribute to an excess shift in abortion rates and provider availability above and beyond what we would expect to see based on temporal trends in factors common across states. While demand-side abortion restrictions are generally thought to have a weak or null effect on abortion rates (19, 28), it is possible that some policies – specifically those involving logistical challenges like multiple clinic visits (time costs) or reduced availability of state funding for abortion (direct/financial costs) – may have a meaningful impact on women's ability to obtain an abortion (19, 35-37). For example, one study (35) assessed the short-term impact of the sudden withdrawal of public funding for abortion in North Carolina, and found that a larger number of pregnancies were carried to term as a result of the funding shift. The available evidence on Medicaid restrictions (a joint federal/state program for low SEP residents through which certain states subsidize abortion), mandatory counselling laws, and parental involvement laws (respectively) is synthesized in three literature reviews (8-10). These reviews concluded that, while the impact of parental involvement laws was

unclear due to inconsistent study quality, Medicaid restrictions may result in an increase in unplanned pregnancies to low-SEP women that are carried to term, and waiting periods likely reduce in-state abortion rates by pushing women out of state for procedures. More recent evidence, however, suggests that waiting periods and mandatory counselling requirements (in-person or otherwise) do not have an impact on abortion rates, but they do appear to increase the time it takes to obtain an abortion (38). A notable restriction of the three aforementioned reviews is that very few of the selected papers contain any data post-2000, which marks the beginning of a significant upsurge in restrictive policy enactment.

There is considerably less evidence on TRAP laws and abortion rates. While the available research suggests that these policies may be more effective than demand-side policies in reducing in-state abortions (19, 28), this is largely based on the assumption that TRAP laws lead to meaningful changes in provider availability. Recent evidence from Texas suggests this may be the case, at least for certain types of TRAP laws (6). Increased distance to abortion providers, which generally occurs when the sole provider in a region (rather than one of several available providers in an urban center) closes their doors, is associated with a decrease in abortion rates (6, 39). Descriptive evidence suggests that TRAP laws may also be associated with an increase in self-induced abortion (40) and an increase in second-trimester abortions (6), which may reflect the additional time it takes women to obtain abortions given newly-enforced structural barriers. Delaying abortion is an adverse event in and of itself: later abortion is associated with higher costs, fewer available providers (many only perform abortions until a certain gestational point), and a slightly higher risk of complications (41).

If TRAP laws close clinics, long-standing spatial inequalities in access to abortion (42) may be exacerbated. Access to care is already unevenly distributed: although women and clinics tend to be clustered in urban areas, approximately 20% of all US women would need to travel over 40 miles to obtain an abortion (42); an earlier survey of women who actually obtained abortions found that 20% of women travelled over 50 miles (43). As most abortion-seeking women are low-income, and approximately half pay for their abortion procedure out-of-pocket (42, 44), the addition of travel or childcare costs associated with an increase in the distance to the nearest provider may prompt women to delay or even forego (in extreme circumstances) their procedure. Interestingly, while the median distance to the nearest provider remained relatively stable in most states from 2011 to 2014, 3 of the 4 states that experienced the largest increases in median distance (30+ miles) also enforced new abortion restrictions over the same period (42).

One of the most convincing (and frequently cited) demonstrations of the potential impact of TRAP laws comes from Texas, which enacted and partially enforced a package of TRAP laws in 2013 under what is known as House Bill 2, or HB2. HB2 contained ASC and admitting privilege requirements, among other (non-TRAP) components. The ASC regulations never went into effect, but Texas lost approximately half of its abortion providers following enactment of the admitting privilege provision, and, there was a 13% decrease in the abortion rate and a slight increase in second-trimester abortions in the year following enforcement (6). The impact of the Texas law was significant enough to prompt a Supreme Court decision declaring HB2 unconstitutional (45). Although HB2 was initially enacted under the pretense of protecting women's health and safety, the Supreme Court's decision was motivated by the fact the requirements had no demonstrable impact on these outcomes (46). Texas, however, was one of many states that passed TRAP laws

in recent years, and there is currently little understanding of the average (and/or long-term) impact of these laws. In the following section, I describe the major barriers to, and considerations for, quantifying the causal impact of these policies beyond a single-state context.

2.4 Quantifying the impact of TRAP laws: barriers and considerations

Given the impracticality of randomizing states to TRAP exposure, a major challenge is identifying an appropriate comparison group for states with TRAP laws. A standard approach might simply compare states that enacted TRAP laws to states that did not, controlling for observed confounders. However, this approach fails to account for important and potentially unobserved time-fixed differences between states, as states that enact TRAP laws may differ systematically from states that do not with respect to state-level abortion attitudes and many other factors. Another approach is to compare pre-TRAP and post-TRAP outcomes in states that enacted these laws, essentially treating states as their own controls. However, this fails to account for important secular trends (common to all states) over the observation period, since other factors that are associated with abortion rates could be different during the pre-intervention period. These two sources of bias could lead us to erroneously attribute shifts in abortion rates to the presence of TRAP laws instead of underlying state characteristics and/or secular trends.

Another key barrier to research on TRAP policies is a lack of longitudinal data on policy enactment and enforcement. Several cross-sectional data sources exist (47, 48), but the lack of information on state-level policy timing (and important nuances across policies) prohibits a multi-state analysis of the impact of TRAP laws on health outcomes and service availability. As such, much of the available information on the impact of TRAP laws comes from a single-state setting. While we

have a working understanding of the short-term impact of policy shifts in certain states, we do not have a sense of the average causal effect of these policies on outcomes such as abortion rates and provider availability.

Finally, much of the existing work on TRAP laws and abortion rates is descriptive and/or cross-sectional, which does not provide an estimate of the causal impact of these policies. Again, states that pass TRAP laws likely differ in many ways from states that do not: it is easy enough to control for many of these factors (for example, certain sociodemographic attributes), but other state characteristics (for example, longstanding attitudes toward abortion or state-level uptake of highly-effective forms of contraception) are more difficult to measure and could bias measures of association if they also impact abortion rates. Assessments of policy endogeneity are also important to ensure states are not enacting new laws in response to abortion trends (49). Given these concerns, estimating the health impacts of TRAP laws requires careful modelling.

2.5 Conclusion

In light of the current political context in the US, it is important to generate high-quality quantitative evidence on the effects of reproductive health policies in order to protect against policy decisions that compromise public health goals. Evidence on TRAP laws – which have become a very common state-level approach to regulating abortion – is lacking, due in large part to an absence of longitudinal data on policy shifts. The collective findings from my research can help inform future policy decisions by focusing specifically on the estimation of causal effects, drawing information from nearly all US states instead of relying on single-state analyses, and identifying which supply-side policies, if any, have a particularly strong impact on abortion rates. In short, the

work presented herein contributes a considerable amount of relevant information to an otherwise sparse research area. Given our genuine uncertainty about the average impact of TRAP laws on abortion rates and provider availability, this work is both novel and urgent.

3. Overview of data and methods

All analyses in this dissertation were conducted using Stata 14 (StataCorp. 2015. *Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP.). Data and analytical code will be made publicly available following publication in the interest of reproducibility. Manuscript-specific data sources and analytical strategies are summarized in detail below.

3.1 Manuscript 1

Manuscript 1 is a systematic review of literature on the association between TRAP laws and health outcomes. Search engines included PubMed, MEDLINE, EconLit. Search strings were intentionally broad as supply-side laws are often assessed in conjunction with other laws. The screening process consisted of four stages (title, abstract, full text, and abstraction); each phase was completed by two independent reviewers and discordance was assessed at the end of each stage. In total, only six articles met our inclusion criteria.

We had some *a priori* expectation of heterogeneity between retrieved publications due to differences in exposure categorization, outcomes of interest, level of geography, and study timeframe. As such, we elected to conduct a narrative synthesis in lieu of a meta-analysis, as any attempt to collapse the observed effect estimates into a single parameter would have been misleading and inaccurate. We used two forms of quality assessment in the screening process: the Newcastle Ottawa Scale (NOS) (50), and the subjective evaluations of our coders.

3.2 Manuscript 2

Manuscript 2 describes the policy data collection process. The goal of this undertaking was to compile a record of state-level TRAP activity over time, as no such data were previously available. Documenting the timing of policy shifts was an essential first step in quantifying the causal effects of these policies. I focused my efforts on three prominent types of TRAP law: ASC requirements, admitting privilege requirements, and transfer agreements.

A key priority in compiling these data was distinguishing between the enactment of a law and its subsequent enforcement. Determining a law's year of enactment (or when it is formally approved by a state's legislature) is generally straightforward, but establishing when the law was formally enforced (or when it began to actively apply to a state's residents) is more challenging, particularly as many TRAP laws are challenged upon enactment and do not go immediately into effect. This may be further complicated by state-level differences in how new laws are rolled out, or the extent to which non-compliance is actually monitored and/or penalized. For the purposes of these data, I defined enforcement as the point at which a TRAP law actually began to apply to a state's clinics and providers (along with any associated penalties for non-compliance).

I used an iterative but systematic process to compile these data. In short, two coders (myself and a research assistant) began with a recent cross-sectional data source (47) of state-level TRAP policies and essentially worked backwards to document years of enactment/enforcement, policy nuances, and qualitative information on each state's particular policy context. Coders used a wide range of sources to retrieve these data: our primary sources were state government websites, but the quality and specificity of policy documentation varied extensively by state. We consequently

supplemented our data with a diverse array of media accounts, as abortion policy tends to be of high public interest and policy shifts are well documented. The media data were instrumental in allowing us to differentiate between enactment and enforcement years. Coders met frequently to discuss individual cases and compare data sources until concordance was reached. Additional cross-referencing was performed toward the end of the data collection process, following the availability of a new (and highly-detailed) cross-sectional source on state-level TRAP laws (48). While this source did not report the years the policies took effect, it did provide valuable information on policy presence and contents. My data were largely concordant with this source; instances of discordance were reviewed in detail and possible reasons were documented.

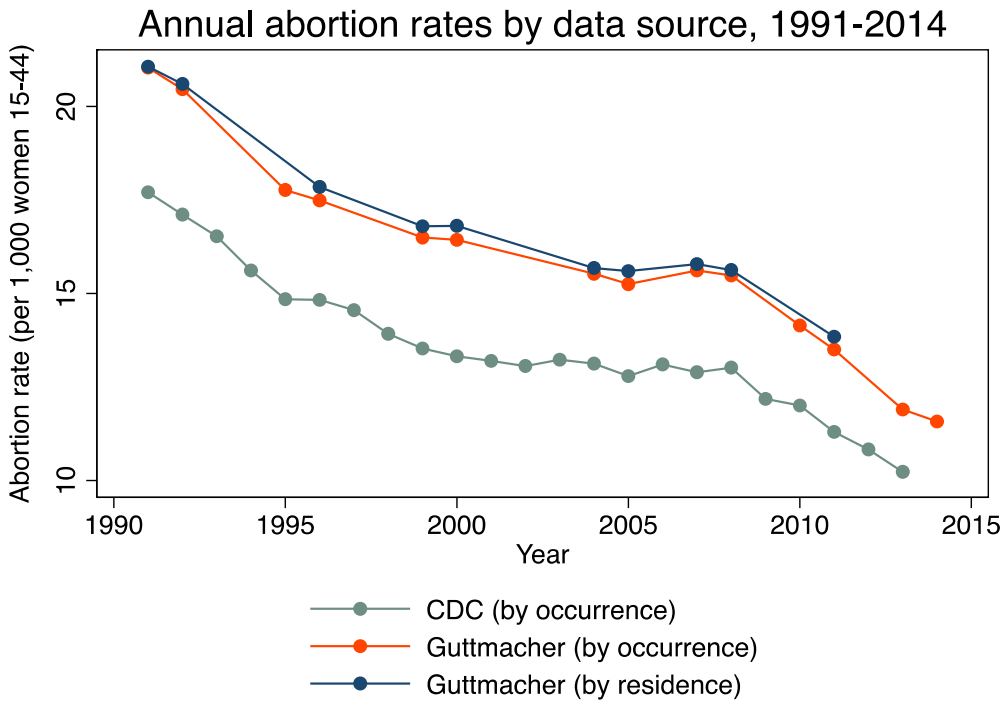
The resulting dataset captures information on policy presence (and associated administrative codes), as well as years of enactment, enforcement, and (if applicable) legal challenge. Coders also captured information on any associated proximity requirements, and whether a law pertained to all abortions or later abortions only. Finally, given the complexity of these data and the data collection process, I included an indicator of our coders' uncertainty to facilitate sensitivity analyses.

3.3 Manuscript 3

In manuscript 3, I merged the aforementioned policy data with several sources of publicly available information to create a state-level database spanning 24 years (1991-2014). The exposure of interest for this analysis was TRAP enforcement: I focused on two specific TRAP laws (ASC regulations and admitting privilege requirements) in light of evidence that these laws may have a particularly pronounced effect on abortion rates through their impact on service availability (6).

The outcome for this analysis was the state-level abortion rate. Data on abortion in the US are available through two sources: the Centers for Disease Control (CDC) (by state of occurrence) and the Guttmacher Institute (by state of occurrence and the woman's state of residence). The two agencies employ different data collection strategies: the CDC relies on voluntary annual reporting (and certain states have historically opted out of this entirely), while the Guttmacher Institute periodically surveys all known abortion providers in the US, employing a fairly intensive follow-up process to capture as much data as possible (1). Due to these differences, the Guttmacher Institute has substantially better coverage of abortion providers (32, 51) and is generally regarded as a more accurate data source, but the CDC has a more complete time series (there are gaps in Guttmacher data years). I collected data from both sources for comparison purposes. Although Guttmacher and CDC rates by state of occurrence were highly correlated ($r > 0.75$), CDC rates are consistently lower than Guttmacher rates (**Figure 3.1**), and sometimes lack information from clinics and individual providers; this is problematic as specialty providers are the primary providers of abortion in the US (1). For this reason, I used Guttmacher data by state of occurrence from 1991 to 2014 (the most recent year for which data were available) for this analysis. All rates reflect the annual number of abortions per 1,000 women aged 15-44 (the denominator is based on US Census estimates).

Figure 3.1: Annual abortion rates by data source, 1991-2014



As states enforced TRAP laws at different times over the observation period, I used a generalized difference-in-differences (DD) design to estimate the average causal impact of TRAP enforcement on abortion rates. A key advantage of this approach is that it offers control for state-level characteristics that are stable over time, control for any factors common to all states that may also affect temporal trends in the outcome, and control for (measured) time-varying state-level covariates. The fully-adjusted DD estimates were obtained via generalized linear models with state and year fixed effects, a time-varying policy term reflecting the presence/absence of a policy in a given state/year (this was the coefficient of interest), and statistical control for governor's political party, the percentage of state residents living below the poverty line, the presence of demand-side abortion policies, and state-level availability of public funds for abortion. All models were

estimated with cluster-robust standard errors (52), clustered at the state level, and an offset term (the natural log of the population of women in their childbearing years).

The use of a DD approach in this context implies the assumption that the timing of policy shifts is essentially random, conditional on state/year fixed effects and model covariates. I conducted several exploratory/descriptive analyses and sensitivity analyses to assess if these assumptions were reasonable and to demonstrate the robustness of my results. I also experimented with modifications to the control group in the interest of enhancing exchangeability. The variables used in this analysis (and their respective sources) are listed in the appendix of **chapter 6**. Not all of these elements played a role in the models; many were used to compare sociodemographic characteristics across states/groups.

3.4 Manuscript 4

The fourth and final manuscript aims to determine if a recent shift in abortion provider availability is attributable to a recent influx of TRAP legislation. To answer this question, I retained much of the data from manuscript 3 and merged it with state-level information on clinic and provider availability in 2008, 2011, 2014. Data on clinics and providers came from the Guttmacher Institute's data center (53), and the two papers from which these data were derived (1, 19).

Because I had three data years of clinic and provider availability, I divided the observation period into two parts: period 1 (2008-2010) and period 2 (2011-2014). For the purposes of this analysis, I used a simple binary exposure definition: states were considered "enforcers" if they enforced an ASC law, an admitting privilege law, or both, between 2011 to 2014 (no states in my data enforced

these laws from 2008-2010). I then assessed whether the change in clinic and provider counts in period 2 was greater than expected among TRAP enforcers, given trends in both groups in period 1 and the trend among unexposed states in period 2 (the null hypothesis was that trends in exposed and unexposed states would remain parallel over both periods). This is a more traditional version of the difference-in-differences design introduced in manuscript 3, but the models differed considerably between these two analyses.

To estimate the impact of TRAP exposure on clinic and provider availability, I fit a series of Poisson models with state and year fixed effects to control for time-fixed differences between states and temporal trends in clinic and provider availability common to all states, and an offset term (the natural log of state population). Standard errors were clustered at the state level. I checked for overdispersion to ensure that the relevant distributional assumptions were met. These models provided estimates of the incidence rate ratio (IRR), comparing rates of clinic/provider loss between groups and periods. In the interest of expressing effects on the absolute scale, I used these models to generate marginal estimates of the difference in clinic and provider counts and rates (defined here as clinics per 1 million population), by exposure category. I also ran several sensitivity analyses to assess the robustness of my findings.

The variables used in this analysis (and their respective sources) are listed in Table 3.1.

Table 3.1: Variables by source

Variable	Description	Values	Source(s)
fips	Federal Information Processing Standards (state-level identifiers to facilitate linkage)	Integer	http://www.columbia.edu/~sue/state-fips.html
state	State	Integer	n/a
year	Year	Integer	n/a
totalpop	Total population by state (based on Census (in available years) or inter-censal population estimates)	Integer	US Census – intercensal estimates
governor	Party affiliation of governor (at midpoint of year - 1 July); even-numbered years 1991-2002 taken directly from source, odd-numbered are based on "date of first service"	String	Council of State Governments, The Book of the States (various years) Table 2.1/4.1 (for all states except DC)
enforcer	State enforced an ASC law, admitting law, or both from 2011-2014	Binary (1=y, 0=n)	Policy data file (manual compilation)
asc_enforced	Year of ASC enforcement	Integer	Policy data file (manual compilation)
admit_enforced	Year of admit. law enforcement	Integer	Policy data file (manual compilation)
transfer_enforced	Year of transfer enforcement	Integer	Policy data file (manual compilation)
num_clin	Number of clinics in a state/year	Integer	Guttmacher Data Center & Jones 2014/2017
num_prov	Number of providers in a state/year	Integer	Guttmacher Data Center & Jones 2014/2017
post	Data year=2014	Binary (1=y, 0=n)	n/a

4. Assessing the impact of TRAP laws on abortion and women's health in the United States: a systematic review

4.1 Preface: Manuscript 1

Literature reviews exist on various demand-side policies, but no such synthesis is available for TRAP laws. The manuscript presented in this section fills this gap and summarizes the existing quantitative evidence on supply-side policies and women's health outcomes.

The outcome of interest in this review – women's health outcomes – was admittedly vague. This was intentional: I had some *a priori* knowledge that quantitative literature on the impact of TRAP laws would be relatively sparse, and (as such) I elected to "cast a wide net" for the purposes of review. Given the paucity of literature in this area and important inconsistencies between studies with respect to study design, exposure definition, and outcomes of interest, I produced a narrative synthesis of the collective evidence.

The following manuscript is entitled "**Assessing the impact of TRAP laws on abortion and women's health in the United States: a systematic review."** This work was peer-reviewed and subsequently published in *BMJ Sexual and Reproductive Health*.

4.2 Manuscript 1

Assessing the impact of TRAP laws on abortion and women's health in the United States: a systematic review

Abstract

Introduction: Targeted regulation of abortion providers (TRAP) laws impose extensive and sometimes costly requirements on abortion providers and facilities, potentially leading to barriers to care. Understanding the impact of these laws is important given their prevalence in the United States, but no review to date has summarized the available evidence. We conducted a systematic review of literature on TRAP laws and their impact on abortion trends and women's health.

Methods: We searched MEDLINE, PubMed, and EconLit for original, quantitative studies where the exposure was at least one TRAP policy and the outcome was abortion and/or any women's physical or mental health outcome.

Results: Six articles met our inclusion criteria. The most common outcome was population-level abortion trends; studies also assessed the effect of TRAP laws on gestational age at presentation and measures of self-perceived burden. While certain TRAP laws (e.g., admitting privilege requirements) appeared to have an effect on abortion outcomes, the impact of other laws - or combinations of laws - was unclear, due in part to heterogeneity between studies with respect to study design, geography, and exposure definition.

Conclusions: TRAP laws may have an impact on the experience of obtaining an abortion in the USA. However, our review revealed a paucity of empirical research on their population and individual-level impact, as well as some disagreement about the effect of different TRAP laws on subsequent abortion outcomes. Future research should prioritize the specific TRAP laws that may have a uniquely strong effect on state-level abortion rates and other outcomes.

***

Introduction

Abortion access in the United States is driven in large part by state-level regulations, yielding considerable regional variation in access to care. States rely on a range of different strategies to regulate abortion access: some policies, like mandatory ultrasound requirements and pre-abortion waiting periods, aim to regulate the individual-level demand for abortion (these are often referred to as "demand-side" policies). There are also "supply-side" policies, which instead regulate providers and the general provision of abortion by instituting facility/licensing requirements and gestational age limits on abortion (28). Both types of restrictions are exceedingly common in the US: over half of all states had four or more restrictions in place as of 2016 (54), yielding potentially important state-level differences in access to abortion.

Targeted regulation of abortion providers (TRAP) laws are a key type of supply-side policy and a relatively recent legislative phenomenon (55). The individual laws beneath the "TRAP" umbrella are diverse, with regulations ranging from minor to potentially insurmountable. Common TRAP laws require abortion clinics to be located within a specified radius of a hospital, require clinics to convert to, and function as, ambulatory surgical centres (ASCs), and require providers to secure admitting privileges at a nearby hospital. Advocates of these laws argue that they play an important

role in protecting women's health, but it is widely accepted that regulated abortion procedures are already exceedingly safe (56). Existing evidence suggests that certain TRAP laws pose important challenges to abortion providers and facilities (6), which is unsurprising since many laws involve costly and/or logistically challenging modifications to facilities and staff. In particular, laws requiring clinics to convert their facilities to ASCs and requiring providers to hold admitting privileges at nearby hospitals appear to decrease provider availability (55). Evidence of the impact of TRAP laws on clinic or service availability, coupled with the lack of medical necessity for these laws, prompted the American College of Obstetricians and Gynecologists in 2014 to call for an end to these policies (57).

If TRAP laws reduce provider availability or close clinics, they may also be associated with a change in US abortion rates, which have been steadily declining over the past two decades (1). Although TRAP laws probably do not explain the entire decline in abortion, the loss of even a single provider may have a profound effect on local service availability (1, 28), and increased distance to abortion providers is associated with a decrease in abortion rates (6, 39). However, TRAP laws may not need to close clinics to have an impact on health and other outcomes: some laws may instead increase service costs or decrease availability of appointment slots, both of which could increase the time it takes for a woman to obtain an abortion. An increase in gestational age at presentation may limit the number of providers willing to perform an abortion (particularly if the pregnancy has entered the second trimester) and increase out-of-pocket costs to patients (58). While women with adequate resources are generally able to obtain an abortion with minimal difficulty, regardless of local policies, access-oriented barriers to abortion may introduce special

challenges to low-income, young, and/or rural women, as these women may be less able to manage increases in cost and distance (42).

Empirical evidence on the impact of TRAP laws on abortion trends and other health outcomes has not yet been summarized in a systematic way. Literature reviews exist on demand-side policies such as parental notification laws and mandatory waiting periods (8-10), but no review to date has assessed the totality of existing literature on supply-side/TRAP laws. Given the ubiquity of TRAP laws, as well as the recent legislation against them (45), it is important to understand their impact. We therefore sought to bridge this gap and summarize what is currently known about the impact of TRAP laws on abortion rates and women's health outcomes.

Methods

We registered this review in Prospero (ID# CRD42016039553), an international database of systematic reviews in the health and social sciences. The review consisted of four phases: title screening, abstract screening, full-text screening, and data abstraction (stage-specific inclusion/exclusion criteria are described in **Appendix Figure A1)**. Each phase was completed independently by two reviewers (NA/JM or NA/FU); disagreements were resolved by a third party (SH). We conducted a systematic search for literature on TRAP/supply-side policies and health outcomes using three electronic databases (MEDLINE, PubMed, and EconLit), searching material published from the date of each database's inception to January 2017. We also scanned the reference lists of relevant articles for additional publications. In the interest of capturing as much pertinent literature as possible, particularly since TRAP laws are sometimes assessed in

conjunction with other abortion policies, we allowed our search strings to be fairly broad; our PubMed string (for example) included the following MeSH terms and keywords:

(Abortion, Induced OR Abortion, Legal/legislation & jurisprudence OR Abortion, Induced/statistics & numerical data OR Abortion, Induced/trends)

AND

(("abortion rate" OR "abortion rates")

OR

(health OR disease OR morbidity OR mental health OR depression)) (AND United States))*

We retained quantitative research articles focused on the US where the exposure of interest was at least one TRAP policy, and the outcome was population and/or individual-level (women's) health outcomes. We did not impose any language restrictions on our search. For the purposes of our review, specific TRAP policies included: ambulatory surgical centre (ASC) conversion requirements, other facility requirements (i.e., room/corridor size specification), distance to hospital, transfer agreements, and admitting privileges at a nearby hospital (or comparable agreement), in accordance with the classification scheme currently employed by the Guttmacher Institute (https://www.guttmacher.org/state-policy/explore/targeted-regulation-abortion-providers). When papers discussed several policies, we focused on specific TRAP policies and their impact on relevant outcomes. We excluded (at the full text phase) papers discussing changes in provider availability without a formal discussion of the TRAP policies that may have led to these changes.

At the data extraction stage, reviewers used piloted data collection forms to capture the primary policy (or policies) of interest and primary outcome measure(s), in addition to supplementary information on study design, sampling/data sources, analytical methods, effect estimates, and a subjective assessment of study quality (including reviewers' specific concerns about opportunities for bias). We used the Newcastle-Ottawa scale (NOS) as a secondary assessment of study quality (50). The NOS score ranges from 0 to 9, and most work to-date considers a score of 7 or greater as evidence of "high-quality" (59). While this scale offers a basic sense of study quality, we relied primarily on reviewers' specific concerns to gauge opportunities for bias, as we found this to be a more comprehensive review strategy. We adhered to the PRISMA guidelines (http://www.prisma-statement.org/) for reporting purposes. This search began in June 2016; findings are current as of January 2017.

Results

Our search returned 2563 unique articles, of which 329 were screened at the abstract stage and 69 were included in a full-text review. Just six articles met our inclusion criteria (flow diagram, **Figure 4.1**); these articles are summarized in **Table 4.1**. The mean NOS score was 7.7 (with individual scores ranging from 6 to 9), which is generally indicative of moderate to good overall quality. There was considerable heterogeneity across studies, particularly with respect to exposure and outcome definition; this was anticipated given the variety of individual TRAP laws and the wide range of possible health outcomes. Because of these differences, reported findings were not amenable to pooling; any attempt to quantitatively combine these studies would produce vague and potentially misleading effect estimates. We therefore present a narrative synthesis as this is a

more appropriate, and we would argue more useful, approach to summarizing a relatively diverse collection of literature.

Half of the retained publications featured national-level analyses, and the other half focused specifically on Texas, which was unsurprising given the state's recent and highly-publicized legislative activity. Two of the Texas-based studies (6, 7) assessed the impact of House Bill 2 (HB2), a group of abortion restrictions enacted in Texas in 2013. HB2's enforced provisions included an admitting privilege requirement, a ban on abortions after 20 weeks' gestation, and restrictions on medication abortion. The third Texas-based analysis (60) examined the effects of an earlier law – the Women's Right to Know Act (WRTK) – which stipulated that all abortions at or after 16 weeks gestation must be performed in an ASC. Studies at the national level assessed a comparatively wider range of regulations: one (32) used data from NARAL (a reproductive rights advocacy group) to group state-level TRAP laws into two categories (licensing fees, plant/personnel laws), and another (49) used the same source but grouped TRAP laws according to a six-category classification scheme. The remaining study (61) assessed the impact of supply-side regulations indirectly by simulating the effect of TRAP-driven provider closures on the national scale.

Figure 4.1: Flow diagram

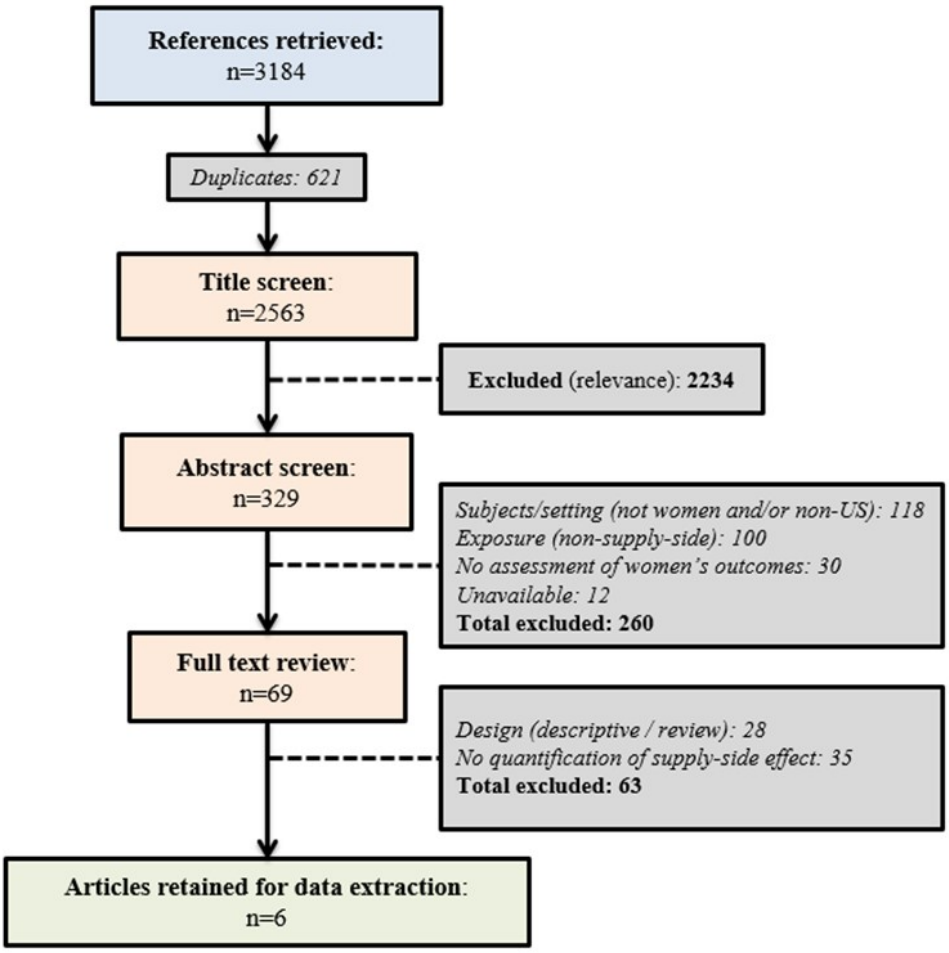


Table 4.1: Summary of search results

Author	Year	Setting	Study period	Relationship of interest	TRAP law(s) assessed	Outcome(s)	Findings
Amador (61)	2015	US	1997-2011	Impact of reproductive policy on choice patterns in young women (18-30)	Simulated TRAP law(s) (inspired by Texas's HB2) resulting in county-level provider closures	Abortion rate/ratio, contraception choices	Simulated closure of county-level provider was associated with a 6.8% decrease in the probability of obtaining an abortion and a 5.5% decrease in abortion ratio (#abortions/#pregnancies). Authors reported substantial substitution between contraception and abortion.
Beauchamp (49)	2015	US	1991-2005 (simulations)	Impact of TRAP laws on abortion market and abortion rates	Licensing, physician law, second trimester hospital requirements, proximity to hospital, transfer agreement, physical/admin. requirements	Abortion rate, provider entry/market patterns	Physical/administrative requirements decreased market entry rates for clinics (-.37; SE: .22). Applying Utah's restrictive provider regulatory scheme to the full country (via simulation) resulted in a 0.77% change in the number of abortions over the observation period (no SE reported).
Colman (60)	2011	Texas	2001-2006	Impact of WRTK Act on late-term abortion rates	ASC requirement for abortion at 16+ weeks' gestation (also waiting/counselling components)	Abortion rate, cost, timing	WRTK Act was associated with a decrease of .57 late-term abortions per 1,000 women (SE=.10), a 72% decline compared to the pre-policy average. Cost of abortions at 20 weeks' gestation increased by 37%. The authors found no effect of WRTK on abortions prior to 16 weeks' gestation.
Gerdts (7)	2016	Texas	2014 (May-Aug)	Impact of HB2 on women who obtained an abortion	Admitting privilege requirements (also medical abortion restrictions, 20 week ban)	Burden (distance, cost, delay, preferred procedures) & hardship (self-reported composite/summary variable)	HB2 was associated with 19% increase in difficulty accessing abortion, a 32.6% increase in women travelling over 50 miles, a 10.3% increase in women spending over $100, a 14.3% increase in "frustrated demand" for medical abortion, and an increase in mean hardship score (.72, no SE reported).
Grossman (6)	2014	Texas	2012-2014	Impact of HB2 on abortion provision	Admitting privilege requirements (also medical abortion restrictions, 20 week ban)	Abortion rate, clinic availability	HB2 was associated with a 13% decrease in the Texas abortion rate over the observation period. The number of abortion facilities declined by 46%.
Medoff (32)	2010	US	1982–2005	Impact of TRAP licensing fees or plant/personnel laws on abortion demand	Licensing fees, plant/personnel laws	Abortion ratio (abortions per 1,000 pregnancies, women 15–44)	The effect of licencing fees on abortion demand (#abortions/#pregnancies) was 1.33 and the effect of facility requirements on abortion demand was -6.29 (no SEs reported for either estimate), based on the model with time effects; the author reported that neither association was statistically significant.

The most common health outcome was population-level abortion trends (abortion rates/ratios), but there was disagreement among the studies in our sample with respect to the effect of TRAP laws on these outcomes. Three of the five articles that assessed abortion outcomes reported an inverse association between certain TRAP laws and abortion rates, with exposure linked to a decrease in abortion (6, 60, 61). Depending on the analysis, the magnitude of this effect ranged from a 6.8% decline in the abortion rate among women aged 18-30 (61), to a 13% decline in the abortion rate among all women of childbearing age (15-44) (6), to a 72% decrease in the abortion rate among women presenting at or after 16 weeks' gestation (60). In contrast, one study in this subgroup found no effect of TRAP laws on abortion demand (32), and one reported a potential increase in abortions following TRAP legislation (49). Both of these studies concluded that demand-side policies (particularly parental consent laws) play a more significant role than supply-side policies in explaining the contemporary decline in abortion rates (32, 49).

Several studies assessed other relevant outcomes, including gestational age at presentation, out-of-state travel for services, and the cost of, and challenges associated with, obtaining an abortion. Collective findings suggest that, aside from any impact TRAP laws may have on abortion rates, these policies may have a meaningful impact on the experience of obtaining an abortion. One study reported a 300% increase in the number of women travelling out of Texas to obtain abortions at or beyond 16 weeks' gestation in the year following the WRTK Act (60). Other publications in our review did not offer a comparable estimate of out-of-state abortion, but one noted that this phenomenon may become increasingly rare among Texas residents given recently-enacted TRAP polices in neighbouring states (6). The clinic closures triggered by HB2 increased within-state travel burdens (6, 7), with one study reporting an average four-fold increase in the distance to the

closest provider (7). HB2 was also linked to increased costs (6, 7) and an increase in women's self-reported hardship in obtaining abortions (7). However, while one analysis (7) found no association between HB2 and gestational age at presentation, the other analysis of the same policy (6) reported a slight increase in second trimester abortion.

Although it was not one of our outcomes of interest, most of the articles in this review assessed the impact of TRAP laws on provider availability, which is likely an important mediator in any relationship between TRAP laws and subsequent health outcomes. Studies in our review tended to agree that TRAP laws were associated with a decrease in provider availability, with one reporting a loss of 46% of all Texas providers in the year following HB2 enforcement (6). The relationship between policies and providers was particularly central to one analysis (49) that was principally concerned with the behaviour of the abortion market in response to regulations. This study reported that TRAP laws decreased market entry rates for clinics and increased the cost of procedures by approximately 10%. The collective findings suggested that a key impact of TRAP laws was not only to close clinics, but also to raise costs for abortion-seeking women because of those closures (7, 60, 61).

Discussion

TRAP laws are widespread in the US, but quantitative evidence on their effects on women's health remains fairly sparse. The relationship between TRAP laws and abortion outcomes emerged as a central theme in this review: certain TRAP laws – specifically admitting privilege and ambulatory surgical centre (ASC) requirements – were associated with a decrease in abortion rates. However, articles assessing other types (or combinations) of TRAP legislation produced contrary findings.

This discordance was probably driven by differences in exposure definition, which suggests that how TRAP exposure is framed has important implications for subsequent conclusions about the laws' effects on abortion outcomes: composite exposure definitions could compromise the ability to quantify the impact of especially deleterious TRAP laws. Given the results of our review, we argue that admitting privilege laws and ASC regulations merit additional research, particularly beyond Texas, as these laws have been enforced in many other states.

We found relatively little evidence on the impact of TRAP laws on other health outcomes. While supporters of these laws argue that extensive regulatory efforts are important in protecting women's health, we did not find any evidence of this impact; however, given the noted safety of abortion in the absence of these policies (56), it would be difficult to detect a protective effect if one existed. We did, however, find some limited evidence on the adverse effects of certain laws, many of which are likely to be linked to TRAP-associated increases in the average distance to providers. Our review suggested that certain TRAP laws may be associated with an increase in gestational age at presentation, self-reported hardship, and costs incurred in obtaining abortion (6, 7), although additional evidence is required to better understand these effects. As abortion becomes more restricted and costly after the first trimester, a substantial increase in gestational age at presentation would be especially troubling. We acknowledge that cost is not a direct health outcome, but it is almost certainly a key factor on any pathway between policy exposure and abortion or health outcomes. If TRAP laws increase out-of-pocket costs to women, as our collective findings suggest, women of lower socioeconomic position may face greater challenges in obtaining abortions.

We did not identify serious quality concerns over the course of our review, but we did document a number of potential sources of bias and practical issues. Although all of the articles in our review were published in 2010 or later, half (32, 49, 60) assessed policy effects from 2006 or earlier, possibly pre-dating the more recent surge in TRAP enactment. This is likely to be due in large part to delays in abortion data availability and a lack of high-quality longitudinal evidence on state-level TRAP enforcement. Nevertheless, given modern trends in TRAP enforcement and currently available abortion data, it will be useful to re-evaluate existing estimates in the light of contemporary policy shifts. Furthermore, standard errors and confidence intervals were rarely reported, which complicates the comparison of estimates across studies. There was some disagreement between studies with respect to policy timing (32, 49), which may be due to differences in policy categorization. It is important to note that narrowing the exposure definition to a single policy or subset of policies may still present challenges, since specific TRAP laws (for example, ASC requirements) vary considerably from state to state (60). This complicates interstate analyses or comparisons and suggests that the findings from the two studies in our review that focused on the admitting privilege requirement of HB2 in Texas may be internally valid, but not generalizable to other states.

Study designs and target populations also varied, which is an important consideration when interpreting policy effects. For example, findings from the survey-based study of women who successfully obtained abortions (7) are unlikely to apply to the general population of abortion-seeking women, as women who were unable to obtain abortions were not represented. Likewise, evidence on supply-side policies regulating abortion in the second and third trimester (60) is probably not generalizable to the broader population, as the majority of US abortions are in the

first trimester (1). Simulation-based approaches were used in two of the studies in our sample (49, 61). Although simulation is certainly a valuable tool, given recent policy trends there is an argument for prioritizing analyses of observed data. It is also important to note that the effects of TRAP laws may be time-dependent: the extent to which these laws impact abortion rates and other outcomes may depend on the speed (and success) of providers' response to new regulations (60). Analyses conducted shortly after a policy shift (6, 7) may overestimate the long-term impact of a policy. Finally, TRAP enactment may be precipitated by a shift in public opinion on abortion or a shift in abortion trends; this is an important and generally overlooked potential source of bias (49), and should be formally considered in future analyses.

Our review has some limitations. Our search strategy may not have captured all relevant literature on TRAP laws and health; we attempted to mitigate this risk by using multiple search engines and manually searching the reference lists of relevant articles. Our search could have been strengthened by including grey literature: we prioritized quantitative findings published in peer-reviewed literature, but it is possible that additional quantitative parameters of the association between TRAP laws and health outcomes are available through less formal channels. Our inclusion criteria were also fairly stringent at the full-text stage: there is a broader body of literature on the effects of provider availability on women's outcomes, but these papers generally fell outside our inclusion criteria as clinic closures were not associated with TRAP enactment/enforcement. We also excluded a paper on the hypothetical impact of an admitting privilege law in Louisiana (62), as the law had not yet taken effect. These exclusions may have omitted relevant information from our narrative synthesis, and they clearly contributed to the low number of articles retained for data extraction, but we believe they were essential in maintaining the integrity of our review. In

focusing specifically on TRAP laws, we excluded other supply-side policies from our synthesis, some of which may also have an important impact on abortion trends: for example, one of the studies in our review reported a 70% decrease in medical abortion following enforcement of HB2, which was likely to have been attributable to policy-driven changes in the availability and cost of mifepristone (6). Finally, although geographic and other access-oriented barriers to abortion are not unique to the USA, TRAP laws are a US phenomenon; as such, our findings may not be generalizable to other countries.

Conclusion

In 2016, the US Supreme Court determined that the ASC and admitting privilege requirements in Texas' HB2 were unconstitutional (45), which effectively opens the door to overturning many similar TRAP laws across the country. However, this process does not occur automatically: state-level policy changes will probably take some time to occur, and decreases in provider availability initially driven by TRAP enforcement may persist well into the future. The current political climate in the US may further delay this process.

Our findings suggest that certain TRAP laws may have an impact on state-level abortion rates, especially in the years immediately following enforcement. These laws may also alter the overall experience of obtaining an abortion. However, additional high-quality research is required to update our knowledge on the impact of TRAP laws on abortion rates and women's health, particularly given post-2005 policy trends. We echo calls from previous work (60) for a research emphasis on specific TRAP laws, such as ASC regulation, that may have a uniquely strong effect

on state-level abortion rates. Finally, future work should more explicitly assess the potentially amplified effects of these laws on young, low-income, and rural women.

4.3 Supplementary appendix: Manuscript 1

Figure A1: Exclusion criteria

Stage 1: Title screening

Date range: No restrictions
Study design: No restrictions
Analysis: No restrictions
Participants: No restrictions
Setting: Should *not* specify/imply setting other than US (retain if multiple)
Exposure: Should mention providers/access and/or one or more supply-side* abortion policies
Outcome: Should mention abortion rates and/or women's health outcomes

***Supply-side**: Pertains to facilities and/or providers (i.e., TRAP, ASC, radius). Include papers on funding cuts at this stage. Exclude if explicitly demand-side (i.e., parental consent, ultrasound, waiting periods), but retain if unclear or if multiple policies are mentioned. Mention of policy is more important than outcome at first stage screening.

Stage 2: Abstract screening

Date range: No restrictions
Study design: No restrictions
Analysis: No restrictions
Participants: Women (15-44) residing in any/all US states
Setting: United States
Exposure: Must mention providers/access and/or one or more supply-side abortion policies
Outcome: Must mention or allude to abortion rates and/or women's health outcomes
**When in doubt, opt to include for full text screen*

Stage 3: Full text screening

Date range: No restrictions
Study design: Original reports only (no reviews, policy statements, etc.)
Analysis: Quantitative (exclude if qualitative)
Participants: Women (15-44) residing in any/all US states
Setting: United States
Exposure: One or more supply-side abortion policies**
Outcome: Abortion rates and/or women's health outcomes

5. "If you build it…": Constructing a longitudinal database of supply-side shifts in abortion policy

5.1 Preface: Manuscript 2

A key barrier to understanding the consequences of TRAP laws is the lack of a longitudinal record of policy shifts. In this manuscript, I describe an approach to compiling these data, which is intended to fill this important gap.

Several sources of cross-sectional data exist on TRAP laws (some more detailed than others), and these played an important role in the generation and validation of this database. Even among these sources, however, there is often discordance surrounding the presence and nuances of TRAP laws at the state level. In addition to documenting the timing of state-level policy shifts to the best of my ability, the data collection process explored these disagreements and captured relevant qualitative information on the circumstances surrounding policy enactment and enforcement, as well as unique aspects of a given law in a given state. The resulting dataset is available for public use.

This manuscript, entitled ""**If you build it…": Constructing a longitudinal database of supply-side shifts in abortion policy**", is being prepared for submission to Health Policy.

5.2 Manuscript 2

"If you build it…": Constructing a longitudinal database of supply-side shifts in abortion policy

Abstract

Introduction: Targeted regulation of abortion providers (TRAP) laws are favored by many states as a way to regulate abortion provision. However, the lack of longitudinal data on state-level policy shifts compromises our ability to quantify the impact of these laws beyond a single-state setting. Our goal was to address this gap and compile state-level data on policy activity.

Methods: Two coders conducted an iterative, state-by-state review of policy activity and policy timing. We focused specifically on ASC laws, admitting privilege requirements, and transfer agreements as these policies may pose significant compliance challenges to clinics. Primary sources included Lexis Nexis Quicklaw, WestlawNext, and state websites. Data were repeatedly cross-referenced, and disagreements were addressed collaboratively by revisiting sources until consensus was reached.

Results: According to our search results, 25 states had ever enacted an ASC, admitting privilege, or transfer agreement law. Fewer states (n=21) enforced these laws. There was a sharp influx of ASC and admitting privilege laws in the 2000s, and many of these laws currently face legal challenges.

Conclusion: This study is the first to longitudinally track state-level shifts in specific types of TRAP legislation over time. These data can easily be merged with other sources to advance our understanding of the impact of TRAP laws.

***

Background

Abortion is heavily regulated in the US, and service provision is largely determined within-state. Restrictive policymaking appears to be on the rise, with nearly a third of all existing restrictions enacted in 2010 or later (5). In particular, supply-side (or TRAP (targeted regulation of abortion providers)) laws have become commonplace, despite a seminal 2016 Supreme Court ruling (45) that is expected to play a role in overturning many of these policies. Supply-side laws are unique in that they target abortion provision at the provider (rather than individual) level, which may ultimately translate to access barriers for abortion-seeking women. These laws come in a variety of different flavors, some more onerous than others. For example, laws requiring clinics to adhere to a state's regulations for ambulatory surgical centers (ASCs) may necessitate extensive and costly renovations. Admitting privilege requirements, which mandate that abortion providers hold admitting privileges at a nearby hospital (often within a specific proximity), may be impossible to secure when the nearest hospital is outside of this range or unwilling to extend these privileges.

Given these mechanisms, it is perhaps unsurprising that TRAP enactment has been linked to a decrease in provider availability in certain contexts (6): certain regulations are so severe that existing providers are simply unable to comply (5). However, the relationship between these laws and subsequent health outcomes (in particular, abortion rates) remains unclear. A recent literature

review of quantitative evidence on the health effects of supply-side policies (63) found a general lack of evidence on this topic, although the available studies did point to an inverse association between enforcement of certain TRAP laws and abortion rates. However, most of the publications in this review focused on a single state, and half assessed policy effects from 2006 or earlier, which does not capture important recent trends in TRAP enactment.

State-level changes in abortion policy are complex and difficult to track over time, but identifying and rigorously documenting state-level shifts is a vital first step in more accurately quantifying the impact of these policies. While various sources of cross-sectional data exist on the presence/absence of supply-side policies, no source to-date provides a sense of the timing of these laws. This lack of data is a key barrier in conducting high-quality research on the causal impact of TRAP laws. We aimed to address this gap by producing a longitudinal record of supply-side abortion policy in the US.

Methods

This was an iterative, state-by-state review of policy activity and policy timing. In early 2016, two coders systematically searched policy documents and a range of secondary sources to track state-level TRAP enactment and enforcement over time. Data were updated in July 2017 to reflect recent policy developments. We focused specifically on ASC laws, admitting privilege requirements, and transfer agreements (all described in **Table 5.1**), as the literature suggests that these policies may pose significant compliance challenges to clinics (5, 6).

ASC laws were defined in our data as policies that explicitly required clinics to adhere to a state's ASC regulations. This exposure definition is slightly more conservative than that employed by the Guttmacher Institute, which considers states exposed if clinics have "structural standards comparable to those for surgical centers" (47). Our data therefore diverge from the Guttmacher Institute on states like Louisiana, which has specific guidelines for abortion facilities but these facilities are explicitly exempted from the state's ASC licensing requirements (64). Admitting privilege laws were defined as laws requiring individual providers to obtain these privileges at a nearby hospital. Transfer agreement policies were defined as laws requiring clinics/facilities to enter into formal agreements with nearby hospitals. This is not the same as requiring clinics to have a written transfer protocol in place; this is an "in-house" policy, whereas a transfer agreement law requires the participation of two entities - the clinic and the hospital. We differentiated between the year of enactment and year of enforcement for all policies. If a state passed multiple laws within a given category, we coded the date of the first law. An example of this occurred in Texas, which passed two different ASC laws roughly 10 years apart; we describe this case in greater detail in the Results section.

Table 5.1: Policy types and definitions

Policy type	Description
ASC requirements	Many states subject abortion providers to the same regulations as ambulatory surgical centers. This type of legislation requires abortion providers to conform to strict facility and personnel guidelines. ASC requirements can apply to all providers or only to those providing abortion beyond a certain gestational age (often early in the second trimester). Regulations governing ASCs are extensive and generally unnecessary for abortion providers. ASC regulations may force existing providers to undergo extensive renovations or purchase unnecessary equipment, the costs of which may be insurmountable.
Admitting privileges	Admitting privilege laws require abortion providers to have hospital/admitting privileges in place at a nearby hospital (the proximity is often explicitly stated). Missouri was the first state to enact such a policy in 1986; these laws remained relatively rare until 2011. Several states successfully established these laws, but they were tied up in legal challenges in many other states. Notably, this was a focal point of *Whole Women vs. Hellerstedt*; admitting privilege requirements for abortion providers were found unconstitutional, which has since impacted other states with similar legislation. This does not, however, change the fact that these laws were in effect for a number of years in a number of states. Guttmacher (65) describes a "minimum admissions threshold" that is often part of gaining admitting privileges at a hospital; because the complication rate is so low with abortion, providers may be unable to satisfy this requirement and would therefore not be granted admitting privileges.
Transfer agreements	Transfer agreements are a common component of ASC regulations and require any ASC facility to have a written agreement in place with a nearby hospital in case of emergency. In contrast to admitting privilege requirements, transfer agreements are facility-level policies and are generally viewed as easier to secure. However, the American Public Health Association maintains that neither admitting privilege requirements nor transfer agreements are medically necessary for abortion providers; while hospitals have a legal obligation to provide emergency care to any patient, they do not have any legal obligation to extend admitting privileges or enter into formal transfer agreements with abortion providers (66). Several states allow clinics to get either admitting privileges or a transfer agreement; while this is certainly more flexible, neither measure is medically necessary.

Sources and process

We began by compiling a basic list of states in which one or more of the aforementioned TRAP laws were in place as of mid-2016, using the Guttmacher Institute's cross-sectional TRAP summary as a point of reference (47). We worked backwards from this list to determine the presence and details of each policy by state/year. Primary sources included Lexis Nexis Quicklaw, WestlawNext, and state websites. The two coders independently captured data on policy enactment/enforcement by state. These data were then cross-referenced between coders and across

available cross-sectional sources (described below). Conflicting accounts of policy presence and/or timing were investigated collaboratively by the coders by revisiting data sources until consensus was reached.

Although they were not always concordant among themselves, key resources for cross-referencing included the Guttmacher Institute's summary of TRAP laws (as of August 2017) (47), a recent summary of TRAP enactment (also from the Guttmacher Institute) (65), a policy database compiled by the American Public Health Association (current as of November 2015) (66), and a media summary of admitting privilege laws by state (as of August 2014) (67). A final resource was released late in our data compilation process (48); these data, while also cross-sectional, were more detailed and served as an important additional source of information. Finally, because the quality of records varied from state-to state (and because some uncertainty is inevitable in this type of data collection endeavor), we included a numeric indicator of our coders' uncertainty in the interest of transparency and to facilitate sensitivity analyses and exclude states for which high-quality data were unavailable.

One of the central challenges in compiling these data was distinguishing between dates of enactment and dates of enforcement. We viewed this as a priority since analyses should ideally evaluate the impact of enforcement, which can potentially occur well after the enactment of a policy for logistical, political, and/or legal reasons. We found that state-level policy documents did not always reflect policy timing; however, because abortion policy shifts are of considerable public interest and are closely monitored by agencies and advocacy groups across the ideological spectrum, we used media reports (from various sources) to corroborate our estimates of

enforcement timing. An unexpected by-product of this process was the construction of a brief narrative component for each exposed state. This qualitative information, drawn in large part from media reports, was helpful both in providing context and in determining how best to code a given state policy.

Validity and uncertainty

There were two key opportunities for error in compiling this dataset: errors in determining the presence of a policy, and errors in determining the timing of a policy. We revisited the dataset at the end of the coding process to check for differences between our data and the cross-sectional policy information published by various agencies/advocacy groups to check for discordance. We used any discordance as an opportunity to further examine our data sources and assess the reasons for discrepancies. This process allowed us to capture more nuanced instances of policy activity; for example, we found that a 2015 Arkansas law (which was enjoined, or temporarily blocked from going into effect, until mid-2017) mandated a fairly convoluted admitting privilege arrangement for physicians providing medication abortion only, which was unique.

It is important to remember that "TRAP" is a heterogeneous category: laws differ from one another, and laws within the same subcategory may differ substantially between states. For instance, in many states, ASC rules only apply to clinics providing abortion after the first trimester (the minority of all abortions). To document this heterogeneity, the policy dataset captures information on state-level policy presence, administrative codes associated with the law(s), year of enactment, year of enforcement, and the year a given law was blocked/enjoined (if applicable), We also captured indicators of severity, including whether an ASC law pertained to *all* abortions

or only to later-term (generally second trimester) abortions, as well as the details of any associated proximity requirements for admitting privilege and transfer agreement laws. We retained the relevant state-level documents and saved them for reference, with relevant passages highlighted. The full dataset is available for public use.

Results

Table 5.2 compactly summarizes the resulting data. According to our search results, 25 states had ever enacted an ASC, admitting privilege, or transfer agreement law, and 21 states went on to enforce these laws. Only two states (Indiana and Missouri) were classified as "low confidence" states. While gestational age played a role in seven of the states with ASC requirements (with regulations only applying beyond a certain point of pregnancy - often the second trimester), the majority of ASC states applied these rules to virtually all providers. Notably, two states (Missouri and Virginia) extended their rules, which were initially for later-term abortions, to all abortions in recent years.

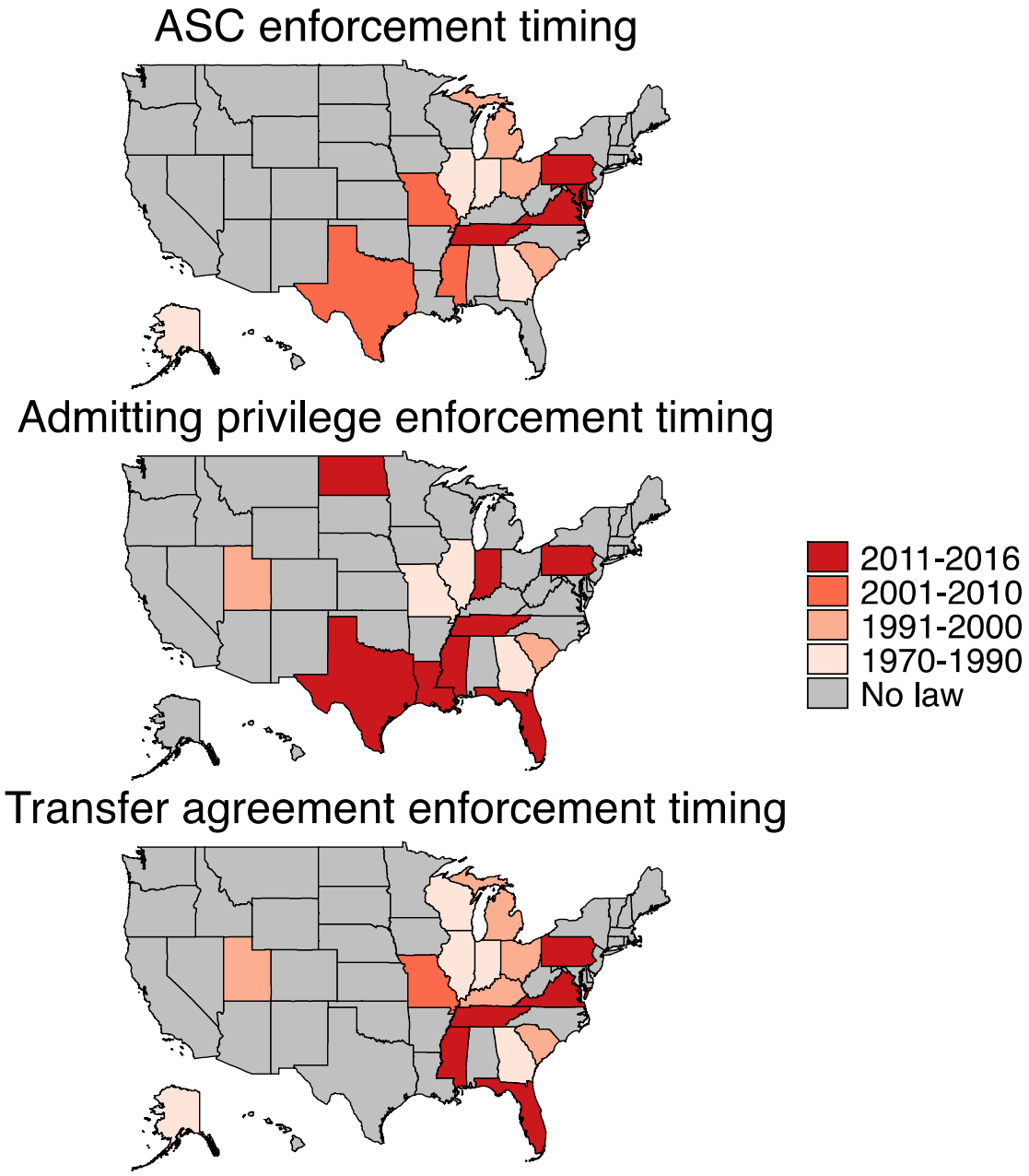
We illustrate the geographic and temporal distribution of enforced policies in **Figure 5.1**. It is clear from these maps that TRAP laws are most common in the Southeast and Midwest regions of the US (and many states in these regions had multiple laws in place as of mid-2017). These maps also reflect trends in policy timing: for instance, admitting privilege laws became quite common from 2011 onward, whereas many ASC regulations were enforced earlier. Readers should note that some of these enforced laws (for example, the admitting privilege laws in Louisiana, Texas, and Mississippi) were challenged/blocked as of mid-2017.

Table 5.2: TRAP laws by state (as of mid-2017)[1]

	ASC laws[2]				Admitting privileges[3]			Transfer agreements[4]			Conf.[5]
State	Tri.	Enacted	Enforced	Blocked	Enacted	Enforced	Blocked	Enacted	Enforced	Blocked	
AK	1	1970	1970	.	.	.	.	1970	1970	.	2
AL	.	.	.	.	2013	0	2014	.	.	.	1
AR	.	.	.	.	2015	0	2015	.	.	.	1
FL	.	.	.	.	2016	2016	.	2016	2016	.	2
GA	2	1974	1974	.	1974	1974	.	1974	1974	.	2
IL	2	1973	1973	.	1973	1973	.	1973	1973	.	2
IN	2	1973	1973	.	2011	2011	.	1973	1973	.	3
KS	1	2011	0	2011	2011	0	2011	2011	0	2011	1
KY	.	.	.	.	.	.	.	1998	1998	.	1
LA	.	.	.	.	2014	2014	2016	.	.	.	1
MD	1	2012	2012	.	.	.	.	.	.	.	1
MI	1	1999	1999	.	.	.	.	1999	1999	.	1
MO	1	2007	2007	2017	1986	1988	2017	2007	2007	2017	3
MS	2	2005	2005	.	2012	2013	2013	2012	2013	.	2
ND	.	.	.	.	2013	2014	.	.	.	.	1
OH	1	1999	1999	.	.	.	.	1999	1999	.	2
OK	.	.	.	.	2014	0	2014	.	.	.	1
PA	1	2011	2012	.	2011	2012	.	2011	2012	.	1
RI	2	1973	1973	.	.	.	.	.	.	.	1
SC	2	1995	1996	.	1995	1996	.	1995	1996	.	2
TN	1	2015	2015	.	2012	2012	.	2015	2015	.	2
TX	2	2003	2004	.	2013	2013	2016	.	.	.	1
UT	.	.	.	.	1998	1998	2017	1998	1998	2017	1
VA	1	2011	2012	.	.	.	.	2011	2012	.	1
WI	.	.	.	.	2013	0	2015	1976	1976	.	2

[1]Full dataset provides additional qualitative information on laws/codes, state-level nuances, and secondary sources. Dates reflect the first law within a given category: for example, Texas enacted a more stringent ASC law in 2013, but our dataset captures an earlier version that was specific to later-term abortions. [2]Laws explicitly require providers to adhere to state's ASC regulations. [3]Laws require providers to hold admitting privileges at a nearby hospital. [4]Laws require a formal transfer agreement (not just a transfer plan) between providers and a nearby hospital. [5]Simple rating of coders' confidence in the listed dates, given the available data (1=high, 3=low). "Tri" reflects the trimester the ASC law takes effect (1=effective for first+ trimester abortions, 2=later abortions only).

Figure 5.1: TRAP laws by type and enforcement year



It is important to note that many states had complex legislative histories surrounding TRAP enactment and enforcement. If a state passed progressively stringent versions of a law over time, we documented this process but generally coded the passage of the first law as the date of exposure. For example, the Women's Right to Know (WRTK) Act in Texas (enacted in 2003, enforced in

2004) required second-trimester abortions to occur in ASCs, but a more restrictive bill with an ASC component (HB2) was passed in 2013, although the ASC component never went into effect. Texas is therefore coded in the policy dataset as enforcing an ASC law in 2004.

The full dataset contains extensive information on state-level sources, proximity requirements, and qualitative information on the nuances of each policy (**Appendix Table A1**). Qualitative/explanatory data also exist for several "unexposed" states, particularly in situations where our findings were discordant with another existing source. Concordance, however, was generally high: with respect to policy presence, our data agreed with one of the highest quality cross-sectional sources (48) 94% of the time for ASC laws, 88% of the time for admitting privilege laws, and 86% of the time for transfer agreement laws. Disagreements were usually easily explained and often linked to the period of review (for example, this particular data source was current as of mid-2016, but our data captured changes after that point).

Discussion

This study is the first to longitudinally track state-level shifts in specific types of TRAP legislation over time. It is evident from these data that TRAP laws are quite common in the US, but the state-level circumstances surrounding the passage of a new law – in addition to the contents of the laws themselves – are nuanced and complex. Our findings also revealed considerable regional heterogeneity and interesting temporal trends in different types of TRAP laws. These data can easily be merged with other datasets on abortion outcomes, provider availability, and sociodemographic attributes, effectively permitting researchers to more rigorously evaluate the

impact of TRAP laws on abortion rates, clinic closures, and a range of other relevant outcomes over time.

There are certainly limitations to our approach, particularly with respect to uncertainty in precise policy timing (especially in states with complex legislative histories). We aimed to minimize this by using a diverse range of sources and cross-referencing our findings with other available data. However, our findings were not perfectly concordant with any other source. This was unsurprising as existing sources are not concordant among themselves, due in large part to the complexity of these laws and differences in exposure definition. We aimed to be as transparent as possible in our exposure definitions, and we supplemented our data with qualitative state-level details to allow other analysts to understand our process (and potentially re-classify states for the purposes of their own analyses, depending on their objectives).

A number of states in our dataset received a confidence rating of 2, reflecting moderate confidence in the available data on policy timing (as opposed to high or low), and many of these states were the earliest enforcers. We caution readers that the comparatively early laws in this dataset (for example, ASC laws enforced in 1973) may not be "true" TRAP laws, in the modern sense of the term. According to our search, a few states appeared to have longstanding requirements that abortion providers adhere to ASC regulations. However, policies immediately following the federal legalization of abortion may not be the same as more recent TRAP laws: abortion provision was new in many states (abortion was completely illegal before Roe v. Wade in four out of six of the states with early laws (68)), and adding abortion providers to a state's existing ASC regulations

may have been a simple way for states to quickly define provider requirements. We therefore recommend that users of these data focus on more recent laws (for example, 1991-present).

TRAP laws may have a meaningful effect on provider availability and other outcomes (6), but there is relatively little information on the impact of these laws beyond the context of a single state. These data are an important step in better understanding the causal impact of supply-side abortion regulations on individual and population-level outcomes. By making these data and supporting documentation publicly available, we hope to incite additional high-quality research in this area.

5.3 Supplementary appendix: Manuscript 2

Table A1: Legal and qualitative data

State	Law(s)/code(s)	Notes	Source(s)
AK	HB270, AK Stat § 18.16.010, 7 AAC 12.910	NARAL gives the date of initial ASC enactment as 1970 (see link), but HB 270 seems to introduce this much later (2008). We went with NARAL's date. The transfer agreement requirement applies to all ASCs - we coded this as applying to abortion providers when the ASC rules first applied.	http://www.akleg.gov/basis/statutes.asp#18.15, http://www.akleg.gov/basis/aac.asp#7.12.340, https://mic.com/articles/160815/the-future-of-reproductive-rights-may-be-hazy-but-abortion-advocates-vow-to-fight#.ZKfVtLVYk, https://www.prochoiceamerica.org/state-law/alaska/
AL	AL chap. 420-5-1 (abortion or reproductive health centers); HB 57: Women's Health & Safety Act	The admitting privilege law was challenged immediately after passing and permanently blocked. Alabama requires abortion facilities to maintain a certain corridor width, but does not require providers to function as ASCs. While Alabama does require abortion clinics to comply with the requirements for existing ambulatory health care occupancy in the Life Safety Code of the National Fire Protection Association, these requirements are specific to fire/safety.	http://www.alabamaadministrativecode.state.al.us/docs/hlth/420-5-1.pdf, https://rewire.news/article/2016/03/28/court-permanently-blocks-alabama-admitting-privileges-law/
AR	SB 845, Ark. State Bd. of Health, Rules and Regulations for Abortion Facilities	Arkansas maintains a comprehensive set of guidelines specifically for abortion providers, but they do not seem to explicitly regulate abortion providers as ASCs (though it looks like bills have been proposed). An admitting privilege law was recently proposed in 2015, but it died in committee (HB 1421). However, Arkansas DOES require all physicians administering medication abortion to have an agreement with another physician who has admitting privileges (as per Guttmacher, HB 1394, also enacted in 2015), which is unusual. This law was enacted in 2015 but blocked before it went into effect; it is set to take effect in August 2017. The facility itself is required to be within 30 minutes of a hospital/acute care center. Arkansas is also quite restrictive in terms of demand-side policies.	https://www.acluarkansas.org/en/the-arkansas-legislature-s-war-on-women-wages-on, https://www.acluarkansas.org/en/arkansas-war-on-women-final-report-the-2011-legislative-session, https://rewire.news/legislative-tracker/law/arkansas-abortion-providers-admitting-privileges-act-hb-1421/, https://www.guttmacher.org/laws-affecting-reproductive-health-and-rights-2015-state-policy-review, https://www.reuters.com/article/us-usa-abortion-arkansas-idUSKBN1AD22A
CT	Conn. State Agencies § 19-13-D54	All clinics need an operating room/equipment comparable to hospital or surgical center (this policy has been in effect since the 1970s), but facilities are not bound to ASC regulations.	Law only
FL	FL Statutes Title XXIX. Public Health § 390.012, HB 1411/SB 1722	Florida enacted anti-abortion legislation that required, among other things, providers to have either transfer agreement or admitting privileges at a hospital within a "reasonable proximity". Parts of this law were challenged before they went into effect (Planned Parenthood v. Philip), but the admitting/transfer requirements were not part of the challenge; these seem to have gone into effect in July 2016, but Guttmacher characterizes them as enjoined as of Aug 2017 (we did not find evidence of this, so coded confidence as "2").	http://www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=0300-0399/0390/Sections/0390.012.html, http://www.tampabay.com/news/politics/stateroundup/supreme-courts-abortion-ruling-could-impact-new-florida-law/2283291, https://rewire.news/legislative-tracker/law/florida-bill-regarding-the-termination-of-pregnancies-hb-1411/, http://www.nbcnews.com/news/us-news/federal-judge-blocks-florida-abortion-law-adds-restrictions-n602161

GA	Ga. Comp. R. & regs. 290-5-32-.01, Ga. Comp. R. & regs. 290-5-32-.02, Ga. Comp. R. & regs. 111-8-4-.09	As per rule 290-5-32-.02, all abortions in the second+ trimester must be performed in an ASC; this rule was effective as of 1974. Georgia's transfer agreement/admitting privilege requirements apply to all ASCs - coded dates of enactment/enforcement to align with abortion-specific ASC requirement.	http://rules.sos.state.ga.us/GAC/290-5-32-.02
ID	Idaho Code § 18-608 (1)	Facilities must have "satisfactory arrangements with one or more acute care hospitals within reasonable proximity", but the law does not require facilities to enter into a formal transfer agreement.	Law only
IL	Ill. Admin. Code. tit. 77, Â§ 205.540(d(1)), Ill. Admin. Code. tit. 77, Â§ 205.710(a)(1)	Illinois ASC regulations have been in effect for a long time, and the transfer/admitting regulations apply to all ASCs. Abortions>18 weeks need to happen in ASC, and ASCs need to have transfer agreements *or* admitting privileges (Georgia has a similar situation). A new, more restrictive, version of the admitting privilege requirement was enacted/enforced in 2014 (providers now need to hold admitting privileges themselves, whereas before they could hold them through a proxy).	http://articles.chicagotribune.com/2013-08-17/opinion/ct-edit-clinics-20130817_1_abortion-clinics-philadelphia-clinic-abortion-rights
IN	Ind. Code Ann. §16-34-2-1 (ASC), Ind. Code Ann. §16-34-2-4.5 (admitting)	The timing of these policies was unclear from available sources; state policy documents indicate the ASC law came into effect in 1993, but NARAL (see link) notes that this was the date of recodification - the original policy was passed in 1973. The first admitting privilege law appeared to be enforced in 2011; a second (more stringent) admitting privilege requirement was signed into law in 2014. Transfer agreement is built into ASC law (1973/1993): it's not specific to abortion, but all ASCs need to have this in place. Coded confidence conservatively as "3" (for exclusion in sensitivity analysis).	https://www.prochoiceamerica.org/state-law/indiana/, https://www.irtl.org/2014/07/abortion-admitting-privileges-law-takes-effect-today/, http://www.nwitimes.com/business/local/new-law-limits-abortion-docs-gary-practice/article_942c10aa-8140-55ea-9747-33c88ac76b45.html; https://www.guttmacher.org/laws-affecting-reproductive-health-and-rights-2011-state-policy-review
KS	SB 36	Multiple laws enacted in 2011; all are enjoined pending litigation. Kansas is one of the most restrictive states otherwise. Note that ASC laws *may* currently apply to late-term (third trimester) abortions.	Guttmacher, http://statelaws.findlaw.com/kansas-law/kansas-abortion-laws.html, http://cjonline.com/news-legislature-state/2015-11-21/us-supreme-court-could-decide-fate-kansas-abortion-regulations
KY	Ky. Rev. Stat. Ann 216B.0435 (trans. agreement)	ASC bill floated in 2006 - abortion providers were initially exempted from more stringent regulations in 1998.	Law only
LA	La. R.S. § 40:1061.10, Act 620 (admitting priv.)	Admitting privilege law was enacted in 2014 and went into effect the same year (though a lawsuit filed before enforcement protected certain providers from penalties of practicing without admitting privilegess). Louisiana has several facility-level regulations for abortion providers, but abortion facilities are not subject to ASC regulations (coded as 0, but this may be conservative - refer to law/documentation for details).	https://www.legis.la.gov/legis/Law.aspx?d=965003; https://www.nytimes.com/2016/03/05/us/politics/supreme-court-blocks-louisiana-abortion-law.html
MD	COMAR 10.12.01	New codes (which apply to surgical abortion only) were adopted in response to abortion complications in the state. Abortion advocates and opponents supported the new regulations. Enforcement was slightly different here: clinics that did not comply had their licences suspended, but this was short-term (goal seemed to be to get all clinics up to par). There was a provisional period of 120 days between enactment & enforcement in 2012. While law requires providers to have written protocols for emergency transfer, providers are not required to enter into a formal transfer agreement with hospitals (transfer coded as 0).	http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=10.12.01.%2a, http://articles.baltimoresun.com/2011-12-03/health/bs-hs-abortion-regulations-20111202_1_abortion-providers-abortion-regulations-abortion-law

MI	MCLS § 333.20115	Existing ASC regulations (which included rules re: transfer agreements and proximity) were expanded to include abortion providers in 1999. ASCs must be within 30 minutes of a nearby hospital. The general transfer regs. were established in 1979, but (since the transfer agreement rules only started to apply to abortion providers once they were required to adhere to ASC requirements) both ASC and transfer years were coded as 1999 here. Refer to highlighted documentation for details.	Law only
MO	Mo. Rev. Stat. Â§ 197.200; A.L. 2007 H.B. 1055; Mo. Rev. Stat. § 188.080.	Missouri was the first state to enact standalone admitting privilege requirements (see Rewire, Vox, & WP links). Some sources give the ASC date as 1986 and the admitting date as 2005 (evidence was stronger and sources were better for the dates as coded - sources may be referring to an earlier version of the ASC law, which was declared unconsitutional and was not enforced). Missouri did implement a number of specific structural guidelines for abortion facilities beginning in the late 80's, but these guidelines did not formally require facilities to function as ASCs. Existing ASC requirements were updated to include essentially all abortion providers (not just second+ trimester) via HB 1055. The timing of the transfer agreement regulation is unclear; we assume it coincided with the ASC law and coded it as such. The admitting privilege law is very similar to the Texas law that was overturned by the Supreme Court, and is expected to be overturned as well. Both the ASC and admitting privilege laws were blocked in 2017 (see link), but case appears to be ongoing.	http://revisor.mo.gov/main/ViewChapter.aspx?chapter=188, https://rewire.news/legislative-tracker/law/missouri-admitting-privileges-law-hb-1596/, https://www.vox.com/2014/8/12/5991167/abortion-admitting-privileges-supreme-court, https://www.washingtonpost.com/news/the-fix/wp/2016/06/27/how-many-states-could-see-their-abortion-restrictions-struck-down-after-the-supreme-courts-big-ruling/?utm_term=.2279dd6f9367, http://www.stltoday.com/lifestyles/health-med-fit/health/clinic-vows-to-resume-abortions-in-columbia-after-supreme-court/article_09414645-e606-5888-b9a3-a329ed7d07e0.html; http://www.stltoday.com/lifestyles/health-med-fit/health/supreme-court-s-ruling-on-abortion-could-have-impact-in/article_d1b2b54d-ea1b-5bc0-8326-07764adeb085.html; http://news.stlpublicradio.org/post/federal-judge-blocks-two-missouris-abortion-restrictions#stream/0, http://stlouisreview.com/article/2017-04-27/mo-attorney-general, http://missourilife.org/legislation/currentlaw.html
MS	Miss. Code Ann. § 41-75-13 (ASC); HB 1390 (admitting/transfer)	Original ASC law (1983) was amended to include second trimester+ abortion providers in 2005. Admitting privilege law was blocked after long court battle (was only partially in effect until 2013, then completely blocked pending legislation). The transfer agreement issue is somewhat unclear: it appears to be wrapped up in HB 1390, so not sure if it was also enjoined.	Jones BS, Weitz TA. Legal barriers to second-trimester abortion provision and public health consequences. American Journal of Public Health. 2009 Apr;99(4):623-30.; https://apnews.com/4033f40be60441c088a50571bd096645; https://rewire.news/legislative-tracker/law/mississippi-admitting-privileges-bill-hb-1390/
NC	SB 353 (see notes)	A 2013 bill gave the Dept of Health the power to say which of the ASC requirements should also apply to abortion providers, but this was not a blanket ASC law (the language was fuzzy). There was concern (in media reports) that this policy would close many NC clinics, but ultimately that did not happen. Coded here as unexposed, but assigned a confidence value of 2 for possible exclusion via sensitivity analysis.	https://medium.com/the-ncga-and-women-s-health/motorcycles-and-ambulatory-surgical-centers-a1ef66d1af90; https://rewire.news/legislative-tracker/law/north-carolina-motorcycle-abortion-bill/

ND	SB 2305	Admitting priviledge requirement was passed in 2013 and challenged, but suit was dropped after a hospital extended admitting privileges to providers at ND's only facility (see NYT article). Law went into effect after lawsuit was dropped in 2014. Note: an earler admitting-type law was passed in 2011, but this was specific to providers of medication abortion and it essentially required them to contract with someone who held privileges, in case of an emergency with the drug. We coded the 2013 law here.	https://apnews.com/9c25700344cf4c0692b18801fcada99a; https://www.nytimes.com/2014/02/14/us/north-dakota-abortion-doctors-get-hospital-privileges.html; https://www.washingtonpost.com/news/wonk/wp/2013/04/02/north-dakotas-only-abortion-clinic-isnt-going-anywhere/?utm_term=.74b2962f3d84; http://www.grandforksherald.com/news/crime-and-courts/4062870-overturning-texas-abortion-law-could-revive-challenge-north-dakota; https://www.reproductiverights.org/press-room/north-dakota-governor-signs-nations-most-extreme-attack-on-womens-constitutional-rights; https://rewire.news/legislative-tracker/legal-case/mkb-management-corp-v-burdick/; http://bismarcktribune.com/news/local/govt-and-politics/clinic-petitions-n-d-supreme-court-for-rehearing-on-medication/article_ac978eee-6b47-11e4-9221-738ac1220320.html
NE	.	Other sources (Guttmacher, Vox, AHPA) suggest presence of TRAP laws in NE, but we found no evidence of the three types listed here.	n/a
OH	Ohio Rev. Code Â§ 3727.60, 3702.30, HB59, HB64	Media accounts indicate that Ohio abortion providers are subject to ASC regulations, but there is some ambiguity surrounding when this requirement began applying to abortion facilities - legal documents (see links) suggests the law was in place, but somewhat loosely enforced, around 1999, as abortion providers were told to apply for ASC licences by inspectors but appealed, questioning whether their facilities were actually ASCs (the court ultimately decided that they were). The first transfer agreement requrements were wrapped up with the ASC regulations; a second transfer law prevented public hospitals from entering into transfer agreements with abortion providers, and required abortion providers to have a transfer agreement with a hospital within a 30 minute radius. It was found unconstitutional in 2016. It is somewhat unclear how long the law was in effect, but at least one Toledo clinic appears to have closed because of these regulations.	http://codes.ohio.gov/orc/3702; http://law.justia.com/cases/federal/appellate-courts/F3/438/595/598251/#fn1; https://cases.justia.com/ohio/tenth-district-court-of-appeals/2002-ohio-4295.pdf; http://www.cbsnews.com/news/ohio-abortion-clinic-operating-license-revoked-state/, http://www.cleveland.com/open/index.ssf/2016/07/ohio_abortion_restrictions_unc.html, https://thinkprogress.org/want-to-understand-why-abortion-clinics-are-disappearing-look-no-further-than-ohio-4ea4017640f8, https://www.washingtonpost.com/news/the-fix/wp/2013/07/01/what-makes-ohios-new-abortion-law-unique/?utm_term=.75c34f93459a
OK	SB 1848	Admitting privilege requirement was signed into law in 2014, but was immediately challenged (never went into effect).It was formally blocked in 2016.	https://www.nytimes.com/2014/11/05/us/oklahoma-supreme-court-blocks-2-abortion-laws.html; https://apnews.com/914df1ddd1bc4930bcdcc142bb186b7d/oklahoma-court-tosses-abortion-law-hospital-privileges; http://www.slate.com/blogs/xx_factor/2016/12/14/oklahoma_supreme_court_throws_out_abortion_law_on_hospital_admitting_privileges.html

PA	35 P.S. § 448.806(h), 28 Pa. Code Â§ 555.23, 28 Pa. Code § 29.33(10), Act 122	The ASC requirement was enacted in 2011 and enforced in 2012 (see links) in response to the Kermit Gosnell case, although existing laws at the time should have resulted in the closure of his clinic. The admitting/transfer agreement components are taken from PA's "Requirements for abortion" (28 Pa. Code § 29.33), and listed in preexisting ASC documentation (last updated: 1999). Since this would only apply to abortion providers once the ASC rules applied, we coded the transfer dates to align with the ASC dates.	http://www.scotusblog.com/wp-content/uploads/2016/01/Ten-PA-Abortion-Care-Providers-Womens-Law-Project.pdf, http://www.npr.org/2013/03/28/175459510/pennsylvania-tightens-abortion-rules-following-clinic-deaths, http://www.phillymag.com/news/2016/06/28/scotus-abortion-daylin-leach-pennsylvania/, https://www.prochoiceamerica.org/state-law/pennsylvania/
RI	R.I. Code R. 14-000-009, Part 2, Section 2, 2.2-2.	This law requires abortions at 15+ weeks to occur in hospital or an ASC. The same document notes that "Provisions shall be made for the prompt and safe transfer of patients for the back-up services referred to in sections 2.2 and 2.3 above," but the rules do not require a formal transfer agreement. These regulations were amended several times, but the general document appears to have been produced in 1973. Note that RI has a seperate (more stringent) set of regulations for abortions occurring at or after 19 weeks (including a transfer/admitting component), which is what the Law Atlas data captures. We coded the earlier requirement here as it would likely apply to more women/abortions.	https://www.prochoiceamerica.org/state-law/rhode-island/
SC	S.C. Code Regs 61-12. 302, S.C. Code Regs 61-12. 205, S.C. Code Regs 61-12. 305, S.C. Code Regs 61-12. 309	The admitting privilege component becomes mandatory for abortions after 14 weeks gestation (S.C. Code Regs 61-12. 309) - for earlier procedures, providers can have either admitting privileges or a transfer agreement. Secondary/media sources suggest the law was enacted in 1995 and enforced in 1996, but this is not entirely clear. SC law requires either admitting privileges or a transfer agreement.	https://www.prochoiceamerica.org/state-law/south-carolina/, http://www.nationalrighttolifenews.org/news/2011/07/south-carolina-experience-proves-why-abortion-clinic-regulations-are-essential/#.WVvogIjys2w
TN	Tenn. Code Â§ 68-11-201, Tenn. Comp. R. & Regs. 1200-08-10 (transfer agreements), SB 1280, HB 3808 (TN Life Defense Act of 2012)	Law exempts private physicians' offices that perform <50 abortions per year from ASC requirements. An amendment to this law to include these physicians (SB 1280) failed to pass. Tennessee's legislative tracker gives ASC enforcement year as 2015 (link provided); transfer agreement requirement is embedded in the ASC rules, so year of enforcement is coded to align with ASC enforcement here. Media reports indicate that both components (ASC and admitting) will no longer be enforced as of April 2017, in light of the Texas decision - a legal challenge was ongoing.	http://www.tennessean.com/story/news/2017/04/13/tennessee-agrees-stop-enforcing-two-abortion-measures/100437468/, http://tennesseerighttolife.nationbuilder.com/tn_abortion_laws, https://rewire.news/article/2016/03/10/tennessee-gop-withdraws-anti-choice-bill-ahead-whole-womans-health-ruling/, http://wapp.capitol.tn.gov/apps/BillInfo/default.aspx?BillNumber=HB1368&GA=109
TX	TX Health & Safety Code Â§ 171.002, TX Health & Safety Code Â§ 245.010, HB2, WRTK	Texas initially passed the "Women's Right to Know" act, which required abortions >16 weeks to take place in a ASC (that is what is reflected here). However, a second, more restrictive law was passed in 2013 (HB2). The enactment/enforcement timeline is complex: the admitting privilege component (which required providers to have privileges within a 30-mile radius) took effect in 2013, and the ASC component was scheduled to take effect in September 2014, but was enforced only briefly before being blocked. Importantly, many clinics closed after enactment, even in the absence of formal enforcement of the ASC component (due to admitting requirements, but perhaps also anticipation of ASC). Both requirements were found unconstitutional in 2016.	Colman S, Joyce T. Regulating abortion: impact on patients and providers in Texas. Journal of Policy Analysis and Management. 2011 Sep 1;30(4):775-97., Grossman D, Baum S, Fuentes L, White K, Hopkins K, Stevenson A, Potter JE. Change in abortion services after implementation of a restrictive law in Texas. Contraception. 2014 Nov 30;90(5):496-501., https://www.vox.com/2016/6/27/12038934/supreme-court-texas-whole-womans-health-closed-clinics-reopen-years, https://www.reproductiverights.org/press-room/texas-continues-to-fight-back-el-paso-clinic-reopens-following-supreme-court-action-blocking-abortion-restrictions

UT	UT Admin Code R432-600	Utah was the second state (after Missouri) to pass an admitting privilege requirement; this type of policy began gaining additional traction in 2011 (as per Vox article). Current law requires either admitting privileges or a transfer agreement with a nearby hospital. These rules were amended in 2017 (see revised admin. code and Rewire link), but laws were in effect in the interim.	https://rules.utah.gov/publicat/code/r432/r432-600.htm; https://www.vox.com/2014/8/12/5991167/abortion-admitting-privileges-supreme-court; http://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2015/12/14/11/04/opposition-to-requirements-for-hospital-admitting-privileges-for-abortion-providers; http://data.rhrealitycheck.org/law/utah-admitting-privileges-law/; https://rewire.news/legislative-tracker/law/utah-admitting-privileges-law/
VA	Va. Code Ann. § 32.1-127(B)(1)	The ASC law was passed in 2011 and applies to any facility performing 5+ first trimester abortions per month (VA already required second trimester abortions to occur in hospital). Media reports indicate that the law was formally enforced in mid-2012. The state determined that the ASC requirements were unconstitutional following the 2016 Texas decision - formal action seems to be pending. The transfer agreement component was already built into the general ASC regulations - we coded this as taking effect at the same time as the abortion-specific ASC requirements (once providers need to adhere to the ASC rules, the transfer rules also apply).	http://www.naralva.org/in-our-state/current-laws.shtml, http://www.motherjones.com/politics/2016/10/virginia-becomes-first-state-change-abortion-clinic-restrictions-based-supreme-cour/, https://pilotonline.com/news/local/health/fate-of-va-abortion-clinics-in-limbo-ahead-of-new/article_f3a1dcc2-a662-55b3-8003-7676048c075d.html
WI	Wis. Admin. Code § Med. 11.04(g)	The admitting privilege law was enacted but never enforced (blocked immediately, and ultimately determined to be unconstitutional in 2015). Judges concluded that it offered no additional protection to women, given the presence of the transfer agreement requirement. The transfer agreement/proximity rules appear to have been in place since 1976, but the admin. documents suggest a modification in 1999.	http://caselaw.findlaw.com/us-7th-circuit/1719222.html

6. Quantifying the impact of TRAP laws on US abortion rates: A multi-state assessment

6.1 Preface: Manuscript 3

Most evidence on the impact of TRAP enforcement on abortion rates comes from single state, "short-run" analyses (e.g., analyzing abortion rates just before and after a law is enforced). As such, these estimates are likely not generalizable to other states (and almost certainly not to the US as a whole) and may only capture the immediate shock of policy enforcement, as some providers may take time to adapt to new regulations.

Although the unique experiences of individual states are important and remain worthy of continued research, it is also important to understand the impact of policy enforcement more generally by assessing the average impact of TRAP enforcement on abortion rates across all states. In this manuscript, my goal was to estimate the average effect of two common TRAP laws using data from 1991 to 2014 across multiple states. I used a difference-in-differences design (with several different comparison group specifications) to explore the effect of ASC laws and admitting privileges, respectively. This approach protects against bias in several ways, which is appealing in a relatively complex panel dataset: specifically, it controls for time-fixed characteristics of individual states, temporal trends common to all states, and time-varying measured confounders.

This manuscript, entitled "**Quantifying the impact of TRAP laws on US abortion rates: A multi-state assessment**", is being prepared for submission to the American Journal of Public Health.

6.2 Manuscript 3

Quantifying the impact of TRAP laws on US abortion rates: A multi-state assessment

Abstract

Introduction: Targeted regulation of abortion providers (TRAP) laws impose important, and sometimes extensive, restrictions on abortion providers. Certain TRAP laws may be onerous enough to lead to changes in abortion rates, but little is known about this association beyond the context of short-term, single state settings. In this paper, we estimate the average effect of two particularly common types of TRAP laws on abortion rates using data from 1991 to 2014 and a novel longitudinal database of state-level policy shifts.

Methods: We merged several sources of policy, abortion, and sociodemographic data for this analysis. We used a difference-in-differences design to control for time-fixed state-level characteristics and common factors affecting abortion trends across all states, as well as measured time-varying state-level factors that may impact TRAP enforcement and abortion rates. Estimates were obtained via generalized linear models with cluster-robust standard errors and an offset term, and models were specified using a time-varying policy term reflecting the presence/absence of a policy in a given state/year.

Results: Our models suggested that ASC and admitting privilege enforcement had a negligible impact on abortion rates. ASC laws reduced the abortion rate by 1.25 abortions per 1,000 women aged 15-44 (95% CI: -3.39, .89), and admitting privilege laws increased the abortion rate by .57 abortions per 1,000 women aged 15-44 (95% CI: -.68, 1.83). Our findings were robust to the inclusion of covariates and various sensitivity analyses.

Conclusion: Our findings suggest that ASC and admitting privilege laws do not, on average, lead to a change in abortion rates, but this does not mean that these laws are without consequence in a particular state (or a given year). The average long-run impact of TRAP laws on other outcomes, such as service availability and shifts in the overall experience of obtaining an abortion, should be assessed in the future.

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Background

In a landmark 2016 case (45), the United States Supreme Court determined that certain provisions of House Bill 2 (or HB2), which was enacted in Texas in 2013 and only partially enforced prior to the ruling, were unconstitutional. HB2 consisted of a group of abortion restrictions, including a requirement that all abortion clinics in the state meet the same standards as ambulatory surgical centers (ASCs), and a requirement that all providers hold admitting privileges at a hospital within a 30 mile radius. HB2 had an immediate and striking effect on service availability, with a 46% decline in state abortion clinics within the year following enforcement of the admitting privilege provision (6). The Supreme Court ruled that these regulations, which offered no discernible benefit to women's health and safety, constituted an "undue burden" to women seeking abortion.

Restrictive abortion policies are not new, nor are they unique to Texas. In the US, states have considerable control over abortion regulation, and over half of all states currently have four or more restrictive policies in place (69). Nearly a third of all existing restrictions were enacted in

2010 or later, reflecting a notable upsurge in restrictive legislation in recent years (5, 70) that coincides with, but is not necessarily responsible for, a steady decline in the US abortion rate. Abortion restrictions can be conceptually partitioned into demand-side (i.e. mandatory counseling laws, parental notification laws) and supply-side policies (28). Provider-focused laws like the ones enacted in Texas fall under the supply-side category and are often collectively referred to as TRAP (targeted regulation of abortion providers) laws. These regulations can be very costly to clinics and may become serious barriers to continued service provision, particularly in rural areas and locations where hospitals are unlikely to extend admitting privileges to abortion providers.

There is some evidence that TRAP enactment is associated with a decrease in provider availability: certain supply-side regulations, like those enacted in Texas, are so severe that existing providers are unable to comply, forcing them to close (5, 6). However, although Texas was not the only US state to enact these laws, less is known about the effect of TRAP laws on provider availability in other states. It is also relevant to consider the impact of TRAP laws on state-level abortion rates, which may be an important downstream consequence of reductions in provider availability (6, 39). Little is known about this association, at least beyond the context of short-term, single state settings that may be susceptible to bias. A recent systematic review of quantitative evidence on the health effects of supply-side policies (63) found little rigorous quantitative evidence on the relationship between TRAP laws and abortion rates. Certain TRAP laws – specifically admitting privilege and ASC requirements – appeared to be associated with a decrease in abortion rates (6, 60), but this evidence was largely derived from a single state (often Texas) and therefore may not be generalizable to the greater US. Furthermore, half of the studies in the review assessed policy effects from 2006 or earlier, which does not capture recent trends in TRAP enforcement.

The Supreme Court decision means that many of the more stringent existing policies are likely to be challenged and overturned, but this will be a gradual process (5). It is therefore important to understand the impact of these laws on US abortion rates. To-date, several factors have precluded this type of analysis, most notably a lack of high-quality, longitudinal data on state policy changes. Furthermore, as states cannot feasibly be randomized to TRAP exposure, it is essential to employ other methods of control for both time-fixed state characteristics and secular trends common to all states, as both could bias estimates (this concern has also been noted in literature reviews on demand-side policies (8-10)). Accounting for important, and often unobservable, differences between states is essential to produce unbiased estimates of policy impact.

The goal of this paper is to address the challenges highlighted above and estimate the effect of ASC and admitting privilege law enforcement, respectively, on US abortion rates using data from 1991 to 2014. We expand upon existing work by utilizing a novel longitudinal database of state-level supply-side policy activity. These data allow us to employ a difference-in-differences approach, which accounts for confounding by secular trends and time-fixed state-level characteristics.

Methods

Policy data

The policy data collection process is described in detail elsewhere (71). Briefly, two coders (NA, JM) systematically searched state-level policy documents and a range of secondary sources to track state-level TRAP enactment and enforcement over time. The resulting policy dataset captures

information on state-level policy presence, administrative codes associated with the law(s), year of enactment, year of enforcement, and (if applicable) the year a given law was blocked/enjoined. The nuances of these laws vary by state: for instance, ASC rules in some states only apply to clinics providing abortion after the first trimester (a minority of all abortions). To document this heterogeneity, we also captured data on whether a law pertained to *all* abortions or only to later-term (generally second trimester) abortions, as well as the details of any associated proximity requirements. Given the complexity of these data and the data collection process, in sensitivity analyses we included an indicator of our coders' uncertainty. The data, including a list of state-level sources, are available for public use (71).

We defined state-level exposure to ASC laws as the presence of an enforced policy that explicitly required clinics to adhere to a state's ASC regulations. This exposure definition is slightly more conservative than that employed by the Guttmacher Institute, which maintains cross-sectional information on state-level TRAP presence (47) and considers states exposed to this type of law if clinics must abide by "structural standards comparable to those for surgical centers". Exposure to admitting privilege laws was defined as the state-level presence of laws requiring individual providers to obtain these privileges at a nearby hospital. As ASC and admitting privilege laws may be enforced independently, simultaneously, or consecutively, we considered a state "exposed" to the first policy it enforced from 1991 to 2014 in order to isolate the effect of individual policies. For example, Texas – which enforced a second trimester ASC law in 2004 and an admitting privilege law in 2013 – was included as an "exposed" state in the ASC analysis, but was excluded from the admitting privilege analysis as it had already experienced a competing policy shift within the observation period. We excluded states simultaneously enforcing both laws from all analyses

(*n*=2), as this prevented us from disentangling policy effects and there was insufficient information in this subgroup to assess the effect of joint enforcement. However, we retained states that simultaneously enforced an ASC or admitting privilege law alongside a transfer agreement component, as patient transfer regulations were very common and often embedded in existing ASC guidelines. Furthermore, several states enforced polices stipulating that abortion providers could either hold admitting privileges or maintain a formal transfer agreement with a local hospital.

Abortion data

We obtained state-level data on abortion by state of occurrence from 1991 to 2014 (the most recent year for which data were available) from the Guttmacher Institute. These data were available as rates and counts: we used the count data for the purposes of this analysis, and we obtained the annual number of women aged 15-44 in each state (the denominator of the abortion rate) from the US Census. Abortion data are also available on an annual basis through the Centers for Disease Control (CDC), but the Guttmacher Institute has substantially better coverage of abortion providers (32, 51) and is generally regarded as a more accurate data source. However, given the Guttmacher Institute's data collection approach, data were not available for every year in our observation period. We revisit this in the Discussion as a potential limitation, but (given the largely monotonic decline in abortion rates over our observation period) we did not anticipate that this would cause bias in our analysis.

Covariates

Evidence on the determinants of TRAP laws suggests that policy enforcement is plausibly exogenous (72): a state's governing political party has a meaningful impact on policy enforcement,

but other factors (religious composition, state abortion rate, public attitude toward abortion) may not. Additionally, many factors, such as the enforcement of subsequent TRAP laws, may mediate the relationship between an earlier law and abortion rates. Our models therefore control for time-varying factors hypothesized to feasibly impact TRAP enforcement and abortion rates: specifically, governor's political party, the percentage of state residents living below the poverty line, the presence of demand-side abortion policies (parental notification, mandatory waiting period, and/or mandatory counseling laws), and a dummy variable reflecting whether a state permits the use of public funds for abortion.

We also collected data on other state-level characteristics (in addition to model covariates) for descriptive purposes. Data on population size, median household income, unemployment rates, educational attainment, and poverty rates were obtained from the US Census. Information on the governor's political party was obtained from Council of State Governments, and data on birthrates (including teen birthrates) and fertility rates were obtained from the National Vital Statistics System. Data on the presence of demand-side policies were retrieved from "Who Decides?", a publicly-available NARAL publication that features an annual summary of state-level reproductive policy legislation (73). A full listing of sources is provided in **Appendix Table A1**.

Analytical approach

We used a difference-in-differences design to control for time-fixed state-level characteristics and common factors affecting abortion trends across all states, as well as measured time-varying state-level factors that may impact TRAP enforcement and abortion rates. This study design relies on panel data to construct an appropriate control group based on pre-policy trends (74). States were

eligible to serve as controls if they did not experience a shift in ASC or admitting privilege policy over the observation period. The main assumption for this design is that states that did not change their abortion policy provide a valid estimate of what would have happened to abortion rate trends in TRAP states, had these states not changed their policy. The presence of a control trend allows us to subtract the effect of underlying secular trends from the effect of the policy in the treated group. The central assumptions are also known as parallel pre-exposure trends and "common shocks" – in other words, any factors that occur throughout the observation period and affect abortion rates in the treated and control groups equally will not generate bias (75).

Difference-in-differences analyses often feature a visual comparison of pre-policy trends in treatment and control groups to ensure that outcome trends are parallel prior to the intervention. While this is straightforward to demonstrate with two groups, it becomes more challenging and less interpretable in the context of multiple groups and multiple periods of intervention. We used two strategies: first, we compared baseline demographic characteristics in relevant groups of states and examined changes in covariate patterns across groups over time. While covariate values need not be equivalent, comparable shifts over time provide some evidence that underlying social and economic factors are changing similarly in treated and control groups. Second, we graphically and statistically assessed differences in abortion trends by enforcement status across a "pseudo" pre-period (the range of observation years preceding the bulk of policy enforcement) to verify if the parallel trends assumption was reasonable in this context.

Estimates were obtained via generalized linear models with state and year fixed effects, and a time-varying policy term reflecting the presence/absence of a policy in a given state/year. Due to

evidence of overdispersion, we fit negative binomial models with cluster-robust standard errors (clustered at the state level (52)) and an offset term (the log of the population of women in their childbearing years). We hypothesized that any impact of ASC or admitting privilege enforcement on abortion rates would be immediate (generally observable within the year of enforcement) given the reported association between TRAP legislation and service availability (6). To relax this assumption, we conducted sensitivity analyses using 1-2 year lags to explore the possibility of a delayed policy impact on abortion rates. We also examined 1-2 year leads to assess the possibility of pre-policy shifts in abortion rates, which could indicate reverse causality. As additional robustness and sensitivity checks, we: 1) distinguished between ASC laws applying to all abortions and those applying to only later abortions; 2) excluded states with pre-existing TRAP laws (enforced prior to 1991) from the comparison group; 3) restricted to states where the policy data were reasonably clear with respect to timing (we refer to these as "high confidence" states); and 4) restricted the comparison group to states that enacted, but did not enforce, a TRAP law from 1991 to present, as these states may better represent counterfactual trends in the treated. All analyses were conducted using Stata 14 (StataCorp. 2015. *Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP.). Study data and code are available here in the interest of reproducibility.

Results

Mean annual abortion rates by US Census division are illustrated in **Figure 6.1**. This figure demonstrates both strong temporal trends in abortion rates from 1991 to 2014 and geographic heterogeneity in "baseline" abortion rates. Declines in abortion rates were largely monotonic at the division level, but trends in some individual states were erratic and/or inconsistent: for

example, Delaware (South Atlantic division) experienced a sharp but likely spurious (76) increase from 2005-2007, and California (Pacific division) had a steeper than average decline in the first half of our observation period.

States are listed by policy category in **Table 6.1**. Following exclusion of joint enforcers and states with competing policy shifts over the observation period for each exposure of interest, 7 states met our ASC exposure definition and 5 met our admitting privilege exposure definition; 35 states were retained in the control group.

Figure 6.1: Mean annual abortion rates by US Census division: 1991-2014

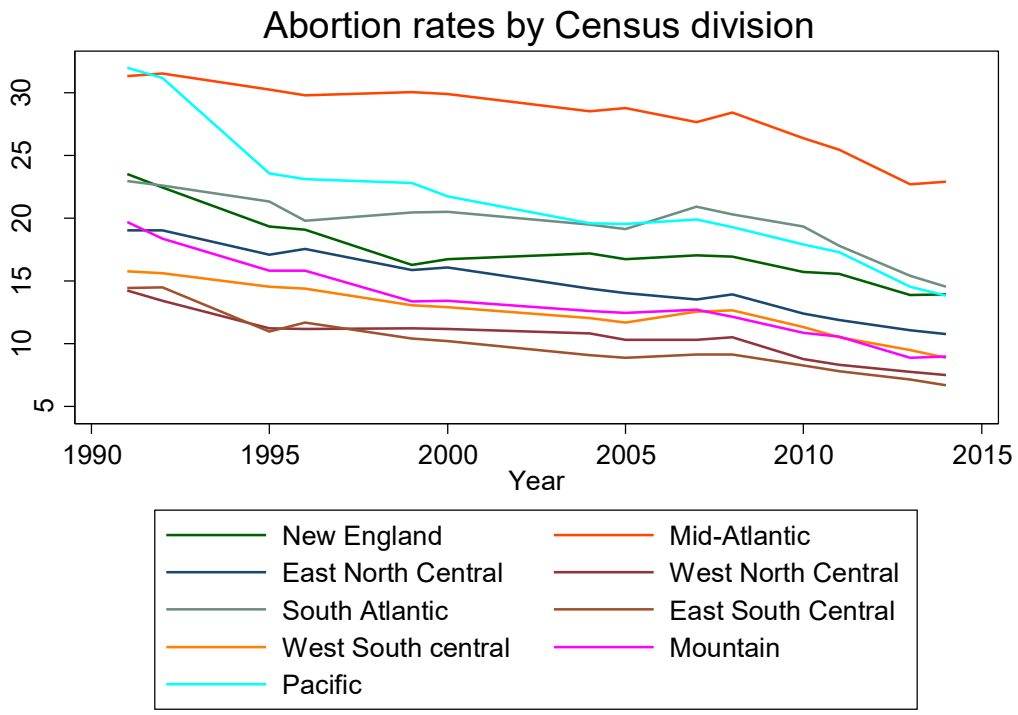


Table 6.1: States by TRAP category[1]

	ASC law	Admitting privilege
Treated states: Policy shift between 1991-2014[2]	MD, MI, MO, MS, OH, TX, VA	IN, LA, ND, TN, UT
Control states: No ASC or admitting policy shift from 1991-2014[3]	AK, AL, AR, AZ, CA, CO, CT, DC, DE, FL, GA, HI, IA, ID, IL, KS, KY, MA, ME, MN, MT, NC, NE, NH, NJ, NM, NV, NY, OK, OR, RI, SD, VT, WA, WI, WV, WY	
Control states that enforced at least one law pre-period (<1991)	AK, GA, IL, RI, WI	
Enforced ASC and admitting laws simultaneously between 1991-2014[4]	PA, SC	

[1]Underlined states enforced a transfer component at the same time as the ASC or admitting privilege law. [2]States categorized according to **first enforced policy** (for example, some states enforcing ASC requirements also enforced other laws later in the observation period). [3]Several states in this category enacted, but did not enforce, policies over the observation period. We use these states as an alternative comparison group in one of our sensitivity analyses.[4]States were excluded from analyses due to simultaneous enforcement of ASC and admitting priv. laws.

Demographic characteristics are summarized in **Table 6.2.** This table compares characteristics of states enforcing ASC laws to states with no TRAP policy shift over the observation period; a similar comparison (for admitting privilege enforcers and control states) is provided in **Appendix Table A2**. We also present the within-group percent change in state-level covariates from 1991-2014. Our data reflect a substantial decline over time in various factors linked to abortion rates in both groups, and the percent change over time in many potentially relevant covariates was generally comparable in exposed and unexposed groups. Notable exceptions include trends in higher education, the percentage of states with a Republican governor, and the presence of various demand-side policies, particularly for the admitting privilege comparison (though it is possible that TRAP enforcement may have impacted some of these factors by the end of our observation period). The admitting privilege sample also diverged with respect to changes in median income and birthrates over time. It is important to note that these changes over time may not have been

linear; nonetheless, this approach offers some evidence that shifts in various factors were comparable over time between our exposure groups, which suggests that the "common shocks" assumption may be reasonable for the analysis of ASC laws, and perhaps less so for the admitting privilege analysis.

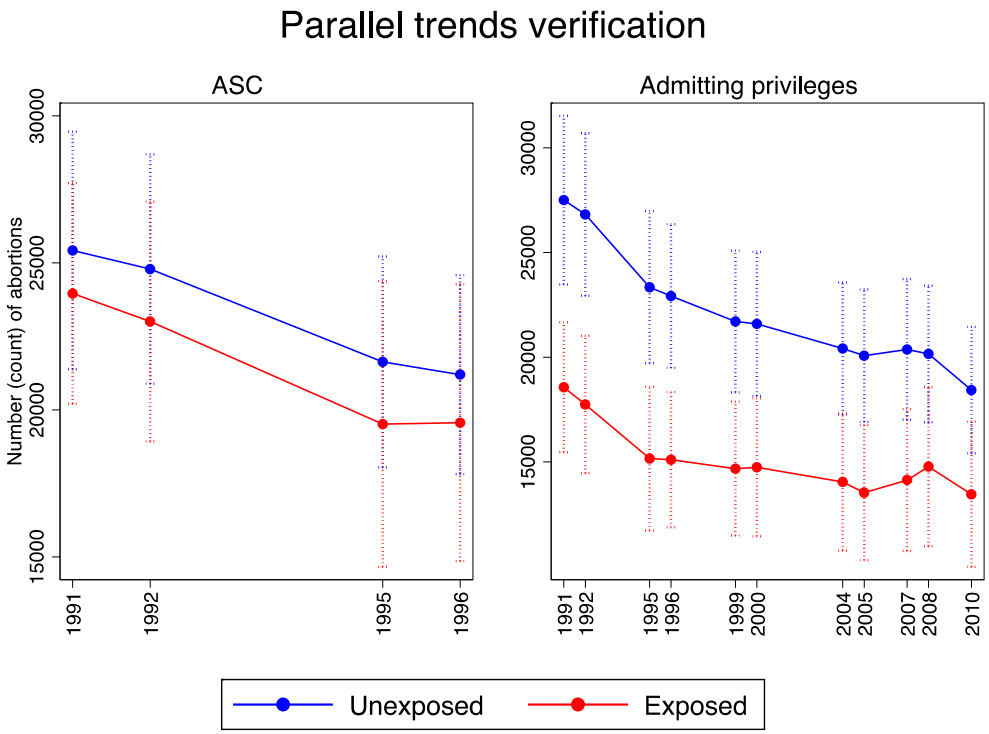
Table 6.2: Demographic characteristics: Treated[a] vs. control[b] states

	1991		2014		*Percent change*	
	Treated (*n*=7)	Control (*n*=35)	Treated (*n*=7)	Control (*n*=35)	*Treated*	*Control*
Population	8097515	4546173	10256132	5788856	*27*	*27*
High school diploma (%)	77.2	80.8	88.8	89.8	*15*	*11*
Bachelor's degree+ (%)	19.8	22.2	31.5	31.7	*59*	*43*
Median HH income[c]	50904	51639	54158	55047	*6*	*7*
Percent living in poverty	14.6	13.3	14.2	13.6	*-3*	*2*
Unemployment rate[d]	7.2	6.6	5.6	5.3	*-22*	*-20*
Birthrate[e]	16.1	15.6	12.7	12.2	*-21*	*-22*
Fertility rate[f]	67.9	67.4	63.7	63.2	*-6*	*-6*
Teen birthrate[g]	65	56.3	26.5	23.2	*-59*	*-59*
Republican governor (%)	42.9	42.9	57.1	51.4	*33*	*20*
Parental notification (%)	42.9	25.7	100	71.4	*133*	*178*
Waiting or counselling) (%)	71.4	40	71.4	42.9	*0*	*7*
Permits use of public funds for abortion (%)	0	34.3	14.3	45.7	*0*	*33*

[a]Enforced an **ASC law** between 1991 & 2014 (before enforcing any other TRAP law, if applicable); [b]Did not enforce any type of TRAP law between 1991-2014; [c]Income in 2014 dollars; [d]Seasonally adjusted percentage of workforce unemployed as of November of a given year; [e]live births/1000 people; [f]live births/1000 females, [g]live births/1000 females aged 15-19

When an intervention occurs at a fixed point in time for all exposed units, evaluating pre-policy trends is straightforward. However, as we note above, there is no defined pre-policy period in this analysis as states enforced TRAP laws at different points over the observation period. We therefore capitalized on the fact that the majority of exposed states in our sample enforced policies several years after the beginning of the observation period: our data suggested that most ASC policies (89%) were enforced after 1998 and most admitting privilege policies (78%) were enforced after 2010. Using these years as our cut-off values, we defined a "pseudo" pre-policy period for each exposure for the parallel trends assessment. Trends in the annual number of abortions over time appeared reasonably parallel for each exposure contrast (**Figure 6.2**; note gaps in data years). We also formally assessed whether the absolute change between groups over time differed statistically by taking the double difference between timepoints and calculating the confidence intervals for these quantities: for example, to compare trends from 1991 to 1992, we calculated $(abortionrate_{exp\_92}\text{-}abortionrate_{exp\_91}) - (abortionrate_{ctl\_92}\text{-}abortionrate_{ctl\_91})$. We then conducted a joint test of all predicted contrasts across the pre-policy period to determine if trends differed meaningfully between exposed and unexposed groups. These tests indicated that abortion trends between exposed and unexposed states were not statistically different across the pre-policy period.

Figure 6.2: Parallel trends verification



Model estimates are presented in **Table 6.3.** This table presents incidence rate ratios (IRRs) for the effect of TRAP exposure on abortion rates per 1,000 women aged 15-44, conditional on state/year fixed effects and model covariates. Naïve models (estimated without state and year fixed effects) illustrate the importance of accounting for both fixed state-level characteristics and secular trends common across states when estimating the impact of either ASC or admitting privilege policies on abortion outcomes. Failure to control for the strong temporal trends demonstrated in Figure 1 resulted in an overestimation of policy impact: in models without year fixed effects (but controlling for state fixed effects), ASC enforcement decreased abortion rates by a factor of .68 (95% CI: .60, .77) compared to non-enforcers. Failure to control for time-fixed state-level characteristics also biased point estimates. In contrast, the fully-adjusted difference-in-differences estimate, which accounts for both state and year fixed effects, suggested that ASC enforcement decreased abortion rates by a factor of .93 (95% CI: .81, 1.06). The fully adjusted difference-in-

differences estimate suggested that admitting privilege laws were associated with a 4% increase in the abortion rate, relative to states without these laws (IRR=1.04, 95% CI: .96, 1.11). All findings were robust to the inclusion of covariates, and there was no evidence that abortion trends were shifting differentially between groups prior to policy enforcement.

Table 6.3: Effect of policy enforcement on abortion rates[a]

	ASC enforcement[b] (n=42)		Admitting enforcement[c] (n=40)	
	IRR	**95% CI**	**IRR**	**95% CI**
Naïve[d]				
Crude	0.74	0.53, 1.05	0.44	0.33, 0.58
Year FEs only	0.85	0.60, 1.20	0.52	0.36, 0.75
State FEs only	0.68	0.60, 0.77	0.74	0.70, 0.79
Difference in differences				
No covariates[e]	0.92	0.81, 1.05	1.01	0.94, 1.09
Fully adjusted[f]	0.93	0.81, 1.06	1.04	0.96, 1.11
Leads				
t-1	0.95	0.82, 1.09	1.04	0.97, 1.12
t-2	0.96	0.84, 1.11	1.02	0.93, 1.11
Lags				
t+1	0.94	0.85, 1.04	1.01	0.96, 1.07
t+2	0.92	0.86, 0.98	1.01	0.96, 1.06

[a]Abortions per 1000 women aged 15-44; [b]Defined as enforcement of an ASC law from 1991-2014, excluding states that first enforced an admitting provision within that period; [c]Exposure defined as enforcement of an admitting privilege law from 1991-2014, excluding states that first enforced an ASC law within that period; [d]Estimation using neither type, or only one of the two types, of fixed effects in the final model; [e]Accounts for state and year fixed effects, but no covariates; [f]Adjusted for annual state-level poverty, parental notification laws, informed consent laws, whether a state permits the use of public funds for abortion, and governor's political affiliation

Table 6.4 re-expresses these findings on the absolute scale. Using the fully adjusted negative binomial model to generate marginal predictions, we found that states enforcing ASC laws could expect to have (on average) 1,986 fewer abortions than states not enforcing these laws (95% CI: -5,408, 1,435), and a rate reduction of 1.25 abortions per 1,000 women aged 15-44 (95% CI: -3.39, .89). Again, findings for admitting privilege enforcement were similar, but closer to the null. We

also present predicted marginal differences based on a crude model (without state or year fixed effects) to further illustrate the importance of these factors in this context: failing to account for state and year fixed effects led to a substantial overestimation of policy-driven differences in abortion counts and abortion rates.

Table 6.4: Absolute effects based on marginal predictions: Differences in counts and rates[a]

	ASC enforcement[b] (n=42)		Admitting enforcement[c] (n=40)	
	Difference: Counts	**Difference: Rates**	**Difference: Counts**	**Difference: Rates**
Crude[d]	-5612 (-11451, 227)	-4.45 (-9.08, 0.18)	-10098 (-13617, -6779)	-9.35 (-12.42, -6.28)
Adjusted[e]	-1986 (-5408, 1435)	-1.25 (-3.39, 0.89)	829 (-981, 2639)	0.57 (-0.68, 1.83)

[a]Derived from fully-adjusted negative binomial model with state/year fixed effects unless otherwise specified; [b]Defined as enforcement of an ASC law from 1991-2014, excluding states that first enforced an admitting provision within that period; [c]Exposure defined as enforcement of an admitting privilege law from 1991-2014, excluding states that first enforced an ASC law within that period; [d]Naive estimation without fixed effects; [e]Adjusted for annual state-level poverty, parental notification laws, informed consent laws, whether a state permits the use of public funds for abortion, and governor's political affiliation

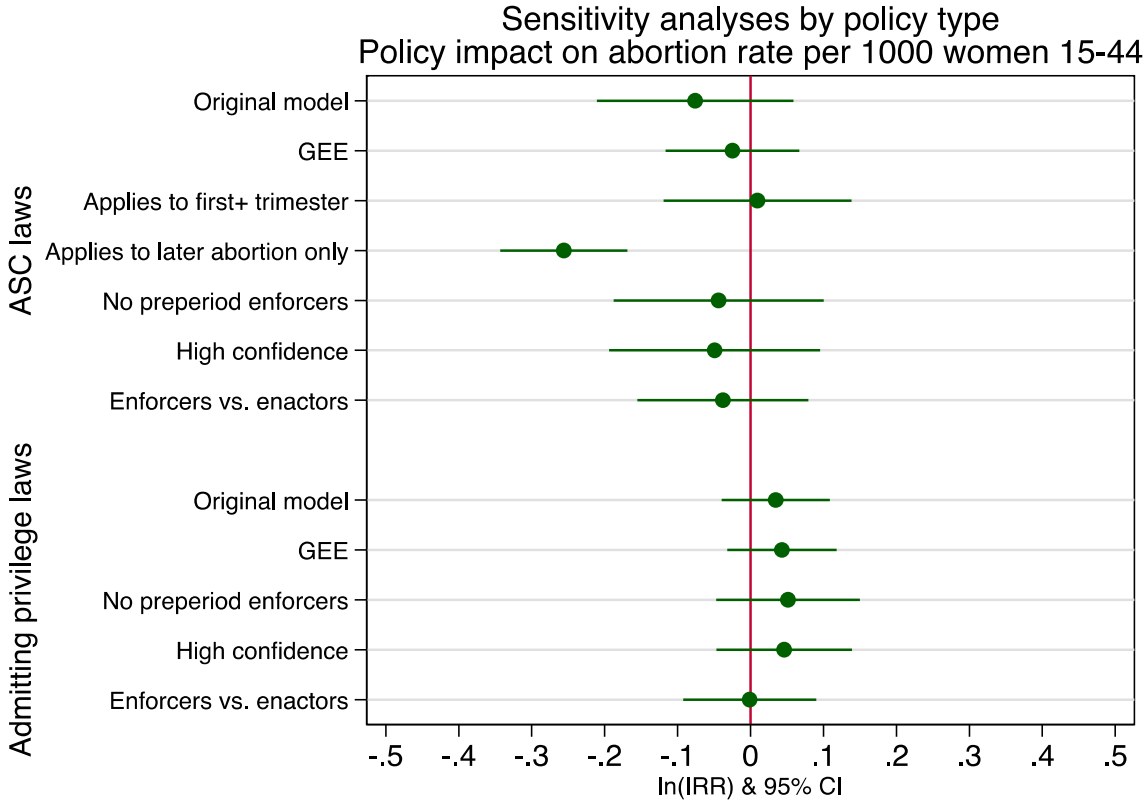
We conducted several sensitivity analyses to test the robustness of our findings and the assumptions required for unbiased difference-in-differences analyses (**Table 6.5; Figure 6.3** (plotted on the log scale)). Point estimates shifted slightly but qualitative findings were quite robust, with one exception: laws targeting later abortions had a stronger impact on abortion rates (IRR=.79, 95% CI: -.67, .94), which was unexpected as later abortions account for the minority of all procedures. However, this estimate was driven by two states (MO, TX) and should therefore be interpreted with caution. We also compared our results to models estimated using generalized estimating equations (GEE) to examine if our approach of clustering standard errors at the state level (rather than explicitly modelling a correlation structure) offered sufficient control for state-level correlation over time in this context. Estimates and confidence intervals were very similar, which suggested that our approach was acceptable.

Table 6.5: Sensitivity analyses by policy type

	ASC laws			Admitting laws		
	Estimate[a]	**95% CI**	***n***	**Estimate[a]**	**95% CI**	***n***
Original adjusted estimate[b]	0.93	0.81, 1.06	42	1.04	0.96, 1.11	40
Law applies to:[c]	-	-	-	-	-	-
First trimester+ abortions	1.00	0.88, 1.15	-	-	-	-
Later abortions only	0.79	0.67, 0.94	-	-	-	-
No preperiod states[d]	0.96	0.83, 1.11	36	1.05	0.95, 1.16	34
High confidence[e]	0.95	0.82, 1.10	41	1.05	0.95, 1.15	39
Enforcers vs. enactors[f]	0.96	0.86, 1.08	12	1.00	0.91, 1.09	10

[a]Estimated policy impact on abortion rate by state of occurrence (IRR); [b]Adjusted for annual state-level poverty, parental notification laws, informed consent laws, whether a state permits the use of public funds for abortion, and governor's political affiliation; [c]Distinguishes between states enforcing ASC laws that apply to all abortions vs. later-term/second+ trimester onl[y]; [d]Excludes states enforcing any TRAP law prior to 1991 (AK, GA, IL, IN, RI, WI); [e]Excludes states where policy timing was uncertain; [f]Comparison group consists only of states that enacted, but did not enforce, TRAP laws in or after the observation period (n=5)

Figure 6.3: Sensitivity analyses by policy type



Discussion

This work adds to a growing body of quantitative evidence on the impact of restrictive abortion laws that target the supply-side. We found little evidence that ASC or admitting privilege laws have a meaningful impact on state-level abortion rates: on the rate scale, exposure to ASC laws led to a difference of -1.25 abortions per 1,000 women aged 15-44 (95% CI: -3.39, .89), and exposure to admitting privilege laws led to a difference of .57 abortions per 1,000 women aged 15-44 (95% CI: -.68, 1.83). Our findings do not necessarily mean that abortion rates in a particular state (or a given year) will be unaffected by the enforcement of these policies; rather, our analysis suggests that the *average* effect of these policies on abortion rates is largely null. Our findings were robust to the inclusion of covariates and to most of our sensitivity analyses, with the exception of potentially heterogeneous effects of ASC laws depending on the trimester the law takes effect.

We focused on policy enforcement, rather than enactment, in this study. However, existing evidence from Texas suggests that enacted laws may impact service provision even before they are enforced: for example, eight Texas abortion clinics stopped providing services in the months leading up to HB2 enforcement (6, 77). Policy enforcement is essentially the endpoint of a lengthy process: enacted and enjoined laws, while not technically in effect, may reflect the political climate of a state at a given time (10). Some studies have included these states in the "pre-exposure" group (78), while others argue that the presence of a law, even if unenforced, may alter behavior (80). We hypothesized that policy enforcement would be associated with the most compelling effects, but it is possible that providers were aware of impending regulatory changes long before the actual polices were enforced. If this is the case, this may result in pre-policy shifts in abortion rates, but we did not detect evidence of this in our analyses.

Our goal in this analysis was to estimate an average causal effect of the impact of ASC and admitting privilege laws on abortion rates. However, we acknowledge a number of important limitations, many of which are directly linked to our data sources. While we were able to determine policy status in most cases, it can sometimes be difficult to establish whether an enacted law has in fact been enforced; furthermore, in practice, enforcement may be "rolled out" at different times in different areas. This is compounded by the reality that the quality and specificity of policy information vary by state, which raises the possibility of exposure misclassification in this analysis, particularly with respect to enforcement timing. We examined this by conducting a sensitivity analysis restricting to states with especially clear policy data; findings did not shift meaningfully, which was reassuring.

We did not control for the severity of individual TRAP laws in our main analysis, and this could have impacted our findings. For example, Arkansas requires abortion providers to be within a 30 mile radius of a hospital, while Utah requires providers to be within 15 *minutes* of a hospital. It is possible that more stringent laws have a different effect on abortion rates and associated outcomes. A more explicit assessment of the often nuanced differences between state TRAP laws could add an interesting layer of complexity, and future work should explore how best to quantify law severity and explore potentially important interactions between multiple laws (this may be more feasible when additional years of abortion data are available). A recently-released cross-sectional data source (48) provides comprehensive information on the specific components of these laws, and may be useful to researchers seeking to advance this work.

The available information on state-level abortion rates introduces another series of limitations. First, abortion data are only available at the state level, which limited us to state-level inference in this analysis. Second, these data were available for most – but not all – years in our observation period. The analysis presented herein is therefore a complete case analysis, where missing data years are dropped. This may not bias our results as the same years were missing for all states, but it certainly impacts our power and may obscure any important (non-linear) shifts in abortion rates across missing data years. This limitation may be remedied, at least in part, by the availability of a secondary source of abortion data through the CDC: although it consistently underestimates Guttmacher's rates, the CDC data may be a useful resource for imputation of missing data years in future analyses. There is also a persistent lag in abortion data availability, which is why our analyses end in 2014. This is a barrier to a more thorough assessment of many of these laws, given trends in TRAP enforcement: many laws were enforced in or after 2010, so additional post-policy years of abortion data would likely yield more precise estimates.

A final set of limitations relates to unmeasured confounding. A key challenge in this analysis is identifying causal effects of a policy in the presence of strong temporal trends in abortion rates. The cause of the decline remains unknown, but it is likely a combination of decreased need for abortions and an increase in abortion restrictions (1). If these factors are driving down rates at a rapid pace in nearly all states, it may be more difficult to detect an impact of ASC or admitting privilege policy enforcement. Our initial exploratory analyses supported this hypothesis, as a basic linear model that included only state and year fixed effects explained the majority of the variation in abortion rates (R^2=.92). Finally, given the absence of a well-defined pre-policy period in this context, our verification of the common trends assumption was somewhat less rigorous than the

typical approach in basic difference-in-differences analyses. However, the similarity of abortion trends between groups in the years preceding the upsurge in policy enforcement provided some assurance that pre-policy trends were quite similar, even if the pre-policy period could not be precisely defined.

Supply-side laws are often passed under the pretense of protecting women, but there is currently no evidence that these laws actually do so, particularly as abortion is already an exceedingly safe procedure in the absence of these laws (33). Nevertheless, a recent cross-sectional analysis found that states target abortion provision and providers to a greater extent than other office-based interventions (80). Our findings suggest that ASC and admitting privilege laws do not, on average, lead to a meaningful change in abortion rates, but this does not mean that these laws are without consequence. Given their apparent link to reductions in provider availability (6), these laws may have the capacity to increase travel burdens, costs, and general hardship associated with obtaining an abortion (6, 7), and the introduction of structural barriers may also increase second trimester abortions (6). While we can expect many supply-side laws to be repealed in the coming years, further work is required to better assess the causal impact of particularly restrictive policies and the potentially differential effects of these laws on disadvantaged women.

6.3 Supplementary appendix: Manuscript 3

Table A1: Variables by source

Variable	Description	Values	Source(s)
fips	Federal Information Processing Standards (state-level identifiers to facilitate linkage)	Integer	http://www.columbia.edu/~sue/state-fips.html
state	State	Integer	n/a
year	Year	Integer	n/a
totalpop	Total population by state (based on Census (in available years) or inter-censal population estimates)	Integer	US Census – intercensal estimates
cbapop	Annual state-level population of women aged 15-44	Integer	US Census
governor	Party affiliation of governor (at midpoint of year - 1 July); even-numbered years 1991-2002 taken directly from source, odd-numbered are based on "date of first service" column	String	Council of State Governments, The Book of the States (various years) Table 2.1/4.1 (for all states except DC)
edu_hsplus	Percent of adults aged 25-34 with high school degree or more in March of a given year	Integer	US Census: CPS (Table 13) until 2007; ACS from 2007 onward
edu_baplus	Percent of adults aged 25-34 with 4-year degree or more in March of a given year	Integer	US Census: CPS (Table 13) until 2007; ACS from 2007 onward
medhhinc	Median household income (in 2014 dollars)	Integer	US Census Historical Tables (H-8); US Census American Factfinder
percentpov	Percent of state residents living below the poverty line	Integer	US Census Historical Tables (CPS data - Table 21)
unemployment	Seasonally adjusted percentage of workforce unemployed as of NOV of a given year (total pop)	Integer	Bureau of Labor Statistics archives (various years, used multi-screen data retrieval tool)
cbapop	Number of state resident women aged 15-44 (bridged-race population estimates as of July 1st)	Integer	NCHS (via WONDER)
birthrate	Live births/total state population (multiplied by 1000)	Integer	CDC Wonder (for 1995-2014); NVSS Vital Statistics of the United States (for 1991-1994)

fertrate	All live births/pop. females aged 15 - 44 (*1000)	Integer	CDC Wonder (for 2003-2014); otherwise calculated manually
teenrate	Live births to girls aged 15-19 / pop. girls aged 15-19 (*1000)	Integer	CDC NCHS
gutcount_occ	Annual count of abortions to women 15-44 by state of occurrence	Integer	Guttmacher Institute (data center)
gutrate_occ	Abortion rate (abortions per 1000 women 15-44) by state of occurrence	Integer	Guttmacher Institute (data center)
asc_trimest	Reflects when the ASC requirement takes effect	1=first trimester/all pregnancies, 2= after first trimester	Policy data file (manual compilation)
inperiod_asc	Indicates if the state enforced an ASC law between 1991 and 2014	Binary (1=y, 0=n)	Policy data file (manual compilation)
asc_enacted	Year of ASC enactment	Integer	Policy data file (manual compilation)
asc_enforced	Year of ASC enforcement	Integer	Policy data file (manual compilation)
asc_blocked	Year law was blocked, if applicable	Integer	Policy data file (manual compilation)
inperiod_admit	Indicates if the state enforced an admitting law between 1991 and 2014	Binary (1=y, 0=n)	Policy data file (manual compilation)
admit_enacted	Year of admit. law enactment	Integer	Policy data file (manual compilation)
admit_enforced	Year of admit. law enforcement	Integer	Policy data file (manual compilation)
admit_blocked	Year law was blocked, if applicable	Integer	Policy data file (manual compilation)
inperiod_transfer	Indicates if the state enforced a transfer agreement law between 1991 and 2014	Binary (1=y, 0=n)	Policy data file (manual compilation)
transfer_enacted	Year of transfer enactment	Integer	Policy data file (manual compilation)
transfer_enforced	Year of transfer enforcement	Integer	Policy data file (manual compilation)

transfer_blocked	Year law was blocked, if applicable	Integer	Policy data file (manual compilation)
prox_detail	Provides the distance specified in the proximity requirement, if applicable	String	Policy data file (manual compilation)
parental	Indicates if a parental notification (notice and/or consent) law was in place in a given year	Binary (1=y, 0=n)	NARAL "Who Decides?"
pubfunds	Indicates if public finds may be used for abortion for low-income women	Binary (1=y, 0=n)	NARAL "Who Decides?"
waitorcounc	Indicates whether the state had EITHER an active waiting period or counselling law in place in that year	Binary (1=y, 0=n)	NARAL "Who Decides?"

Table A2: Demographic characteristics: treated[a] vs. control[b] states (admitting priv. enforcement)

	1991		2014		*Percent change*	
	Treated (*n*=5)	Control (*n*=35)	Treated (*n*=5)	Control (*n=35*)	*Treated*	*Control*
Population	3450357	4546173	4293903	5788856	*24*	*27*
High school diploma (%)	76.8	80.8	89.8	89.8	*17*	*11*
Bachelor's degree+ (%)	18.7	22.2	29.1	31.7	*56*	*43*
Median HH income[c]	44344	51639	51663	55047	*17*	*7*
Percent living in poverty	15.5	13.3	15	13.6	*-3*	*2*
Unemployment rate[d]	5.9	6.6	5	5.3	*-15*	*-20*
Birthrate[e]	16.3	15.6	14.4	12.2	*-12*	*-22*
Fertility rate[f]	70.1	67.4	71	63.2	*1*	*-6*
Teen birthrate[g]	58.9	56.3	28	23.2	*-52*	*-59*
Republican governor (%)	20	42.9	100	51.4	*400*	*25*
Parental notification (%)	80	25.7	100	71.4	*25*	*162*
Waiting or counselling) (%)	100	40	80	42.9	*-20*	*18*
Permits use of public funds for abortion (%)	0	34.3	0	45.7	*0*	*45*

[a]Enforced an admitting privilege **law** between 1991 & 2014 (before enforcing any other TRAP law, if applicable); [b]Did not enforce any type of TRAP law between 1991-2014; [c]Income in 2014 dollars; [d]Seasonally adjusted percentage of workforce unemployed as of November of a given year; [e]live births/1000 people; [f]live births/1000 females, [g]live births/1000 females aged 15-19

7. Is TRAP enforcement associated with an excess change in abortion providers?

7.1 Preface: Manuscript 4

An underlying assumption behind the existing research on TRAP laws and abortion/health outcomes is that these laws have an impact on provider availability. Indeed, this relationship was particularly pronounced in Texas following the passage of HB2, where nearly half of all of the state's providers were forced to close. However, the situation may be more nuanced in other states.

While the number of abortion clinics (and to a lesser extent, other types of abortion providers) is declining in the US, a piece of this trend is likely attributable to decreased need for abortion, given temporal trends in abortion rates. In states enforcing TRAP laws, however, we may observe an "excess decline" in clinics and/or providers attributable to policy exposure. The goal of this analysis was to disentangle these effects and quantify the association between TRAP enforcement and clinic and provider availability as of 2014.

This manuscript, entitled "**Is TRAP enforcement associated with an excess change in abortion providers?**", is being formatted for submission to *Perspectives on Sexual and Reproductive Health*.

7.2 Manuscript 4

Is TRAP enforcement associated with an excess change in abortion providers?

Abstract

Background: The number of abortion-providing facilities in the US decreased from 2011 to 2014, and this decline was particularly pronounced among abortion clinics. While a portion of this trend is likely attributable to reduced need for abortion services (given trends in abortion rates), it is possible that abortion policies that target providers and facilities – commonly known as TRAP laws – also play a role in determining provider availability. In this paper, we aim to quantify the relationship between these policies and clinic/provider availability using data from 2008 to 2014.

Methods: We merged data on TRAP policies with publicly-available data on state-level counts of 1) abortion and nonspecialized clinics and 2) all abortion providers in 2008, 2011, and 2014. We used Poisson regression models with state and year fixed effects, an offset term, and cluster robust standard errors to compare changes in the number of clinics/providers in states that enforced TRAP policies to changes among states that did not enforce TRAP policies as of 2014. We also estimated marginal differences in clinic/provider counts and rates between exposure groups.

Results: TRAP enforcement was associated with an excess clinic decline of approximately 14% as of 2014 (IRR: .86, 95% CI: .65, 1.14), and a smaller change in providers (IRR: .90, 95% CI: .74, 1.09). In absolute terms, TRAP laws resulted in 2.3 fewer clinics (95% CI: -6.27, 1.74) and 3.4 fewer providers (-9.41, 2.70) as of 2014, conditional on state and year fixed effects. However,

given the imprecision we were unable to conclude that any of these estimates were reliably different from zero.

Conclusion: TRAP laws did not appear to trigger a reliably meaningful excess decrease in clinic or provider availability from 2011 to 2014, but the point estimates for clinic losses suggest a decrease is more likely than an increase. As many of these laws are relatively recent, and our analysis may have been underpowered to detect an effect, future analyses should revisit this question when additional (post-TRAP) years of clinic and provider count data are available.

***

Background

Abortion clinics provide the majority of all abortions in the United States (1, 19)). These facilities, in conjunction with nonspecialized clinics, provided roughly 95% of all abortions in 2014 (the most recent year for which data were available); the remaining 5% of abortions were performed in hospitals and private doctors' offices (1). Clinics are clearly essential to abortion provision, but their numbers are declining: from 2011 to 2014, there was a 17% drop in abortion clinics and a 6% decrease in abortion/nonspecialized clinics combined (compared to a 1% decline from 2008-2011). There was also a 3% drop in the number of all providers. There was considerable regional heterogeneity in clinic shifts, with losses generally concentrated in the US South and Midwest (1).

Facility closures are not necessarily indicative of barriers to service provision. Given temporal shifts in abortion rates common to nearly all states, part of the decline in clinics and providers is likely driven by decreased need for abortion, even in states where abortion is highly restricted.

However, any "natural" losses may be compounded by restrictive policies, potentially triggering a loss above and beyond what we would expect due to a shifting need for abortion, and restricting the ability of those in need to obtain an abortion within a reasonable timeframe. This is particularly relevant as the recent decline in clinic availability comes on the heels of an upsurge in abortion restrictions, many of which target facilities specifically (5). These laws are commonly known as TRAP (targeted regulation of abortion providers) laws.

There are state-level accounts of TRAP enactment and enforcement leading to striking facility closures (6), and abortion clinics may be less resilient to these policies than other providers. What is less clear, however, is whether the upsurge in these laws from 2010 onward is associated with what appears to be a disproportionately large reduction in certain types of abortion providers as of 2014. A recent descriptive analysis (1) reported an association between restrictive abortion policies and clinic counts (abortion and nonspecialized), but some states that did not enact new policies over this period also experienced sizable decreases in clinic availability, which (again) reflects a potential background trend of need-based reductions. There are also instances (for example, in Massachusetts, Connecticut, and New Jersey) of increased clinic counts and declines in abortion (1), which suggests that, in some areas, abortion trends are operating independently of clinic availability.

It is clear that restrictive abortion policies alone do not fully account for shifts in clinic and provider availability, but the aforementioned analysis did not provide an estimate of the excess change in clinics/providers that may be associated with TRAP exposure. Any excess shift (above and beyond what a state would experience in the absence of such restrictions) may have important implications

for state-level service provision: a decline that is due to fewer unintended pregnancies is qualitatively different, from both a public health and an ethical perspective, than a decrease due to restrictive policy enforcement. While there is conflicting evidence on whether reductions in clinics/providers also reduce abortion rates (1, 6, 32, 39, 49), closures likely impact other aspects of the experience of obtaining an abortion, such as travel time, hardship, and cost (7). At face value, the upswing in policy enforcement and the decline in provider availability over the 2011-2014 period appear potentially related, and this relationship merits further investigation.

Objectives

In this paper, we respond to calls to elucidate the drivers of clinic/provider availability and subsequent shifts in providers and abortion trends (1). The goal of this analysis is to assess if part of the sizable decline in clinics – and to a lesser extent, providers – observed from 2011 to 2014 is associated with the enforcement of new supply-side laws. Specifically, we look at states enforcing TRAP laws (ASC laws, admitting privilege regulations, or both) from 2011 to 2014 to examine if states enforcing these laws experienced a greater change in clinics/providers over the observation period than states not enforcing these laws, conditional on pre-period trends and measured covariates.

Methods

Data

Information on clinic and provider counts in 2008, 2011, and 2014 came from the Guttmacher Institute Data Center and two publications (1, 19). These data contain information on provider availability and clinic availability: the latter category is a combination of abortion clinics (defined

as “non-hospital facilities in which half or more patient visits are for abortion services”) and nonspecialized clinics, which provide a substantial proportion of abortions per year (1). In contrast, provider counts capture these clinics as well as hospitals, doctors’ offices, and other clinics (where fewer than half of all services are abortion-related). Given the available data, we assessed two outcomes: clinic counts (abortion and nonspecialized clinics) and provider counts (all facilities providing abortion).

We adopted a simple binary exposure definition for this analysis: states were considered “exposed” if they enforced a new ASC regulation, admitting privilege law, or both (with or without a transfer agreement component) between 2011 and 2014. Data on policy enforcement were compiled manually (71); briefly, we employed an iterative strategy to collect information on state-level policy shifts over time, drawing from state-level policy documents and secondary sources. We captured information on the presence, timing, and type of these policies, including qualitative information on any nuances of these laws. Policy data were merged with state demographic information on population size and the governor’s political affiliation; data on these variables came from the US Census and the Council on State Governments, respectively.

Analyses

Our goal was to assess whether the change in clinics/providers in exposed states was larger than expected from 2011-2014 – in other words, we were interested in detecting an “excess loss” over and above what might be expected in the context of existing trends. We began by examining the distribution of policy enforcement years in our sample and comparing the pre-policy (2008-2011) trajectories of clinic/provider loss in our two exposure groups to ensure that these trends were

roughly parallel (a key assumption in difference-in-differences analyses). To estimate the effect of TRAP enforcement on clinic and provider loss, we fit a series of Poisson models with cluster-robust standard errors (clustered at the state level (52)), controlling for state governors' political affiliation. Models also included state and year fixed effects to control for time-fixed differences between states and temporal trends in clinic and provider availability common to all states, and an offset term (the natural log of state population) to account for the fact that more populous states would naturally have higher counts of clinics and providers (and vice versa). To capture the association between TRAP enforcement and excess changes in clinics and providers, we introduced an *exposure*post* interaction term in our models to allow the effect of exposure to differ between groups over time. This interaction term – which is a simple difference-in-differences estimator in this scenario – was our main parameter of interest.

A number of assumptions are encoded in our analysis: first, that changes in abortion are a key driver of clinic/provider availability; second, that abortion rates do not undergo additional changes as a result of need-based declines in providers; and third, that TRAP enforcement is associated with provider availability, based on existing evidence (5-7). From a conceptual standpoint, we also assume that any impact of TRAP laws on abortion rates functions exclusively through provider availability (although we do not assess abortion trends in this analysis). Existing evidence suggests that TRAP enforcement is relatively exogenous (72): TRAP laws do not seem to be enforced in response to changes in abortion trends, but enforcement may be influenced by a state's political majority. Since political factors may also influence clinic and provider availability, we include governor's political party as a covariate in our models.

The aforementioned models provided estimates of the incidence rate ratio (IRR), comparing rates of clinic/provider loss between groups and periods. This is a valid measure, but it is often more interpretable to express findings on the absolute scale. As such, we used our models to generate marginal estimates of the difference in clinic and provider counts and rates (defined here as clinics per million), by exposure category. We also ran a series of sensitivity analyses to examine the robustness of our estimates. Analyses were conducted in Stata 14 (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP).

Results

Nine states in our dataset enforced a new ASC or admitting law from 2011-2014 (**Table 7.1**). According to our data, no states enforced new ASC or admitting privilege laws from 2008 to 2010, and only one state enforced a new law in 2011; this offers some assurance that any observed changes/differences are not a by-product of TRAP policy exposure in the previous period. As we note in the table, there are potential validity concerns for two of these states: the available policy information were relatively weak (with respect to policy timing) for Indiana, which was also the only state to enforce a law in 2011, and Louisiana's law did not appear to go fully into effect. We excluded these states in sensitivity analyses to ensure these concerns did not bias our results. We also excluded Texas in a separate sensitivity analysis to examine the extent to which the sizable and well-documented (6) clinic shift in this state influenced our estimates.

Table 7.1: TRAP states by enforcement year and policy type

State	Year[1]	Policy type(s)[2]
Indiana	2011	Admitting[3]
Louisiana	2014	Admitting[4]
Maryland	2012	ASC
Mississippi	2013	Admitting, transfer
North Dakota	2014	Admitting
Pennsylvania	2012	ASC, admitting, transfer
Tennessee	2012	Admitting
Texas	2013	Admitting
Virginia	2012	ASC, transfer

[1]Reflects year of enforcement – if multiple laws were enforced from 2011-2014, this date is the year the first policy went into effect; [2]All policies enforced over the observation period; [3]"Low confidence" state - excluded in sensitivity analysis; [4]Data suggest that this law was only partially enforced and never went fully into effect - excluded in sensitivity analysis

Figure 7.1 illustrates the distribution of clinic counts as of 2014. The shape of the provider distribution was very similar, but the scale differed since states tend to have far more providers than clinics (**Appendix Figure A1**)). State-level information on average population size, clinic/provider counts, and clinic/provider rates from 2008 to 2014 is also summarized in **Appendix Table A2**. The raw clinic and provider counts were strongly skewed: most states had fewer than 50 clinics or providers in any given year, but certain states (California, New York, and Florida in particular) had much higher counts in each category. However, conditional on governor's political affiliation and state and year fixed effects, these data were not overdispersed: the conditional variance did not exceed the conditional mean, which supported the use of a Poisson rather than a negative binomial model in this context.

Mean and median clinic and provider counts (by year and by exposure status) are reported in **Table 7.2**: this table further illustrates the skewness of the raw data and demonstrates changes in counts over time in each exposure category. Both the counts and rates of providers and clinics declined in each group over time: for example, the group of states that would eventually enforce TRAP laws had 141 clinics in 2008 (1.98 per million) and 114 as of 2014 (1.51 per million), whereas the numbers among non-enforcers dropped from 706 to 669 over the same period (from a rate of 3.04 to 2.76 clinics per million). Non-enforcers had much higher overall numbers of clinics and providers than enforcers; this is likely attributable to differences in population size, as three of the four most populous states in the US - New York, California, and Florida - were included in the non-enforcer group.

Figure 7.1: Distribution of clinic counts: 2014

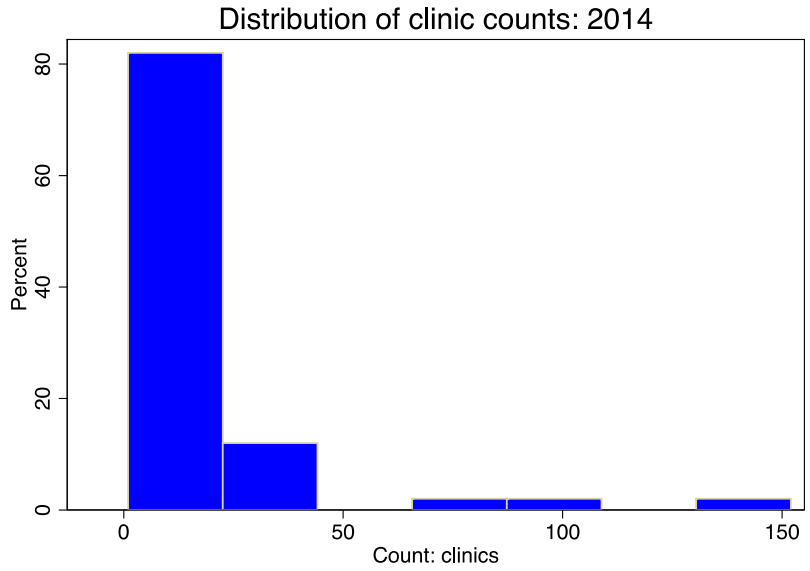


Table 7.2: Clinics and providers by exposure category

	2008			2011			2014		
	Total (rate)[1]	Median (IQR)	Mean (SD)	Total (rate)[1]	Median (IQR)	Mean (SD)	Total (rate)[1]	Median (IQR)	Mean (SD)
Clinics									
Enforcers	141 (1.98)	10 (14)	15.7 (15.2)	136 (1.85)	10 (14)	15.1 (14.0)	114 (1.51)	9 (15)	12.7 (10.3)
Non-enforcers	706 (3.04)	6 (14)	17.2 (31.5)	698 (2.94)	6 (16)	17.0 (29.3)	669 (2.76)	5 (13)	16.3 (28.7)
Providers									
Enforcers	226 (3.18)	13 (33)	25.1 (23.6)	214 (2.91)	14 (28)	23.8 (21.6)	191 (2.53)	11 (36)	21.2 (18.6)
Non-enforcers	1559 (6.71)	11 (31)	38.0 (87.7)	1497 (6.30)	12 (31)	36.5 (84.7)	1471 (6.07)	11 (24)	35.9 (84.8)

[1]Rates reflect the number of clinics/providers per 1,000,000 individuals: the denominator is a sum of all state populations in a given year/exposure category, and the numerator is a sum of all clinics or providers in a given year/exposure category

Appendix Figure A3 illustrates the total change in clinics/providers over time by exposure status. We also generated a basic estimate of the percentage change between years by summing annual clinic/provider counts by exposure category and comparing each period to its predecessor. These figures show a steeper gradient of change from 2011 to 2014, compared to the previous period, for both clinics and providers. However, changes were more pronounced among TRAP enforcers compared to non-enforcers for both clinics and providers (-16.18% vs. -4.15% for clinics; -10.75% vs. -1.74% for providers). **Figure 7.2** compares the pre-policy trends in clinic and availability in exposed and unexposed states (provider trends were very similar). This plot offers visual evidence supporting the parallel trends assumption. We also formally tested whether the change in clinics and providers differed over time by exposure status, and findings were in accordance with our plots: the pre-policy difference between groups was -.20 (95% CI: -1.32, .92) for clinics and .87 (95% CI: -.93, 2.66) for providers, supporting the validity of a difference-in-differences approach in this context.

Figure 7.2: Adjusted predictions of pre-policy clinic counts

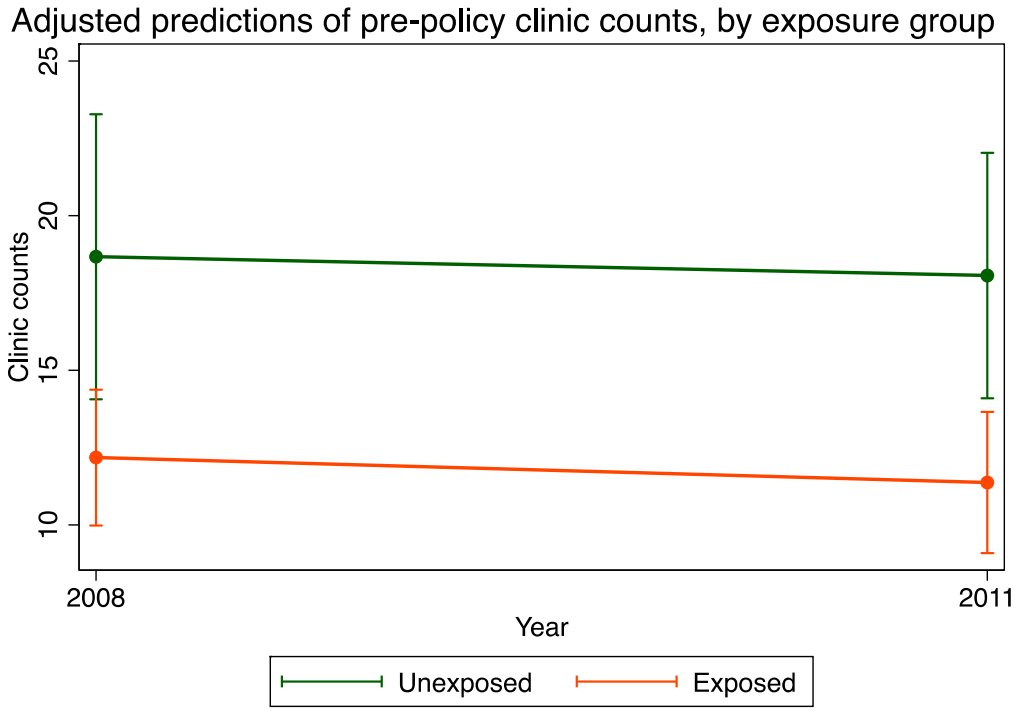


Figure 7.3 illustrates the state-level percent change in clinics and providers in 2014, compared to 2011 (plotted against the median change for each variable). Distributions varied slightly between clinics and providers, but exposed and unexposed states were fairly evenly distributed around the median change for each outcome (-.5% and -5%, respectively).

Figure 7.3: Percent change in clinics and providers, by exposure group

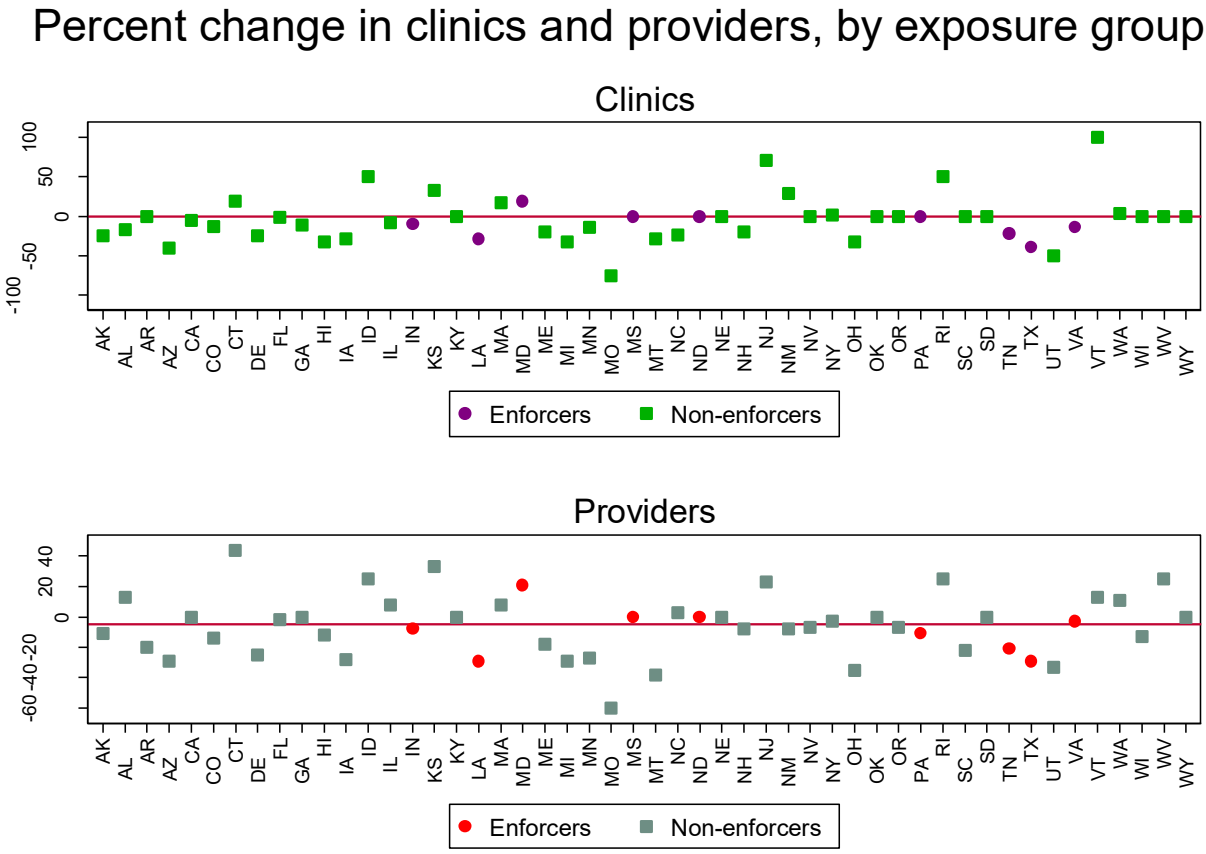


Table 7.3 summarizes the output from the regression models. Again, the parameter of interest from the models was the coefficient on the *enforcer*post* interaction term: this quantity represents the "extra" change in clinics and providers among TRAP enforcers, after accounting for time-fixed state-level characteristics and temporal trends in clinic/provider availability common across states. The fully adjusted model indicated that TRAP enforcers experienced an additional 14% decrease in clinics as of 2014 (IRR=.86, 95% CI: .65, 1.14) and a 10% decrease in providers (IRR=.90, 95% CI: .74, 1.10). Controlling for governor's political affiliation had virtually no effect on our effect

estimates or confidence intervals. On the absolute scale (**Table 7.4)** these findings translate to a policy-driven reduction of 2.3 clinics (95% CI: -6.27, 1.74), and an excess reduction in the clinic rate of .35 clinics per million (95% CI: -.96, .26). Findings were similar for providers: according to our results, TRAP laws led to an average of 3.4 fewer providers (95% CI: -9.41, 2.70) and a rate reduction of .50 clinics per million as of 2014.

Table 7.3: Effect of TRAP enforcement on clinic and provider counts (model coefficients)[1]

	Base model[2]		Adjusted[3]	
	Estimate	95% CI	Estimate	95% CI
Clinics				
β	-0.15	-0.42, 0.13	-0.15	-0.43, 0.13
IRR	0.86	0.65, 1.14	0.86	0.65, 1.14
Providers				
β	-0.11	-0.30, 0.09	-0.10	-0.30, 0.09
IRR	0.90	0.74, 1.09	0.90	0.74, 1.10

[1]"Clinics" include abortion clinics and nonspecialized clinics; "providers" include these clinics plus hospitals and private doctors' offices; [2]Includes state and year fixed effects and an offset term (the natural log of population per million); [3]Adjusted for governor's political affiliation

Table 7.4: Marginal differences in clinic/provider counts and rates [1]

	Predicted count		Predicted rate	
	Difference	**95% CI**	**Difference**	**95% CI**
Clinics	-2.27	-6.27, 1.74	-0.35	-0.96, 0.26
Providers	-3.36	-9.41, 2.70	-0.50	-1.40, 0.40

[1]Marginal predictions based on fully adjusted model

Sensitivity analyses (**Appendix Table A4**) demonstrated very little change when Indiana and Louisiana were removed from the exposed group. In contrast, all point estimates shifted dramatically when Texas was removed from our models. This was unsurprising as the magnitude of policy-driven clinic loss in Texas over this period was substantial. Although the confidence intervals surrounding these point estimates overlapped to some degree with those of our original

estimates, the shift in point estimates suggests that ASC and admitting privilege enforcement may not, on average, have a strong effect on clinic or provider availability.

Discussion

Given our findings, we are unable to conclude that TRAP laws led to a meaningful excess decrease in clinic or provider availability from 2011 to 2014: according to our models, TRAP laws resulted in an average policy-driven difference of -2.3 clinics (95% CI: -6.27, 1.74) and -3.4 providers (95% CI: -9.41, 2.70) as of 2014. However, this relationship may merit additional attention when new data are available as it is likely that our analysis was underpowered to detect an effect. Since many of the policies in this analysis were enforced fairly recently, it is possible that clinic availability will continue to diverge over time between enforcers and non-enforcers in (lagged) response to these laws.

It is also possible that outliers with potentially unique policy-driven trends in clinic and provider availability (in this case, Texas) will continue to have a strong influence on effect estimates. The substantive utility of excluding Texas from this analysis is debatable: the state is often considered anomalous for several reasons (including the severity of the policy exposure and the magnitude of the clinic/provider response), but it is also an informative example of what happens when particularly stringent legislation is passed. Given recent trends in highly restrictive abortion policymaking in the rest of the US (81-83), it may not be unreasonable to expect similar scenarios in other states.

This study had a number of limitations. First, we used only three data years and two time periods (2008 to 2011, and 2011 to 2014) to calculate our estimates. Additional years of data would have allowed us to more closely examine whether changes in clinic/provider availability were due to policies or other factors. More data would also be helpful with respect to power and precision: we had relatively few observations in our sample, which may have compromised our ability to detect an effect (particularly if the true average effect of TRAP laws on clinic/provider availability is considerably less extreme than the example in Texas, which is likely).

Second, given the complexity of abortion policy shifts in the US, there is always a possibility of misclassification in our policy data. However, our study design offers some protection against bias due to misclassification: even if the precise date of enforcement is incorrect, states would be still be correctly classified as "enforcers" as long as they enforced new laws within the range (2011 to 2014). We were reassured that our findings were robust to the exclusion of Indiana and Louisiana, both of which had complicated/unclear policy data. A final limitation is that, while our exposure definition offered some protection against misclassification, it was also fairly crude: we did not account for the type(s) of law in force, nor did we account for differences in policy type. These analyses should be revisited when additional rounds of clinic/provider data are available.

As abortion rates continue to fall in the US, we should expect to see corresponding declines in clinic and provider availability. If declines in clinics and providers occur organically - that is, if they are proportional to demand - this is unlikely cause for concern. However, given the recent enforcement of several state-level TRAP laws, it remains possible that availability trends among exposed and unexposed states may diverge meaningfully in the future. While many TRAP laws

are expected to be challenged and potentially overturned in coming years (5, 45), these policies may have a lasting impact on state-level service availability. We recommend continued monitoring of these trends to ensure that all women have adequate access to safe abortion.

7.3 Supplementary appendix: Manuscript 4

Figure A1: Distribution of provider counts: 2014

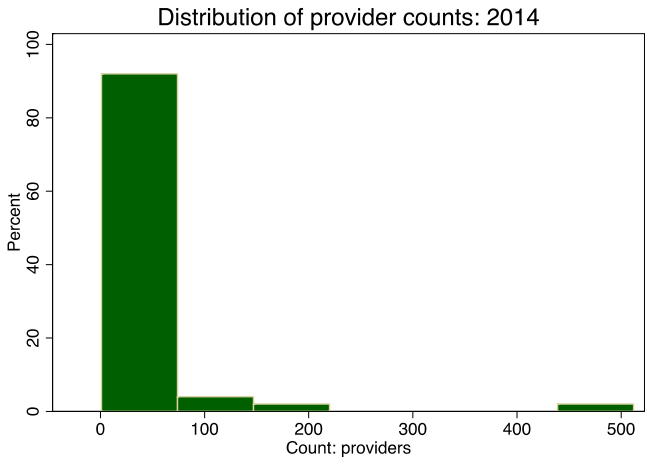


Table A2: Mean population and clinic/provider counts and rates, 2008-2014[1]

		Clinics		Providers	
State	**Population[2]**	**Count**	**Rate[3]**	**Count**	**Rate[3]**
AK	715,626	3.3	4.7	8.3	11.6
AL	4,788,053	6	1.3	8.3	1.7
AR	2,926,482	3.3	1.1	5	1.7
AZ	6,494,287	13.3	2.1	16	2.5
CA	37,659,020	160.3	4.3	515.3	13.7
CO	5,118,725	23	4.5	40	7.8
CT	3,572,720	22.7	6.3	49	13.7
DE	908,652	3.7	4	7.3	8.1
FL	19,157,863	71.7	3.7	88.3	4.6
GA	9,802,428	17.7	1.8	29.3	3
HI	1,374,457	5	3.6	33	24.1
IA	3,062,358	13	4.2	14	4.6
ID	1,584,279	2.7	1.7	4.3	2.7
IL	12,827,946	24	1.9	38	3
IN	6,512,320	9.3	1.4	11.7	1.8
KS	2,859,558	3.7	1.3	3.7	1.3
KY	4,357,430	2	0.5	3	0.7
LA	4,552,767	6.3	1.4	6.3	1.4
MA	6,602,138	12.3	1.9	41.3	6.3
MD	5,826,850	22	3.8	36.3	6.2
ME	1,329,805	5	3.8	11	8.3
MI	9,912,948	27.3	2.8	38.7	3.9
MN	5,348,329	6.3	1.2	13.3	2.5

MO	5,998,511	3.3	0.6	4.3	0.7
MS	2,972,906	1	0.3	2	0.7
MT	999,160	6	6	7	7
NC	9,633,416	18.3	1.9	34.7	3.6
ND	693,802	1	1.4	1	1.4
NE	1,840,055	2.7	1.4	5	2.7
NH	1,320,948	4.3	3.3	12	9.1
NJ	8,819,082	30.7	3.5	72.7	8.2
NM	2,058,637	7.3	3.6	11.7	5.7
NV	2,736,655	7.3	2.7	13.3	4.9
NY	19,465,383	97.3	5	230.7	11.9
OH	11,551,583	16.3	1.4	23	2
OK	3,779,328	3.3	0.9	5.3	1.4
OR	3,869,659	15	3.9	28.3	7.3
PA	12,715,245	20.7	1.6	46.3	3.6
RI	1,053,595	2.3	2.2	4.3	4.1
SC	4,678,885	3	0.6	7.3	1.6
SD	825,256	1	1.2	2	2.4
TN	6,398,476	8.7	1.4	12.7	2
TX	25,642,824	41.3	1.6	57.7	2.3
UT	2,807,362	3	1.1	7.3	2.6
VA	8,082,491	20	2.5	36.3	4.5
VT	625,855	4.3	6.9	9	14.4
WA	6,815,488	32.7	4.8	48.3	7.1
WI	5,703,713	4	0.7	8	1.4
WV	1,848,063	2	1.1	4.3	2.3
WY	565,948	0.3	0.6	3	5.3

[1]All figures averaged across three years: 2008, 2011, 2014; [2]Data drawn from US Census; [3]Rate reflects number of clinics/providers per 1,000,000 state residents

Figure A3: Crude clinic and provider counts over time

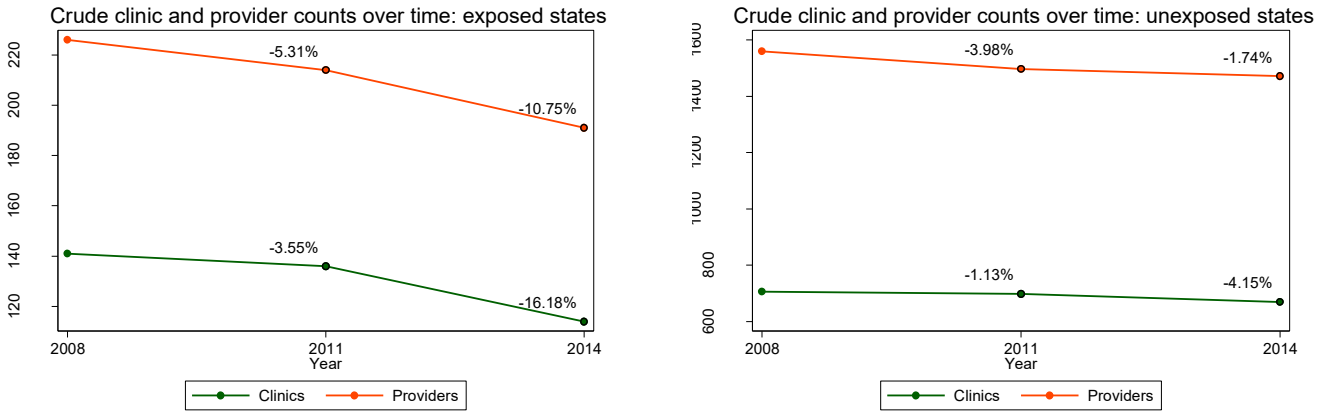


Table A4: Sensitivity analyses

	β (95% CI)	Diff: count (95% CI)	Diff: rate (95% CI)
Clinics			
Original estimates[1]	-0.15 (-0.43, 0.13)	-2.27 (-6.27, 1.74)	-0.35 (-0.96, 0.26)
Excluding IN & LA[2]	-0.16 (-0.48, 0.15)	-2.57 (-7.10, 1.96)	-0.39 (-1.08, 0.30)
Excluding TX	0.01 (-0.15, 0.17)	0.18 (-2.40, 2.76)	0.03 (-0.38, 0.44)
Providers			
Original estimates[1]	-0.10 (-0.30, 0.09)	-3.36 (-9.41, 2.70)	-0.50 (-1.40, 0.40)
Excluding IN & LA[2]	-0.11 (-0.32, 0.11)	-3.57 (-10.37, 3.24)	-0.53 (-1.53, 0.48)
Excluding TX	-0.003 (-0.14, .13)	-0.10 (-4.64, 4.43)	-0.02 (-0.71, 0.68)

[1]Estimates based on fully-adjusted model

8. Discussion

8.1 Summary of findings

The work presented herein offers a detailed picture of the distribution and consequences of TRAP laws in the US. A number of conclusions can be drawn from the collective findings in this dissertation. First, the available empirical evidence on the impact of TRAP laws on women's health outcomes is sparse (Chapter 4), and conclusions vary with respect to the relationship between TRAP laws and abortion rates. This was likely due to important differences in study design and exposure definition. Second, using a novel longitudinal database of policy shifts (Chapter 5), we found that ASC and admitting privilege laws did not lead to a meaningful decrease in abortion rates by state of occurrence (Chapter 6). Finally, TRAP laws may lead to important changes in clinic availability, but our analysis was likely underpowered to determine whether this effect was reliably different from zero (Chapter 7). This association should be re-examined when additional years of clinic and provider data are available.

Readers are cautioned that these results are not necessarily conclusive. Many of the most onerous TRAP laws in the US were enacted and enforced from 2010 onward (5). While we initially hypothesized, based on evidence from Texas (6), that TRAP laws would have an immediate effect on service availability and abortion outcomes, this may not be the case in every state, or for every policy type. It is also likely erroneous to conclude that these laws are without impact, even if they are not associated with substantial declines in abortion rates: for example, one of the studies in our systematic review addressed the impact of TRAP enforcement on women's experience obtaining abortions, and concluded that these laws increased self-reported travel burdens, costs, and overall

hardship in obtaining abortion (7). These factors should play an important role in any definition of "access".

As a result of the seminal Supreme Court decision in Whole Women vs. Hellerstedt, many existing TRAP laws have been challenged. This decision will also complicate future attempts to pass new TRAP-type legislation, but strategies to regulate abortion evolve quickly. Some of the most restrictive policies on record were proposed or enacted over the course of the past year, from a law in Iowa to prohibit abortion upon detection of a fetal heartbeat (81), to a Mississippi law to ban abortions after 15 weeks of pregnancy (82), to an Arkansas law that effectively bans medication abortion and could close two out of the state's three abortion providers (83). While many of the more severe restrictions are unconstitutional and were immediately challenged in court, states have started to use these laws as a way to challenge Roe v. Wade – in other words, to ultimately challenge the federally recognized right to abortion in the US – as the balance of the US Supreme Court begins to tilt in conservatives' favor (82). While TRAP laws have historically been veiled as a way to protect women's health (46), states are becoming less covert and more forthright about their motivations for passing restrictive abortion policies, in spite of compelling evidence to suggest that restricting access to abortion has a detrimental effect on the health and socioeconomic outcomes of women (24, 84).

8.2 Limitations and opportunities for future research

We noted several specific limitations throughout the four manuscripts presented in this thesis, but a few overarching limitations are important to consider. A key concern, given the complexity of the policy data, is that certain enactment/enforcement years are misclassified. We attempted to

protect against this in several ways: we used two independent policy coders, consulted with knowledgeable researchers in this area, cross-referenced our final data against various sources and closely examined any discordance, and (where data were truly unclear with respect to timing) we included an indicator of uncertainty in our database, which we used to exclude these states from our subsequent analyses**.** Estimates shifted very little when these states were excluded, which was reassuring.

Another limitation is that we did not control for out-migration in this work. Migration out of a state with restrictive abortion policies into a more permissive state in order to obtain abortion services may be a fairly common phenomenon (19, 28, 51, 79). However, this tends to occur in less populous states with fewer women and fewer providers, and is unlikely to introduce substantial bias (personal communication: R. Jones (Guttmacher Institute), 31 May 2016). Nevertheless, assessing data on abortion rates by both state of occurrence (i.e., where the abortion was performed) and state of residence (i.e., where the woman seeking the abortion resides) may be helpful in understanding nuanced patterns of abortion-seeking behavior. While the Guttmacher Institute maintains data on abortion by state of residence, these are only estimates, and they were only available through 2011 as of this writing; as such, we chose to use data by state of occurrence in these analyses.

Finally, the analyses in this thesis were conducted at the state level, as individual-level data on abortion are not available for the full US population, which precluded a number of important and interesting analyses. While much can be learned from an assessment of state-level trends, the women within these states are not homogenous, and these differences may have a dramatic impact

on how TRAP enforcement is experienced at the individual-level. For example, recent cross-sectional work suggests that approximately one fifth of abortion-seeking women travel over 50 miles for abortion (43). Some of these women may be travelling out-of-state for care, which we did not assess here (the abortion rates in our dataset are by state of occurrence, not residence). Importantly, women of higher-socioeconomic position (SEP) generally have more resources and are better able to overcome structural barriers, whereas low-SEP women may experience events like clinic closures very differently. Women without the means to travel may rely on unsafe forms of abortion, delay their abortions until later in the pregnancy in order to secure the required financial resources, or carry their pregnancies to term (this phenomenon was previously observed in a study on Medicaid restrictions (35)).

In sum, the structural barriers introduced by these policies (increased distance to providers, increased costs of obtaining abortion) may be more difficult to surmount for women of low SEP, and this may ultimately translate to differences in abortion rates. As young and low-SEP women are disproportionately more likely to experience unintended pregnancies and abortions (15, 16), it is essential to understand whether TRAP laws have a uniquely strong impact in these higher risk groups. Understanding the impact of supply-side abortion restrictions on low-SEP women in particular should be a priority in future analyses, but may be challenging given data limitations.

8.3 Conclusion

We are at an important crossroads for reproductive health policy in the US. While a seminal Supreme Court decision (45) has significant implications for the survival of existing and future

TRAP laws, many policies will remain in effect until they are formally challenged. As such, the importance of the role played by states in regulating women's access to abortion and other reproductive health services cannot be overemphasized (5): continued access to safe abortion has far-reaching implications for women's economic capacity and decision-making (24), but this access – including component factors such as cost and distance to providers - depends in large part on state-level policy decisions. While we did not detect an effect of TRAP laws on abortion rates, the association between these laws and clinic availability (the most common providers of abortion in the US) was less clear, and it is possible that clinic reductions may exacerbate existing inequalities in abortion access (6, 42). With the help of the data produced by my research, these trends can easily be monitored into the future.

9. References

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