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ABSTRACT

Criminalization of Homosexuality and Sex Ratios

Sexual activities between consenting adults of the same sex are still criminalized in more than one third of the countries in the world despite a global wave of decriminalization in the past sixty years. This paper empirically investigates the effect of sex ratios, i.e. relative number of men to women, on the criminalization of same-sex sexual conducts. At the individual level, people in high sex ratio countries are found to be more hostile against homosexuality and the homosexuals than their counterparts in low sex ratio countries. At the country level, sex ratios have a positive effect on criminalization. In particular, the two-stage least squares estimate using temperature as instrumental variable suggests that adding another man per 100 women in a country would increase the probability of criminalization by nearly three percentage points. Moreover, the fixed-effect estimate based on a US state-level panel data show that adding another man per 100 women in a state would have lowered the probability of revoking the state sodomy law by nearly two percentage points. These findings suggest that a high sex ratio creates a homophobic social environment that facilitates (hampers) the criminalization (decriminalization) of homosexuality.

JEL Classification: J1, K4

Keywords: sex ratio, sodomy law, social norm, homosexuality

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1. Introduction

This paper investigates the interplay between demography and criminal law in the context of homosexuality. In 2013, sexual activities between consenting adults of the same sex were criminalized in more than one third of the countries in the world (ILGA 2013). The applied penal codes are generally known as *sodomy laws*.[1] As shown in Figure 1, these countries (shaded countries) tend to cluster in Africa and Asia, including the Middle East. Many of these countries are highly influenced by the Abrahamic religions, i.e. Judaism, Christianity and Islam, which condemn homosexuality in their religious teachings.[2]

In addition, more than half of them were once ruled by the British Empire, which undemocratically imposed its sodomy law upon its colonies (Human Rights Watch 2008).[3] Most of these former British colonies inherited the colonial sodomy

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[1] The word, *sodomy*, originates from a biblical city *Sodom*, which was destroyed by God for the sins of its inhabitants (the Book of Genesis). The sexual acts meant by the term *sodomy* generally refer to not only sexual intercourse between individuals of the same sex but also oral sex, anal sex and bestiality.

[2] For example, a proscription in the *Old Testament* states: "*If a man lies with mankind, as he lieth with a women, both of them have committed an abomination: they shall surely be put to death; their blood shall be upon you*" (Leviticus 20:13). Similar prohibitions for Muslims can be found in the *Quran* and the *Hadith*.

[3] One famous example is the introduction of the Section 377 into the Indian Penal Code in 1860 by the British colonial government. It states that "*Whoever voluntarily has carnal intercourse against the order of nature with any man, woman or animal, shall be punished with imprisonment for life, or with imprisonment of either description for term which may extend to ten years, and shall also be liable to fine*." In fact, Section 377 was inherited by most of the former British colonies in Africa, Asia and the Pacific. Among them, only New Zealand, Australia, Hong Kong and Fiji have recently repealed it (Human Rights Watch 2008).

law even after they became independent (Kirby 2011).

[Figure 1 about here]

Nevertheless, there is a global wave of decriminalization initiated in the second-half of the twentieth century. In 1957, the famous *Wolfenden Report* in Britain recommended that homosexual behavior between consenting adults in private should no longer be a criminal offense. Many believed that this report eventually resulted in the repeal of the sodomy laws in England and Wales in 1967. Since then, the world has witnessed an exponential growth of decriminalization. More specifically, 70 countries have rescinded their sodomy laws during 1950-2012 (ILGA 2013).

A natural question arises: why some countries still punish homosexual sexual acts, while many others have revoked their sodomy laws? In the scant literature that directly deals with reforms of sodomy laws and related gay rights, researchers have investigated a variety of factors. Haider-Markel and Meier (1996) focused on the influence of interest group politics. Kane (2003, 2007) stressed the importance of social movement. All of these papers, however, only study the case of the United States. As a welcome exception, Frank et al. (2009, 2010) scrutinized the repeal of sodomy laws across countries and even more broadly the worldwide trends in the criminal regulation of sex after the Second World War. They argued that a world-level support for criminal laws has shifted from protecting collective entities, e.g. the

family and the nation, to protecting individuals, leading to decriminalization of sodomy and other sex laws around the world.

This paper contributes to this literature by investigating the effects of a less noticed demographic factor—sex ratios, i.e. relative number of men to women. Countries that criminalize same-sex sexual conducts in Figure 1 tend to have higher sex ratios than others. Their average population sex ratio in 2010 is 107 men per 100 women.[4] However, the other countries on average have only 98 men per 100 women. In other words, the former group tends to have more men than women, while the latter group is more likely to have more women than men.

Historically, countries that used to criminalize same-sex sexual conducts in the past also tend to have lower sex ratios when they repealed their sodomy laws. Figure 2 plots historical sex ratios—men per women in this figure—for these countries at the time when they decriminalized homosexual conducts. As shown, most of their sex ratios lied below either the world sex ratio (the solid line) or the unity line, suggesting that decriminalization is more likely to occur in lower sex ratio countries.

[Figure 2 about here]

These two observations on sex ratios are not a coincidence for two reasons. First, the sex research literature has well documented that heterosexual men hold

[4] Data are from World Population Prospects 2012 (WPP 2012). More details about WPP 2012 are provided in section 3.

more hostile attitudes toward the homosexuals than heterosexual women (Kite 1984; Herek 1988; LaMar and Kite 1998). Second, a high sex ratio indicates an aggregate scarcity of women in a society, in which the mating competition among heterosexual men would be intensified. The intensified competition is likely to promote masculinity, which in turn generates antagonistic attitudes against homosexuality. Therefore, a high sex ratio creates a hostile social environment against the homosexuals and facilitates the criminalization. The next section elaborates more on the potential mechanisms for sex ratios to affect the criminalization of homosexuality. For clarification, homosexuality in this paper mainly refers to the sexual behaviors between people of the same sex.

To empirically estimate the effect of sex ratios on criminalization, I employ data at three levels. Empirical findings based on individual-level data show that sex ratios are correlated with negative views of homosexuality and the homosexuals. At the country level, two-stage least squares (2SLS) estimates suggest that adding another man per 100 women in a country would increase the probability of criminalization by about three percentage points. Moreover, the fixed-effect estimate based on a US state-level panel data show that adding another man per 100 women in a state would lower the probability of revoking the state sodomy law by nearly two percentage points.

All these findings suggest that a high sex ratio creates a homophobic social environment that facilitates (or hampers) the criminalization (or decriminalization) of homosexuality. In retrospect, the findings offer an alternative, but not exclusive, explanation on why the global wave of decriminalization in the past sixty years has removed sodomy laws mostly in lower sex ratio—thus less homophobic—countries, especially in Europe.

The rest of this paper is organized as follows. In section 2, I propose a framework that conceptualizes the interplay between sex ratios and sodomy laws. Section 3 investigates the determinants of individuals' attitude toward homosexuality and the homosexuals with a focus on sex ratios and gender. Section 4 estimates the effect of sex ratios on criminalization by OLS and 2SLS method. Section 5 estimates the effect of sex ratios on the repeals of state sodomy laws in the US. The last section discusses and concludes the findings.

2. Conceptual Framework

In criminal justice, there are two major perspectives on criminal lawmaking (Chambliss and Seidman 1971). The first perspective is the so-called *consensus model*, which asserts that most members in a society agree on what constitutes criminal offenses and thus a criminal law is simply a codification of the agreed-upon social values. The second one is the *conflict model*, which argues that a criminal law is the

prize for antagonistic struggle among vested interest groups and only reflects the values of those who eventually grab the power, sometimes leading to the criminalization of those without power.

The two perspectives are not necessarily mutually exclusive and intertwine heavily with the political system in a state. In democratic countries, legislative candidates are more likely to be elected if they hold the same values as those held by the majority of their constituency. Once elected, they are more likely to pass or rescind criminal laws in accordance with the value-consensus. On the contrary, laws in totalitarian countries are more likely to reflect only the values of the few in power and to be used as a means of social control or even suppression.

Following these two models, one can infer that revoking sodomy laws would require either the majority of members in a society or those with power to at least tolerate, if not encourage, same-sex sexual relations. Even though laws can be nullified through the judicial approach in some countries, judges' rulings are often influenced by public opinion.[5]

Building upon the insight derived from criminal justice, I argue that sex ratios affect the criminalization of homosexuality through changing the social hostility against homosexuality and the homosexuals. More specifically, a high sex ratio

[5] For example, in *Lawrence and Garner v Texas* in 2003, the US Supreme Court found the Texas sodomy law unconstitutional, invalidating all remaining state sodomy laws.

creates a more homophobic social environment that is conducive to the retaining of sodomy or other anti-homosexuality laws and *vice versa*. There are two channels for sex ratios to create a homophobic social environment, which I elaborate below.

The first channel arises from the sex difference in the heterosexuals' attitudes toward homosexual people. The sex research literature has well documented that heterosexual men hold more hostile attitudes toward the homosexuals than heterosexual women (Kite 1984; Herek 1988; LaMar and Kite 1998). In addition, heterosexual men's attitudes toward gay men are even more negative than toward lesbians. In a high sex ratio society where the heterosexuals constitute the majority, therefore, men's hostility against the homosexuals is more likely to dominate the social consensus. Moreover, throughout the human history, men generally hold more power than women in determining social norms and laws. All things considered, it implies that a high sex ratio society is more likely to criminalize homosexuality than a low sex ratio counterpart.

The second channel derives from the heterosexual mating competition intensified by the aggregate scarcity of women. A shortage of women in a country aggravates the competition among men who woo women for a formal or informal romantic relationship. The enhanced competition bestows women more bargaining power to demand more out of a relationship (Becker 1981; Guttentag and Secord

1983). As a result, the male traits preferred by women would be highly valued by both sexes.

Masculinity is one such trait. It refers to a collection of qualities that are generally considered typical of men such as physical strength, aggression, and restricted emotions etc. (Levant and Kopecky 1995). Studies have shown that more masculine men tend to have more sexual partners than their less masculine counterparts (Rhodes, Simmons and Peters 2005; Pleck, Sonenstein and Ku 1993a, 1993 b). Some researchers tried to explain the difference from an evolutionary biology perspective by arguing that masculinity signals good health and greater developmental stability, both of which attract women (Rhodes et al. 2003; Thornhill and Gangestad 2006). This leads a hypothesis that masculinity would be highly valued in a high sex ratio environment as a result of the enhanced mating competition.

Yet, more masculine men are also more homophobic than less masculine men. Parrot and Zeichner (2008) found in a lab experiment that men with greater masculinity are more likely to inflict physical aggression toward a gay after being exposed to a male-to-male erotic video. One can thus infer that through mating competition a high sex ratio environment would promote masculinity, which in turns enhances homophobia.

Overall, above two channels suggest that a high sex ratio would lead to a

hostile environment against homosexuality. Coupled with the two aforementioned perspectives in criminal justice, three testable hypotheses can be derived. First, individuals in a high sex ratio society are more hostile against homosexuality than those in a low sex ratio society. Second, countries with a high sex ratio are more likely to criminalize homosexuality.[6] Third, sex ratios have a greater influence on the criminalization of homosexuality in democratic countries than in autocratic countries. This is because lawmaking in democratic countries is more likely to reflect the preferences of social members. In the following sections, I use data at both individual and country level to test these hypotheses.

3. Determinants of Individual Attitudes toward Homosexuality

This section investigates the determinants of individual attitudes toward homosexuality with a focus on gender and country sex ratio. I employ a sample extracted from the fifth wave of the *World Values Survey* (WVS 5) conducted during 2005-2008. The sample consists of 44,596 individuals from 46 countries across the world.[7] I use two measures of individual attitudes toward homosexuality and the homosexuals. First, in WVS 5, respondents were asked about whether they think homosexuality can be justified on a 10-point scale, ranging from never justified (1) to

[6] If a country already has a sodomy law, a high sex ratio would imply that this country is less likely to repeal the law.

[7] Among them, 13 countries are in Asia, 7 in Africa, 7 in the Americas, 18 in Europe and 1 in Oceania.

always justified (10). Second, they were also asked to choose from a list of various groups of people who they would *not* like to have as neighbors.[8] I construct a dummy variable to indicate if one would not like to have homosexual neighbors.

Table 1 summarizes these two measures by gender (Panel A) and country sex ratio (Panel B) as well as tests the equality of group averages.[9] Country sex ratio is defined as the number of men per 100 women in the country in the year of survey. Sex ratio data are obtained from the *World Population Prospects*, *the* 2012 *Revision* (WPP 2012), which was produced by the Department of Economic and Social Affairs, Population Division of the United Nations.[10]

[Table 1 about here]

As shown in Panel A, men are more hostile against homosexuality and the homosexuals than women. In terms of the justifiability of homosexuality, men's average score is only 3.08, which is 11% lower than women's average score. Meanwhile, men are also more likely than women to reject homosexual neighbors (56% for men versus 52% for women). The differences between men and women of these two measures are both statistically significant.

In Panel B, people in countries that have more men than women—thus

[8] Respondents were allowed to choose multiple groups.

[9] Country-specific sampling weights are used when calculating the averages.

[10] The data can be downloaded from http://esa.un.org/wpp/. It is worth noting that the WPP 2012 sex ratios are estimated under various assumptions. Its methodology can be found at http://esa.un.org/wpp/.

country sex ratio is greater than 100—appear to be, on average, less tolerant of homosexuality and the homosexuals than people in countries that have more women than men. In particular, the average score of justifiability in the high sex ratio countries (SR>100) is 46% lower than that in the low sex ratio countries (SR≤100) (1.97 versus 3.62). The high sex ratio countries also have 74% of people rejecting homosexual neighbors, which is 25-percentage-point higher than the low sex ratio countries. It is worth noting that the differences in attitudes between the high and low sex ratio countries are much larger than the differences between men and women in Panel A.

To identify the effect of gender and sex ratio more precisely, I further control for individuals' age, marital status, education, employment, income and religion as well as the regime type of their own country. To measure the regime type, I use the polity2 score from the *Polity IV Project* to construct a dummy variable to indicate if a country is a democracy.[11] In addition, I include a full set of country dummies and survey year dummies to control for country and year fixed effects. For statistical inference, I use robust standard errors clustered at country level.

[Table 2 about here]

[11] The original polity2 score ranges from +10 (full democracy) to -10 (full autocracy). As recommended by the Polity IV Project, countries with a score between -10 and -6 are autocracy, -5 and +5 anocracy and +6 and +10 democracy. Data are available at http://www.systemicpeace.org/polity/polity4.htm.

Table 2 reports the regression results. Dependent variable in column (1) and (2) is the 10-point scale measure of justifiability. The difference between the two columns is an additional control for individuals' gender in column (2). The coefficient on *Sex Ratio* in column (1) implies that all else being the same, adding another man per 100 women in a country would lower the average justifiability score by 0.533, which is about 16% of the overall average score (3.28). Its magnitude only decreases by about 4% to 0.513 in column (2) after the gender dummy, *Male*, is being controlled. This suggests that the difference between men and women only partially explains the sex ratio effect. A larger portion of the sex ratio effect is attributable to the relative scarcity of women in the population. The coefficient on *Male* shows that men's justifiability is lower than women's by 0.345, which is slightly smaller than the sex difference without any control (0.37) in Table 1.

In column (3) and (4), the dependent variable is the dummy variable indicating if one rejects homosexual neighbors. The coefficient on *Sex Ratio* in column (3) shows that adding another man per 100 women into a country would increase the probability of rejecting homosexual neighbors by 22.9 percentage points, which is about 43% of the average probability (0.53). Similarly, controlling for individuals' gender in column (4) only slightly attenuates the coefficient. Meanwhile, the coefficient on *Male* shows that men's probability of rejecting homosexual neighbors

is higher than women's by 4.2 percentage points, which is slightly larger than the sex difference without controls (4 percentage points) in Table 1.

As for other covariates, the results suggest that people in democratic countries, of younger age, unmarried, having no children, having higher education and income tend to be more tolerant of homosexuality and the homosexuals. Besides, religion also plays an important role. In comparison to Buddhists, Muslims appear to have the most negative attitudes.

Overall, the profound implication of the regression results in Table 2 is that a country with more men than women is likely to form a social environment—as a result of both the sex difference and the aggregate scarcity of women—that is more hostile against homosexuality and the homosexuals. Such environment is therefore conducive to retaining the extant anti-homosexuality laws, if there is any in a country.

4. The Effects of Sex Ratios on the Legal Status of Homosexual Sexual Conducts

Building upon the previous findings on individual attitudes, this section tests the hypothesis that all else being equal a high sex ratio country is less likely than a low sex ratio country to decriminalize homosexual sexual conducts using a cross-section data set of 190 countries or territories in the world in 2013.[12] Note that at the country level, both the sex difference and the aggregate scarcity of women

[12] Some places such as Hong Kong and Macau are not independent countries but have their own legal system.

operate through the aggregate country sex ratios.

4.1 *Country-level Data*

I collected data regarding the country-level legal status on homosexual sexual conducts from the website of the *International Lesbian, Gay, Bisexual, Trans and Intersex Association* (ILGA).[13] The legal status was evaluated at the end of 2013. In the following regressions, the key outcome is a dummy variable equal to one if at least one same-sex sexual conduct is illegal in a country and zero if otherwise. The same-sex sexual conducts refer to both male-to-male and female-to-female sexual relationships.

Sex ratios and population data were obtained from WPP 2012.[14] In addition to the overall country sex ratio, I also utilized sex ratios for three age groups: 0-19, 20-49 and 50 and older. Age-specific sex ratios allowed me to examine the heterogeneous sex ratio effects by age. Data regarding each country's largest religious group, Gross Domestic Product (GDP) per capita adjusted for purchasing power parity (PPP) and literacy rate were acquired from the CIA Factbook website.[15] These variables were evaluated in either 2013 or the latest year available.

[13] The URL for ILGA is http://ilga.org/ilga/en/index.html. Data were retrieved in December 2013.

[14] Since WPP 2012 only updates its data up to 2010 by the time of this paper, I have to use sex ratios and population in 2010 in the regressions. Between 2010 and 2013, only Lesotho repealed its sodomy law in 2012 among the 190 countries in the sample. Thus, using sex ratio in 2010 should not lead to a serious bias in the estimation.

[15] The URL is https://www.cia.gov/library/publications/the-world-factbook/.

Table 3 summarizes country characteristics by the legal status of same-sex sexual acts. Among the 190 countries, same-sex sexual acts are legal in 119 countries (called legal countries hereafter) and illegal in the other 71 countries (called illegal countries hereafter).[16] The overall sex ratio for the whole world is quite balanced. Yet, the illegal countries have a much higher overall sex ratio than the legal countries (1.07 versus 0.98). Note that from now on the sex ratios are defined as the number of men per women. By age, the largest difference occurs to the oldest age group (50+) and the second largest to the group of age 20-49. It is interesting, however, to note that their sex ratios are very similar for the minors of age 0-19.

[Table 3 about here]

In terms of religion, the Christians are the largest religious group for 71% of the legal countries but only 39% of the illegal countries. The Muslims are the largest group for only 14% of the legal countries but 45% of the illegal countries. As for the geographic distribution, the illegal countries are more likely to cluster in Africa and Asia, including the Middle East, while the legal countries spread out across continents. At last, in comparison to the legal countries, the illegal countries are more likely to be poorer, have a larger population size and a lower literacy rate.

4.2 *Benchmark Regressions*

[16] Among the 71 countries, all of them penalized male-to-male sexual relation, but only 48 of them also criminalized female-to-female sexual relation.

In the benchmark regressions, I regress the legal status dummy on different sex ratios, literacy rate, logarithm of GDP per capita, logarithm of population size and a full set of religious group and region dummies. The results are reported in Table 4. Column (1) through (4) respectively uses overall sex ratio, sex ratio for age 0-19, 20-49 and 50 and older. Robust standard errors clustered at region are reported for statistical inferences.

[Table 4 about here]

The estimate of the overall sex ratio in column (1) is 0.218 and statistically significant. This implies that all else being equal, if a country's overall sex ratio increases by 0.01, i.e. one additional man per 100 women, the probability for it to criminalize homosexual conducts would increase by about 0.218 percentage points. It is probably more helpful to interpret this estimate from the perspective of the whole world. The world sex ratio has increased from 0.996 in 1950 to 1.016 in 2010, which is equivalent to two men per 100 women (WPP 2012). Assuming the number of countries is fixed and no structural changes in the parameters over this period, the OLS estimate implies that additional 0.8 countries have criminalized same-sex sexual conducts in the past 60 years due to the rise in sex ratio ((1.016-0.996)

×0.218×190=0.828).[17]

Estimates in column (2)-(4) show that the sex ratio effect increases by age. The group of 50+ has the largest effect at 0.279 and the group of 20-49 has the second largest effect at 0.126. On the contrary, the effect for the group of 0-19 is negative but not statistically significant. One explanation for the heterogeneity by age is that in most countries, the older cohorts have the most political and economic powers to influence social norms and laws. Therefore, the legal status is most likely to reflect the values of the older adults, rather than the values of the minors.

Table 4 also reports the estimates on the largest religious groups. As shown, countries where the Muslims are the largest religious group are more likely to criminalize homosexual conducts in comparison to countries where the Buddhists are the largest group. It is also the only statistically significant estimate among all religions.

In addition to the legal status, I also conducted an ordered probit estimation of the sex ratio effects on the maximum penalties on homosexual sex sexual acts. The maximum penalties include in ascending order imprisonment up to 14 years, 14 years

[17] I also examined the non-linearity of the sex ratio effect by adding a squared sex ratio. The estimate of the sex ratio and the squared sex ratio are 0.88 and -0.17 respectively. However, neither of them is statistically significant. The signs of them do suggest an inverted U-shape with a turning point occurring at 2.6, i.e. 260 men per 100 women. Yet, only one country, Qatar with a sex ratio at 3.12, among the 190 countries has a sex ratio higher than 2.6.

to life and death penalty. The results show that a country with a higher sex ratio would impose more severe punishments on homosexual conducts (Table A1 in the online appendix).

4.3 *Interaction with Politics*

In general, democratic countries are more likely to pass or repeal laws in accordance with the values of the majority of its citizens than do autocratic countries. Therefore, whether and how sex ratios affect laws likely depends on the regime type. To explore such dependency, I interact the sex ratios with two regime dummy variables—one indicating anocracy and the other democracy—again, based on the *polity*2 score from the Polity IV Project in 2012. The reference group is autocracy. The *polity*2 score, however, is only available for 161 countries in the sample for various reasons.[18]

Panel A in Table 5 reports the original OLS estimates, while Panel B reports the average marginal effects (AME) of sex ratios for each regime type. Although none of the interaction terms is statistically significant, most of them are positive. In terms of the magnitudes of the AMEs, the largest sex ratio effects always occur to

[18] One reason is that the Polity IV project only covers countries with total population of 500,000 or more. Another reason is that some countries, e.g. Afghanistan, were intervened by foreign powers in 2012. Among the 161 countries which the polity2 score is available, 105 are legal countries and 56 are illegal countries. The legal status dummy thus has a mean of 0.35, which is only slightly smaller than the original mean of 0.37 when we have 190 countries.

democratic countries, although only the case for age 50+ is statistically significant. Nevertheless, the findings still suggest that if sex ratios could influence anti-homosexuality laws, their effect would be larger in a democratic regime. Of course, the caveat is still that the results lack statistical significance.

[Table 5 about here]

4.4 *Two-stage Least Squares Estimation*

There are two major identification concerns with the OLS estimates of the sex ratio effect. The first concern is the potential measurement errors in the sex ratios. As noted earlier, the WPP 2012 sex ratios were estimated under various assumptions, instead of using the raw data from each country. Moreover, due to data limitation, I had to use the sex ratios in 2010, instead of 2013 when the legal status was measured. If the classic errors-in-variables assumptions hold, the previous OLS estimates could be underestimated.

The second concern is that there could be an unobserved country-level cultural factor that affects both the laws and sex ratios. For example, patriarchal societies typically prefer sons over daughters in order to pass assets along the male line, thus leading to a high sex ratio (Das Gupta et. al. 2003; Hesketh and Zhu 2006). Meanwhile, such societies are unlikely to welcome homosexuality as it would pose as a threat to the continuation of the male lineage, although it remains unclear whether

non-patriarchal societies are more tolerant of homosexuality. Unfortunately, there exists no well-accepted measure of the patriarchal culture and failing to control for it may result in an overestimate of the sex ratio effect.

The two potential estimation biases move in the opposite directions and thus may offset each other to an extent about which we do not have any prior knowledge. Nor do we know that if one of them would be large enough to dominate the net bias. To mitigate these concerns, I employ temperature to instrument for the sex ratios and apply the two-stage least squares (2SLS) estimation method. I discuss the validity of using temperature as an instrumental variable in the following.

Catalano et al. (2008) found that in Nordic countries cold ambient temperatures during gestation lowered the sex ratio at birth, because male fetuses are more likely than female fetuses to be aborted by women under environment stressors. In another study, Catalano et al. (2012) found that Swedish male infant of age 1-4 who experienced relatively warm times in utero but encountered relatively cold temperatures in early life had a shorter lifespan than other males. These two studies suggest that temperatures are correlated with sex ratios at young ages. Moreover, there is a lengthy literature documenting heat-related mortality (see a recent review by Basu and Samet 2002). In general, men are more likely than women to do strenuous jobs, e.g. construction works, in an unsheltered environment. It is thus reasonable to

suspect that men and women are on average exposed to different levels of temperature-related mortality risk. If this is true, temperature could also affect the sex ratio among adults.

On the other hand, I argue that temperature is unlikely to be correlated with the measurement errors and the unobserved patriarchal culture. None of the assumptions that WPP 2012 made in order to impute sex ratios is related to temperature. On the other hand, patriarchal societies can be found in all climatic regions.

I collected the average temperature for each country during 1990-2009 from the World Bank's Climate Change Knowledge Portal (CCKP).[19] The 2SLS estimates are reported in Panel A of Table 6. The same set of control variables from Table 4 is used. In column (1), the 2SLS estimate on overall sex ratio is 2.941, implying that if an individual country adds one additional man per 100 women, the probability for it to criminalize homosexual sexual conducts would increase by nearly three percentage points.

From the world perspective, the 2SLS estimate implies that additional eleven countries have criminalized same-sex sexual conducts in the past sixty years (1950-2010) due to the rise in the world sex ratio ((1.016-0.996) ×2.941×190=11.18).

[19] Its URL is http://sdwebx.worldbank.org/climateportal/index.cfm.

In fact, about 74% of the 190 countries already criminalized homosexuality in 1950 and about 69 countries decriminalized it in the following 60 years. Therefore, a better interpretation of the 2SLS estimate would probably be that about eleven countries could have decriminalized homosexuality but failed to do so. At any rate, the 2SLS estimate is much larger than the OLS estimate, suggesting the bias seems to be dominated by the measurement errors. As for the age-specific sex ratios in column (2)-(4), the 2SLS estimates are also much larger than the OLS counterparts in Table 4.

[Table 6 about here]

The first stage estimation results are reported in Panel B. The results show that the average temperature is positively correlated with the sex ratios. The *F* statistics, however, suggest that the correlations between temperature and sex ratios are not very strong.[20]

4.5 *Can High Sex Ratios Create More Homosexual Behaviors?*

There is no consensus in the nature versus nurture debate about the determinants of human sexual orientation. It is theoretically plausible, however, that a high sex ratio environment could lead to more homosexual behaviors, if not more gays, among heterosexual men. If this was true, heterosexual men may become more

[20] Factors that could cause large changes in human sex ratios typically are immigrations, wars, sex-selective abortions etc. Unfortunately, these factors are all related to laws and cultures in a country and thus cannot be used as instrumental variables.

tolerant with or sympathetic toward gays as homosexual behaviors become more prevalent among them. In other words, this could be a third channel for sex ratios to affect anti-homosexuality laws, although it works in the opposite direction as predicted by the aforementioned theory.

To investigate the possibility of this channel, I use the Human Immunodeficiency Virus (HIV) adult (age 15-49) prevalence rate to proxy for the size of homosexual behaviors. It has been found that men who have sex with men (MSM) are the group that has the highest HIV adult prevalence rate in the world (Beyrer et al 2012). If high sex ratios do increase homosexual behaviors among men, it is reasonable to expect that countries with high sex ratios should also have higher HIV adult prevalence rates.

I collected the HIV adult prevalence rates data from the CIA Factbook and regress it on sex ratios and the same set of controls as before. As shown in Table 7, the signs of the coefficients are mixed and none of them is statistically significant. The findings show little evidence on the link between sex ratios and homosexual behaviors at least measured in terms of the HIV prevalence rate.

[Table 7 about here]

5. The Effect of Sex Ratio on the Repeals of State Sodomy Laws in the US

Until 1961, every state in the US had a sodomy law that criminalized same-sex

sexual acts (Kane 2003, 2007). Illinois was the first state that repealed its sodomy law in 1961. During 1961-2002, 36 other states also rescinded their sodomy law (see Table A2 in the online appendix). In 2003, the Supreme Court decision on *Lawrence and Gardner v. Texas* found the sodomy law in Texas unconstitutional, thus making all remaining state sodomy laws void. The case of the US state sodomy law repeals offers another great opportunity to examine the effect of sex ratio on sodomy laws at the state level. It also allows me to conduct fixed-effect estimations using a state-level panel data set, which I explain in more details below. One advantage of the fixed-effect estimation is that it can remove time-invariant unobserved state factors.

I constructed a decennial panel data set at the state level for 1960-2000. It is decennial because the state-level regressors were mostly acquired from decennial *Census of Population and Housing* 1960-2000, except for the GDP per capita, which was collected from the website of *Bureau of Economic Analysis*.[21] The regressors include state overall sex ratio (number of men per women), percentage of African Americans, percentage of adults who were aged 25 and older and completed at least high school and GDP per capita.[22]

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[21] The census data were retrieved from http://www.census.gov/prod/www/decennial.html#y1970. The GDP data were retrieved from http://www.bea.gov/iTable/index_regional.cfm.

[22] State GDP per capita is evaluated in current dollars. The real term is unavailable. Unlike the previous regressions, the state regressors do not include regime type and religion because all fifty states are in the same regime and overwhelmingly dominated by the Christians.

The dependent variable is a dummy variable indicating whether the state sodomy law had been repealed in each decennial year. Each of the fifty states has five observations in year 1960, 1970, 1980, 1990 and 2000. Hence, the sample has a total of 250 observations. In addition to the aforementioned regressors, I also include a full set of year dummies in the fixed effect estimation. For statistical inference, I report standard errors clustered at state level. The regression results are reported in Table 8.

[Table 8 about here]

The specification difference between column (1) and (2) is the control of race, education and per capita GDP. The fixed effect estimates on the overall sex ratio in both columns are similar. They imply that if a state reduced one man per 100 women, the probability for it to repeal the sodomy law would increase by nearly two percentage points. During 1960-2000, the US sex ratio actually decreased from 0.98 to 0.96. This means that it could have accounted for nearly two state repeals ((0.98-0.96)×1.8×50=1.8).

One concern about the fixed effect estimation is that the repeals may have caused migrations across states and changed the state sex ratios. To check this, I regress the changes in migrants on the changes in state sodomy law status and found little evidence on the effect of repeals on migration. The details are offered in A3 in the online appendix.

6. Conclusions

This paper explores the interplay between demography and criminal law in the context of homosexuality. Empirical findings based on various data sources all lead to a robust conclusion: a high sex ratio creates a homophobic social environment that facilitates (or hampers) the criminalization (or decriminalization) of homosexuality. In retrospect, the findings offer an alternative, but not exclusive, explanation on why the global wave of decriminalization in the past sixty years has removed sodomy laws mostly in lower sex ratio—thus less homophobic—countries especially in Europe.

As for policy implications, manipulating sex ratios through policies in an attempt to change social hostility against homosexuality is likely to be controversial and even unethical. Nevertheless, previous findings show that individuals with higher education tend to have more liberal attitudes. Therefore, education could serve as a better policy instrument to mitigate the social hostility in the long run.

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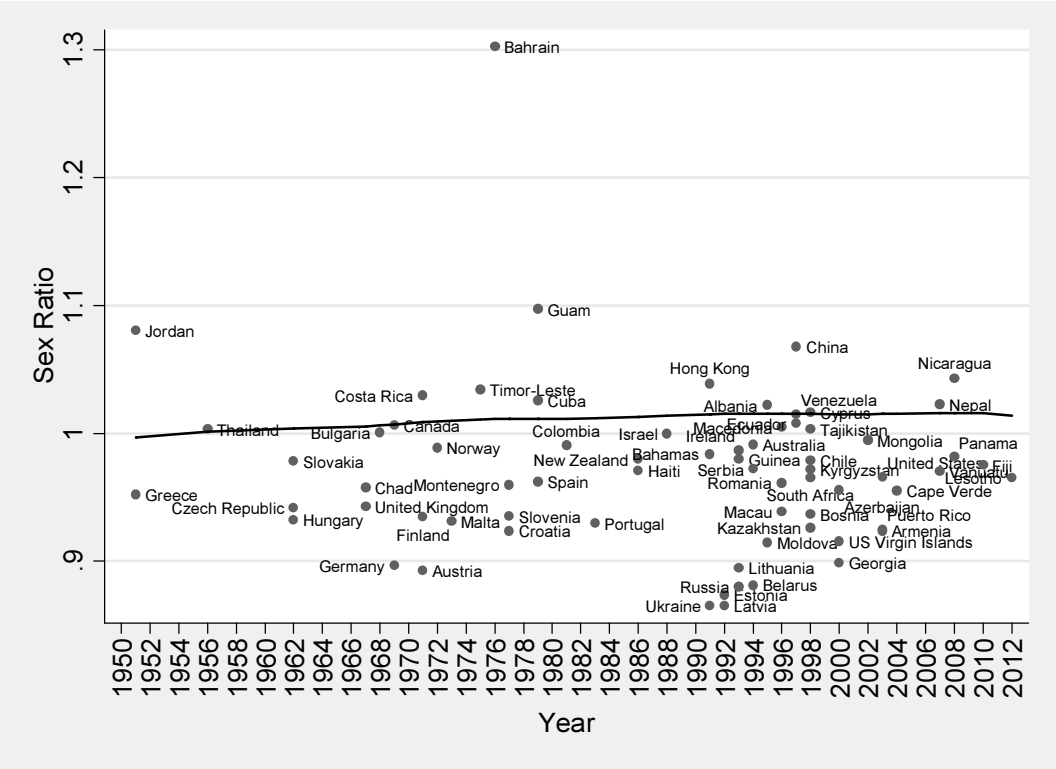
Figure 1. Legal Status of Homosexuality in the World in 2013

Note: countries marked grey criminalize sexual conducts between people of the same sex in 2013.
Source: the *International Lesbian, Gay, Bisexual, Trans and Intersex Association* (ILGA) (http://ilga.org/ilga/en/index.html).

Figure 2. Country Sex Ratios upon Decriminalization: 1950-2012



Note: the solid line is the world sex ratio. 70 countries decriminalized same-sex sexual acts during 1950-2012.
Source: World Population Prospects: the 2012 Revision, Department of Economic and Social Affairs, Population Division, United Nations (http://esa.un.org/wpp/).

Table 1. Individual Attitudes toward Homosexuality & the Homosexuals

	Panel A: by Gender		
	(1) Men	(2) Women	(3) Difference
Justifiability of Homosexuality (10-point scale)	3.08 (21,286)	3.45 (23,310)	-0.37 [-12.85]
Rejecting Homosexual Neighbors (Dummy)	0.56 (20,983)	0.52 (22,932)	0.04 [9.48]
	Panel B: by Country Sex Ratio		
	(1) SR>100	(2) SR≤100	(3) Difference
Justifiability of Homosexuality (10-point scale)	1.97 (9,714)	3.62 (34,882)	-1.65 [-59.23]
Rejecting Homosexual Neighbors (Dummy)	0.74 (9,653)	0.49 (3,4262)	0.25 [48.1]

Notes: numbers of observations are in parentheses. *t* statistics are in brackets. Sex ratio is defined as men per 100 women. Country-specific sampling weights are used when calculating averages.

Table 2. Regressions of Individual Attitudes toward Homosexuality & the Homosexuals

	Justifiability (mean=3.28) (1)	*Justifiability* (mean=3.28) (2)	*No Homo Neighbors* (mean=0.53) (3)	*No Homo Neighbors* (mean=0.53) (4)
Sex Ratio	-0.533***	-0.513***	0.229***	0.227***
	(0.019)	(0.016)	(0.002)	(0.002)
Male		-0.345***		0.042***
		(0.071)		(0.008)
Democracy	1.501***	1.466***	-0.419***	-0.414***
	(0.090)	(0.090)	(0.013)	(0.013)
Age	-0.022***	-0.021***	0.002***	0.002***
	(0.003)	(0.003)	(0.000)	(0.000)
Married	-0.035	-0.039	0.010	0.011
	(0.039)	(0.037)	(0.007)	(0.007)
Education				
Secondary	0.057	0.080	-0.005	-0.008
	(0.062)	(0.063)	(0.010)	(0.010)
Tertiary	0.502***	0.523***	-0.060***	-0.063***
	(0.132)	(0.134)	(0.016)	(0.016)
Employed	0.159***	0.239***	-0.019***	-0.029***
	(0.041)	(0.047)	(0.005)	(0.006)
Income				
Step 2	0.106**	0.106**	-0.011	-0.011
	(0.052)	(0.052)	(0.011)	(0.011)
Step 3	0.236***	0.232***	-0.026**	-0.026**
	(0.065)	(0.065)	(0.011)	(0.011)
Step 4	0.443***	0.440***	-0.044***	-0.044***
	(0.107)	(0.107)	(0.013)	(0.013)
Religion				
Christian	-0.214*	-0.217*	0.029	0.029
	(0.110)	(0.109)	(0.026)	(0.025)
Islam	-0.594***	-0.571***	0.101***	0.098***
	(0.132)	(0.128)	(0.030)	(0.029)
Hindu	-0.245	-0.225	0.067***	0.064***
	(0.270)	(0.271)	(0.024)	(0.024)
Others	-0.359**	-0.339**	0.050**	0.047**
	(0.135)	(0.137)	(0.023)	(0.023)
Observations	44,596	44,596	43,915	43,915

Notes: sex ratio is the number of men per 100 women in the country. All regressions additionally include a full set of country dummies and survey year dummies. Income is divided into four steps with step 4 as the highest. The reference religious group is Buddhist. Robust standard errors clustered at country in parentheses. *, ** and *** denotes significant at 10%, 5% and 1% respectively.

Table 3. Summary Statistics by Legal Status of Same-sex Sexual Acts

	(1) *All countries*	(2) *Legal Countries*	(3) *Illegal Countries*
Sex ratios			
Overall	1.01	0.98	1.07
0-19	1.04	1.05	1.04
20-49	1.04	1.01	1.10
50+	0.91	0.87	0.98
Largest Religious Group			
Christian	0.59	0.71	0.39
Buddhist	0.08	0.08	0.07
Muslim	0.26	0.14	0.45
Hindu	0.02	0.02	0.03
Others	0.05	0.05	0.06
Region			
Asia	0.19	0.19	0.18
Africa	0.28	0.15	0.51
America & the Caribbean	0.19	0.23	0.13
Europe	0.21	0.33	0
Oceania	0.06	0.07	0.06
Middle East	0.07	0.03	0.13
Population (millions)	36.4	35.6	38.2
GDP per capita (PPP)	15712.6	18652.5	11016.9
Literacy Rate (%)	84.7	89.8	76.1
Observations	190	119	71

Notes: legal status was evaluated at the end of 2013. Sex ratios were defined as the number of men per women and evaluated in 2010. All other variables were evaluated in 2013 or the most recent year available.
Sources: legal status data are from the *International Lesbian, Gay, Bisexual, Trans and Intersex Association* (ILGA) (http://ilga.org/ilga/en/index.html). Sex ratios and population data are from World Population Prospects: the 2012 Revision, Department of Economic and Social Affairs, Population Division, United Nations (http://esa.un.org/wpp/). Religion, GDP per capita and literacy rate are collected from the CIA Factbook (https://www.cia.gov/library/publications/the-world-factbook/).

Table 4. Regressions of Legal Status on Sex Ratios

	Dependent variable is a dummy indicating at least one same-sex relation is illegal (mean=0.37)			
	(1)	(2)	(3)	(4)
	Overall	Age 0-19	Age 20-49	Age 50+
Sex ratio	0.218**	-0.116	0.126***	0.279*
	(0.078)	(1.372)	(0.029)	(0.129)
Largest religious group				
Christian	-0.062	-0.061	-0.062	-0.053
	(0.059)	(0.043)	(0.060)	(0.053)
Muslim	0.086**	0.096	0.090**	0.081**
	(0.028)	(0.062)	(0.028)	(0.026)
Hindu	0.076	0.082	0.078	0.076
	(0.161)	(0.163)	(0.162)	(0.157)
Others	-0.122	-0.129	-0.123	-0.109
	(0.108)	(0.108)	(0.107)	(0.103)
Observations	190	190	190	190

Notes: same-sex relations include male-to-male and female-to-female relation. The dependent variable equals one if at least one relation is illegal in the country and zero if both are legal. Sex ratio in column (1), (2), (3) and (4) are for overall population, age 0-19, age 20-49 and age 50 and older respectively. All regressions additionally control for literacy rate, log of GDP per capita adjusted for purchasing power parity, log of population and a full set of region dummies. The reference religious group is Buddhist. Robust standard errors clustered at region are in parentheses. *, ** and *** denotes significant at 10%, 5% and 1% respectively.

Table 5. Interaction of Sex Ratios and Regime Types

	Panel A: Original OLS Estimates			
	(1)	(2)	(3)	(4)
	Overall	Age 0-19	Age 20-49	Age 50+
Sex ratio	0.193***	-0.259	0.117***	0.235***
	(0.055)	(2.396)	(0.033)	(0.055)
Anocracy	-0.264	-0.704	0.485	-0.417
	(0.382)	(2.202)	(0.827)	(0.225)
Democracy	-1.405	0.444	-0.622	-0.519
	(1.076)	(3.166)	(0.605)	(0.421)
Sex ratio × Anocracy	0.155	0.539	-0.600	0.326
	(0.498)	(2.123)	(1.001)	(0.450)
Sex ratio × Democracy	1.355	-0.543	0.550	0.499
	(1.072)	(3.138)	(0.552)	(0.432)
Observations	161	161	161	161
Regime type	Panel B: Average Marginal Effects of Sex Ratios			
Autocracy	0.193***	-0.259	0.117***	0.235***
	(0.055)	(2.396)	(0.033)	(0.055)
Anocracy	0.347	0.279	-0.482	0.561
	(0.544)	(1.741)	(1.016)	(0.483)
Democracy	1.547	-0.802	0.667	0.733*
	(1.079)	(2.500)	(0.549)	(0.443)

Notes: sex ratio in column (1), (2), (3) and (4) are for overall population, age 0-19, age 20-49 and age 50 and older respectively. The reference political group is autocracy. All regressions in panel A additionally include literacy rate, log of GDP per capita (PPP), log of population and a full set of religion and region dummies. Panel B reports the average marginal effects of sex ratios under each regime type based on the coefficients in Panel A.

Table 6. 2SLS Estimates of Legal Status on Sex Ratios

	Panel A: 2SLS Estimate			
	(1)	(2)	(3)	(4)
	Overall	Age 0-19	Age 20-49	Age 50+
Sex ratio	2.941**	70.464	2.586	2.085**
	(1.496)	(160.477)	(1.583)	(0.824)
Observations	190	190	190	190
	Panel B: First Stage Estimate			
Average temperature (°C)	0.005**	0.0002	0.005*	0.007***
	(0.002)	(0.0005)	(0.003)	(0.002)
F	4.86	0.18	2.92	8.00
p-value	[0.03]	[0.67]	[0.09]	[0.01]

Notes: sex ratio in column (1), (2), (3) and (4) are for overall population, age 0-19, age 20-49 and age 50 and older respectively. Average temperature is the average of monthly temperatures over 1990-2009. All regressions additionally include literacy rate, log of GDP per capita (PPP), log population, a full set of religion and region dummies. Robust standard errors are in parentheses. *, ** and *** denotes significant at 10%, 5% and 1% respectively.

Table 7. Regression of HIV Adult (15-49) Prevalence Rate on Sex Ratios

	Dependent variable: HIV adult prevalence rate (%)			
	(1)	(2)	(3)	(4)
	Overall	Age 0-19	Age 20-49	Age 50+
Sex ratio	0.129	-11.069	0.235	-1.332
	(0.370)	(7.586)	(0.169)	(2.185)
Observations	167	167	167	167

Notes: sex ratio in column (1), (2), (3) and (4) are for overall population, age 0-19, age 20-49 and age 50 and older respectively. All regressions additionally include literacy rate, log of GDP per capita (PPP), log of population, a full set of religion and region dummies. Robust standard errors clustered at region are in parentheses.

Table 8. Fixed Effect Estimation of State Sodomy Law Repeal in the US

	(1) *Sodomy law repealed*	(2) *Sodomy law repealed*
State sex ratio	-1.826*	-1.846*
	(0.998)	(0.981)
Year dummies	Yes	Yes
Other controls	No	Yes
Observations	250	250

Notes: the panel data contain 50 states for 5 decennial years, i.e. 1960, 1970, 1980, 1990 and 2000. Dependent variable in both columns is a dummy variable indicating whether the state sodomy law has been repealed in a given decennial year. Other controls include percentage of black people, percentage of adults of age 25 and older who have completed at least high school and logarithm of state GDP per capita. Robust standard errors clustered at state in parentheses. * indicates statistically significant at 10%.
Sources: dependent variable is constructed based on Cane (2007). Sex ratio, percentage of black people, percentage of adults of age 25 and older who have completed at least high school are acquired from US *Census of Population and Housing* 1960, 1970, 1980, 1990 and 2000. Data are available at http://www.census.gov/prod/www/decennial.html#y1970. GDP per capita is collected from Bureau of Economic Analysis. Data are available at http://www.bea.gov/iTable/index_regional.cfm.

Online Appendix

A1. Ordered Probit Estimates

Table A1. Ordered Probit Estimates of the Sex Ratio Effects on Maximum Penalty

Sex ratio	(1) Ordered Probit estimates	(2) AME for up to 14 yrs	(3) AME for 14-life	(4) AME for death
Overall	0.769***	0.096*	0.055*	0.058***
	(0.256)	(0.050)	(0.028)	(0.010)
0-19	0.140	0.017	0.010	0.011
	(3.747)	(0.460)	(0.270)	(0.291)
20-49	0.467***	0.058**	0.034**	0.035***
	(0.117)	(0.027)	(0.014)	(0.007)
50+	0.971**	0.121**	0.069*	0.072***
	(0.381)	(0.062)	(0.041)	(0.016)

Notes: the dependent variable is a categorical variable indicating maximum penalties on same-sex relations, which include in ascending order 1) no penalty, 2) up to 14 years in prison, 3) 14 years to life in prison and 4) death penalty. All regressions additionally include literacy rate, logarithmic of GDP per capita (PPP), logarithmic population, a full set of religion dummies and a full set of region dummies. Column (1) reports the original ordered Probit estimates. Average marginal effects (AME) for the second, third and fourth penalty outcome are reported in column (2), (3) and (4). Robust standard errors clustered at region are in parentheses. *, ** and *** denotes significant at 10%, 5% and 1% respectively.

A2. Time Line of State Sodomy Law Repeals in the US

Table A2. Sodomy Law Decriminalization in the US	
State	*Year*
Illinois	1961
Connecticut	1969
Colorado	1971
Oregon	1971
Delaware	1972
Hawaii	1972
Ohio	1972
New Hampshire	1973
North Dakota	1973
California	1975
Maine	1975
New Mexico	1975
Washington	1975
Indiana	1976
Iowa	1976
South Dakota	1976
West Virginia	1976
Nebraska	1977
Vermont	1977
Wyoming	1977
Alaska	1978
New Jersey	1978
New York	1980
Pennsylvania	1980
Wisconsin	1983
Kentucky	1992
Nevada	1993
Tennessee	1996
Montana	1997
Georgia	1998
Rhode Island	1998
Maryland	1999
Arizona	2001
Minnesota	2001
Arkansas	2002
Massachusetts	2002
Notes: this table is adapted from Table 1 in Kane (2007). Sodomy laws in states that are not listed were automatically repealed after the Supreme Court decision on *Lawrence and Garner v. Texas* in 2003.	

A3. Fixed Effect Estimation of the Effect of State Sodomy Law Repeals on Migration

I use data (only available for 1970-2000) on the percentage of people who lived in a different state or other countries five year prior to the census year to calculate the change in migration between two adjacent census years and match the difference with the repeal of sodomy law in each state. I then run a fixed effect estimation of the effect of sodomy law repeals on migration. The estimate is reported below.

Table A3. Fixed Effect Estimation of the Effect of State Sodomy Law Repeals on Migration

	Diff in % of Migrants
Diff in Sodomy Law Status	0.005
	(0.006)
Observations	150

Notes: the dependent variable is the difference in percentage of migrants between two adjacent census years. The migrants are defined as people who lived in a different state or other countries 5 years prior to the census year. This variable is available for 1970, 1980, 1990 and 2000. Therefore, the difference is available for 1970-1980, 1980-1990 and 1990-2000. A full set of year dummies is added.
Source: US *Census of Population and Housing* 1970, 1980, 1990 and 2000. Data are available at http://www.census.gov/prod/www/decennial.html#y1970.