NEWSPAPERS, INDUSTRIALIZATION, AND STATE-LEVEL PROGRESSIVE EDUCATION REFORM FROM 1896 TO 1911

by

MATTHEW TELFORD TYLER

(Under the Direction of Scott Ainsworth)

ABSTRACT

The turn of the twentieth century marked the rise of many of the institutions we now view as fundamental to American public schooling. The teaching workforce became more professionalized and public secondary education proliferated. In this paper, I apply statistical analyses to the extensive theoretical work on progressive education reform by historians to gain a better understanding of the causal factors behind these changes. Specifically, I look at the increase in the number of normal schools and high schools. I hypothesize that ballot reform, the feminization of teaching, industrialization, and the spread of newspapers were all necessary to education reform. Using a Poisson count model, this paper concludes with evidence for positive effects of newspaper distribution and industrialization on reform.

INDEX WORDS: Progressive Education, Patronage, Industrialization, Feminization of Teaching, Secondary Education, Ballot Reform, Interest Groups

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TABLE OF CONTENTS

Page

ACKNOWLEDGEMENTS iv

LIST OF TABLES vii

LIST OF FIGURES viii

CHAPTER

1 INTRODUCTION 1

2 LITERATURE REVIEW 2

I. Pre-Reform Education 2

II. Progressive Education Reform 3

III. The Drivers of Education Reform 8

3 THEORY, DATA, AND METHODS 19

I. Theory 19

II. Data 21

III. Hypotheses 28

IV. Methods 29

4 ANALYSIS 31

I. Dynamic Poisson "Count" Models 31

II. Discussion 33

5 CONCLUSION 37

WORKS CITED 39

APPENDICES

A COMMENTS ON DATA AND ANALYSIS 43

I. Missing Variables 43

II. Distribution of the Dependent Variables 44

B ALTERNATIVE MODELS 46

C DIAGNOSTICS 48

I. Dynamic Specification 49

II. Static Specification 51

D REPLICATION CODE 53

LIST OF TABLES

Page

Table 1: Number of Public Normal Schools, Poisson Count Model with Lag 32

Table 2: Number of Public High Schools, Poisson Count Model with Lag 33

Table 3: Missingness of Variables Used in Models 43

Table 4: Number of Public Normal Schools, Poisson Count Model with Random Effects 46

Table 5: Number of Public High Schools, Poisson Count Model with Random Effects 47

LIST OF FIGURES

Page

Figure 1: Number of Public Normal Schools by State over Time 5

Figure 2: Number of Public High Schools by State over Time 6

Figure 3: Number of Newspapers by State over Time 12

Figure 4: Feminization of Teaching by State over Time 18

Figure 5: Distribution of Public Normal Schools in Five Imputed Datasets 44

Figure 6: Distribution of Public High Schools in Five Imputed Datasets 45

Figure 7: Distribution of Residuals against Fitted Values, Public Normal Schools, Poisson Count Model with Lag 49

Figure 8: Distribution of Residuals against Fitted Values, Public High Schools, Poisson Count Model with Lag 50

Figure 9: Distribution of Residuals against Fitted Values, Public Normal Schools, Poisson Count Model with Random Effects 51

Figure 10: Distribution of Residuals against Fitted Values, Public High Schools, Poisson Count Model with Random Effects 52

CHAPTER 1

INTRODUCTION

Schools have often been a microcosm for national political debates, from school prayer to sex education to the assimilation of immigrants. The resultant education policies from these battles have often reflected political attitudes writ large. At the turn of the twentieth century, the broad ideals of business-like efficiency and demands for the bureaucratization of civil services were embodied in the classroom as many of the institutions we now view as fundamental to education began to emerge. As a result, demands for teacher certification permeated the United States and access to public secondary schooling greatly increased.

While there was great variation in school systems across the United States at the end of the nineteenth century, if one were to look across the contemporary United States—from urban to rural school districts, from the Northeast to the Southwest—one would find remarkable uniformity. What, then, led to these systematic, foundational changes in education in every state in the Union? Historians have provided extensive theoretical accounts of progressive education reform, yet their analyses have been unsystematic. In this paper, I will apply statistical analyses to a unique dataset to look for the causal mechanisms behind two small parts of progressive reform: the adoption of public normal schools and public high schools. I hypothesize that education reform was the result of newspaper penetration, industrialization, ballot reform, and the feminization of teaching. I conclude with evidence for a positive effect of industrialization and newspapers on education reform.

CHAPTER 2

LITERATURE REVIEW

I. Pre-Reform Education

In the mid- to late-1800s, most states had some form of publically funded primary education, especially in more urban areas. Education standards and access to schooling, however, were far from uniform. In his seminal piece *The One Best System* (1974), David Tyack provides an extensive account of the pre-reform education systems. Attendance in schools varied from day to day, depending on when children were needed at home or on the farm. In more rural areas, teaching cohorts varied throughout the year: men tended to teach during the winters while women taught during the summers. Schools in rural areas were of the ungraded, one-room variety while urban areas had already begun to create "graded" schools.

Like many public sector employees during the nineteenth century, the position of teachers was tenuous. Teachers typically received their jobs based on "political pull" and were accountable to a board of trustees or a partisan school board (Knott and Miller 1987). Would-be teachers had to be put on "eligibility lists," and yearly examinations of contracts were facades for political bosses who could fire those teachers who were not their "vassals" (Knott and Miller 1987; Tyack 1974; Murphy 1990).

As early as the 1850s and 1860s in some urban areas, and more widely by the 1870s, the ideas of bureaucratic efficiency had already begun to permeate education. In his 1874 report *The Theory of Education in the United States of America*, St. Louis Superintendent of

Schools and future progressive era U.S. Commissioner of Education outlined a bureaucratic model of education based on "punctuality and precision." The ideas of punctuality, precision, and uniformity would soon spread throughout America, leading to the professionalization of the teaching workforce and an expansion of access, especially to secondary schooling.

II. Progressive Education Reform

The reforms of the progressive educationalists resembled in many ways the reforms of the larger progressive movement. Knott and Miller (1987) describe education reform in the context of the era's ethos of professionalism. As notions of scientific management of public services spread, schools and school systems became increasingly dominated by a managerial sector and teachers sought professional certification and training from the increasing number of state-sponsored and private normal schools. In a professionalized system, teachers would no longer be chosen on the basis of political pull but, rather, by testing and education-based qualifications.

It is unclear, however, how professionalization should be measured. While most states did not require training from normal schools—the precursors to teachers' colleges—until well into the twentieth century, looking just at formal legislative requirements would not capture a rise in the ethos of professionalization and voluntary decisions about attaining higher levels of professionalization via education. Ogren (2005) says, "After a few decades in which [Normal Schools] did little more than instill the notion of teaching as a calling, state normal schools did create a strong professional spirit through teacher-education coursework, observation and practice teaching, and student activities" (201).

Looking at the number of public normal schools in a state might elucidate these attitudes, as public normal schools predated formal requirements for certification by decades. The increase in normal schools during this period also signifies a latent demand for more training and set up the necessary infrastructure for subsequent certification mandates. As Figure 1 shows, most states only had a few normal schools during this period and, for the most part, stayed this way. There is, however, a fair amount of variation across states, and there appears to be two different strata. While most states had fewer than ten normal schools and did not dramatically increase the number of normal schools between 1895 and 1911, several states started the period off with more schools and continued to increase the number, suggesting a "contagion" effect for normal schools. Figure 1 also raises the question of why some states increased the number of their public normal schools while others did not.

Secondary education also began to expand during this period. In 1890, 6-7 percent of 14-17 year olds were in secondary schools; by 1900, 11 percent of the same age group were in secondary schools, and by 1920, a third were, and these youth were increasingly attending *state*-funded secondary schools. Although the rise of secondary schooling falls under the general auspices of the progressive movement, it represents the ambiguity of the definition of "progressive" education reform as the groups that supported professionalization were not always the same ones that supported secondary education. Murphy (1990) highlights these different groups of progressive education, noting that four competing theories of progressive education existed during this time period.

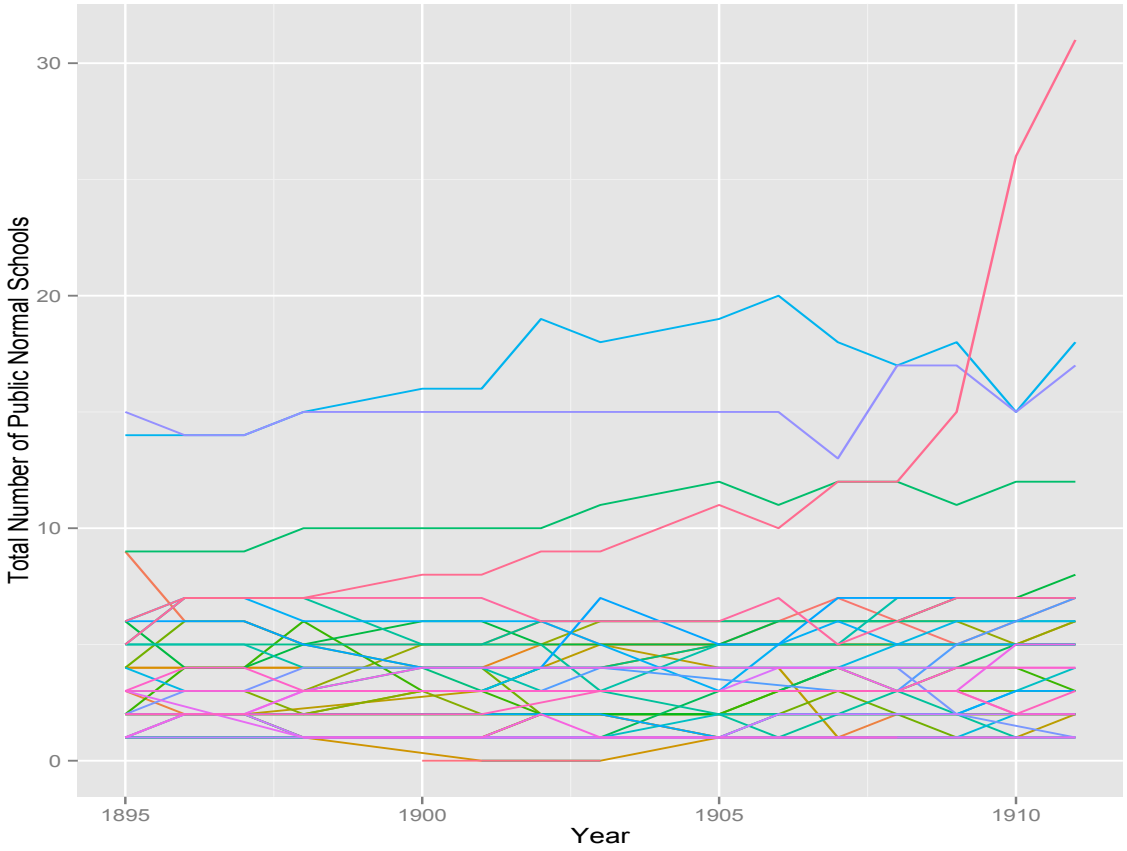

Figure 1: Number of Public Normal Schools by State over Time

Each line represents a state. The state with the most normal schools in 1911 was Wisconsin with 31, followed by New York with 20. Tennessee, Rhode Island, Oregon, Montana, Mississippi, and Colorado all had one school.

Figure 2, which shows the number of public high schools across states, again elucidates an existence of "strata" in education reform; while most states are clustered around the bottom of the graph, a few states started off with more high schools and increased the number of high schools at a faster rate than those that started off with fewer schools. Across all states, though, the number of high schools started to increase between 1905-1910. While Goldin and Katz (1999) note that secondary schooling really began to increase starting in the 1920s, this early increase in infrastructure may have been necessary to

future increases in enrollment and, similar to normal schools, may have represented a latent demand or change in attitudes that was later manifested by an increase in the number of students. In other words, there may be a lag between infrastructure change and legal requirements for training. Looking at education reform through two outlets—the number of public normal schools and high schools—it is clear that there is variation in numbers and trends across states.

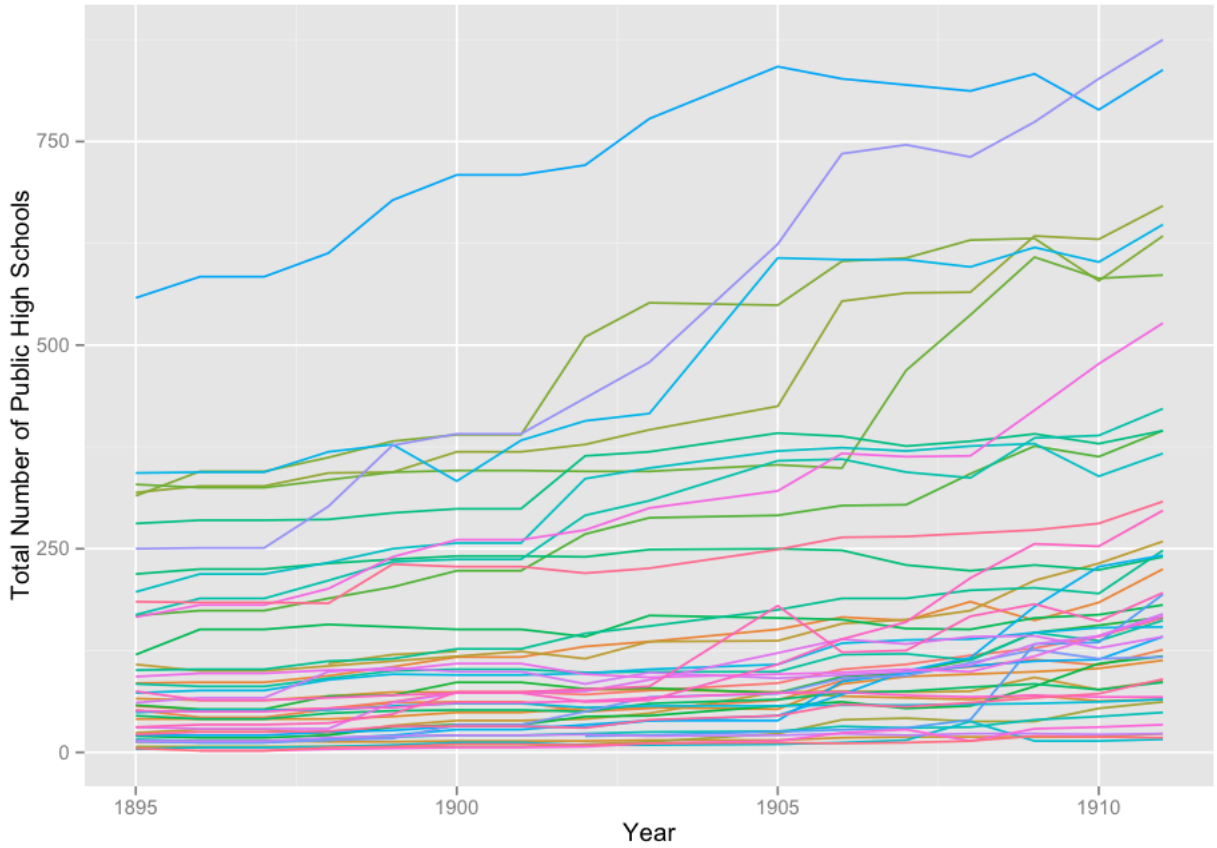

Figure 2: Number of Public High Schools by State over Time

Each line represents a state. The states with the most public high schools in 1911 are Pennsylvania (875), Ohio (838), and Illinois (671), while the states with the fewest are Nevada (16), Wyoming, (18), and Rhode Island (23)

For several reasons, these measures may not fully capture professionalization and secondary education reform. While the number of students enrolled in high schools during this time period increased dramatically, the number of high schools did not increase proportionally because high schools generally became larger. There is also reason to believe that normal schools may have started to taper off around this time. While normal schools tended to provide liberal education and teacher training for those who wanted to become teachers, teachers colleges—the successors of normal schools—only provided pedagogical training without a liberal education and started to appear in the early 1900s. That being said, the widespread transformation of normal schools into teachers college did not start in most states until the 1920s and continued into the 1940s (Ogren 2005).

The proliferation of normal schools and high schools also does not encompass the entirety of education reform. Much of the public service reform during this time period dealt with management (Wiebe 1967). The numbers of managerial staff both at the school-level and district-level increased, and modes of evaluating students and teachers became commonplace as it was believed that good data would lead to good management. There were also dramatic changes in the curricula as schools moved away from studies of classics and the liberal arts toward a broader curriculum that included more "practical" skills and a wider variety of subjects (Spring and Illich 1972). Curricular changes complemented the formation of high schools that separated students by grades and an increased focus on extracurricular activities as a means to provide a broader education. The limitations of available data, however, have necessitated a more narrow exploration of education reform, and the two indicators chosen are believed to be associated with the other types of reform.

III. The Drivers of Education Reform

a. Interest Groups

As Knott and Miller (1987) note, bureaucratization of public services did not happen because it was necessarily the best, most logical next step in American political development but, rather, because political actors made it happen. Many authors have attributed progressive era reform across sectors to civic association activity (Skocpol et al. 2000; Putnam 2000; Crowley and Skocpol 2001). And according to Truman (1968), among others, the organization of interests helps to translate the public will into policy. But the same factors that are often attributed to interest group formation—industrialization, urbanization, and party politics fatigue—are also often directly tied to changes in education. Thus, any model that looks to discern the causes of progressive education reform must take into consideration the potentially confounding effects of industrialization, urbanization, political reform, and interest group activity.

While Putnam (2000) links civic involvement with progressive reform, general civic engagement may not capture the diversity of interest group activity arising at the end of the 19th century. These interest groups, however, were predicated on the stratification of socioeconomic groups during the 1800s. The battle over professionalization was generally one that pitted middle and upper class protestant "schoolmen" against teachers and "working class people with sectarian religious and local neighborhood values (Urban 1976, 38). Callahan describes the "muckrakers" as "moderate men…of general prosperity. They did not intend to stir the American people to drastic action which would transform American society. They did not attack the business system….[T]heir solution to many of the problems was the application of modern business methods" (Callahan 1962, 5). Among

other things, this "business model" included the professionalization of the workforce, dislodging public employees from political patronage and creating a more meritocratic civil service. In the case of education reform, this meant increasing demand for teaching certification and teacher training.

Secondary education, too, was subject to debate among competing groups. As Ansell (2010) notes, the coalitions that argue for education have a great impact on what level of education is provided. While a coalition of the rich and the poor may advocate for less public funding for education—the rich would want it to be privatized while the poor see it as primarily benefiting the middle class and the rich—a coalition of the rich and the middle class may advocate for more secondary education, and the poor may advocate for more technical education. Goldin (1998) offers ancillary evidence, finding that stronger industrial presence in states during the progressive and post-progressive eras actually led to *less* secondary education because industrialization provided jobs that did not require advanced schooling. Moreover, working class groups largely believed that traditional, esoteric learning provided by secondary schools did not provide much benefit to working class students.

b. Newspapers

Measures for interest group activity during this era are often limited. Data on interest group membership are often constrained to a select number of locales or years (Putnam 2000; Crowley and Skocpol 2001). However, proxies for looking at the level of reform activity—the demand for reform among constituents—do exist. Several education historians have noted the rise of newspapers during this period as an important political

development for both progressive reform writ large as well as progressive education reform. For reasons to be discussed later, newspapers may also serve as a fair proxy for interest group activity. Moreover, the spread of newspapers during this time period increased communication among citizens, decreased isolation, and promoted civic engagement (Skowronek 1982; Putnam 2000; Kliebard 2004).

To look at the connection between education reform and newspaper distribution as a possible proxy for interest group activity, it is useful to look at newspapers as a form of political capital. Gentzkow et al. (2011) show that the introduction of new newspapers tends to increase voter turnout at the end of the nineteenth and the beginning of the twentieth centuries. This increase in turnout could be a result of newspaper entry signifying heightened civic engagement and civic organization—the creation of a newspaper requires monetary capital and suggests both organization and demand. Salisbury (1969) notes that early interest groups, especially those at the turn of the century, often offered newspapers as a particularistic benefit to members; consequently, some newspaper circulation could be directly tied to interest group organization. Salisbury also contends that newspapers function as a type of political currency—that the consumption of newspapers in and of itself represents a certain set of coherent political views.

It is difficult, however, to break down newspaper circulation beyond general political activity. Around the turn of the century, education reform was not clearly affiliated with a particular party—reformers and reform politicians were often more affiliated with certain reform groups than a political party (Wiebe 1967). Consequently, even measuring the political affiliation of newspapers may not capture the dividing lines of different interests.

This could be further exacerbated by a growing localistic tendency among politicians and parties—a vote for a Democrat in one part of the country could represent a completely different policy position from a vote for a Democrat in another part of the country. Much of the extant political science and education history research, however, suggests that newly emerging groups during this period were reform groups concerned about unhindered political machines, unregulated capitalism, and industrialization. This is consistent with equilibrium theories of interest group formation, which suggest that the demand for status quo interests has been fully satiated and that shocks disrupt the current equilibria—meaning that new groups are different ideologically from status quo groups. Because there were more untapped unorganized citizens on the reform side, there would have been much more room for reform groups.

Consequently, increases in newspapers during this period are likely to signify reform activity. That being said, the number of newspapers is a blunt measure for reform organizing. While it is not the case that the only people who created newspapers during this time were reformers, changes in the number of newspapers signify a move away from party entrenchment toward competition and accountability. Figure 3 shows that there were at least small increases in the number of newspapers within each state around the turn of the century, and that differing levels of newspaper organization may have represented existing potential reform. Indeed, Gentzkow et al. (2012) hypothesize that a more robust media environment increases the likelihood that the public's views will reflect the truth as newspapers representing opposite factions hold opposing politicians accountable. This type of media activity can reasonably be linked to reform of the teaching profession, which sought to de-politicize teaching and remove teaching positions from the

patronage slate. The similarities across Figures 1, 2, and 3 suggest that newspapers may be at least correlated with different progressive education reforms. The potential for the prevalence of newspapers being associated with literacy rates in a state, however, should not be ignored, and an increase in the number of newspapers may just lead to increased responsiveness among politicians in general rather than reform stemming from interest group activity.

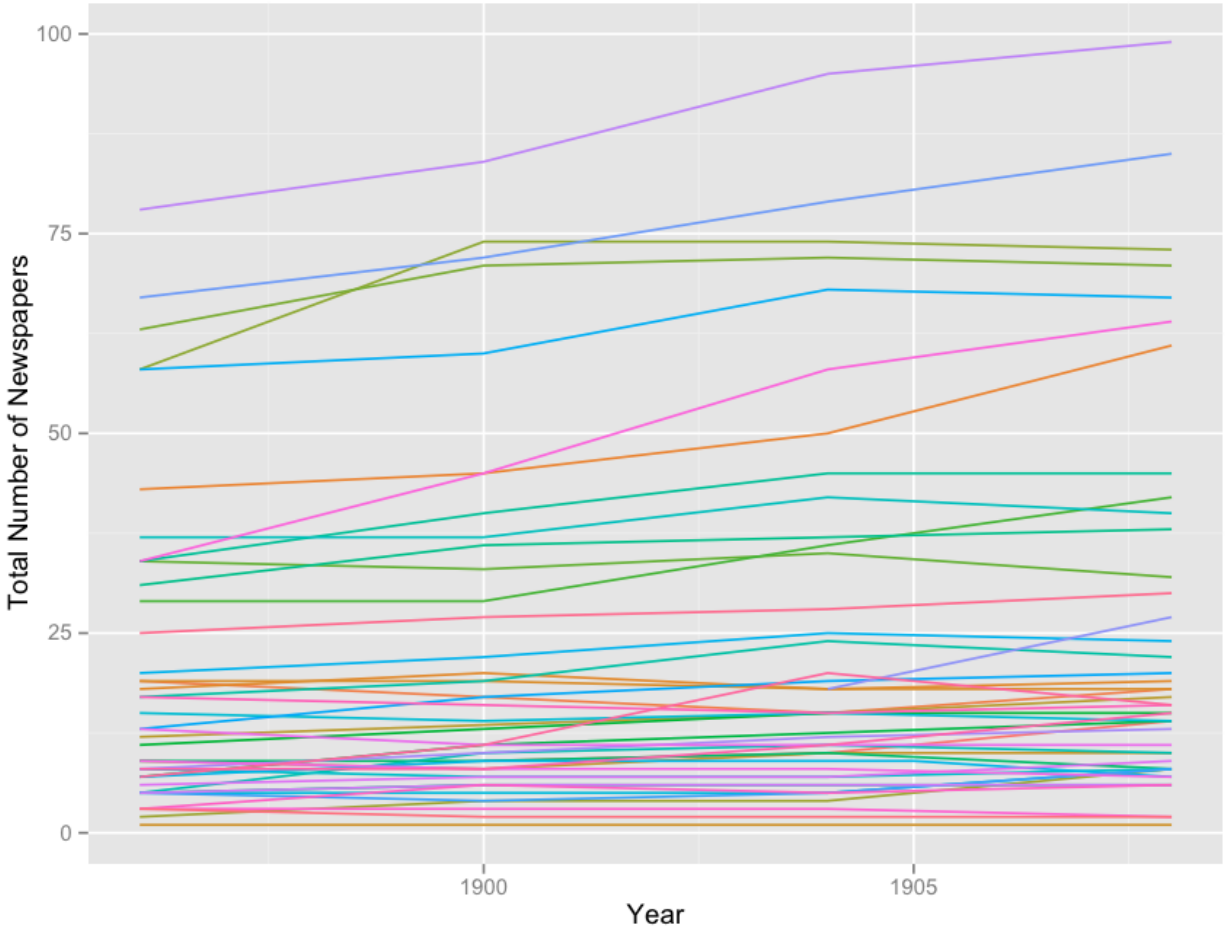

Figure 3: Number of Newspapers by State over Time

Each line represents a state. The states with the most newspapers in 1908 were Pennsylvania (99), Ohio (85), and Illinois (73), while the states with the fewest newspapers were Delaware (1), Utah (2), and Wyoming (2).

c. Industrialization

In the context of education reform, Ansell (2010) argues that an increase in interconnectivity and industrialization changes the value of returns on education: people can more easily "export" their education to areas that demand it if the ability to travel increases, and the rise of industrialization increased the demand for a skilled and semi-skilled workforce. The idea that increasing technology helped to bring about reform is also consistent with the education history literature, which contends that the role of schools changed from an institution controlled by community to one that necessarily tried to acculturate students to a national lifestyle based around technology and interconnectivity—especially in the new, large, and graded high schools (Kliebard 1995). Finally, the ideals of business-like efficiency that surrounded progressive education reform were certainly reflective of practices embodied in the manufacturing industries.

It is possible, however, that industrialization may have changed the decision-making calculus of families. The prevalence of semi-skilled and unskilled jobs decreased the incentives for youths to attend secondary school, which may have provided little benefit to those with no intention to pursue white-collar jobs or tertiary education (Goldin 1998). Consequently, an increase in the number of laborers may have led to more strength among working class individuals who did not support secondary education—especially in the late 1800s and early 1900s.

Salisbury 's seminal "An Exchange Theory of Interest Groups" (1969), which highlights existing theories of interest group formation, notes the possibility that the presence of more people working within a specific sector may lead to more interest group formation

and more diversity in interest groups. While these groups may be delineated along certain lines, many of them within a certain sector would have similar goals. For example, unions or groups for different types of manufacturing laborers would be in favor of increased manufacturing wages and increased union power. An increased workforce size, especially in the era of industrialization, suggests a breakdown of a sector into more and more particularized parts as certain fields of labor become more specialized; these specializations lead to more fractured groups with common interests. So while industrial workers in a state with a large number of wage earners may not necessarily be more organized, the presence of more workers over time makes it more likely that there will also be more organized workers.

Finally, the rise of industrialization is associated with the adoption of a broader industrialization ethos. Spring and Illich (1972), for example, notes how the newly created extracurricular activities in schools very closely resembled the types of activities organized around industrial workplaces. An increase in the number of managerial staff in schools and school systems made the classroom resemble more closely a factory style of education, and relationships between students and teachers at the secondary level became increasingly hierarchical as high schools became larger.

It is difficult to disentangle the possible countervailing effects of industrialization on education reform. In general, though, increased industrialization will lead to fewer secondary schools as industrial workers were more in favor of technical education rather than secondary education, but industrialization will lead to more professionalization ideals and reforms, embodied through more normal schools

d. Political Reform

While many politically organized citizens were advocating for changes in education reform, these groups were a subset of a larger political reform movement. These larger political reforms may have had spillover effects onto the education reform movement; consequently, activists may have both directly and indirectly brought about progressive education reform during this period.

Gilded Age politics were dominated most notably by the presence and strength—albeit declining strength—of party machines. Trounstine (2006) characterizes machines as parties that seek to maximize particularistic benefits to their core constituent groups at the expense of other constituencies and the public good. Political machines provided particularistic benefits, including patronage jobs—government jobs that were the spols of winning elections. At the national level, these jobs were often in the form of postmaster positions. Postmaster jobs were common spoils in rural areas—there were 77,000 rural fourth class postmasters before postal reform occurred (Kernell 1999). In education, patronage might have been doled out through school construction or textbook contracts, although it is unclear what the role of teachers was in party machine politics.

At the national level, the progressives were successful in implementing many of their platforms—and this was largely due to public pressure on increasingly weak political parties (Theriault 2003). In 1883, the Pendleton Civil Service Act was passed by Congress, switching 100,000 employees to "merit-based" employment by 1900. The adoption of the Australian ("secret") ballot throughout the U.S. got rid of the "party strip" ballots and made voting secret, making it more difficult for party bosses to enforce de facto "vote buying" and

making politicians less beholden to local parties (Rusk 1970). By 1896, 32 states had already implemented some form of the Australian ballot.

It is hard to imagine that these political reforms that weakened the influence of political parties did not affect an education system based around teaching positions as patronage. The severing of the power and connection of political parties to patronage as well as the severing of political parties to politicians changed the decision-making calculus of elected officials. This may have led them to seek out new ways of gaining a "personal vote"—rather than doling out patronage positions, they may have sought to enact good policy or credit-claim for things they have personally done—and may have made them more receptive to groups that were beginning to emerge. Thus, while political reform may be indicative of the strength of reform groups that may have directly influenced education reform, the diminution of party power may have also affected the ways in which legislators received interest groups.

e. Feminization of Teaching

One of the most notable aspects about the pre-progressive teaching workforce was the great variation in the level of feminization across states. Feminization is presumably related to industrialization and urbanization, which created more routinized schedules for all workers and made the informal, voluntary means of teaching less suitable. As the teaching profession became more stable in cities, as year-long schools began to proliferate, and as more requirements for teachers were demanded, it became more difficult for men to teach for only part of the year (Strober and Tyack 1980).

Tyack (1974) argues that feminization was a prerequisite to the bureaucratization of education—or at least it made it easier as it created a more "logical" division of male managers ("schoolmen" or principals) and female teachers. Tyack says:

> Especially for the women, who constituted the great majority of teachers, the social pressures against militant organization were many….In the society as a whole women were trained to be submissive to men, and the schools permitted few to rise into high administration positions…Communities often regarded teachers as public property. City teachers remained subordinate members of the elaborate bureaucracies (268).

The mechanism through which this occurs may be found through one of the primary—if insidious—reasons for the feminization of teaching: money. In order for school systems to be able to afford bringing in tens of thousands of new students into the auspices of public education, costs per-pupil had to be greatly reduced. Hiring female teachers—who were typically women in between schooling and marriage, who had few other career options, and who could consequently be hired very cheaply—saved school systems money. Indeed, Tyack (1974) finds that in 14 "representative" cities, women outnumbered men by a ratio of 10:1 by 1885. If true, this feminization hypothesis has great implications for regional variations in progressive reforms. Moreover, a common complaint across many progressive reformers was that teaching had been feminized, and consequently there was a push among some to bring more men into the teaching workforce with different levels of salaries for men and women. Figure 4 shows the great variation in feminization across states, even as late as 1911. Was feminization a pre-requisite for reform in every state, or just in early reforming states? Could it be possible that the relationship between

feminization and progressive reform is spurious? Certainly, accounts that feminization set the stage for more "logical," gender-based bureaucratic hierarchies are speculative at best.

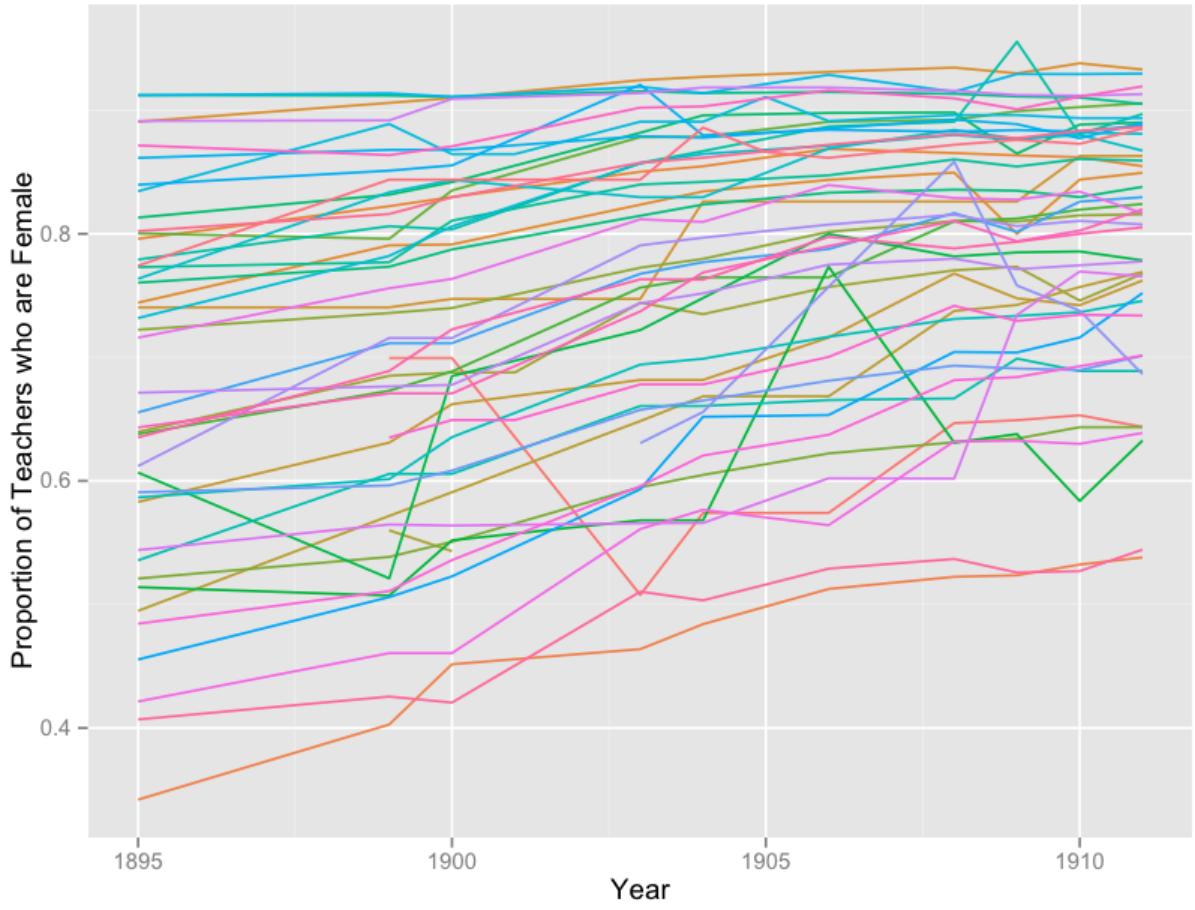

Figure 4: The Feminization of Teaching by State over Time

Each line represents a state. The states with the highest levels of feminization in 1911 were Connecticut (93.3% female), New Hampshire (93.0%), and Vermont (91.9%), while the states with the lowest levels of feminization in 1911 are Arkansas (53.8%), West Virginia (54.4%), and Kentucky (63.3%).

CHAPTER 3

THEORY, DATA, AND METHODS

I. Theory

At the end of the twentieth, many changes in American society helped to spur reform in education. One of the most important of these changes was industrialization. The second industrial revolution at the end of the nineteenth century rapidly changed the socioeconomic structure of America. Industrialization attracted immigrants and fostered urbanization. It created a class of wage earners, whose views of the proper role of government were in contrast to those of the burgeoning American middle class—and battles between these two groups often occurred over education.

Middle class groups tended to advocate for more professionalization in teaching as part of a larger movement to move public services away from public patronage toward a reliable system of business-like efficiency. Immigrants and teachers tended to oppose this bureaucratization for several reasons: immigrants were often the ones who benefited from patronage; centralization and professionalization were often tied to xenophobic, assimilation movements; and, at least initially, teachers saw professionalization and bureaucratization as an affront to their connection to communities.

As demand for teacher professionalization increased, more would-be teachers sought training at normal schools and, especially later in the twentieth century, teachers colleges. Many states, however, did not have formal requirements for teaching certification until well into the twentieth century. There was, however, still a large push for teacher education at the turn of the century,

providing the necessary infrastructure and attitudinal changes that later led to codified certification requirements.

Concurrently, public secondary education was also beginning to take hold across states. Middle class groups sought to provide their children with a path into a growing number of jobs that required formal education. Working class groups, however, viewed secondary education as a benefit for middle class families and often opposed its expansion, instead calling for increased technical education. Industrialization, however, also made secondary education more feasible in many ways. Urbanization due to industrialization provided the level of population density necessary for sustaining large, graded high schools, and new forms of transportation made it even easier to overcome problems due to low density.

As part of these battles, as well as larger battles for political reform, different groups distributed newspapers, and the presence of newspapers was a good indicator of groups with large amounts of monetary and organizational capital. At the same time, newspapers not affiliated with interest groups were often important in combatting entrenched political machines and bringing about reform.

In order for reform to be brought about, however, two institutional changes were necessary. Because the teaching workforce was entrenched in patronage politics, ballot reform—which helped to disconnect party machinery from politicians and weaken patronage systems—was necessary to the professionalization of teaching. And for a rapid expansion of secondary education, the teaching workforce had to be sufficiently feminized as school systems could pay female teachers less.

II. Data

a. Sources

Due to the limited availability of contiguous historical data, the analysis has been restricted to 1896 through 1911. The majority of the data from this study comes from *The Annual Report of the Commissioner of Education*. As the national mood on education gravitated toward scientific management, the Commission of Education devoted much time to collecting extensive data on international, national, state, and local education systems. Like other historical data, these data are susceptible to potential measurement error, which could lead to inefficient, inconsistent, or biased estimators.[1] As Tyack notes, "[E]ducational statistics need to be interpreted guardedly because of poor returns from local and state officials and the vagueness and shifting character of the classification of 'secondary schools" (Tyack 1974, 57). Goldin (1998) specifically comments on the difficulty of using data from *The Annual Report of the Commissioner of Education* prior to 1910, largely due to non-response rates from different states. As far as I can tell, this is the first time these data from this time period have been extensively used for rigorous statistical analyses on school systems.[2]

As part of the process, the Commissioner solicited reports from chief education officers from different states. Consequently, measurements may vary from state-to-state depending on how a certain state education official decided to measure a certain statistic. It is important to take this into consideration when specifying models as there is a risk that

[1] Because data from the Commissioner of Education is used for both independent and dependent variables, the potential effect of measurement error is unknown. An improperly measured dependent variable would lead to inefficient estimators while improperly measured independent variables would lead to biased and inconsistent estimators.

[2] It should be noted that Skocpol and Crowley (2001) included data on the number of teachers from the Commissioner's Report in their analysis of interest groups after the Civil War and Goldin (1998) uses post-1910 data.

there are non-randomly distributed measurement errors. This is especially important because some data were estimated by the state education official. It is also worth noting that reports were often published several years after the period being reported because of the amount of time that it took to receive information from individual states. For this time period, there were two separate commissioners of education.[3] That being said, it is not believed that the two commissioners collected data differently, and the similarity in presentation of the reports suggests that data collection did not change.

Finally, the reports were categorized by fiscal year (e.g. "for the year ending on June 30th, 1896). Given the necessity of organizing data by calendar year for combining with other data, data from *The Annual Report of the Commissioner of Education* were classified by whatever year they began in; for "the year ending on June 30th, 1896," then, the data would be coded as 1895. While this classification is not ideal and while it may lead to problems with regards to the "moment" of causality, there is little way to break down and reassemble these data by calendar year.

Data have also been collected from several other sources. Census data have been used for the number of wage earners in manufacturing jobs across states. Data on newspapers from Gentzkow, et. al. (2011) has been retrieved from the ICPSR database. Data on ballot reform come from Engstrom and Kernell (2005) and Davis (1917). Data on voting behavior come from Burnham, Clubb, and Flanigan (1991).[4]

[3] Harris (1895-1905) and Brown (1906-1911) in the dataset

[4] I am also appreciative of Robert Putnam, Gerald Gamm, Jocelyn Crowley, and Theda Skocpol who all who generously provided data that was ultimately not incorporated into the final analyses.

The data contain 716 observations across 48 states and 16 years.[5] The data exclude Washington, DC, Indian Territories, and any territory that had not yet become a state.[6] The unit of analysis is at the state level.

Finally, the dataset set is constructed as panel (time series cross sectional) data. Most research in political science deals with data that is either time series *or* cross sectional. Panel data presents extra challenges related to potential correlations among states as well patterns over time and consequently requires extra precautions, which I will address later.

b. Missingness

The data contain a large amount of missingness; while several variables were completely observed, the missingness for variables that had missing values ranged from about six percent to over eighty percent. A chart has been included in the appendix listing the level of missingness for each variable used in the analyses.

Multiple imputation—which, in this case, creates five separate imputed data sets and then combines them—is generally considered the best way to address missingness for most types of political science data. It avoids many of the pitfalls related to selection bias and reduction in sample size in list-wise deletion (Little and Rubin 1987; King et al. 2001; Honaker et al. 2013). If data are systematically missing from certain years or states, dropping these observations could bias the results, and given the large amounts of missingness, list-wise deletion would also result in a very small sample size. Multiple

[5] Since several states were territories for part of the time period covered, 48 observations may not be available for each year.
[6] While the entire dataset contains more observations and includes the year 1895, 1895 has been excluded from the analysis since data for 1894 (which would be the lagged data for 1895) were not available. 1895 was excluded from the analyses that did not include lagged variables for the sake of consistency.

imputation also incorporates uncertainty due to missingness into estimates and standard errors.

The data were run through the *Amelia* package in R (Honaker et al. 2013). Large amounts of missingness make results of the analysis model much more dependent on how the imputation model is specified. Sensitivity to the imputation of data necessitates increased model specification testing, including the use of polynomial transformations of variables of interest in the imputation model (Honaker and King 2010; Honaker et al. 2013). Because large amounts of missingness can also lead to high covariances, it is also important to add a ridge prior, which adds "artificial observations to the data set with the same means and variances as the existing data but with zero covariances" (Honaker et al. 2013, 23). Because *Amelia* and multiple imputation is predictive and not causal, additional variables not included in the analyses presented were incorporated into the pre-imputation dataset. All of the per capita variables as well as lagged dependent variables were generated using post-imputation data.

Some variables, such as those obtained from the Census, contained around ninety percent missingness because the variable is reported only once every ten years. Because the dataset starts at 1895, Census data for 1895 was linearly interpolated using data from 1890 and 1900 before the dataset was run through the imputation program.[7] Much of the data from the report of the commissioner of education had around twenty-five percent missingness due to inconsistencies in which data were reported from year-to-year.

[7] The Census data from 1895 should be viewed with caution since the depression of 1893 may have caused a non-linear increase in manufacturing between 1890 and 1900, making linear interpolation less accurate. That being said, there is no other way to get around this problem without starting the period of analysis at 1890, for which much of the education data is unavailable.

For all of the reasons mentioned above, results from this analysis should be viewed tentatively. Traditional levels of statistical significance may be too stringent for these data and may lead us to fail to reject false null hypotheses.

c. Variables

This paper looks at progressive education reform from two different aspects: the professionalization of teaching, as measured by the number of public normal schools in a state, and the rise of public high schools. While there are numerous other reforms that occurred during this time period, these two reforms have been chosen due to the availability of data. These variables have been measured Both dependent variables have been measured in terms of raw counts, and both of these measures have been collected from *The Annual Report of the Commissioner of Education*.

This paper proposes several key independent variables of interest as potential explanations of progressive education reform. As many of the ideas proposed by progressives were based on ideals of corporate efficiency, and as much progressive reform was championed by business and corporate elites, much of the previous literature has suggested that industrialization was a large driver of education reform. To measure industrialization, this paper uses the number of wage earners working in manufacturing, measured in raw counts (by thousands). While professionalization may have been driven by industrialization, the working class was opposed to secondary schooling as advanced education was often viewed as a benefit exclusively for the middle and upper class. Consequently, I predict that this measure of industrialization will have a positive effect on the professionalization of teaching but a negative effect on the rise of public high schools.

Consistent with Salisbury (1969), it is assumed that more wage earners working in manufacturing should lead to more organized workers in these areas.

Because of the blunt nature of measuring just the number of wage earners, the potential for the positive impact of industrialization and the negative impact of organized workers to cancel each other out should be recognized. To test the robustness of the number of wage earners, auxiliary models will look at the effect of the raw value of manufactured goods produced in each state as another measure of industrialization. This variable also does not necessarily account for whether or not workers have been organized, and consequently assumes that more workers leads to more influence, which may not necessarily be true.

The model also predicts that reforms in political structures were necessary to breaking the influence of party machinery and, consequently, should be associated with more professionalization in teaching. To measure political reform, a dummy variable signifying whether or not a state has the Australian ballot in a particular year will be used (1 for if reform has been implemented, 0 otherwise). Party column and office bloc ballots within the Australian ballot, however, will not be distinguished due to a lack of available data, even though previous literature has suggested that office bloc reforms should lead to even less party influence than the party column reform. Since the available data only include the year of reform, a state will be considered "reformed" starting the year in which it passed reform, even though it may not have been implemented until a later date. This measure may also be an indicator of civic group organization as these reforms were often initiated by middle class citizens' groups, similar to education reform groups. For this reason, the Australian ballot measure should also have a positive effect on the number of high schools.

While much of the literature has alluded to the necessity of the feminization of teaching to reform, few (if any) authors have more thoroughly explored this as a causal factor for education reform. To measure this possibility, the models will include a "feminization" variable, measured as the proportion of teachers in a state who are female. This variable may, however, pick up some regional variance, as the Northeast was the earliest region to feminize their working force. The timeframe for this dataset simplifies this measure as well: while later reformers lamented the feminization of teaching, the movement to bring more men back into teaching was not strong during the time period covered in this paper. By 1895, feminization was fairly widespread throughout the country, and state-by-state variation in the feminization of the teaching workforce may not be as great as it was earlier; in other words, the feminization of teaching that is hypothesized to have been necessary to reform may have largely already occurred by 1896. Moreover, there may be potential problems associated with not delineating between secondary teachers and the rest of the teaching workforce: the high school teaching workforce was more masculine, and consequently, as the number of high schools increased the feminization of the teaching workforce may become less pronounced. Finally, because the effect of feminization may only be important if it reaches a certain level, several splines will be tested, interacting the feminization variable with a dummy variable indicating if feminization has reached 75% in a state.[8]

Finally, civic groups are believed to be one of the key causes for progressive education reform during this time period. While no dataset for civic groups across all of the states during this time period currently exists, this paper uses the number of newspapers in a

[8] As the previous literature does not suggest a specific cutoff for feminization, 75% has been chosen as an arbitrary cutoff, representing (roughly) the mean for the entire United States during the period studied.

state as a very rough measure of interest organization. It is believed that more newspapers signifies more interest group and reform group organization, as the groups organizing during this period would have primarily been working against the status quo. While this is not a perfect measure of all of the different interests that were organizing at the time, it should still get at the underlying idea of citizens organizing against status quo political arrangements. For some models, newspapers will be measured as a raw number, while in others, it will be measured per one thousands residents.

Control variables include a dummy variable measure for the South[9] (which may pick up some variation due to segregation as well as a strong history of private secondary schooling) and, for some models, population (measured by thousands).[10] A "time" variable has been included in some ancillary models to check for problems related to trending series. [11]

III. Hypotheses

The theory and methods can be summarized as follows:

> Hypothesis 1: As the number of newspapers in a state increases, the number of public high schools and public normal schools will also increase.
>
> Hypothesis 2: As industrialization increases, the number of public normal schools will increase but the number of public high schools will decrease.

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[9] This includes the 11 states of the old Confederacy (which excludes the contested states of Missouri and Kentucky).

[10] It should be noted that the population variable came from the Annual Report of the Commissioner of Education; for inter-Census years, this was often an estimate (although it is not specified whether this was estimated by the Commissioner of Education or by state officials). The reliability of these population estimates has not been evaluated.

[11] While there are certainly other variables that could have been included in the models, the degrees of freedom have been limited by the number of states, demanding parsimony in the model.

Hypothesis 3: As the level of feminization increases, the number of public high schools and public normal schools will also increase.

Hypothesis 4: States that have implemented the Australian ballot will have more public normal schools and more public high schools than those that have not implemented ballot reform.

Hypothesis 5: There will be fewer public normal schools and public high schools in states in the South relative to the rest of the country.

IV. Methods

a. Poisson "Count" Model

In all cases, the moment of causality is considered to be contemporaneous; that is, the effect of the independent variables is not expected to have an advanced or delayed effect.

As seen in the appendix, neither dependent variable is distributed normally, with values concentrated on the left side of the distribution. King (1988) shows that OLS may not appropriately estimate parameters in the case of positive, discrete dependent variables and may lead to inaccurate—in that they predict a negative number of "events"—and inefficient—by ignoring heteroskedasticity—estimates. To account for this, the dependent variables have been evaluated using Poisson count models; the Poisson models will be evaluated using both static specification and dynamic specification.[12]

[12] As a basic diagnostic, distributions of the residuals against fitted values for each model have been included in the appendix.

b. Dynamic Specification

It is believed that the independent variables from previous years will affect the dependent variable in the current year. For example, not only do we believe that industrialization affects the number of high schools this year—we also believe that continuous pressure from industrialization in all of the years leading up to this year will also affect the number of high schools *this year*. To control for this noise from previous years' independent variables, it is necessary to include a lagged dependent variable as an independent variable. The lagged dependent variable ensures that the other independent variables in the model are only measuring the effects from the current year. Finally, this lag will be logged so that it is scaled in the same way that the dependent variable is scaled by the Poisson model. Figures 1, 2, 3, and 4 all suggest that the data could best be modeled with random slopes and random intercepts for each state, and consequently, a random effects model has been included in the appendix.

CHAPTER 4

ANALYSIS

In general, the models provide evidence for positive effects for newspapers on the rise of high schools and for industrialization on teacher professionalization. The spline for teaching feminization was generally statistically insignificant and had little or no effect on the coefficients and significance of other variables. Switching "number of wage earners" with "value of manufactured goods" corroborated the results presented. The models were also tested excluding "number of wage earners" completely, as it was the variable with the most missingness; this had no substantive effect on the model. Finally, the "time" variable was statistically insignificant in all models and had little or no effect on the coefficients and statistical significance of the covariates, suggesting that no trending series problem exists for the models presented. A variable will be considered statistically significant if it has a p-value of less that 0.05.

I. Dynamic Poisson "Count" Models

For the dynamically specified count model for number of normal schools, the number of wage earners is positive and statistically significant. To interpret the coefficients for these models, it is necessary to look at the incident rate ratio (IRR), which measures the rate at which events are expected to occur, where the number of events occurring at any specific point in time is 1 – *IRR*. With an IRR of 1.00150, we can expect 0.0015 more normal schools for every additional 1,000 wage earners in a state. While this may seem substantively

small, it still suggests that there will be one new normal school in a state for every 667,000 wage earners. Only New York (before 1895) and Pennsylvania (by 1900) had this many wage earners during the time period studied, although Massachusetts, Ohio, and Illinois all approach this threshold by 1909; New York and Pennsylvania had 1,000,000 and 875,000 wage earners by 1909, respectively. The intercept suggests that on average and all else equal, a state during the time period covered will have somewhere between one and two normal schools. The intercept indicates that the average state has between 0 and 1 normal schools, all else equal, and the lag indicates that for every unit increase in the log of the number of normal schools in the previous year, there are 0.787 (1.787 – 1) more normal schools in the current year.

Table 1: Number of Public Normal Schools, Poisson Count Model with Lag

Parameter	Estimate	IRR	Std. Error	95% Conf. Int.
Intercept	0.43578*	1.54617	0.10728	[0.22551, 0.64605]
Wage Earners	0.00149*	1.00150	0.00030	[0.00090, 0.00208]
Prop. Female	0.00589	1.00590	0.04237	[-0.07716, 0.08894]
Newspapers	0.00042	1.00042	0.00210	[-0.00370, 0.00454]
South	0.03419	1.03479	0.07360	[-0.11007, 0.17845]
Australian Ballot	0.03063	1.03110	0.07726	[-0.12080, 0.18206]
Population	-0.00006	0.99994	0.00003	[-0.00012, 0.00000]
Normal Schools Lag	0.58027*	1.78651	0.05886	[0.46490, 0.69564]
N	714			
AIC	2748.6			
Log-Likelihood	-1366.307			

While several variables in the high schools model reach statistical significance, the substantive significance of the coefficients is dubious. With an IRR of 1.00519, the coefficient for the newspapers variable indicates that there would have to be 193

newspapers in a state for an additional high school to be formed; in reality, by 1908 no state had even 100 newspapers while the largest states had over 750 high schools. Similarly, while the IRR for the Australian ballot dummy is much larger than those for the other variables, its substantive significance is almost null given that the variable may only reach a value of one. While the ICC for the intercept for the high schools model is only 2.456, the lag is also statistically significant and suggests that for every unit increase in the log of the number of high schools in the previous year, there are 1.222 (2.222057 - 1) more high schools in the current year.

Table 2: Number of Public High Schools, Poisson Count Model with Lag

Parameter	Estimate	IRR	Std. Error	95% Conf. Int.
Intercept	0.89848*	2.45586	0.19329	[0.51963, 1.27733]
Wage Earners	-0.00016	0.99984	0.00016	[-0.00047, 0.00015]
Prop. Female	0.00862	1.00866	0.01522	[-0.02121, 0.03845]
Newspapers	0.00518*	1.00520	0.00130	[0.00263, 0.00773]
South	0.01456	1.01467	0.02115	[-0.02690, 0.05601]
Australian Ballot	0.03140	1.03189	0.01641	[-0.00076, 0.06356]
Population	0.00001	1.00001	0.00002	[-0.00003, 0.00005]
High Schools Lag	0.79843*	2.22206	0.04770	[0.70494, 0.89192]
N	714			
AIC	13205.2			
Log-Likelihood	-6594.603			

II. Discussion

In general, the models provide evidence for a potential positive effect for the number of wage earners on the number of normal schools, the number of newspapers on the number of high schools, and the Australian Ballot on the number of high schools. As explained in the historical literature, increased communication and interest organization appear to be

strong drivers of progressive education reform. The newspapers variable, however, does not necessarily capture the nuances of the values of different groups, specifically those of teachers unions, immigrant groups, "good government" groups, and benevolent corporate foundations.

Surprisingly, few of the other variables of interest reached statistical significance in any of the models. Even when incorporated into a spline model, the feminization variable was not statistically significant. This may have been due to a lack of variation or by a delayed effect of feminization—the causal variation of feminization may have occurred earlier than 1895, or the minimal increases in feminization occurring during this time period may have taken time to cause reform. Some of the causal variation due to feminization may have also been absorbed by an increased number of high schools—which typically had a greater proportion of male teachers than the workforce at large—as well as efforts by some progressive reformers to bring more men into teaching.

Electoral reform also does not seem to facilitate professionalization, and its effect on secondary education seems to be minimal. This could be a result of the differences between party column and office bloc reform or a delayed effect of ballot reform—it may have taken time before ballot reform affected local patronage. It could be that the period of analysis does not include enough variation, and that the causal moment actually occurred earlier: by 1896, the first year of the analysis, 32 states had already implemented a form of the Australian ballot. As a result, a variable measuring the number of years since implementing the Australian Ballot might be more appropriate. Moreover, the null results suggest that the relationship among larger progressive political reform during the period, city party

machines, and local patronage (as opposed to national patronage) needs to be explored further.

Perhaps most surprising is that the dummy variable for the South was not statistically significant in either model. It is possible that the South variable could have picked up noise due to omitted variable bias due to the proportion illiterate, urbanization, the size of the African American population, or some other variable.

While these models do not necessarily mean that feminization and electoral reform were not important for the progressive education reform, they do suggest that explanations proposed by other authors may be more nuanced than previously considered. Other authors have posited that feminization allowed for a more "logical" managerial hierarchy—but hierarchical models in many masculine fields also exist. And while feminization may have reduced the cost of schools, the feminized areas may have also had different taxation structures than the less feminized areas. High schools tended to have more male teachers and consequently a higher level of feminization at the state level may have actually been indicative of *fewer* high schools. And perhaps feminization is not a causal factor but, rather, just a coincidence; progressive reform seems to have occurred regardless of feminization. Or, it may be possible that feminization interacts with other items of interest, such as unionization or the presence of women's civic clubs. Finally, a "requisite" level of feminization should be explored in future literature.

In terms of ballot reform, it is possible that teaching positions as patronage do not function in the same way that other political patronage systems worked. Future research should explore the relationship between political machines (as opposed to just school trustees) and the changing dynamics of teacher patronage.

While traditional levels of significance were used in this paper, it is possible that lower levels would have been more appropriate given the complexity of the dataset; using a p-value of 0.05 may have led to failing to reject false null hypotheses in several instances.

While some of the null results are theoretically surprising, it is still possible, given the problems with the available data, that more of the variables actually affected education reform. Future research should expand the time period covered, should include other potential measures of civic group formation that differentiate among different interests, and should look at local-level data rather than state-level data. Finally, it is also possible that the dependent variables used in this paper do not fully capture how professionalization and secondary education actually spread.

CHAPTER 5

CONCLUSION

The turn of the twentieth century ushered in many of the educational practices fundamental to the contemporary American education system. A growing middle class sought to make the provision of public services more reliable—and part of this involved professionalizing the teaching workforce. At the same time, a great amount of civic activity began to occur, perhaps arising from an era of industrialization that had increased connectivity among people but which had also generated fatigue with machine party politics. Using a unique dataset, this paper presented evidence for a positive effect of newspapers on the number of high schools and industrialization on the number of normal schools across states from 1896 to 1911. While this paper did not find evidence for many of the variables that the education history literature has suggested are important, there are several explanations for this. The existing literature has not fully specified the causal mechanisms through which different variables influenced reform. And given the great limitations of the data and the use of blunt proxies, many of the null results may not reflect true null hypotheses.

By looking at the bureaucratization of education at the local level, we can understand better the mechanisms through which other bureaucratic, progressive reforms were brought about, moving away from a discussion of just incentive structures and institutions toward a discussion of the politics at play at different levels of government and how these politics affected how reform was advocated. Given the pervasiveness of education systems

across thousands of localities in the United States, an exploration of school reform provides a unique way of understanding the larger progressive reform movement. An understanding of the mechanisms through which education patronage was dissolved and education reform was brought about may allow future political scientists to gain greater leverage on an underexplored area of one of the most important components of American political life.

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APPENDIX A

COMMENTS ON DATA AND ANALYSIS

I. Missing Variables

Table 3: Missingness of Variables Used in Models

Parameter	Percent Missing
Number of Public Normal Schools	18.1%
Number of Public High Schools	6.3%
Australian Ballot	13.2%
South	0.0%
Number of Male Teachers (for prop. fem.)	19.8%
Number of Female Teachers (for prop. fem.)	22.7%
Population	23.6%
Total Wage Earners	82.5%
Newspapers	76.4%

II. Distribution of the Dependent Variables

a. Public Normal Schools

The distribution of public normal schools across units suggests that a count model is the most appropriate specification. As King (1988) notes, discrete, non-normally distributed data with medians around zero and conducive to event count modeling as larger numbers of observations of the dependent variable are "rare events." Each histogram represents one of the imputed datasets.

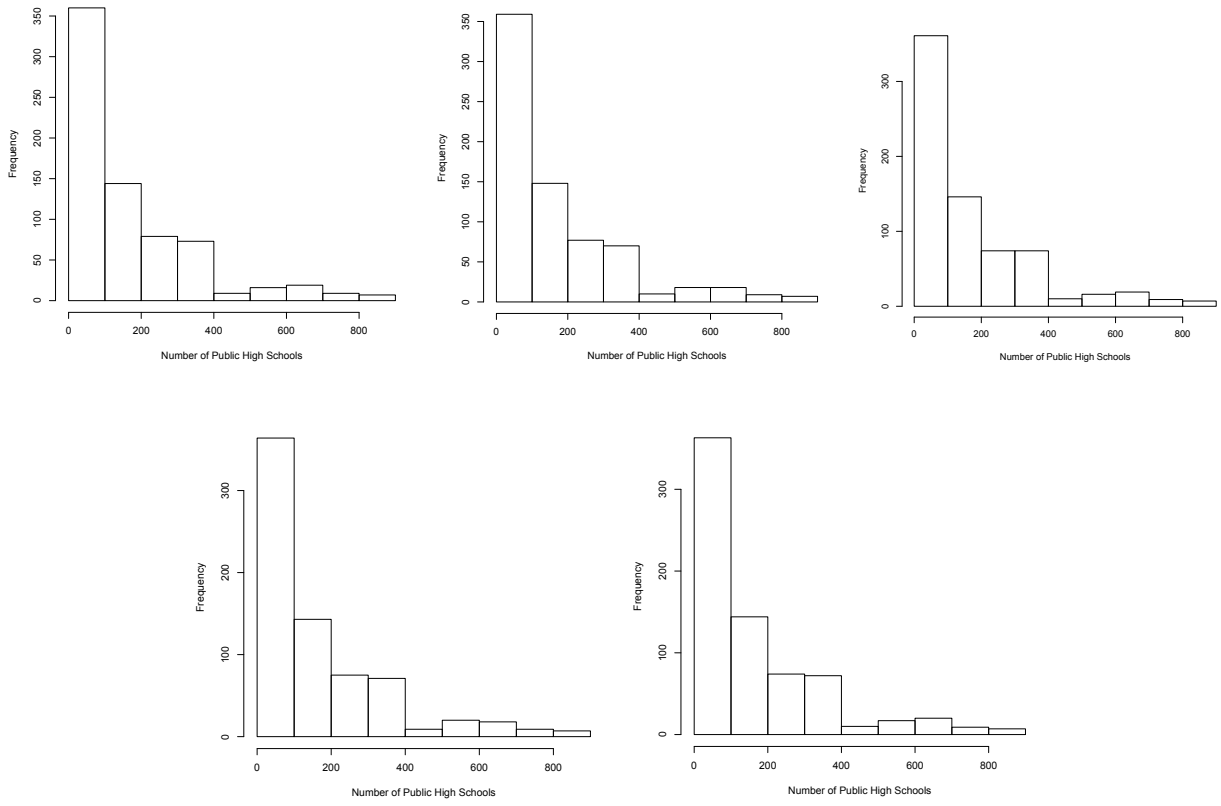

Figure 5: Distribution of Public Normal Schools in Five Imputed Datasets

b. Public High Schools

Similarly, the distribution of high schools also appears to be conducive to a Poisson count model. Each histogram represents one of the imputed datasets.

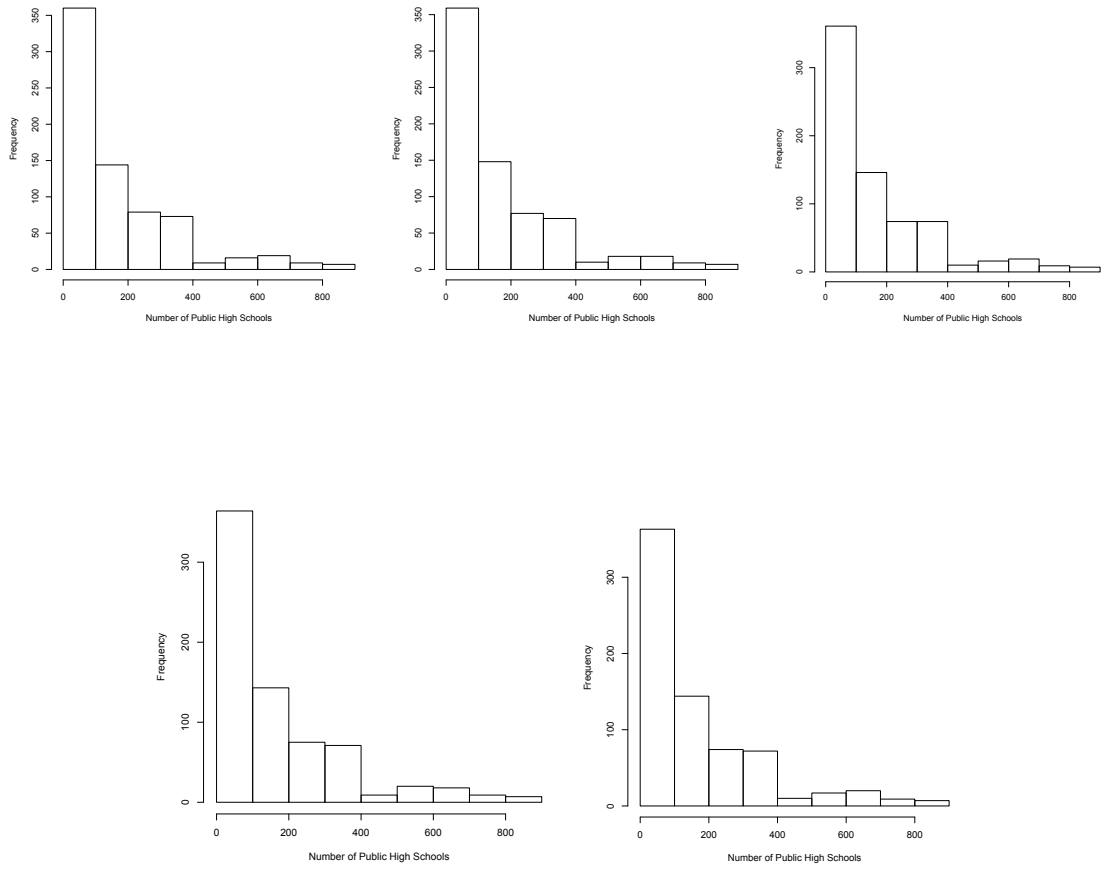

Figure 6: Distribution of Public High Schools in Five Imputed Datasets

APPENDIX B

ALTERNATIVE MODELS

Alternative "static" specifications of the models presented in the body of the paper have been included below, generally corroborating the results presented in Chapter 4. The most substantive difference is for ballot reform, which is not statistically significant in the statically specified high schools model.

Table 4: Number of Public Normal Schools, Poisson Count Model with Random Effects

Parameter	Estimate	IRR	Std. Error	95% Conf. Int.
Intercept	0.87556*	2.40022	0.17276	[0.53695, 1.21417]
Wage Earners	0.00157*	1.00157	0.00023	[0.00112, 0.00202]
Prop. Female	0.01815	1.01832	0.05377	[-0.08272, 0.12354]
Newspapers	0.00158	1.00158	0.00331	[-0.00491, 0.00807]
South	0.00551	1.00553	0.18916	[-0.36524, 0.37626]
Australian Ballot	0.10586	1.11167	0.15873	[-0.20525, 0.41697]
Population	-0.00002	0.99998	0.00006	[-0.00014, 0.00010]
N	714			
Groups	48			
Intra-Class Correlation	0.7453			
AIC	2779.59			
Log-Likelihood	-1381.295			

Table 5: Number of Public High Schools, Poisson Count Model with Random Effects

Parameter	Estimate	IRR	Std. Error	95% Conf. Int.
Intercept	4.16758*	64.55903	0.18230	[3.81027, 4.52489]
Wage Earners	0.00006	1.00006	0.00029	[-0.00051, 0.00063]
Prop. Female	0.06487	1.06702	0.09510	[-0.12153, 0.25127]
Newspapers	0.01119*	1.01125	0.00194	[0.00739, 0.01499]
South	0.15489	1.16753	0.19899	[-0.23513, 0.54491]
Australian Ballot	0.04088	1.04173	0.12618	[-0.20643, 0.28819]
Population	0.00005	1.00005	0.00003	[0.00000, 0.00008]
N	714			
Groups	48			
Intra-Class Correlation	0.86068			
AIC	13367.29			
Log-Likelihood	-6674.646			

APPENDIX C

DIAGNOSTICS

In general, we are looking for residuals that are randomly distributed across fitted values. The distributions for the count models provide further substantiation that Poisson is the correct specification, as the residuals for both the statically specified and dynamically specified count models appear to be randomly distributed. While heteroskedasticity may be problematic across all of the models, especially for lower values, this appears to be less so for the dynamically specified models than the statically specified models. Moreover, the appearance of heteroskedasticity may be more due to the clustering of observations around certain areas rather than an actual non-random distribution of residuals.

I. Dynamic Specification

a. Public Normal Schools

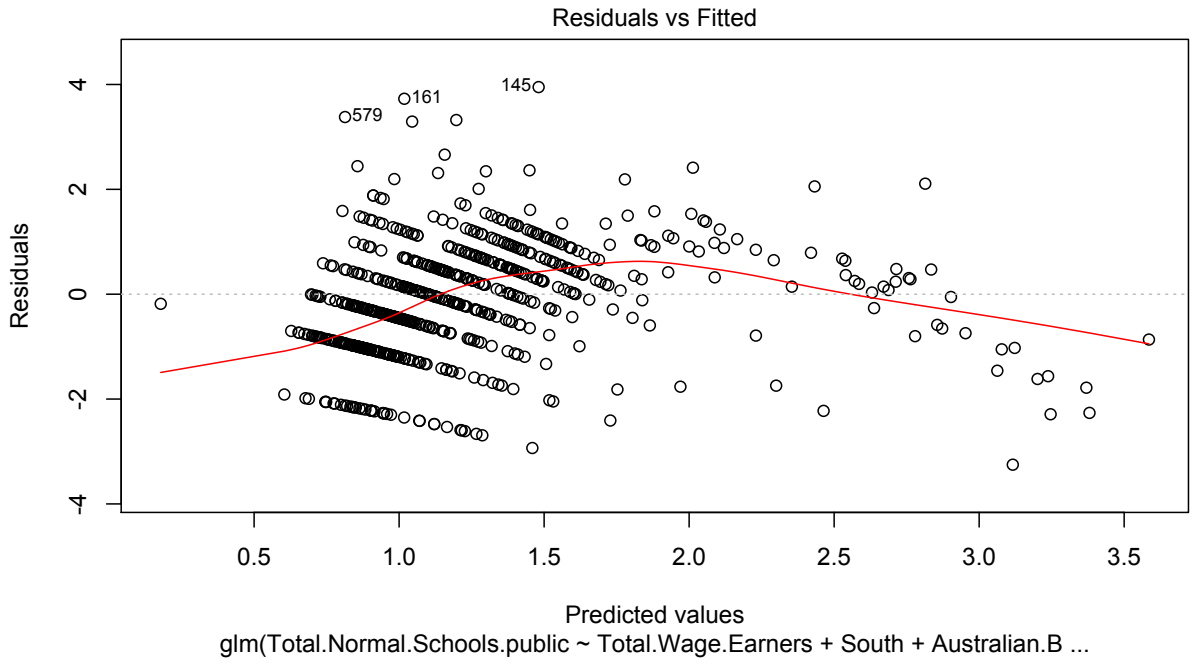

Figure 7: Distribution of Residuals against Fitted Values, Public Normal Schools, Poisson Count Model with Lag

b. Public High Schools

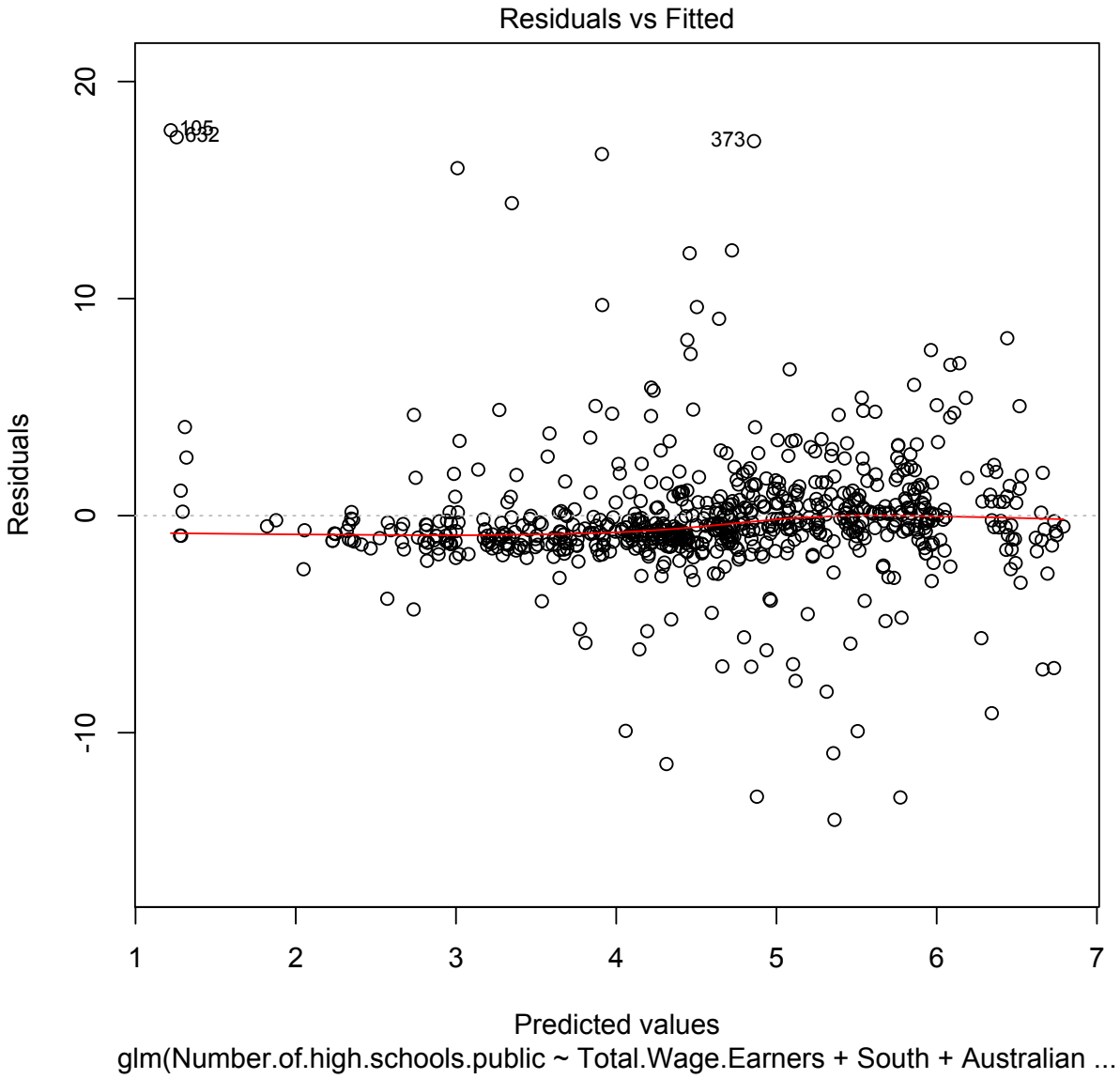

Figure 8: Distribution of Residuals against Fitted Values, Public High Schools, Poisson Count Model with Lag

II. Static Specification

a. Public Normal Schools

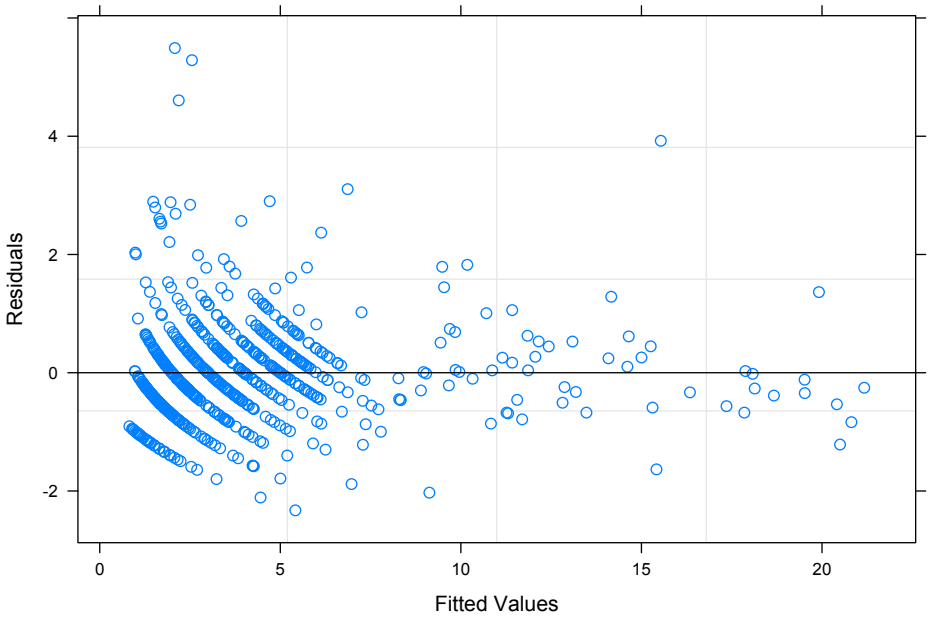

Figure 9: Distribution of Residuals against Fitted Values, Public Normal Schools, Poisson Count Model with Random Effects

b. Public High Schools

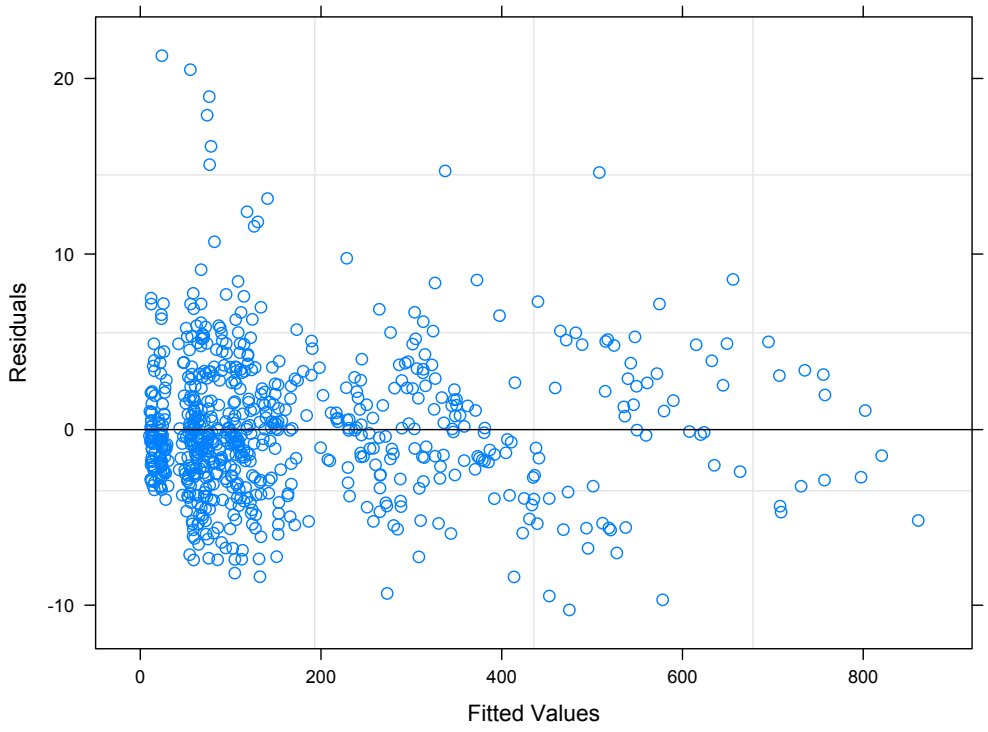

Figure 10: Distribution of Residuals against Fitted Values, Public High Schools, Poisson Count Model with Random Effects

APPENDIX D

REPLICATION CODE

R version: 3.0.2 for Mac OSX – x86_64-apple-darwin10.8.0 (64-bit)

```
rm(list=ls())
library(foreign)
library(xtable)
library(lme4)
library(reshape)
library(tseries)
library(car)
library(lmtest)
library(ggplot2)
library(rgdal)
library(maptools)
library(plyr)
library(Amelia)
library(timeSeries)
library(Zelig)
library(ZeligChoice)
library(quantmod)
library(ZeligMultilevel)
library(lme4)
library(ZeligGAM)
library(multilevel)
setwd("/users/matthewtyler/R Directory")

load("Final Education 1895 Data.RData")


#########################
####Poisson With Lag#####
#########################

b.out<-NULL
se.out<-NULL
for(i in 1:education.1895.mi$m){
 poisson.out <-
 glm(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+Pr
 op.Female+Newspapers+Total.Normal.Schools.public.lag.log+Population,
```

```
 family="poisson", data=education.1895.mi$imputations[[i]])
 b.out <- rbind(b.out, poisson.out$coef)
 se.out <- rbind(se.out, coef(summary(poisson.out))[,2])
 }
normal.schools.poisson <- mi.meld(q=b.out, se=se.out)

normal.schools.poisson

####AIC and Log Likelihood
norm.poisson <-
 glm(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+Pr
 op.Female+Newspapers+Total.Normal.Schools.public.lag.log+Population,
 family="poisson", data=education.1895.mi$imputations[[1]])
summary(norm.poisson)
logLik(norm.poisson)
norm.poisson <-
 glm(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+Pr
 op.Female+Newspapers+Total.Normal.Schools.public.lag.log+Population,
 family="poisson", data=education.1895.mi$imputations[[2]])
summary(norm.poisson)
logLik(norm.poisson)
norm.poisson <-
 glm(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+Pr
 op.Female+Newspapers+Total.Normal.Schools.public.lag.log+Population,
 family="poisson", data=education.1895.mi$imputations[[3]])
summary(norm.poisson)
logLik(norm.poisson)
norm.poisson <-
 glm(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+Pr
 op.Female+Newspapers+Total.Normal.Schools.public.lag.log+Population,
 family="poisson", data=education.1895.mi$imputations[[4]])
summary(norm.poisson)
logLik(norm.poisson)
norm.poisson <-
 glm(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+Pr
 op.Female+Newspapers+Total.Normal.Schools.public.lag.log+Population,
 family="poisson", data=education.1895.mi$imputations[[5]])
summary(norm.poisson)
logLik(norm.poisson)

##AIC
(2753.2+2774.3+2679.8+2741.7+2794)/5

##LL
(-1368.61-1379.169-1331.882-1362.875-1389.001)/5
```

```
b.out<-NULL
se.out<-NULL
for(i in 1:education.1895.mi$m){
 poisson.out <-
 glm(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+High.Schools.Lag.log+Population, family="poisson",
 data=education.1895.mi$imputations[[i]])
 b.out <- rbind(b.out, poisson.out$coef)
 se.out <- rbind(se.out, coef(summary(poisson.out))[,2])
 }
high.schools.poisson <- mi.meld(q=b.out, se=se.out)

high.schools.poisson
####AIC and Log Likelihood
hs.poisson <-
 glm(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+High.Schools.Lag.log+Population, family="poisson",
 data=education.1895.mi$imputations[[1]])
summary(hs.poisson)
logLik(hs.poisson)
hs.poisson <-
 glm(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+High.Schools.Lag.log+Population, family="poisson",
 data=education.1895.mi$imputations[[2]])
summary(hs.poisson)
logLik(hs.poisson)
hs.poisson <-
 glm(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+High.Schools.Lag.log+Population, family="poisson",
 data=education.1895.mi$imputations[[3]])
summary(hs.poisson)
logLik(hs.poisson)
hs.poisson <-
 glm(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+High.Schools.Lag.log+Population, family="poisson",
 data=education.1895.mi$imputations[[4]])
summary(hs.poisson)
logLik(hs.poisson)
hs.poisson <-
 glm(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+High.Schools.Lag.log+Population, family="poisson",
 data=education.1895.mi$imputations[[5]])
summary(hs.poisson)
logLik(hs.poisson)

#AIC
```

```
(10673+13902+14878+12740+13833)/5

#LL
(-5328.619-6942.959-7430.795-6361.972-6908.672)/5

####With different manufactured

b.out<-NULL
se.out<-NULL
for(i in 1:education.1895.mi$m){
 poisson.out <-
 glm(Number.of.high.schools.public~Manufactured.Goods.Value+South+Australian.Ballot.B
 inary+Prop.Female+Newspapers+High.Schools.Lag+Population, family="poisson",
 data=education.1895.mi$imputations[[i]])
 b.out <- rbind(b.out, poisson.out$coef)
 se.out <- rbind(se.out, coef(summary(poisson.out))[,2])
 }
high.schools.poisson <- mi.meld(q=b.out, se=se.out)

high.schools.poisson



##########################
####Poisson With RE######
##########################

b.out<-NULL
se.out<-NULL
for(i in 1:education.1895.mi$m){
 hier.out <-
 glmer(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+Population+(1|State),
 data=education.1895.mi$imputations[[i]], family=poisson)
 b.out <- rbind(b.out, hier.out@beta)
 se.out <- rbind(se.out, coef(summary(hier.out))[,2])
 }
normal.schools.random.poisson <- mi.meld(q=b.out, se=se.out)

normal.schools.random.poisson

##AIC and LL

norm.poisson <-
 glmer(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+Population+(1|State),
```

```
 data=education.1895.mi$imputations[[1]], family=poisson)
summary(norm.poisson)
logLik(norm.poisson)
norm.poisson <-
 glmer(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+Population+(1|State),
 data=education.1895.mi$imputations[[2]], family=poisson)
summary(norm.poisson)
logLik(norm.poisson)
norm.poisson <-
 glmer(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+Population+(1|State),
 data=education.1895.mi$imputations[[3]], family=poisson)
summary(norm.poisson)
logLik(norm.poisson)
norm.poisson <-
 glmer(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+Population+(1|State),
 data=education.1895.mi$imputations[[4]], family=poisson)
summary(norm.poisson)
logLik(norm.poisson)
norm.poisson <-
 glmer(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+Population+(1|State),
 data=education.1895.mi$imputations[[5]], family=poisson)
summary(norm.poisson)
logLik(norm.poisson)

##AIC
(2884.172+2823.566+2789.736+2722.751+2853.765)/5
##LL
(-1434.086-1403.783-1386.868-1353.376-1418.882)/5


b.out<-NULL
se.out<-NULL
for(i in 1:education.1895.mi$m){
 hier.out <-
 glmer(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary
 +Prop.Female+Newspapers+Population+(1|State),
 data=education.1895.mi$imputations[[i]], family=poisson)
 b.out <- rbind(b.out, hier.out@beta)
 se.out <- rbind(se.out, coef(summary(hier.out))[,2])
 }
high.schools.random.poisson <- mi.meld(q=b.out, se=se.out)
```

```
high.schools.random.poisson

#ICC
aov.1 <- aov(Number.of.high.schools.public~State,
 data=education.1895.mi$imputations[[1]])
ICC1(aov.1)
aov.1 <- aov(Number.of.high.schools.public~State,
 data=education.1895.mi$imputations[[2]])
ICC1(aov.1)
aov.1 <- aov(Number.of.high.schools.public~State,
 data=education.1895.mi$imputations[[3]])
ICC1(aov.1)
aov.1 <- aov(Number.of.high.schools.public~State,
 data=education.1895.mi$imputations[[4]])
ICC1(aov.1)
aov.1 <- aov(Number.of.high.schools.public~State,
 data=education.1895.mi$imputations[[5]])
ICC1(aov.1)
###ICC
(0.8505533+0.8494383+0.8448625+0.8508739+0.8550169)/5

####AIC and Log Likelihood
hs.poisson <-
 glmer(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary
 +Prop.Female+Newspapers+High.Schools.Lag+Population+(1|State), family="poisson",
 data=education.1895.mi$imputations[[1]])
summary(hs.poisson)
logLik(hs.poisson)
hs.poisson <-
 glmer(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary
 +Prop.Female+Newspapers+High.Schools.Lag+Population+(1|State), family="poisson",
 data=education.1895.mi$imputations[[2]])
summary(hs.poisson)
logLik(hs.poisson)
hs.poisson <-
 glmer(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary
 +Prop.Female+Newspapers+High.Schools.Lag+Population+(1|State), family="poisson",
 data=education.1895.mi$imputations[[3]])
summary(hs.poisson)
logLik(hs.poisson)
hs.poisson <-
 glmer(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary
 +Prop.Female+Newspapers+High.Schools.Lag+Population+(1|State), family="poisson",
 data=education.1895.mi$imputations[[4]])
summary(hs.poisson)
logLik(hs.poisson)
```

```
hs.poisson <-
 glmer(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary
 +Prop.Female+Newspapers+High.Schools.Lag+Population+(1|State), family="poisson",
 data=education.1895.mi$imputations[[5]])
summary(hs.poisson)
logLik(hs.poisson)

##AIC
(14818.754+15270.259+15766.717+15235.375+14649.654)/5
##LL
(-7400.377-7626.129-7874.358-7608.688-7315.827)/5




####With different manufactured
b.out<-NULL
se.out<-NULL
for(i in 1:education.1895.mi$m){
 hier.out <-
 glmer(Number.of.high.schools.public~Manufactured.Goods.Value+South+Australian.Ballot
 .Binary+Prop.Female+Newspapers+Population+(1|State),
 data=education.1895.mi$imputations[[i]], family=poisson)
 b.out <- rbind(b.out, hier.out@beta)
 se.out <- rbind(se.out, coef(summary(hier.out))[,2])
 }
high.schools.random.poisson <- mi.meld(q=b.out, se=se.out)

high.schools.random.poisson



########################################
##################SPLINES################
########################################

####################################
#####With female binary#############
####################################
normal.schools.ols.spline.lag <-
 zelig(Total.Normal.Schools.public.Per.Capita~Total.Wage.Earners+South+Australian.Ballo
 t.Binary+Prop.Female*prop.female.dummy+Newspapers+Total.Normal.Schools.public.lag
 +Population, model="ls",
 data=education.1895.mi);summary(normal.schools.ols.spline.lag)
```

```
high.schools.ols.lag.count <-
 zelig(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary
 +Prop.Female*prop.female.dummy+Newspapers+High.Schools.Lag+Population,
 model="ls", data=education.1895.mi); summary(high.schools.ols.lag.count)

####Still significant even when adding in a "time" variable for trending series
###Manufactured Goods value is insignificant

high.schools.ols.lag.continuous <-
 zelig(Number.of.high.schools.public.Per.Capita~Total.Wage.Earners.Per.Capita+South+Au
 stralian.Ballot.Binary+Prop.Female*prop.female.dummy+Newspapers.Per.Capita+High.Sc
 hools.Per.Capita.Lag, model="ls", data=education.1895.mi);
 summary(high.schools.ols.lag.continuous)



####Should note that a lag model with a trend was tried, with the trend not reaching
 traditional levels of significance

######################
####Random Effects####
######################

#########################################################
#####Looking at random with the female binary##########
#########################################################


b.out<-NULL
se.out<-NULL
for(i in 1:education.1895.mi$m){
 hier.out <-
 lmer(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+P
 rop.Female*prop.female.dummy+Newspapers+Population+(1|State),
 data=education.1895.mi$imputations[[i]])
 b.out <- rbind(b.out, hier.out@beta)
 se.out <- rbind(se.out, coef(summary(hier.out))[,2])
 }
normal.schools.random.spline <- mi.meld(q=b.out, se=se.out)

normal.schools.random.spline


b.out<-NULL
se.out<-NULL
for(i in 1:education.1895.mi$m){
```

```
 hier.out <-
 lmer(Number.of.high.schools.public.Per.Capita~Total.Wage.Earners.Per.Capita+South+Au
 stralian.Ballot.Binary+Prop.Female*prop.female.dummy+Newspapers.Per.Capita+High.Sc
 hools.Per.Capita.Lag+(1|State), data=education.1895.mi$imputations[[i]])
 b.out <- rbind(b.out, hier.out@beta)
 se.out <- rbind(se.out, coef(summary(hier.out))[,2])
 }
high.schools.random <- mi.meld(q=b.out, se=se.out)

high.schools.random



#########################
####Poisson With Lag#####
#########################

####Spline
b.out<-NULL
se.out<-NULL
for(i in 1:education.1895.mi$m){
 poisson.out <-
 glm(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+Pr
 op.Female*prop.female.dummy+Newspapers+Total.Normal.Schools.public.lag+Population,
 family="poisson", data=education.1895.mi$imputations[[i]])
 b.out <- rbind(b.out, poisson.out$coef)
 se.out <- rbind(se.out, coef(summary(poisson.out))[,2])
 }
normal.schools.poisson.spline <- mi.meld(q=b.out, se=se.out)

normal.schools.poisson.spline



b.out<-NULL
se.out<-NULL
for(i in 1:education.1895.mi$m){
 poisson.out <-
 glm(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female*prop.female.dummy+Newspapers+High.Schools.Lag+Population,
 family="poisson", data=education.1895.mi$imputations[[i]])
 b.out <- rbind(b.out, poisson.out$coef)
 se.out <- rbind(se.out, coef(summary(poisson.out))[,2])
 }
high.schools.poisson <- mi.meld(q=b.out, se=se.out)
```

```
high.schools.poisson



#########################
####Poisson With RE######
#########################

b.out<-NULL
se.out<-NULL
for(i in 1:education.1895.mi$m){
 hier.out <-
 glmer(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female*prop.female.dummy+Newspapers+Population+(1|State),
 data=education.1895.mi$imputations[[i]], family=poisson)
 b.out <- rbind(b.out, hier.out@beta)
 se.out <- rbind(se.out, coef(summary(hier.out))[,2])
 }
normal.schools.random.poisson <- mi.meld(q=b.out, se=se.out)

normal.schools.random.poisson

b.out<-NULL
se.out<-NULL
for(i in 1:education.1895.mi$m){
 hier.out <-
 lmer(Number.of.high.schools.public~Total.Wage.Earners.Per.Capita+South+Australian.Bal
 lot.Binary+Prop.Female*prop.female.dummy+Newspapers+Population+(1|State),
 data=education.1895.mi$imputations[[i]], family=poisson)
 b.out <- rbind(b.out, hier.out@beta)
 se.out <- rbind(se.out, coef(summary(hier.out))[,2])
 }
high.schools.random.poisson <- mi.meld(q=b.out, se=se.out)

high.schools.random.poisson



####################
####Diagnostics########
####################

#########################
####Poisson With Lag#####
#########################
```

```
education.1895.mi$imputations[[1]]$Total.Normal.Schools.public.lag <-
 ifelse(education.1895.mi$imputations[[1]]$Total.Normal.Schools.public.lag==0, 0.0001,
 education.1895.mi$imputations[[1]]$Total.Normal.Schools.public.lag)
education.1895.mi$imputations[[2]]$Total.Normal.Schools.public.lag <-
 ifelse(education.1895.mi$imputations[[2]]$Total.Normal.Schools.public.lag==0, 0.0001,
 education.1895.mi$imputations[[2]]$Total.Normal.Schools.public.lag)
education.1895.mi$imputations[[3]]$Total.Normal.Schools.public.lag <-
 ifelse(education.1895.mi$imputations[[3]]$Total.Normal.Schools.public.lag==0, 0.0001,
 education.1895.mi$imputations[[3]]$Total.Normal.Schools.public.lag)
education.1895.mi$imputations[[4]]$Total.Normal.Schools.public.lag <-
 ifelse(education.1895.mi$imputations[[4]]$Total.Normal.Schools.public.lag==0, 0.0001,
 education.1895.mi$imputations[[4]]$Total.Normal.Schools.public.lag)
education.1895.mi$imputations[[5]]$Total.Normal.Schools.public.lag <-
 ifelse(education.1895.mi$imputations[[5]]$Total.Normal.Schools.public.lag==0, 0.0001,
 education.1895.mi$imputations[[5]]$Total.Normal.Schools.public.lag)

poisson.dynamic.normal <-
 glm(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+Pr
 op.Female+Newspapers+Total.Normal.Schools.public.lag.log+Population,
 family="poisson", data=education.1895.mi$imputations[[1]])
plot(poisson.dynamic.normal, xlab="Fitted Values", ylab="Residuals")

poisson.dynamic.hs <-
 glm(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+High.Schools.Lag.log+Population, family="poisson",
 data=education.1895.mi$imputations[[1]])
plot(poisson.dynamic.hs, xlab="Fitted Values", ylab="Residuals")


#########################
####Poisson With RE######
#########################

poisson.static.normal <-
 glmer(Total.Normal.Schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary+
 Prop.Female+Newspapers+Population+(1|State),
 data=education.1895.mi$imputations[[1]], family=poisson)
plot(poisson.static.normal, xlab="Fitted Values", ylab="Residuals")


poisson.static.hs <-
 glmer(Number.of.high.schools.public~Total.Wage.Earners+South+Australian.Ballot.Binary
 +Prop.Female+Newspapers+Population+(1|State),
 data=education.1895.mi$imputations[[1]], family=poisson)
plot(poisson.static.hs, xlab="Fitted Values", ylab="Residuals")
```