The Gender Gap in Oregon Public Schools: Trends and a Decompositional Breakdown

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Abstract

Increasingly, female students in Oregon outperform their male colleagues on important indicators of academic success such as graduation rates and state exam scores. Quantifying the magnitude of the gender gap and determining the reasons for this gulf in performance will enable the Oregon Department of Education (ODE) to take steps toward ameliorating this divide between students. This study, using regression analysis and data from the ODE, will provide educators around the nation with a more complete understanding of the factors that most significantly affect the creation and persistence of all kinds of gaps in educational outcomes.

Approved:_____
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For years the Oregon Department of Education (ODE) has noticed a concerning gap between male and female students in important educational measurements such as state test scores and application rates to secondary education institutions. According to such data, female students have increasingly come to outperform their male colleagues. In a time in which disparity in success and inequality of opportunity have come to dominate both media coverage and academic study, the explicit gap that has developed between males and females in public schools has yet to receive adequate attention. More specifically, the ODE, deeply in need of answers, has sought out a comprehensive study of both the state's low graduation rate, when compared to national averages, and the widening divide between female and male graduation rates. This paper, by incorporating various economic tools, will analyze the performance of students within Oregon's public school districts to find those counties with the least and most variation in attainment by gender. Student performance will be assessed using data on key academic indicators provided by the ODE. From there, the goal of this analysis will be to incorporate regression analysis to identify the cultural, socioeconomic, institutional and demographic causes that explain why some areas produce smaller gaps measured in performance than others. Additionally, patterns in changes of the size of the gender gap over time will be examined.

Introduction:

From a societal perspective, the provision of a quality education to the population at large has long remained an important component of promoting general prosperity. An increase in years of education will garner a student a number

of positive externalities that can be reaped for years after leaving school. These externalities include gains for both society and the student. The spillover effects of a more educated populace include the election of superior leaders, a reduced crime rate and higher standards of living (Federal Reserve Bank of St. Louis 2014). On an individual level, education will increase your level of productivity, appreciation for and understanding of your role in society and, on average, your health (Cutler et. al. 2006). Individuals also have continually demonstrated a demand for an education that will allow them to positively contribute to their community and to attain their personal goals. Oregon's current education system does not appear to adequately fulfill either of the aforementioned tasks – assisting in the achievement of predetermined societal goals and enabling all to have an opportunity to reach their aspirations.

The state government's education goal – voiced by former Governor Kitzhaber in 2011 – is to facilitate 40 percent of the population earning a baccalaureate degree or higher, 40 percent receiving at least an associate's degree or certificate in a skilled occupation and for the rest of the citizenry to, at the very minimum, obtain a high school degree or an equivalent measure (Oregon Learns 2011). Notably, this goal requires all students to graduate from high school. The feasibility and efficacy of such a policy are questionable. Variation in the magnitude of constraints facing individual students makes universal graduation from high school difficult to attain. Some students will face additional costs such as a less financially stable home environment. Others likely have greater opportunities outside of an academic setting that may spur them to leave the classroom earlier

than most. Still yet, there exists a wide range in the innate ability of the students that will make learning immensely easier for some while others try to overcome the comparatively higher mental costs generated by a school environment.

The state, likewise, lacks the resources to guarantee that students of such varying ability surpass the requisite standards. In addition, such an imposing, specific goal may already be altering the way in which the state measures high school graduation rates (Hammond 2015). These changes could be interpreted as officials attempting to skew numbers related to graduation rates rather than boost performance. In light of these trends, the state working to ensure each student reaches his or her respective highest desired level of education in an efficient manner might be a more economical and feasible goal.

Recent data from Oregon's public schools attest that since the Governor's lofty goals were made public the state's education system has failed to begin to make progress on the primary objective – increased graduation from high school. In 2014, for instance, the students enrolled in public schools actually graduated from high school at a rate one percent below that of the prior year with rates falling from 69 to 68 percent (Hammond 2015). A negative trend in graduation rates and the need to quickly make gains towards the 2025 goals stand in as a few of the reasons reform advocates have cited when trying to pressure the Oregon Department of Education into determining how best to enable their students to make it through high school and then onwards to their next educational milestone.

To foster a student population that graduates at a higher level, the Oregon Department of Education has begun to focus on the divide that exists between their

most and least successful students, in terms of academic achievement. One such gap persists between female and male students in Oregon public schools. Ample evidence substantiates that males have failed to keep up with their female colleagues in the classroom. Take, for example, the fact that 59 percent of those students that failed to graduate in 2014 were males (Hammond 2015). Such a disconcerting pattern receives further evidence by measuring the gaps in graduation rates in 2013. In that year, 73 percent of female students graduated from Oregon public high schools whereas males only did so at a rate of 64 percent (Hammond 2014). This divide between the achievements of the two sexes will undoubtedly be deleterious to the completion of the 40-40-20 benchmarks.

The gender gap between females and males commonly does not receive as much attention as other recognized disparities between different demographic groups. For instance, in both of the articles written by Betsy Hammond in *The Oregonian* in 2014 and 2015 covering the state's high school graduation rates, there is no explicit mention of the problems that may spawn from the gender gap in the education system. Hammond chooses instead to focus on disparities more commonly covered by the media such as the urban-rural and minority-white gaps (Hammond 2014; Hammond 2015). The reasons for the discrepancy in media coverage of these gaps, all equally in need of being solved to ensure Oregon reaches its aspiration of universal graduation from high school, will be discussed in the literature review.

Past research both on the gender gap specifically and on demographic divides as a whole in educational achievement makes clear that such deviations in

academic success have occurred for decades and centuries as well as across the globe. For many years, numerous educational studies sought to find out how best to assist females in mirroring the success of their male counterparts in the STEM fields (science, technology, engineering and math). Likewise, many have and continue to examine the source of racial gaps in educational achievement. Comparatively less focus seems to be paid to the gender gap despite its prevalence both nationally and internationally in other developed nations.

The primary goals of this analysis will be to determine the magnitude of the gender gap in Oregon public schools and to then use statistical analysis to parse out the factors that are correlated with the generation of the divide. Although correlational in nature, they may speak to other causal mechanisms. A thorough analysis of past studies relating to gulfs in academic achievement by different demographic groups verifies that a plethora of variables will need to be analyzed. In particular, demographic, institutional, geographic and socioeconomic factors will all be under investigation in this paper. When one thinks back on their own academic experiences and tries to enumerate all of the variables that factored into one's education, it becomes clear just how long this list of factors must be to ensure a study as comprehensive as possible.

Once completed, this report should assist the Oregon Department of Education (ODE) in identifying the most significant components of an explanation of the gender gap. Ideally, the results at the conclusion of the paper will provide the ODE with a list of the counties in most need of intervention while simultaneously giving the ODE information regarding what tangible steps they can take to try to

bolster the performance of all students. The results will also give the ODE some guidance as to what academic subjects most significantly contribute to the gender gulf. As a matter of fact, it is easy to imagine that this study will provide other educational jurisdictions with tools that can be used to combat their own gender gaps or to measure and quantify the variables most important to the derivation of other demographic divides. Finally, regression results will allow the ODE to identify how the gender gap varies over time in different subjects.

Theoretical Analysis:

Human capital theory, when applied to educational investment, allows for the identification of the costs and benefits that influence a student's decision to pursue additional years of schooling. Like other investments, schooling requires the imposition of costs in the current period to make gains in future periods possible. Whether or not to make an investment depends solely on if the expected accrued benefits exceed the current and, in some cases, ongoing costs. Like other models, the idiosyncrasies of an individual's preferences and abilities are hard to reflect accurately in this model. Nevertheless, the present value model incorporated by the human capital theory conveys the various influences of forgone wages, psychic costs and direct costs on how a student will value future years of school. The discounted benefits of an education also impact the outcome of a student's present value calculation.

Below is an example of a present value formula that a student could theoretically use to justify whether or not to attend an additional year of schooling. Worth noting, present value can be defined as the current value of a series of future

benefits and costs. In the formula below, B represents the increase in wages additional years of schooling will bring, r represents a student's discount rate, t is the time the investment can be recouped and C relates the various kinds of costs impacting a student's calculation.

$$\frac{B_1}{(1+r)^1} + \frac{B_2}{(1+r)^2} + \cdots + \frac{B_t}{(1+r)^t} = C_1 + \frac{C_2}{(1+r)^1} + \cdots + \frac{C_t}{(1+r)^t}$$

For a student with a positive present value, where the benefits exceed the initial or sum costs, another year of school makes economic sense. Alternatively, some recommend the use of an internal rate of return to measure the viability of another year of education. In this case, costs are set equal to expected benefits to derive a certain r value. An r in excess of the market's interest rate indicates that a student should opt for another year. In both cases, students with certain traits will be more likely to favor more schooling. All else equal, students with lower discount rates, higher expected benefits, lower costs and longer time windows over which to enjoy the results of their investment will more probably stay in school.

Students who place less weight on the present will discount future gains less than those predominantly focused on current gains. Their forward outlook will result in them possessing a lower r. If a student were completely indifferent between current and future gains they would have an r = 0. Such a phenomenon is a rarity because gains earned in the present can be invested in the present, presumably at the market rate, and, hence, become larger in magnitude in future periods. Also, there is no certainty that a student will live to receive the totality of

the future gains. Students with higher benefits and lower costs will clearly be more likely to find that an additional year of schooling will be worthwhile. [1]

Finally, in counties with lower life expectancies, students would be less likely to invest in school due to a lower value of t or periods of time over which gains can be collected. Likewise, it is reasonable to hypothesize that females on average have a lower value of t because of the expected pauses in their education and professional tracks associated with childbirth and rearing. If women have fewer periods over which to reap the gains of their investment, they will be less likely to invest in the first place. Larger families would indicate cultures in which it is typical for females to spend more time birthing and, traditionally, raising the children.

The present value calculation above presumed individuals exhibit time consistent preferences, a common assumption when trying to characterize rational economic agents.[2] By holding r constant, the model depicts the decision making process of an individual who does not adjust the value with which they discount future consumption regardless of when that consumption will occur. A few economists, such as Stephen Hoch and George Loewenstein, posit that economic agents typically demonstrate time-inconsistent preferences. In alternative words, economic agents occasionally make a decision that "would not have been made if it had not been contemplated from a removed, dispassionate perspective" (Hoch and Loewenstein 1990). Students with inconsistent time preferences could make an irrational decision that ultimately may harm their future self as a result of placing so

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[1] This section borrows heavily from chapter nine of Ronald Ehrenberg and Robert Smith's textbook, "Modern Labor Economics."

[2] Other assumptions within the rational choice model include the agent possessing perfect information about the options they face, that they exhibit constant and quantifiable preferences and that they place greater value on having more than less of a normal good.

much additional weight on the present. Interestingly, students may resemble workers in underdeveloped nations in regards to their time preferences. Like those in poor nations, students do not earn a substantial income and, as a result, may be more inclined to lack an appropriate appreciation for the future and proper self-control (Fisher 1930 from Cardenas and Carpenter 2008).

Quasi-hyperbolic discounting serves as a framework for how a student, or any economic agent, could come to display a "reversal of preferences."

$$D(y,t) = (1\ if\ t = 0)$$

$$D(y,t) = (\propto \exp(-rt)\ if\ t = 1)$$

Here the present bias is conveyed by $\propto < 1$. Thus, for all periods when t > 0, an agent will discontinuously discount those benefits received in the future. More simply, agents incorporate higher discount rates in the short run than in the long run (Benhabib et. al. 2009). Youths without knowledge of the future benefits of college will likely not attach the correct discount rate to the benefits associated with a higher education and therefore, will be more disposed to partaking in potentially more risky alternatives (Gruber 2000).

Past research indicates that a student's inherent ability to reap benefits from education training varies significantly across individuals. Thus, the correlation between an individual's level of education and marketable skills ranges from very high to weak (Mincer 1974). Likewise, a considerable amount of a student's attitude toward and likelihood to succeed in an academic setting depends on their family. Gary Becker and Nigel Tomes, in their paper, "Human Capital and the Rise and Fall of Families," point out that to what extent parents invest in their children will alter

their offspring's "skills, health, learning, (and) motivation…" (1994). Thus, this paper, as will be covered later, will try to control for the innate differences between students.

Forgone wages measure the income a student could have earned in a setting outside of school. Increases in the wage rate, the availability of jobs and in the stability of a job will make dropping out seem more attractive to a student. A comprehensive study must therefore include indicators of economic conditions facing a student. Examples of indicators include the unemployment rate, average income, average wage rate and types of industries that pertain to a student's geographic location.

Those students who are comparatively less adept at dealing with the mental stresses associated with schooling – studying for tests, balancing a number of priorities and completing assignments – will similarly be more likely to pursue opportunities outside of school. Variables that may influence mental stress include the commute facing an individual student. Those with shorter, cheaper commutes are far more likely to attend school (Rowland 2010; Owens 2014). In a similar manner, freshman college students with superior measures of emotional health were found to outperform their colleagues (Eagan et. al. 2014).

Finally, the direct costs of an education include the tuition rate charged by a student's school less their family's expected contribution, the cost of living of an area and other items such as books. As the direct costs of college diminish a student will be more likely to attend school as the present value formula will more likely be positive. A recent Pew study revealed that women viewed attending university in a

more positive light and were significantly more likely to have financial assistance from their parents (Taylor et. al. 2011). These results indicate that females may not only have fewer direct costs but also fewer mental costs. Collectively, these trends, and others, when incorporated into the present value formula, assist in showing why females continue to make more educational progress.

The explicit benefits of an education – a higher level of pay – vary from year to year based on a number of factors. If more of the labor force begins to stay in school for longer periods, driving up the area's average level of education, then eventually the wage rate for educated workers will decrease as the supply of educated workers exceeds demand. Similarly, the types of jobs thought to be available by a student post-graduation will fuel whether or not members of that community feel an education is a prudent investment.

Not all variables fit neatly into one of the previously identified categories. By way of example, as partially discussed, a longer commute will sap financial resources in the form of travel fees but can also increase both mental stress and the forgone wages that could have been attained working a job closer to home. A couple of variables will similarly have impacts on the costs of different categories. As an illustration, if the unemployment rate of a county increases, the forgone wages for students should decrease and thus, students should be incentivized to stay in school. However, for those students with already high mental costs due to an unstable economic familial situation or just a dislike of schooling, this trend may make their mental costs even higher as they worry about their family's economic outlook.

Determining how costs as a whole impact a student is more important than properly labeling them. Nevertheless, a sample delineation of variables into disparate cost categories is below.

Table 1: Example variables sorted by the different costs described by the human capital theory.

Mental Cost	**Forgone Wage**	**Direct Cost**	**Benefit**
English as Second Language (ESL)	Per capita average county Income	Cost of tuition	Difference in pay with and without high school graduation
Winning percentage of football team	Education level of the county	Cost of textbooks	Greater appreciation for their job
Past exam scores	Labor force participation rate of males and females	Cost of room and board	Increased understanding of society at large
If on track freshman year	Mean commute time to work		

Another type of economic analysis regarding education, referred to as the signaling model, envisages the purpose of education as a tool for employers to determine which workers have a higher level of productivity. This model views employers as making a gamble of sorts when selecting workers. The financial outcome of 'investing' in a worker will depend on how closely the employee matches the employer's expectations of their productivity. In some cases, an employer may simply look at whether or not a student graduated from high school as a signal. Those students that failed to reach this point would be deemed as less productive and consequently, would not receive the job (Spence 1973). Unlike the model discussed above, the signaling method does not as clearly outline a way to

assess the varying costs and benefits facing a student. Therefore, this analysis will rely on assessing the variables associated with the costs and benefits included in the present value formula.

However, importantly, if education merely acts as a signaling tool then gaps in education achievement may in fact be beneficial to society. Under present conditions, a high school diploma may assist firms and society in identifying more productive workers. If true, then efforts to promote graduation rates among less productive students, those who currently would not earn their diploma, may actually add costs to firms searching for new workers. By pooling students with less productivity with those who previously were able to separate themselves by means of graduating from high school, the likelihood of a firm hiring a less productive worker increases. Correspondingly, firms simply placing higher value on the signaling power associated with a college degree may offset the benefits presumed to follow from efforts to augment high school graduation rates.

Collectively, these cost and benefit categories cover the variables past studies have indicated influence achievement gaps of all sorts such as those between white and minority students and male and female students. Unfortunately, some influences on the persistence and magnitude of the education gap between male and female students, such as societal stereotypes and expectations of the different genders, cannot be quantified or easily measured. While some proxy variables for these more cultural measures have been included above, they cannot comprehensively stand in for how culture has changed over the years. In addition, some variables simply were not available. Particularly, much of the data on the

family situation of the student, including their parent's marital status and education level, how many siblings they have and whether or not the family practiced any kind of religion could not be attained. The ultimate impact of these arguably omitted variables will be discussed below.

Literature review:

The difference in academic success between demographic groups has been the subject of study for decades due, at least partially, to the ease with which one can see variation in educational achievement through analyzing measures like test scores on international assessments such as the Program for International Student Assessment (PISA) and on state tests like those common in the United States. Educators around the world have long had an interest in promoting the success of all students. This goal has spurred research into educational gaps evident in student results from a plethora of schools in a multitude of different nations. Investigation into the various kinds of gaps that exist in a certain nation or global region can reveal a lot about that society's educational as well as economic prospects.

Review of Economic Thought:

An important economic occurrence across the globe – the pay disparity between males and females in a broader economic context - may help explain why in some nations females do not mirror the educational achievement of males. Economic theory postulates that if the market does not pay females as well as males they will have less of an incentive to obtain more years of education. In other words, the opportunity cost of not pursuing more schooling may be lower for females than for males because their wage rate is relatively lower (Kingdon 2011). Worth noting,

though, analysis conducted by the Center for American Progress in 2013 found that increasing access for females to higher education has led to a diminishment in the gender pay gap in the United States. Still, the study's authors maintain that "[w]omen need an additional degree in order to make as much as men with a lower degree over the course of a lifetime"(Farrel et. al. 2013). Childbirth, marriage and other typical disruptions of a female's educational and professional career indicate that the likelihood of finding an investment in so many years of education to be positive will be less probable.

Conversely, some use another economic mainstay – analysis of the margins – to contend that the surge in female academic success and application rates to higher education institutions can be traced back to the fact that the marginal increase in benefits, on average, from an extra year of schooling is higher for a female than a male. These benefits "include a higher probability of marriage, a higher standard of living, and insurance against poverty" (Diprete et. al. 2006). Importantly, these benefits extend well beyond the traditional wage rate used to measure the economic outcome of a decision. In general, economists presume that rational economic agents will maximize utility, a function of a great number of variables, rather than income alone.

Economic thinking offers a number of solutions to remedy the gulf that has formed. One line of reasoning posits that market forces, exemplified by the wage rate offered to males and females, serve as the best predictors of when a nation will shift from a gender gap in which males lead to a gap in which females outperform the males (Ganguli et. al. 2008). If true, policies regarding wages and other market

factors may address the formation and closing of education gaps. Conversely, those like Thomas Mortensen, from the Pell Institute, argue that pre-market factors such as males being less behaviorally suited for education, evidenced by males having much higher school disciplinary rates than females, most significantly explain the gender divide in education (Mortensen 2014).

A different economic theory focuses on analysis of a student's parents, who act as the primary sources of funds invested in an individual child. Holding other variables constant, how much money and time a parent spends on a child can assist in predicting how that student will fare academically. Interestingly, it appears that students with the same-sex as the parent with the higher level of education do better than those with the more learned parent being a different sex (DiPrete et. al. 2006).

Cultural Explanations:

Some argue that female superiority in the classroom has existed for decades. One pair of authors claims that the 'boy crisis', which posits that males have only recently fallen behind, has been evident since as early as the 1900s. During the early years in the 20th century, social commentators were not so much worried about a 'boy crisis' in relation to female performance but rather believed that the crisis, if one existed at all, was that the high proportion of female teachers and longer class periods were preventing males from fulfilling their manly potential. They theorized that males could only reach the aforementioned zenith by surrounding themselves with other men and nature. Caryl Rivers and Rosalind Barnett cite the magnitude of other divides, for instance the 20-point gap in graduation rates found among higher

and lower income students, as being more worthy of societal focus and resources than the divide in gender achievement (2006).

While not all analysts subscribe to this notion of a nearly permanent divide between the two sexes, many continue to compile proof that a gap does in fact exist and has existed for at least some time. In one such case, it was found that females have bested the males in the classroom in terms of grade point average for several decades, if not a century. In this paper, the researchers amassed marks for students created by their teachers rather than the students' test scores. Interestingly, the authors submit that grades received in class, as a result of requiring effort over a longer period of time, more comprehensively show a student's intellect. The fact that females have frequently beaten their male colleagues in this regard, in the opinion of the authors, corroborates their academic superiority (Voyer et. al. 2014).[3]

A number of researchers attribute this longstanding division to the inherent characteristics associated most commonly with males and females. In the opinion of some observers, males simply are more fidgety, more likely to have behavioral problems and more seriously negatively impacted by the cuts in recess and PE time seen across the nation in the aftermath of the Great Recession (Bekiempis 2012; Rivers and Barnett 2006; Mack 2012). If accurate, the mental predisposition of males – apparently not suited to learning in a formal setting – would represent an increase in the mental costs of pursing further academic advancement relative to their female colleagues. Along these same lines, international commentators have

[3] Evidence for female superiority in the classroom is apparent in data from several other member nations of the Organization Economic Cooperation and Development (OECD). A study by researchers at Glasgow and Missouri universities lent support to the idea of a widespread gender gap in education, at least in developed nations. These researchers looked at student performance on the PISA exams from 2000 to 2010 and found that even across students with differing socioeconomic and political backgrounds, females were more likely to surpass males in terms of academic performance (Richardson 2015).

pointed out that there appears to be some level of ambivalence towards education among young men. Take Victoria Bekiempis, a writer for *The Guardian*, who reasons that "many Americans have come to think that poor academic performance and a lack of focus and abject hooliganism are male rites of passage" (2012). Bekiempis' assertion, if correct, would help explain why the 'boy crisis' does not seem to garner as much attention as other gaps from reform advocates.

Another study, one that reinforces the idea and prevalence of a 'boy crisis' in terms of academic achievement, also concludes that the source of females attending college at higher rates than males and earning higher scores on tests is the female gender's temperament being better suited to learning in our current educational system (Kimmel 2013). The true impact of these more behavioral and cultural aspects of the gender gap is hard to assess and to support empirically. That is likely why rather than cite specific educational data, Bekiempis relies on pieces of American culture, such as the movies Dennis the Menace, The Sandlot and Stand By Me, to explain how we shaped our perception of how males should regard educational achievement.[4]

The kinds of analysis mentioned above, which rely heavily on the stereotypes of males as tough and energetic and of females as more tranquil and serious, have not been well received by all of those within the educational field (Rivers and Barnett 2006). In fact, some analysts go as far as to theorize that the whole concept of a 'boy crisis' is an attempt by conservative Americans to diminish efforts to assist

[4] A society's culture does appear to have impact on both the financial and mental costs of attending more years of schooling. When a daughter is married in India, her finances benefit the family-in-law much more than her own parents and siblings. Thus, Indian families have a much lower level of motivation to bolster the financial prospects of females through investing in things like their education (Hausmann et. al. 2009). Similarly, In Bhutan, females residing in the rural part of the nation are expected to play a much larger part in the completion of domestic chores. Hence, the marginal productivity of a female student at home may exceed the level of productivity associated with remaining in school (Chitrakar 2009).

females (Chemaly 2014). In a similar manner, others blame stereotypes for preventing male interest in expanding fields such nursing. As a consequence of growing fields like nursing being labeled in the media as a female's position, male students have been limiting their academic range of study and thus, their employment opportunities (Mortensen 2011, cited in Sparks 2011). A reduction in the number of professional opportunities following graduation could result in a reduction of the opportunity cost of dropping out for males. In other words, if fewer jobs in expanding fields seem attainable to male students, they will collectively have less of an incentive to continue their education. Still yet, at least one writer, Judith Warner, would argue that white males are still "doing just fine" in comparison to females in the classroom and, in her opinion, more significantly, in the labor market. Society's primary concern should therefore, in Warner's mind, instead be on the income-based divides that have become prevalent in the American education and economic systems (Warner 2013).

How a school performs in the athletic arena may have a detrimental influence on the achievement level of males. A survey conducted in 2011 at the University of Oregon found that male students fared worse in class than their female colleagues only during fall term. The researchers attributed this decline to males' higher level of alcohol consumption, greater attendance at parties and decrease in time studying during football season (Waddell et. al. 2011). Some of these trends – like an increase in partying - do not seem applicable to high school students, let alone middle and elementary school students. However, a more successful football team in high school could reasonably lead to more students spending less time in

class as they travel to different schools, attend pep rallies and dedicate fewer hours to more academic extracurricular activities.

Other Educational Achievement Gaps

Many in America have consistently prioritized addressing other educational gaps such as the divide between certain minorities and white students in terms of achievement. Those in the Latino community commonly voice concern over the education system's failure to adequately confront their students' relatively poor academic performance. A report issued by the National Women's Law Center and the Mexican American Legal Defense and Education Fund (MALDEF) in 2009 outlined the continuing difficulties young females in the Latino community have experienced in the American education system. The report cites teacher bias, lower involvement in school activities, comparatively higher levels of responsibility within the household, a decreased level of parental involvement in general, language difficulties and the systematic provision of inadequate resources as some of several reasons why there exists a gap between Latino and white students (Listening to Latinas 2009).[5] Comparing this report to the sources of gaps in other countries and in other settings highlights the similarities that exist in the formation of gaps across educational jurisdictions. It seems fairly reasonable that some of these same sources of division may apply to the divide that exists between male and female students.

It is relatively easy to place some of the hindrances discussed above within the cost categories outlined by human capital theory. An inability to understand

[5] The seemingly institutional bias that the Mexican American Legal Defense and Education Fund fears resembles the legal barriers that exist in other nations. Until recently, the law in Bangladesh allowed females to be married before the age of 18. Thus, in the eyes of certain males, the marginal productivity of a young female at home as a wife likely supersede the additional gains to productivity she could acquire from attending school. Unsurprisingly, females still lag behind males in Bangladesh in terms of school attendance and achievement (Chitrakar 2009).

one's teacher, as a result of predominantly speaking another language, could represent an added mental cost that reduces the net benefits a student receives from attending school. Similarly, based on MALDEF's report, Latino students may have a relatively higher marginal productivity at home than students from other races. This increase in the opportunity cost of schooling may also assist in rationalizing why a gap exists between Latino and white students.

The divide between African American and white students has analogously received a fair amount of attention over the years, especially by groups such as the National Association for the Advancement of Colored People (NAACP). One analysis produced by the NAACP discovered that a number of sources of inequality affecting the Latina community were apparent in schools with predominantly African American populations as well. These resemblances include a lack of the requisite resources, the existence and perpetuation of certain stereotypes, diminished access to and participation in afterschool activities and a lack of a stable home environment (NAACP 2014).[6] The connections that exist between both the MALDEF and NAACP reports suggest that some underlying, essential variables may play a role in the shaping the magnitude of all demographic educational gaps.

Other studies cover general steps that may assist school districts in promoting the performance of all students. Work completed by Thomas Dee and Martin West expounded on the idea that non-cognitive skills that can be developed in schools and later impact the economic success of students are affected by class

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[6] The length of a student's commute to school, as well as the fees associated with their travel, may also negatively impact student performance. This why explain why numerous studies, conducted in nations like the Maldives, reveal that the strength of a region's infrastructure may influence the rates at which students attend school (Chitrakar 2009; Rowland 2010; Owens 2014).

size. In fact, their investigation revealed that investing in smaller class sizes provided a 4.6 overall internal rate of return once the gains and costs of such a reduction had been measured. To quantify a student's development of non-cognitive skills the authors consulted data on student engagement collected as part of a national observational study. The kinds of non-cognitive skills outlined by Dee and West, when assessed on a per student basis, may reflect the mental costs a student associates with schooling. A smaller class size, according to Dee and West, will allow for students to focus more on the aspects of the curriculum they find interesting and to communicate with the teacher on a more regular and personal basis. All else equal, a student who has greater interest in their education and a more personal relationship with their teacher will have fewer mental costs than their colleagues in larger classes. On the whole, lowering mental costs will make it more probable that a student finds additional studying and/or years of school to be worth the investment (Dee and West 2008).

Gaps in educational achievement by student health level have been documented as well. Much as OECD countries have become concerned about the gender gap, reformers and policy makers in developed nations are increasingly paying attention to the high correlation that exists between those in good health and those with higher levels of education. Researchers in this field have struggled to find reliable data due to so many of their observations being from participant's own reports, a data collection mechanism that often brings a substantial amount of bias into a dataset. That being said, an analysis completed by David Cutler and Adriana Lleras-Muney conjectured that for each additional year of educational attainment an

individual's health would increase. Their results indicate that over time the life expectancy of more educated people has risen at a faster and faster rate in comparison to people with relatively fewer years of schooling (Cutler and Lleras-Muney 2006). Determining whether good health causes higher education levels or vice versa does not seem feasible with regression analysis. Still, the fact that the two are very much related warrants additional consideration for how health may explain some of the gaps that persistent in educational systems.

In the presence of cutoff dates for certain major life events, such as when a child can permissibly attend kindergarten, economists as well as psychologists tend to examine the impact of relative age effects. Oregon law mandates that only those who are 5 years old prior to or on September 1st can opt to attend the upcoming year of kindergarten. Thus, in a given cohort of students for a certain year some students will be comparatively much younger than their colleagues. The impact of this discrepancy can be analyzed by seeing how academic success varies by the time of the year at which a student was born.

A previous study that looked at an array of academic metrics found that older students, born in September, October or November, outperformed their colleagues in a number of regards. For instance, they scored higher in the majority of school subjects, were more likely to be members of talented and gifted (TAG) programs and, especially in comparison to those born in later in the cutoff year, had fewer behavioral issues. Strikingly, these trends were evident in older students, between the ages of 11 and 14, who were well beyond their kindergarten years, when one might expect the divide in age to be most prominent (Cobley et. al. 2009). Incidences

of students with summer birthdays failing to match the academic success of those with autumn birthdays have been found among 11-, 13- and 15-year-olds as well. Typically, psychologists posit three explanations for this phenomenon – climate effects associated with the season of birth, length of schooling effects and the age-position effect (Bell and Daniels 1990). Which of these explanations most comprehensively explains the gap in success remains subject to debate. Interestingly, analysis of the age-position effect does not always reveal a statistically significant variation in the performance between students of different ages, at least among the most gifted students (Sweeney 1995).

National Trends

Oregon is not the only state to have found evidence of a gender divide in their public school populations. Data from Michigan, for instance, illustrated that in 2007 males were almost 50 percent more likely to drop out of high school (Mack 2012). On the national level, over a forty year interval from 1970 to 2010, the percentage of females between the ages of 25 and 29 years old with a high school diploma increased by 16 percentage points, from 74.2 to 90.2 percent. In contrast, the male graduation rate only increased by 10.8 percent to 87.4 percent in 2010. Cultural conditions seem to be stable across the nation as well. In public K-12 schools, Thomas Mortensen found that male students were at least two times as likely than their female counterparts to be suspended (Mortensen 2014).

Studies of trends in higher education in America also reinforce the notion that a variety of variables favor the academic success of females. A recent Pew report strikingly found that in a comparison of individuals between the ages of 25-

29, 36 percent of females possessed a bachelor's degree whereas only 28 percent of males had earned the same milestone. In fact, the Pew study revealed that women viewed attending university in a more positive light and were significantly more likely to have financial assistance from their parents (Taylor et. al. 2011). More monetary support from one's parents would lower the direct costs of schooling and therefore, tilt a student's scale towards attending more years of schooling. Female high school graduates being 11.2 percent more likely to continue on to college than male graduates in 2009 further illustrates how the gap extends beyond K-12 schooling (Mortenson 2014).

Not surprisingly, given female success in college, female students appear to not only be taking more rigorous college preparatory classes in high school but also receive higher grades than those male students in those advanced courses (Warner 2013). If it were true that students who took intensive classes more thoroughly enjoyed learning, one could come to the conclusion that their mental costs would be lower than students in comparatively easier courses. Likewise, in comparison to other students in top tier classes, those with the highest grades – the females in this case – may be more content spending time in an academic setting as a result of their past success in such demanding courses. The notion of a 'boy crisis' has also been discussed at a higher level among educational reformers for quite some time. A few backers of initiatives to address the gap posit that in the United States efforts to assist males, long assumed to be the superior sex in classroom setting, are failing because people cannot accept that females could be outperforming their male colleagues (Sommers 2000; Bekiempis 2012).

Several researchers of the mental costs of pursuing further education claim they have data that shows psychic costs have grown in recent years. The 49th edition of the Cooperative Institutional Research Program's (CIRP) annual report on the health of college freshman disclosed a number of substantial findings. CIRP's interpretation of the results from their survey, completed by 150,000 students on American college campuses, noted that among the youngest cohort of college students the proportion of religious students reached a new low. The number of freshman planning to eventually earn a graduate degree, in contrast, stood at a new high. In relation to emotional and mental health, survey results confirmed that student self-rated mental health also was at its lowest point in the survey's long history. More than ever, students feel depressed on campus. According to the CIRP, depressed students are less likely to attend class, to find the content exciting and to interact with their colleagues. In a similar manner, students with mental health problems, even after four years of studying, were most likely those who left campus not feeling like they ever were a part of a larger community (Eagan et. al. 2014). These findings speak to what human capital theory, at least as described by those like Ronald Ehrenberg, has long assumed – higher mental costs will disincentivize a student continuing their education.

So, in summary, analysis of educational patterns and of past investigations into achievement gaps reveals that a number of factors can play a role in shaping the success of students in different demographic groups. Firstly, cultural barriers are of extreme importance in shaping the rate at which certain groups attend school and in determining the net benefits respective groups will attach to reaching higher levels

of education. Similarly, the legal fabric and framework within a nation or community can significantly impact the likelihood of students reaching certain educational heights. A nation's educational infrastructure, economic conditions and political stability also affect the rates at which certain population groups will prosper in terms of education. Finally, inherent personal traits, such as behavioral tendencies and mental health, at least in the opinion of some, may largely influence how successful any single group of student can be in a certain academic setting. The majority of the variables mentioned above can nicely fit into the human capital theory model. This model, built upon the assumption of three kinds of costs – opportunity costs, direct costs and mental costs, seems to be capable of sorting each of the aforementioned variables into one of the three cost categories. Consider that males have been assumed to be more finicky during class according to several studies. In this case, the inability to focus represents a mental cost that obstructs males from learning as easily as females.

This overview has also made clear that gender gaps of different magnitudes and directions have existed and continue to do so both in international and national education systems. One clear objective, going forward, will be to determine if the similarities found in the studies of the causes and sources of other achievement gaps pertain to the gender gap in Oregon too. Gauging how some of the solutions that have been tested in other districts might be well suited to districts in Oregon will be of the utmost importance. Will strategies such as same sex classrooms work in Oregon to eliminate some of the variation in female and male success? Evidence from several trials of such programs in places like California, South Korea and New

York indicate that same sex classrooms largely fail to induce significantly better student performance on test scores and do not necessarily mitigate the gap between males and females (Park et. al. 2013). Maybe Oregon districts simply need to mirror the structure of the Department of Defense's (DOD) schools located around the world that service the children of military parents. It has been argued that the DOD's schools produce better students due to their strict behavioral policies, high expectations and well-trained teachers (Rivers et. al. 2006).

Findings from this study should enable the Oregon Department of Education to identify the variables that are most highly correlated with the production of a gender achievement gap. By listing the magnitude of the gender gap in Oregon schools by subject, county and a number of other factors, this report will first allow the ODE to narrow down the schools in most need of attention. Quantifying the gender gap on test scores taken in math, science and reading by students from 2004 up to 2014 will make organizing a list of counties with the broadest gender gaps possible. Next, assessment of the variance of the gender coefficient by year and subject will allow for further refinement of reforms under consideration. Ultimately, my hope is that this paper will allow the ODE to target the schools in most need of intervention and to pare down the list of potential remedies presently under consideration.

Methodology:

This research relies on an Oaxaca decomposition to identify the magnitude and significance of a number of the variables previously mentioned that may, according to previous studies, pertain to the development and persistence of a

gender gap in Oregon's public schools. Regression analysis will be conducted on data from 2004 to 2014 retrieved from the Oregon Department of Education. Additionally, some data for variables included in the regression such as the unemployment rate of the county in which a student's school resides will be retrieved from different sources. For a full summary of the sources and traits of the data under investigation, please turn to the data description.

Firstly, though, the counties will be lined up by the average size of the achievement gap at schools within said county measured by performance on statewide exams over the past ten years. I will find the average gulf in female and male scores for each county for math, reading and science tests taken in 3rd, 4th, 5th, 7th, 8th and 12th grade. This initial list may reveal some early insights into what kinds of schools and districts are struggling most clearly in facilitating equal learning incentives among their male and female students. The derivation of this list will go a long ways in aiding the Oregon Department of Education in identifying those schools and areas that require further investigation and assistance to ensure both males and females have the resources necessary to promote educational success. These schools will also be mapped by geographic region to further assist the ODE in trying to resolve how they can most efficiently and effectively go about instituting reforms at these various institutions.

On top of measuring the size of the gender gap by simply recording the difference in student test scores by sex and subject, I will run several regressions that will characterize the gender gap in performance by analyzing the coefficient of the gender term on test performance. In this case, the female and male observations

will not be separated. Beyond including the gender of the student, a number of additional control variables will be featured in the regression model. Once completed, this regression will assist in analyzing how the gender gap changes over time and by subject. That is to say, this regression will show what subjects and years appear to have the largest gender gaps. By assessing the direction of these trends the ODE may ultimately be able to target the specific subjects that seem to foster the greatest separation between the sexes.

Due to a dearth of data, I will have to run two different regressions. The first will compromise of a smaller list of variables but cover the years from 2004 through 2013. This regression will not include variables such as statistics relaying the percentage of a county's population with at least a bachelor's degree level of education. Data from the Census Bureau covering demographic information at the county level was only available for the years 2009 through 2013. Even then, these statistics did not include annual data but instead lumped the average for the five-year span into single observations. Hence, a second regression model will be run over the years 2009 to 2013 with the addition of data from the Census Bureau. The mathematical implications of omitting these variables in the first regression and the corresponding change in the coefficients of different variables will be discussed in the sources of error section. The female coefficients for each test and each year will be recorded for all of the regressions.

Once these regressions have been completed, the next task at hand will be to conduct the Oaxaca decompositions. To facilitate the use of the Oaxaca decomposition method, the data for males will be separated from the female data.

Mathematicians and econometricians commonly rely on the Oaxaca decomposition method when assessing the sources of divides between two groups. For example, the method has been implemented in the study of pay differentials amongst demographic groups of workers as well as in the study of differences in health that may be attributable to income level. More specifically, this method decomposes the differences in the data into three parts: the endowment effect, the differences in the coefficients and the interaction effect, which is defined as the combined difference that results when one allows for the differences in endowments and coefficients to occur at the same time between the groups of interest. Ben Jann, who produced a guide for the usage of the Oaxaca decomposition method in Stata, defines the endowment effect as "the part of the differential that is due to group differences in the predictors." In other words, the endowment effect attempts to measure the alterations that result by subtracting the average observation of group A from group B then applying that value to the coefficients determined for group B. The impact of the opposite change, the change that results from considering the difference of the coefficients of groups A and B with group B's observations, represents the second portion of the decomposition. Finally, the last of the decompositions factors both the differences in coefficients and observations into its calculation. The aforementioned decompositions could then be repeated from the perspective of group A (Jann 2008).

I will refer to these groups as endowments, coefficients and interactions. In context, the endowment effect will quantify the impact of baseline differences between the sexes. Put simply, these are the effects separating the genders at the

most basic level and prior to the introduction of the decomposition variables. In contrast to the endowment effect, the coefficient report will indicate how the variables featured in the decomposition contribute to the formation of the overall gap in score by subject. Finally, the interaction effect will convey the amount of variation that is left unexplained.

Importantly, this method is not without its shortfalls. Frequently, the use of the Oaxaca decomposition is contingent upon the acceptance of one crucial assumption – that the groups being studied represent valid counterfactuals for one another. The use of counterfactuals involves trying to ascertain "what would have occurred if some observed characteristic or aspects of the topic under consideration were different from those prevailing at the time" (Pesara et. al. 2012). In laymen terms, the use of Oaxaca decomposition in this analysis means assuming that male students serve as valid counterfactuals of females and vice versa. However, one cannot unequivocally say that the two groups are opposite sides of a coin. Furthermore, like most other regression tools, the results from a Oaxaca decomposition cannot tell for certain which variables undoubtedly impact the results in a causal fashion. Instead, results will enable us to declare with some level of confidence the likelihood and magnitude of a variable influencing test scores (Fortin et. al. 2010).

The Oaxaca decomposition will include a smaller subset of the overall list of variables in comparison to the regressions discussed below to narrow in on how the most important variables are contributing to female and male performance at disparate rates. For example, the Oaxaca decomposition will feature whether or not

a student falls within the talented and gifted cohort, has a summer, fall, winter or spring birthday, the average median income of the county in which they attend school as well as their economically disadvantaged status. Cumulatively, the impacts of these variables will then be reported on a yearly basis through endowment, coefficient and interaction effects. The various effects will be recorded by year and test. Two different decompositions will be conducted to hopefully shed light on the importance of classroom size on the formation of gaps. The first will not include the teacher to pupil ratio of a school but the second will incorporate that ratio in addition to the variables from the first decomposition.

Data Description:

Unemployment rate information, compiled by the Bureau of Labor and Statistics (BLS), covers all Oregon counties from 2004 through 2013. The BLS refers to these data sets as the Local Area Unemployment Statistics (LAUS) and cites the Current Population Survey as its source. To bolster the reliability and comprehensiveness of the data, the BLS includes measurements taken by the Current Employment Statistics program and state unemployment insurance systems in its LAUS calculation. These statistics highlight the uneven recovery that has taken place in Oregon following the Great Recession. While counties such as Multnomah and Washington recorded unemployment rates hovering around six percent in 2012 and 2013, many of the rural counties recorded rates just below ten percent. These trends predominately mirror the recovery patterns seen following the dot-com bubble bursting in the early 2000s.

Data covering the per capita personal income, as a percent of the state average, for Oregon counties from 2004 through 2013 originates from the Bureau of Economic Analysis (BEA). According to the BEA, "This measure of income is calculated as the total personal income of the residents of an area divided by the population of the area." Several patterns emerge from reviewing the data. For instance, measures for Clackamas, Multnomah and Washington counties exceed the state average in every year. Comparatively, Klamath County's per capita income rate remains at least 15 percent below the state average over the 10-year span.

The American Community Survey, conducted by the US Census Bureau, compiled demographic information on Oregon's 36 respective counties. Important statistics such as the number of persons per household on average, the percentage of people living in the same house as a year ago, the percentage of foreign born persons and the mean travel time to work for each county will be included in the regression model covering only the years 2009 through 2013. As discussed in the theoretical analysis, this data supplies information on the opportunity cost, direct costs and mental costs facing students. A lot of variation exists at the county level. Correspondingly, some schools will differ more from the average county data than others. For example, while one school may statistically resemble the county averages, several others may diverge to a significant extent from the county. That said, for several of the counties, especially those with a relatively few number of schools, the county level data will likely closely parallel the factors shaping a student's decision to stay in school. Look to the next section for a full list of the variables to be included in the empirical model from the county level data.

A measure of the direct costs of continued education – the average tuition at Oregon University system institutions – will only be included in a regression over the whole time span. Because the average tuition is the same for all students in a given year, including the variable in regressions focused on annual changes in the female coefficient does not make sense. Future studies may consider how tuition changes at the higher education institution closest to a student's high school may affect graduation rates. While this specificity may produce a change in the calculated coefficients, it seems reasonable to postulate that enough students opt not to attend the nearest college or university to use statewide data. On the whole, the patterns in the data show that increases in tuition are fairly similar, in terms of percentage, across the different institutions.

Data from the Oregon Department of Education covers everything from the sex of the student to whether or not they qualify as economically disadvantaged or as a talented and gifted (TAG) student. The date of birth of the students is used to assess the applicability of relative age effects to the severity of the gender gap. Students will be sorted in the season of their birth to make distinctions between age cohorts more distinct. Fall birthdays will include September, October and November births. Correspondingly, the remaining nine months will be separated in equal chronological groups of three months into winter, spring and summer categories. I will quantify the magnitude of the gender gap over time and by subject by comparing student performance on math, science and reading state test scores.

The ODE provided data on the average teacher to student ratio at all of their schools from 2004 through 2013. These figures will be incorporated into the Oaxaca

decomposition to see how the ratio, a proxy measure for class size, impacts females and males differently, if at all. Unfortunately, many factors suggest the ratio is inaccurate. Firstly, the ODE collects the number of full time teachers at a school in the spring whereas student population counts for a school come from the number of students enrolled on the first of October. Obviously, not conducting measurements at the same time could lead to a number of errors as students and teachers can be removed or added to a school's roster throughout the year. Secondly, according to a research analyst at the department, the ODE instituted procedural changes in 2006 that may have altered the level of accuracy with which these figures were collected. Finally, the department typically assumes that the numbers being reported by individual schools regularly fall short of 100 percent accuracy. These errors persist because of the high costs tied to auditing every school's data gathering process.

Empirical Model:

$$Score(reading, math, science)_{icy} = \beta_0 + \beta_1 ecdis_{iy} + \beta_2 tag_{iy} + \beta_3 county_{iy} + \beta_4 lep_{iy} + \beta_5 female_i + \beta_6 unemployment_{cy} + \beta_7 ethnicity_i + \beta_8 winter\_birth_i + \beta_9 spring\_birth_i + \beta_{10} summer\_birth_i + \beta_{11} percapincome_{cy}$$

The regression model above will be used over the entire data period – 2004 through 2013 - as it omits the county level data from the Census Bureau, which only conveys information from 2009 through 2013. From left to right, the variables read as the constant, economically disadvantaged status, talented and gifted status, county of the school, limited English proficiency status, the gender of the student, the unemployment level of the county, the ethnicity of the student, whether they were born in the winter, spring or summer and the county per capita level of

income. Readers may notice the exclusion of fall birthdays. Leaving out those born in September, October or November, the oldest students in a grade, will allow for comparison to the other seasons. Likewise, the ethnic code for white students will be absent to make comparison to a base ethnicity possible and one of the counties will be dropped for the same purpose. The scores are indicated for individual i in county c in year y.

$$Score(reading, math, science)_{icy} = \beta_0 + \beta_1 ecdis_{iy} + \beta_2 tag_{iy} + \beta_3 lep_{iy} + \beta_4 female_i$$
$$+\beta_5 unemployment_{cy} + \beta_6 ethnicity_i + \beta_7 winter\_birth_i + \beta_8 spring\_birth_i + \beta_9 summer\_birth_i$$
$$+\beta_{10} perCapIncome_{cy} + \beta_{11} prcntBach_{cy} + \beta_{12} prcntSameHouse_{cy} + \beta_{13} percntForBorn_{cy} +$$
$$\beta_{14} LangOther_{cy} + \beta_{15} LFPartRate_{cy} + \beta_{16} MeanTravTime_{cy} + \beta_{17} MedGrossRent_{cy}$$

The second model, to be regressed over the data from 2009 through 2013, includes the variables from the first regression in addition to the percentage of the county with a bachelor's degree or higher, the percentage of the county that lives in the same house as the previous year, the percent of foreign born residents in the county, the percentage that speaks a language other than English at home, the county labor force participation rate, the mean travel time to work in minutes and the median gross rent of the county in 2013 dollars. The additional information from the counties warranted removing the county fixed effect variable that was included in the first regression model.

To run the Oaxaca decomposition, the data will be separated in female and male categories and the gender coefficient will be removed. This process will facilitate contrasting the size and then swapping the coefficients of each variable. The decomposition will highlight variables strongly tied to individual academic

performance. A comparison will also be made between a decomposition featuring the teacher to pupil ratio for each school and one without. These distinct decompositions should provide an explicit indication as to the true impact of smaller class sizes on test scores in general but also on the development and magnitude of gender gaps.

Hypothesized Results:

Preexisting economic theory and findings from other researchers serve as reliable guides when attempting to predict the magnitude and direction of the regression model coefficients. Relying on those past findings, I suspect that the regression analysis will show that over the course of time within the scope of this study the size of the gap present in specific counties will most prominently depend on variables that most explicitly quantify economic benefits and costs.

Leaning heavily on human capital theory, expounded and applied in the sections above, I predict that variables serving as proxy variables for the benefits and costs – opportunity, direct and mental - affiliated with schooling such as the unemployment rate of the student's county and the percentage of county employees with at least a bachelor's degree will help explain why females have so dramatically outperformed males. In essence, variables that relay information on the costs of education will be higher in absolute value for males than females. Conversely, the variables that would inspire a rational student to pursue additional schooling, such as higher familial income, will be larger in magnitude for females than males. Under this hypothesis, the ODE will need to focus on targeting ways in which to prop up

the benefits and reduce the costs facing male students, assuming the ODE opts to increase male achievement to close the gender achievement gap.

This hypothesis can be easily applied to the coefficient of the county level unemployment variable. All else equal, under the theory outlined above, a one unit increase in the percent of county unemployment, indicating a less preferable labor market, will result in larger increases in test scores for females than males. Because the unemployment rate serves as a proxy measure for potential forgone wages, when the rate increases the costs of attending school decrease as the unexpected income for laborers falls. For the formation of a gap to occur then, females should receive a larger benefit from this decrease in cost relative to males.

This reasoning can be applied to the impact of a student qualifying or not as economically disadvantage on test scores as well. Recognition as economically disadvantaged implies that the direct cost of schooling both now and in the future will be higher for an individual. Applying theory and considering the direction of the gender gap leads me to hypothesize the effect of economically disadvantaged status on test scores will be larger for males than females. Again, such a finding would reinforce what theory and empirical results suggest must hold true - that females are affected by benefits more positively and costs less negatively than males.

An increase in the percentage of county residents with at least a bachelor's degree level of education, according to economic theory, should have an indeterminate impact on test scores. A one unit increase in the percentage would simultaneously drive down the wage gain expected to be garnered from more education and, per the literature review, result in a culture that prompted students

to place a heavier emphasis on attending more years of school. The decrease in the expected wage would be the result of the labor market being comparatively more crowded with educated workers. Holding other factors constant, a more educated work force would place a downward pressure on wages to be paid to those with more years of schooling. If post-college wages go down, the opportunity cost of attending school would decrease and propel students to drop out. However, if the prevalence of educated people in a county reduced the mental costs associated with schooling then students would more probably opt to continue their pursuit of an education.

I theorize that given Oregon's low high school graduation rate, a small increase in the percentage with at least a bachelor's degree level of education would not diminish the wage enough to override the reduction in mental costs generated by a more supportive community.[7] Therefore, an increase in average years of schooling at the county level will more positively impact the test scores of females than males. This result would be consistent with the persistence of an educational gap between the sexes.

Results:

The aggregation of math, science and reading scores by schools within Oregon's 36 counties revealed a number of interesting trends. Below you will find side-by-side lists of the ten highest and lowest performing counties on the respective subject tests on average from 2004 through 2013, with the higher scoring counties on the left.

[7] Remember that, as laid out in the introduction, Oregon's four-year graduation rate is among the worst in the nation and, as of 2014, was below 70 percent (Hammond 2015).

Average Math Score by County from 2004 through 2013			
Top Ten		**Bottom Ten**	
1) **WALLOWA**	229.1406	**KLAMATH**	223.1013
2) **DESCHUTES**	228.2688	MALHEUR	223.9214
3) **CLACKAMAS**	228.0621	**LINCOLN**	223.9304
4) **SHERMAN**	227.7607	CROOK	224.0139
5) **WASHINGTON**	227.7234	**MARION**	224.1523
6) **GRANT**	227.4572	COOS	224.3323
7) **BENTON**	227.0259	POLK	224.8562
8) HOOD RIVER	226.9663	**UMATILLA**	224.8839
9) MULTNOMAH	226.6834	LANE	224.8864
10) MORROW	226.5652	LINN	224.9847

Table 2: Highest and lowest performing counties on math from 2004 through 2013.

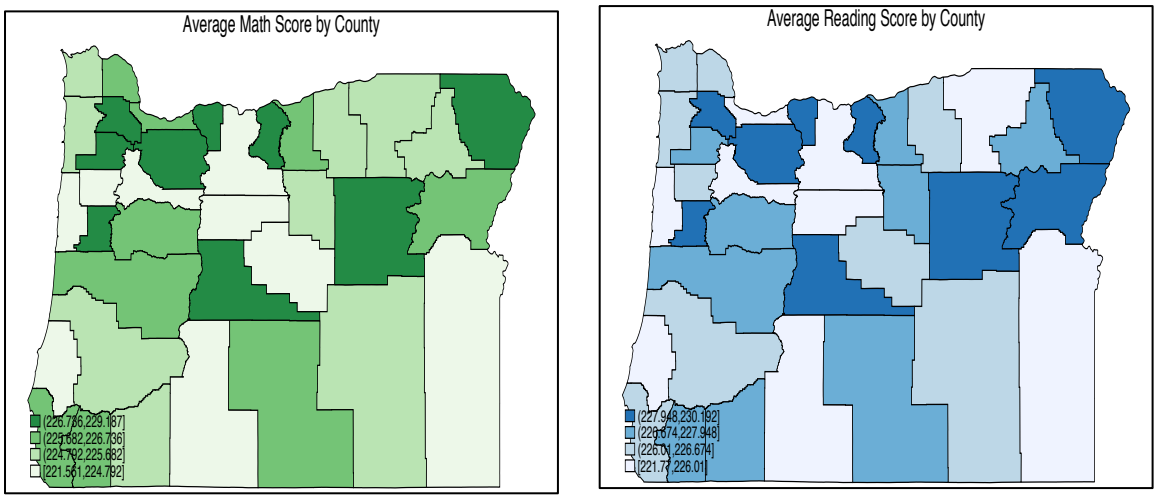
Average Reading Score by County from 2004 through 2013			
Top Ten		**Bottom Ten**	
1) **WALLOWA**	230.0047	**KLAMATH**	224.4892
2) **GRANT**	229.5167	MALHEUR	224.6855
3) **DESCHUTES**	229.3697	**LINCOLN**	225.1182
4) **CLACKAMAS**	228.7124	**MARION**	225.4608
5) **WASHINGTON**	228.5114	COOS	225.6492
6) **BENTON**	228.3115	LINN	225.7543
7) **SHERMAN**	228.15	CROOK	225.8522
8) WHEELER	227.9213	YAMHILL	225.8685
9) HOOD RIVER	227.8545	**UMATILLA**	226.1533
10) JACKSON	227.8245	COLUMBIA	226.1856

Table 3: Highest and lowest performing counties on reading from 2004 through 2013.

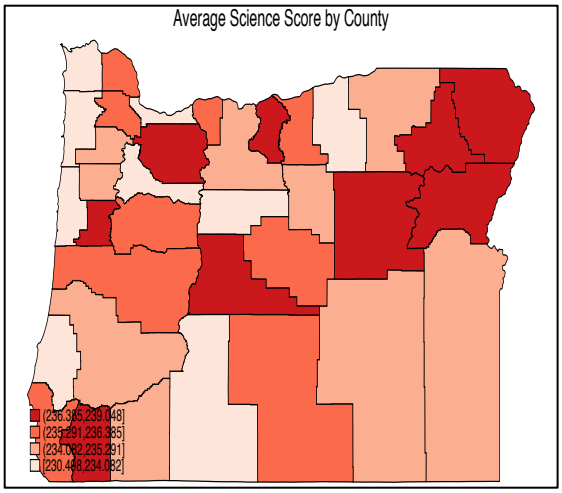
Average Science Score by County from 2004 through 2013			
Top Ten		**Bottom Ten**	
1) **SHERMAN**	238.9354	**KLAMATH**	232.1225
2) **GRANT**	237.953	**MARION**	232.2582
3) **WALLOWA**	237.8792	BAKER	232.6264
4) **DESCHUTES**	237.7049	DOUGLAS	233.2555
5) **BENTON**	236.7953	**LINCOLN**	233.3658
6) **CLACKAMAS**	236.5298	MORROW	233.6408
7) **WASHINGTON**	236.2252	CLATSOP	233.6941
8) JOSEPHINE	236.1275	HOOD RIVER	233.866
9) UNION	235.6637	**UMATILLA**	234.0408
10) CROOK	235.6129	CURRY	234.0734

Table 4: Highest and lowest performing counties on science from 2004 through 2013.

Importantly, the number of observations per county varies significantly as the number of schools and school districts are not directly proportional to population. In total, Gilliam County recorded 2,665 observations whereas over 500,000 observations came from Clackamas County. The bolded text signifies those counties that repeat in their respective categories. Observation counts aside, seven of the counties occur in the top ten list for each subject: Wallowa, Deschutes, Clackamas, Sherman, Washington, Grant and Benton. In a like manner, four counties – Klamath, Marion, Lincoln and Umatilla – fell within the bottom ten scoring counties on each subject matter exam. No county that ranked among the top ten for one subject fell to the bottom ten in another subject. The high number of repeat counties in both categories could evidence total educational attainment being strongly tied to a student's county.



Figures 1-2: Average math and reading score by county over 2004 through 2013 (left to right).



Figures 3: Average science score by subject and county over 2004 through 2013.

Each of these maps, in which darker counties scored higher, confirms the patterns displayed in the top ten lists. Unlike the counties in the northeast region of the state and upper Willamette Valley that typically fared relatively well, counties in the southern and western portions rarely show up among the top achieving counties for any of the subject tests. Surprisingly, the counties grouped together by shade of color commonly have very different demographic, cultural and economic conditions. Regression results below may help determine to what extent the aforementioned factors contribute to test performance. Moreover, delving into these trends and characteristics sparks a number of important questions. For example, on average, do the counties that appear in top ten lists vary in any noteworthy regard from those counties that were in each of the bottom ten lists? A brief glance would suggest that finding clear divisions among these two groups may be challenging because even neighboring counties such as Deschutes and Klamath counties, likely to be similar to an extent, end up in top and bottom for each subject, respectively.

Females only outperformed males on one of the subjects of the standardized tests, on average, from 2004 through 2013. Typically, males scored about .05 points higher than females on the math exam and 1.03 points higher on the science test. However, females outpaced males on the reading exam by an average of 2.01 points.

Of the three tests, only the magnitude of the gaps in science and reading were statistically significantly different from zero.[8] The math gap not being significantly different than zero testifies to just how small of a divide separates the sexes on the subject. However, note that females as of late have typically surpassed males in math and, if recent trends continue, females seem likely to also outperform males on the science test on average soon. These predictions garner additional support below.

The existing gaps encourage asking what type of student – high, middle or low performing – is most heavily contributing to the formation of gaps and has the group responsible changed over time? To partially assess this question, I will compare the male and female distributions of scores in math, science and reading for 2004 and 2013. A comparison of these chronologically distanced distributions may allow the ODE to determine how, if at all, the type of student generating the gaps has changed over time.

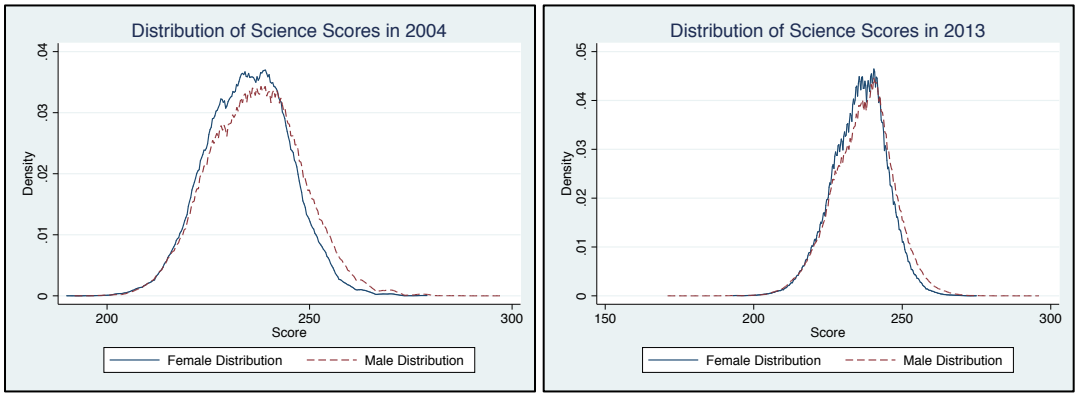


Figure 4: Distribution of male and female science scores in 2004 and 2013.

[8] T-tests of the gaps, each run with null hypothesis of zero, indicated that at a confidence level of 95% the reading and science gaps in scores were different than zero. These results hold at a confidence level of 99% as well.

Male and female science score distributions in 2004 differ to a greater extent as the score increases. Whereas the lowest performing male and female students tend to perform at the same rate, the mid- and top-level students significantly outperformed their female counterparts. From the 2004 plot it becomes clear that the formation of the gender gap is primarily as a consequence of the leading males scoring so much higher than the top females. A greater proportion of females in 2004 scored in the lower portion of the middle distribution than males as demonstrated by the height of the female distribution in the second quartile of the distribution. Such a trend also helps explain the size of the divide.

By 2013, when the science gap has decreased, males scoring in the second quartile appear to still be besting their female colleagues to a noticeable degree. More females continue also to score in the second quartile. However, the top females have partially closed the gap between them and the top tier male students. The highest scoring male students still lead the way though. Notably, as with the rest of the distributions shown below, this is only a comparison between two years. But the changes in the distributions portray a closing gap as a result of the best females improving in relation to their colleagues of the opposite sex and a greater percentage of females in the second quartile scoring higher than in years past.

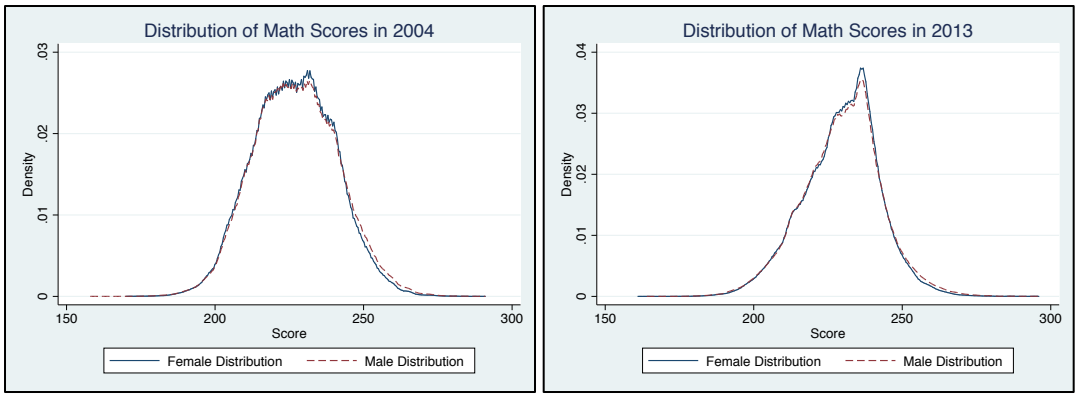


Figure 5: Distribution of male and female reading scores in 2004 and 2013.

Much like the earlier science distributions, the difference in 2004 math distributions most evidently occurs at higher scores. Male and female lines seem to follow one another until approximately just before scores above 250. At that point a clear divide emerges as the top males garner higher scores than their counterparts. Unlike the science gap, females, by 2013, have not only closed the gap but have gained a slight advantage in terms of average score. A higher proportion of females than males scoring slightly above the middle of the score distribution in 2013 represents the most visible difference between the plots. Having said that, the divide between top students also narrowed by 2013.

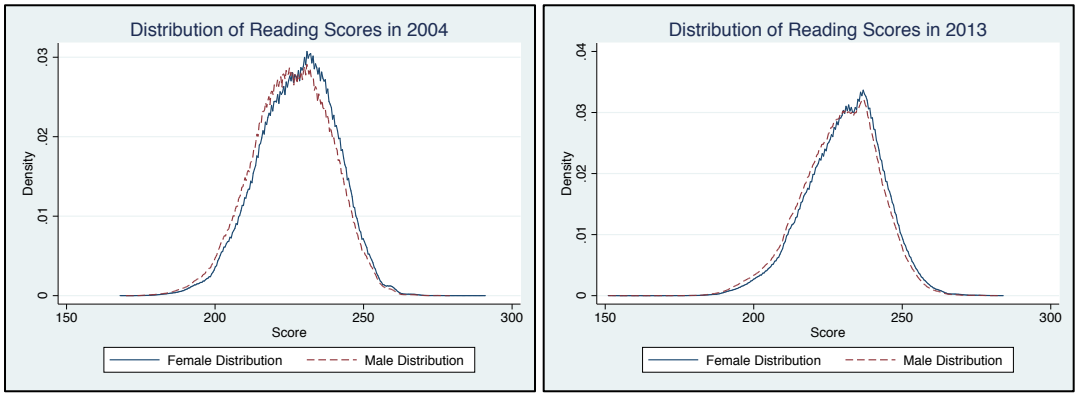


Figure 6: Distribution of male and female reading scores in 2004 and 2013.

The reading gap has favored females over the course of the period under study to a relatively similar degree and, perhaps unsurprisingly, the distributions from 2004 and 2013 exhibit similar features. For instance, in both years a higher percentage of females score in the third quartile than males. Middle-scoring females in 2004, however, contribute marginally more to the gap in 2004 than in 2013 as demonstrated by the tip of the female distribution just barely rising above the male distribution in the latter year. In both cases, the bottom of the male student distribution lags behind the lower-scoring females and the top females edge their counterparts. Although, the differences at lower scores more significantly affect both the 2004 and 2013 gaps. Figure 10 below shows exactly how the average gap has varied on a yearly basis on the different subject tests.

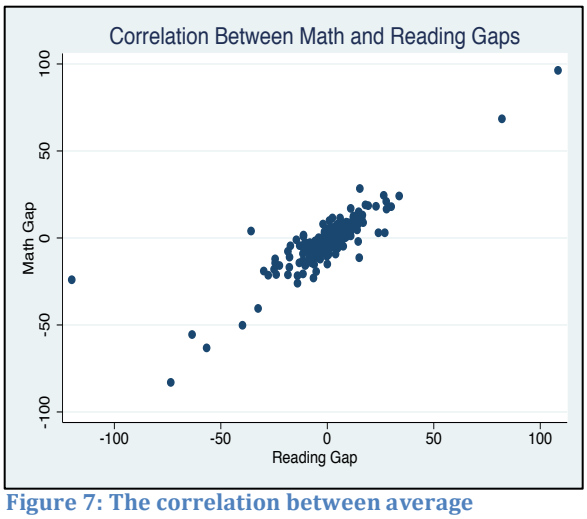
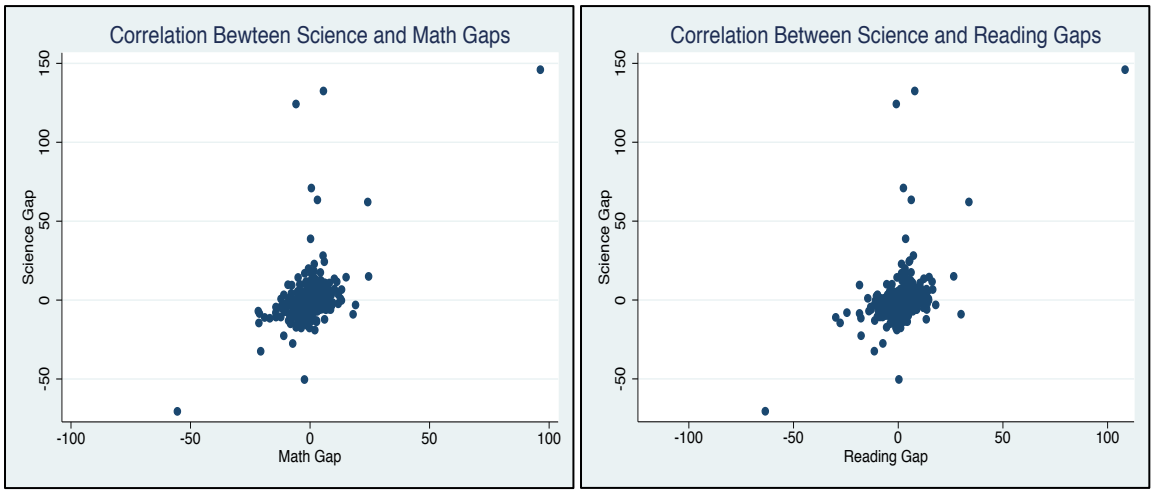


Figure 7: The correlation between average reading score gap and that of the math gap.

The correlation between gaps indicates that the formation of score gulfs in certain subject areas may be related to the disparity that exists in other subjects as well. Consider that the correlation coefficient between the gap in math and the gap in reading test scores is 0.8480 (see figure 7).

Such a high, positive correlation coefficient indicates that an increase in the math or reading gap suggests that the corresponding gap will grow as well. The correlations between the math gap and science gap and the science and reading gaps are lower at 0.5714 and 0.5181, respectively (see figures 2 and 3). These lower

correlation coefficients indicate a less strong, positive linear relationship between the two kinds of gaps.



Figures 8 and 9: Both figures 8 and 9 (left and right) indicate less strong, positive linear relationships between the gaps of their respective tests.

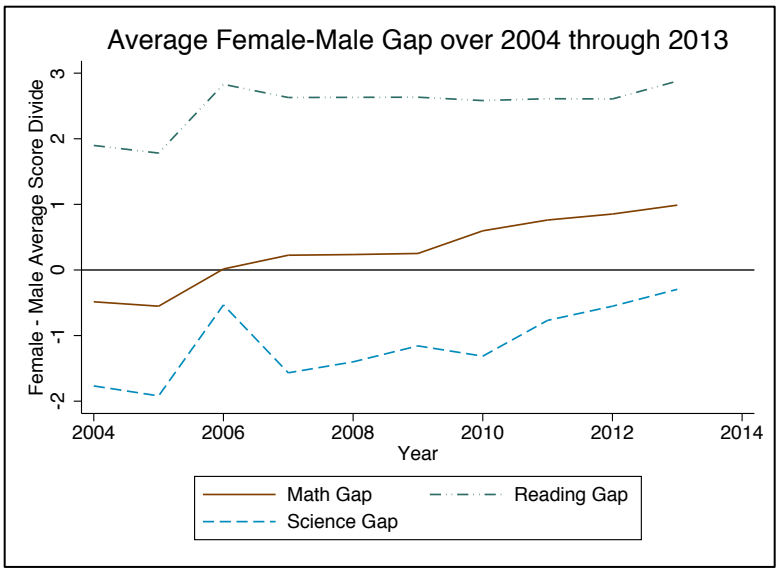


Figure 10: Females, as indicated by the positive slopes of the lines, have been closing or expanding upon the gulf with their male counterparts across all subjects.

A temporal analysis of the gaps indicates that females have been making steady gains on their male counterparts in the last ten years across all subjects (see figure 10). From top to bottom, the gaps in reading, math and science have, to varying degrees and at different rates, moved upwards, signaling females scoring higher. Whereas females outperformed males in reading as early as 2004, initially they lagged behind on both the science and math exams. Interestingly,

they have come to surpass males on math exams and have significantly closed the gap on the science exam, especially in recent years. The impressive gains made in 2006 from 2005 on each of the exams by females raise a number of questions. For instance, did the administration or content of the exams change in those years? Or perhaps was there a change in curriculum or teaching method that disproportionately spurred females to attain higher scores? Decreases in the rate at which females were advancing in the year following 2006 should also receive attention.

Top Ten Male Leaning Math		Top Ten Female Leaning Math	
LAKE	-3.271939	MORROW	0.3460167
WHEELER	-2.120796	**CLATSOP**	0.3700977
MALHEUR	-1.158652	JEFFERSON	0.4786794
JACKSON	-0.8302507	LINCOLN	0.4822052
COOS	-0.7210246	MARION	0.6095794
POLK	-0.5635659	KLAMATH	0.6159638
HARNEY	-0.5553715	**BAKER**	0.6816651
BENTON	-0.5085388	**GRANT**	0.8135538
UNION	-0.3903498	HOOD RIVER	0.9379593
UMATILLA	-0.346518	**GILLIAM**	2.08203

Table 5: Top ten counties with largest math score divides by gender.

Top Ten Male Leaning Reading		Top Ten Female Leaning Reading	
LAKE	-3.589196	HOOD RIVER	2.543881
WHEELER	-0.3867126	YAMHILL	2.562328
MALHEUR	0.6970373	WASHINGTON	2.642709
UMATILLA	1.125105	TILLAMOOK	2.815457
UNION	1.32096	**BAKER**	2.872412
COOS	1.335405	**CLATSOP**	2.899998
HARNEY	1.505131	JEFFERSON	3.105131
JACKSON	1.584785	WALLOWA	3.373745
POLK	1.612532	**GRANT**	3.460873
BENTON	1.656659	**GILLIAM**	3.764877

Table 6: Top ten counties with largest reading score divides by gender.

Top Ten Male Leaning Science		Top Ten Female Leaning Science	
LAKE	-2.612704	MORROW	-0.7014008
JACKSON	-2.241018	LINCOLN	-0.4819092
WHEELER	-2.223297	**BAKER**	-0.4371234
POLK	-2.197614	**CLATSOP**	-0.4147856
JEFFERSON	-2.027516	SHERMAN	-0.2037048
WASCO	-2.015649	LANE	-0.0733405
DESCHUTES	-1.635492	**GRANT**	0.3011821
MALHEUR	-1.635336	DOUGLAS	0.4861845
COLUMBIA	-1.510533	HARNEY	0.7043706
UNION	-1.462552	**GILLIAM**	2.422004

Table 7: Top ten counties with largest science score divides by gender.

The tables above convey the counties with the largest gaps, both in terms of female and male dominance, by subject. Those tables on the left represent the counties that exhibit male leaning tendencies and those on the right relay the counties with the broadest positively female divides. Once again, analysis shows a number of repeat counties across the different tests. Lake, Wheeler, Malheur, Jackson, Polk and Union counties each occur in the top ten male leaning counties. Likewise, Baker, Clatsop, Grant and Gilliam counties each are in the top ten female leaning counties per subject. Repetition of counties on both ends of the spectrum may serve as an indication of the entrenched nature of gaps on both the female and male ends of the spectrum. Consideration of the top male leaning-reading counties reveals that only two counties, Lake and Wheeler, actually had males outperform females on average. Likewise, in the science category, only four of the top ten female leaning counties actually recorded males falling below females on average. These findings highlight the gender gulf related to reading and science tests.

Amongst the top counties in terms of average female score on the three subject tests, are females simply scoring higher randomly or do county

characteristics make a statistically significant difference? Some counties must perform better than others. Through running a basic regression model that measures the impact of being female, living in a certain county, and the interaction variable – being female in a certain county, the significance of a county's characteristics on the gender gap may become more explicit. This regression will focus on the 2013-2014 school year to test the relationship when the gender gaps are near maximum magnitude. A statistically significant coefficient on the interaction variable would provide evidence supporting the notion that county attributes contribute to the gender gap.

Reading		
2013-2014		
County	**Coefficient**	**P-Value**
Baker	-0.37	0.403
Clatsop	0.74	0.015
Gilliam	1.512	0.653
Grant	-0.485	0.415
Hood River	0.14	0.672
Jefferson	0.305	0.384
Tillamook	0.605	0.097
Wallowa	0.211	0.748
Washington	0.114	0.479
Yamhill	0.2	0.12

To the left and below, tables 8-10 contain the results of this regression on the top ten female leaning counties in terms of score on math, science and reading tests. Overall, the vast majority of coefficients on the interaction terms do not qualify as statistically significant. Insignificant coefficients convey a limited relationship between counties and the magnitude of the gender gap. However, in some cases, as indicated by the red text, being female and in a specific county can lead to a statistically significant change in the size of the divide between males and females. The regression on the reading exam indicated a statistically significant positive relationship between being female and residing in Clatsop County. The remaining coefficients have relatively high p-values.

Math		
2013-2014		
County	**Coefficient**	**P-Value**
Baker	-0.303	0.55
Clatsop	0.776	0.06
Gilliam	1.974	0.072
Grant	-0.323	0.608
Hood River	0.857	0.048
Jefferson	1.135	0.01
Klamath	0.353	0.374
Lincoln	0.636	0.483
Marion	0.708	0.04
Morrow	0.55	0.73

Science		
2013-2014		
County	**Coefficient**	**P-Value**
Baker	-1.656	0.231
Clatsop	-0.123	0.927
Douglas	-0.648	0.622
Gilliam	-7	0.109
Grant	-1.183	0.416
Harney	-0.754	0.6
Lane	-0.813	0.533
Lincoln	-0.128	0.924
Morrow	-1.312	0.336
Sherman	-0.056	0.4

Tables 8-10: Interaction term coefficients for top ten female leaning counties on the different exams.

On the math exam, residing in Hood River, Jefferson or Marion county led to a significantly positive increase in score relative to living in a different county and being male. Most notably, females in Jefferson County added 1.135 points to their math exam on average. Most of the other coefficients failing to be significant may bolster claims that county characteristics have a random, indeterminate influence on the magnitude and prevalence of a gender gap in most cases. None of the top ten female leaning counties on the science exam recorded a statistically significant coefficient.

The results from including controls largely mirror the results of simply looking at the average point divide between males and females. In terms of interpretation, these coefficients indicate how, in comparison to being male, being female impacts a student's total points scored on an exam on average. For instance, a coefficient of five in the math regression would indicate that a student being female rather than male, on average and with all else held constant, would led to an increase in that student's math score by five points. A negative coefficient means that being female typically will lead to a lower score on that exam. The general

positive trend of the coefficients attest to the closings of the various gaps seen in figure 10. While the coefficients associated with reading performance have largely remained flat, if not slightly decreased, over time, the math and science coefficients have steadily increased.

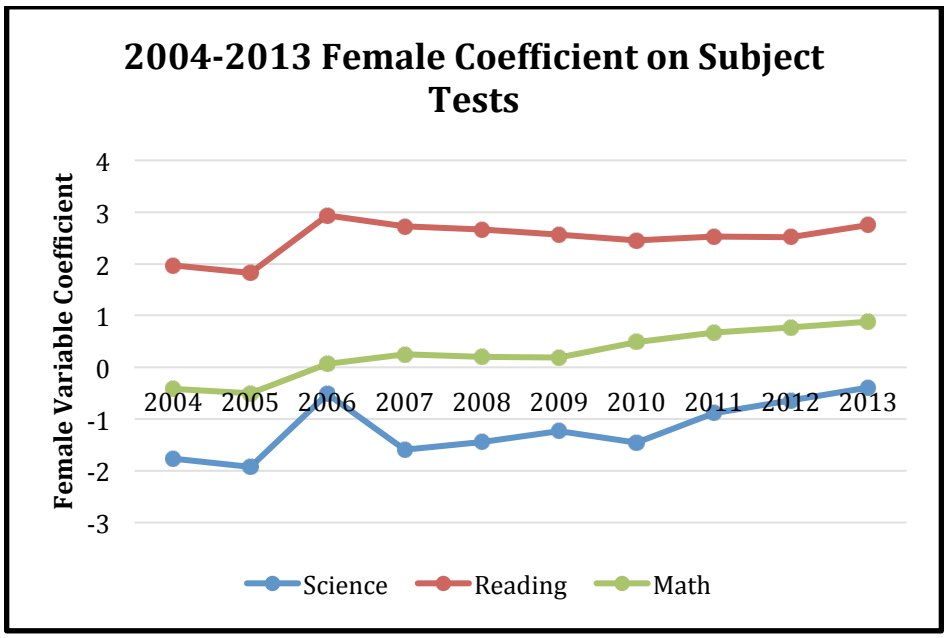


Figure 11: The coefficients of the female variable on the different subject tests from 2004 to 2013.

The second regression, which includes more county level information and thus, did not require including the county fixed effects, yielded female coefficients that nearly mirrored those calculated from the first model (see table 11 below). In context of the regression, the differences shown in table 11 amount to changes of less than one thousandth of a point on a particular subject test.

Difference in the Female Coefficient Values			
Year	**Science Difference**	**Reading Difference**	**Math Difference**
2009-2010	-0.00099	0.000389	-0.0000617
2010-2011	-0.00245	0.00987	-0.001102
2011-2012	0.003368	0.001196	-0.000312
2012-2013	0.000696	0.001004	-0.000824
2013-2014	0.002963	0.002716	0.001462

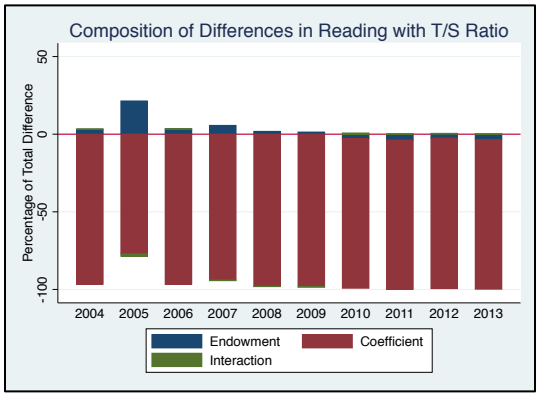
Table 11: Comparison of female coefficients from two regressions.

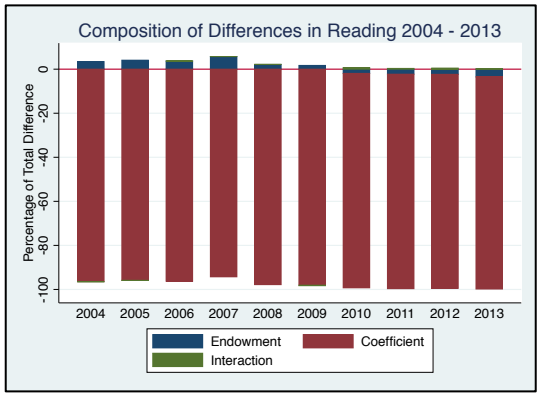
The second empirical model included county information on the percentage of residents with a bachelor's degree or higher, the percentage of residents living in the same house as the year before, the percentage of foreign born individuals, the percentage that speak a language other than English, the labor force participation rate, the mean travel time to work and the median gross rent in that county. Given that the latter regression produced nearly the same coefficients as the regression that included a county fixed effect variable, it appears that the aforementioned characteristics of counties go a long way in covering the impact of county characteristics on test scores. As mentioned in the theoretical analysis section, some of these variables, such as the percentage of residents that predominately speak a language other than English at home, serve as good indicators of direct, opportunity and mental costs. In the case of a student in a county with fewer English speakers, having to transition between two different languages would surely be taxing on the student in the classroom.

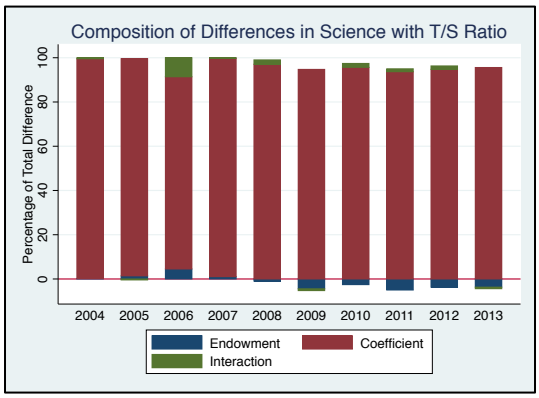
The Oaxaca decomposition, included with the intent of identifying the variables that have the largest disparate impact on female and male variables, produced a number of intriguing results. After acquiring more data, specifically information on the average teacher to student ratio by school, two different Oaxaca

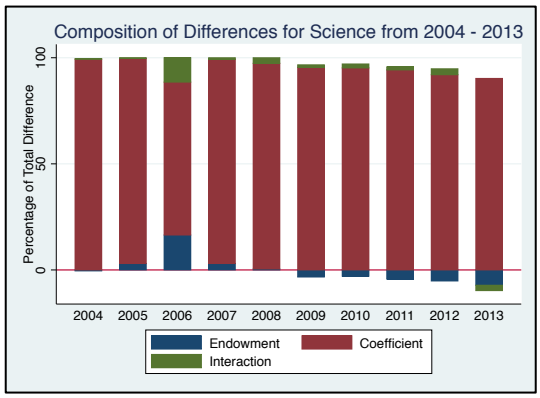
decompositions were conducted for each subject for each year. Whereas the first decomposition did not include class size, it did feature the season of birth of a student, whether or not a student identified as TAG, displayed limited English proficiency or was economically disadvantaged. Furthermore, it considered the median income for the county in which they resided.

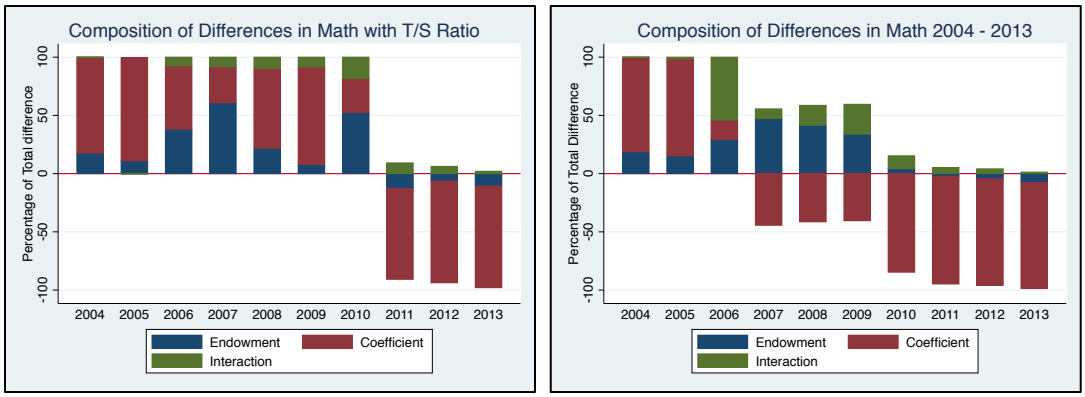
The charts below compare the percentage of the total difference in female and male scores on the various subject tests made up of the coefficient, endowment and interactions effects for two different Oaxaca decompositions. The charts on the right show the results from the first decompositions. Those on the left charts convey the same information but for Oaxaca decompositions conducted for each subject with the average student to teacher ratio. Note that a negative score indicates a female advantage.











Figures 12-14: Difference in percentage composition of total difference between Oaxaca decompositions.

The endowment effect, the impact of the conditions prior to consideration of additional variables, does not have as substantial of an impact as previously expected. In nearly every year for all subjects, the coefficient effect – a measure of how students respond to variables differently, comprises of the vast majority of the point difference between males and females. Correspondingly, the interaction effect takes on a minimal value in most cases.

A number of important observations stick out while solely evaluating the results on the decompositions without the average teacher to student ratio. In one extremely noticeable case – the 2006 math results – the interaction and endowment effects were much larger proportionally as a percentage of the total difference in test score. On the whole though, the results suggest that the gaps across time and subject mainly occur as a result of variables such as being of limited English proficiency having disparate effects on males and females. These results again testify to the widening gap on test performance, typically with females performing better. The science results show the male advantage shrinking from 2009 onwards as evidenced by the endowment effect becoming increasingly negative in the following years. Both the reading and math charts display how females have

maintained and gained, respectively, advantages over their male colleagues. Interestingly, only the math chart contains a switch from male prevailing on the exam to a female advantage. The years of clear transition in this process merit further attention. As early as 2007 females were responding more positively to the variables included in this decomposition shown through the coefficient effect taking on a negative value in that year. From 2007 onwards, the coefficient effect tends to grow and by 2013, the female response to those variables has facilitated a massive divide between the two genders. Notably, the rate of change for all three of the subjects, in terms of the direction of the gap, explicitly varies by subject. These disparate trends appear in the results above as well, such as in figure 11. In that diagram, as in the charts relying the Oaxaca results, the female advantage in reading stays flat while they make up ground on the math and science exams, albeit at varying rates.

For the most part, the findings relayed by the charts on the left mirror the trends seen on the right. Looking at the decompositions with the teacher to student ratio, the science scores move towards females over time and the female advantage in reading is maintained. For both of these subjects the percentage of the difference found in the coefficient effect appears fairly similar. Such similarities imply that the additional consideration of the average teacher to student ratio, at least when reviewing science and reading, may not explain away any more of the interaction term or reduce the amount of the endowment effect.

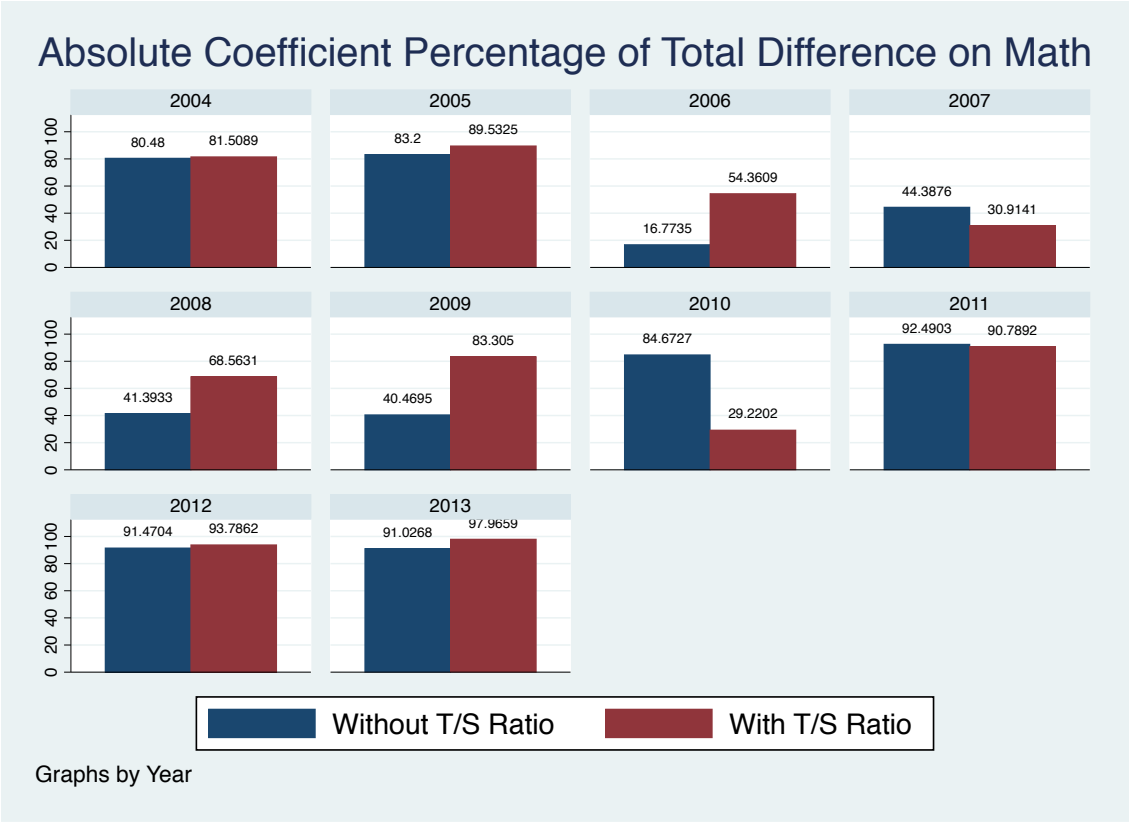


Figure 15: A comparison of coefficient percentage from 2004 through 2013.

Comparatively, as seen above, the inclusion of average teacher to student ratios in the Oaxaca decomposition on math results leads to a noticeably greater portion of the difference in total points being explained by the coefficient effect. With the exception of 2007 and 2010, the inclusion of the average teacher to student ratio leads to the coefficient effect being equal to or above the absolute percentage of the coefficient effect from the decomposition that excluded the ratio. At the very least, the divergent influence of class size on the coefficient effect of the different tests illustrates that the teacher to student ratio may most induce gender differences in math.

Interpretation of Results:

Since 2003, female students have rapidly caught up to male students in science and math. What is more, they continue to surpass males in reading. These findings receive support from analyzing test score gaps, both of the regressions and from the Oaxaca decompositions. As mentioned, no clear trends regarding county characteristics and test scores seem readily apparent. Counties from a variety of different regions, of different populations and with a wide range of economic and demographic characteristics scored in the top ten in average subject test score and in the bottom and top ten in terms of male and female advantage by each subject. Most of the top and bottom ten lists include several repeating counties. In one case, that of the top overall counties by subject, seven of the top ten counties repeated in each subject. Repetition of counties would suggest that the conditions which foster overall academic success or a gender gap of either direction might be inherent to individual counties and not necessary to certain broader county traits. The differences in test scores and gap direction and magnitude in Grant and Umatilla counties – demographically, geographically and economically similar – evidences the idiosyncrasies demonstrated by the results. If attributes of counties on a broader level do not have much of an influence on test scores, then the ODE should more heavily look at the structural components of the school districts in those counties to parse out explanations for variation in scores and gaps.

The regressions make clear that the female advantage over males on test scores, even in the presence of other controlling variables, still is statistically significant. However, given that the female coefficient is not large, gender does not

predominately explain the differences in test scores. A number of the other variables in the regressions ran, although no one variable in particular, had influence on test scores. Therefore, any ODE action should not necessarily focus only on adjusting conditions by gender but on the broader conditions in a classroom. The Oaxaca decompositions reinforce this finding by showing that the endowment effect compromises of only a very small portion of the difference in results. Such large differences in the coefficient effects mean that the ODE may more wisely spend resources addressing differing responses to factors such as being of limited English proficiency between females and males.

Teachers may have disparate roles by subject in shaping the magnitude of differences in performance by gender. Whereas the percentage of the total difference comprised expressed by the science and reading tests does not substantially differ between the two Oaxaca decompositions, including the average teacher to student ratio altered the make-up of the differences in math. A larger coefficient effect resulting from the additional consideration of this ratio indicates that teachers may have an outsized role in shaping performance on math tests that varies by gender. If true, then the ODE should attempt to study this phenomenon further by seeing if the coefficient changes at all based on whether or not the gender of the teacher aligns with the gender of the student.

Importantly, gaps, especially in math and reading, demonstrate a strong, positive correlation. A correlation of above 0.8480 between math and reading similarly bolsters the argument that gaps seem to persist where they develop. Low endowment effects and a relatively random pattern of county achievement illustrate

that the ODE should concentrate on studying conditions in those counties with the largest gaps and highest math and reading gaps. By the same token, due to the fact that females have long beaten males on reading exams, specific attention should be paid to those males with low reading and math scores. The data makes clear that a male student that is already behind his female colleagues in reading will likewise most probably be contributing to the development of a larger math gap.

Some observations and trends do not lend themselves to obvious interpretation. For instance, the small difference in math and science test scores between the two genders in 2006 stands out. An examination of the history of assessments of this sort in Oregon reveals one possible explanation – mandated changes to the standards and metrics being used by the districts as dictated by the United States Department of Education. According to an ODE memo, the federal department demanded that the ODE come up with a plan to meet new compliance requirements by the end of the 2006-2007 school year. The memo urges districts to have their standards reviewed and potentially revised by a larger group of stakeholders. Indeed, the memo lays out other changes that districts must make such as what exams will factor into assessing compliance, which grades of students will have to test and what kinds of tests will be issued. As posited, alterations of this sort may have resulted in changes in examination procedures and content that favored females. If one supposes that these changes did spark the state of the gaps seen to today, then clearly the adoption of new policies on behalf of the ODE can influence marked changes in test performance. The same memo provides information on how the different subject tests should be used when compiling a

district's report card. In particular, the ODE did not factor science test scores into school report cards for 2006-2007. This change could have contributed to curriculum changes in the classroom that influenced the gender gap (Oregon Department of Education 2006).

In sum, average scoring female students in science and math seem to have facilitated the closing the gender gap. More specifically, females in the second quartile in science dramatically increased their performance in 2013 relative to 2004, which may spur the ODE to study changes in teaching techniques and standards that may especially impact the typical student. In contrast to science, females in the third quartile of the math distributions have driven the closure of the gap that existed in 2004. Granted, in both cases, some level of closure spawned from top performing females scoring higher relative to the top males as well. The reading distributions show fairly similar distributions that in both years suggest the male distribution has been shifted left, lower on the score axis, in relation to that of the females. Such a clear difference nearly across the board in reading over time should raise flags at ODE because males seem to so comprehensively be lagging behind.

Sources of Error:

ODE did not collect or release other variables that may have enhanced the accuracy and comprehensiveness of the decomposition. The inclusion of more variables in both the regression models and Oaxaca decompositions could refine the impact attributed to the variables included in this study while also conveying the significance of these presently omitted variables. The collection of additional data would raise costs and, in some cases, spark concerns about privacy. Much in the

same way, releasing certain data raises some privacy issues. Lacking access to variables such as the family size of the student, the marriage status of their parents and the number of days they have missed that, according to past studies, do influence school performance means that there was some level of omitted variable bias in the regressions performed above.

When a regression is ran without a variable that is correlated with the outcome, the coefficients of other variables become biased due to picking up on the impact of the variable left out of the model. Consider, for instance, a regression being run on the factors shaping housing prices and the average price of surrounding houses was the only variable included in the regression model. The omission of a variable like the quality of the surrounding schools would positively bias the coefficient of the average prices of the other houses if the schools were positively correlated with housing prices and vice versa. Potential omitted variables in the context of this study include after school activity participation fees and the health of a county's general population and of an individual student. These variables, as discussed in the literature review, are correlated with a student's performance in school.

Variance in the provision and content of the various tests over the years also represents a source of potential error. The questions on the tests, settings in which they were administered and the efforts of a student's teacher to directly teach to a test cannot be held entirely fixed across school, time and subject. By way of example, a student in one class may have a teacher that positively views state exams and earnestly covers the associated curriculum while another spurns the system by less

passionately and comprehensively covering the exam materials. Alternatively, those making the test may include easier or harder questions in a particular year while trying to maintain the same level of difficulty. School administrators may likewise adjust the degree to which they urge preparation for these exams. In 2006, following the federal Department of Education's mandated modifications, principals and teachers may have increased the class time used on test curriculum to avoid higher expected punishment for inadequate school performance.

The previously mentioned errors associated with the Oaxaca decomposition method may have also factored into discrepancies in the results. Female and male students should not be regarded as perfect substitutes in experimental settings. Physiological differences in addition to alterations in personality and preferences that spawn from our culture can lead to very different groups. As Mortensen, River and Barnett lay out, males tend to be more fidgety and society often pushes the genders in opposing professional directions. Fewer variables, in comparison to the conducted regressions, were used in the decompositions, which could have modified results. However, fewer variables allowed for a more explicit examination of variables such as limited English proficiency and TAG status on males and females.

Amendments to recording processes and methods may have also altered the results. In 2009, the Oregon Department of Education opted to begin recording Pacific Islanders as a separate ethnic code rather than group Asian and Pacific Islanders under one heading. Alterations to policies of this sort may have changed the accuracy of the data. Recording errors on behalf of both the students and the ODE may have affected the results, albeit presumably to a minor extent given the

large number of observations. ODE shifts in data collection for teacher-student ratios may have similarly produced time periods with periods of differing accuracy. While these adaptations in policy frequently lead to more accurate measurements, they can introduce factors that may skew the results between two different periods.

The characteristics of schools, including the number of grades included in a single building and whether or not a school has an academic focus of any sort, should be attempted to be held constant in future studies. Variation in the number and age of students by schools could lead to systematic deviation in opportunity, direct and/or mental costs in students. Students enrolled in K-12 schools, for instance, may have increased opportunities to interact with children of different ages. These types of conversations and projects could reduce or augment mental costs on a per student basis and thus, merit further attention.

These findings leave out private Oregon schools and therefore, cannot be said to be representative of the entire state. According to *Education Bug*, in 2015, over 50,000 students attended over 390 different private schools in Oregon (2015). The omission of such a high number of students limits the extent to which these findings can be applied to the state as a whole. More significantly, it may be that boys and girls attend private schools at different rates. If so, then the gap recorded might under or overstate the true gulf between the sexes. Females attending private schools at a higher rate would mean that the measured divide in public schools understates the magnitude between Oregonian male and female students.

Suggestions for Future Study:

Hopefully, this study will spur additional research into gaps of all sorts but specifically into differences in educational attainment. I selected this topic as a result of my passion for providing all future Oregonians with the tools they need to succeed and am confident that more research into this topic can advance efforts related to that objective. Those who embark on such a course of study would be wise to learn from the methodology, potential errors and findings of this report. Additionally, future studies should mirror my application of a less commonly used procedure - Oaxaca decomposition in this case - to garner new insights into frequently studied topics.

Most significantly, the size of this study, measured by the number of observations, rendered certain procedures extremely difficult and prevented in depth analysis at the individual, school and even school district levels. With upwards of five million total observations, I did not possess the time or resources necessary to investigate differences even among Oregon's 197 school districts. While looking at the county level, in my opinion, still provides substantial insight into how a specific region of Oregon is related to the formation of gaps, I am confident that district level analysis would enable the ODE to better tailor their potential plans to the needs of students in that area.

Although potential explanations were listed above, analysts should persist in their efforts to pinpoint the cause for the jump and then decrease in female performance on each of the subject tests in 2006 and 2007. ODE staff should do their best to determine how changes in the procedures and weights of these

assessments have directly led to gulfs in scores. Over time the administration of tests has changed. Likewise, the use of the scores in determining school funding and in assessing teacher performance have shifted. Are these assessments themselves partly causing the formation of gaps?

Other investigations may opt to focus more on the human element of education – the students, teachers, classified staff and administrators. Future studies into how the children and staff perceive the presence of a gap, if at all, may further efforts to refine the list of solutions under consideration. The Oaxaca decomposition results illustrated that differences in responses to educational conditions between males and females noticeably impact gap formation. Thus, the behavioral tendencies of students to different situations merit further study. This research could be in conducted in a myriad of ways. For example, student interviews, general observation of classrooms and teacher surveys represent just a couple of the tools at a researcher's disposal. This kind of analysis, in the opinion of those like Rivers and Barnett who place a heavier emphasis on how a school's culture can influence education results, could be well worth the ODE's investment. Notably, though, such a course of study would mandate a far greater amount of money and work hours.

It could also be intriguing to directly compare the characteristics of two counties on opposite ends of the gap spectrum. Take, for instance, Lake and Clatsop counties. Lake fell among the top ten counties in terms of male leaning gaps on all of the subject tests. In contrast to Lake, Clatsop was included in the top ten counties

exhibiting female leaning gaps on all of the different tests.[9] Analysis of the underlying structure of these counties, the organization of their school districts and the distribution of their demographic values could yield new insights. Ascertaining how the respective economies and cultures of these counties factor into the development and persistence of their educational gaps may produce relevant findings.

If possible, a future study should attempt to compile county level data for all of the years for which the ODE can provide student level information. Additionally, later investigations would surely benefit from the provision of more information from the ODE regarding a student's personal background and home environment. Including these variables would reduce omitted variable bias while assisting the ODE by identifying a greater number of areas through which they can incite change.

Shifting the metric of study – for instance to graduation from college or high school – could also spark consequential results. Qualitative and quantitative analysis of differences in high school graduates could arguably augment the usefulness of my findings by trying to parse out how the prevalence of gaps earlier in one's education career can shape future educational attainment. Moreover, this sort of study may be of greater significance to deciphering the impact of differences in achievement by demographic groups on labor statistics such as unemployment, underemployment and labor force participation rates.

Why some gaps, such as those in reading and math, exhibit higher correlation coefficients than others represents a field of inquiry that a subject other than

[9] Wheeler, Malheur, Jackson, Polk and Union counties also placed in the top ten for each exam leaning towards males. Comparatively, in addition to Clatsop, Baker, Grant and Gilliam counties displayed gaps favoring females to such an extent that they too were featured in the top ten female leaning for each test.

economics could likely more comprehensively answer. This kind of question brings up the importance of encouraging greater interdisciplinary study of issues like educational gaps that would benefit from all sorts of inquiry. Including results from other fields can complement findings from economic tools. These cumulative studies can provide the ODE and other similar bodies with the requisite information to most efficiently bolster student attainment across the board.

Another useful study would track students that come from areas with large and small gaps in educational achievement among different demographic groups and contrast their earnings and educational achievements. These differences, once quantified, could help put an economic price tag on education gaps. Hedonic methods would likely best facilitate this kind of work. In a world of scarcity it will become increasingly important to attach monetary values to different issues to ensure that they attract the requisite financial and political support. While research, as evidenced above, has been conducted on the prevalence and magnitude of gaps in education, there is a dearth of information on the economic, social and emotional repercussions of these conditions. This type of research, from an economics standpoint, may ultimately reveal that resources spent on "closing" gaps may be best spent elsewhere.

Finally, it will be of the utmost importance to measure the impact of any implemented programs with the explicit purpose of raising one gender to the level of the other or of closing a different education gap. If a school district places such a program into practice, the ODE should consider helping that organization monitor

the results, learn from its impacts and, if successful, how best to package the program to be of the most assistance across Oregon.

Studies of this sort should continue as long as Americans prioritize equal opportunity. The findings above indicate that in many cases students with certain characteristics have not been able to achieve the same level of success as their colleagues. As a nation that emphasizes providing all students with the tools they need to reach their goals, gaps of this sort deserve consideration from several perspectives.

Conclusion:

The results evidence the suspected female gains across all subjects in test scores. A variety of metrics made these patterns unambiguously clear. Likewise, the Oaxaca decomposition, in sum, provided relatively straightforward findings showing that inferior male performance does not spawn from inherent characteristics but rather result predominately from disparate reactions to environmental conditions. The application of economic tools demonstrates that males and females respond to variables in distinct ways. These divergent reactions should be studied and acted upon. Correlation coefficients speak to the relationship, especially between reading and math exam scores, that exists between educational gaps. Upon recognizing that a gap in one subject area relates highly to gaps in other fields, the ODE may want to focus on areas with the highest differences in reading and math scores given that these two subject areas appear to be closely tied together. In other words, addressing reading or math gaps individually might help reduce the prevalence of the other gap. These kinds of actions, ones that

simultaneously combat two or more issues, will assist the ODE in being as efficient and pragmatic as possible.

This study sought to quantify the current magnitude of educational gaps in Oregon public schools by analyzing differences and trends in performance on state exams. As outlined above, the research suggests that females have made gains on their male colleagues over the past decade in math, science and reading. Although males still lead in math on average from 2004 through 2013, the typical female has come to surpass the average male in reading by at least two points and has nearly eliminated the preexisting gap in science as of 2013.

The second objective – to determine the specific impact of the gender variable on test performance – also made clear that sex has shaped how students perform on these exams. The female coefficient, when regressing scores on math, science and reading exams, varied substantially year by year and by subject. However, a clear trend emerged – as time passed the average number of points gained through being a female, all else equal, grew positively on math and science exams. The coefficient largely remained the same on reading exams. However, the point differentials that correspond to gender were not incredibly large. Therefore, the ODE should not solely focus on addressing the gender gap by intervening only through gender. Instead, the department should allocate some resources into managing and monitoring the broader characteristics of a school and of school districts.

Finally, this study attempted to pinpoint which factors most disproportionately influenced the performance of females and males on the

different subject exams through the application of the Oaxaca decomposition method. The results obtained from this tool should enable the ODE to begin to develop more refined programs to boost male performance. In fact, if this model is applied to other gaps in the education system, the ODE may come to have a set of variables to focus on when trying to parse out the factors leading to the generation of demographic divides. The decompositions suggest that these divergences come mainly from reactions to conditions rather than innate disparities. Hence, the ODE would be wise to take steps to see why students react differently to being TAG, of limited English proficiency and included in economically disadvantaged metrics. Results also indicate that the average teacher to student ratio affects female and male students differently on the subject exams. Particularly, the ratio leads to the biggest change in math between females and males. Perhaps a decrease in the number of math teachers and/or an increase in typical class sizes have more significantly hindered male student scores.

Attempting to manage these divides in student performance will require greater attention from the press including the state's largest paper, *The Oregonian.* Other student divides, even in recent years, persistently garner more coverage than the gender gap. Reporting on educational separation by different demographic groups does not need to be mutually exclusive. Fortunately, groups such as the NAACP have been raising awareness about differences in black achievement for several decades. However, an established voice for ensuring equal provision of opportunity for both genders appears to be absent in the current conversation.

Test scores do not stand as perfect indicators of future success. Regression analysis above demonstrated that how a student performed on their math, reading and science state exams was very weakly, positively correlated with on-time graduation from high school. Often times students claim they simply do not do well on standardized states. Likewise, given the increasing number of parents opposed to standardized testing, it would not be surprising if some of the negativity exhibited by parents regarding the tests affected the performance of their children. However, these tests still do provide researchers with arguably the best metrics with which to assess student progress across time and their peers. The ODE may also find that focusing instead on differences in graduation trends may reveal more about the well-documented gains made by females in higher education performance.

From university attendance and graduation rates to state tests, the broader trend toward females surpassing males in metrics of academic achievement stands out as an increasingly noticeable educational divide. The results above confirm a gulf across subjects in Oregon public schools that occurs throughout the entire distribution of students and has been steadily increasing over time. These gaps vary over time and by subject but remain statistically significant. Still, the divide in test scores amongst K-12 students is relatively small in magnitude. So while females do outperform males on these exams, this divide makes up just fraction of a larger societal and educational trend. The ODE's response to these findings should appropriately weigh the limited impact of inherent differences between the sexes and place this trend in context of the many other educational gaps mentioned above such as the income gap.

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