Education and Wellbeing of a Country

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Abstract

This paper examines education, employment sectors and GDP per capita. The study examines which aspects of education math, reading, or science is more important to an economy, and how they affect different employment sectors. The model will attempt to show if educational subject scores have an impact in different sectors of the economy. The main function of this model is to decipher how education affects the wellbeing of a country. The results will attempt to discern whether education impacts employment in various sectors, and conversely GDP per capita.

JEL Classification: I25, 047, 030, B54, C21

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1.0 Introduction

Education plays a pivotal role in the wellbeing of an individual and on the wellbeing of a country. It seems as if the better educational system that a country possess the greater the output and production of the economy, and in this study that theory will be tested. There have been countless papers that discuss how education affects the wellbeing of individuals in that country. An abundance of these studies have used IQ tests to test its relation to national prosperity. In this study 2009 PISA reading, math and science scores across 48 countries will be used in relation to employment in different sectors of the economy and GDP per capita. PISA scores overcome a limitation of IQ scores; it is able to test various subjects. This can be imperative in telling us if a particular subject plays a bigger role in the development of an economy than another subject. This study aims to enhance the understanding of various subjects' education as it relates to sectors of the economy and ultimately GDP per capita. From a policy perspective, this analysis is important because it will discern how important different subjects of education are in accordance to the prosperity of the individuals in said country. The relevance of this study is how countries, through shifts in education, may be able to improve their economy.

One aim of the study hand is to decipher the impact of varying educational subjects. The paper will examine three subjects that are incorporated into PISA standardized tests; math, reading and science. From these differing subjects we can decipher whether one subject is more important to an economy than another subject. It will also allow for testing subjects with employment in various sectors of the economy (service, agriculture, industry, and R&D). Doing this will indicate whether or not there is a relationship between education and GDP per capita. The model will offer for formulations of possible policy measures if a country is looking to enhance a certain sector of the economy, and possibly also GDP per capita. For example, if it is found that math scores greatly increase the amount of employment in the service sector, than a country can enact educational changes that focus more on mathematical achievement. The only paper found that examines differing subjects at its effect on sectors of the economy as well as GDP per capita is the paper written by Cheung and Chan (2008). This model will hope to expand on Cheung and Chan's paper and avoid some of the limitations that were previously present. One such limitation was only 33 countries were employed; this paper will examine 48 and have updated PISA results from 2009 as opposed to 2003. Various regression analyses were run, but I believe some more regression analyses involving differing variables can assist in telling a deeper story about the relation between education and GDP per capita. This model will attempt to replicate Cheung and Chan's model in an attempt to discover new results and observe if the Cheung and Chan's results hold true.

Another aim of this study is to measure the importance of education toward a country's wellbeing. Does education play as important a role in the wellbeing of a country as many people believe? What is the actual magnitude of education in relation to a country's economy? These are the questions that this paper will attempt to answer. This will be done running a regression analysis on 48 countries and the results of PISA scores in math, reading and science. Education has always believed to be monumental in the standard of living of individuals in said country, and that is why it is such a substantial part of this study. Policy actions can be constructed based on the findings that this model will hopefully create. If education is shown to have a monumental impact on GDP per capita than countries should greatly invest in education. I am optimistic that this study will be able to answer some vital questions about the effect of education o different sectors of the economy and ultimately GDP per capita.

The rest of the paper is organized as follows: Section 2 offers a brief literature review pertaining to the papers I have observed related to this topic. Section 3 outlines the empirical model: Section 4 contains the data and estimation methodology, the empirical results and discussion are pronounced in section 5. Lastly, Section 6 is the conclusion.

2.0 Trend

Figure 1 and Figure 2 show that employment in the service sector of the economy has grown quite substantially over the past 15 years. This growing trend in the amount of service workers in high income counties exhibits the fact that the wealthier countries are starting to move more towards a service economy. Since the selected countries for the study are mostly made up of the higher income countries, the model will attempt to examine if the rising service sector has a positive effect on GDP per capita. This will be done by testing if countries with a higher percentage of service employees have a higher GDP per capita. That is one question the model will aspire to solve. Conversely, in **Figures 3 and 4** you can see that the percentage of workers in industry has fallen. The model will also attempt to indicate whether or not there is a significant relationship between percentage of workers in industry and GDP per capita. Also attainment scores in the areas of Math, science and reading will be tested against employment in these two industries to ascertain whether or not educational scores have any impact on these two trending sectors.

Wölfl (2005) examines the role of the service sector in OECD countries on the economy. Wölfl explains the growing role of the service sector in high income countries, which also represented in Figures 1 and 2. The paper postulates the increasing importance of the service sector on economic growth, stating that the performance of service industries can assist in the performance of other industries because "services provide key intermediate inputs to such sectors" Wölfl (2005). Financial, insurance and business services have become key drivers of the economy as their value added has greatly increased. The article explores one of the key elements that this paper will attempt to explore, and that is the relationship between GDP per capita and percentage of employees in the service sector. Wölfl (2005) uncovered that there is does seem to be a positive relation among these two variables. This is a result that I will attempt to test in my model and see if the Wölfl (2005) data holds true in my model. Additionally, I will test educational scores with percentage of employees in the service sector to discover if any particular subject or education in general has a relationship with the amount of service workers.

PISA stands for Program for International Student Assessment, and it is an international assessment test that tests 15 year old students' knowledge in reading, math and science. The test also measures areas such as problem solving. The PISA test is coordinated by the Organization for Economic Cooperation and Development (OECD). The initial PISA test was administered in 2000, and is conducted every 3 years. 2012 was the most recent assessment, but the scores for that test are not available to the public yet. (nces.ed.gov). The schools and students that participate are chosen at random, and are attempted to accurately portray that countries population. For example, in the U.S 240 schools are randomly chosen, and 50 students are than chosen from each of the 240 selected schools. The participation in the test has been growing; since its inception 43 countries participated, in 2009 75 countries partook. However, in 2012 there was a decline in participants from 75 to 64, hopefully that doesn't end up being a trend, and we see more countries participate in this assessment. If more countries participate, it will permit researchers to do more thorough studies of education across countries. (nces.ed.gov).

Figure 1: Employees Service Female (% of female employment) in High income OECD countries

Figure 2: Employees Service Male (% of male employment) in High income OECD income countries

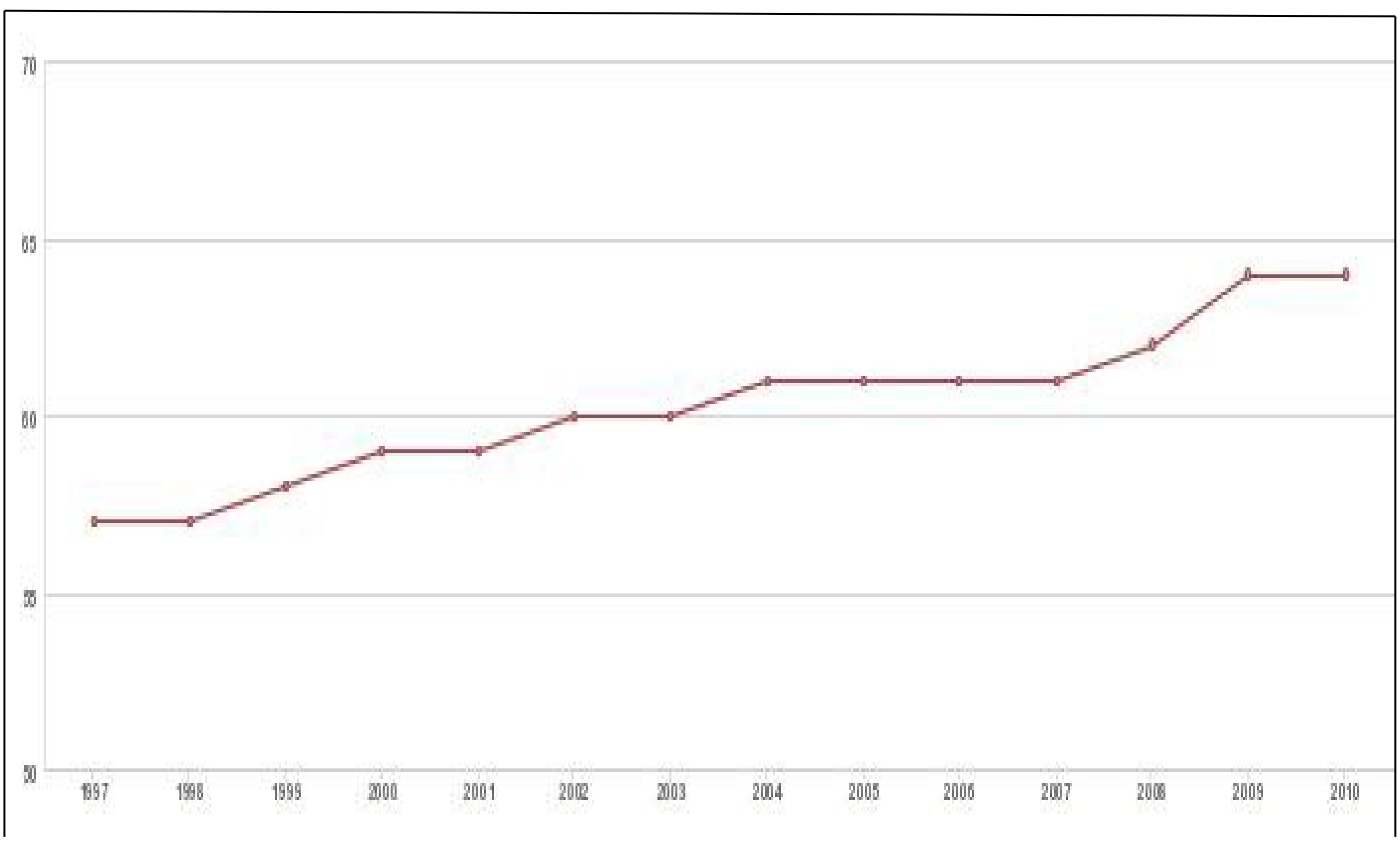


Figure 3: Employees Industry Male (% of male employment) in High income OECD countries

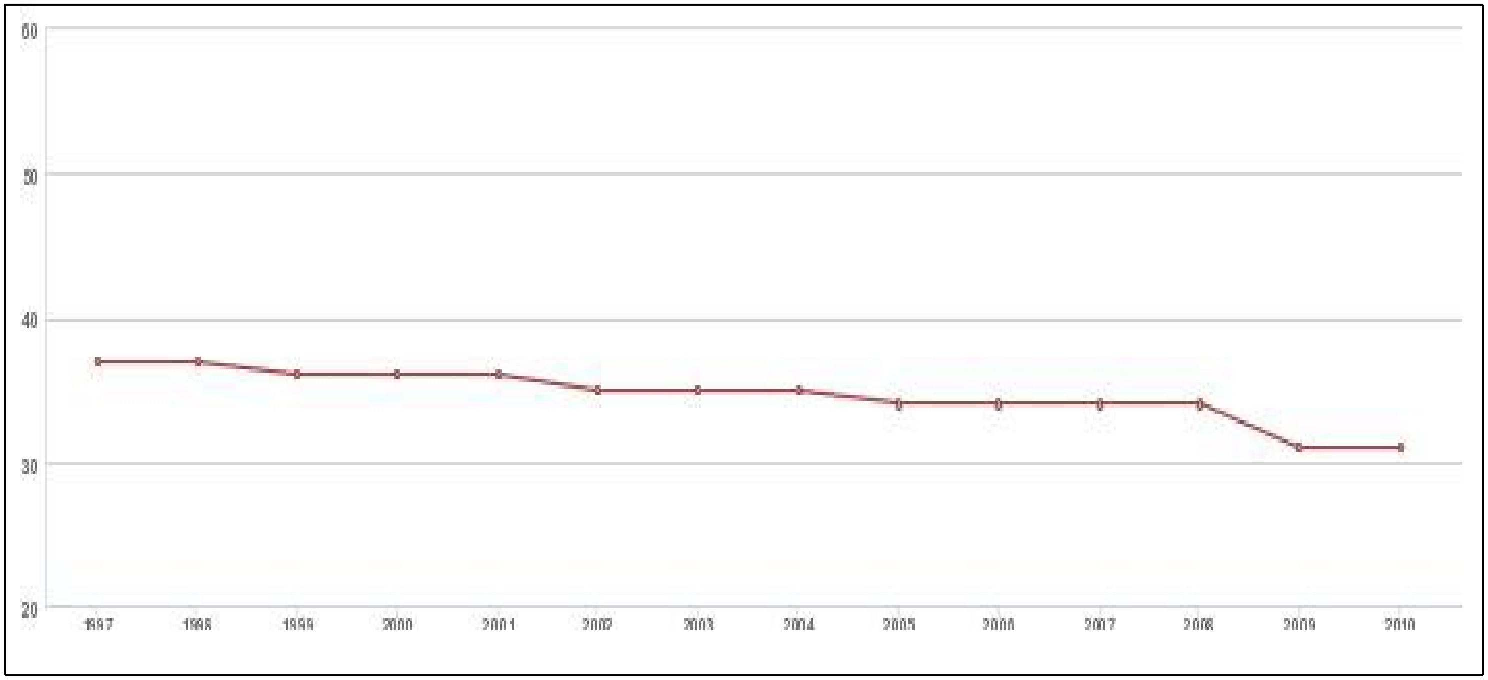
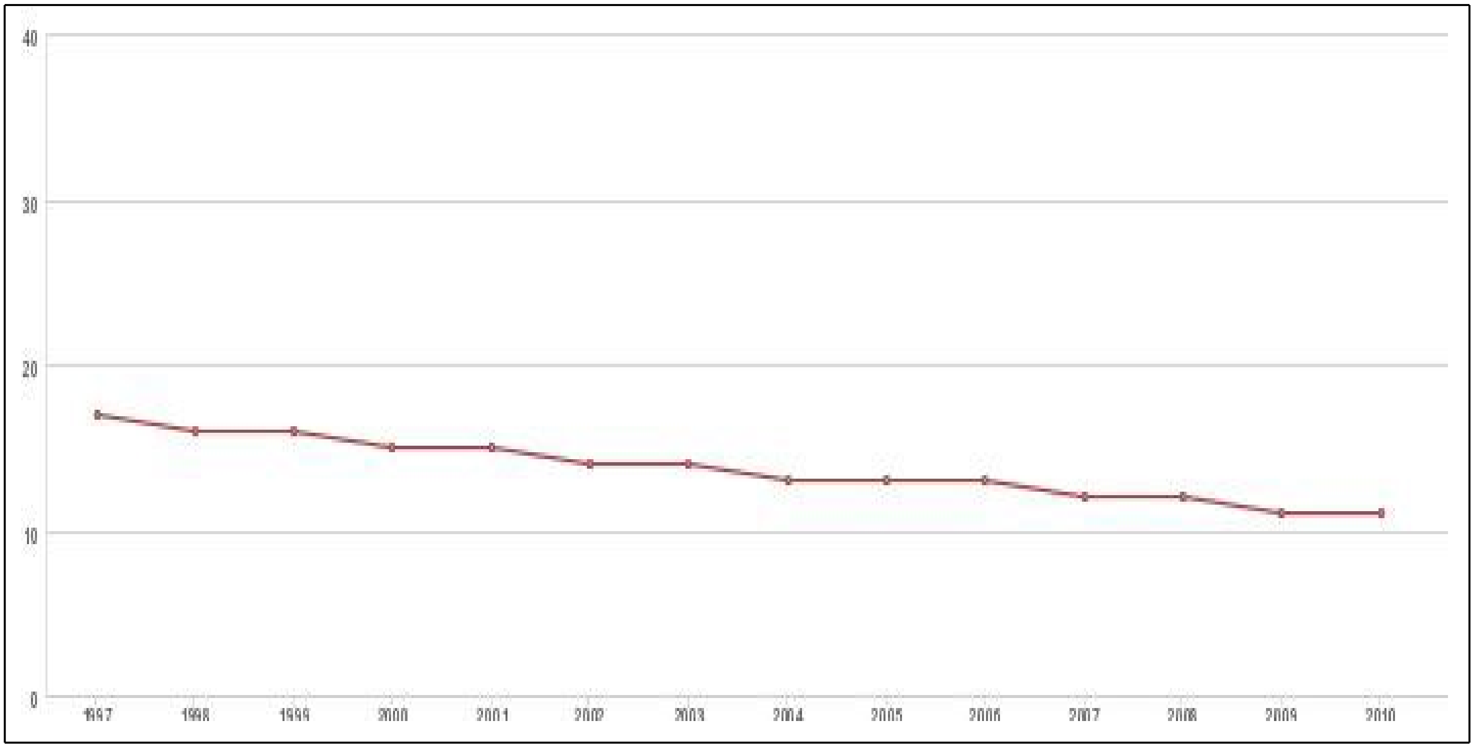


Figure 4: Employees Industry Male (% of male employment) in High income OECD countries



3.0 Literature Review

Education has been thought as a key driver in economic activity. This paper will examine its effect on the wellbeing of individuals in the selected countries as well as the effect on the differing employment sectors. Rosenzweig (1995) purports differing opinions as to why effective education can increase productivity. He states that better educated citizens will have a better idea of using technology, and secondly they will be able to work more efficiently. Another key point that is proposed in Rosenzweig (1995) is the fact that if education only improves access to external resources than production will only increase when production is new. On the other hand, if education induces learning, then productivity will increase when technology is new, as well as when technology is developed. This relates to the model in this paper because level of education is not being tested, but rather the test scores. Assuming that PISA test scores are an accurate measure of the quality of knowledge of the test takers, the effectiveness of the particular countries educational system can be tested alongside economic outcomes. The empirical findings in Rosenzweig (1995) suggest that schooling returns are high when returns to learning are also high. It is also important to note that no evidence was found that schooling investments, in the absence of learning opportunities are profitable for an economy. This relates to the point just made that learning is tested in this model not solely the access to education. Another article that related education to increase productivity is Dufflo (2000). He found that an extra year of schooling in farming has shown to increase output in agricultural sectors. Shahbaz (2002) states that increase education are related to faster technology adoption, thus leading to higher productivity. Another article by Bravo-Ortega and Lederman (2010) conclude that increases in human capital increase the share of labor dedicated to R&D.

One of the main functions of this study is to test scores, and its effect on the economy. Test scores seems to be an accurate measure of intelligence, and in Whetzel and McDaniel (2006); Meisenberg (2011); Hunt and Wittmann (2006) the effects of intelligence on the prosperity of a country are tested. Whetzel and McDaniel (2006); Meiseberg (2011) find IQ scores to have a significant impact on national prosperity. It was found that there is a growing trend for national wealth to be aligned more with IQ, but it is explained that IQ scores could be a result of high prosperity opposed to the other way around. Proving PISA scores relations with prosperity as opposed to the other way around will be a big obstacle in the model that will be run. Hunt and Wittman (2006) try to explain intelligence through PISA scores rather than IQ scores. This is because Hunt and Wittman (2006) pronounce biases inherit in IQ scores across countries because each culture has its owned specialized bank of knowledge and required methods of problem solving. So, Hunt and Wittman used PISA scores to eradicate these biases. As well as comparing PISA scores with IQ scores do see if there is a significant differential. It was found that PISA scores are a significantly better indicator of GDP. Hunt and Wittman (2006) found that there is a significant relationship between PISA scores and economic status of that country as it the Wittman model predicts 67% of the variance in national wealth. However, Hunt and Wittman (2006) explain later that a bigger sample size is needed to imply a definitive relationship.

Cheung and Chang (2008) is the primary article observed and is the model which this one is based on. In this paper PISA scores from 2003 are observed with employment in differing sectors along with GDP per capita across 33 countries. The authors used various models to ascertain differing relationships between subject attainment scores, employment in differing sectors and GDP per capita. Their model showed that PISA scores in reading are able to predict employment in the service sector; mathematics scores are able to positively predict R&D workers, and predict employment in agriculture negatively, and science scores are able to predict employment in industry. Another conclusion found is that researchers in R&D and employment in the service sector have a significantly positive relationship on GDP per capita. These are vital findings that were found, and in this model the model will be replicated in seeing if these results hold true with a bigger sample size and updated PISA scores. In the model differing models will also be created in order to determine if there are any other significant relationships.

Empirical Methodology

4.1. Data

The data used for this model include numerous received from two sources. The World Bank for the percentage employed in the service sector for male and female; percentage employed in the industry sector for male and female; and percentage employed in agriculture for male and female. Another employment sector that was retrieved from the World Bank was the number of workers in R&D (in millions). Those were all the data collected for the differing employment sectors. The dependent was also found using WorldBank.Org, and that is the GDP per capita. The log of GDP per capita was used in the model to gather better results. The last portion of data was collected through OECD.org, and this was the PISA scores for math, reading and science. The model that employs this data contains mostly the wealthier countries because they were the ones participating in the PISA assessment. The data is cross sectional across 48 countries and the data for all variables except the 2009 PISA results are average from 2006-2010 because not all data was available for 2009. The complete list of data and variables are presented in appendix A.

4.2 Model

In this empirical study, the regressions are estimated using ordinary least squares (OLS) to determine the variables effects on the dependent variable. Various models are utilized in this paper to determine differing variables effect on one another. There are six models used the first three attempt to ascertain the effect of each subject score on log_GDP per capita. Another two are used to determine the effects of a subject score on a particular sector of the economy. The last one measures the service sectors effect on log_GDP per capita. The model that is used in this paper is taken from Cheung and Chan (2008). The model that is used in this paper is updated with 2009 PISA results, and contains 48 countries instead of 33. Also, the models that I ran differ from the ones used in the previous model. For example, I measured the effect of each subject on the GDP per capita. Thus, determining how particular subjects relate to the wellbeing of a country directly. I also did this to determine if there are any glaring differences between the effects of one subject on GDP per capita, and another. I also tested the effect of the service economy directly on GDP per capita, because it was mentioned earlier of the importance of the service sector on the economy, and I also tested the reading score with the service sector to see if reading effected the service sector, and then if the service sector effected GDP per capita. I used the same variables as Cheung and Chang (2008), and some of the same models, but also altered it slightly to figure out the results I was looking from paper I discussed. The aims of this model is to determine the effects of PISA scores on GDP per Capita, the differing employment sectors, and then testing the employment sectors to GDP per capita. It should be noted that other models were run for the PISA scores effect on Agricultural sectors and Industry sectors. As well as agricultural effects and industry effects on log_GDP per capita, and no significant relationships or reliable models were found, therefore they were not included in the paper. The set of models used in the paper have the following form:

I) $RESRD\ t = \beta_0 MATH + E$

II) $LOG\_GDPPERCAPITA\ t = \beta_0 MATH + E$

III) $LOG\_GDPPERCAPITA\ t = \beta_0 READING + E$

IV) $LOG\_GDPPERCAPITA\ t = \beta_0 SCIENCE + E$

V) $LOG\_GDPPERCAPITA\ t = \beta_0 EMPLFEMSE + \beta_1 EMPLMSE + E$

VI) $EMPLFEMSE\ t = \beta_0 READING + E$

VII) $EMPMSE\ t = \beta_0 READING + E$

VIII) *LOG_GDPPERCAPITA t=* β_0RESRD+E

Descriptive Statistics

	Log_GDP Per Capita	Math	Reading	Science	EmpFEAG	EMPLFEIN	EMPFEMSE	EMPLMI	EMPMF	EMPMS	RESRD
Mean	4.32	**480.05**	**478.30**	486.05	6.83	14.06	78.68	33.60	10.20	56.25	2818
Median	**4.40**	491.29	486.34	495.35	2.87	13.66	82.14	32.24	6.56	56.25	2843
Maximum	5.01	562.02	539.27	554.08	42.10	27.40	94.55	50.76	40.68	79.08	7595
Minimum	**3.34**	359.75	370.73	375.90	0.15	5.02	42.28	20.33	0.17	35.10	90
Std. Dev.	0.38	49.22	39.28	45.03	9.33	5.30	11.79	7.12	9.21	9.53	1898

5.0 Empirical Results:

The OLS regressions that were run were used to minimize the sum of the squared residuals of the data. Table 2 represents the results obtained from this estimation. The results that were obtained reinforce other articles and models that were used previously, as well adding generating new results that shed light on education, employment sectors and their relation to GDP per capita. Various models were run in an attempt to ascertain the relationships among education, employment sectors and GDP per capita. The first three models test how PISA scores in each subject directly affect GDP per capita. In each of the first three models LOG_GDP PER CAPITA is used as the dependent variable. In Model 1 the effect of PISA scores in the area of mathematics has a significant positive relationship on GDP per capita. In the model which accounts for 48 countries, Math scores are able to predict 60% of the variations in GDP per capita. This means that Math scores do have a significant relationship with GDP per capita, and is a reliable model. Similar models were run for 2 and 3 and similar results were gathered. Reading and Science scores had a significant positive relationship on GDP per capita. They also predict just fewer than 60% of the variations and GDP, and the coefficients are similar. The reading scores effect on GDP per capita is the highest at .007227 meaning a change in reading scores by 1 point constitute a .7227% change in GDP per capita which is a decent amount considering the high level of average GDP per capita in these countries. Science scores had a slightly smaller effect than reading scores, but slightly more than math. Nonetheless all three models predict GDP per capita positively and have a significant relationship, with a reliable model. There is only a slight difference between the PISA scores and their effect on GDP per capita, all of them are similar in their impact. As I discuss more models I will touch upon why reading scores and science scores have a slightly bigger impact than math scores on GDP per Capita.

The next set of models I ran studied the impact of subject scores on the employment in the service sector. 6 models were run involving each subject and the percentage employed in service for male, and percentage employed in services for female. Cheung and Chang (2008) only studied the impact that reading scores has on the service sector, but after running various models I discovered each subject has a similar positive relationship with employment in the service sector. The strength of each model is also similar as each when is relatively low. These subjects are the best indicators of employment in the service sector because the model, but they do show significant positive relationships, and represent the fact that these subjects all have similar impacts on the service sectors. As you can see in table 2 model 4-7, the effects of each subject on service employment are similar as well as the R^2 and they are statistically significant at the 1% level. This shows that the subject scores are all intertwined showing similar relationships. Therefore, all subjects have a similar impact on the service sector. As I mentioned earlier reading scores had a slightly higher effect on GDP per capita, and this is because of it has a larger effect on the service sector. Later I will discuss that the service sector has relationship with GDP per capita, thus explaining why the service sector is important, and reading scores result in a slightly higher impact on GDP per capita.

Then I ran another set of 3 models to show the effect of subject scores on the amount of workers in R&D. Again, each subject exhibited similar relationship on this particular service sector. All three showed significant positive relationships, as well as having an R^2 around .57. The coefficients were again differed slightly as reading again showed the highest impact. This reinforces my previous point that all the subjects are interconnected because of their high correlations with each other, which was discussed in Cheung and Chan (2008). Since reading and science scores have a slightly bigger impact on workers in R&D, they effect GDP per capita slightly more. As will be shown later researchers in R&D do show a significant positive relationship with GDP per capita which is also why reading and science scores have a slightly bigger impact than math scores. Then, I ran a model that showed the effect of the service sector on GDP per capita. This showed a significant positive relationship of the effect of service sector employment for male and female on GDP per capita. The model was strong with an R^2 of .55. This shows just as Wölfl (2005) explains the importance of the service sector on higher income countries. This only showed that because reading scores had a higher effect on the service sector, and the service sector had a significant positive relationship on GDP per capita why reading scores had a slightly larger effect on GDP per capita than the other two subjects. Lastly, I ran a model that tested the effect of the amount of R&D workers on GDP per capita. This also had a significant positive relationship on GDP per capita with a R^2 of .57. This shows that the amount of R&D workers is has an important effect on GDP per capita, and this was also shown in Shahbaz (2002) these results are consistent with other papers such as Rosenweig (2005) and Hunt and Witman (2006) as they show the positive relationship test scores can have an economy. I also came across some new findings pertaining to educational scores. It seems just as Cheung and Chan (2008) pronounce that the subject scores are highly correlated, thus they all have similar impacts on GDP per capita and R&D workers and the service sector. This strong correlations makes it harder to distinguish the subjects effect on the economy, therefore each one has a positive impact, but there isn't much differential. Reading is slightly more important, than science, and math but they are very close.

Table 2:

Math scores effect on GDP per capita				
Dependent Variable- Log GDP per capita				
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**
Math	0.005908***	0.000712	8.3	0
C	1.48	0.3434	4.31	0.0001
R^2	0.59961			
F-statistic	68.9			

Reading scores effect on GDP per capita				
Dependent Variable- Log GDP per capita				
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**
Reading	0.007227***	0.000922	7.8346	0
C	0.861596	0.442678	1.946326	0.0577
R^2	0.57162			
F-statistic	61.38121			

Science scores effect on GDP per capita				
Dependent Variable- Log GDP per capita				
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**
Science	0.006268***	0.000811	7.730759	0
C	1.271761	0.395747	3.213568	0.0024
R^2	0.565			
F-statistic	59.76464			

Reading Scores Effect on Service employment				
Dep: Employment male services				
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**
Reading	0.125285***	0.030617	4.092	0.0002
C	-3.669952	14.69259	-0.249783	0.8039
R^2	0.266865			
F-statistic	16.74426			
Dep: Employment female services				
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**
Reading	0.130333	0.039873	3.268699	0.002
C	16.33829			
R^2	0.188489			
F-statistic	10.68439			

Math scores effect on employment in service sector				
Dependant variable- Log GDP Per Capita	Employment male services			
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**

Math	0.103739***	2.41E-02	4.305673	0.0001
C	6.45939	11.625	0.555248	0.5814
R^2	0.287251			
F-statistic	18.53882			
Dep: Employment Female Services				
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**
Math	0.105357***	3.17E-02	3.320766	0.0018
C	28.10065	15.30847	1.835628	0.0729
R^2	0.193371			
F-statistic	11.02749			

Science scores effect on employment in service sector				
Dependant variable- Log GDP Per Capita	Employment male services			
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**
Science	0.102702***	2.73E-02	3.766089	0.0005
C	6.336326	13.31	0.476052	0.6363
R^2	0.23567			
F-statistic	14.18			
Dep: Employment Female Services				
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**
Science	0.115066***	3.47E-02	3.317613	0.0018
C	22.7491	16.92843	1.343858	0.1856
R^2	0.193075			
F-statistic	11.0065			

Math scores effect on amount of workers in R&D				
	Variable- Workers in R&D (Per Million)			
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**

Math	28***	3.84	7.37	0
C	-1084.92	1857.078	-5.818	0
R^2	0.54			
F-statistic	54.37			

Science scores effect on number of workers in R&D				
Dependent variable-	Workers in R&D (Per Million)			
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**
Science	30.88411***	4.23E+00	7.304498	0
C	-12192.71	2063.664	5.908281	0
R^2	0.537			
F-statistic	53.35569			

Reading scores effect on number of workers in R&D				
Dependant variable-	Workers in R&D (Per Million)			
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**
Reading	36.19971***	4.72E+00	7.673294	0
C	-14495.99	2263.883	-6.403152	0
R^2	0.561401			
F-statistic	58.87945			

RESRD Effect on GDP per capita				
Dependent variable- Log GDP Per Capita				
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**
RESRD	0.000015***	1.90E-05	7.91	0
C	3.895	0.0643	60.57	0
R^2	0.57635			
F-statistic	62.58			

Service sector effect on GDP per capita				
Dependent Variable- Log GDP per Capita				
Variable	**Coefficient**	**STd. error**	**t-statistic**	**Prob**
Employment Female Service	0.012466**	0.004989	2.498535	0.0162
Employment Male Service	0.015783**	0.006176	2.555511	0.0141
C	2.44974	0.255326	9.594542	0
R^2	0.556117			
F-statistic	28.18908			

6.0. Limitations

There are a few limitations that are present with this study. One limitation is the fact that only 48 countries were included in the model, and these countries are mostly higher income countries. This model only tests higher income countries not lower income countries that need the most help in terms of economic development. Another limitation is the fact that some data for 2009 was not available, so for all variables excluding the PISA scores an average of 2006-2010 figures were used. Another limitation is that the three PISA scores had a high correlation between each other, so there was minimal differential in the effects of each individual subject on employment sectors and GDP. Small differentials were seen, but because of this high inter-correlation, results were very similar making it a limitation of subject scores.

6.1 Policy Implications

Policymakers can make a few decision based on the results that the model showed. First off education is shown to have a positive significant relationship on GDP Per Capita. Therefore, as most government leaders already know, the quality of education is vital to the wellbeing of the country. Efforts to increase the quality, and reach of education is imperative to maintain a strong economy. Also, from my results it is shown that the service sector as well as the amount of researchers has a positive effect on GDP Per Capita. Therefore, measures to gain more service jobs and more workers in Research and development can increase the economic standing of a country. Although these results were shown it's tough to pronounce that increasing these two employment sectors will increase GDP Per Capita because there are a variety of other factors, and you might be sacrificing other economic activity if you do this. It's never as easy as a model makes it appear; there's a lot more to take into account. But, on its own the service sector and R&D should help the wellbeing of a country.

6.2 Future Research

Future research can be done that involves more countries as the PISA scores are starting to grow, and taken by more countries. A bigger sample size and maybe the inclusion of medium income countries can be done to compile more data points. Also, other variables could be used that have an effect on GDP per capita, and a test can be run just involving PISA scores to see effect with more observations.

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Acronym	Variable Description	Expected Sign on LOG GDP per Capita	Expected sign on RESRD	Expected sign on service sector
RESRD	Workers in Research and development (per million people)	+	N/A	N/A
LOG_GDPPERCAPITA	Log of GDP Per Capita	N/A	N/A	N/A
EMPLFEMSE	Percentage of female workers employed in services	+	N/A	N/A
EMPMSE	Percentage of male workers employed in services	+	N/A	N/A
EMPFEAAG	Percentage of female workers employed in farming	N/A	N/A	N/A
EMPLFEIN	Percentage of female workers employed in industry	N/A	N/A	N/A
EMPLMI	Percentage of male workers employed in industry	N/A	N/A	N/A
EMPMF	Percentage of male workers employed in farming	N/A	N/A	N/A
Science	PISA scores in Science	+	+	+
Math	PISA scores in Math	+	+	+
Reading	PISA scores in Reading	+	+	+

OECD.Org

Nces.ed.gov

Appendix A: