Redefining the Work Week: An analysis of productivity based on hours worked in various countries.

Prepared for

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**Abstract**:

*There has been a surge in popularity for the prospect of having a 4-day, 32-hour workweek in recent years. There have been several controlled studies by businesses that show positive results. Historically, there have also been numerous studies that show similar results. The authors of those studies stressed that the positive results are seen only in the short-term, and in the long-term productivity goes back to the levels before the reduction or even below the original levels. Using a multivariate model with country and year fixed effects, this paper analyzes if there is still a strong linear relationship in the modern economies of OECD countries between productivity and the average number of hours worked. The results show that there is some evidence that these countries may be in Stage III of the production function.*

## I. **Introduction**:

The prospect of a four-day (32 hour) work week has been growing in popularity in recent years and has been a major part of the discussion in labor economics for many years (Conner 1976). The 40-hour 5-day work week has been a staple of the American workforce, but as economists are aware the marginal product of labor increases at a decreasing rate and starts decreasing after a certain point. Given the move away from the manufacturing, hands-on economy of the 20th century, the 40-hour work timeframe may now be in Stage III of the production. So, is the 5-day 40-hour workweek still useful in an economy that is heavily service-oriented and one that is trending towards a point where more people can do their job remotely? Additionally, a 4-day workweek has shown to improve employee morale, decrease stress levels and increase job satisfaction (Bird 2010).

This topic is useful to researchers, policymakers, and managers to determine if there is a need to change work hour policies. This would then allow them to do a cost-benefit analysis to determine if it would be beneficial in the long term to shorten the workweek to diminish the cost of employee turnover/burnout.

## II. Objective/Dataset:

The goal of this paper is to see if there is strong evidence of a linear relationship between the average number of hours worked and productivity while controlling for education levels, percent of GDP spent on R&D, net capital stock, fixed capital consumption, and total ICT investment. Using the OECD database, a preliminary OLS model is built to determine if there is a strong linear relationship between the number of labor hours and productivity since OECD countries have shifted towards a service and information-oriented economy while controlling for education levels, population, labor force, labor force participation rate. The model is then adjusted to account for country and time fixed effects. Since the study is on a macroeconomic level, there are many confounding variables that cannot be controlled for. The countries and the dataset measurement are limited to the following OECD countries between 1998 and 2005: Australia, Austria, Canada, Germany (DEU), Denmark, Spain (ESP), Finland, France, United Kingdom (GBR), Ireland, Italy, South Korea (KOR), Netherlands, Sweden, and United States. All of these countries are considered to be first-world countries that have strong, service-oriented economies between the years 1998 and 2005.

## III. Literature Review:

The prospect of a 4-day workweek has been in discussions among labor economists since the early 1970s. The popularity in the discussion of the topic grew in the 1970s and then dwindled until very recently when the prospect of decreasing work hours became a center point of workplace discussions for many millennials. The popularity of this prospect boomed because of the changes to the workplace that occurred during the COVID-19 pandemic, and workers realized that drastic and immediate changes to workplace behavior can be changed and the technology is in place right now to do so.

There have been numerous case studies by private companies that have reported positive effects from reducing the workweek. In February 2020, NPR reported that a 4-day workweek trial by Microsoft in their offices in Japan showed a 40% increase in productivity (measured as sales per employee), and a similar trial by Shake Shack in some of their stores went so well that the company decided to expand the program to a third of their 164 US stores. The most popular implementation of the 4-day workweek, however, was done in the offices of Perpetual Guardian; reported in the same article by NPR in February 2020, the Perpetual Guardian study showed that sales and profits increased since the time the company moved to the 4-day workweek. According to a March 2021 article by Insider, the Spanish government has agreed to test a 4-day workweek where employees will be paid the same amount for working fewer hours. There has never been a country-wide workweek reduction project done during modern times, so this test project will show the effects of the work hour reduction on a macroeconomic scale.

These recent studies are not brand-new implementations of the 4-day workweek. As stated earlier, the prospect of the 4-day workweek had amassed great popularity in the 1970s, especially among labor unions. The unions fought for the idea of decreasing the workweek by arguing that it would lead to greater employment (Leslie, Wise 1980). As a result, numerous studies investigated the prospect from the point of view of the workers. One of the most popular and exhaustive studies of workers' attitudes toward the prospect of reducing the workweek was done by Riva Poor in 1970. In *Social Innovation: 4 days -- 40 hours*, Poor finds that one of the most frequently noted benefits are employee morale, reduction in absenteeism, increased ease of recruitment, and reduction in labor costs among others cited by the firms in the survey. Another worker-focused survey by Thomas Mahoney, Jerry Newman, and Peter Frost finds that, from a variety of small samples, 55 percent of workers supported the implementation of the 4-day workweek. Mahoney, Newman, and Frost find that the 4-day workweek is especially popular among the 18–30-year-old group of workers.

It is important to note, however, that these studies along with others also showed the disadvantages/detractions to the benefits for workers in a reduction of the workweek, which is why there has never been a consensus among labor economists regarding the efficacy of reducing the workweek. In the same 1970 study, Poor also finds that most firms in the survey find the 4-day 40-hour workweek to not be all advantages; the fatigue that comes about for workers and the effort required to overhaul the entire firm's work procedures is not sustainable in the long term. This finding is echoed by Martin Gannon in a 1974 study titled *Four Days, Forty Hours: A Case Study*. Gannon supports Poor's concerns that the gains in employee morale, reduction in absenteeism, etc. only occur in the short term. Gannon finds that the novelty of the decrease in the workweek wears off among employees and that the fatigue and increased morale will disappear. Gannon additionally finds that even in the short-term, some firms saw either little to no increase in productivity or a decrease in productivity after implementing the 4-day workweek. Additionally, the study conducted by Mahoney, Newman, and Frost finds that there is no general understanding of what the 4-day workweek entails; in *Workers' Perception of the Four Day Week*, Mahoney, Newman, and Frost find that 36 percent characterized the 4-day week in terms of longer workdays and 64 percent characterized it in terms of a shorter workweek, and 71 percent indicated that the 4-day workweek would provide more leisure time. Mahoney, Newman, and Frost also found that the relationship between timeframe and perceived leisure time is statistically significant ($p<0.0001$), with those characterizing the 4-day workweek as a shorter workweek tending to favor the proposal.

Another aspect of the workers' perception that needs to be considered is the prospect of freedom that workers believe they will find in a shortened/flexible workweek. In their 1980 study, *Assessing Impact of Flexitime on Productivity*, Welch and Gordon find that there exists a significant difference in the average hourly production rates before and after implementation of the flexitime schedules. Employees get a lot more done when they have the freedom to establish their own work schedule (Welch, Gordon 1980). The ability to control the work schedule also affects a worker's job satisfaction, and a worker's job satisfaction can affect their productivity (Nanda 1977). Since firms cannot observe workers' true productivity, they use standardized, long working hours as a mechanism to sort productive workers, however, long weekly hours and long daily hours do not necessarily yield high output (Pencavel 2014). Welch and Gordon's study shows that productivity varies from worker to worker regardless of how many hours they work. This leads to many inefficient hours of labor hours – in fact, in their 2003 study, Sousa and Ziegler find that based on their model, high productivity workers tend to work inefficient long hours. This finding is echoed by Collewet; in the 2017 study *Working hours and productivity*, Collewet and Saurmann conclude that as the average number of hours worked increases, the workers become less productive. Even in manufacturing industries where it is assumed that the more labor hours inputted the higher productivity would be, the empirical results found in Clifton and Shepard's 2000 study suggests that overtime hours (longer hours) lower average productivity for almost all manufacturing industries included in the study. Similarly, Hanna, Taylor, and Sullivan's 2005 study on construction labor productivity shows a decrease in productivity as the number of hours worked per week increases and/or as project duration increases. Berman's 2009 study which also looks at the construction industry and reducing the workweek to a 4 day 40-hour week, finds that reducing the days in a workweek would be both feasible and cost-beneficial for the specialized construction firms included in the study. Like Berman's study, Milligan's 1978 case study of a Jet aircraft manufacturing company shows that using a staggered, 4 day 40-hour workweek would be economically beneficial to the company.

However, as mentioned earlier, some studies show the opposite relationship between working hours and productivity, or no relationship at all. *Explaining Canada-U. S. Differences in Annual Hours Worked* by Isgut, Bialas, and Milway found that between 1997 and 2004, Canadians worked 157 hours less on average than Americans, and that was a significant contributor to the difference in per capita GDP between Canada and the United States. The 2020 case study by Vallo of Sabertek LTD, South Africa concludes a positive, significant relationship between hours worked (standard and long hours) and the employee's productivity. Additionally, Crocker and Horst in their 1981 study found no evidence that marginal value product declines as more hours are worked, and Calvasina and Boxx, in their 1975 study, found that changing to a four-day week from a five-day week did not materially affect employees' productivity.

## IV. Model:

The key factor being investigated is the productivity (GDP per person employed) of a country. Although the main independent variable being looked at is the average number of hours worked per week per person employed, other variables including education levels, percent of GDP spent on R&D, net capital stock, fixed capital consumption, and total ICT investment will be investigated to control for as many factors as possible. The main empirical analysis will be done using a multivariate linear regression model after converting values to a log-log scale to account for the differences in the units of the variables while using country and year fixed effects. The specific metrics that will be used to conclude are the coefficient estimates, standard errors, p-value, and t-statistic of the various models that will be developed. The t-statistic describes how many standard errors from the null hypothesis value of 0 the coefficient estimates (sample slopes) are, and the p-value gives the probability of obtaining a sample slope at least as unusual if there is no linear relationship between the average number of hours worked and productivity.

The current null hypothesis is that there is no statistically significant linear relationship between the average number of hours worked and the GDP per person employed in the country when controlling for education levels, percent of GDP spent on R&D, net capital stock, fixed capital consumption, and total ICT investment ($H_0$: $\beta_1 = 0$, where $\beta_1$ is the true average change in GDP per person employed for each additional average hour worked per person employed per week). The alternative hypothesis being tested is that there is a strong statistically significant, negative linear relationship between the average number of hours worked per person employed per week and the GDP per person employed ($H_A$: $\beta_1 < 0$, where $\beta_1$ is the true average change in GDP per person employed for each additional average hour worked per person employed per week). This hypothesis assumes that in the modern economies of the developed countries being investigated, service and information-oriented industries dominate, and these industries are in Stage III of the production function.

## V. **Analysis**:

Based on Figures 1 and 3, we can see that both GDP Per Person Employed and the Average Number of Hours Worked Per Week Per Person Employed have remained relatively constant in the period for this observational study; there are not any outwardly clear outliers to be accounted for over the period. However, after observing Figures 2 and 4, Korea is a clear outlier in both the GDP Per Person Employed and Average Number of Hours Worked Per Week Per Person Employed.

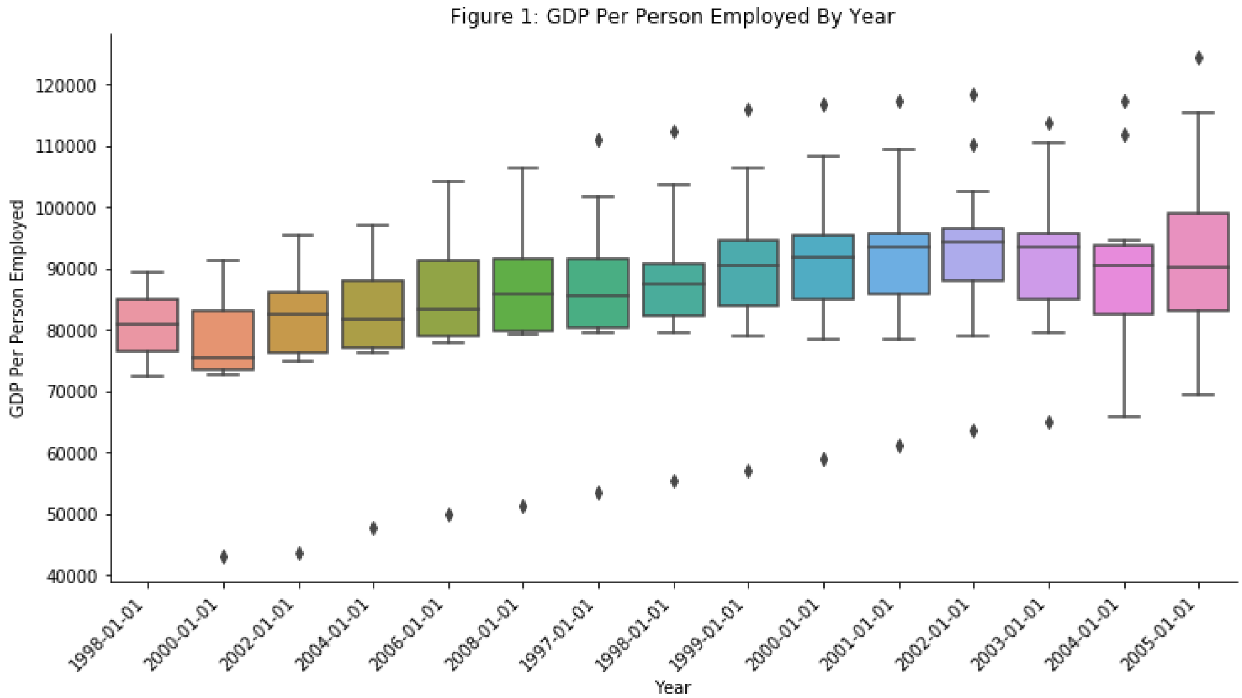
Figure 1: GDP Per Person Employed By Year
GDP Per Person Employed
120000
110000
100000
90000
80000
70000
60000
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40000
1998-01-01
2000-01-01
2002-01-01
2004-01-01
2006-01-01
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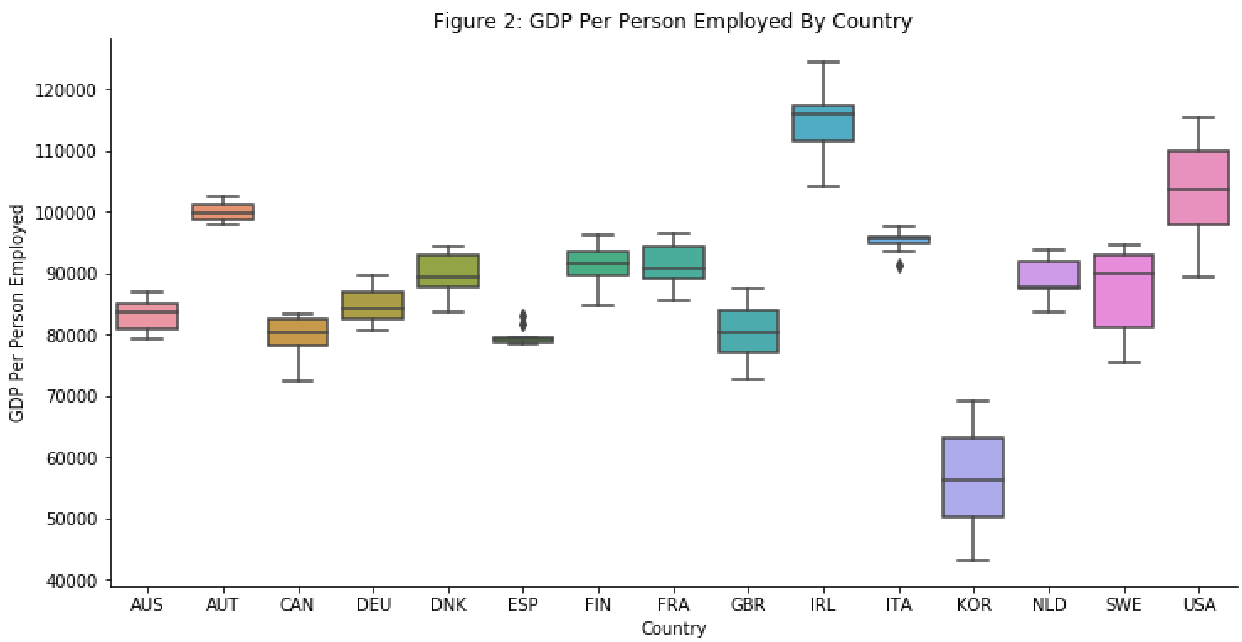


Figure 2: GDP Per Person Employed By Country
GDP Per Person Employed
120000
110000
100000
90000
80000
70000
60000
50000
40000
AUS
AUT
CAN
DEU
DNK
ESP
FIN
FRA
GBR
IRL
ITA
KOR
NLD
SWE
USA
Country

Figure 3: AVG Hours Worked Per Person Employed Per Week By Year

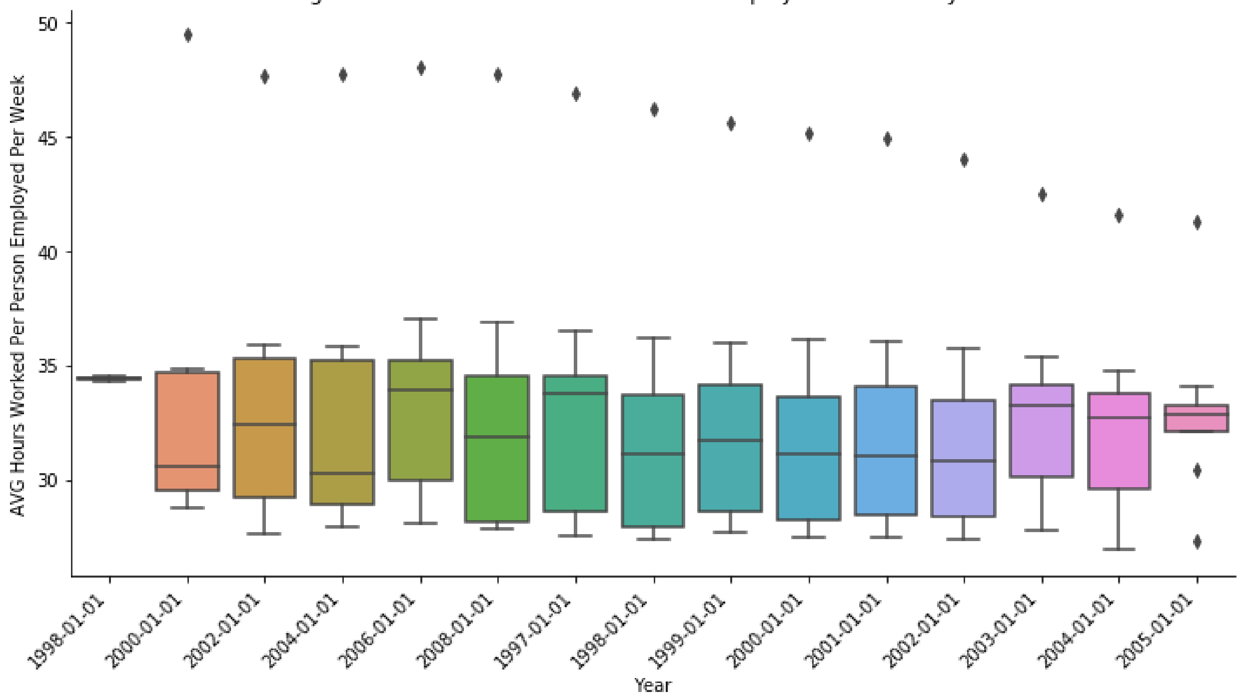
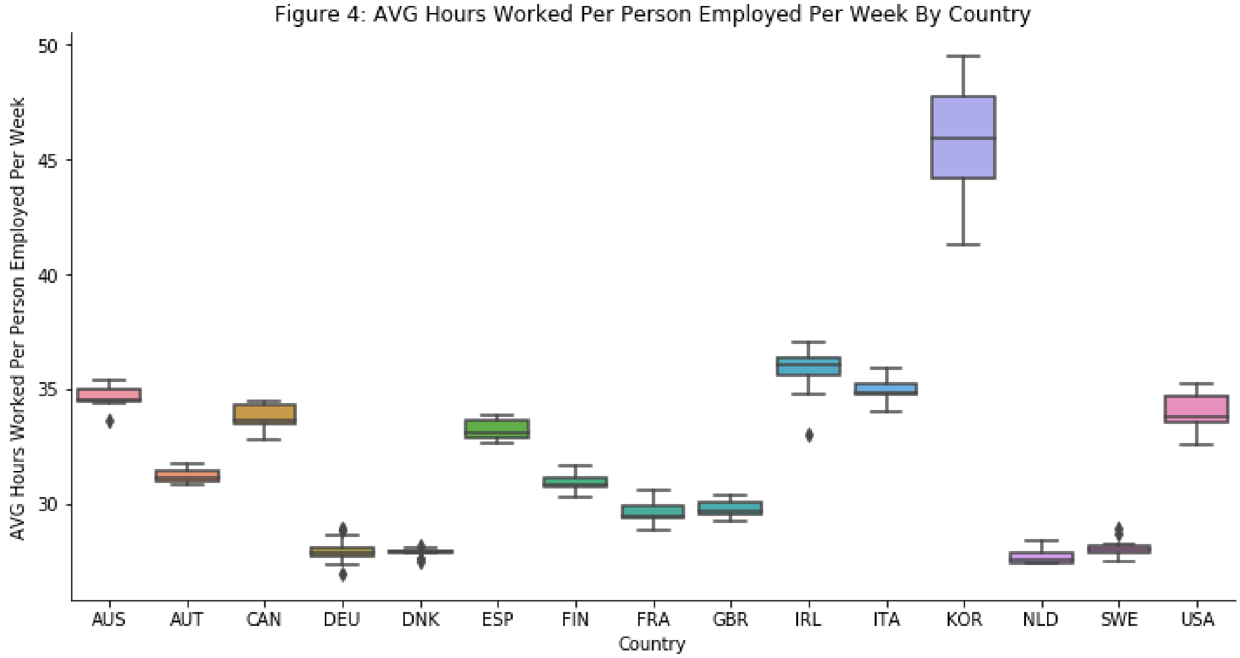



Figure 4: AVG Hours Worked Per Person Employed Per Week By Country




Given the outline of this study, there is no definitive reason to exclude Korea; it is an outlier and is affecting the coefficient estimates for the model (refer to Tables 1 and 2 to see the difference after dropping Korea), however since Korea fits the characteristics for the subjects chosen for the study it cannot be excluded. As such, Table 1 should be used to draw conclusions for the study, and Table 2 should be used to simply keep note of the influence of Korea on the coefficient estimates in Table 1.

Table 1: Regression Summary Estimates for various models – The main figure to be used for analysis.

| Regression Summary Estimates | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Model 1: Log-Log | | Model 2: Log-Log | | Model 3: Log-Log | | Model 4: Log-Log | |
| Average Hours Worked Per Person Employed Per Week | -0.6277 (0.089) | *** | -1.4779 (0.190) | *** | -0.5335 (0.111) | *** | -0.9933 (0.209) | *** |
| Percent of Population with Upper Secondary Education | | | | | 0.3024 (0.072) | *** | -0.1547 (0.057) | *** |
| Percent of Population with Tertiary Education | | | | | 0.135 (0.047) | *** | -0.0266 (0.048) | |
| Total ICT Investment (as percentage of total non-residential gross fixed capital formation) | | | | | -0.1562 (0.043) | *** | 0.0224 (0.030) | |
| Percent of GDP spent on R&D | | | | | -0.1595 (0.068) | ** | -0.1412 (0.047) | *** |
| Net Capital Stock, Volume, Year 2015 = 100 | | | | | 0.225 (0.082) | *** | 0.3466 (0.059) | *** |
| Consumption of Fixed Capital, % of GDP | | | | | -0.7623 (0.184) | *** | -0.2995 (0.091) | *** |
| Country Fixed Effects | No | | Yes | | No | | Yes | |
| YearFixed Effects | No | | Yes | | No | | Yes | |
| Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1 | | | | | | | | |

Table 2: Regression Summary Estimates After Dropping Outlier (Korea)

| Regression Summary Estimates - After dropping Korea | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Model 1: Log-Log | | Model 2: Log-Log | Model 3: Log-Log | | Model 4: Log-Log | |
| Average Hours Worked Per Person Employed Per Week | 0.3464 (0.096) | *** | -0.0438 (0.230) | 0.582 (0.117) | *** | 0.1593 (0.200) | |
| Percent of Population with Upper Secondary Education | | | | 0.239 (0.050) | *** | -0.1051 (0.043) | . |
| Percent of Population with Tertiary Education | | | | 0.0085 (0.034) | | -0.1545 (0.037) | *** |
| Total ICT Investment (as percentage of total non-residential gross fixed capital formation) | | | | -0.1248 (0.032) | *** | 0.0809 (0.025) | * |
| Percent of GDP spent on R&D | | | | 0.0499 (0.051) | | -0.1138 (0.036) | * |
| Net Capital Stock, Volume, Year 2015 = 100 | | | | 0.1028 (0.062) | | 0.2392 (0.046) | *** |
| Consumption of Fixed Capital, % of GDP | | | | -0.3569 (0.137) | * | 0.0056 (0.074) | |
| Country Fixed Effects | No | | Yes | No | | Yes | |
| YearFixed Effects | No | | Yes | No | | Yes | |
| Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 | | | | | | | |

The variables were converted to a log-log scale to account for their different unit measurements. There are a total of four different models built: the first one is a simple linear regression model without country and year fixed effects, the next one is a simple linear regression model that includes country and year fixed effects, the third one is a multivariate linear regression model without country and year fixed effects, and the final one is a multivariate linear regression model the includes country and year fixed effects. The final model that includes the control variables and country and fixed effects is the best model to be used to get the clearest view of the relationship between productivity and the average number of hours worked.

In Model 4 of Table 1, the key observation to take away is that for every one percent increase in the average number of hours worked per week per person employed, there is a 0.9933 percent decrease in the GDP per Person Employed after controlling for upper secondary and tertiary education percentages, total ICT investment, R&D investment, net capital stock, and consumption of fixed capital and including country and year fixed effects. The average hours worked per week per person employed coefficient estimate has a t-statistic of -4.754, which shows that the coefficient estimate of -0.933 is 4.754 standard errors away from the null hypothesized value of 0. The variable also has a p-value < 0.0001 which makes the coefficient estimate statistically significant (the probability of seeing a t-statistic at least unusual if there is no linear relationship between GDP per person employed and the average number of hours worked per week per person employed is less than 0.00001). The coefficient estimate, along with the t-statistic and p-value, shows strong evidence of a negative, linear relationship between the GDP per person employed and the Average number of hours worked per week per person employed among the countries included in the study. Additionally, the overall model also an f-statistic of 183.3 (there is 183.3 times more explained variability in the model than unexplained variability) and an R-squared value of 0.98 (98% of the variability in GDP Per Person Employed can be explained by the independent variables used in the model). The f-statistic and R-squared values are not a necessity in determining the relationship between productivity and the average number of hours worked, however, they do show the validity of the overall model itself.

Given the results of Model 4 in Table 1, it can be gathered that countries included in the dataset are in Stage III of the production function, however, many limitations must be considered before concluding.

## VI. **Limitations**:

There are numerous variables that are not accounted for in the models and are beyond the scope of the paper. This paper is simply an observational study on a macroeconomic level, and as such there are numerous variables, quantifiable or otherwise, that simply cannot be controlled. Even if all possible quantifiable variables were accounted for, the labor productivity of a country's workforce can be heavily influenced by the culture of the country, which is something that cannot be quantified and included in the model. These confounding variables can lead to omitted variable bias, which can affect the parameter estimates that were found in this paper's analysis. There may be key variables missing that may lead to the parameter estimates being biased upward or downward. Additionally, the issue of endogeneity must be considered. Since this is an observational study, true causality cannot be determined; labor hours may affect productivity, but productivity can also affect how many hours a person works. Finally, as mentioned earlier, based on Figures 2 and 4, we can see that Korea is an outlier. Korea cannot be excluded from the dataset; however, its outlier measurements do need to be kept in mind when looking at the coefficient estimates presented in Model 4 of Table 1.

## VII. **Conclusion**:

Based on the results found in Model 4 in Table 1, we can say that there is strong evidence of a negative linear relationship between the GDP Per Person Employed and the Average Number of Hours Worked Per Week Per Person Employed among the countries selected in the dataset. The 0.9933 percent decrease in GDP Per Person Employed for every one percent increase in the average number of hours worked per week per person employed suggests that countries in the dataset are in Stage III of production function between 1998 and 2005. There is statistically significant evidence to reject the null hypothesis. However, it is important to keep note that this is an observational study over fewer than 10 years. Given the constraints and limitations of this study, there need to be numerous controlled studies done with a dataset of the countries' measurements over a much longer period to see what the relationship between productivity and the average number of hours worked is over the long term. Another aspect that needs to be investigated is the reason behind Korea being an outlier; it is affecting the model, so there needs to be an investigation to determine if Korea should truly be excluded from the countries in the dataset.

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