ECON 388 Data Project 3

Memorandum

To: Whom It May Concern
From: Henry Andrus
04/12/2024

Section 1 – Introduction

One of the classic questions of development economics is “What factors play a direct contributing role to a country’s improvement in economic wellbeing and quality of life?” If one could learn what factors directly cause a country to be able to grow and develop, policy makers could potentially solve poverty issues around the world. One way that economists quantify the economic well-being of a country is by measuring the Gross Domestic Product (GDP) of a country, which measures the monetary value of final goods and services produced in a country over a given time period. Another metric of interest is technological growth within a country.

We have performed an analysis relating to these metrics of interest. In the following memo, we first explore the differences in GDP and technological growth rates between developed and non-developed countries. We also analyze whether growth rates for a variety of technological indicators had any effect on the economic growth of countries around the world from the years 1970-2000. The following section describes the data used in our analysis. Section 3 presents and discusses the results from our analysis, and Section 4 concludes.

Section 2 – Data

The data that we have used in our analysis comes from two major sources. The Penn World Table data gives information on relative levels of income, output, input, and productivity covering 183 countries for the years 1950 to 2019. The Penn World Table is maintained by researchers from the University of Groningen and University of California, Davis. This data set is where the population and GDP statistics we use come from.

The second set of data is the Cross-country Historical Adoption of Technology (CHAT) dataset that is maintained by the National Bureau of Economic Research (NBER). The CHAT is an incomplete panel dataset with information on the adoption of over 100 technologies in more than 150 countries since 1800.

Because of the scope of our research question, we only used data from the years 1970 to 2000. Further, because of countries that the datasets didn't have in common, we were only able to use data from 149 countries.

From the Penn World Table data, we were able to construct a GDP per capita variable by simply dividing the GDP each year by the population in that year. After merging the two datasets, we then constructed growth rates for GDP by dividing the GDP of one year by the year previous, subtracting one, and multiplying by 100. Technological growth rates were constructed in a similar way. In this memo, GDP is measured as the country's real GDP at constant 2017 US prices.

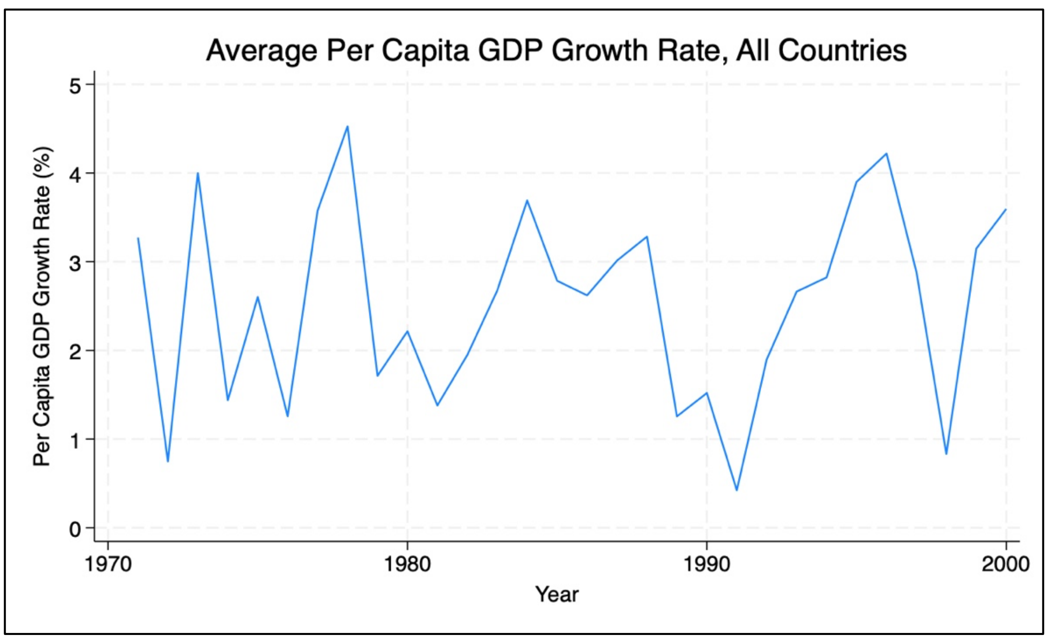
The technological measures chosen for this study were number of visitor beds in hotels or other places in the country, electricity production in the country, number of radios in the country, percent of the country's population that was DPT immunized, and number of tractors in the country. The rationale behind the choosing of these variables is that most of the countries had data on them for many of the years. It also provides indicators of technological growth in various sectors, such as healthcare, agriculture, industry, and tourism. In any case, the dataset was still not perfect, and some variables, such as DPT immunization, did not have observations for all 30 years, as can be seen in the graphs of this memo.

Table 1 shows summary statistics for GDP and GDP per capita as well as the technological growth rate variables. Graph 1 and Graph 2 show how these variables vary over time.

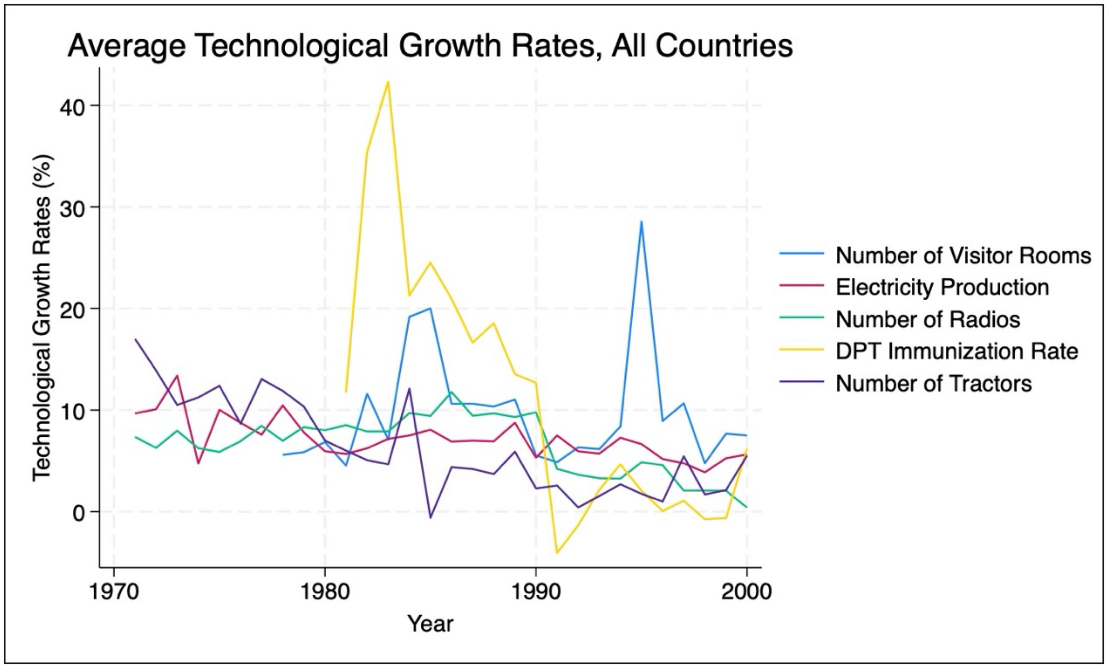
Table 1. Summary Statistics for GDP and Technological Variables for Panel Data Set

GDP and Technological Measures by Country by Year (1970-2000)					
	Observations	Mean	Std. Dev	Min	Max
GDP (mil of 2017 US $)	4140	312550	953705.4	374.0261	14143361
GDP per capita (2017 US $)	4140	12167	17419.65	266.8447	204345.4
# of Visitor Beds in Hotels or Other Places	2457	92552	309625.7	155	4100000
Electricity Production (in millions of KwHr)	3732	69563.88	245762.1	1	3200000
# of Radios	3877	12700	50554.89	5	585000
DPT Immunized	2609	69.97%	26.58%	1.00%	99.00%
# of Tractors	4022	172500	540643	3	5270000

Graph 1. Average Per Capita GDP Growth Rate from 1970-2000, All Countries



Graph 2. Average Technological Growth Rates from 1970-2000, All Countries



Section 3 – Empirical Analysis

One question of interest in our analysis was the difference in GDP and technological growth rates between developed and developing nations. For the purposes of our analysis, France, Germany, Italy, Japan, the United Kingdom, and the United States of America were considered “developed countries”. All other countries were considered “developing countries”.

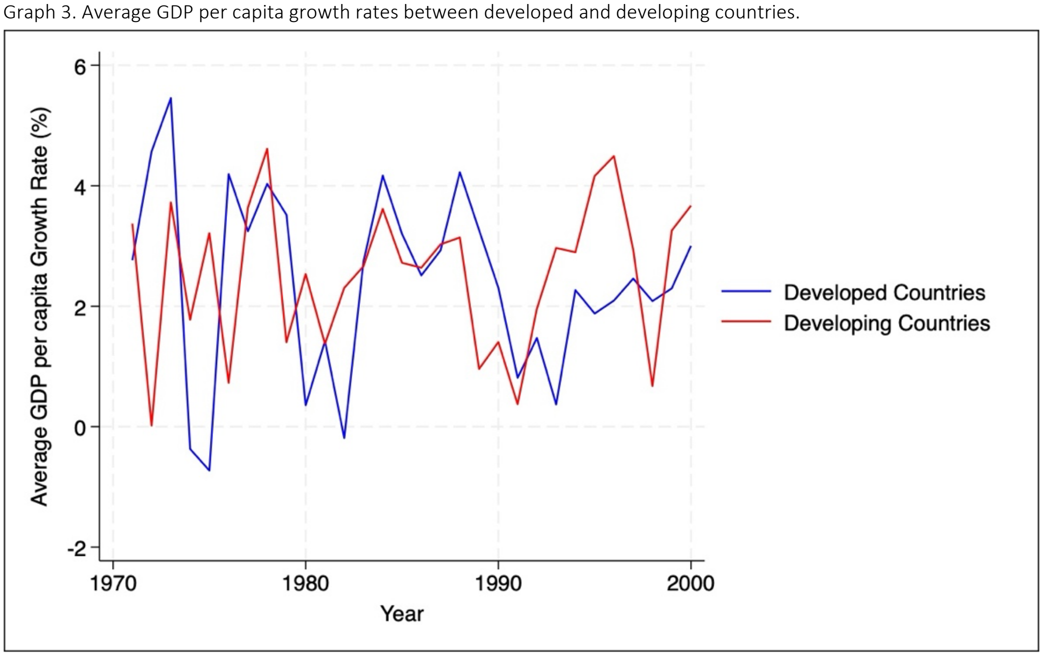
Table 2 shows the results from our analysis. As can be seen from the table, there is a substantial difference in means between the GDP per capita of developed vs. developing nations. The associated p-value of a t-test is shown to be virtually 0. Further, the difference in means for electricity production growth rate, radio growth rate, and the tractor growth rate are all statistically different than 0. Interestingly, the GDP growth rate, visitor room growth rate, and DPT immunization rate growth rate are not statistically different between developed and developing countries.

Table 2. Growth rates for GDP and Technologies. GDP per capita is also shown. Differences in means is shown with standard errors in parentheses.

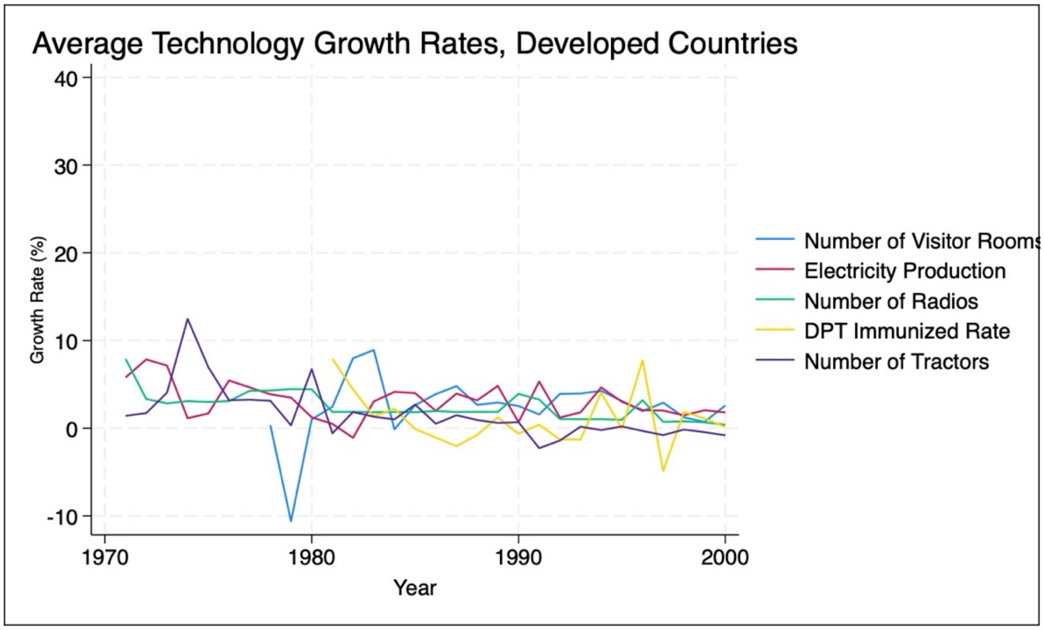
Average Growth Rates for GDP and Technologies, 1970-2000				
	Developed Countries	Developing Countries	Difference	p-value
GDP per capita ($)	31350	5391	25959.32 (1182.616)	0.0000
GDP per capita Growth	2.41%	2.54%	-0.13% (.358)	0.7190
Visitor Rooms Growth	13.19%	10.20%	2.99% (10.883)	0.7848
Electric Production Growth	3.09%	7.78%	-4.68% (.559)	0.0000
# of Radios Growth	2.48%	7.42%	-4.94% (.632)	0.0000
% DPT Immunized Growth	4.52%	12.74%	-8.22% (4.889)	0.1011
# of Tractors Growth	1.59%	7.05%	-5.47% (1.117)	0.0000

Graph 3 shows how the average GDP per capita growth rate varies over the given time period between developed and developing countries. Once again, we can see that there doesn't seem to be a significant difference in the two groups.

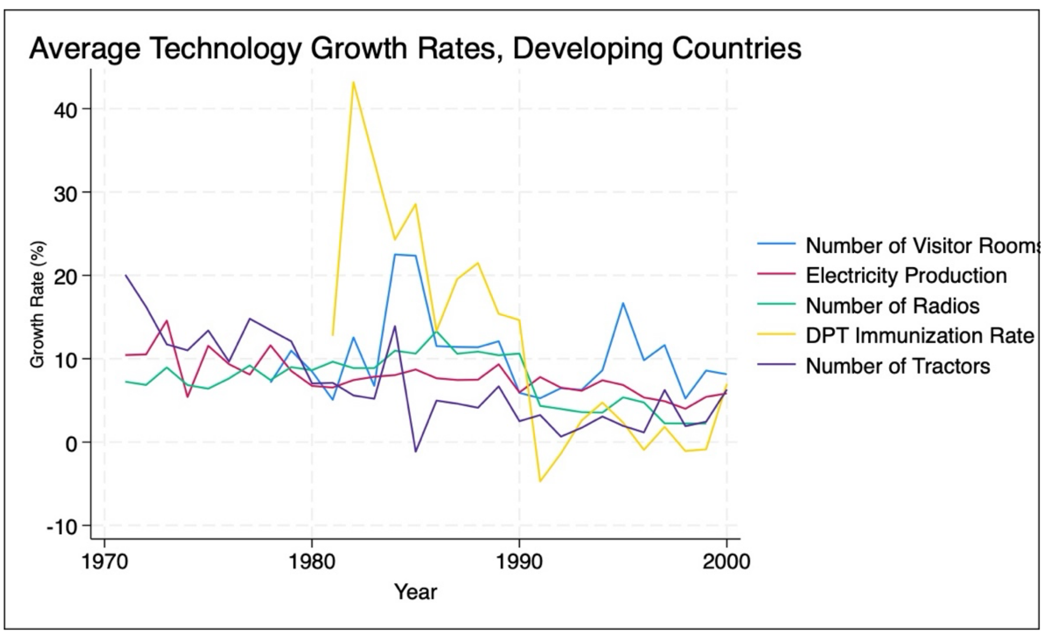
Graph 3. Average GDP per capita growth rates between developed and developing countries.



Graphs 4. Average technology growth rates for developed countries, 1970-2000



Graph 5. Average technology growth rates for developing countries, 1970-2000



Graph 4 and Graph 5 show how the technological growth rates vary over time for developed and developing countries, respectively. As can be seen, growth rates for electricity production, the number of radios, and number of tractors maintain higher levels in developing countries than developed countries.

Another one of our questions was to determine whether technological growth rates had a causal effect on GDP growth rates. To ascertain this relationship, we performed a fixed effects regression using our panel data set. The dependent variable was GDP per capita growth rate, with the various technological growth rates as the independent variables. We also included the population of the country, the exchange rate with the American Dollar, and the average annual hours worked by employed persons as control variables in our model. These control variables were chosen to mitigate the effects of omitted variable bias in our results. It is highly likely that the amount of work hours is correlated with our independent and dependent variables. The same goes with other included control variables. Thus it is necessary to include them in our model.

Table 3 shows the results from our regression. As can be seen, the only variables that have statistically significant results at the 5% level are working hours and the electricity production growth rate. The coefficient on electricity production implies that if a country were to increase their electricity production growth rate by a percentage point, we would expect to see a .12% increase in their GDP growth rate. Similarly, if a country's average personal annual working hours were to increase by 100, we would expect to see a .76% increase in the country's GDP per capita growth rate.

Table 3. Results of regression of GDP per capita growth rate on technological growth rates.

Regression of GDP per capita Growth Rate on Technological Growth Rates				
	Coefficient	**Std. Error**	**t**	**p-value**
Visitor Rooms	0.0073	0.0052	1.41	0.159
Electric Prod.	0.1292	0.0184	7.03	0.000
Radio	-0.0344	0.0223	-1.54	0.124
DPT Immunization	-0.0022	0.0034	-0.66	0.511
Tractor	-0.0181	0.0178	-1.02	0.310
Population	0.0055	0.0063	0.87	0.385
Working Hours	0.0076	0.0026	2.9	0.004
Exchange Rate	0.0007	0.0009	0.79	0.432

Other variables in our regression did not have statistically significant results. These include the growth rates of the number of visitor rooms, radio, DPT immunization rate, and tractors. These findings seem to show that changes in technological growth rates do not cause changes in GDP growth rates. Section 4 expounds more on potential pitfalls of our model.

When choosing control variables for our model, we also had to strike a balance between the validity of our model and the number of observations that would then be included in our regression. We found that as we increased the number of control variables, the number of observations in our regression decreased dramatically. A low number of observations would not provide a sound and reasonable econometric analysis of our research question. Thus, only a limited number of control variables could be included in our model. Section 4 talks more about potential problems this could bring.

Section 4 – Conclusion

We have found that while average GDP per capita is significantly different between developed and developing nations, the GDP per capita growth rate is not significantly different. We also found that growth rates for electricity production, radios, and tractors were statistically higher in developing countries than in developed countries. We found no statistical evidence that there are differences in the growth rate for the other measures of technological progress between the two groups.

One potential pitfall of our study in this regard is the definition of a “developed nation”. We have only restricted this designation to six select countries, and other countries should arguably hold this distinction as well. South Korea, Canada, Australia, New Zealand, and a handful of European countries rank high on measures of economic and human wellbeing yet were considered “developing countries” in this analysis. It is also very likely that these omitted countries influenced our analysis, especially when comparing the two groups of countries.

From our regression analysis, we found that overall, technological growth rates do not seem to contribute in statistically significant ways towards GDP growth rates. This is not the case for electricity production though. We found a strong and significant positive correlation between the growth rate of electricity production in a country and their per capita GDP growth rate. We also found that the average number of working hours in a country contributed positively to GDP growth rates.

It is important to mention that while outside variables were attempted to be controlled for, there is a very high likelihood that there is endogeneity in our model specification, which would lead to biased results in our regression. Because of the violation of the Gauss-Markov assumptions, our findings do not hold much weight as a causal effect of technological growth rates on GDP growth rates. This is also true for the number of working hours variable.

One last thing to note, many of the potentially most telling indicators of technological growth had a plethora of missing values in the panel data set. If better data were obtained, a more detailed analysis could be performed.

Development economists have been researching for decades on the various factors that contribute to economic growth. If nothing else, our analysis has shown the complexities that development economists face when determining the factors of economic growth. A vast amount of research questions remain unanswered in this field, thus allowing for many future opportunities for research.