Empirical Analysis of the Relationship between Exports and GDP

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ABSTRACT

Our project examines the possible link between various countries' exports as percent GDP and it's GDP in US dollars in the year 2011 to determine exactly what effect an emphasis on exporting goods has on country GDP. We take into account the many varying theories currently tested and in place regarding the impact of exports on GDP of a country, which are oftentimes at odds with each other. The main two hypotheses our report focuses on are the export-led growth hypothesis and the paradox of plenty hypothesis. We use our collected data to create a multi-variable regression that includes cross-country data related to trade.

INTRODUCTION

In this report our main focus is to examine the relationship between exports and country GDP in order to provide a clearer indication of which hypothesis regarding the stance a country takes on whether or not to emphasize exporting is the correct assumption based on the data we have collected. We chose to source all of our data from the World Bank because it has a reputation for providing accurate country data for a plethora of countries around the world. Our choice to include as many countries as possible (151 observations in total) is part of what separates us from the literature and studies already available for our subject matter. These previous studies have chosen to focus more on a specific subset of countries such as developing nations, or regional country data. We have also opted to use the most recent data available to us that does not encounter significant holes in country data (2011 statistics). Our initial hypothesis is that we will see a somewhat negative correlation between exports and GDP due to the theory of the paradox of plenty that many economists and country leaders alike subscribe to. Simply put, the paradox of plenty theory states that a country can sometimes focus too heavily on exporting only one lucrative export that is not a value-added export and thus neglects the rest of its economy and decreases its GDP. At first we struggled to identify exactly which type of simple regression model we should use. However, after running various regressions of different measurement methods of both GDP and exports of a country, we found that the most suitable and correlated model was that of GDP denominated in USD and exports expressed as a percentage of this GDP. We then strategically selected numerous variables to use in our multi-variable regression model. As there are a large amount of variables that affect state GDP we ran several tests to determine which variables seemed the most statistically significant within the confines of our model.

LITERATURE REVIEW

Below is the review of three separate studies we found to be very applicable to our research on the correlation between export volume and GDP. While many studies have been conducted on the subject, the studies utilize quite different data and also have very targeted regions included in the study. Thus we find that the outcomes of the literature vary greatly and therefore we were able to find studies that both reinforced and undermined our own hypothesis about how our results would appear. From the studies we reviewed, two of the academic papers seem to support the theory of export led growth, establishing that exports due seem to be a causal factor of GDP growth. However, one of our other academic papers reaches a completely separate conclusion: that exports seem to have a slightly negative impact on GDP growth when considered in the long run. This would instead support our hypothesis and also provide evidence for the paradox of plenty theory which we used as the basis for our hypothesis.

The paper by Dreger and Herzer published in 2013 takes a similar stance to the hypothesis presented in our own paper. The study was conducted on the impact of export-growth on the GDP growth of developing countries around the world. Dreger and Herzer use much more sophisticated and detailed comparison techniques in this case study then in ones conducted previously on similar material and thus it has much less of an impact from omitted variable bias (as do many of the other studies). One of the most interesting things about this paper is that the study also compares export growth to the growth in non-export GDP for these developing countries in order to avoid the correlation being simply based upon the fact that GDP usually includes exports and thus as exports grow so should that portion of the country's GDP. The findings from this study are quite interesting and very relevant to our own research in this paper. The three conclusions reached in the Dreger Herzer study are that i) in the short – run export growth does have an impact on GDP growth and vice-versa (e.g. the two both have an effect on growing each other) ii) that in the long-run the growth of exports tends to have a negative effect on the growth of a country's GDP (disproves the export-led growth hypothesis and supports the paradox of plenty hypothesis) but it also acknowledges that iii) there is a wide variation among the correlation in individual countries caused by a variety of different scenarios. One such variable that is discussed as having a large impact on the variance of the correlations is that some countries have high-levels of primary export dependence while others do not. In our own study we try to asses this "paradox of plenty" scenario by including data on how much of the goods exported by the countries examined in the study are high-tech merchandise goods.

Yuhong Li, Zhongwen Chen and Changjian San of the Junggangshan University Business School performed a study published in 2010 in the academic journal Modern Economy examining the relationship between foreign trade and GDP growth in East China. The data used in the research spans from 1981 to 2008, a period in time in which GDP went from 146.1 billion U.S. dollars to 3,300 billion U.S. dollars, exports went from 15.7 billion U.S. dollars to 1,425 billion U.S dollars. The results of the study suggest that foreign trade is the long and short term source of the GDP growth. It states that the two measures are mutually causal. Over the course of the 28 years dependence on export trade went from 10.74% to 43.17%. Li, Chen and San believe that much of the period's GDP growth during the period studied can be directly attributed to drastically increased exports. The authors adopted cointegration analysis with error correction model to test time series data. Following the analysis the authors made a few recommendations. The authors state that the correlation between exports and GDP is not constant. In order to further utilize this relationship, the authors recommend that the East Chinese government implements policies to boost emerging technologies, meet international environmental standards and ensure a healthy trade environment in order to maintain a competitive environment in which increasing exports swill lead to increase in overall GDP.

Mehmit Erygit of the Abant Izzet Baysal University in Turkey conducted a study in 2012 which discussed the long run relationship between foreign direct investments, gross domestic product (GDP), and exports. FDI, or foreign direct investment, is “establishing a new company or branch of a foreign company by a foreign investor… in a host country (Eryigit 71). There are many benefits for the host countries that invest in FDI; these benefits include better employment levels, improved performance, increasing levels of productivity, more technological improvements, and even better managerial talent. Therefore it is reasonable to assume that FDI has an effect on export volume and GDP, although the degree to the effect is unclear. Additionally, export volume and GDP are most likely related. This study used data from 2000-2010 from fifteen countries that invested in Turkey. Turkey is a very popular destination for other countries interested in FDIs; for example, Turkey’s percentage of FDI inflows is 4.1%, which is the highest share among all developing countries. Part of the purpose of an FDI is to “contribute to the host country’s exports (Eryigit 81). Erygit states definitively that residual based tests showed that there is a lasting correlation between FDI and export volume, FDI and GDP, and export volume and GDP.

DATA

All data used was taken from the year 2011. The logistics performance index variable was taken for the years 2009-2013. The dependent variable is the gross domestic product in USD, abbreviated gdp. The key independent variable used in the regression is the natural log of merchandise exports in USD. The other variables used in the multiple regression are educational spending as percent of gross national income, abbreviated educ; logistics performance index, abbreviated lpi, population, abbreviated pop, and educational expendatures, abbreviated educ. Natural log approximations have been performed on gdp, merche and pop abbreviated lgdp, lmerche and lpop respectively. All data was provided by World Bank.

Descriptive statistics of variables used:

Variable	Obs	Mean	Std. Dev.	Min	Max
lgdp	198	24.36229	2.605067	17.48708	31.53273
lmerche	208	22.73632	3.139721	12.61154	30.18422
educ	186	4.164848	1.849222	.83706	12.93185
lpi	162	2.774788	.666872	1.27	4.26
lpop	223	15.36809	2.506369	9.194617	22.30081
unemp	223	7.093564	6.108497	0	31.4

Variable	Variable Type	Description	Measurement
lgdp	dependent/y	Natural Log of Gross Domestic Product	USD
lmerche	independent/x_1	Natural Log of Merchandise Exports	USD
educ	independent/x_2	Educational Spending as a % of Gross National Income	Percentage
lpi	independent/x_3	Logistics Performance Index	1-5 Scale
lpop	independent/x_4	Natural Log of Population	Numerical
unemp	independent/x_5	Unemployment	Percentage

Gauss Markov Assumptions

In any statistical experiment, you must not violate any of the Gauss Markov assumptions. We did not violate any of the assumptions, so our data was both unbiased and efficient (least variance). We have listed below the five Gauss Markov assumptions and our corresponding proof that we did not violate them.

A1) Linear in Parameters

- Our simple and multiple regression models are linear; they are as following:

  Simple Regression → $lgdp = {}_0 + {}_{lmerche}(lmerche) +$

  Multiple Regression → $lgdp = {}_0 + {}_{lmerche}(lmerche) + {}_{educ}(educ) + {}_{lpi}(lpi) + {}_{lpop}(lpop) + {}_{unemp}(unemp) +$

A2) Random Sampling

- We have a random sample of 194 observations in the simple regression model and a random sample of 151 observations in the multiple regression models.

A3) Sample Variation in the Explanatory Variable (single regression)

- The sample outcomes on x are not the same value.

A3) No Perfect Collinearity (multiple regression)

- As seen in Figure 1 in the appendix, none of the independent variables in our multiple regression are constant, and none of the variables have an exact linear relationship.

A4) Zero Conditional Mean

- The error m has an expected value of 0 in both the simple and multiple regression models given any values of the independent variables.

Simple Regression → E(I merche) = 0

Multiple Regression → E(I lmerche, educ, lpi, lpop, unemp) = 0

Therefore (see Figure 2 and Figure 3):

Simple Regression → lgdp = 5.768449 +3.73474(lmerche)

Multiple Regression → lgdp = 2.246116 + 0.6425724(lmerche) + 0.372746(educ) + 0.4948686(lpi) + 0.3605129(lpop) + 0.0061624(unemp)

A5) Homoskedasticity

- The error has the same variance given any value of the independent variables.

  Single regression → Var(I lmerche) = ^{2}

  Multiple regression→ Var(I lmerche, educ, lpi, lpop, unemp) = ^{2}

RESULTS

Stata output is in the appendix for both regression models.

Dependent Variable log(gdp)		
Independent Variables	Model (1)	Model (2)
log(merche)	3.73474 (49.60)***	0.6425724 (20.20)***
educ		0.372746 (1.69)*
lpi		0.4948686 (5.34)***
log(pop)		0.3605129 (10.73)***
unemp		0.0061624 (0.86)
Intercept	5.768449 (14.58)***	2.246116 (5.30)***
No. of obs.	194	151
R-square	92.76%	96.16%
*Significant at 10%, ** 5%, ***1% Critical Value at 1%: 2.576 Critical Value at 5%: 1.96 Critical Value at 10%: 1.645		

Simple regression of GDP in USD against exports in USD shows that based on the two measures alone the two are highly correlated. The R^2 of 92.76% and t-value of the sole regressor of 49.6 are both very strong, which demonstrates a strong correlation. The coefficient on the explanatory variable (lmerche) is 3.73 meaning that for every dollar of merchandise exported from a nation one can predict GDP to go up 3.73 dollars.

The multiple regression brought the R^2 up to 96.16%. Log(merche), lpi and log(pop) are significant at 1%, educ is significant at 10% and unemp is independently statastically insignificant.

Robustness Tests

Our t-statistics show which variables individually have a significant effect on GDP. Using an F test, we determine which sets of variables jointly have a significant effect on GDP.

Note that individually, unemp is not statistically significant. We wish to test if unemp and educ are jointly significant.

Data comes from Figure 3 and Figure 4 in the Appendix.

H_0: $_{unemp} = 0$, $_{educ} = 0$

H_1: H_0 is not true

$d.f._{UR}$ $= n - k - 1$

$= n - 5 - 1$

$= n - 6 \rightarrow 151 - 6 = 145$

$d.f._{R}$ $= n - k - 1$

$= n - 2 - 1$

$= n - 3$

q $= d.f._{R} - d.f._{UR}$

$= (n - 3) - (n - 6)$

$= n - 3 - n + 6$

$= -3 + 6$

$= 3$

F $= ((R_{UR}^2 - R_R^2) / q) / ((1 - R_{UR}^2) / (d.f._{UR}))$

$= ((0.9616 - 0.9587) / 3) / ((1 - 0.9616) / 145)$

$= (0.0029 / 3) / (0.0384 / 145)$

= (0.00096667 / 0.00026483)

= 3.65

c.v. = 2.6

c.v < F, therefore we can reject H_0. When tested jointly, education and unemployment are statistically significant. In other words, education and employment jointly have a significant impact on GDP.

Thus it makes sense to keep both variables in the multiple regression model because they do seem to have a significant impact on GDP, even though when tested originally it seems that they may not have been significant enough to be included.

Interpretation of Results

The results of our models were right along the lines of what we expected to see, although we were surprised to find a significant positive correlation between log(merche) and log(gdp) in both models whereas we had expected to see a slight negative correlation instead. In the first simple model with only log(merche) and log(gdp) we found a very strong positive correlation between the two variables insinuating that the larger the exports as percent gdp, the larger the country's GDP should be. However since this model did not account for other variables that may have affected GDP it may violate assumption 4 of the Gauss-Markov assumptions and therefore we moved forward with the multiple regression model. When we added in the other variables of lpi, lpop, unemp, and educ into the equation we found that the t-statistic of l(merche) did indeed drop down from 49.6 to 20.20, cutting it by more than half, as we expected. This shows that the simple model was overstating the significance of exports on GDP. However even in the multiple regression model l(merche) proved to be the most significant with the highest t-statistic (20.20) and also the largest coefficient (0.6425724), followed by lpop at 10.73 and 0.3605129 respectively. Thus we can still maintain that according to our model, it seems that an increase in exports as percent GDP can cause an increase in GDP, or that simply put exports as percent gdp can be seen as the causal variable in our model.

CONCLUSION

Originally our group had assumed that our results would support the findings of the theory of the paradox of plenty as opposed to the export-led growth theory. However, through the testing of both our simple and multiple regression models we discovered that there was a significant positive correlation between GPD and exports in the year 2011. These findings would instead support the export-led growth hypothesis, insinuating that an increase in exported merchandise leads to a subsequent increase in GDP. This mirrors the findings in some of the literature we had reviewed in this paper which found a similar increase in GDP with an increasing percentage of exports. Clearly even the multiple regression model cannot account for all factors affecting GDP and thus there is room for error. Still, our multiple regression model proved to be much more accurate at explaining the impact that exports had on GDP and while some of our variables did not come out significant, when tested jointly they proved to indeed be statistically significant. Another factor that may have affected our results was our choice to not include regions or specify developing versus developed economies in our report. Other studies which take these factors into account seem to come by results that favor the paradox of plenty theory. However we chose to distinguish our study from other's conducted in this manner by keeping the countries together as a whole, as to give a general overview of how exports affect GDP and not be narrowed down by selecting a certain region or development level. Overall, our results, while not what we expected, are certainly not unreasonable and seem to be in line with the theory of export-led growth.

APPENDIX

Figure 1 → Correlation Table of Variables

	lgdp	lmerche	educ	lpi	lpop	unemp
lgdp	1.0000					
lmerche	0.9648	1.0000				
educ	0.0474	0.0491	1.0000			
lpi	0.6645	0.6840	0.2021	1.0000		
lpop	0.7521	0.6659	-0.1673	0.1883	1.0000	
unemp	-0.1059	-0.0935	0.2004	-0.0578	-0.1955	1.0000

Figure 2 - Simple Regression of log(gdp) against log(merche)

```
     Source |       SS       df       MS              Number of obs =     194
-------------+------------------------------           F(  1,   192) = 2254.00
      Model |   1224.7359     1   1224.7359           Prob > F      =  0.0000
   Residual |   104.32518   192  .543360312           R-squared     =  0.9215
-------------+------------------------------           Adj R-squared =  0.9211
      Total |  1329.06108   193  6.88632684           Root MSE      =  .73713

------------------------------------------------------------------------------
       lgdp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lmerche |   .8117948   .0170989    47.48   0.000     .7780689    .8455206
      _cons |   5.768449   .3955604    14.58   0.000     4.988247    6.548651
------------------------------------------------------------------------------
```

Figure 3 - Multiple Regression of log(gdp) against log(merche), educ, lpi, log(pop) and unemp

- Note that this is the unrestricted model used for the F test).

```
     Source |       SS       df       MS              Number of obs =     151
-------------+------------------------------           F(  5,   145) =  726.01
      Model |   796.61455     5   159.32291           Prob > F      =  0.0000
   Residual |  31.8201214   145  .219449113           R-squared     =  0.9616
-------------+------------------------------           Adj R-squared =  0.9603
      Total |  828.434671   150  5.52289781           Root MSE      =  .46845

------------------------------------------------------------------------------
       lgdp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```

lmerche	.6425724	.0318073	20.20	0.000	.5797066	.7054383
educ	.0372346	.0220301	1.69	0.093	-.006307	.0807763
lpi	.4948686	.0927277	5.34	0.000	.311596	.6781412
lpop	.3605129	.033583	10.73	0.000	.2941375	.4268884
unemp	.0061624	.0071963	0.86	0.393	-.0080608	.0203857
_cons	2.246116	.4240621	5.30	0.000	1.407974	3.084257

Figure 4 - Restricted model used for F test

Source	SS	df	MS
Model	842.623558	3	280.874519
Residual	36.3453255	154	.236008607
Total	878.968884	157	5.59852792

Number of obs	= 158
F(3, 154)	= 1190.10
Prob > F	= 0.0000
R-squared	= 0.9587
Adj R-squared	= 0.9578
Root MSE	= .48581

lgdp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lmerche	.620477	.0310591	19.98	0.000	.5591201	.6818339
lpi	.537404	.091314	5.89	0.000	.3570142	.7177937
lpop	.3600587	.0328638	10.96	0.000	.2951366	.4249808
_cons	2.883282	.3898814	7.40	0.000	2.113076	3.653488

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