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FDI and GDP growth: A Case Study on China

I. Introduction
II. Literature Review
III. Model
IV. Data
V. Results
    - Regression
    - Functional Form
    - Omitted Variables
    - Irrelevant Variables
    - Multicollinearity
    - Serial Correlation
    - Heteroskedasticity

VI. Conclusion

I. Introduction

China has been the fastest growing economy in the world for most of the 2000s. The country's growth was so spectacular that it has been used as evidence by both developmentalists arguing for and against governmental controls. Some argue that China's growth is key evidence for the advantages of export-led growth versus state-controlled economic growth; others argue that the growth was due to careful governmental planning, and therefore government played an important role in facilitating growth[1]. However, despite China's earlier success, according to the Law of Comparative Advantage[2] it will soon lose its edge in attracting foreign investment due to rising wages; in addition, the sustainability of its growth is called into question. To determine whether foreign trade activities or governmental control played a more crucial role in growth, it is advisable to utilize FDI (foreign direct investment) as a measure: the government has no direct control on it whatsoever; instead, the final decisions are made by foreign investors looking at many factors, such as the maturity of financial institutions[3] and geography, among many things. In this paper, the question of "whether China's growth was mostly reliant on foreign contributions" is answered, while the effects of domestic policies are taken control of, including independent variables of initial GDP, urbanization, terms of trade, inflation and population growth.

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[1] Edwards, Sebastian. "Trade Policy, Growth, and Income Distribution." *The American Economic Review* 87, no. 2 (1997): 205–10.

[2] Dodaro, Santo. "Comparative Advantage, Trade and Growth: Export-Led Growth Revisited." *World Development* 19, no. 9 (September 1, 1991): 1153–65. doi:10.1016/0305-750X(91)90064-O.

[3] Allen, Franklin, Jun Qian, and Meijun Qian. "Law, Finance, and Economic Growth in China." *Journal of Financial Economics* 77, no. 1 (July 2005): 57–116. doi:10.1016/j.jfineco.2004.06.010.

II. Literature Review

FDI is quintessential to development, in that it enables technological transfer from developed countries to developing ones[4]. According to the Romer model, technology enables countries to advance their products. Combined with high quality human capitals, FDIs can facilitate transferring technology from developed countries to developing ones. Another theory[5] found that the effects of FDI depend on other policies of the country. For instance, if a country's international trade framework is not well-developed, FDI may be the only channel through which any international transaction can take place.

Domestic factors such as the maturity of financial institutions, education, urbanization[6] all play a role in determining how well a country can attract FDI. As a result, such policies coming from domestic governments are controlled for in this essay.

While it is hard to pinpoint in time specific effects of domestic policies, their generally positive conditions can help attract more FDI, because then investment will be secured by legal protection; there will be plenty of educated labors available; and transportation would be relatively easy because of high quality infrastructure. But investors may instead prefer places where development has not taken place yet, and therefore lower the costs of building materials and labor, although these places are usually devoid of a well-functioned legal framework to

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[4] Borensztein, E., J. De Gregorio, and J-W. Lee. "How Does Foreign Direct Investment Affect Economic growth?1." *Journal of International Economics* 45, no. 1 (June 1, 1998): 115–35. doi:10.1016/S0022-1996(97)00033-0.

[5] Ibid.

[6] Ho, Samuel P. S. "Rural Non-Agricultural Development in Post-Reform China: Growth, Development Patterns, and Issues." *Pacific Affairs* 68, no. 3 (1995): 360–91. doi:10.2307/2761130.

protect foreign investment. However, such a heated debate is up until now still a theory without much empirical evidence to support. This essay will expand on this idea, and aims to provide some initial evidence by analyzing China's rapid economic growth in the past decade and a half.

In the case of China, all research points to a positive correlation between GDP growth and FDI. Some studies even point to FDI contributing to about a third of China's GDP growth, and that FDIs contributed to 30% of China's industrial output[7]. Meanwhile, trade has also contributed substantially to GDP growth[8]. Despite having many existing data proving that both trade and FDI are largely responsible for China's rapid economic development, there has not been empirical research on how the other variables mentioned interact with FDI: for instance, a developed legal system could hinder or increase FDI, for foreign investors desire both financial security protected by law and cheap labor whose rights are not well protected. But due to the situation of the country, the effects may vary. In order to single out the effects of FDI, it is crucial to examine which force dominates in a specific country. Often it is difficult to distinguish exactly how many domestic policies or the international market forces contributed to the gross GDP growth. This paper will examine the effects of FDI on GDP growth by conducting econometrics research, while controlling for variables representing changes made by domestic policies. Although there are some past papers that explored similar topics, none of them took into account the recent economic slowdown, perhaps because it is too recent. This essay will study the period of 1990-2015, which will allow us to take into account the academic downturn ongoing since 2012.

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[7] Berthélemy, Jean-Claude, and Sylvie Démurger. "Foreign Direct Investment and Economic Growth: Theory and Application to China." *Review of Development Economics* 4, no. 2 (June 1, 2000): 140–55. doi:10.1111/1467-9361.00083.

[8] Backus, David K, Patrick J Kehoe, and Timothy J Kehoe. "In Search of Scale Effects in Trade and Growth." *Journal of Economic Theory* 58, no. 2 (December 1, 1992): 377–409. doi:10.1016/0022-0531(92)90060-U.

II. Model

The proposed equation is

$$\widehat{GROWTH}t = \beta_0 - \beta_1 GDPt + \beta_2 TRADEt + \beta_3 URBANt + \beta_4 INVESTt + \beta_5 INFLATEt - \beta_6 POPGROWt$$

Below is a list of independent variables that measure the influence of different societal factors on GDP growth. The reason for their inclusion in the model, the meanings of their coefficients, and their hypothesized signs will be explained below.

Initial GDP (β_1):

Measured in current US dollars, 1 unit decrease in GDP leads to β_1 units of decrease in GDP growth, while holding other variables fixed. According to the conditional convergence hypothesis[9], the GDP per capita of poorer countries tends grow faster than in richer countries; as a result, as time passes there will be convergence in wealth level. Therefore, we expect initial GDP level to be negatively correlated with GDP growth, thus β_1 is hypothesized to be negative.

Terms of Trade (β_2) :

Net barter terms of trade index is calculated as the percentage ratio of the export unit value indexes to the import unit value indexes, measured relative to the base year 2000, where 1 unit

[9] Dodaro, Santo. "Comparative Advantage, Trade and Growth: Export-Led Growth Revisited." *World Development* 19, no. 9 (September 1, 1991): 1153–65. doi:10.1016/0305-750X(91)90064-O.

increase in trade results in β_2 unit increase in GDP growth; again, assuming other variables are fixed. Although many studies use the openness index instead of terms of trade, due to the former's potential high correlation with GDP, this paper will use the terms of trade instead because only data on them are freely available. Furthermore, although there are debates about the positive effects of trade in development, it is an acquiescence that international trade activities are positively correlated with growth among development economists. Thus, in this paper, trade is expected to have positive correlation with GDP growth, and hence a positive hypothesized sign is assigned to trade.

Foreign Direct Investment (FDI) (β_4) :

Foreign direct investment refers to direct investment inflows in the reporting economy, measured in current dollars, where one unit increase in FDI results in one unit increase in GDP growth, holding other variables fixed. As discussed in the literature review, although in a few exceptional cases the effects of FDI were ambivalent, most scholars would agree that FDI has positive effects on growth to varying degrees. In China's case, FDI has certainly contributed to technological transfer from developed countries. As a result, this paper hypothesizes a positive sign for β_4

Inflation (β_5) :

Inflation is measured in annual percentage, showing the rate of price change in an economy as a whole, where one unit increase in inflation results in one percent increase in GDP

growth. Because of GDP growth, GDP and FDI are all in nominal terms. Therefore inflation needs to be included to control for the price level, or otherwise there will be bias in the data.

Population growth (β_6):

Population growth is also measured annually, as a percentage of the total population, where 1 unit decrease in GDP leads to β_6 units of decrease in GDP growth. In the Solow growth model, the change in capital accumulation is shown in the equation

$$\Delta k = sf(k) - (\delta + n)k ,$$

where n represents the population. A large population will increase depreciation and slows down GDP growth. According to this model, population growth should prevent GDP growth, hence we hypothesize β_6 to be negative.

Poverty Rate:

While poverty rate is theoretically correlated with GDP growth, the data on China of the targeted period remains unavailable. After exhausting several credible data sources, this variable unfortunately has to be left out of the regression.

Education:

While education has been found to be essential by multiple studies, no relevant data could be found online for free. As with poverty rate, education is left out of the regression without a choice.

Functional form:

Following the functional forms in the literature review, the regression in most cases are linear, and so there is no need to change the functional form of the variables.

IV. Data

All data used in this regression were directly downloaded from the World Bank website. Data were found for all variables except for poverty rate and education. mEfforts were exhausted when websites such as the National Bureau of China also did not contain the data for the desired variable, such as poverty rate and education level.

V. Results

Below are the results of the first regression:

$$GROWTH = \underset{}{193.64} - \underset{(8.24\,e^{-13})}{5.83e^{-13}GDP} + \underset{(0.089)}{0.08TRADE} + \underset{(0.559)}{0.06URBAN} + \underset{(1.85\,e^{-11})}{8.26e^{-12}INVEST} + \underset{(0.095)}{0.347INFLATE} - \underset{(8.422)}{5.09POP}$$

t = (-0.71) (0.93) (0.11) (0.45) (3.65) (-0.61)

$\overline{R^2}$ = 0.4688 N = 26

- Functional form

In the first regression, the coefficients of GDP and foreign direct investment are close to zero. After investigating into variables, it is found that all other variables are in percentage forms. Even though in most relevant scholarly articles, the regression follows a linear function, but there is one article, where when all other variables are in percentage forms, the FDI and GDP variables are logged as well[10]. In this case, it would mean that one unit increase in GDP/FDI will result in $-5.83^{11}/-8.26^{-10}$ percent in growth. In order to avoid biases towards these two variables, another regression is run with both variables in natural log form. Results are as follow:

$$GROWTH = \underset{(4.4)}{193.64} - \underset{(0.1)}{9.75GDP} - \underset{(0.48)}{0.02TRADE} + \underset{(1.63)}{0.75URBAN} + \underset{(0.13)}{2.6INVEST} + \underset{(5.1)}{0.198INFLATE} - 2.72POPGROW$$

t = (-2.22) (-0.17) (1.56) (1.59) (1.54) (-0.53)

$\overline{R^2}$ = 0.5668 N = 26

Degrees of Freedom = N-K-1 = 26 - 6 - 1 = 20
T-critical = 1.725 for t-test at a 95% confidence level

Variables	LnGDP	TRADE	URBAN	LnINVEST	INFLATE	POPGRO

[10] Borensztein, E., J. De Gregorio, and J-W. Lee. "How Does Foreign Direct Investment Affect Economic growth?1." *Journal of International Economics* 45, no. 1 (June 1, 1998): 115–35. doi:10.1016/S0022-1996(97)00033-0.

Hypo Sign	-	+	+	+	+	-
Reg Sign	-	-	+	+	+	-
T critical	1.725	1.725	1.725	1.725	1.725	1.725
T score	2.22	0.17	1.56	1.59	1.54	-0.53
Decision	Fail to reject	Fail to reject	Reject	Reject	Reject	Reject

where one percent increase in GDP leads to -9.75 percent decrease in GDP growth; one percent increase in trade leads to 0.02 percent decrease in GDP growth; one percent increase in urbanization leads to 0.75 percent decrease in GDP growth; one percent increase in FDI leads to 0.75 percent increase in GDP growth; one percent increase in inflation leads to 0.198 percent increase in GDP growth; one percent increase in population growth leads to 2.27 percent decrease in GDP growth.

- Omitted variables

Because there are very theoretically relevant variables missing due to a lack of data in the World Bank (poverty rate and education), there is likely to be omitted variable bias: capital accumulation, poverty and education are not controlled when we measure the effect of foreign direct investment. Therefore, it is not surprising that variances are high and that there are unexpected signs for TRADE. However, no data were found after an exhaustive search, and so there is no way to add in the relevant variables. Besides, the large variance and low significance are expected from having a small sample. A small sample size causes the degree of freedom to be small, and thus a high t-critical value, making it easy to reject variables.

When an expected bias analysis is conducted, poverty is anticipated to negatively impact GDP growth and trade, so the Expected Bias of trade when poverty is left out is negative, for Bias (Trade) = (+)(-) = -.

Although the magnitude of the bias is unknown, this is likely to be why trade has an unexpected sign despite theory stating that it should positively impact trade.

- Irrelevant Variables

Even though the t-score of TRADE is really low, it is theoretically very relevant according to multiple sources. The reason for its low t-score may be due to omitted variables or the small sample size. With another sample, trade may easily become one of the most important variables in the regression. Along the same line, although the t-score of inflation is low, it needs to be included in the regression because other variables, such as GDP, GDP growth, trade and investment need to be controlled because they are in nominal terms.

The variable with the second lowest t-score is population growth. Even though the Solow model claims that population is key to GDP growth because it accelerates depreciation of infrastructure, *population growth* may still be irrelevant here, because it is simply not the same as *population*. Because it is difficult to know for sure which effect dominates, the relevance of population growth is ambiguous. Thus, a regression is run to examine this possibility:

$$\widehat{GROWTH} = 207.07 - 10.96LNGDP - 0.053TRADE + 0.85URBAN + 3.34LNINVEST + 0.147INFLATE$$

	(3.71)	(0.078)	(0.436)	(0.86)	(0.086)
t =	(-2.96)	(-0.69)	(1.95)	(3.88)	(1.71)

$\overline{R^2} = 0.5823$ N = 26

Variables	LnGDP	TRADE	URBAN	LnINVEST	INFLATE
Hypo Sign	-	+	+	+	+

Reg Sign	-	-	+	+	+
T critical	1.725	1.725	1.725	1.725	1.725
T score	-2.96	-0.69	1.95	3.88	1.71
Decision	Fail to reject	Fail to reject	Fail to Reject	Fail to Reject	Reject

As discussed before, even though the Solow model predicts a negative correlation between population and GDP growth, population growth may be slightly different from population. Besides, population growth may lead to increase in consumption, which positively contributes GDP growth. So the theory behind dropping the variable is plausible.

As for the regression statistics, the t-scores of every variable have improved. With population growth dropped, almost all irrelevant variables became relevant (except for inflation and trade). Along with the population growth's low t-score of -0.53, there is plenty of reason to drop population growth from looking at the changes in other independent variables.

In the meantime, a slight increase in $\overline{R^2}$ (from 0.5668 to 0.5823) also indicates that the variable POPGROWTH is irrelevant, for now the regression specification form is a better fit to the data adjusted for degrees of freedom.

The magnitude of every other variables' coefficients also slightly increased, suggesting an increase in elasticity; but the change may be too slight to justify the variable's relevance. Besides, there is no changes in variables' signs that would suggest apparent biases.

Because the t-scores, $\overline{R^2}$, t-scores, and most important of all, the theory all indicate that population growth is an irrelevant variable, the variable is dropped.

- Multicollinearity

To test for the degree of multicollinearity, or the correlation among independent variables, a Variance Inflation Factors (VIF) test was conducted:

Variables	VIF
LnGDP	168.29
urbanization	159.80
lninvest	10.67
trade	5.43
inflation	2.03
Mean VIF	69.25

Because of strikingly high levels of VIFs in GDP and urbanization, a simple correlation test is done between LnGDP and urbanization to find out the independent variables that caused the most correlations:

	LnGDP	urbanization	trade	invest	inflation
LnGDP	1.0000				
urbanization	0.9962	1.0000			
trade	-0.8291	-0.8449	1.0000		
invest	0.9346	0.9246	-0.7516	1.0000	
inflation	-0.4020	-0.3971	0.0932	-0.2537	1.0000

As shown, 1.0000 would indicate positive, perfect collinearity between two variables, and there are two variables above near perfect collinearity (LnGDP and urbanization). This is quite surprising because

urbanization is not one of the factors directly factored into GDP, even though it is expected to have a positive correlation with GDP and GDP growth. The answer may lay in the fact that from 1990-2015 China was urbanizing very rapidly, while growing rapidly, which is likely to cause predictability of one from the other. Although a simple correlation test suggests that GDP is a good predictor of urbanization in this case, they are clearly indices that measure completely different aspects of development: one is income, the other is the building modern industries. A high correlation in this case indicates that a higher GDP in China at this time can be largely explained by urbanization, which presents even more reason not to drop the variable.

Another focus of the simple correlation test is between the GDP term and trade, since the trade term is highly correlated to import and export, and they are factors directly determining GDP. Even though there appears to be a correlation --- as evident in the magnitude of R --- the sign is the opposite from what is suggested by theory, reasons being, as suggested before, omitted variables. Therefore, the VIF is also impacted because of omitted variable bias.

Same as urbanization, GDP and foreign direct investment are expected to have positive correlations, but they do not necessarily measure the same factors. A high correlation does not necessarily cause a problem in the case that the correlation of FDI and GDP growth is examined, because a high predictability signifies that FDI is a relevant predictor of the magnitude of GDP, and therefore there is more reason not to drop FDI as a factor. And because urbanization in this period of time is highly correlated with GDP, it is also highly correlated with trade and investment, but they are very different and necessary measures for development and growth.

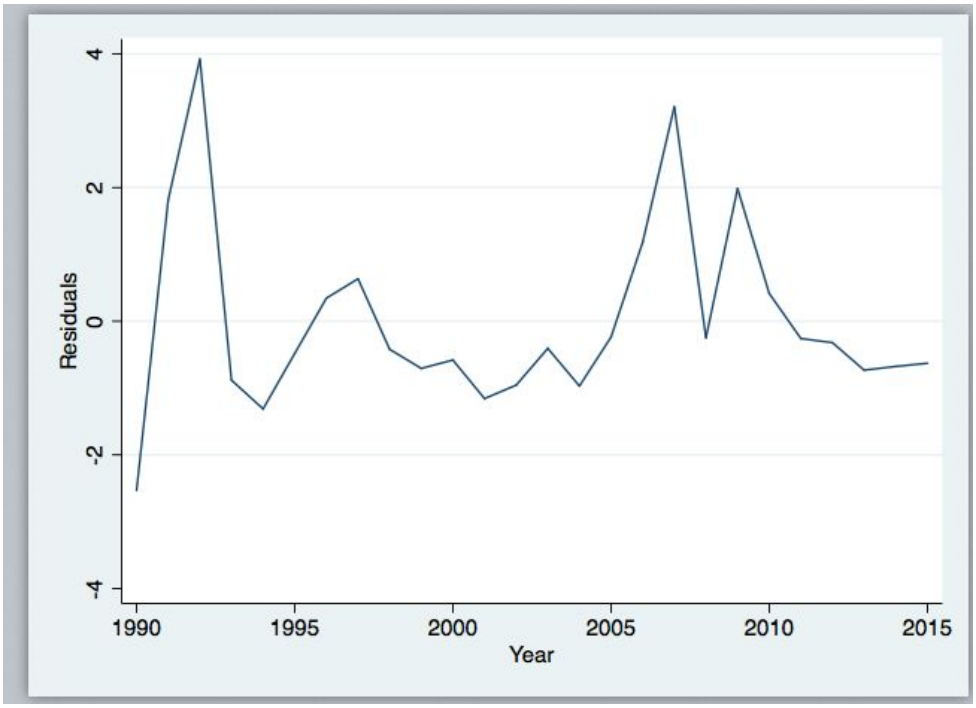
After a holistic examination, this paper concludes that it is best to not drop any of the variables. First of all, t-scores are mostly significant after dropping population growth as an irrelevant variable, therefore a high variance as a result of multicollinearity does not necessarily affect the regression. Besides, dropping a

theoretically sound variable is likely to cause even more omitted variable balance, which does not worth the energy trying to do so.

A more likely cause to severe multicollinearity would be a small sample size. As analyzed before, the near linear collinearity between GDP and urbanization were likely to be an coincident due to this period's development policies. If the observations, or in this case the time span, could be extended, such close correlations are not likely to happen. With more observations, variances would be lower, which will lead to more accurate estimation.

- Serial correlation

Because the regression is in time-series, it runs a high risk of having time-series issues, where the previous events are still affecting later events. Initially, the relationship between years and the residuals (the error term) is graphed:



The graph above shows an apparent cyclical pattern, where the residuals are positive in a row, and turn negative, and positive again. A negative correlation exists.

To further test for positive correlation, a Durbin-Watson test is conducted, where $H_0 \leq 0$ and $H_1 > 0$:

Using Table B-4 for K=5, N=26: $d_L = 0.98$, $d_U = 1.88$

Durbin-Watson d-statistic = 1.533. Because $0.98 < 1.533 < 1.88$, it is inconclusive whether there is positive correlation or not.

After both tests, it is certain that there is a negative serial correlation but not necessarily a positive one, and negative serial correlations are usually caused by errors in specifications, such as omitted variables. This is especially likely if the omitted variable is expected to increase or decrease over time, such is the case with poverty rate and education, which are both theoretically sound variables that are left out due to lack of data. In China's case, poverty rate decreases, and education increases as time goes on, which are likely to cause negative serial correlation. And because of the inconclusive test result to Durbin-Watson test, a Lagrange Multiplier test is run to make sure that the result is due to limitations of Durbin-Watson test (serial correlation has to be first-order, there has to be a constant, among other things). The results are as follow:

Breusch-Godfrey LM test for autocorrelation

lags(*p*)	chi2	df	Prob > chi2
1	**0.854**	**1**	**0.3555**

H0: no serial correlation

N R^2 = 26 * 0.6658 = 17.3108

From trading the Chi-Square Distribution: Degrees of Freedom = 26 - 5 - 1 = 31.4 > 17.3108

So we fail to reject null hypothesis, and conclude that there is not enough evidence to prove positive serial correlation.

Because both tests confirm that positive serial correlation does not exist, and specification errors that caused negative serial correlation cannot be fixed due to missing data, the best option here is to do nothing to fix serial correlation.

If there were to be positive serial correlations, however, a new

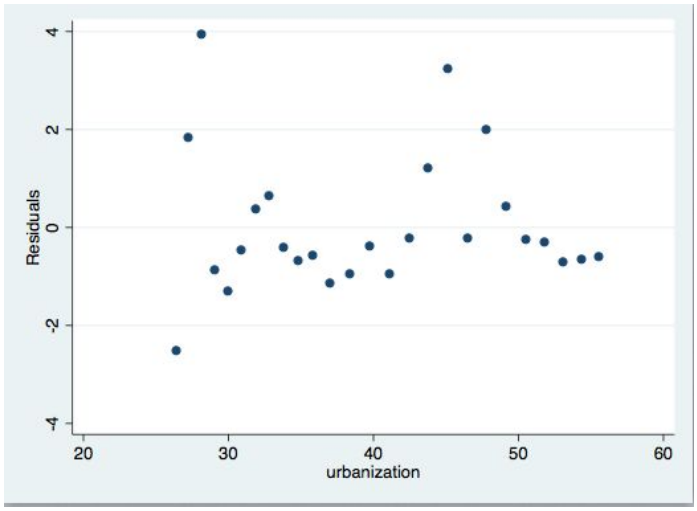
Regression with Newey-West standard errors — Number of obs = 26
maximum lag: 1 — F(5, 20) = 9.71
Prob > F = 0.0001

growth	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
lngdp	-10.96413	2.300954	-4.77	0.000	-15.76384	-6.164423
urbanization	.8491633	.2530838	3.36	0.003	.3212398	1.377087
trade	-.0536426	.0445856	-1.20	0.243	-.1466465	.0393614
lninvest	3.336937	.9580113	3.48	0.002	1.338561	5.335314
inflation	.1475198	.07114	2.07	0.051	-.0008757	.2959153
_cons	207.0749	49.55011	4.18	0.000	103.7152	310.4346

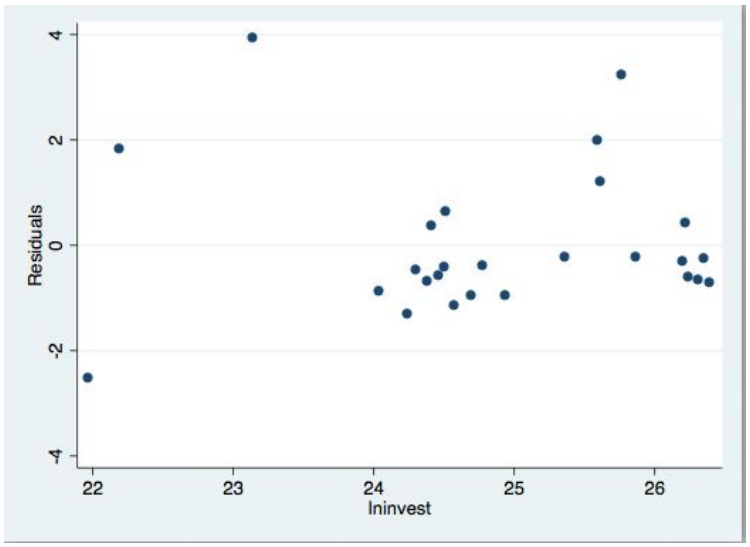
Where the corrected newey-west standard errors are rid of serial correlation errors and another t-test can be done with the new standard errors.

- Heteroskedasticity

Heteroskedasticity is when variances of some terms are not constant. Early on there is a sign of heteroskedasticity, which is that some coefficients are many times bigger than other coefficients. For instance, the coefficient of GDP is -10, when that of trade is only -0.05. So graphs are drawn to see which variables demonstrate patterns of heteroskedasticity. Here are a few that seem to demonstrate patterns between residuals and variables.



The relations between residuals and urbanization have shown a cyclical pattern, where the positive residuals and negative residuals seem to cluster together and alternate around 0.



The residuals for investment seem to be clustered only when the number of investment are bigger. This is perhaps due to omitted variable. Where there is a lot of FDI, the economy is expected to do well. In China this means the more recent years. Because GDP growth is due to many factors, some of which could not be included due to missing variables or limitation on number of variables in the regression.

Although there are sufficient reasons to suspect heteroskedasticity, official tests are run so that the evidence of heteroskedasticity can be quantified. Here are the test results of Breusch-Pagan test and the White test:

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of growth

         chi2(1)      =     0.02
         Prob > chi2  =   0.8751
```

```
White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(20)     =     22.42
         Prob > chi2  =    0.3184

Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	22.42	20	0.3184
Skewness	5.92	5	0.3143
Kurtosis	2.37	1	0.1236
Total	30.70	26	0.2394

Both tests contained negative results for heteroskedasticity ($p>0.05$). But there may still be impure heteroskedasticity, meaning that there are errors in specification. And since it is already known that there are omitted variables due to missing data, it is highly likely that at least some heteroskedasticity can be attributed to incorrect functional form. Because there are no ways to fix it, it is assumed that the impure specification errors are already solved and it is alright to proceed to the next step.

Here are the results of the t-tests based on the corrected standard errors presented by the White Test:

Variables	LnGDP	TRADE	URBAN	LnINVEST	INFLATE
Hypo Sign	-	+	+	+	+
Reg Sign	-	-	+	+	+
T critical	1.725	1.725	1.725	1.725	1.725
T score	-4.33	3.31	-1.28	3.10	2.31
Decision	Reject	Fail to reject	Fail to Reject	Reject	Reject

As seen from the results, the t-scores are larger now that large variances are corrected. Using these corrected standard errors, all variables are now significant except for urbanization. As analyzed before, the reason that it is not significant is likely to be an coincident where urbanization coincides with GDP and GDP growth in the targeted time period.

VI. Conclusion

In conclusion, the functional form was changed because once it was found that when other variables are in percentage form, log forms make more theoretical sense for initial GDP and FDI. After discovering severe multicollinearity, a simple correlation test was conducted; based on theory and necessity to control certain variables, such as GDP, FDI and trade, the multicollinear variables are not dropped either because of theoretical relevance or the need for it to control other variables. Although there appear to be no positive serial correlation and heteroskedasticity, it is likely that there are impure serial correlation and heteroskedasticity problems for the regression due to omitted variables.

Moreover, due to the small sample size and missing data, the regression did not produce many significant results, but nonetheless we can still draw certain conclusions. First, initial GDP appears to be very crucial in predicting GDP growth; the regression showed a strong, negative correlation between the two variables. FDI's influence comes second, also showing a strong, positive relationship. When issues such as omitted variables and small sample sizes are ignored, it can be concluded that FDI indeed played a crucial role in China's growth from 1990 to 2015.

Although education is omitted from the regression, theoretically it is very relevant on the effects of FDI on GDP growth --- for without necessary human capitals, FDIs may not contribute nearly as much to economic development. Future researchers can focus on exploring in this aspect, to see the effects of human capitals with education on receiving and absorbing technology transferred from developed countries.