Did Uzbekistan overstate its GDP growth?

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ABSTRACT

Using cross-sectional and panel data methods, I examine whether Uzbekistan had systematically been overstating its GDP growth from 2004 to 2015 until the new methodological changes took effect and the political regime changed. The average annual growth of GDP in this period was 7.8%. I use diff-in-diff design and fixed effects models to detect the overestimation and to measure its magnitude. Most of the analysis show that there was an overestimation of the economic growth and the models allow to measure its magnitude at about 2.5 - 3%.

Keywords: GDP growth, overestimation, Uzbekistan, diff-in-diff, measurement

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1. INTRODUCTION

From 2004 to 2015 Uzbekistan[1] has been declaring its GDP growth at least at 7.0%, the highest point being at 9.5% in 2007. The impressive growth rate however fell down to 6.1% in 2016 with the following reduction up to 4.5% in 2017. The more modest growth rate was declared right after the new president Mirziyoyev came to power, who is now known for easing the political regime and conducting economic reforms. The country's Statistics Office has also adopted a new methodological basis to calculate GDP with the production approach in 2016[2].

The consistent rates of large growth together with instant drop followed by political changes raise the question of whether the government has been declaring correct statistical data or not.

The methodological changes were introduced with the Methodological Provisions for the Calculation of GDP with the Production Method in the Context of the Types of Economic Activity dated June 29, 2016. In all likelihood, those changes are not based solely on political reasons, since the adoption of the document determining their entry into force took place two months earlier than the serious political changes that happened in the country, namely the death of the first president who ruled 28 years and subsequent election of the new president. Therefore, I dwell on the technical rather than political aspects of these changes, to analyze the accuracy of previous estimates.

In January 2019, the State Statistics Committee announced a revision of GDP for 2017, explaining this by a change in methodological approaches. In January 2019, the Committee carried out a large-scale revision of GDP for 2017, which mainly affected the agricultural sector. The state body explained this by stating that "the prices for agricultural products

[1] Uzbekistan is a lower-middle-income economy according to the World Bank Group classification with a GDP per capita of USD 1,532 and a population of 33 million as of 2018. It is a former soviet republic.

[2] Uzbekistan National Accounts Metadata
https://stat.uz/uploads/docs/10.1-10.2_Natsional'nyye%20scheta%20-%20rus.pdf

significantly lower than the market prices have been used for calculating the volume of agricultural output over the course of several years.[3]" Average annual prices for agricultural products were revised and brought into line with market prices for all types of products, while volumes in physical terms remained unchanged.

After the price review, the gross value added of the agricultural sector increased from 43.1 trillion Uzbekistani soums to 91 trillion soums, and GDP increased from 254 trillion soums to 302.5 trillion soums (+47.9 trillion soums came from agriculture, +0.6 trillion soums came from other sectors).

As a result of the revision, the GDP growth rate for 2017 was re-evaluated and reduced from 5.2% to 4.5%. The share of agriculture in the sectoral structure of GDP was augmented and raised from 19.7% to 34%, while the shares of industry, construction, and service sector decreased from 27.2% to 22.2%, from 6.9% to 5.7%, and from 46.2% to 38.1% respectively [4].

In July 2019 the Committee recalculated the data on GDP for the period from 2010 to 2016 and announced the results. According to the statistics body, the revision of GDP was carried out to ensure the comparability of data over time. Such components of GDP as net taxes on products, value added of industry and services were re-specified[5]. Reportedly, experts of the International Monetary Fund provided methodological support in the process of revising the GDP as part of a technical assistance mission on National Accounts Statistics.

This time the revision changed downwards the previous estimates of GDP growth rates, but it affected only those starting from 2010 (Table 1).

In this paper, I do not address the issues regarding retrospective analysis, and the new revision. Instead, my focus will be on important changes that have influenced estimates made

[3] Goskomstat explained the difference in GDP data. (2019, May 13). Retrieved from https://www.gazeta.uz/ru/2019/05/13/stat/

[4] Goskomstat explained the difference in GDP data. (2019, May 13). Retrieved from https://www.gazeta.uz/ru/2019/05/13/stat/

[5] Goskomstat revised GDP indicators for 2010−2016. (2019, July 16). Retrieved from https://www.gazeta.uz/ru/2019/07/16/recalculation/

after 2015/2016 (2016 hereafter). In particular, I address the questions whether there was a problem with an incorrect estimation of GDP growth before 2016 even taking into account the adjustments made by the Statistics Office and if yes, what was the possible extent of error in the estimations?

Table 1. Uzbekistan GDP revision for 2010-2017 *

Years	**GDP (current billion soums)**			**GDP annual growth, %**		
	before revision	*after revision*	*change*	*before revision*	*after revision*	*change*
2010	62 388,3	74 042,0	+11 653,7	108,5	107,3	-1,2
2011	78 764,2	96 949,6	+18 185,4	108,3	107,8	-0,5
2012	97 929,3	120 242,0	+22 312,7	108,2	107,4	-0,8
2013	120 861,5	144 548,3	+23 686,8	108,0	107,6	-0,4
2014	145 846,4	177 153,9	+31 307,5	108,0	107,2	-0,8
2015	171 808,3	210 183,1	+38 374,8	107,9	107,4	-0,5
2016	199 993,4	242 495,5	+42 502,1	106,2	106,1	-0,1
2017	254 043,1	302 536,8	+48 493,7	105,2	104,5	-0,7

* Press release of the State Statistics Committee of the Republic of Uzbekistan. (2019, July 13). Retrieved from https://stat.uz/ru/press-tsentr/novosti-komiteta/6304-davlat-statistika-qo-mitasi-2

I use the revised version of the series in my analysis because my hypothesis implies that the error still exists even after the adjustments. Moreover, it is worth noting that when using the estimates before methodological changes, the overestimation of GDP growth for the period up to 2015 is likely to be even greater than after the changes.

The comparison of various indicators and GDP growth and the regression analysis provided further are generally consistent with my hypothesis that Uzbekistan was overstating its economic growth in the period between 2004 and 2015. The findings show that the magnitude of the overestimation was at about 2.5 – 3%.

The rest of the thesis consists of five sections. In the second section, I describe the data and the methodology used to analyze the economic growth estimation. In the third section, I observe some initial evidence of the growth overestimation with simple comparisons. The fourth section represents the regression analysis with different model specifications on both cross-section and panel data. In the fifth section, I check the robustness of the results obtained. Finally, I draw conclusions, indicate the limitations of the exercises, and state the implications of the analysis done.

2. DATA AND METHODOLOGY

Firstly, to test the research question, I use the data on several indicators that are correlated with GDP growth and check the variation in correlation before and after the political change.

I collected the data on 19 indicators of Uzbekistan. These indicators are directly related to economic growth and usually co-move with GDP (Subramanian, 2019). Most of them are produced not by the Statistics Office of the country, so they are not affected by the possible bias or mistake of the authority.

I check the annual average growth rate for each of the indicators for the 2004-2015 and 2016-2018 time periods and analyze the behavior of the indicators before and after the political change compared to the behavior of the GDP growth rate. I also check the correlation between all indicators' annual growth and GDP growth calculated for the two periods – 2004-2015 and 2016-2018, to analyze the differences in correlations (positive vs negative, the difference in magnitudes).

For the misestimation test, I choose the indicators that co-move with GDP growth: exports, imports, domestic credit, and electricity consumption which also explain to a fair extent the variation in GDP growth. The selection of these indicators is in line with the methodology used by Subramanian (2019) and Wei Chen et al. (2019) in their analysis of India's and China's economic growth respectively. So, I check the relationship of the change in these indicators with GDP growth for 2004-2015 and 2016-2018 to clarify whether Uzbekistan followed the common pattern of other countries or was an outlier. For this sake, I use cross-sectional and static panel analysis.

2.1. Cross-sectional and diff-in-diff analysis

I utilize the difference-in-differences technique to capture the difference in the impact of the treatment (methodological change) on the relationship between selected indicators and GDP growth after 2016 in Uzbekistan compared to other countries. The treatment period is the

period after 2016 when the political and methodological changes took place where I emphasize the latter. However, the political aspect is also crucial, since before 2016 the more authoritarian regime was possibly manipulating statistical reporting and overstating the country's economic growth for which I have some direct and indirect evidence stated in Section 3.

First, I run a cross-sectional analysis separately for two time periods with the OLS regression method. I use the averages of the values for each country's indicators across the 2004-2015 and 2016-2018 time periods. I include the Uzbekistan dummy variable to get the country fixed effect. So, the model specification is as following:

$$GDP\ growth_i = \beta_0 + \beta_1 CreditGrowth_i + \beta_2 ElectricityGrowth_i + \beta_3 ExportsGrowth_i + \\ + \beta_4 ImportsGrowth_i + \beta_5 Uzbekistan + \varepsilon_i \quad (1)$$

i – country index.

I am interested in estimating the effect of treatment after the political changes. So, the timeline will be as following both for cross-sectional and panel estimations:

2004… …2015	2016… …2018
	Treatment period

Then to test the difference in two time periods I run a pooled cross-section regression. I include T – second time period dummy and its interactions with other independent variables this time. The coefficient of interest in this specification is β_5 which allows to determine whether there is a significant change in the relationship between the indicators in Uzbekistan compared to the outer world and thus whether there is an overstatement in the GDP growth in the pre-2016 period.

Model specification for pooled estimation is as follows:

$$GDP\ growth_{it} = \beta_0 + \beta_1 CreditGrowth_{it} + \beta_2 ElectricityGrowth_{it} + \beta_3 ExportsGrowth_{it} + \\ + \beta_4 ImportsGrowth_{it} + \beta_5 Uzbekistan*T + \beta_6 Uzbekistan +$$

$$+ \beta_7 T + \beta_8 CreditGrowth_{it} * T + \beta_9 ElectricityGrowth_{it} * T +$$

$$+ \beta_{10} ExportGrowth_{it} * T + \beta_{11} ImportGrowth_{it} * T + \varepsilon_{it} \quad (2)$$

t – two time periods

Uzbekistan – country dummy – country fixed effect

T – second time period (2016-2018) dummy, equals to 1 during the treatment period and 0 otherwise.

β_5 – coefficient of interest

2.2. Static panel analysis

For panel data estimation I use three different model specifications. All of them have their own advantages and drawbacks which I cover later within this paper.

First, I use a simple fixed effects model with percentage changes in absolute values of variables. I follow this model specification:

$$GDPgrowth_{it} = \beta_0 + \beta_1 Creditgrowth_{it} + \beta_2 Electricitygrowth_{it} + \beta_3 Exportsgrowth_{it} +$$

$$+ \beta_4 Importsgrowth_{it} + \beta_5 Uzbekistan * T + \beta_6 Creditgrowth_{it} * T +$$

$$+ \beta_7 Electricitygrowth_{it} * T + B_8 Exports_{it} * T + \beta_9 Imports_{it} * T +$$

$$+ \eta_i + \omega_t + \varepsilon_{it} \quad (3)$$

β_5 – coefficient of interest here as well. It captures the extent to which the methodological changes affected the GDP growth and the level of GDP is understated in the second post-2016 period in Uzbekistan compared to the pre-2016 period. This specification includes interaction between each of the variables on the right-hand side and second-period time dummy that allows the variability in the relationship between the explanatory variables and GDP growth before and after the methodological changes.

Then I use the natural logarithm of the annual absolute level values of all the selected indicators in order to make the data less skewed and to improve the fit of the model. So, the model specification is as following:

$$LnGDP_{it} = \beta_0 + \beta_1 LnCredit_{it} + \beta_2 LnElectricity_{it} + \beta_3 LnExports_{it} + \\ + \beta_4 LnImports_{it} + \beta_5 Uzbekistan*T + \beta_6 Credit_{it}*T + \beta_7 Electricity_{it}*T + \\ + B_8 Exports_{it}*T + \beta_9 Imports_{it}*T + \eta_i + \omega_t + \varepsilon_{it} \quad (4)$$

Since I use the log of each variable, the interpretation of the coefficient is such that the level of GDP misestimation equals to $e^{\beta_5} - 1$.

Lastly, I utilize the model with the first differences of natural logarithms of selected indicators.

$$DiffLnGDP_{it} = \beta_0 + \beta_1 DiffLnCredit_{it} + \beta_2 DiffLnElectricity_{it} + \beta_3 DiffLnExports_{it} + \\ + \beta_4 DiffLnImports_{it} + \beta_5 Uzbekistan*T + \eta_i + \omega_t + \varepsilon_{it} \quad (5)$$

I test the results with using different samples and excluding/replacing some of the variables in the regressions.

Almost all the estimations are done following the methods used by Subramanian in his analysis of misestimation of India's GDP (2019).

3. ECONOMIC GROWTH OVERSTATEMENT IN UZBEKISTAN. DOES IT EXIST?

Controversies about mismeasurement of main statistical indicators in Uzbekistan go back to the 1990s, when the declared growth of GDP was far more moderate than those of the post-2004 period when the figures demonstrated an economic boom.

IMF working paper of 1998 by Taube and Zettelmeyer argues that Uzbekistan may be involved in methodically overstating its output figures relative to the average indicators of transition countries of that time. They explain it with possible upward bias or less downward bias in the methodology of output measurement than those in other countries with transition economy. They suspect Uzbekistan in substantially overestimating its economic growth. The authors argue about methodological problems in the national accounts compilation process, "including an inconsistent treatment of informal sector activities over time, inappropriate procedures for dealing with the increased share of high-value commodities with low trade margins in organized retail turnover, and the use of the downward biased consumer price index as a deflator for trade activities and subsidies" (Taube and Zettelmeyer, 1998, p. 11).

They also draw attention to the discrepancies in estimating the growth for specific economic sectors. For example, the growth in the agricultural sector in 1997 was mainly due to the dramatic increase (22 %) in "other products" including fodder and feed crops. Contrarily, other sources including both official and unofficial ones, stated that there was no growth in the production of fodder and feed in 1997. As another possible explanation, they specify the government's underestimation of the private sector's output which was typical for young transition economies of that time. They back this argument empirically with IMF's own estimations of the unofficial sector based on electricity consumption which I also utilize in the estimations (Taube and Zettelmeyer, 1998, p. 11).

Moreover, on December 22, 2017, in his speech, President Mirziyoyev admitted that because of the Ministry of Finance the government had been declaring the wrong indicators for

more than 20 years while not specifying which indicators were incorrect. In the same speech, he stated that pompous declarations of 8-9% economic growth brought nothing to the country and that he ordered to check thoroughly the 5.5% GDP growth forecast for that year with representatives of international institutions[6].

As I focus on changes in 2016 and their impact on estimates, and the extremely high GDP growth had been declared since 2004, the corresponding two different periods of evaluation are 2004-2015 and 2016-2018. For verification, it is necessary to clarify deviations from the expected normality in the data on GDP growth during these time periods. To do this, I use 19 indicators that co-move with GDP growth and most of which are not produced by and independent of the Statistics Office. Information about the indicators is given in Table 2.

Table 2. Selected indicators and their codes *

#	**Indicators** (annual % growth)	**Code** (in the figures)	**Source**
1.	Exports of goods and services	Exp	WDI
2.	Imports of goods and services	Imp	WDI
3.	Industrial production	Ind2	Statistics Office
4.	Industry (including construction)	Ind	WDI
5.	Manufacturing of consumer goods	Cons	Statistics Office
6.	Process manufacturing	Manuf	Statistics Office
7.	Oil consumption	Oil	Energy Information Administration (EIA)
8.	Natural gas consumption	Gas	EIA
9.	Steel consumption	Steel	World Steel Association
10.	Electricity consumption	Elec	EIA
11.	Real domestic credit	Cred	Central Bank
12.	Foreign direct investments (FDI)	FDI	UNCTAD
13.	Foreign direct investments, Balance of Payments	FDI BoP	WDI
14.	Personal remittances, received	Remit	WDI
15.	Foreign tourist arrivals	Tour	UNWTO, Tourism Office
16.	Receipt from inbound tourism	Tour$	UNWTO, Tourism Office

[6] Mirziyoyev expressed readiness to leave his post in case of failure of his financial reform. (2017, December 22). Retrieved from https://www.fergananews.com/news/27666

17.	Railways, goods transported	Rail	WDI
18.	Commercial vehicle sales	Vehic	The International Organization of Motor Vehicle Manufacturers
19.	Airline passenger traffic	Air	WDI

* The annual % growth is calculated based on constant USD for most of the indicators measured in currency units. When constant USD data was not available, I converted current prices to constant prices using World Bank methodology[7].

First, I compare each of the 19 indicators' annual average growth rates for 2004-2015 and 2016-2018. The data for the two time periods is spread over the corresponding two axes as indicated on the chart. The figure contains a diagonal red line to better illustrate the comparison.

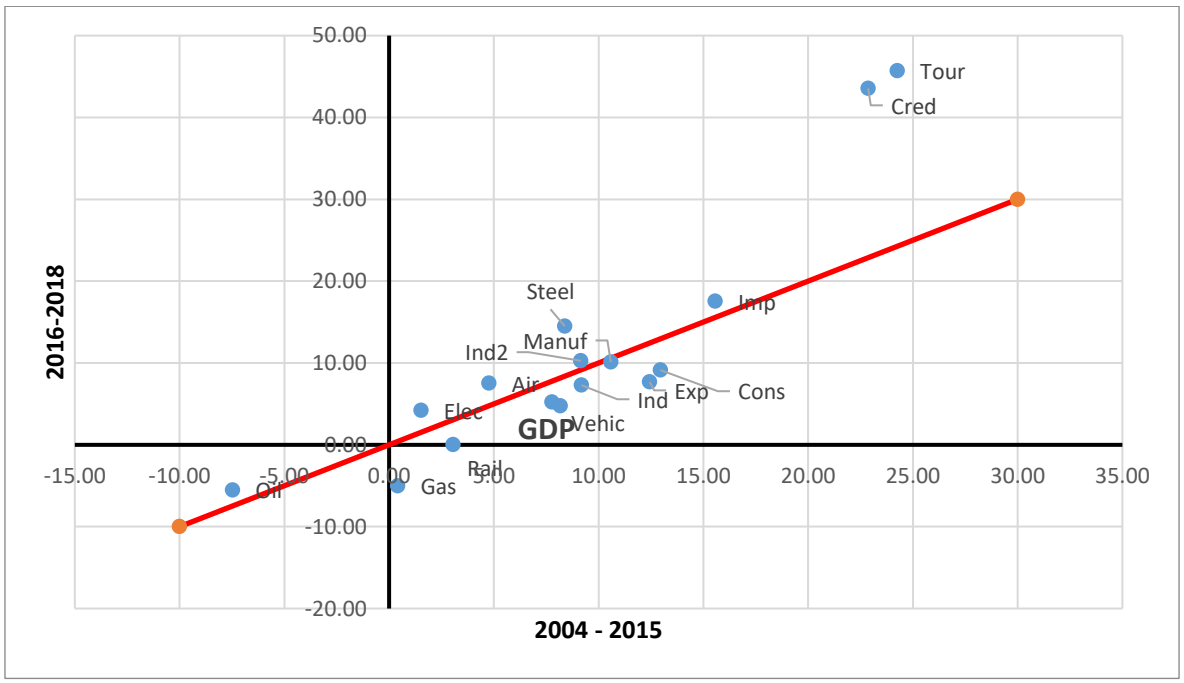


Figure 1. Comparison of Annual Average Growth for the Two Periods, Selected Indicators and GDP, 2004-2015 & 2016-2016 (%)

The extremely high average annual growth of FDI, the Receipts from Inbound Tourism, and Personal Remittances in the post-2016 period would have distorted the scale of the chart.

[7] What is your constant U.S. dollar methodology? (n.d.). Retrieved from https://datahelpdesk.worldbank.org/knowledgebase/articles/114943-what-is-your-constant-u-s-dollar-methodology

Therefore, I excluded them from the figure. But even without these indicators, the main differences between 2004-2015 and 2016-2018 data are clear and as followings:

● out of 19 indicators, only 7 of them grew faster in the pre-2016 period: exports, industry (including construction), manufacturing of consumer goods, natural gas consumption and sales of commercial vehicles, railway freight traffic, and manufacturing of consumer goods. This result contradicts to the intuition of high growth of selected indicators corresponding to the respective high economic growth rates;

● there are some indicators that not only grew faster but exploded in the post-2016 period: FDI, tourism arrivals, tourism receipts, remittances, credits, and steel use. Nevertheless, the economic growth remained modest on average in the second period.

Now I calculate, the correlation of each indicator's annual growth and GDP growth for the two periods, 2004-2015 and 2016-2018. Data for the first period is on the horizontal-axis and for the second period is spread over the vertical-axis.

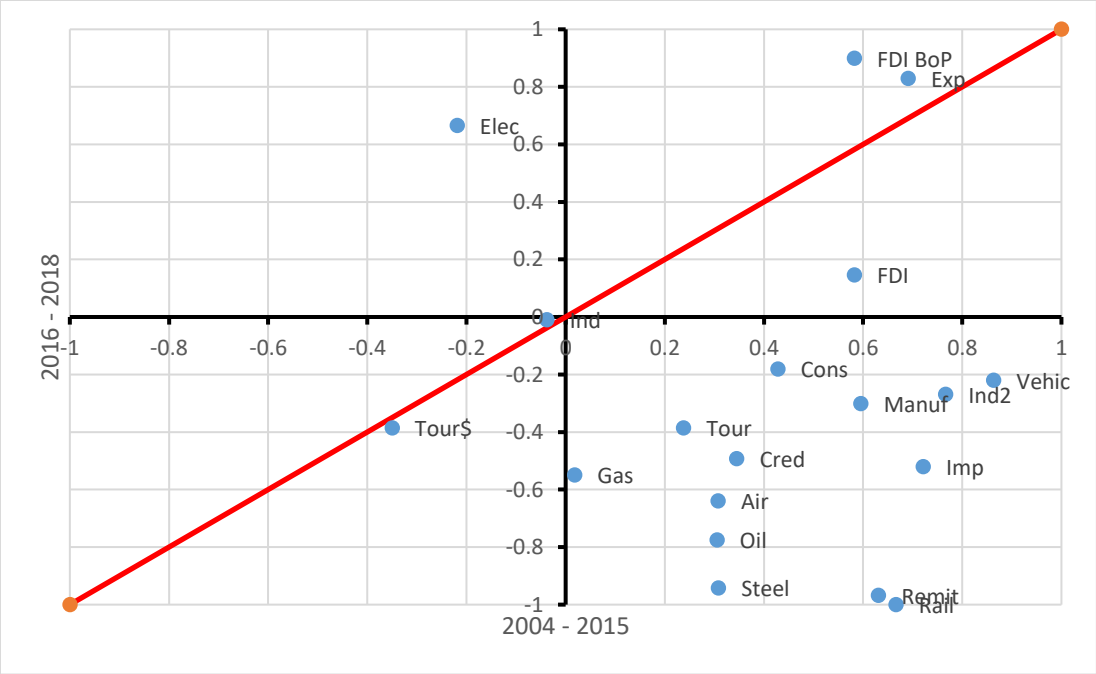


Figure 2. Comparison of Correlation Between Selected Indicators and GDP Growth for the Two Periods, 2004-2015 and 2016-2018

The correlations chart exposes some outstanding information.

First, 16 out of 19 indicators have a positive correlation with GDP growth in the 2004-2015 period, which can be clearly seen from their position on the right side of the chart. But in the 2016-2018 period, 15 of them have a negative correlation with GDP growth, so all of them are under the horizontal axis.

Second, ideally evenly distributed correlation within two periods without dramatic deviations would imply their more or less smooth distribution close to the diagonal red line. Specifically, given the specific relationship between indicator and GDP growth, the difference between overall correlation for indicators is typical, but the significant difference between this relationship for the same indicator over two different time periods implies that there might be some issue related to the time of the change in GDP measurement methodology.

The fact that the points for 15 indicators are substantially below the red line shows that the correlation which existed between them and GDP growth in the first period didn't show up in the second period.

In general, the fact that most of the indicators grew faster in the 2016-2018 period and most of them had negative correlations with GDP growth in that period can be regarded as an evidence of GDP misestimation in Uzbekistan.

4. TEST FOR OVERESTIMATION

Now the issues in the reported statistical data are clear, so I try to estimate the extent to which GDP was miscalculated or misreported.

Since I do not have all the economic data and methodology information that is used in calculating GDP, I use some indirect techniques also in the spirit of Subramanian's examination (2019) to establish how the methodological changes affected Uzbekistan's GDP growth and try to build some quantitative analysis in order to make conclusions about the correctness of pre-2016 GDP growth estimates.

To do so, I take the indicators that generally correlate with economic growth. It is important that those indicators should be independent of the country's statistics authority which reports GDP and other related statistical data. I make some assumptions, i.e. these indicators have a similar relationship to and are able to explain a considerable part of the variation of economic growth of countries worldwide (there can be exceptions, and I take care of them in building the samples of countries). Given these assumptions, I check this relationship between selected indicators and GDP growth and try to figure out the features of a particular relationship for Uzbekistan. Based on the behavior of this relationship for Uzbekistan for two time periods, I will be able to draw some conclusions.

I include in the model 4 variables, namely: the growth of domestic credits to the private sector, exports growth, imports growth, and growth of electricity consumption. Most part of the data is available in the World Development Indicators (WDI) database at the World Bank Group's (WB) Databank online statistical analysis tool website. I got the data for electricity consumption from EIA (US Energy Information Administration), UNSD (United Nations Statistics Division), and British Petroleum (BP) all of which collected it from energy authorities, so they are neither reported nor collected by the statistics offices. Credit data is also usually sourced by the banking and financial authorities of the countries even when they are

reported by the statistics authority. The same is true for the foreign trade data which is collected and consolidated by customs or foreign trade authorities and can be checked against the data of the partner countries.

To build a sample of countries, I take all of the countries which are included in Word Development Indicators (WDI) databases and exclude the countries which do not fit the general typical economic growth picture. Those countries are the ones that are in fragile and conflict-affected situations (38 countries), small states (78 countries), communist countries with the planned economy (2 countries), and the biggest oil exporters (25 countries). Since Slovenia has abnormally high credit growth data for some of the years, I exclude Slovenia from the general sample. So, 73 countries remain after I filter out the initial set of countries with these exclusive criteria.

EIA and UNSD/IEA data for electricity consumption is up to 2017, that's why I also utilize the British Petroleum global energy statistics dataset which includes 2018 data. For out of 73 countries of my sample the BP dataset has statistics for 53 of them, so I use the specification where I utilize BP electricity consumption data separately as another sample.

4.1. Cross-sectional and diff-in-diff analysis

I start with the cross-sectional analysis for two separate time periods using the average values of indicators for the given period. The coefficient of interest is on the Uzbekistan dummy variable. I compare it within those periods with and without treatment and its expressively different behavior would be the clear pointer to the statistical miscalculation or reporting issues. To do so I report the results of the pooled cross-section regression. Basically, this is a diff-in-diff technique run on observational data that allows detecting the differential effect of a treatment on Uzbekistan compared to other countries.

The results are shown in Table 3. I also check the model with subsamples of Middle-income countries and Low middle-income countries according to the World Bank classification (2nd and 3rd columns respectively). The BP sample results are on the 4th column.

Table 3. Cross-sectional and diff-in-diff analysis

	General sample	**Middle-income countries**	**Low middle-income countries**	**British Petroleum**
	1	*2*	*3*	*4*
2004-2015				2004-2015
Uzbekistan	**1.64**	**2.26**	**2.31**	**1.01**
t-stat	2.56	3.45	2.83	1.23
R-squared	0.71	0.58	0.81	0.75
2016-2017				2016-2018
Uzbekistan	**-2.85**	**-3.12**	**-1.52**	**-2.30**
t-stat	-2.16	-1.96	-0.87	-1.38
R-squared	0.53	0.54	0.64	0.54
Observations	73	41	15	53
Diff-in-diff				
Uzbekistan	**-4.49**	**-5.38**	**-3.83**	**-3.30**
t-stat	-3.07	-3.14	-2.03	-1.78
R-squared	0.64	0.59	0.73	0.66
Observations	143	80	28	105

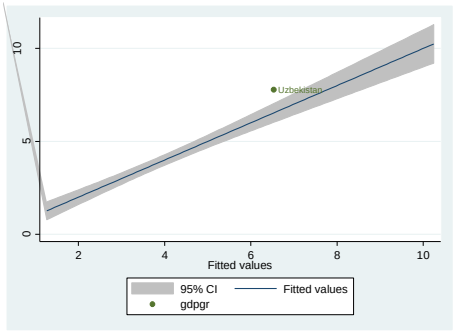
I get positive and mostly statistically significant results for the first-period cross-section analysis, and negative and mostly statistically significant results for the second period at the 95% confidence level regardless of model specification and data source.

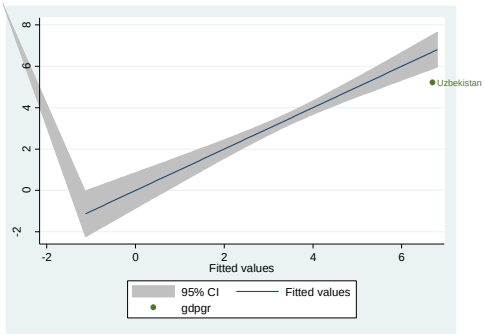
Figures 3a-h help in understanding how Uzbekistan's economy performed differently during the two time periods compared to other countries. The actual measured growth rates are

a) 2004-2015

b) 2016-2017

General sample with electricity

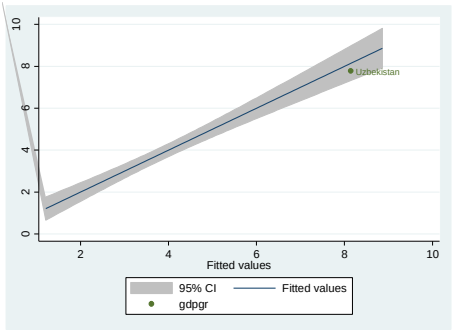


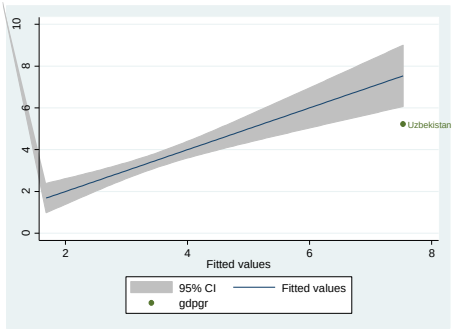


c) 2004-2015

d) 2016-2018

General sample without electricity

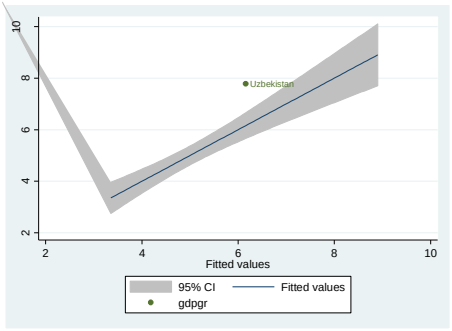


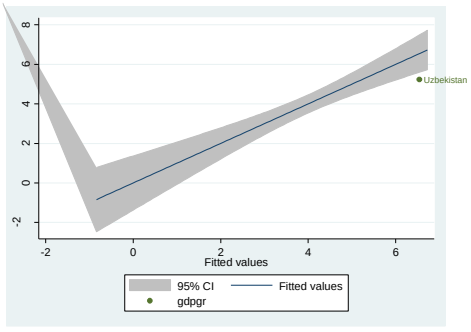


e) 2004-2015

f) 2016-2017

MIC with electricity

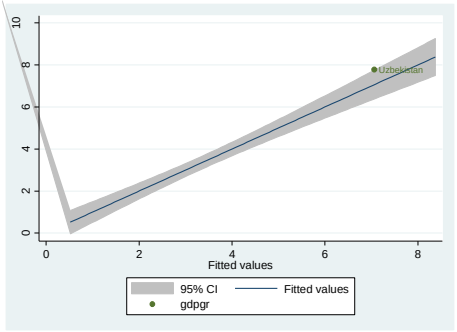




g) 2004-2015

h) 2016-2018

BP sample with electricity



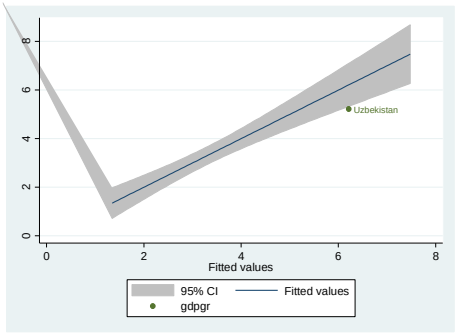


Figure 3 a-h. Relationship between real and predicted values

on the vertical axis, and the GDP growth rate values predicted using the selected indicators are on the horizontal axis. The grey areas stand for the 95 percent confidence interval around the regression diagonal line.

In an ideal world, all the points should be close to the line of best fit. It would mean that predicted and actual values should be fairly close to each other. But more importantly, if we plot such a figure for two time periods, there should be no significant difference between the placement of points for countries.

In all the pre-2016 figures, Uzbekistan is above the line of best fit (exception is Figure 3 c), which means that the actual growth rate was greater than the predicted one. And in figures 3 a and 3 e Uzbekistan is positioned outside of the confidence interval meaning that it was an outlier. Uzbekistan's position as an outlier is especially evident within Middle-income countries. However, the situation changes drastically in the post-2016 period where Uzbekistan is now always under the best fit line meaning that the actual growth now was less than the predicted one. Moreover, though here Uzbekistan is within the confidence interval in only one of the 4 cases, in neither figures it can be seen as a significant outlier as it was within Middle-income countries previously.

There are some limitations to this analysis. First, the two time-periods are not balanced. Particularly, the second period is comprised of only 3 years (2016-2018), and due to the data unavailability, in some cases, it is even reduced to 2 years decreasing the variability in the statistics. Second, there are only four independent variables in the model whereas more indicators independent of the Statistics Office could help to do a better job. Nevertheless, the R-squared varies between 0.55 and 0.75 across model specifications and time-periods, so the selected indicators are explaining the variance in the GDP growth in a regression model fairly well.

4.2. Static panel estimations

The panel estimation consists of three parts. First, I use a simple fixed effects model with percentage changes in absolute values of selected indicators as in equation (3). Then I use the log of selected indicators in order to make the data less skewed and comparable across different panels. It is also useful in terms of the interpretation of the results as percentage changes. Here I use the model shown in equation (4). In the third part, I utilize the model with the first differences of the log of selected indicators in the equation (5).

4.2.1. Simple growth rate model

In this analysis, I deal with annual data. The values of indicators for each country are annual growth rates. The coefficient of interest is the Uzbekistan coefficient where there is an interaction of Uzbekistan dummy and T dummy which is one for the post-2016 period and zero otherwise. It is useful in detecting whether the GDP growth in Uzbekistan was behaving differently after the methodological changes.

The results are shown in Table 4. I use two-way fixed effects panel estimation with robust standard errors clustered at the country level. Here all the Uzbekistan coefficients for different samples are negative and statistically significant in most cases.

Table 4. Simple growth rate regression model estimations

	General sample	**Middle-income countries**	**Low middle-income countries**	**British Petroleum**
	1	*2*	*3*	*4*
Uzbekistan	**-0.80**	**-0.88**	**-2.41**	**-1.26**
t-stat	-1.78	-1.95	-7.20	-2.07
p-value	0.08	0.06	0.00	0.04
R-squared	0.49	0.44	0.28	0.49
Observations	919	520	189	738
Countries	67	38	14	50

There are some limitations to this estimation as well. First, percentage changes are relative indicators, so using them may result in the loss or distortion of the useful information regarding the differences in absolute values between the cross-sectional data. Second, using percentage changes may create substantial outliers depending on the difference in the magnitude of the selected indicators. These weaknesses can make them less useful.

In my case, I am checking only the behavior of indicators which co-move, so using percentage changes should not be the big problem, and I already excluded the biggest outliers from the sample. However, in order to check the results, I address the normalizing transformation of level data further on.

4.2.2. Log-log model

In this model, I use annual level data. For the reasons indicated in the methodological part of the paper, I normalize all variables using natural log transformation as specified in equation (4).

From the samples, I exclude China, because no level data on Chinese foreign trade in constant US dollars is available in the WDI dataset. I also dismiss Canada, Tunisia, Georgia, Mongolia, Latvia, and Lithuania, because the domestic credit to the private sector data for these countries has substantial gaps for some time periods.

The main results can be observed in Table 5. I use the same two-way fixed effects panel estimation, and the robust standard errors are clustered at the country level. Surprisingly, the estimations manifest the results that are directly opposite to my hypothesis – all the Uzbekistan coefficients are positive here, and statistically significant in most cases.

While the power of this model is probably greater than the previous one, there are also some caveats to using it. The model implies the multiplicative relationship between the outcome and the input variables as it is in the constant elasticity of substitution (CES)

production function. That means the assumptions that the absolute value of GDP is proportional to the relationship between powers of selected indicators that comove with GDP and/or the elasticity of GDP with respect to the indicators is constant over cross-sections should hold. To address this issue, I use another transformation.

Table 5. Log-log regression model estimation

	General sample	**Middle-income countries**	**Low middle-income countries**	**British Petroleum**
	1	*2*	*3*	*4*
Uzbekistan	**0.18**	**0.27**	**0.05**	**0.12**
t-stat	2.98	3.86	0.32	1.90
p-value	0.00	0.00	0.752	0.06
R-squared	0.96	0.89	0.85	0.94
Observations	909	508	189	726
Countries	66	37	14	49

4.2.3. The first difference of log (diff-log) model

By utilizing the first difference of log model I switch my focus again to the linear relationship between percentage changes. Using log transformation in combination with first differencing allows the series to represent the percentage change in a variable with time, since percentage change in X at period t: $\frac{X_t - X_{t-1}}{X_{t-1}}$ is approximately equal to $\log X_t - \log X_{t-1}$. Here the assumption is: the GDP growth is a linear function of the percentage change in the selected indicators.

Table 6 represents the results of the diff-log model. The regression is two-way linear fixed effects, the standard errors are robust and clustered at the country level. This time, the results of the estimations are in line with my hypothesis. All the Uzbekistan coefficients are negative and statistically significant. The model detects a different behavior of GDP growth in

the post-2016 period and the negative coefficient for Uzbekistan and post-2016 time dummy interaction term means that there was possibly an overestimation in the first period.

Table 6. Diff-log regression model estimations

	General sample	**Middle-income countries**	**Low middle-income countries**	**British Petroleum**
	1	*2*	*3*	*4*
Uzbekistan	**-0.016**	**-0.015**	**-0.025**	**-0.036**
t-stat	-5.85	-4.25	-7.73	-11.71
p-value	0.00	0.00	0.00	0.00
R-squared	0.51	0.46	0.32	0.52
Observations	842	471	175	676
Countries	66	37	14	49

4.3. Interpretation of the coefficients

The main results of the different model regressions are represented in Tables 3-6. All of the results except for those that came from the log-log model are in line with the thesis hypothesis that there was an overestimation of GDP growth in the pre-2016 period in Uzbekistan. However, the coefficients are different and as they come from various models, so they need careful interpretation.

First, in the pooled cross-sectional regression (Table 3), the coefficients vary within the range between -3.3 and -4.5. This means that the degree of the annual average GDP growth rate overestimation in Uzbekistan in the first period was at around 3.3 – 4.5 percentage points.

Second, the static panel estimations show different results. Simple growth rate model specification coefficients display that the annual average GDP growth rate overestimation in Uzbekistan in the first period was at around 0.8 – 2.4 percentage points (Table 4). The log-log model specification results contradict my hypothesis and show that the level of GDP was

underestimated by about 5.1 – 30.9 percent which is cumulative for 3 years (Table 5, I use $e^{\beta 5} - 1$ formula to interpret the coefficients). And lastly, the diff-log model specification results vary from -0.015 to -0.036 (Table 6) which means the overestimation was at around 1.5 – 3.6 percent.

Getting the exact extent of the growth overestimation is nearly impossible. But the magnitude of about 2.5 – 3 percent is in line with the results of both pooled cross-section and static panel analysis results.

5. ROBUSTNESS OF THE RESULTS

5.1. Indicators tests

I check the robustness of the pooled cross-sectional regression specification with replacing some of the regressors. The main specification in Table 3 includes exports and imports of goods and services data in constant 2010 US dollars. I test the results with foreign trade of goods and services in current US dollars and exports and imports of only merchandise in current US dollars. The outcomes are represented in Appendix Tables A1-A2. All Uzbekistan coefficients are negative, statistically significant, and consistent with the main results.

A similar robustness check is done with the panel estimation. I run tests on the model with a diff-log functional form that is in line with my hypothesis. The results are in Appendix Table A 3. Here all Uzbekistan coefficients are negative, statistically significant, and in line with the main results as well.

5.2. Country test

I also test the actual GDP growth of countries against their predicted growth to detect other outlier countries which also probably were overstating their GDP growth. In Appendix Table A1 I listed the top 15 countries with the largest difference in actual and fitted values of GDP growth for the pre-2106 period. The results for the general sample are represented in Figure 4 (Y-axis: actual growth, X-axis: predicted growth) where I showed the positions of other 3 countries as well: China, Pakistan, and Ireland out of the top 15. The overestimation of the economic growth of those countries is already the subject of discussions. Estimations showed that China's GDP growth from 2008 to 2016 was 1.7 percentage points lower compared to the official statistics (Chen et al., 2019). Ireland which is known as one of the tax havens in Europe because of its taxation and economic policies is also prone to possible GDP

overestimation (Subramanian, 2019). In 2012 Pakistan's GDP was to shrink by roughly 10% because of double counting in some goods and services for preceding several years[8]. Presence of these countries in the possible outliers list can serve as an evidence to the hypothesis.

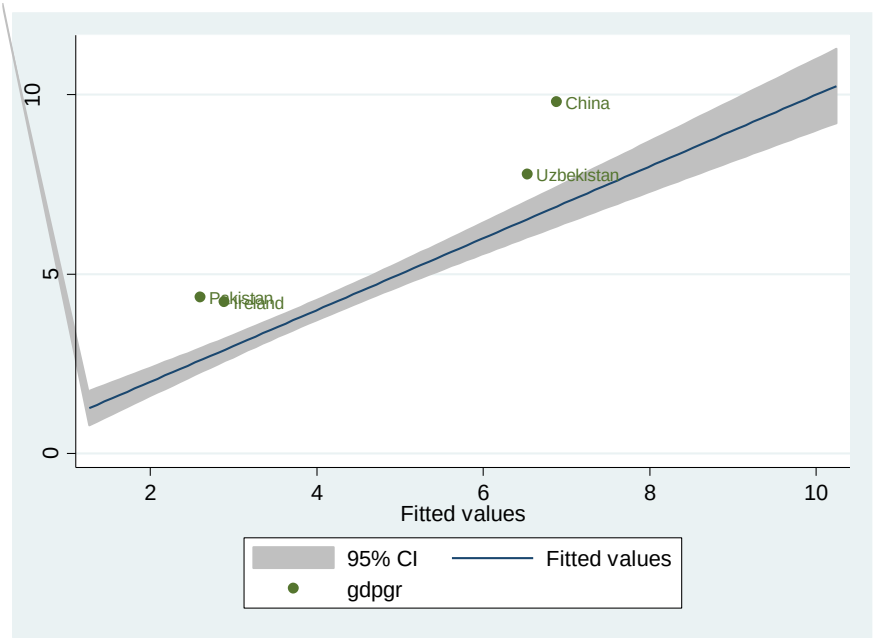


Figure 4. Country test. 2004-2015

[8] Double-counting: GDP overestimated, may be slashed by 10%. (2012, April 29). Retrieved from https://tribune.com.pk/story/371594/double-counting-gdp-overestimated-may-be-slashed-by-10/

6. CONCLUSION

The initial comparisons and further regression analysis except one of the model specifications show that there was an overstatement of economic growth in Uzbekistan from 2004 to 2015. It should be noted that the tests for misestimation were conducted on the GDP growth data which was already adjusted for the period from 2010 to 2016 by the new government. So, the detected overestimation may be coming from the previous period or even the adjusted GDP growth may still contain some upward bias which is more likely.

The presence of overestimation in the indicated period is by no means a decisive statement, and the magnitudes derived are not necessarily precise, and further research with access to the methodological documents and disaggregate economic country data may do a far better job and make significant corrections to these results.

There are some limitations to this research. First, more time periods hence more variation in the second-period data would make it more comparable to the pre-2016 period, subsequently, that would lead to better results. As this comes over time, future research on the topic is promising.

Second, I used only four indicators to explain the variation in GDP growth. I didn't use national tax data, because of the attempts of the new government to reduce the informal sector in the country and make a big part of it official. That would introduce a bias to the models. I didn't use FDI which is typical to the analysis of the economic growth, because Uzbekistani officials often speculate over these figures for their own benefits, thus there are different numbers on this indicator depending on the reporting institution (the Central Bank, the Statistics Office or the Ministry for Foreign Trade and Investments).

Lastly, I couldn't use province-level data to estimate a model and to use it in the prediction of GDP as it is done by Chen et al. (2019) in their analysis of China's National Accounts. The main reason is there is no province-level independence in economic policy and

handling statistics in Uzbekistan as it exists in China. So that data would be predisposed to the bias of the Statistics Office and it would be less useful in analysis.

The main implication of the findings is that the data quality and accuracy should be on the focus of economical and statistical authorities. The possibility of statistical data manipulation by officials for their political benefits still exists. Overstatement or understatement of key economic indicators may have a significant negative impact on the further economic decisions and policy. Moreover, it results in the loss of the data comparability making the measurement of changes nearly impossible. To avoid this issue the transparency of those authorities should be ensured, and more independent national and international professionals should be involved in further discussions on the topic.

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APPENDICES

Appendix 1. Pooled cross-sectional estimation.

Table A 1. Cross-sectional regression, exports and imports in current USD

	General sample*	Middle income countries	Low Middle income countries	British Petroleum
Dependent variable – GDP growth				
	1	2	3	4
2004-2015				
Uzbekistan	**3.39**	**3.52**	**3.87**	**2.56**
t-stat	7.52	7.27	4.39	5.71
p-value	0.00	0.00	0.00	0.00
R-squared	0.74	0.59	0.82	0.78
2016-2018				
Uzbekistan	**-4.06**	**-4.63**	**-3.40**	**-4.48**
t-stat	-3.17	-3.20	-3.06	-2.81
p-value	0.00	0.00	0.02	0.00
R-squared	0.51	0.55	0.68	0.51
Observations	73	41	15	53
Diff-in-diff				
Uzbekistan	**-7.45**	**-8.16**	**-7.27**	**-7.04**
t-stat	-5.50	-5.35	-5.14	-4.26
p-value	0.00	0.00	0.00	0.00
R-squared	0.66	0.60	0.74	0.67
Observations	144	81	29	105

Table A 2. Cross-sectional regression, exports and imports of merchandise in current USD

	General sample	Middle income countries	Low Middle income countries	British Petroleum
Dependent variable – GDP growth				
	1	*2*	*3*	*4*
2004-2015				
Uzbekistan	**3.31**	**3.40**	**3.76**	**2.46**
t-stat	7.63	7.08	4.92	5.08
p-value	0.00	0.00	0.00	0.00
R-squared	0.73	0.57	0.80	0.74
2016-2018				
Uzbekistan	**-3.89**	**-3.99**	**-1.79**	**-4.34**
t-stat	-3.21	-2.63	-1.97	-2.43
p-value	0.00	0.01	0.08	0.02
R-squared	0.53	0.56	0.68	0.55
Observations	73	41	15	53
Diff-in-diff				
Uzbekistan	**-7.20**	**-7.39**	**-5.56**	**-6.80**
t-stat	-5.60	-4.65	-4.69	-3.68
p-value	0.00	0.00	0.00	0.00
R-squared	0.66	0.60	0.74	0.67
Observations	144	81	29	105

Appendix 2. Panel estimation. Simple growth rate model

Table A 3. Panel regression, exports and imports in current USD

	General sample	Middle income countries	Low Middle income countries	British Petroleum
	1	*2*	*3*	*4*
Uzbekistan	**-1.62**	**-1.62**	**-1.68**	**-2.11**
t-stat	*-5.23*	*-4.51*	*-3.75*	*-2.64*
p-value	0.00	0.00	0.00	0.01
R-squared	0.52	0.52	0.49	0.53
Observations	923	527	210	739
Countries	67	38	15	50

Table A 4. Panel regression, exports and imports of merchandise in current USD

	General sample	Middle income countries	Low Middle income countries	British Petroleum
	1	*2*	*3*	*4*
Uzbekistan	**-1.16**	**-1.26**	**-1.40**	**-1.77**
t-stat	*-3.93*	*-3.78*	*-3.52*	*-2.15*
p-value	0.00	0.00	0.00	0.04
R-squared	0.49	0.50	0.46	0.50
Observations	923	527	210	739
Countries	67	38	15	50

Appendix 3. Panel estimation. Diff-log model

Table A 5. Panel (diff-log) regression, exports and imports in current USD

	General sample	Middle income countries	Low Middle income countries	British Petroleum
	1	*2*	*3*	*4*
Uzbekistan	**-0.021**	**-0.018**	**-0.025**	**-0.038**
t-stat	*-10.21*	*-6.54*	*-7.83*	*-12.64*
p-value	0.00	0.00	0.00	0.00
R-squared	0.53	0.48	0.32	0.54
Observations	844	473	175	676
Countries	66	37	14	49

Table A 6. Panel (diff-log) regression, exports and imports of merchandise in current USD

	General sample	Middle income countries	Low Middle income countries	British Petroleum
	1	*2*	*3*	*4*
Uzbekistan	**-0.019**	**-0.017**	**-0.025**	**-0.035**
t-stat	*-9.82*	*-6.17*	*-9.11*	*-12.14*
p-value	0.00	0.00	0.00	0.00
R-squared	0.49	0.51	0.24	0.51
Observations	842	471	175	676
Countries	66	37	14	49

Appendix 4. Country test

Table A 7. Top 15 countries with the largest difference between actual and predicted GDP growth rates, 2004-2015

	Country	**Actual GDP growth**	**Predicted GDP growth**	**Difference**
1.	China	9.79	6.88	2.91
2.	Panama	7.58	4.83	2.75
3.	Dominican	5.48	2.73	2.75
4.	Armenia	5.68	3.24	2.44
5.	Sri Lanka	6.21	4.05	2.15
6.	Philippines	5.49	3.55	1.93
7.	Pakistan	4.35	2.59	1.75
8.	Mongolia	8.51	6.86	1.65
9.	Belarus	5.30	3.79	1.50
10.	Malaysia	5.10	3.63	1.47
11.	Ireland	4.22	2.88	1.33
12.	***Uzbekistan***	***7.78***	***6.52***	***1.25***
13.	Israel	3.84	2.69	1.15
14.	Turkey	5.92	4.94	0.98
15.	Jordan	5.12	4.16	0.96