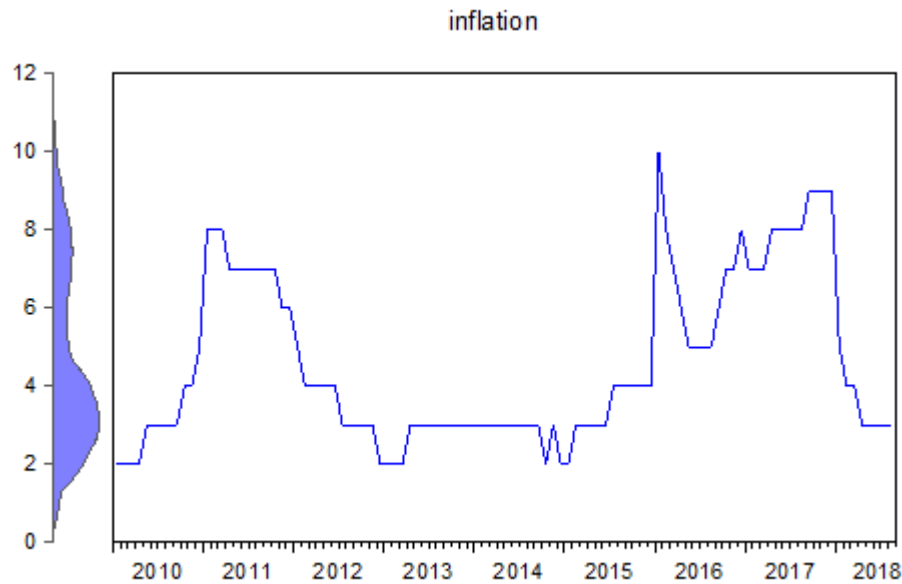


Deriving an Alternative Inflation Rate for Azerbaijan

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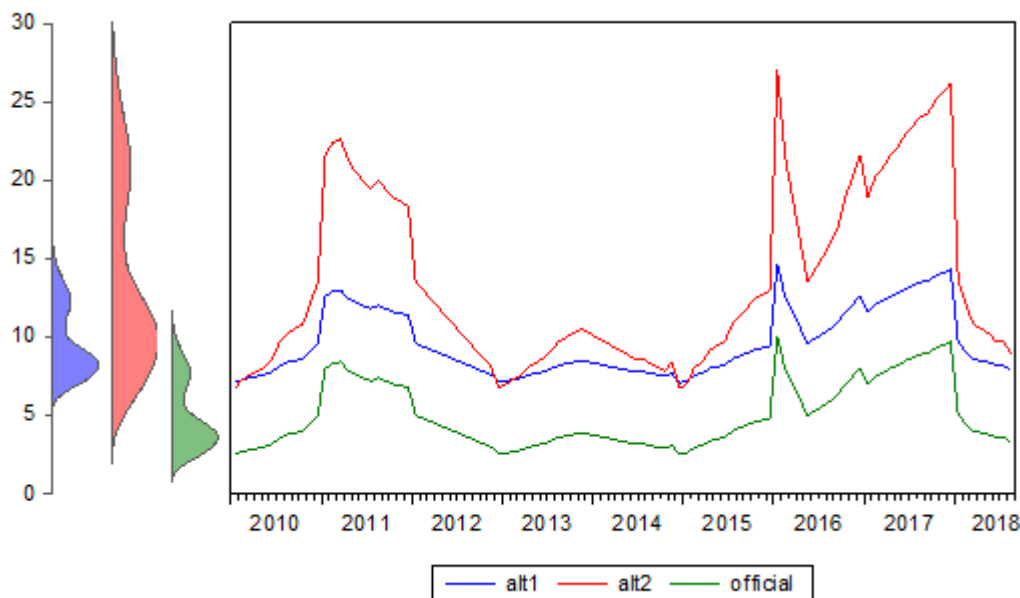
Inflation is one of the crucial fundamentals of an economy. It is vital to have reliable inflation numbers and their estimations. Michalski and Stoltz (2013) note that governments might have an incentive to play with macroeconomic variables in order to seem more attractive for investment. It is not a coincidence that Azerbaijan's macroeconomic variables are also included in the analysis of Michalski and Stoltz (2013). In this article, we will employ Benford's Law in our approach as in their paper. In addition, we will apply Vector Autoregression (VAR) as well to test our derived alternative inflation numbers. Of course, our derived inflation numbers will be higher than those which the Azerbaijani government publicly shares. For VAR analysis, we will refer the main determinants of inflation from Rahimov, Adigozalov and Mammadov (2016) then compare our results. Our main standpoint will be the figure that Center for Economic and Social Development (CESD) calculated as an alternative inflation rate for Azerbaijan in 2019. They used 50 districts as well as Baku in their sample. Whereas the official inflation rate provided by the state for 2019 was 2.7%, the CESD calculated 7.3% as an alternative inflation rate. There are many ways to derive 7.3% from 2.7% mathematically. We will apply some of those and try to understand how they behave under the application of both Benford's Law and VAR.

Graph 1. Official Inflation Rates



We derive our inflation estimates by additive and multiplicative approaches. As noted above, there are multiple ways to derive an inflation estimate, but we will strive for simplicity.

Graph 2. Alternative Inflation Rates



Firstly, we will apply Benford's Law to the first and second digits of official and derived inflation numbers.

Table 1. First Digits of Official Inflation

Official Inflation	Benford	Z Score
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0,01	0,3	3,351237139
0,04	0,176	1,81775312
0,24	0,125	1,745335045
0,22	0,097	2,098384242
0,17	0,079	1,652568925
0,01	0,067	1,038053564
0,12	0,058	1,227509717
0,06	0,051	-0,015321069
0,15	0,046	2,467793037

As we can see from the Z score above, the first digits of the official inflation do not follow the Benford distribution.

Table 2. Second Digits of Official Inflation

Official Inflation	Benford	Z Score
0,229	0,12	1,675127351
0,009	0,114	1,643878342
0,3	0,109	3,187931455
0,21	0,104	1,729408828
0,12	0,1	0,18959627
0,04	0,097	0,876936698
0,01	0,093	1,38395042
0,01	0,09	1,347089398
0,017	0,088	1,186810585
0,1	0,085	0,105753635

Although some second digits fall under the Benford distribution, in general, we can conclude that it does not follow Benford.

Table 3. First Digits of Alternative Inflation

Alternative Inflation	Benford	Z Score
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0,23	0,3	0,721734199
0,06	0,176	1,530098944
0,2	0,125	1,082872109
0,17	0,097	1,173045194
0,11	0,079	0,434228886
0,03	0,067	0,599914073
0,09	0,058	0,524530584
0,03	0,051	0,283439776
0,11	0,046	1,421947577

From the table above, we observe that first digits of alternative inflation follow Benford's Law.

Table 4. Second Digits of Alternative Inflation

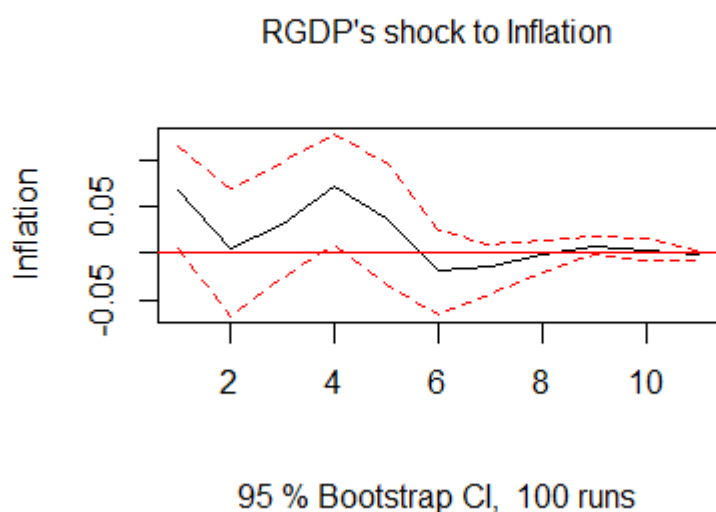
Alternative Inflation	Benford	Z Score
0,15	0,12	0,343582622
0,125	0,114	0,02386275
0,2	0,109	1,430378066
0,18	0,104	1,191125154
0,17	0,1	1,102467199
0,05	0,097	0,691868889
0,03	0,093	1,006773157
0,02	0,09	1,155699648
0,013	0,088	1,264146613
0,1	0,085	0,105753635

We observe that second digits of alternative inflation also follow the Benford distribution.

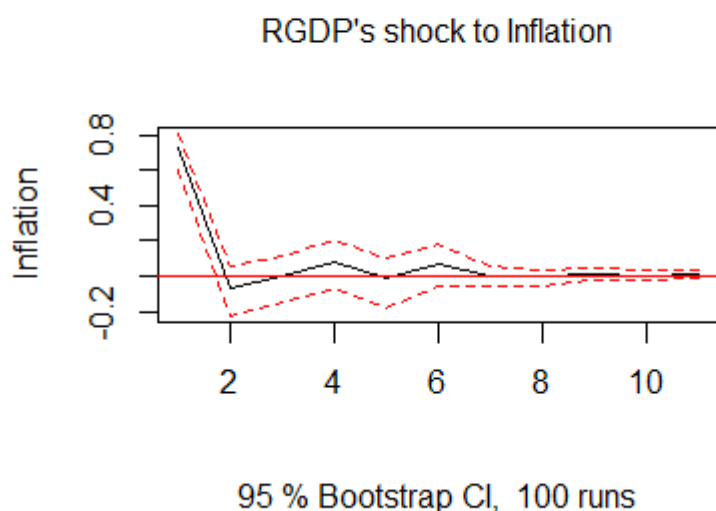
Next, we will try to build a VAR scheme and evaluate the behavior of official and alternative inflation. In Rahimov et al. (2016), there are some variables given for running a VAR. We will use some variables from their paper and add some more. As a first variable, we will use non-oil real GDP. Note that

we use the monthly variable instead of quarterly, and there might be some discrepancies as a result.

Graph 3. Impulse-Response of Official Inflation and RGDP



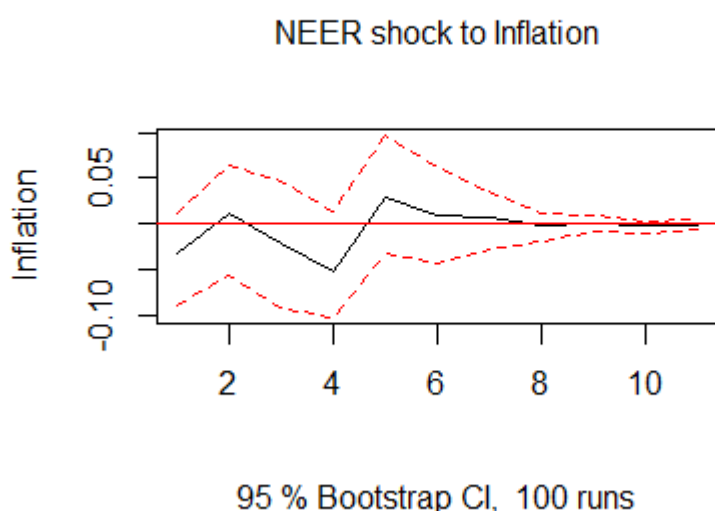
Graph 4. Impulse-Response of Alternative Inflation and RGDP



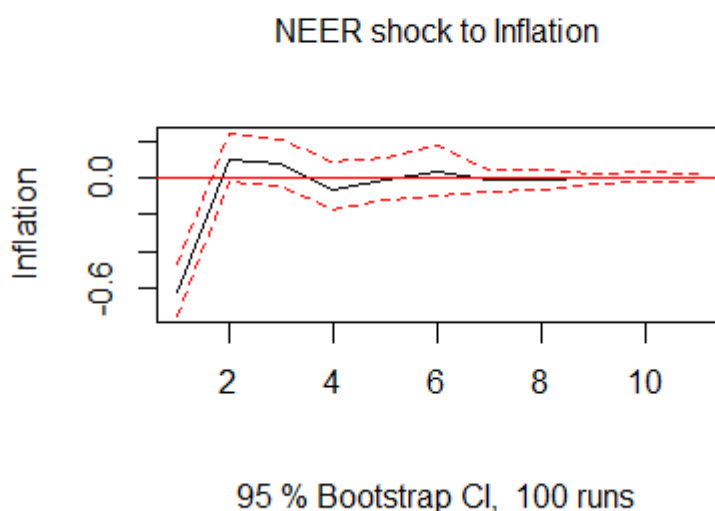
Above are the graphs of impulse-response functions of real non-oil GDP and inflation. In the first graph, the figures for official inflation are used. The result is in line with the previous literature about Azerbaijani inflation rates. The second graph is obtained by using our derived alternative

inflation rates. Both have explanatory value, but the second one is more significant. As with our Benford's Law analysis, we obtained better results with our derived inflation numbers, which speaks to their accuracy over the official numbers. Next, we employ the nominal effective exchange rate.

Graph 5. Impulse-Response of Official Inflation and NEER



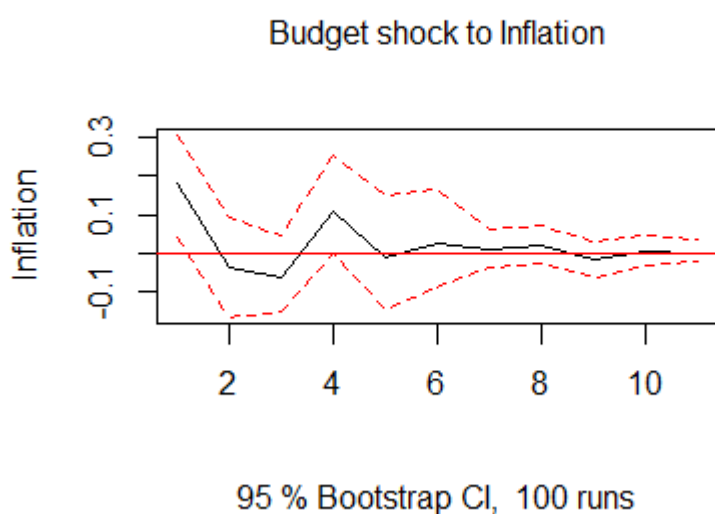
Graph 6. Impulse-Response of Alternative Inflation and NEER



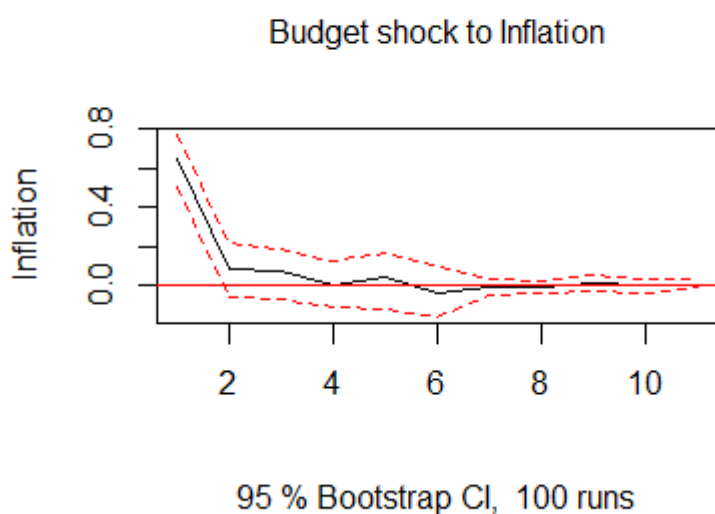
Again, the results are in line with those provided in Rahimov et al. (2016) and our estimates yield better results.

Next, we will use budget deficit per GDP as a part of our VAR mechanism. Although it is not used as a variable in Rahimov et al. (2016), we believe it might be a good predictor of inflation in Azerbaijan.

Graph 7. Impulse-Response of Official Inflation and Budget Deficit



Graph 8. Impulse-Response of Alternative Inflation and Budget Deficit



Here we see a positive relationship between budget deficit and

inflation. One more time our derived alternative inflation rates show more significant results.

To conclude, overall, our estimates of alternative inflation rates in several models behave better than official statistics. Below are the summary statistics of official and alternative inflation rates.

Table 5. Summary Statistics of Official and Alternative Inflation Rates

Inflation	Minimum	Average	Maximum
Official	2.5%	5.0%	10%
Alternative	6.8%	13.4%	27%

References:

1. Michalski, Tomasz and Gilles Stoltz. "Do countries falsify economic data strategically? Some evidence that they might." *Review of Economics and Statistics*. 2013, 95 (2), pp.591-616.
2. Vugar Rahimov, Shaig Adigozalov and Fuad Mammadov. "Determinants of Inflation in Azerbaijan." *CBAR*. 12 October, 2016<https://uploads.cbar.az/assets/eab8c8c4d73082b4b2110955a.pdf>