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Temporal Disaggregation Method for Estimating Indonesia's Monthly GDP

Action Area C. SC5
It is worth investing in integrated statistics for integrated analysis

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1. Introduction

- Estimation of higher frequency data is a useful monitoring tool for policy-makers.

- It is also a valuable input in the analysis and development of models in the fields of both macroeconomics and finance.

- However, the estimate of GDP is measured until only on a quarterly basis.

- Producing the estimate of monthly GDP become important in order to observe the economic progress alongside provide more timely data for the users to take crucial decisions.

- Proposing a method to disaggregate the historical values of quarterly GDP.

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2. Methodology

- The monthly series of estimate value of GDP is the summation a preliminary series and the zero Mean unobserved series (Guererro, 2003)

- Basic Formulation:

$$Z_t = W_t + S_t$$

Z_t is the estimate series of monthly GDP
Wt is the preliminary series
St   is the zero mean unobservable series
t = 1, 2, 3,….. mn
m= intra-period frequency;
n = quarterly value

In this research, the data that used is the Quarterly GDP (2010 constant price) from Q1-2000 until Q4-2018 (76 observations)

The formulation become:

$$GDP_t = W_t + S_t$$
$$\text{with } t = 1, 2, 3,….. 228$$
$$m = 3;$$
$$n = 76$$

Two assumptions (Guererro, 2003)
1. Preliminary series (Wt) followed ARIMA model ;
2. Unobservable series (St) followed ARMA model

2. Methodology

Estimation of Preliminary Series (Wt)

- In practical application, the preliminary series has to estimated from the variables related to the GDP.

- Here some criteria In order to get reasonable preliminary estimate :
    1. Variable/s admits an adequate economics intrepetation;
    2. Variable/s had high correlation with monthly GDP (Friedman, 1962)
    3. Variable of interest has the same lenght with the length of desired monthly series.

- In this cases, the Indonesia's Production Index (IP) are used to get preliminary estimate.

- The IP itself is the published figure of monthly index from an indicator for the Large Medium Manufacturing Production. (Using the data from January-2000 untill December-2018)

Estimation of Preliminary Series (Wt)

- After that, an indicator of quarterly IPAGR (IP Aggregate) is built by averaging the monthly figures of IP.

- Thus, a regression model was fitted to the aggregated data, yielding the result:

$$GDP_i = -751695 + 23865,03 IPAGR_i \quad \text{for i} = 1, 2, \ldots, 76 \quad R^2 = 0,9711 \ldots (1)$$

- Then the monthly preliminary data were obtained for (January 2000 to December 2018) with the equation

$$W_t = -751695 + 23865,03 IP_t \ldots (2)$$

- Thus, an ARIMA model for the preliminary series was built by using the standard Seasonal ARIMA modelling, yielding the following results:

Seasonal-ARIMA (1,1,10)(0,1,1)$_{12}$

$$(1 - B)(1 - B^{12})W_t = (1 - 0,8981 B^{10})(1 - 0,8739 B^{12})\hat{a}_t \ldots (3)$$

Estimation of The Zero Mean Unobservable Series (St)

- let us concern with the calculation of series of zero mean unobserved variable (St).

- The figure of Wt then aggregated to get the values of $GDPAGR_i$, for i = 1,2,...., 76

- Then, make the quarterly series of differences Di, by using the formula:
$$D_i = GDP_i - GDPAGR_i \quad ..... (4)$$

- Then, make the model of the series D_i by ARMA model. The estimation results of such a model is :

$$(1 - 0,5943L^4)D_i = \widehat{\varepsilon_i} \quad \text{with } \hat{\sigma}_\varepsilon = 65770,49 \quad .... (5)$$

- By using standard ARMA modelling, the final model for St is given by

Seasonal ARMA (0,03)(1,0,0)$_{12}$

$$(1 - 0,5943L^{12})S_t = (1 + 0,5042B^3)\widehat{\varepsilon_i} \quad .... (6)$$

3. Result/Discussion/Recommendation

- Once the estimated model for series $\{S_t\}$ is available, The Basic Formulation can be applied to disaggregate the GDP series directly by summing the series of W_t and S_t

$$GDP_t = W_t + S_t$$

Quaterly Series

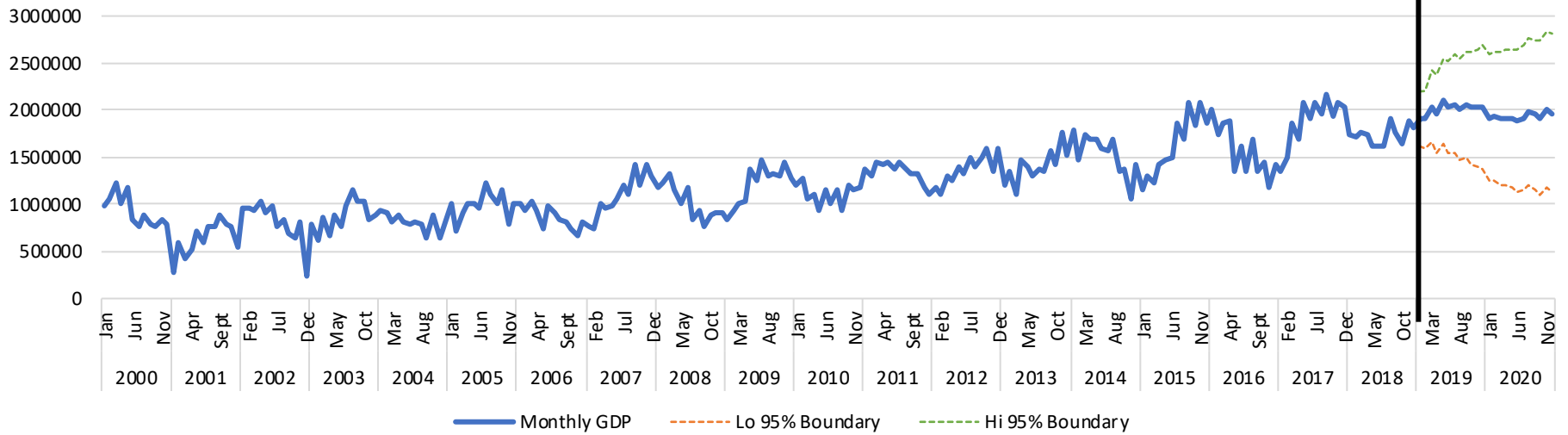| Year	Quarter	GDPi	IPAGRi	GDPAGRi	Di
2000	I	1016818.49	81.02	1181770.18	-164951.69
	II	1010924.93	77.62	1100788.18	-89863.25
	III	1053703.97	73.22	995622.95	58081.02
	IV	1040278.85	79.03	1134437.87	-94159.02
2001	I	1056151.91	73.22	995622.95	60528.96
	II	1069254.94	79.03	1134437.87	-65182.93
	III	1089969.00	82.29	1212237.87	-122268.87
	IV	1056524.11	75.38	1047171.41	9352.70
-	-	-	-	-	-
	-	-	-	-	-
	-	-	-	-	-
	-	-	-	-	-
-	-	-	-	-	-
	-	-	-	-	-
	-	-	-	-	-
2017	I	2378097.30	133.59	2436513.91	-58416.61
	II	2473433.20	136.88	2514950.31	-41517.11
	III	2552301.60	139.91	2587340.90	-35039.30
	IV	2508871.50	139.06	2566976.07	-58104.57
2018	I	2498488.20	140.75	2607307.97	-108819.77
	II	2603748.20	139.18	2569760.33	33987.87
	III	2684185.60	145.29	2715655.21	-31469.61

After Disaggregation Process →

Monthly Series

Year	Month	IPt	Preliminary Series (Wt)	Unobserved Series (St)	Monthly Estimated GDP (In-sample)
2000	January	79.73	1027173.14	-46488.89	980684.25
	February	82.03	1092779.01	-46488.89	1046290.12
	March	81.29	1281315.48	-46508.64	1234806.84
	April	82.57	1084323.33	-71359.01	1012964.31
	May	81.02	1250634.76	-71359.01	1179275.75
	June	69.28	899879.41	-71456.67	828422.74
	July	71.04	771574.83	2677.65	774252.48
	August	72.47	891077.09	2677.65	893754.75
	September	76.14	780249.08	2539.74	782788.83
	October	75.51	777417.92	-10879.89	766538.03
	November	80.49	847744.06	-10879.89	836864.18
	December	81.1	794591.53	-10623.66	783967.88
2001	January	71.04	401246.83	-128568.27	272678.56
	February	72.47	715147.32	-128568.27	586579.05
	March	76.14	544866.38	-129079.89	415786.49
	April	75.51	473495.32	38232.53	511727.85
	May	80.49	677861.96	38232.53	716094.50
	June	81.1	564994.73	38769.04	603763.77
	July	82.13	783806.21	-17291.45	766514.76
	August	83.33	786329.35	-17291.45	769037.90
	September	81.42	894486.04	-17991.92	876494.12
	October	83.87	886366.17	-108987.38	777378.78
	November	81.13	865298.88	-108987.38	756311.50
	December	61.13	664796.76	-107874.45	556922.31
	-	-	-	-	-
	-	-	-	-	-
	-	-	-	-	-
	-	-	-	-	-
	-	-	-	-	-

Indonesia's Monthly GDP (Billion Rupiahs)

Legend: Monthly GDP — Lo 95% Boundary ------ Hi 95% Boundary

Forecasted Series (Out of Sample)

Year	Month	GDP
2019	January	1914422.19
	February	1902381.10
	March	2036876.76
	April	1963028.00
	May	2101640.10
	June	2037355.40
	July	2068526.38
	August	2003698.34
	September	2058622.90
	October	2021446.60
	November	2020855.02
	December	2033509.75
2020	January	1921414.52
	February	1935181.84
	March	1917472.34
	April	1921944.76
	May	1906636.71
	June	1892653.25
	July	1915989.89
	August	1982915.85
	September	1952030.73
	October	1914742.75
	November	2004079.28

Mean Absolute Percentage Error (MAPE)

$$\text{MAPE} = \frac{\sum \left| \left(\frac{F_t - A_t}{A_t} \right) * 100 \right|}{n}$$
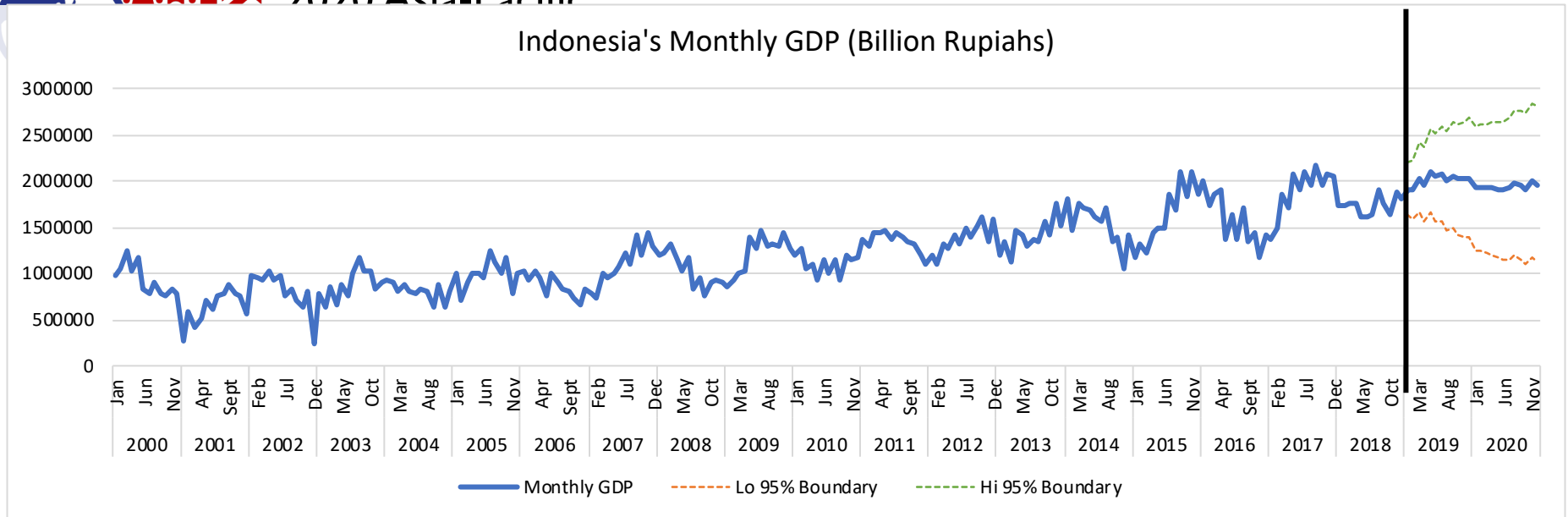
Ft = Forecast Value
At = Actual Value

In-sample MAPE = 29,04%

Out Sample MAPE = 26,90 %

MAPE	Interpretation
<10	Highly accurate forecasting
10-20	Good forecasting
20-50	Reasonable forecasting
>50	Inaccurate forecasting

Source: Lewis (1982, p. 40)

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Indonesia's Monthly GDP (Billion Rupiahs)

Legend: Monthly GDP — Lo 95% Boundary — Hi 95% Boundary

Recommendations

1. Indonesia's current trend of growth between 5 and 6 percent.
2. Indonesia needs to boost economic performance, even in the midst of uncertainty and global economic slowdown.
3. several ways can be applied by government such as making good governance and institutions, maintaining foreign direct investment, and/or and boost inter-regional infrastructure
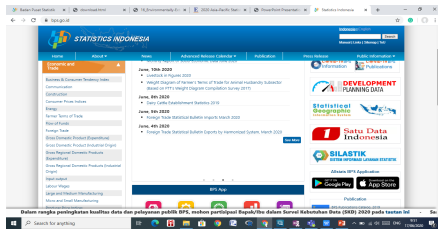
1. **Develop the model with Structural Breaks (Ex : Monetary Crisis, world Pandemic, etc)**
2. **Trying another variable/indicator of interest**
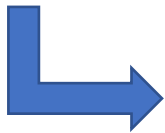
Integrated Statistics for Integrated Analysis

Integrated data sources:
1. Quarterly Gross Domestic Product
2. Monthly Index of Large Medium Manufacturing Production

Disaggregate the Quarterly Figure To Estimate Monthly GDP

Provide More Timely Data for Users

Thank You

If any questions, please free to email to irsyad.ilham@bps.go.id