Impact of Gross Domestic Product (GDP) on Water Consumption

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Presented by

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OBJECTIVES

- To identify and investigate the relationship between water consumption and the socio-economic development

- To identify the effect of GDP and its lagged values to water consumption

TERMINOLOGIES

- **Water Consumption** - refers to the billed volume (BV) of Manila Water's customers through its meter reading system. In the study, it is expressed in Million Liters per Day (MLD).

- **Business Intelligence (BI)** – is a system in Manila Water containing BV information
- **DOM** – represents BV of domestic accounts
- **COM –** represents BV of commercial accounts

METHODOLOGY

INPUT
GDP *(From PSA)*
Water Consumption
(From MWCI Database)

LONG RUN
Ordinary Least Squares Model (OLS)

SHORT RUN
Error Correction Model (ECM)

OUTPUT

Water Consumption Forecast

LONG RUN MODEL - OLS

$$logBV = c + logGDP$$

Where:

BV – *is the quarterly billed volume expressed in MLD*

GDP *– is the Gross Domestic Product (at constant prices) expressed in Million PhP*

SHORT RUN MODEL - ECM

logBV= c + logGDP + logGDP(previous 2 Qtrs) + logBV (previous 4 Qtrs) + logGDP(previous 4 Qtrs)

Where:

BV – is the quarterly billed volume expressed in MLD

GDP – is the quartely Gross Domestic Product (at constant prices) expressed in Million PhP

RESULTS

STATISTICAL TEST RESULT

- Prior to modeling, the study considered Johansens Cointegration test, and the results suggest that GDP and Billed Volume are Cointegrated.

- We also check on Granger causality test, and the results suggest that the Billed Volume and GDP granger causes each other.

- Lastly, all time series used were stationary according to the Augmented Dickey Fuller Test.

OLS - RESULT

GLOBAL

	Coefficient	Std. Error	p-value
C	1.241892	0.426073	0.0067
LOG(GDP)	0.407828	0.029653	0.0000

Ceteris paribus, for every 1 unit in logGDP (on a quarter basis), log of water consumption will increase by 0.4078.

OLS - RESULT

DOMESTIC SEGMENT

	Coefficient	Std. Error	p-value
C	-0.031471	0.485860	0.9488
LOG(GDP)	0.477352	0.033814	0.0000

With other variables held constant, for every 1 unit increase in GDP, log of residential water consumption increases by 0.4774.

OLS - RESULT

COMMERCIAL SEGMENT

	Coefficient	Std. Error	p-value
C	3.060985	0.305138	0.0000
LOG(GDP)	0.181951	0.021237	0.0000

Assuming all other variables unchanged, an increase in the GDP will increase the water consumption by 0.1820. That is, for every 1 unit increase in GDP, log of residential water consumption increases by 0.1820.

OLS – FORECASTING ACCURACY

Quarter	Actual (million cu.m)	Forecast (million cu.m)	Forecast Bias	Forecast Bias %	MAD	MAPE
2017Q1	115.95	115.79	-0.16	99.86	2.34 *(Train)*	0.02 *(Train)*
2017Q2	126.27	123.39	-2.89	97.71		
2017Q3	124.41	120.51	-3.90	96.87		
2017Q4	121.76	124.98	3.23	102.65		
2018Q1	120.35	118.79	-1.56	98.70	2.72 *(Test)*	0.02 *(Test)*
2018Q2	129.64	126.43	-3.21	97.52		
2018Q3	125.99	122.08	-3.91	96.90		
2018Q4	127.20	129.41	2.21	101.73		
TOTAL	991.57	981.38	-10.19	98.97		

ECM – RESULT

GLOBAL

	Coefficient	Std. Error	p-value
C	0.138587	0.264841	0.6060
LOGGDP	0.616669	0.191271	0.0039
LOGGDP(-2)	0.259514	0.119134	0.0404
LOGMWC(-4)	0.756903	0.096368	0.0000
LOGGDP(-4)	-0.767056	0.185477	0.0004

If all else remains the same:

LOGGDP: 1 unit increase in logGDP will lead to an increase of 0.6167 in logBV

LOGGDP(-2): 1 unit increase in logGDP of the previous two quarters will lead to an increase in logBV by 0.2595.

LOGMWC(-4): 1 unit increase in log of consumption for the previous 4 quarters will lead to an increase in logBV by 0.7570

LOGGDP(-4): 1 unit increase in logGDP of the previous 4 quarters will lead a decrease of 0.7671 to logBV

ECM – RESULT

DOMESTIC SEGMENT

	Coefficient	Std. Error	p-value
C	-0.258206	0.228592	0.2708
LOGGDP	0.691265	0.184051	0.0011
EPSILON_DOM(-1)	0.028304	0.073315	0.7032
LOGGDP(-2)	0.239099	0.119102	0.0571
LOGDOM(-4)	0.834030	0.085542	0.0000

For the residential accounts of short run model, ceteris paribus, one unit increase in logGDP will lead to an increase of 0.6913 for log of water consumption; and 0.2391 and 0.8340 for unit increase of logGDP(-2) and logDOM(-4).

ECM – RESULT

COMMERCIAL SEGMENT

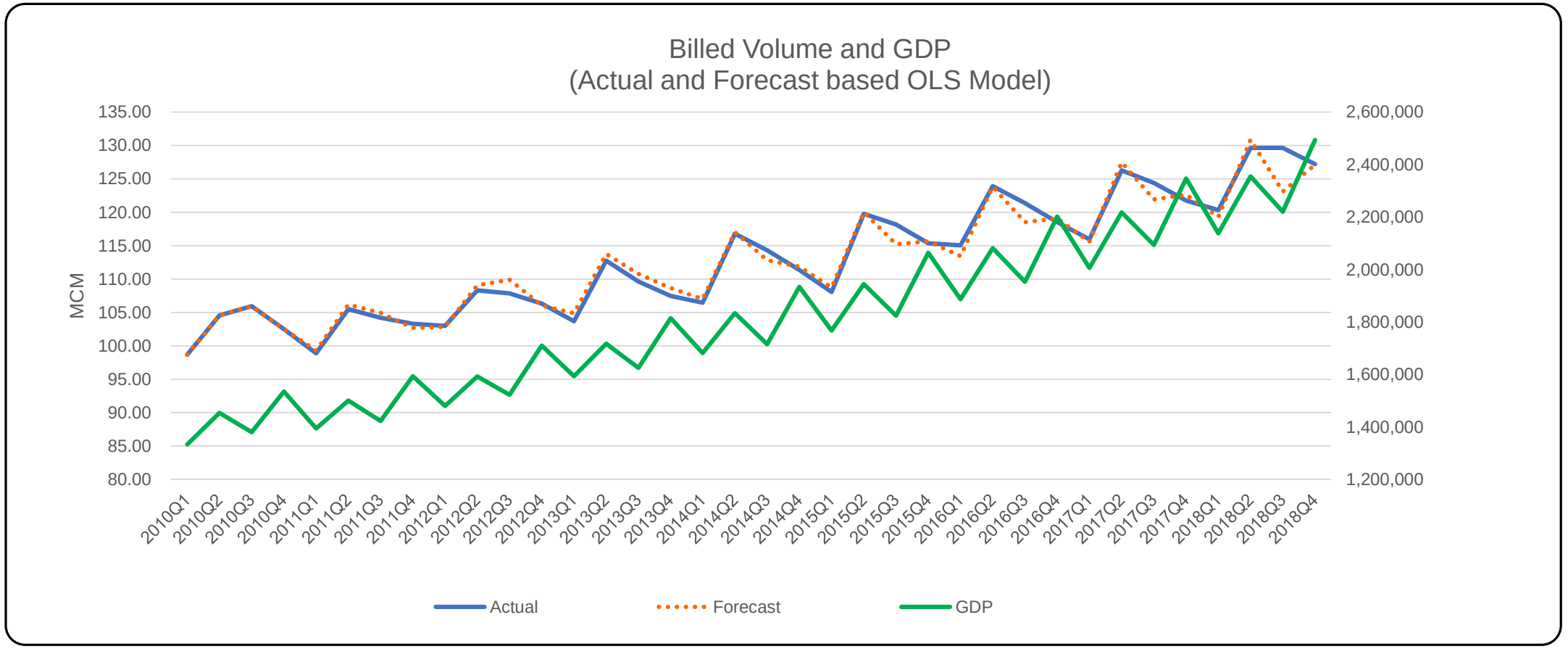
	Coefficient	Std. Error	p-value
C	3.139862	0.333681	0.0000
LOGGDP	0.176462	0.023211	0.0000
EPSILON_COM(-1)	0.196318	0.192006	0.3153

For the commercial accounts in the short run model, as logGDP increases by 1 unit, log of water consumption increases by 0.1765.

ECM - FORECASTING ACCURACY

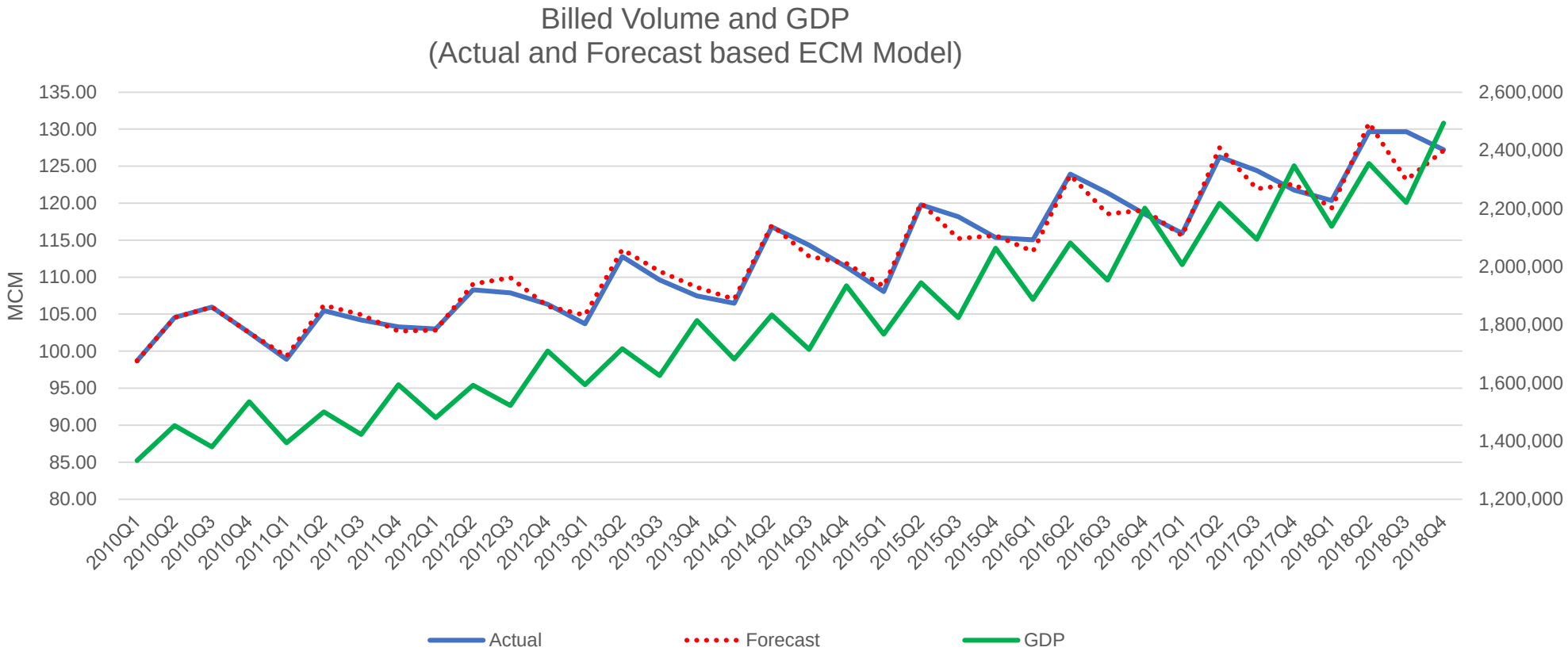
Quarter	Actual (million cu.m)	Forecast (million cu.m)	Forecast Bias	Forecast Bias %	MAD	MAPE
2017Q1	115.95	115.58	-0.37	99.68%	**0.8467** *(Train)*	**0.0074** *(Train)*
2017Q2	126.27	127.49	1.22	100.96%		
2017Q3	124.41	121.93	-2.48	98.01%		
2017Q4	121.76	122.61	0.85	100.70%		
2018Q1	120.35	119.32	-1.02	99.15%		
2018Q2	129.64	130.87	1.23	100.95%	**2.2130** *(Test)*	**0.0172** *(Test)*
2018Q3	129.64	123.12	-6.52	94.97%		
2018Q4	127.20	127.12	-0.08	99.94%		
TOTAL	**995.23**	**988.05**	**-7.17**	**99.28%**		

APPLICATION – OLS MODEL



Accuracy	MAD	MAPE
2010 - 2017	2.3427	0.0208
2018	2.7230	0.0215

APPLICATION – ECM MODEL



Accuracy	MAD	MAPE
2010 - 2017	0.8467	0.0074
2018	2.2130	0.0172

CONCLUSION

We therefore conclude that among other external factors, GDP is one of the drivers of Billed Volume, as the two were found to be cointegrated. Further, the use of simple linear models where good enough for predicting the log of Water Consumption.

FURTHER STUDY

- Check other models such as Neural Networks and other external factors such as rainfall and temperatures.