A VECTOR ERROR CORRECTION ANALYSIS OF THE NUMBER OF HIV CASES IN THE PHILIPPINES USING SELECTED HEALTH AND SOCIO-ECONOMIC DETERMINANTS

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ABSTRACT

This study aims to investigate the short run and long run equilibrium between the number of HIV cases in the Philippines and selected health and socio-economic determinants namely: number of registered marriages, number of deployed OFW's, female population, number of barangay health stations, and number of private hospital beds in the Philippines. The data used for this study is from 1984-2014. After a series of preliminary procedures, the Vector Error Correction Model (VECM) was found to be the most appropriate. The final model consisted of three cointegrating equations showing the long run relationship between HIV and the above mentioned variables. The results of this study showed that in reducing the number of HIV cases, construction of policies will be deemed the most effective if the focus would be on marriages and OFW's.

Keywords: time series analysis, marriages, deployed Overseas Filipino Workers (OFW), female population, barangay health stations, private hospital beds

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I. INTRODUCTION

Human Immunodeficiency Virus (HIV) and Acquired Immuno Deficiency Syndrome (AIDS) are among the most complex health problems of the 21st century. HIV is the virus that causes AIDS, which is the illness that damages a person’s ability to fight off diseases. The first case of HIV/AIDS in the Philippines reported in 1984 afflicted a foreigner, not a Filipino. (DRDF, 2007)

The Philippine government has confronted the problem of HIV/AIDS with an action plan that included an emphasis on the response of the local government agencies, involvement and support of nongovernmental organizations (NGOs), incorporation of HIV/AIDS education into the school curriculum, and laws forbidding discrimination against persons with HIV/AIDS or belonging to risk groups. (Mateo, 2014)

Although HIV prevalence and incidence are low, the number of HIV infection is slowly increasing. There is mostly an increasing trend yearly according to the data of HIV/AIDS Registry, and even if the Philippines is currently experiencing low rates of HIV/AIDS, the country needs to be prepared for the possibility of an increase in the spread of the disease. Primary prevention of HIV infection for key populations has to start in adolescence mainly because infections now occur at a younger age: 20–29. (UNICEF, 2012)

The aim of this research is to determine dynamic interactions among HIV Cases on selected health and socio-economic indicators. It is of our best interest to come up with a good model but likewise, it is also our priority to obtain logical estimates. Other than that, this research also aims to assess the significant variables of the final model.

II. REVIEW OF RELATED LITERATURE

A. Health Indicators

Number of Barangay Health Stations

According to a study in rural Uganda, geographic distance from residence to health facility can be of a great hindrance in receiving adequate healthcare. People who live near a health facility are more likely to seek healthcare than those who live farther away. Furthermore, easier access to healthcare often have better health outcomes. (Akullian, 2016)

Number of Hospitals and Hospital Beds and medical practitioners

A study on hospital bed occupancy and HIV/AIDS in three major public hospitals in Addis Ababa, Ethiopia was conducted in 2010. The researchers concluded that the HIV epidemic will result in more and more people having health problems which will increase the burden and pressure on hospitals. (Haidar, 2010)

Number of Tuberculosis Cases

HIV and tuberculosis (TB) are so closely connected that their relationship is often described as a co-epidemic. In the last 15 years the number of new TB cases has more than doubled in countries where the number of HIV infections is also high. In Africa, TB is the leading cause of illness and death among HIV-positive people, killing almost half of all AIDS patients. (World Health Organization).

B. Socio-economic Indicators

Total Female Population (15-34 years old)

According to the Philippine Statistics Authority, youth is defined as the individuals belonging to the age group 15 to 30 years. In sub-Saharan Africa, three in four new HIV infections in young people are among girls. Globally, HIV is the third leading cause of death among young women aged 15–19. Young women are twice as likely to acquire HIV as their male counterparts. (UNAIDS, 2016)

Unemployment Rate

A study on unemployment and poverty mortality in countries of the Organisation for Economic Co-operation and Development (OECD) showed that between 1981 and 2009, a 1% increase in unemployment was associated with an increase in HIV mortality in the OECD.

Urban Population Growth

Other things equal, the higher the level of urbanization in a country, the higher the overall level of HIV prevalence is likely to be-both because the urban sector constitutes a larger fraction of the total population and because levels of rural infection are likely to be raised through greater migratory interaction between rural and urban population.

Explanations for this positive relationship include the fact that the urban sector usually serves as a conduit for new influences-as in the growth in use of injecting drugs, which has spread HIV in the countries of the former Soviet Union during the 1990s. Also, rates of social interaction are higher in urban areas, and fields of social interaction are wider too-phenomena that doubtless have implications for patterns of sexual interaction. (Dyson, 2003)

Number of Registered Marriages

Marriage would be protective if both partners were HIV negative at the time of marriage and maintain a monogamous relationship However, not all marriages are ideal. Many still face a substantial risk of contracting HIV from their partners, presumably through premarital and extramarital sexual behaviour. (Chirwa, 2011)

Researchers at the Johns Hopkins School of Public Health looked at 467 Thai couples, most of whom were married, in which the men were found to be HIV-positive when they donated blood. Wives were twice as likely to be infected by their husbands if either partner in the marriage had a history of sexually transmitted disease (STD). Further, the rate of heterosexual transmission to these women was 46.3 percent, substantially higher than the 12 to 24 percent transmission rates reported for heterosexual couples in the United States and Europe.

Heterosexual spread of HIV is the major route of infection in Asia and throughout most of the world. A better understanding of the epidemiology of heterosexual transmission is crucial to controlling the spread of HIV. Few careful studies of sexual transmission of HIV among married couples in developing countries have been reported. (Johns Hopkins School of Public Health , 1999)

Population Size

The population density is one of the major factors affecting the spread of diseases and infections. (Population Action International, 2011, p. 3) This is because diseases spread more quickly when people are in close proximity with each other. A study of the United Nations claims that there is a positive correlation between HIV/AIDS and the population density as evidenced by the cases of India and China. (PTI, 2011)

Number of OFW's deployed and Visitor Arrivals

In a fact sheet released by UNAIDS, migration was identified as an independent risk factor for HIV. It also heightened vulnerability of migrants to HIV because of their limited access to health services, either for HIV prevention for those who are HIV-negative or treatment for those who are HIV positive. (UNAIDS, 2014, p. 7) In addition, female migrants are also vulnerable to exploitation and/or physical/sexual violence, often by their employers. (UNAIDS, 2014, p.9)

III. METHODOLOGY

A. Description of Data

The data for this research is a compilation of selected statistical databases gathered from World Bank (data.worldbank.org), Department of Health (doh.gov.ph), Philippine Overseas Employment Association (poea.gov.ph), and the Philippine Statistics Authority yearbooks. All the variables in this study were collected annually from 1984-2014.

B. Definition of Variables

Variable Code	Variable Name	Description
brgy	number of barangay health stations	number of recorded barangay health stations from 1984-2014
govt_h	government hospitals	number of recorded government hospitals from 1984-2014
pvt_h	private hospitals	number of recorded private hospitals from 1984-2014
govt_b	government hospital beds	number of recorded government hospital beds from 1984-2014
pvt_b	private hospital beds	number of recorded private hospital beds from 1984-2014
tb	number of tuberculosis cases	number of recorded tuberculosis cases in the Philippines from 1984-2014
doc	doctors	number of government doctors from 1984-2014
nurses	nurses	number of government doctors from 1984-2014
visitor	visitor arrivals	the number of tourists who went to the Philippines and stayed at least one night in a collective or private accommodation in the country
f_pop	total female population	female population between the ages 15-19 from 1984-2014
unemp	unemployment rate	percentage of the total number of unemployed persons to the total number of persons in the labor force from 1984-2014
urban	urban population growth	refers to people living in urban areas as defined by national statistical offices from 1984-2014
marriages	number of registered marriages	number of registered marriages from 1984-2014
pop	population size	all registered Filipino citizens from 1984-2014
ofw	number of OFW's deployed	the number of Overseas Filipino Workers who worked abroad at any time between 1984-2014.

C. Model Specification

The Vector Error Correction (VEC) model is a restricted Variance Autoregressive (VAR) designed for use with nonstationary series that are known to be cointegrated. The cointegration relations restrict the long-run behavior of the endogenous variables to converge to their cointegrating relationship while allowing for short-run adjustment dynamics. The VEC Model is of the form:

$$\Delta y_t = \beta_0 + \sum_{i=1}^{n} \beta_i \Delta y_{t-1} + \sum_{i=0}^{n} \delta_i \Delta x_{t-i} + \varphi_i z_{t-1} + \varepsilon_t$$

$where\ \beta_0\ is\ the\ intercept$

$\beta_i's\ are\ the\ coefficients\ of\ the\ lagged\ values\ of\ y$

$\delta_i' sare\ the\ coefficients\ of\ the\ lagged\ values\ of\ all\ the\ other\ endogenous\ variables$

$\varphi_i' sare\ the\ coefficients\ of\ the\ cointegrating\ equations$

$\varepsilon_t\ is\ the\ error\ term$

The cointegrating equations are of the form:

$$z_{t-i} = y_{t-1} - \sum_{i=0}^{n} \gamma_i x_{i_{t-1}}$$

$where\ \gamma_i's\ are\ the\ coefficient\ of\ the\ first\ lags\ of\ the\ endogeneous\ variables$

D. Model Building Procedure: Overview

Individual unit root tests were performed to each of the 16 variables to test for stationarity and appropriate transformations were applied. Granger Causality was used to test for exogeneity of the variables with HIV. Since endogenous variables were present, the Vector Autoregression Model (VAR) was used. Only those variables that Granger caused HIV were utilized in the VAR model. In order to satisfy the I(1) assumption of the VAR, the variables that are I(2) were removed. The Lag Length Criteria was used to determine the optimal lag and the Johansen's Cointegration test was then used to check whether the variables are cointegrated. Since cointegration was present, the Vector Error Correction Model (VECM) was used. To check for the adequacy of the VECM, diagnostic procedures were carried out.

IV. RESULTS AND DISCUSSION

A. Preliminary Tests

Individual Unit Root tests were performed to each of the 16 variables. The variables hiv, brgy, and f_pop are trend stationary. They were detrended by obtaining their first difference. The variable pop is integrated of order 3 and all the other variables are integrated of order 1.

Table A.1. Summary of Individual Unit Root Tests

Variable	p-value				Integration Order
	I(0)	I(1)	I(2)	I(3)	
*hiv**	0.0226	0.0136			1
*brgy**	0.0025	0.0000			1
doc	0.5615	0.0006			1
*f_pop**	0.0085	0.0277			1
govt_b	0.1088	0.0000			1
govt_h	0.5928	0.0008			1
marriages	0.5555	0.0092			1
nurses	0.0976	0.0001			1
ofw	0.9989	0.0054			1
pop	0.0054	0.1874	0.1794	0.0013	3
pvt_b	0.9740	0.0004			1
pvt_h	0.0004	0.0168			1
tb	0.4097	0.0000			1
unemp	0.4877	0.0001			1
urban	0.2528	0.0029			1
visitor	0.9996	0.0068			1

*detrended variables

Pairwise Granger Causality was performed to test for the exogeneity of the variables with HIV. The test was done at lag 6 which is the minimum number of lags for annual data. The table below summarizes the results.

Table A.2. Summary of Results from Granger Causality

Y Granger Causes X	X Granger Causes Y	Bi-conditional	No Relationship
govt_h	brgy		doctors
pvt_h	f_pop		govt_b
	marriages		nurses

	ofw		tb
	pop		unemp
	pvt_b		urban
			visitor

Govt_h and Pvt_h together with those variables that do not exhibit any relationship with HIV were removed from the analysis. In order to satisfy the I(1) assumption of the VAR, the variable pop that is I(3) was removed. The VAR model included the following I(1) variables: hiv, brgy, f_pop, marriages, ofw, pvt_b.

The Lag Length Criteria was used to determine the optimal number of lags. However, since the number of observations was insufficient, the maximum lag to include is only up to 3.

Table A.3. Lag Length Criteria

VAR Lag Order Selection Criteria
Endogenous variables: HIV_STAT BRGY_STAT F_POP_STAT MARRIAGES_STAT OFW_STAT PVT_B_STAT
Exogenous variables: C
Date: 12/02/18 Time: 11:37
Sample: 1984 2014
Included observations: 27

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1619.101	NA	7.67e+44	120.3778	120.6658	120.4635
1	-1541.516	114.9403*	3.79e+43	117.2975	119.3132*	117.8969
2	-1501.943	41.03924	4.55e+43	117.0328	120.7763	118.1459
3	-1425.824	45.10716	1.08e+43*	114.0611*	119.5324	115.6880*

Lag 3 was selected since the Final Prediction Error (FPE), Akaike Information Criterion (AIC), and Hannan-Quinn Information Criterion (HQ) are smallest at this lag.

The Johansen's Cointegration Test was used to check whether the variables are cointegrated. The results are as follows.

Table A.4. Johansen Cointegration Test Summary

Date: 12/02/18 Time: 11:39
Sample: 1984 2014
Included observations: 27
Series: HIV_STAT BRGY_STAT F_POP_STAT MARRIAGES_STAT OFW_STAT PVT_B_STAT
Lags interval: 1 to 2

Selected (0.05 level*)
Number of Cointegrating
Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	3	3	3	4	3
Max-Eig	3	2	2	2	2

*Critical values based on MacKinnon-Haug-Michelis (1999)

Information Criteria by
Rank and Model

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or No. of CEs	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
	Log Likelihood by Rank (rows) and Model (columns)				
0	-1511.369	-1511.369	-1508.212	-1508.212	-1496.754
1	-1481.207	-1479.986	-1477.079	-1435.290	-1426.028
2	-1463.928	-1454.832	-1451.926	-1406.777	-1397.517
3	-1451.165	-1441.764	-1438.942	-1391.692	-1382.875
4	-1444.257	-1433.563	-1431.014	-1380.536	-1374.691
5	-1440.066	-1428.467	-1427.792	-1372.615	-1371.563
6	-1439.152	-1425.824	-1425.824	-1369.827	-1369.827

Since cointegration is present, VEC-M is used with 3 cointegrating equations. (See Section B of Appendix for the full VEC-M output). It should be noted that the series used for VEC-M are the non-stationary data series. Block Exogeneity Wald Tests were performed to be able to determine the Cholesky ordering. The network graph below contains information on which series Granger causes another series. An arrow coming from a series means that the series Granger causes the series when the arrow is pointing at a 0.05 level of significance.

Figure A.1.: Network Graph from the Granger Causality Test

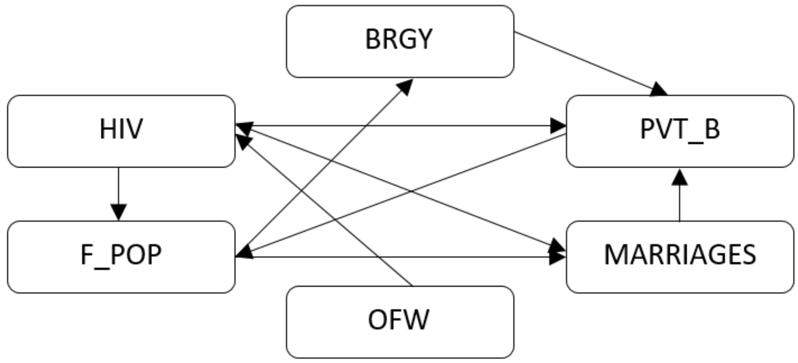


Table A.5. VEC Granger Causality

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/02/18 Time: 11:44
Sample: 1984 2014
Included observations: 28

Dependent variable: D(HIV)

Excluded	Chi-sq	df	Prob.
D(BRGY)	0.021294	2	0.9894
D(MARRIAGES)	9.417983	2	0.0090
D(PVT_B)	0.864352	2	0.6491
D(OFW)	7.455454	2	0.0240
D(F_POP)	5.562246	2	0.0620
All	26.68880	10	0.0029

The Cholesky ordering based on the results of the Granger Causality test would be: *hiv, marriages, ofw, f_pop, pvt_b, brgy*. This will be used in the VEC Model.

B. Model Building

The VEC Model is as follows:

$$\Delta HIV_t = -0.0404323\Delta HIV_{t-1} + 0.047394\Delta\, HIV_{t-2} + 0.003515\Delta\, marriages_{t-1}$$
$$+0.001690\Delta\, marriages_{t-2} + 0.00519\Delta\, ofw_{t-1} + 0.000858\Delta\, ofw_{t-2}$$
$$+0.005483\ \Delta fpop_{t-1} - 0.001390\ \Delta fpop_{t-2} + 0.00702\Delta\, pvtb_{t-1}$$
$$+0.016530\Delta pvtb_{t-2} - 0.000659\Delta\, brgy_{t-1} - 0.00266\Delta brgy_{t-2}$$
$$+0.254916 z_{t-1} - 0.002073 z_{t-2} + 0.0000326 z_{t-3}$$

Cointegrating equations:

$$z_{t-1} = 1.0000\ HIV_{t-1} - 0.000121 fpop_{t-1} - 0.006382 pvtb_{t-1} - 0.073197 brgy_{t-1}$$
$$-940.0616$$

$$z_{t-2} = 1.0000\ marriages_{t-1} - 0.030237 fpop_{t-1} - 9.747252 pvtb_{t-1} - 12.74312\ brgy_{t-1}$$
$$+576{,}071.5$$

$$z_{t-3} = 1.0000\ ofw_{t-1} + 0.380574\ fpop_{t-1} + 61.65330\ pvtb_{t-1} - 122.2489\ brgy_{t-1}$$
$$-3175989$$

From the Lag Length Criteria,the optimal lag obtained is lag 3. However,if lag 3 were to be used in the VEC model estimation won't run. With this, lag 2 was chosen instead and from the Lag Exclusion Test, lag 2 was found to be significant.

Table B.2. Lag Exclusion Criteria

VEC Lag Exclusion Wald Tests
Date: 12/02/18 Time: 11:31
Sample: 1984 2014
Included observations: 28

Chi-squared test statistics for lag exclusion:
Numbers in [ ] are p-values

	D(HIV)	D(MARRIAGES)	D(OFW)	D(F_POP)	D(PVT_B)	D(BRGY)	Joint
DLag 1	16.18204	12.71522	6.388490	32.89480	20.14963	10.03367	441.9762
	[0.012810]	[0.047788]	[0.381106]	[1.10e-05]	[0.002605]	[0.123241]	[0.000000]
DLag 2	9.693174	8.268967	5.901713	21.27593	18.50137	5.866092	253.0685
	[0.138182]	[0.219053]	[0.434290]	[0.001636]	[0.005094]	[0.438357]	[0.000000]
df	6	6	6	6	6	6	36

Based on the results of the Lag Exclusion tests, all lags were found to be significant. Thus, we will retain the current model.

C. Diagnostic Checking

The Jarque-Bera test for normality of residuals was performed and since its p-value is 0.7276 (See appendix C.1.), we conclude that the residuals satisfy the normality assumption. The correlograms of the residuals were also inspected and no ACF's exceeded the bartlett band, hence the residuals are not autocorrelated (See appendix C.2.). The correlogram of the squared residuals was examined on all variables. Upon checking, only the ACF of pvt_b at lag 2 exceeded the Bartlett band. To test this formally, the homoskedasticity of the residuals was checked by the ARCH LM Test at lag 6. The residuals satisfy the homoskedasticty assumption since all the p-values based on the F-distribution are greater than 0.05.

Figure C.3.1: HIV Correlogram of Squared Residuals and ARCH LM Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.105	0.105	0.3447	0.557
		2	-0.266	-0.280	2.6274	0.269
		3	0.088	0.168	2.8858	0.410
		4	-0.098	-0.239	3.2186	0.522
		5	-0.156	-0.024	4.1026	0.535
		6	-0.017	-0.116	4.1135	0.661
		7	-0.090	-0.108	4.4342	0.729
		8	-0.180	-0.212	5.8010	0.670
		9	-0.058	-0.112	5.9487	0.745
		10	0.206	0.128	7.9258	0.636
		11	0.096	-0.030	8.3822	0.679
		12	0.056	0.121	8.5450	0.741

Heteroskedasticity Test: ARCH

F-statistic	2.612577	Prob. F(6,15)	0.0615
Obs*R-squared	11.24222	Prob. Chi-Square(6)	0.0812

Figure C.3.2: Marriages Correlogram of Squared Residuals and ARCH LM Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.013	0.013	0.0050	0.943
		2	-0.074	-0.074	0.1816	0.913
		3	-0.124	-0.123	0.6997	0.873
		4	-0.082	-0.087	0.9360	0.919
		5	0.074	0.057	1.1349	0.951
		6	-0.226	-0.261	3.0783	0.799
		7	0.167	0.177	4.1968	0.757
		8	-0.042	-0.097	4.2697	0.832
		9	0.050	0.046	4.3817	0.885
		10	-0.046	-0.080	4.4819	0.923
		11	-0.154	-0.100	5.6517	0.896
		12	-0.008	-0.106	5.6549	0.932

Heteroskedasticity Test: ARCH

F-statistic	0.432155	Prob. F(6,15)	0.8462
Obs*R-squared	3.242467	Prob. Chi-Square(6)	0.7779

Figure C.3.3: OFW Correlogram of Squared Residuals and ARCH LM Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.098	-0.098	0.2961	0.586
		2	-0.176	-0.187	1.2932	0.524
		3	-0.163	-0.211	2.1819	0.536
		4	0.295	0.232	5.2216	0.265
		5	-0.075	-0.090	5.4246	0.366
		6	-0.104	-0.068	5.8352	0.442
		7	0.070	0.139	6.0309	0.536
		8	-0.078	-0.219	6.2873	0.615
		9	-0.089	-0.080	6.6387	0.675
		10	-0.057	-0.042	6.7905	0.745
		11	0.236	0.097	9.5533	0.571
		12	-0.046	0.023	9.6650	0.645

Heteroskedasticity Test: ARCH

F-statistic	2.101184	Prob. F(6,15)	0.1141
Obs*R-squared	10.04656	Prob. Chi-Square(6)	0.1227

Figure C.3.4: F_POP Correlogram of Squared Residuals and ARCH LM Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.163	-0.163	0.8288	0.363
		2	-0.098	-0.128	1.1377	0.566
		3	-0.053	-0.096	1.2306	0.746
		4	0.073	0.035	1.4191	0.841
		5	-0.084	-0.085	1.6787	0.892
		6	-0.175	-0.210	2.8547	0.827
		7	0.057	-0.033	2.9840	0.886
		8	-0.091	-0.164	3.3315	0.912
		9	-0.097	-0.193	3.7500	0.927
		10	-0.158	-0.295	4.9115	0.897
		11	0.234	0.016	7.6170	0.747
		12	-0.081	-0.201	7.9602	0.788

Heteroskedasticity Test: ARCH

F-statistic	0.429138	Prob. F(6,15)	0.8482
Obs*R-squared	3.223145	Prob. Chi-Square(6)	0.7804

Figure C.3.5: PVT_B Correlogram of Squared Residuals and ARCH LM Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.059	0.059	0.1074	0.743
		2	0.554	0.552	10.006	0.007
		3	0.062	0.022	10.137	0.017
		4	0.271	-0.052	12.715	0.013
		5	0.039	-0.016	12.771	0.026
		6	0.121	-0.014	13.328	0.038
		7	0.008	-0.019	13.330	0.064
		8	0.047	-0.005	13.423	0.098
		9	-0.114	-0.158	14.003	0.122
		10	0.115	0.152	14.617	0.147
		11	-0.139	-0.014	15.566	0.158
		12	0.035	-0.112	15.632	0.209

Heteroskedasticity Test: ARCH

F-statistic	2.202834	Prob. F(6,15)	0.1006
Obs*R-squared	10.30493	Prob. Chi-Square(6)	0.1124

Figure C.3.6: BRGY Correlogram of Squared Residuals and ARCH LM Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.107	0.107	0.3576	0.550
		2	-0.252	-0.267	2.4107	0.300
		3	-0.278	-0.235	5.0150	0.171
		4	0.107	0.108	5.4154	0.247
		5	0.194	0.061	6.7934	0.236
		6	-0.075	-0.137	7.0100	0.320
		7	-0.309	-0.220	10.827	0.146
		8	-0.106	-0.059	11.299	0.185
		9	0.190	0.046	12.894	0.167
		10	0.025	-0.183	12.923	0.228
		11	-0.130	-0.092	13.758	0.247
		12	-0.204	-0.142	15.934	0.194

Heteroskedasticity Test: ARCH

F-statistic	0.647910	Prob. F(6,15)	0.6915
Obs*R-squared	4.528088	Prob. Chi-Square(6)	0.6056

D. Final VEC Model

The VEC Model is as follows:

$$\Delta HIV_t = -0.0404323\Delta HIV_{t-1} + 0.047394\Delta\, HIV_{t-2} + 0.003515\Delta\, marriages_{t-1}$$
$$+0.001690\Delta\, marriages_{t-2} + 0.00519\Delta\, ofw_{t-1} + 0.000858\Delta\, ofw_{t-2}$$
$$+0.005483\ \Delta fpop_{t-1} - 0.001390\ \Delta fpop_{t-2} + 0.00702\Delta\, pvtb_{t-1}$$
$$+0.016530\Delta pvtb_{t-2} — 0.000659\Delta\, brgy_{t-1} - 0.00266\Delta brgy_{t-2}$$
$$+0.254916z_{t-1} - 0.002073z_{t-2} + 0.0000326z_{t-3}$$

Cointegrating equations:

$$z_{t-1} = 1.0000\, HIV_{t-1} - 0.000121fpop_{t-1} - 0.006382pvtb_{t-1} - 0.073197brgy_{t-1}$$
$$-940.0616$$

$$z_{t-2} = 1.0000\, marriages_{t-1} - 0.030237fpop_{t-1} - 9.747252pvtb_{t-1} - 12.74312\, brgy_{t-1}$$
$$+576{,}071.5$$

$$z_{t-3} = 1.0000\, ofw_{t-1} + 0.380574\, fpop_{t-1} + 61.65330\, pvtb_{t-1} - 122.2489\, brgy_{t-1}$$
$$-3175989$$

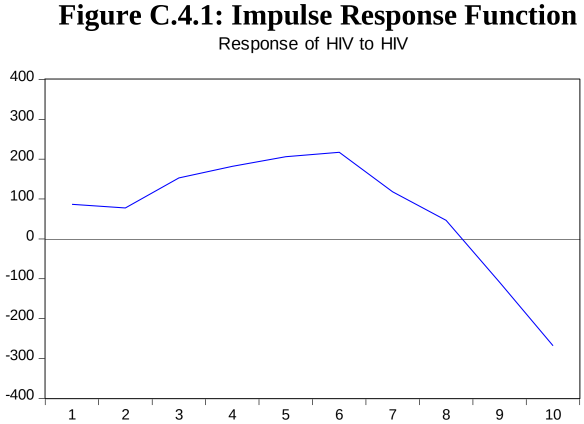
E. Interpretation

On the average, holding all other variables constant, a percent change in the number of registered marriages is associated with a 0.003515% increase in the number of HIV cases. A percent change in the number of deployed OFW’s is associated with a 0.00519% increase in the number of HIV cases. A percent change in the number of female population is associated with a 0.005483% increase in the number of HIV cases. A percent change in the number of private hospital beds is associated with a 0.00702% increase in the number of HIV cases. A percent change in the number of barangay health stations is associated with a 0.000659% decrease in the number of HIV cases.

These findings are supported by previous studies which were presented in the review of related literature.

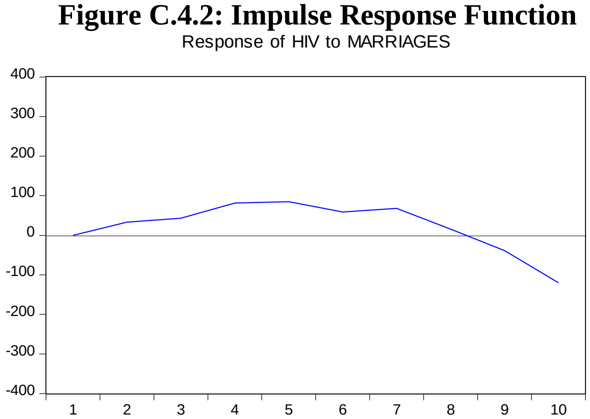
Impulse Response Functions

Figure C.4.1: Impulse Response Function



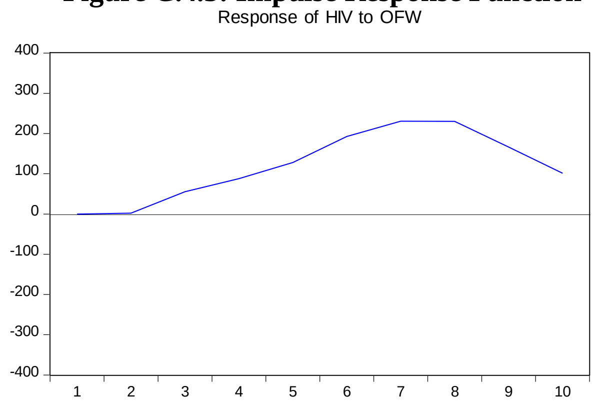
It can be drawn from the graph that HIV had a slightly decreasing trend and it responded positively to a shock that occurred at the second period and this was carried over for four more periods. Another shock at the sixth period resulted to a negative response.

Figure C.4.2: Impulse Response Function



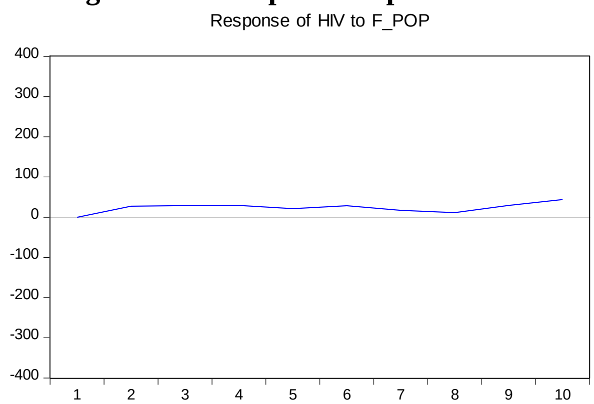
It can be drawn from the graph that HIV responded negatively to a shock that occurred at the seventh period.

Figure C.4.3: Impulse Response Function



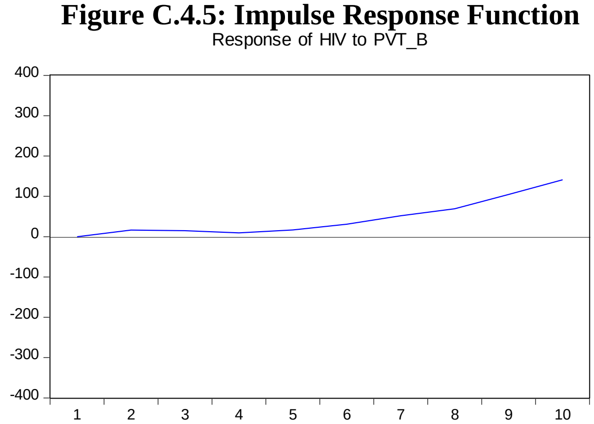
It can be drawn from the graph that HIV had an increasing trend and it responded negatively to a shock that occurred at the eight period.

Figure C.4.4: Impulse Response Function



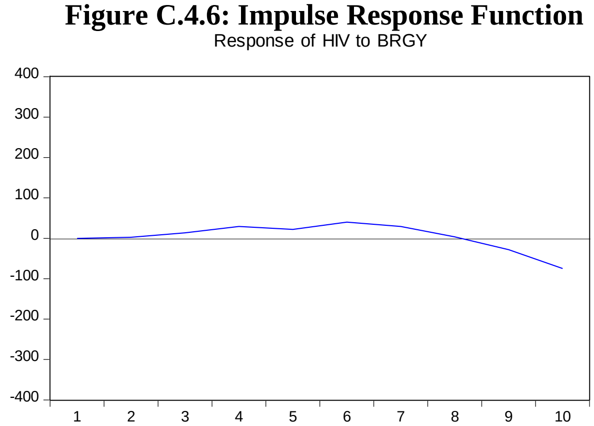
It can be drawn from the graph that HIV had an increasing trend and a shock that occurred at the second period resulted to a somewhat steady trend that was carried over for six more periods. Another shock at the eighth period resulted to a positive response.

Figure C.4.5: Impulse Response Function



It can be drawn from the graph that HIV had an increasing trend and a shock that occurred at the second period resulted to a somewhat steady trend that was carried over for two more periods. Another shock at the fourth period resulted to a positive response.

Figure C.4.6: Impulse Response Function



It can be drawn from the graph that HIV had an increasing trend and it responded negatively to a shock that occurred at the sixth period.

V. CONCLUSION

From the final model, it can be concluded that the number of HIV cases in the Philippines has a positive relationship with number of registered marriages, number of OFWs deployed, female population, and number of private hospital beds and it has a negative relationship with the number of barangay health stations. These findings are supported by the review of related literature.

As seen in the impulse response function graphs, a policy intervention directed to marriages and OFWs will result to a decrease in the number of HIV cases in the Philippines. While a policy intervention directed to the female population, private hospital beds, and barangay health stations will not result to a significant decrease in the number of HIV cases. Thus construction of policies will be deemed the most effective if the focus would be on marriages and OFWs.

VI. RECOMMENDATION AND IMPLICATIONS

Recommendation and Implications on Policy Making

There should be a continuous practice of safe sex even among married couples. Family planning methods should be given more importance to help in having and maintaining healthier relationships.

OFWs should have more access to health services and be given more health benefits. There should also be a stricter health screening before leaving the country.

Sex education should be taught in schools since many HIV patients are among the youths. It is of great importance that they know basic knowledge about sex in order to avoid Sexually Transmitted Diseases (STDs) like HIV.

Hospitals, barangay health station medical practitioners, and health facilities should be made accessible to accommodate the increasing number of HIV cases. Every barangay should have a barangay health station wherein services like HIV testing is available.

Recommendation on Future Studies

The researchers wanted to study the more recent data on the number of HIV cases in the Philippines. However, the only available data were annual. Thus, a minimum of 30 years' worth of data were needed. The researchers worked with annual data from 1984 until 2014. As a result, fewer independent variables were considered. Other variables that were desired to be in the study were not included because there were no available data from 1984. If high frequency data (i.e. quarterly or monthly) were to be available and easily accessible, the model could be improved further. This study still needs additional references and review of related literature for the betterment of the analysis and conclusions.

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APPENDIX

A.1. Individual Unit Root Tests

Variable	p-value				Integration Order
	I(0)	I(1)	I(2)	I(3)	
*hiv**	0.0226	0.0136			1
*brgy**	0.0025	0.0000			1
doc	0.5615	0.0006			1
*f_pop**	0.0085	0.0277			1
govt_b	0.1088	0.0000			1
govt_h	0.5928	0.0008			1
marriages	0.5555	0.0092			1
nurses	0.0976	0.0001			1
ofw	0.9989	0.0054			1
pop	0.0054	0.1874	0.1794	0.0013	3
pvt_b	0.9740	0.0004			1
pvt_h	0.0004	0.0168			1
tb	0.4097	0.0000			1
unemp	0.4877	0.0001			1
urban	0.2528	0.0029			1
visitor	0.9996	0.0068			1

*detrended variables

A.2. Granger Causality
Pairwise Granger Causality Test

Pairwise Granger Causality Tests
Date: 12/02/18 Time: 00:53
Sample: 1984 2014
Lags: 6

Null Hypothesis:	Obs	F-Statistic	Prob.
BRGY does not Granger Cause HIV	25	5.887805073699275	0.004565111373995535
HIV does not Granger Cause BRGY		1.595847461669377	0.2308932478395778
DOCTORS does not Granger Cause HIV	25	0.1469283429695232	0.9861805411192748
HIV does not Granger Cause DOCTORS		0.1650201724181285	0.9814788607297942
F_POP does not Granger Cause HIV	25	13.50238468427173	0.0001021641564134776
HIV does not Granger Cause F_POP		1.933430325052487	0.155920616228397
GOVT_B does not Granger Cause HIV	25	0.4612701215737702	0.8239519123628056
HIV does not Granger Cause GOVT_B		0.7183544216774874	0.6427184963958241
GOVT_H does not Granger Cause HIV	25	1.639902343905377	0.2192159172457813
HIV does not Granger Cause GOVT_H		4.999413976174182	0.00870776097149314
INFLATION does not Granger Cause HIV	25	0.9906033541180859	0.4733784180329223
HIV does not Granger Cause INFLATION		1.728148937915634	0.1976783386294179
MARRIAGES does not Granger Cause HIV	25	3.28846255966262	0.0375950826528409
HIV does not Granger Cause MARRIAGES		1.039972668995051	0.4468220215636251

NURSES does not Granger Cause HIV	25	0.07300496293706274	0.9978594127767502
HIV does not Granger Cause NURSES		0.170227540953362	0.9799897752189754
OFW does not Granger Cause HIV	25	5.54389067091184	0.005816140253988602
HIV does not Granger Cause OFW		1.611344751508396	0.2267118986063531
POP does not Granger Cause HIV	25	14.41843681179536	7.339837300611661e-05
HIV does not Granger Cause POP		1.288313885526412	0.3327963175259839
PVT_B does not Granger Cause HIV	25	4.010212303765958	0.01948819387091252
HIV does not Granger Cause PVT_B		1.194265634901848	0.3722667702514377
PVT_H does not Granger Cause HIV	25	2.154924583341368	0.1214173871725224
HIV does not Granger Cause PVT_H		5.584067845655069	0.005651130528954654
TB does not Granger Cause HIV	25	0.3814338119010399	0.8770963578604786
HIV does not Granger Cause TB		0.8888617423551092	0.5322843795686494
UNEMP does not Granger Cause HIV	25	0.199764815479628	0.9704190752123509
HIV does not Granger Cause UNEMP		0.6813027860294209	0.6683154978911402
URBAN does not Granger Cause HIV	25	0.07365713250900044	0.9978061518267696
HIV does not Granger Cause URBAN		0.358354622492043	0.8914910955207754
VISITOR does not Granger Cause HIV	25	2.716234292822664	0.06642355275782379
HIV does not Granger Cause VISITOR		0.3380212478711661	0.9036991540997225

A.3. Lag Length Criteria

VAR Lag Order Selection Criteria
Endogenous variables: HIV_STAT BRGY_STAT F_POP_STAT MARRIAGES_STAT OFW_STAT PVT_B_STAT
Exogenous variables: C
Date: 12/02/18 Time: 11:37
Sample: 1984 2014
Included observations: 27

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1619.101	NA	7.67e+44	120.3778	120.6658	120.4635
1	-1541.516	114.9403*	3.79e+43	117.2975	119.3132*	117.8969
2	-1501.943	41.03924	4.55e+43	117.0328	120.7763	118.1459
3	-1425.824	45.10716	1.08e+43*	114.0611*	119.5324	115.6880*

A.4. Johansen Cointegration Summary Test

Date: 12/02/18 Time: 11:39
Sample: 1984 2014
Included observations: 27
Series: HIV_STAT BRGY_STAT F_POP_STAT MARRIAGES_STAT OFW_STAT PVT_B_STAT
Lags interval: 1 to 2

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	3	3	3	4	3
Max-Eig	3	2	2	2	2

*Critical values based on MacKinnon-Haug-Michelis (1999)

Information Criteria by Rank and Model

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or No. of CEs	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
	Log Likelihood by Rank (rows) and Model (columns)				
0	-1511.369	-1511.369	-1508.212	-1508.212	-1496.754
1	-1481.207	-1479.986	-1477.079	-1435.290	-1426.028
2	-1463.928	-1454.832	-1451.926	-1406.777	-1397.517
3	-1451.165	-1441.764	-1438.942	-1391.692	-1382.875
4	-1444.257	-1433.563	-1431.014	-1380.536	-1374.691
5	-1440.066	-1428.467	-1427.792	-1372.615	-1371.563
6	-1439.152	-1425.824	-1425.824	-1369.827	-1369.827

A.5. VEC Granger Causality

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 12/02/18 Time: 11:44
Sample: 1984 2014
Included observations: 28

Dependent variable: D(HIV)

Excluded	Chi-sq	df	Prob.
D(BRGY)	0.021294	2	0.9894
D(MARRIAGES)	9.417983	2	0.0090
D(PVT_B)	0.864352	2	0.6491
D(OFW)	7.455454	2	0.0240
D(F_POP)	5.562246	2	0.0620

All	26.68880	10	0.0029

B.1. Vector Error Correlation Estimates

Vector Error Correction Estimates
Date: 12/02/18 Time: 03:25
Sample (adjusted): 1987 2014
Included observations: 28 after adjustments
Standard errors in ( ) & t-statistics in [ ]

CointegratingEq:	CointEq1	CointEq2	CointEq3
HIV(-1)	1.000000	0.000000	0.000000
MARRIAGES(-1)	0.000000	1.000000	0.000000
OFW(-1)	0.000000	0.000000	1.000000
F_POP(-1)	-0.000121	-0.030237	0.380574
	(4.5E-05)	(0.00781)	(0.08761)
	[-2.68186]	[-3.87180]	[4.34406]
PVT_B(-1)	-0.006382	-9.747252	61.65330
	(0.01329)	(2.31062)	(25.9205)
	[-0.48008]	[-4.21846]	[2.37855]
BRGY(-1)	-0.073197	-12.74312	-122.2489
	(0.02124)	(3.69237)	(41.4210)
	[-3.44548]	[-3.45120]	[-2.95137]
C	-940.0616	576071.5	-3175989.
	(622.768)	(108239.)	(1214230)
	[-1.50949]	[5.32220]	[-2.61564]

Error Correction:	D(HIV)	D(MARRIAGES)	D(OFW)	D(F_POP)	D(PVT_B)	D(BRGY)
CointEq1	0.254916	-84.35791	-24.50686	-39.69914	5.278537	5.167516
	(0.19237)	(40.1505)	(124.277)	(15.0922)	(1.72862)	(3.98811)
	[1.32513]	[-2.10104]	[-0.19719]	[-2.63044]	[3.05361]	[1.29573]
CointEq2	-0.002073	0.035753	-0.781839	0.133539	0.009375	0.070877
	(0.00103)	(0.21456)	(0.66412)	(0.08065)	(0.00924)	(0.02131)
	[-2.01630]	[0.16664]	[-1.17726]	[1.65579]	[1.01491]	[3.32571]
CointEq3	3.26E-05	-0.047429	0.027360	0.005058	0.004760	0.009195
	(0.00018)	(0.03660)	(0.11330)	(0.01376)	(0.00158)	(0.00364)
	[0.18599]	[-1.29572]	[0.24148]	[0.36759]	[3.02053]	[2.52899]
D(HIV(-1))	-0.404323	295.1628	120.5676	89.27530	-15.05689	-8.167921
	(0.45993)	(95.9939)	(297.129)	(36.0832)	(4.13288)	(9.53498)
	[-0.87909]	[3.07481]	[0.40578]	[2.47415]	[-3.64320]	[-0.85663]
D(HIV(-2))	0.047394	15.10362	-443.0687	59.12623	-8.894098	-2.572338
	(0.67502)	(140.886)	(436.084)	(52.9579)	(6.06566)	(13.9941)
	[0.07021]	[0.10720]	[-1.01602]	[1.11648]	[-1.46630]	[-0.18382]
D(MARRIAGES(-1))	0.003515	-0.116851	1.331093	0.090027	-0.011131	-0.018086
	(0.00116)	(0.24197)	(0.74897)	(0.09095)	(0.01042)	(0.02403)
	[3.03194]	[-0.48291]	[1.77723]	[0.98981]	[-1.06847]	[-0.75250]

D(MARRIAGES(-2))	0.001690	-0.364087	1.393601	0.013476	0.028232	-0.017747
	(0.00139)	(0.28908)	(0.89479)	(0.10866)	(0.01245)	(0.02871)
	[1.21989]	[-1.25946]	[1.55746]	[0.12401]	[2.26839]	[-0.61807]
D(OFW(-1))	0.000519	-0.069170	-0.140206	-0.014415	0.004923	-0.012026
	(0.00038)	(0.07839)	(0.24265)	(0.02947)	(0.00338)	(0.00779)
	[1.38202]	[-0.88234]	[-0.57781]	[-0.48918]	[1.45872]	[-1.54438]
D(OFW(-2))	0.000858	0.053294	0.037275	0.036928	-0.006417	0.009448
	(0.00042)	(0.08706)	(0.26948)	(0.03273)	(0.00375)	(0.00865)
	[2.05608]	[0.61215]	[0.13832]	[1.12841]	[-1.71191]	[1.09258]
D(F_POP(-1))	0.005483	0.190950	-0.122558	0.566036	-0.004398	-0.142979
	(0.00275)	(0.57485)	(1.77933)	(0.21608)	(0.02475)	(0.05710)
	[1.99081]	[0.33217]	[-0.06888]	[2.61955]	[-0.17771]	[-2.50404]
D(F_POP(-2))	-0.001390	-0.749998	-0.001306	-0.254247	0.013015	0.060686
	(0.00196)	(0.40991)	(1.26878)	(0.15408)	(0.01765)	(0.04072)
	[-0.70773]	[-1.82968]	[-0.00103]	[-1.65009]	[0.73746]	[1.49048]
D(PVT_B(-1))	0.007027	-1.040071	-14.58753	-3.310300	-0.337285	-0.213133
	(0.02281)	(4.76091)	(14.7364)	(1.78958)	(0.20497)	(0.47290)
	[0.30806]	[-0.21846]	[-0.98990]	[-1.84976]	[-1.64551]	[-0.45070]
D(PVT_B(-2))	0.016530	-4.358934	-10.67799	-3.707745	0.125438	-0.210170
	(0.01779)	(3.71207)	(11.4899)	(1.39533)	(0.15982)	(0.36872)
	[0.92940]	[-1.17426]	[-0.92934]	[-2.65725]	[0.78488]	[-0.57001]
D(BRGY(-1))	-0.000659	-6.769047	11.09182	-0.565992	1.054162	1.028973
	(0.03717)	(7.75823)	(24.0140)	(2.91625)	(0.33402)	(0.77062)
	[-0.01772]	[-0.87250]	[0.46189]	[-0.19408]	[3.15599]	[1.33526]
D(BRGY(-2))	-0.002666	1.740779	15.19339	0.430522	0.319269	0.559488
	(0.02943)	(6.14181)	(19.0107)	(2.30865)	(0.26443)	(0.61006)
	[-0.09061]	[0.28343]	[0.79920]	[0.18648]	[1.20740]	[0.91710]
R-squared	0.978781	0.667722	0.665267	0.936038	0.820790	0.740379
Adj. R-squared	0.955930	0.309885	0.304785	0.867157	0.627794	0.460788
Sum sq. resids	97790.16	4.26E+09	4.08E+10	6.02E+08	7896147.	42029061
S.E. equation	86.73131	18102.03	56030.99	6804.380	779.3561	1798.056
F-statistic	42.83316	1.865992	1.845493	13.58907	4.252895	2.648075
Log likelihood	-153.9475	-303.4945	-335.1312	-276.0977	-215.4258	-238.8336
Akaike AIC	12.06768	22.74961	25.00937	20.79269	16.45899	18.13097
Schwarz SC	12.78136	23.46329	25.72305	21.50638	17.17267	18.84465
Mean dependent	213.6429	1437.179	51944.79	260992.5	367.6786	435.8571
S.D. dependent	413.1476	21790.46	67199.91	18668.90	1277.451	2448.631

Determinant resid covariance (dof adj.)	3.27E+40
Determinant resid covariance	3.28E+38
Log likelihood	-1479.988
Akaike information criterion	113.6420
Schwarz criterion	118.9232

B.2. Lag Exclusion Criteria

VEC Lag Exclusion Wald Tests
Date: 12/02/18   Time: 11:31
Sample: 1984 2014
Included observations: 28

Chi-squared test statistics for lag exclusion:
Numbers in [ ] are p-values

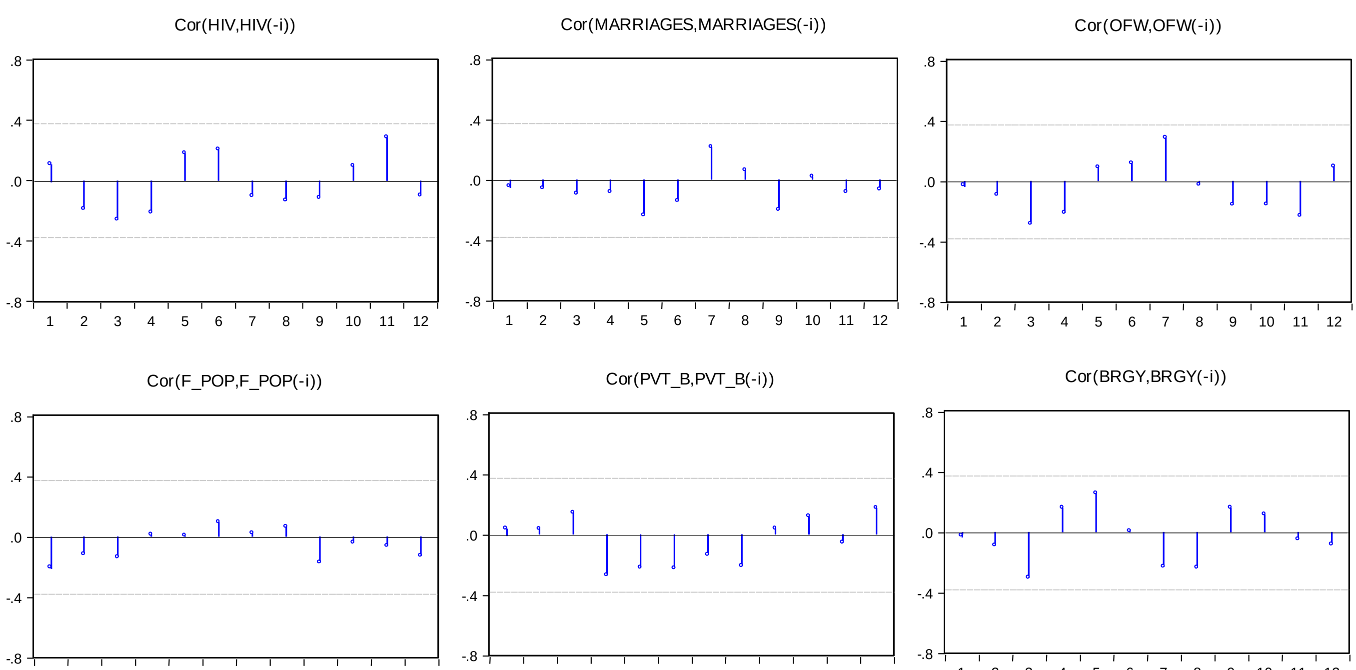
	D(HIV)	D(MARRIAGES)	D(OFW)	D(F_POP)	D(PVT_B)	D(BRGY)	Joint
DLag 1	16.18204 [0.012810]	12.71522 [0.047788]	6.388490 [0.381106]	32.89480 [1.10e-05]	20.14963 [0.002605]	10.03367 [0.123241]	441.9762 [0.000000]
DLag 2	9.693174 [0.138182]	8.268967 [0.219053]	5.901713 [0.434290]	21.27593 [0.001636]	18.50137 [0.005094]	5.866092 [0.438357]	253.0685 [0.000000]
df	6	6	6	6	6	6	36

C. Diagnostic Checking

C.1. Checking for Normality

Component	Jarque-Bera	df	Prob.
1	0.509436	2	0.7751
2	1.347947	2	0.5097
3	4.999941	2	0.0821
4	0.266029	2	0.8755
5	6.041198	2	0.0488
6	0.920734	2	0.6311
Joint	170.0495	182	0.7276

C.2. Checking the Correlograms



C.3. Checking for Heteroskedasticity

Figure C.3.1: HIV Correlogram of Squared Residuals and ARCH LM Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.105	0.105	0.3447	0.557
		2	-0.266	-0.280	2.6274	0.269
		3	0.088	0.168	2.8858	0.410
		4	-0.098	-0.239	3.2186	0.522
		5	-0.156	-0.024	4.1026	0.535
		6	-0.017	-0.116	4.1135	0.661
		7	-0.090	-0.108	4.4342	0.729
		8	-0.180	-0.212	5.8010	0.670
		9	-0.058	-0.112	5.9487	0.745
		10	0.206	0.128	7.9258	0.636
		11	0.096	-0.030	8.3822	0.679
		12	0.056	0.121	8.5450	0.741

Heteroskedasticity Test: ARCH

F-statistic	2.612577	Prob. F(6,15)	0.0615
Obs*R-squared	11.24222	Prob. Chi-Square(6)	0.0812

Figure C.3.2: Marriages Correlogram of Squared Residuals and ARCH LM Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.013	0.013	0.0050	0.943
		2	-0.074	-0.074	0.1816	0.913
		3	-0.124	-0.123	0.6997	0.873
		4	-0.082	-0.087	0.9360	0.919
		5	0.074	0.057	1.1349	0.951
		6	-0.226	-0.261	3.0783	0.799
		7	0.167	0.177	4.1968	0.757
		8	-0.042	-0.097	4.2697	0.832
		9	0.050	0.046	4.3817	0.885
		10	-0.046	-0.080	4.4819	0.923
		11	-0.154	-0.100	5.6517	0.896
		12	-0.008	-0.106	5.6549	0.932

Heteroskedasticity Test: ARCH

F-statistic	0.432155	Prob. F(6,15)	0.8462
Obs*R-squared	3.242467	Prob. Chi-Square(6)	0.7779

Figure C.3.3: OFW Correlogram of Squared Residuals and ARCH LM Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.098	-0.098	0.2961	0.586
		2	-0.176	-0.187	1.2932	0.524
		3	-0.163	-0.211	2.1819	0.536
		4	0.295	0.232	5.2216	0.265
		5	-0.075	-0.090	5.4246	0.366
		6	-0.104	-0.068	5.8352	0.442
		7	0.070	0.139	6.0309	0.536
		8	-0.078	-0.219	6.2873	0.615
		9	-0.089	-0.080	6.6387	0.675
		10	-0.057	-0.042	6.7905	0.745
		11	0.236	0.097	9.5533	0.571
		12	-0.046	0.023	9.6650	0.645

Heteroskedasticity Test: ARCH

F-statistic	2.101184	Prob. F(6,15)	0.1141
Obs*R-squared	10.04656	Prob. Chi-Square(6)	0.1227

Figure C.3.4: F_POP Correlogram of Squared Residuals and ARCH LM Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.163	-0.163	0.8288	0.363
		2	-0.098	-0.128	1.1377	0.566
		3	-0.053	-0.096	1.2306	0.746
		4	0.073	0.035	1.4191	0.841
		5	-0.084	-0.085	1.6787	0.892
		6	-0.175	-0.210	2.8547	0.827
		7	0.057	-0.033	2.9840	0.886
		8	-0.091	-0.164	3.3315	0.912
		9	-0.097	-0.193	3.7500	0.927
		10	-0.158	-0.295	4.9115	0.897
		11	0.234	0.016	7.6170	0.747
		12	-0.081	-0.201	7.9602	0.788

Heteroskedasticity Test: ARCH

F-statistic	0.429138	Prob. F(6,15)	0.8482
Obs*R-squared	3.223145	Prob. Chi-Square(6)	0.7804

Figure C.3.5: PVT_B Correlogram of Squared Residuals and ARCH LM Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.059	0.059	0.1074	0.743
		2	0.554	0.552	10.006	0.007
		3	0.062	0.022	10.137	0.017
		4	0.271	-0.052	12.715	0.013
		5	0.039	-0.016	12.771	0.026
		6	0.121	-0.014	13.328	0.038
		7	0.008	-0.019	13.330	0.064
		8	0.047	-0.005	13.423	0.098
		9	-0.114	-0.158	14.003	0.122
		10	0.115	0.152	14.617	0.147
		11	-0.139	-0.014	15.566	0.158
		12	0.035	-0.112	15.632	0.209

Heteroskedasticity Test: ARCH

F-statistic	2.202834	Prob. F(6,15)	0.1006
Obs*R-squared	10.30493	Prob. Chi-Square(6)	0.1124

Figure C.3.6: BRGY Correlogram of Squared Residuals and ARCH LM Test

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.107	0.107	0.3576	0.550
		2	-0.252	-0.267	2.4107	0.300
		3	-0.278	-0.235	5.0150	0.171
		4	0.107	0.108	5.4154	0.247
		5	0.194	0.061	6.7934	0.236
		6	-0.075	-0.137	7.0100	0.320
		7	-0.309	-0.220	10.827	0.146
		8	-0.106	-0.059	11.299	0.185
		9	0.190	0.046	12.894	0.167
		10	0.025	-0.183	12.923	0.228
		11	-0.130	-0.092	13.758	0.247
		12	-0.204	-0.142	15.934	0.194

Heteroskedasticity Test: ARCH

F-statistic	0.647910	Prob. F(6,15)	0.6915
Obs*R-squared	4.528088	Prob. Chi-Square(6)	0.6056

C.4. Impulse Response Functions