The impact of human capital flight on economic growth in Trinidad and Tobago

Paper submitted for coursework

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Date submitted: December 01, 2021

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Introduction

Abstract

This paper seeks to examine the relationship between human capital flight or “brain drain” and economic growth in Trinidad and Tobago. An empirical approach is used by applying the statistical technique of ordinary least squares (OLS) to develop a regression model. GDP growth (annual %) is used as a proxy for economic growth (as the endogenous variable) while net migration rate (NMR) is used as a proxy for human capital flight (as an exogenous variable). Other independent variables include personal remittances (current $US), as a proxy for positive benefits to emigration, and population growth (annual %) and net official development assistance per capita (ODA) (current $US) are included as control variables.

Subsequent sections of the paper include the Literature Review, Methodology, Output and Findings, Discussion, Limitations, Recommendations and Conclusion.

Overall, the model was found not to be significant with only the coefficient for population growth being significant and demonstrating a negative relationship with economic growth. However, although not significant, a negative relationship was found between economic growth and NMR, implying that economic growth increases as NMR decreases i.e. emigration is greater than immigration. This may warrant further exploration.

Limitations of the study include lack of relevant specific data, for example exact emigration rates, uncertainty regarding the endogeneity of NMR and the lack of rigour in applying the technique of OLS.

Context

Trinidad and Tobago (T & T) is a relatively small country in the Caribbean with an area of 4768 km^2 and a population of approximately 1.2 million (Anatol et al, 2013). As the closest Caribbean island to South America combined with economic dominance within the region, T & T has been a transit point for migrants seeking to gain entry to North and South America, as well as a destination for job and educational opportunities. The economy is driven by the energy sector (petroleum and natural gas production) where the GDP per capita has been one of the highest in Latin America (Central Intelligence Agency, 2021a). T & T can be considered a resource-rich country. However, due to recent hydrocarbon reserves shortages and depressed commodity prices, there has been general economic decline from 2009 to 2017.

The Real GDP per capita estimate for 2020 (in 2010 USD dollars) was $23,700 which is 80th highest in the world; however, growth in Real GDP has been generally negative for the past 6 years estimated at -2.6% in 2017 putting the country at 210th in the world (Central Intelligence Agency, 2021a). T & T ranks significantly low on the net migration rate of -5.18 per 1000 population at 203 out of all countries, meaning that there is a net outflow of migrants (Central Intelligence Agency, 2021b). In terms of annual personal remittances received, the country is ranked 136 as of 2018, significantly lower than the rest of the world (Index Mundi, 2021b). The estimated annual percent change in population for 2021 is -0.28 and ranks T & T at 214 in the world which is extremely low. In terms of Net Official Development Assistance (ODA) per capita, T & T is ranked at 137th in the world as of 2010, meaning that the country receives relatively little foreign aid (Index Mundi, 2021a).

Almost all Caribbean nations are included in the top 20 countries in the world for the highest tertiary-educated migration rates (Docquier and Marfouk, 2004). In contrast, most Caribbean nations are included among the top 30 countries for highest remittances as a fraction of GDP (Mishra, 2006) which shows that there can be some benefit to human capital flight. However, Mishra (2006) argues that when accounting for the welfare loss, domestic educational investment and the augmented emigration loss (positive externality due to knowledge transfer) the net effect of "brain drain" can be negative for Caribbean nations.

Steinberg (2017) found that under conditions of a resource boom, a tradable sector which is intensive in highly-skilled labour, and where the initial resource transfers do not compensate for the decline in returns to skills of high-skills labour, conditions are created for "brain drain."

The experience of T & T has some parallels to Nigeria, in that the economy of T & T can be considered a microcosm of Nigeria's. Abundant in natural resources, including hydrocarbons, the Nigerian economy is strongly dependent on oil revenue for foreign exchange and government revenues but economic growth has been hampered in recent years by depressed commodity prices and lower production. Its population is roughly 220 million with a population growth rate of 2.53%. The net migration rate per 1000 persons is -0.21. Real GDP per capita was $4,900 in 2020 (in 2017 USD) while the estimated real GDP growth rate was 0.8% in 2017 (Central Intelligence Agency, 2021c).

Considering T & T's resource boom, high GDP per capita, high skill levels and small size by geography and population, it can be considered a good candidate for human capital flight. This paper attempts to examine the effect of human capital flight on economic growth.

Literature Review

What is human capital flight?

Human Capital Flight or "Brain Drain" can be defined as the "large-scale emigration of educated individuals from the countries of their birth" (Baptiste, 2014). As Baptiste (2014) notes, the effect of human capital flight can be positive for the migrants and the countries that hire them. However, there can also be negative effects whereby the countries of origin lose a significant part of the tax base, as well as, the individuals needed to reform the institutions and infrastructure towards economic growth.

Models used to determine the impact of human capital flight on economic growth

Different models have attempted to explain economic growth in terms of foreign aid (Fashina et al, 2018) and models like the Medicine Model which indicate that aid has an optimal level as a percentage of GDP, beyond which its effect becomes negative. Studies have also examined the effect of foreign aid on education and indirectly, human capital but have acknowledged that cross-country analyses have been inconclusive in ascertaining the link between foreign aid, human capital and economic growth.

The empirical model by Fashina et al (2018) proposes using several versions of the Medicine Model to study effects on economic growth in Nigeria. The endogenous variable in these models are real growth and the exogenous variables including foreign aid, secondary school enrolment (percentage share of gross school enrollment), government expenditures on education, and health, real investment, foreign direct investment and trade openness as

percentages of GDP. The researchers use different transformations of the exogenous variables to develop different VECM models using relevant data from Nigeria to examine the relationships.

Fashina et al (2018) empirically found evidence to support the Medicine Model; however, more pertinent to this paper, the study found a positive relationship between human capital, as a function of expenditure on education and health, and economic growth.

A similar empirical approach for Nigeria was taken by researchers using an ARDL statistical technique (Adeosun & Popogbe, 2021). The researchers examined the long-run relationship between emigration, remittances, education and output growth. Real GDP annual growth was used as a proxy for economic growth for the endogenous variable. Net migration rate was used as a proxy for human capital flight. The model included control variables such as remittances from abroad, population growth rate and secondary school enrolment. The source data was taken from the World Bank and UNESCO for 1986 to 2018.

The data from 1986 to 2018 exhibited the following: (1) High variation and growth in remittances; (2) consistent negative net migration rate; (3) significant and declining growth in real GDP; (4) consistent and stable population growth rate; and (5) increasing enrolment in secondary education. A large proportion of remittances was spent on consumption. Standard statistical validity checks were performed on the data including stationarity and normality. The ARDL regression demonstrated the following:

1. The lagged data series for NMR and remittances had a negative impact on real GDP in both the short and long run.

2. Population growth rate also demonstrated a negative impact on real GDP.
3. In the long run, a unit increase in net migration reduces growth in real GDP by 59 units.
4. A unit rise in secondary school enrolment produced a rise in the GDP growth rate by 28%.

The paper acknowledged its limitations as a lack of examination of wage differential and skilled emigration data.

Another study attempted to determine the effect of brain drain on growth in Total Factor Productivity (TFP) of developing by estimating TFP using Research and Development (R & D) stock (trade-related technology diffusion), imports from OECD countries and GDP (Schiff and Wang, 2009). Models were defined for an endogenous variable TFP as a function of "North-foreign R&D of developing country c, NRD_c", human capital and a dummy variable identifying the country as a large or small state. Human capital was estimated the average number of years of education of the developing country. Overall, the goal of this study was to determine whether the impact on TFP was different between large or small states. The study looked at 50 developing countries and 15 OECD trading partners. In all, 9 models were developed and empirically examined.

It was determined that brain drain induces a fall in the educational level of a developing country, as well as the absorption capacity for technology and, significantly, that small states have higher rates of brain drain. The study found that in 2000, the brain drain was 43.2% for small states (population less than 3 million) as compared to 7.4% for all developing countries in the examined. However, it is important to note that this study does not consider the impact of brain gain (unrelated to the impact of return migration) and acknowledges that it is possible for

brain gain to exceed brain drain for a net positive effect. The impact on TFP growth in small states is still negative due to higher sensitivity to technology transfer and higher relative migration rates compared to larger states.

Methodology

Procedure

1. Review the literature in order to:
    a. Describe, briefly, the models used to analyze the impact of human capital fight on economic growth in terms of techniques, exogenous variables and endogenous variables (this is outlined in the section of this paper titled ***Literature Review***).
    b. Identify the factors related to human capital that have a significant impact on economic growth.
2. Based on the techniques and variables identified, develop a simple OLS model for T & T using appropriate exogenous and endogenous variables. Gather the relevant available data, perform statistical checks and develop the regression model.

Identification of factors affecting economic growth

The studies outlined in the literature review used the following proxies for economic growth:

- Real GDP annual growth rate in time, t;
- Real GDP
- Total Factor Production (TFP) estimated using R & D stock imports and GDP.

The following variables were examined in the literature for impacts on economic growth:

- net migration rate in time, t;
- workers' remittances in time, t;
- population growth rate in time, t (as a control variable);
- official aid and other development assistance;

- human capital as:
    - secondary school enrolment (percentage share of gross school enrollment);
    - percentage share of total government expenditures on education to GDP;
    - percentage share of total government expenditures on health to GDP;
- real investment as ratio of gross fixed capital formation to GDP;
- foreign direct investment to GDP;
- trade openness as sum of import and export relative to GDP.

Model specification

The researcher formulated the model below using variables identified in the literature review and for which annual data was available. Variables were chosen to proxy migration (x_1), benefits to migration (x_2), with foreign aid (x_3) and population growth (x_4) as control variables.

To represent economic growth, the researcher selects GDP growth (annual %) as the endogenous variable:

Y = GDP growth (annual %)

The exogenous variables to be examined for impact on economic growth are:

X_1 = net migration rate (per 1000 persons)

X_2 = personal remittances received (current million US$)

X_3 = net Official Development Assistance (ODA) received per capita (current US$)

X_4 = population growth (annual %) (as a control variable)

The regression model is formulated as follows:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \varepsilon$$

Sources of data collected and descriptions are shown in ***Appendix 2*** and the ***Bibliography***. The software used was ***EViews***, a statistical package for Windows. Data was available in ***Microsoft Excel*** and was imported into ***EViews.*** The regression technique of Ordinary Least Squares (OLS) was chosen for its simplicity.

In choosing these variables, the researcher wants to examine if there is a direct relationship at time, t, between net migration rate and growth in GDP. Additionally, the researcher wants to determine if there is a positive impact on growth in GDP due to remittances (which are a direct impact of emigration).

In the context of human capital flight, the researcher acknowledges that net migration rate per 1000 persons is not wholly indicative of the number of highly educated persons emigrating. However, 5-year data from the ***Institute for Employment Research*** (Brücker et al, 2013) indicates that a significant proportion of the emigrant population is highly educated as shown in Table 1. The researcher was unable to use this data in the regression model because the number of observations was not sufficient to satisfy the assumption of normality.

Table 1: 25 years and older emigration rates, both genders together, by country of origin and educational level for Trinidad and Tobago

Emigration rates	Education Level (Men and Women)	Percentage
1980	Total	15.41
	Low	7.43
	Medium	19.46
	High	69.45
1985	Total	0.18
	Low	0.08
	Medium	0.20
	High	0.75
1990	Total	0.21
	Low	0.08
	Medium	0.21
	High	0.78
1995	Total	0.22
	Low	0.08
	Medium	0.21
	High	0.78
2000	Total	0.24
	Low	0.10
	Medium	0.19
	High	0.80
2005	Total	0.27
	Low	0.10
	Medium	0.19
	High	0.83
2010	Total	0.26
	Low	0.11
	Medium	0.16
	High	0.83

NOTE: For any given skill level and year, the emigration rate is defined as the total migrant population from a given source country divided by the sum of the migrant and resident population in the same source country.

Statistical Checks

Under the assumptions of OLS, the following basic statistical checks were performed.

Stationarity

The stationarity of the data was checked using the Dickey-Fuller test. If not found stationary at level, data was differenced and rechecked. Differencing was performed until stationarity was determined a maximum of two times.

- Null Hypothesis (H_0): The data series is non-stationary, where t-statistic > α
- Alternative Hypothesis (H_1): The data series is stationary, where t-statistic < α

Multicollinearity

Multicollinearity was examined using a correlation matrix between predictor variables. An acceptable R-squared value would be 0.6 or less (Allison, 2012), otherwise one of the correlated variables would need to be removed[1].

Homoskedasticity

The homoskedasticty of the model was tested using White's test to inspect the consistency of the regression through the error terms.

- Null Hypothesis (H_0): Homoskedasticity exists where p > 0.05
- Alternative Hypothesis (H_1): Heteroskedasticity exists where p < 0.05

[1] The researcher found no definitive threshold for multicollinearity. Values for threshold R-squared values range from 0.6 to 0.9 from different sources. The researcher found no sources that indicate that an R-squared value of 0.6 or below will cause the regression to be unusable and, thus, used 0.6 as the threshold value.

Serial correlation

The Durbin-Watson test statistic was used to determine serial correlation in the model.

Overall validity of regression model

The significance of the regression model was assessed using the f-statistic from the regression output, the goodness of fit (R^2) and the coefficients. A significance level of 5% was used in all tests.

- Null Hypothesis (H_0): $\beta1 = 0$ and $\beta2 = 0$ and $\beta3 = 0$ and $\beta4 = 0$
- Alternative Hypothesis (H_1): $\beta1 \neq 0$ or $\beta2 \neq 0$ or $\beta3 \neq 0$ or $\beta4 \neq 0$

Expected results

The following results are expected:

1. In alignment with the alternative hypothesis, the predictor variables will have a significant impact on GDP growth (annual percent).
2. The exogenous variables of net migration rate, remittances, net ODA and population growth will be positively correlated with GDP growth.

Data gathering and manipulation

The data and variables used in the model are summarized in Table 1. Further descriptions and sources are shown in Appendix 2. Panel data from 1975 to 2010 was utilized.

Table 2: Summary of model variables and derivatives

Indicator	Variable Name	Variable type	Transformation
GDP growth (annual %)	GDP_GROWTH	Endogenous	None
Personal remittances, received (current US$)	REMIT_MM	Original data series	Divided by a factor of 1,000,000
Personal remittances, received (current US$)	REMIT_MM_D1	Exogenous (predictor)	First difference of REMIT_MM
Net ODA received per capita (current US$)	NET_ODA_PER_CAPITA	Original data series Exogenous (predictor)	None
Population growth (annual %)	POP_GROWTH	Original data series Exogenous (predictor)	None
Net migration rate per 1000 persons	NMR_1000	Original data series	None
Net migration rate per 1000 persons	NMR_1000_D2	Exogenous (predictor)	Second difference of NMR_1000

Results and Findings

Validity checks on variables

Stationarity

Each data series was tested for a unit root using the Dickey-Fuller test at the 5% confidence interval. If the t-Statistic was more negative than the critical value at 5%, the null hypothesis that a unit root exists was rejected and the data series was accepted as stationary. If not, the data series was differenced once and re-tested to a maximum of two times until the data was found to be stationary.

GDP GROWTH (1975-2010)

Data series was stationary at level.

Null Hypothesis: GDP_GROWTH has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.982078	0.0465
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

*MacKinnon (1996) one-sided p-values.

Figure 1: EViews output for stationarity - GDP growth

NET MIGRATION RATE PER 1000 PERSONS (1975-2010)

Data series was stationary after differencing twice.

Null Hypothesis: NMR_1000 has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.492563	0.8789
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(NMR_1000) has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.009498	0.7363
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(NMR_1000,2) has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.527423	0.0000
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

*MacKinnon (1996) one-sided p-values.

Figure 2: EViews output for stationarity - NMR

POPULATION GROWTH (1975-2010)

Data series was stationary at level.

Null Hypothesis: POP_GROWTH has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.873840	0.0000
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

*MacKinnon (1996) one-sided p-values.

Figure 3: EViews output for stationarity - Population growth

REMITTANCES (1975-2010)

Data series was stationary after differencing once.

Null Hypothesis: REMIT_MM has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.212901	0.9276
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(REMIT_MM) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.480111	0.0000
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

*MacKinnon (1996) one-sided p-values.

Figure 4: EViews output for stationarity - Remittances

FOREIGN AID (1975-2010)

Data series was stationary at level.

Null Hypothesis: NET_ODA_PER_CAPITA has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.654836	0.0095
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

*MacKinnon (1996) one-sided p-values.

Figure 5: EViews output for stationarity - ODA

Multicollinearity

A correlation matrix was generated for all variables. No correlation coefficients were found to be more than 0.6 indicating no significant multicollinearity. Consequently, the model can be assumed to valid using the explanatory variables.

Correlation				
	NMR_1000_D2	POP_GROWTH	REMIT_MM_D1	NET_ODA_PER_CAPITA
NMR_1000_D2	1.000000	-0.127238	0.122154	0.094772
POP_GROWTH	-0.127238	1.000000	-0.192460	-0.209847
REMIT_MM_D1	0.122154	-0.192460	1.000000	-0.032336
NET_ODA_PER_CAPITA	0.094772	-0.209847	-0.032336	1.000000

Figure 6: EViews output - Correlation matrix for independent variables

Homoskedasticity

The White's Test was used to examine the residuals for homoskedasticity. The probabilities of all three statistics were found to be greater than 0.05 meaning that we accept the null hypothesis that homoskedasticity exists i.e. the variance of the residuals is consistent.

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	1.233077	Prob. F(14,19)	0.3295
Obs*R-squared	16.18573	Prob. Chi-Square(14)	0.3022
Scaled explained SS	7.706374	Prob. Chi-Square(14)	0.9041

Figure 7: EViews output for homoskedasticity

Regression analysis

GDP GROWTH VS POPULATION GROWTH, NET MIGRATION RATE, REMITTANCES AND FOREIGN AID (1975-2010)

The figure below shows the ***EViews*** output executed for the regression model described.

Dependent Variable: GDP_GROWTH
Method: Least Squares
Date: 11/14/21 Time: 01:56
Sample (adjusted): 1977 2010
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
POP_GROWTH	-4.921843	2.117771	-2.324068	0.0273
NMR_1000_D2	-3.447545	4.222656	-0.816440	0.4209
REMIT_MM_D1	0.020951	0.099324	0.210940	0.8344
NET_ODA_PER_CAPITA	-0.156813	0.113142	-1.385983	0.1763
C	8.589615	2.211883	3.883396	0.0005

R-squared	0.197562	Mean dependent var	3.790149
Adjusted R-squared	0.086880	S.D. dependent var	5.804358
S.E. of regression	5.546487	Akaike info criterion	6.399260
Sum squared resid	892.1420	Schwarz criterion	6.623724
Log likelihood	-103.7874	Hannan-Quinn criter.	6.475808
F-statistic	1.784962	Durbin-Watson stat	1.196666
Prob(F-statistic)	0.158884		

Figure 8: EViews regession model output

Auto-correlation

The Durbin-Watson test statistic (DW) of 1.19 was evaluated against the Durbin-Watson Significance tables at 5%. At K = 4 degrees of freedom and n = 34, dL is shown at 1.012 and dU is shown as 1.511. The DW value lies between dL and dU and thus is inconclusive for positive serial correlation. The 4 – DW value (2.81) is greater than dU meaning that there is no statistical evidence of negative serial correlation. The implication here is that although the possibility of positive serial correlation still exists and there may be better explanatory variables not considered by the model, the coefficient estimators are still unbiased. Figure 9 shows the relevant extract of the Durbin-Watson tables.

Significance of Model

The p-value of the F-statistic was determined to be 0.158884 which means that, collectively, the explanatory variables are not significant in explaining the dependent variable. The r-squared value of 0.197562 is objectively small and implies that roughly 20% of the variation in the dependent variable is explained by the predictor variables. The model is, therefore, not a good predictor for the dependent variable.

Table A-1

Models with an intercept (from Savin and White)

Durbin-Watson Statistic: 1 Per Cent Significance Points of dL and dU

	$k'^{*}=1$		$k'=2$		$k'=3$		$k'=4$		$k'=5$		$k'=6$		$k'=7$		$k'=8$		$k'=9$		$k'=10$	
n	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU	dL	dU
6	0.390	1.142	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
7	0.435	1.036	0.294	1.676	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
8	0.497	1.003	0.345	1.489	0.229	2.102	----	----	----	----	----	----	----	----	----	----	----	----	----	----
9	0.554	0.998	0.408	1.389	0.279	1.875	0.183	2.433	----	----	----	----	----	----	----	----	----	----	----	----
10	0.604	1.001	0.466	1.333	0.340	1.733	0.230	2.193	0.150	2.690	----	----	----	----	----	----	----	----	----	----
11	0.653	1.010	0.519	1.297	0.396	1.640	0.286	2.030	0.193	2.453	0.124	2.892	----	----	----	----	----	----	----	----
12	0.697	1.023	0.569	1.274	0.449	1.575	0.339	1.913	0.244	2.280	0.164	2.665	0.105	3.053	----	----	----	----	----	----
13	0.738	1.038	0.616	1.261	0.499	1.526	0.391	1.826	0.294	2.150	0.211	2.490	0.140	2.838	0.090	3.182	----	----	----	----
14	0.776	1.054	0.660	1.254	0.547	1.490	0.441	1.757	0.343	2.049	0.257	2.354	0.183	2.667	0.122	2.981	0.078	3.287	----	----
15	0.811	1.070	0.700	1.252	0.591	1.465	0.487	1.705	0.390	1.967	0.303	2.244	0.226	2.530	0.161	2.817	0.107	3.101	0.068	3.374
16	0.844	1.086	0.738	1.253	0.633	1.447	0.532	1.664	0.437	1.901	0.349	2.153	0.269	2.416	0.200	2.681	0.142	2.944	0.094	3.201
17	0.873	1.102	0.773	1.255	0.672	1.432	0.574	1.631	0.481	1.847	0.393	2.078	0.313	2.319	0.241	2.566	0.179	2.811	0.127	3.053
18	0.902	1.118	0.805	1.259	0.708	1.422	0.614	1.604	0.522	1.803	0.435	2.015	0.355	2.238	0.282	2.467	0.216	2.697	0.160	2.925
19	0.928	1.133	0.835	1.264	0.742	1.416	0.650	1.583	0.561	1.767	0.476	1.963	0.396	2.169	0.322	2.381	0.255	2.597	0.196	2.813
20	0.952	1.147	0.862	1.270	0.774	1.410	0.684	1.567	0.598	1.736	0.515	1.918	0.436	2.110	0.362	2.308	0.294	2.510	0.232	2.174
21	0.975	1.161	0.889	1.276	0.803	1.408	0.718	1.554	0.634	1.712	0.552	1.881	0.474	2.059	0.400	2.244	0.331	2.434	0.268	2.625
22	0.997	1.174	0.915	1.284	0.832	1.407	0.748	1.543	0.666	1.691	0.587	1.849	0.510	2.015	0.437	2.188	0.368	2.367	0.304	2.548
23	1.017	1.186	0.938	1.290	0.858	1.407	0.777	1.535	0.699	1.674	0.620	1.821	0.545	1.977	0.473	2.140	0.404	2.308	0.340	2.479
24	1.037	1.199	0.959	1.298	0.881	1.407	0.805	1.527	0.728	1.659	0.652	1.797	0.578	1.944	0.507	2.097	0.439	2.255	0.375	2.417
25	1.055	1.210	0.981	1.305	0.906	1.408	0.832	1.521	0.756	1.645	0.682	1.776	0.610	1.915	0.540	2.059	0.473	2.209	0.409	2.362
26	1.072	1.222	1.000	1.311	0.928	1.410	0.855	1.517	0.782	1.635	0.711	1.759	0.640	1.889	0.572	2.026	0.505	2.168	0.441	2.313
27	1.088	1.232	1.019	1.318	0.948	1.413	0.878	1.514	0.808	1.625	0.738	1.743	0.669	1.867	0.602	1.997	0.536	2.131	0.473	2.269
28	1.104	1.244	1.036	1.325	0.969	1.414	0.901	1.512	0.832	1.618	0.764	1.729	0.696	1.847	0.630	1.970	0.566	2.098	0.504	2.229
29	1.119	1.254	1.053	1.332	0.988	1.418	0.921	1.511	0.855	1.611	0.788	1.718	0.723	1.830	0.658	1.947	0.595	2.068	0.533	2.193
30	1.134	1.264	1.070	1.339	1.006	1.421	0.941	1.510	0.877	1.606	0.812	1.707	0.748	1.814	0.684	1.925	0.622	2.041	0.562	2.160
31	1.147	1.274	1.085	1.345	1.022	1.425	0.960	1.509	0.897	1.601	0.834	1.698	0.772	1.800	0.710	1.906	0.649	2.017	0.589	2.131
32	1.160	1.283	1.100	1.351	1.039	1.428	0.978	1.509	0.917	1.597	0.856	1.690	0.794	1.788	0.734	1.889	0.674	1.995	0.615	2.104
33	1.171	1.291	1.114	1.358	1.055	1.432	0.995	1.510	0.935	1.594	0.876	1.683	0.816	1.776	0.757	1.874	0.698	1.975	0.641	2.080
34	1.184	1.298	1.128	1.364	1.070	1.436	1.012	1.511	0.954	1.591	0.896	1.677	0.837	1.766	0.779	1.860	0.722	1.957	0.665	2.057
35	1.195	1.307	1.141	1.370	1.085	1.439	1.028	1.512	0.971	1.589	0.914	1.671	0.857	1.757	0.800	1.847	0.744	1.940	0.689	2.037
36	1.205	1.315	1.153	1.376	1.098	1.442	1.043	1.513	0.987	1.587	0.932	1.666	0.877	1.749	0.821	1.836	0.766	1.925	0.711	2.018
37	1.217	1.322	1.164	1.383	1.112	1.446	1.058	1.514	1.004	1.585	0.950	1.662	0.895	1.742	0.841	1.825	0.787	1.911	0.733	2.001
38	1.227	1.330	1.176	1.388	1.124	1.449	1.072	1.515	1.019	1.584	0.966	1.658	0.913	1.735	0.860	1.816	0.807	1.899	0.754	1.985
39	1.237	1.337	1.187	1.392	1.137	1.452	1.085	1.517	1.033	1.583	0.982	1.655	0.930	1.729	0.878	1.807	0.826	1.887	0.774	1.970
40	1.246	1.344	1.197	1.398	1.149	1.456	1.098	1.518	1.047	1.583	0.997	1.652	0.946	1.724	0.895	1.799	0.844	1.876	0.749	1.956
45	1.288	1.376	1.245	1.424	1.201	1.474	1.156	1.528	1.111	1.583	1.065	1.643	1.019	1.704	0.974	1.768	0.927	1.834	0.881	1.902
50	1.324	1.403	1.285	1.445	1.245	1.491	1.206	1.537	1.164	1.587	1.123	1.639	1.081	1.692	1.039	1.748	0.997	1.805	0.955	1.864

Figure 9: Extract of relevant Durbin-Watson tables. From the University of Notre Dame (https://www3.nd.edu/~wevans1/econ30331/Durbin_Watson_tables.pdf)

Table 3: Sample statistics

Indicator	Coefficient	Value of coefficient	Significance
Net migration rate per 1000 persons	β_1	-3.447545	0.4209
Personal remittances, received (current US$)	β_2	0.020951	0.8344
Net ODA received per capita (current US$)	β_3	-0.156813	0.1763
Population growth (annual %)	β_4	-4.921843	0.0273

Although the model was, overall, found not to be significant, the coefficients show a positive relationship between GDP growth and personal remittances, as expected. However, the coefficients demonstrated a negative relationship between GDP growth and net migration rate, foreign aid and population growth, which was not expected. Population growth was the only predictor found to be statistically significant with a p-value of 0.0273.

Discussion

The output of the regression models indicates that the only significant variable affecting GDP growth is population growth. The coefficient is -4.92 which implies that population growth has a negative impact on GDP growth.

Population growth was a control variable and was not expected to have a significant impact on GDP growth. However, population growth was shown to have a significant negative impact on GDP growth. This is consistent with the literature, in particular, the study by Adeosun & Popogbe (2021). One possible reason could be due to historical deficiencies in capital. The panel data is from 1975 to 2010 with population growth stronger in former rather than latter periods (shown in Figure 10). It is possible that levels of both human and physical capital were not adequate in former periods to promote economic growth.

Net migration rate, personal remittances and ODA were not significant in explaining any change in GDP. However, the expected direction of the coefficients for net migration rate and ODA were negative and opposite to what was predicted; the expected direction of the coefficient for remittances was as predicted but not significant.

NMR was not found to be a significant variable in its impact on GDP growth. However, because there may be a lag in the impact of this phenomenon, the model may be improved by examining the effect of lagging this variable. Future economic growth may be dependent of past NMR. It is interesting that the direction of the coefficient was not as predicted which implies, albeit without significance, that an increase in emigration has a positive impact on GDP growth. Further investigation is required.

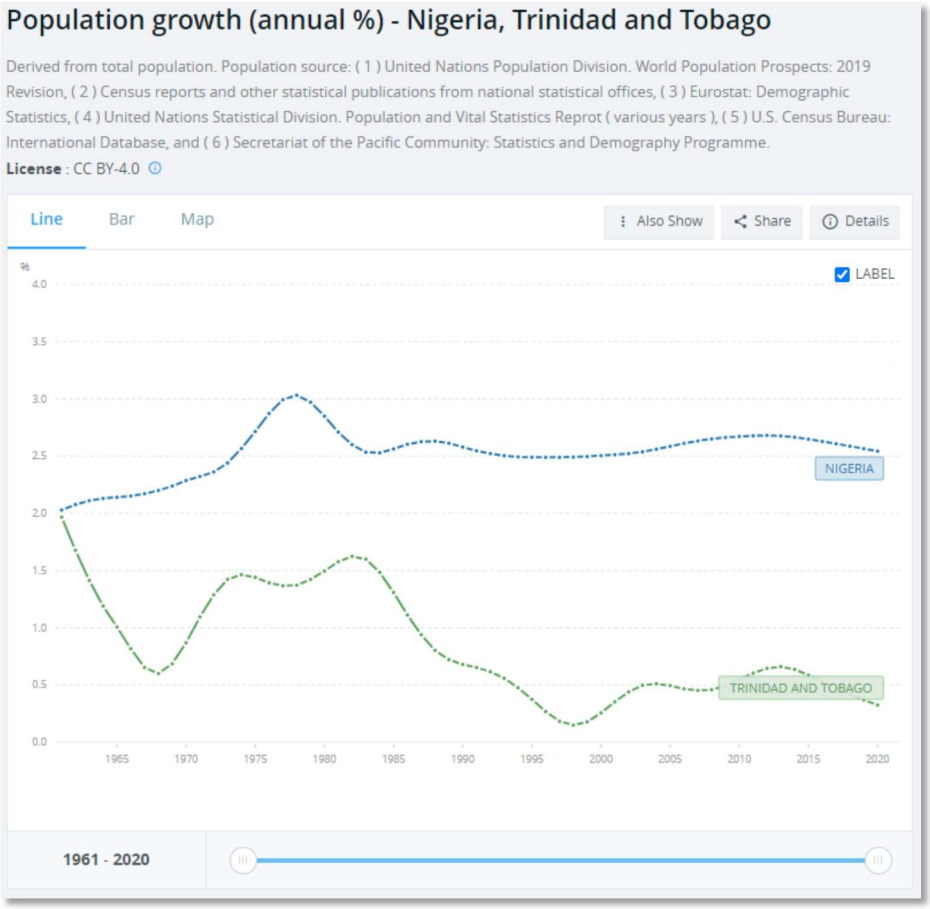


Figure 10: Population growth (annual %) - Nigeria, T & T. From The World Bank, World Development Indicators (2021d) (https://data.worldbank.org/indicator/SP.POP.GROW)

The researcher noted that personal remittances were significantly lower for T & T as compared to the rest of the world, including Nigeria (shown in Figure 11). This can explain why there was no significant relationship between the variables and GDP growth. Additionally, it is possible that personal remittances are used in consumption rather than investment purposes which would not contribute to economic growth. The researcher concludes that due to the high p-value and low coefficient value that this variable can be disregarded.

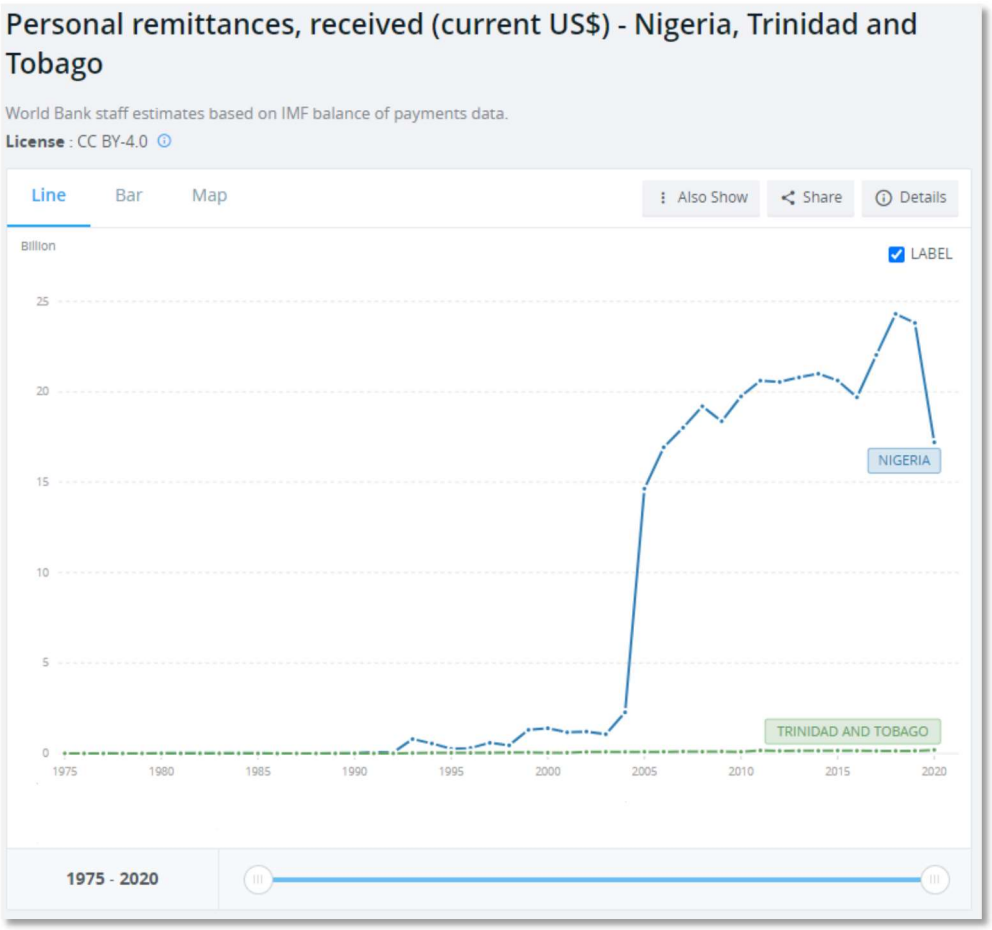


Figure 11: Personal remittances, received (current US$) - Nigeria, T & T. From The World Bank, World Development Indicators (2021c) (https://data.worldbank.org/indicator/BX.TRF.PWKR.CD.DT)

Net ODA is also small relative to GDP per capita which may explain that the variable was not significant and had a small coefficient. The researcher concludes that this predictor can also be disregarded.

Overall, the results imply that other independent variables are better predictors for change in GDP growth.

Limitations

The following limitations are acknowledged:

1. The net migration data was not for highly skilled labour specifically but for overall net migration. Data on highly skilled labour migration was only available in five year intervals from 1985 to 2010.The validity of net migration rate as a proxy was discussed previously under the section ***Model specification***.
2. Net migration rate is the migration outflows minus the migration inflows. Therefore, as a variable, it does not exclusively represent a measure of the number of persons emigrating.
3. Data on wage differentials and educational expenditures may be better explanatory variables. However, this data was not available.
4. The regression technique of OLS was not rigorous and excludes the possibility that the effect of independent variables could have a lagged effect or that the relationship could be non-linear.
5. The model ignores the possibility of reverse causality i.e the endogeneity of the independent variable of net migration rate. It is possible that the associated increased opportunities for education with higher GDP and incomes, and the premise that education increases the prospect of migration, economic growth can actually lead to an increase in emigration.

Recommendations

The following recommendations are proposed:

1. The cause and effect relationship could be reversed with GDP as the exogenous variable and net migration rate as the endogenous variable. The model could also include data on education expenditures and wage differentials, if available.
2. Other regression techniques could be applied (similar to the literature) including VAR, VECM or ARDL.
3. Other contributors to GDP growth could be included as control variables e.g. hydrocarbon revenues.
4. This methodology can be applied to determine this relationship among other countries and to perform cross-country analyses.
5. The effect on migration to Trinidad and Tobago from other regions could be examined if data are available.
6. There can be further investigation of how remittances are spent (consumption or investment).

Conclusion

Overall, the OLS model regression was not found to be significant with a p-value of 0.158884 (greater than 0.05). Based on an R-squared value of 0.197562, only about 20% of the independent variable can be explained by the dependent variables. The only significant predictor was population growth which exhibited a negative relationship with GDP growth, possible indicating historical deficiencies in capital.

No relationship could be established between human capital flight and economic growth because the independent variable of net migration rate (NMR) was not significant. Interestingly, the coefficient of -3.447545 implied an inverse relationship with GDP growth, meaning that as more persons emigrate than immigrate, GDP growth increases. This can be investigated further.

Personal remittances and net official development assistance were not found to be significant with small coefficients. The researcher concludes that these have little effect on economic growth owing the small size relative to GDP per capita.

The main limitations of the paper include the lack of relevant data regarding emigration only, wage differentials and expenditure on education, the use of the OLS technique which is simplistic, and exclusion of lagged variables where the effects of most of these independent variables would more likely affect future economic growth. The model can be improved by compensating for these limitations.

Appendices

Appendix 1: Terms and definitions

1. **Autoregressive distributed lag, ARDL**: An ordinary least square (OLS) based model which is applicable for both non-stationary time series as well as for times series with mixed order of integration.
2. **Gross Domestic Product, GDP:** The sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products (The World Bank, 2021a).
3. **Net Migration Rate, NMR**: The number of immigrants minus the number of emigrants over a period, divided by the person-years lived by the population of the receiving country over that period. It is expressed as net number of migrants per 1,000 population (The World Bank, 2021c).
4. **OECD:** Organizations for Economic Co-operation and Development
5. **Official Development Assistance, ODA:** Disbursements of loans made on concessional terms (net of repayments of principal) and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions, and by non-DAC countries to promote economic development and welfare in countries and territories in the DAC list of ODA recipients (The World Bank, 2021b).
6. **Ordinary least squares, OLS:** A method for estimating the unknown parameters in a linear regression model.
7. **Personal Remittances**: See Appendix 2.
8. **UNESCO**: United Nations Educational, Scientific and Cultural Organization

9. **Vector autoregression, VAR:** A statistical model used to capture the relationship between multiple quantities as they change over time.
10. **Vector error correction model, VECM**: A multiple equation model based on a restricted VAR that accounts for cointegration of variables.

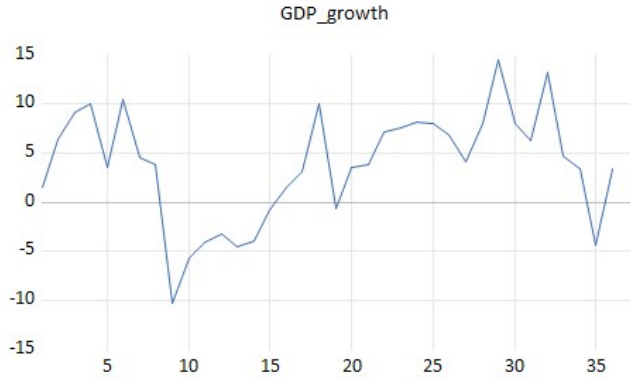
Appendix 2: Data description and sources

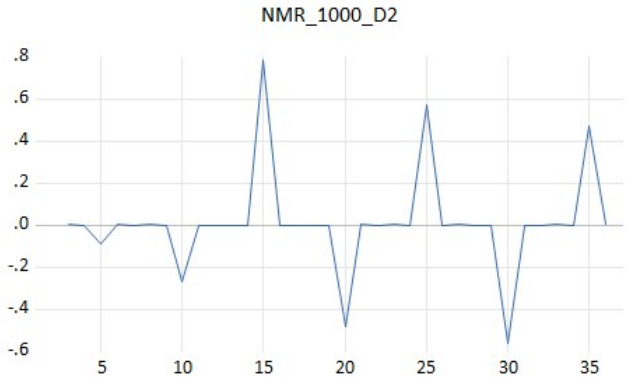
Indicator Name	Source Notes	Source Organization
GDP growth (annual %)	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2015 prices, expressed in U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	World Bank national accounts data, and OECD National Accounts data files. (The World Bank, 2021a)
Personal remittances, received (current US$)	Personal remittances comprise personal transfers and compensation of employees. Personal transfers consist of all current transfers in cash or in kind made or received by resident households to or from nonresident households. Personal transfers thus include all current transfers between resident and nonresident individuals. Compensation of employees refers to the income of border, seasonal, and other short-term workers who are employed in an economy where they are not resident and of residents employed by nonresident entities. Data are the sum of two items defined in the sixth edition of the IMF's Balance of Payments Manual: personal transfers and compensation of employees. Data are in current U.S. dollars.	World Bank staff estimates based on IMF balance of payments data. (The World Bank, 2021a)

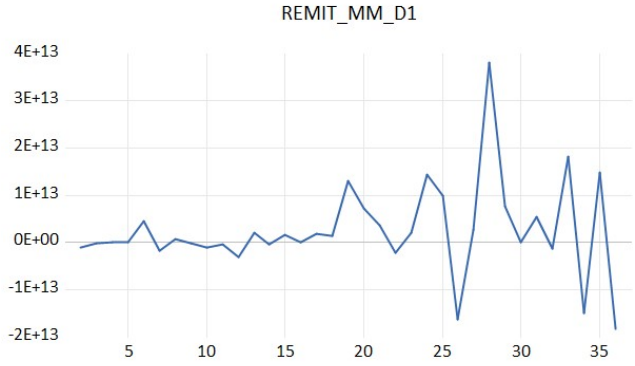
Indicator Name	Source Notes	Source Organization
Net ODA received per capita (current US$)	Net official development assistance (ODA) per capita consists of disbursements of loans made on concessional terms (net of repayments of principal) and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions, and by non-DAC countries to promote economic development and welfare in countries and territories in the DAC list of ODA recipients; and is calculated by dividing net ODA received by the midyear population estimate. It includes loans with a grant element of at least 25 percent (calculated at a rate of discount of 10 percent).	Development Assistance Committee of the Organisation for Economic Co-operation and Development, Geographical Distribution of Financial Flows to Developing Countries, Development Co-operation Report, and International Development Statistics database. Data are available online at: www.oecd.org/dac/stats/idsonline. World Bank population estimates are used for the denominator. (The World Bank, 2021b)
Population growth (annual %)	Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship.	Derived from total population. Population source: (1) United Nations Population Division. World Population Prospects: 2019 Revision, (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) United Nations Statistical Division. Population and Vital Statistics Reprot (various years), (5) U.S. Census Bureau: International Database, and (6) Secretariat of the Pacific Community: Statistics and Demography Programme. (The World Bank, 2021d)

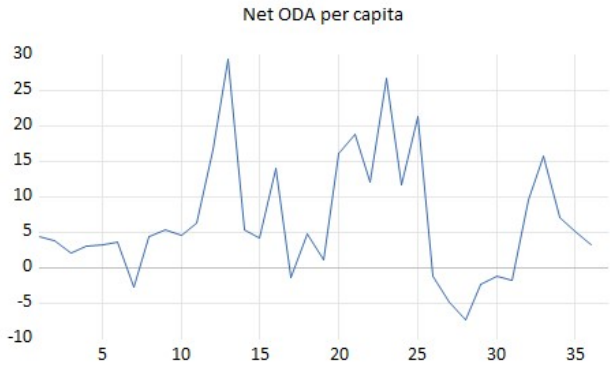
Indicator Name	Source Notes	Source Organization
Net migration rate	Macrotrends Data Download Trinidad And Tobago Net Migration Rate 1950-2021	Original Source: United Nations - World Population Prospects (MacroTrends.net, 2017)
Personal remittances, received (% of GDP)	Personal remittances comprise personal transfers and compensation of employees. Personal transfers consist of all current transfers in cash or in kind made or received by resident households to or from nonresident households. Personal transfers thus include all current transfers between resident and nonresident individuals. Compensation of employees refers to the income of border, seasonal, and other short-term workers who are employed in an economy where they are not resident and of residents employed by nonresident entities. Data are the sum of two items defined in the sixth edition of the IMF's Balance of Payments Manual: personal transfers and compensation of employees.	World Bank staff estimates based on IMF balance of payments data, and World Bank and OECD GDP estimates. (The World Bank, 2021c)

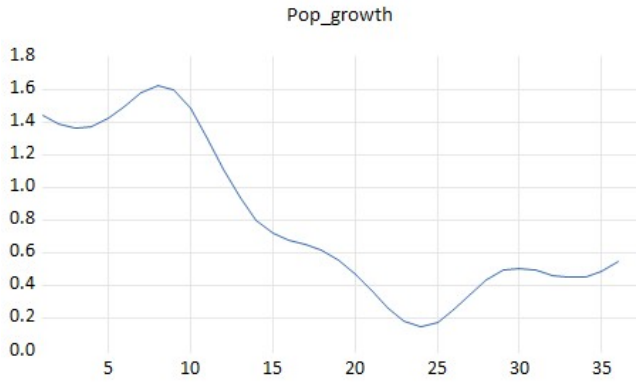
Appendix 3: Graphs of final stationary data for each variable











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