Estimating Tax Buoyancy: Using Empirical Bayesian Technique

Submitted By

Ridda Bibi

PIDE2017MPHILETS08

Supervised By

Dr. Hafsa Hina

A Dissertation submitted to the Pakistan Institute of Development Economics (PIDE), Islamabad, in partial fulfillment of the requirements for the award of the degree of Masters of Philosophy in Econometrics

Department of Economics & Econometrics

Pakistan Institute of Development Economics

Islamabad, Pakistan

2020

Pakistan Institute of Development Economics

CERTIFICATE

This is to certify that this thesis entitled: **"Estimating Tax Buoyancy: Using Empirical Bayesian Technique"** submitted by Ms. Ridda Bibi is accepted in its present form by the Department of Economics and Econometrics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in **Master of Philosophy in Econometrics**.

Supervisor:

Dr. Hafsa Hina
Assistant Professor
PIDE, Islamabad

External Examiner:

Dr. Umaima Arif
School of Economics
Quaid-i-Azam University
Islamabad

Head,
Department of Economics & Econometrics:

Dr. Karim Khan

DEDICATION

This thesis is dedicated to my parents, beloved brothers and sisters and my friends and supporters all the people in my life who touch my heart, And also "Dedicated to All Knowledge Thirsty Souls"

ACKNOWLEDGEMENT

In the name of Almighty Allah, the most Gracious and the most Merciful who made me capable enough to do field work without being dispirited.

I thank Allah for blessing me with the strength and patience. All respects to the Holly Prophet Muhammad (P.B.U.H) who is the role model for humanity and enabled us to recognize our creator.

I would like to pay my humble gratitude Dr. Hafsa Hina who taught me what I did not know with patience. I thank him for ignoring my faults, for precious time and help he provided me.

I express my heartiest gratitude to my parents, my brothers, my dear sisters, Friends and my respectable teachers who did their best in my study. And I would like to special thanks to my senior Tariq Majeed for helping me at every stage.

Ridda Bibi

TABLE OF CONTENTS

LIST OF TABLES

ACRONYM

EB	Empirical Bayes
ECM	Error Correction Mechanism
GDP	Gross Domestic Product
OLS	Ordinary Least Square
RMSE	Root Mean Square Error
GMM	Generalized Method of Moments
VECM	Vector Error Correction Mechanism
TMP	Tax Modernization Program
RARMP	Revenue Administration Reform and Modernization Program
PIT	Personal income tax
CIT	Corporate income tax
TSG	Tax on goods and services
SSC	Social security contribution tax
AD	Advance economies
EME	Emerging Economies
LIC	Low income country
OECD	Organization for economic co-operation and development
DF	Dicky Fuller
ADF	Augmented Dicky Fuller

ABSTRACT

Tax buoyancy is an instrument used by fiscal policy makers in order to know the responsiveness of tax revenue to change in GDP, without adjusting for discretionary measures, and to design future polices. This study investigate the short run and long run buoyancy of different components of tax revenue such as PIT, CIT, SSCT and TGS, for 28 advanced, 17 emerging and 13 low-income countries over the period 2000-2016 by using empirical Bayesian techniques. Along with empirical Bayesian D- prior and G prior estimators, we have also used Engle Granger co-integration, for individual's country, and Kao panel co-integration test for testing long run relationship. The study reveals that long run relationship happens between tax revenues components and its determinants both for all individual's country, except Kenya, and all panels. The posterior results of empirical Bayesian D-prior, with lowest root mean square forecast error, showed that in long run CIT is buoyant for all of the developed counties and PIT and SSCT for most of them, except few, while in short run PIT and CIT and SSCT show buoyancy. The study also reveals that for emerging economies CIT, SSCT and PIT are buoyant in long run while in short run TGS and SSCT are not buoyant. Mostly for low income countries PIT and TGS are buoyant in short run and CIT, SSCT, PIT and TGS in long run. CIT is buoyant for few of the low income countries. Moreover, we also pointed out that for most of the countries, in advance, emerging and less developed nations, inflation and output volatility have negative impact on tax buoyance. In last, this study indicate that empirical Bayesian D-prior is the more efficient Bayesian technique for estimation.

Key Words:

Tax buoyancy, Unit roots, Co-integration, Empirical Bayes D-prior and G-prior

CHAPTER 1

INTRODUCTION

Government play an important role in nation's economy. It seems that there is strong relation between economic growth and government's revenue earnings (Adkins.W.2017). Therefore, most of the countries frequently use government expenditure as a strong weapon for lifting economic growth and expect that the ensuing income would lead to raise government revenue to keep the fiscal imbalance in balance over long run. But, unfortunately several economies are not able to generate enough revenue through taxation to fill the gap between government revenue and expenditure and thus putting fiscal sustainability at risk. In this case most often the government resorted to internal and external borrowing in order to finance the budget deficit. To understand whether the economic growth will raise government revenue and allow the fiscal balance rely on tax buoyancy. Tax buoyancy shows the responsiveness of change in revenue to change in output. A tax is said to be buoyant if the tax revenues increase more than proportionately in response to a rise in national income or output. Tax buoyancy in an important factor for tax policy maker to formulate tax policy. It help to illustrate the role of revenue policy in long run for fiscal sustainability and in short run for economy stabilization. If in short run both output and revenue move in same direction, it means that the tax system work as a good output stabilizer and if this movement observed in long run it indicate fiscal sustainability. In this study we are going to find out individual tax buoyancy, in order to know the weak and strong spots of revenue system and how the government has to keep tax mobilization in line with economic activity. In addition, we also trying to find out the structural factors that influence the tax buoyancy.

Moreover, change in tax revenues to variation in GDP leads to an efficient and good tax system. White (1983) showed that not all taxes respond in the same way to those variations occur in national income. So, he suggested that there should be modification in the tax structure which further improve the highest possible growth of tax revenue. According to Bird *et al.* (2008) state is the key instrument in both developed and developing nations to attain the satisfactory level of tax efforts, If there is system of accountability, improved institutions and corruption control then it will ultimately leads to increase level of taxes. Different countries have different views on the role of government, expenditures related to enhance growth, and these opinions varies majorly depending on the party in power. Therefore, due to different tax revenue function and policy implications economic activities may vary from country to country. So, based on this background tax buoyancy may also vary from tax to tax, because the nature of each type of tax is different, and across the countries which consequently leads to the heterogeneity condition.

To account for this country specific heterogeneity, it would be better to run a separate regression model for each county. As we know that different countries, developed, developing and poor, share some common attributes, such as geographical area, governance structure, social, culture and economic indicators etc., but unfortunately separate regression model for each country does not account for these common behaviors and result to a loss of some useful information. However, fortunately panel data, specially pooled mean group, and cross section estimators are used to capture these commonalities but unfortunately these estimators ignore the cross country heterogeneity {Siddiqui,A., & Rehman, A. U. (2017), Dudine and Jalles, 2017}.

Nevertheless, various other panel data techniques, such as fixed and random effect models, also tried to account for this observed heterogeneity, but usually they have their own set of econometric problems especially the problems of heteroscedasticity and autocorrelation for random effects model and loss of degrees of freedom for fixed effect (Gujarati and Porter 2009).

To surmount the problems associated with conventional panel data and country specific OLS estimators, in this study we are using empirical Bayesian estimator introduced by Robbins (1956). EB technique has the ability to estimate the commonality among countries by prior estimator and country specific heterogeneity by posterior estimator. In the more likely case of neither zero nor perfect heterogeneity this estimator provide the ever best estimate of common characteristics and country specific heterogeneity, it is because this estimator use more information than separate OLS and panel data estimators (Zaman 1996). Bayesian estimates, both frequentist or empirical, depends on likelihood function, information retain by data, and on prior information. In frequentist Bayesian approach the prior information is frequently obtain by using any suitable conjugate prior but there is no way to check its reliability. Contrary to this, in empirical Bayesian approach the prior information is directly estimate from given data set and it reliability can be checked (Zaman 1996). In empirical Bayesian technique three feasible choices are available for prior selection, D-prior, G-prior and hierarchical Bayesian prior which we will explain in more detail in chapter 3. In this study we will use only two of them, D-prior and G-prior, and will compare their estimated results on the basis of root mean square error criteria.

1.1 Research Gap

The plethora of studies reveals that previous studies used OLS technique, Co-integrational analysis, ECM and other panel data estimators for estimating tax buoyancy. As we mentioned above that these technique have their own problems while estimating tax buoyancy. In order to correctly estimate the buoyancy and to pinpoint the strong and weak spots of tax system as well as its structural factors that influence tax revenue for all developed, developing and poor nations, in this study we intend to use empirical Bayesian (EB) estimators, especially G-prior and D-prior, to estimate tax buoyancy for several taxes like personal income tax, after here (PIT), corporate income tax (CIT), tax on goods and services (SSCT) and social security contribution (TGS).

1.2 Objectives of the Study

- To find out the strong and weak points of the tax revenue for advance, emerging and low income countries as well as the structure factors that affect tax buoyance.
- To find more efficient estimator amongst the different alternates

1.3 Motivation of Study

Tax system of a country work as an engine for government revenue. In order to finance public projects the government need money which can be collect through different taxes and non-taxes resources. Whenever, the government expenditure exceeds government revenue a phenomenon called fiscal deficit happened. In this situation the government either make some discretionary fiscal policy measures or move toward internal or external financial institution in order to finance the deficit. Most often external borrowing lead to twin deficit and keep the sustainability and stabilization of economy at risk. Therefore, we have been motivated to find out the strong and weak spots of government tax revenue to solve the problem of deficit by redesigning the fiscal policy instead of further worsening it by external borrowing, which happen most of the time for emerging and low income countries.

Apart from this, as mentioned earlier, the individual's country OLS estimates ignore the common attributes among countries and conventional panel techniques is incapable to handle the problem of heterogeneity and thus lead to some inaccurate and inefficient results. The empirical Bayesian technique allow for both of these problems, commonality and heterogeneity. Therefore, we have been motivated by empirical Bayesian method to get more accurate results of tax revenue buoyancy.

1.4 Significance of the Study

In order to know the ideal level of expenditure it's required to have knowledge of the buoyancy of tax system. This study will help the government to know the strong and weak spots of tax system for raising government tax revenue both in the short run and long run. Additionally, it would also be helpful for fiscal policy maker to improve and restructure the tax system in order to obtain economic stability and sustainability.

1.5 Organization of the Study

The remaining of the study organized as, chapter 2 review of literature in which we review tax buoyancy for individuals and group of counties at national, subnational and international levels. Chapter 3, methodology comprises source of data, theoretical framework and algorithm of empirical Bayesian estimators. Chapter 4 contain empirical finding and discussion while in chapter 6 we concluded our study with summary conclusion and recommendation.

CHAPTER 2

LITERATURE REVIEW

A wide range of studies examined that economic growth play an important role in tax revenue. These chapter offerings the literature reviews on the impact of GDP on tax revenue in different countries.

Work on efficient tax system is one of the worldwide criterions as it helps the economies to come out of the fiscal deficit. Pakistan is developing economy and to find out the Efficiency of Pakistan Federal tax system, Gillani (1980) use time series data of 1971-1983 by using Division index method and ordinary least square technique. The observer take logarithm of the equation and then estimate the buoyancy of major taxes in Pakistan excluding custom duties that is 1.05.Later Akbar and Ahmed (1997) also evaluate buoyancy of various taxes and expenditures by using Ordinary Least Square method and results shown were somehow interested that estimated elasticity and buoyancy is too much low and the reason behind this is that the elasticity and buoyancy of income taxes and excise duty is also low. Import duty is performing relatively well and sales tax turns out to be the most elastic and buoyant tax and is expected to remain so in the long run.

Destabilizing the tax base in communist countries was the major problem during last two decades, countries like Latin America and Eastern Europe shows a major fall in tax revenue chart. Friedman *et al.* (2000) estimated a nexus and find out one of the major cause of destabilizing the tax base into the unofficial economy is the poor institutions of the economy. The rate of Tax revenue as a percentage of totals GDP goes down because investors go underground to lessen the burden of bureaucracy and corruption. The research also concluded that governments with no corruption can raise high tax rates as compared to corrupt governments.

Work on buoyancy and elasticity of major taxes is done by Mukarram (2001) by using time series data from 1981 to 2001 by “chain indexing technique " and ordinary least square technique for the regression of an equation and finds out that estimate of buoyancy and elasticity are greater for sales taxes , direct taxes However excise duties and custom seem to be comparatively inflexible having buoyancy of 0.51 and 0.6.Same investigation of factor influencing tax revenues is estimated by Khattry and Mohan Rao (2002) using fixed-effects regression framework to estimate the data, and the conclusion is the structural characteristics, like urbanization and per capita income explaining the decline of income tax and trade tax revenues in low-income countries

Tax buoyancy in Arab countries is discussed by Eltony (2002) by using pool time series and cross sectional country data and results shows that share of mining in GDP, share of agriculture in GDP and per capita income were the main determinants of tax revenue share of GDP. Although mining is one of the largest businesses in Arab countries, the factors like government attitude, quality of tax administration, political system and other government institutes also considered as important factors in GDP share. Considering the buoyancy of income tax exclusive of withholding tax Bilquees (2004) estimated the time series data of 1974-2003 by using vector auto regressive technique and show that revenue augmentation did not significantly lead by tax changes. The estimated buoyancy of income tax is as low as it implies that withholding taxes imposition coupled with an increase in the taxable income limits is working at cross purposes.

The system GMM method is used by Agbeyegbe *et al*. (2006) to estimate the buoyancy of 22 countries in SSA, to find out nexus between tax revenue variables, exchange rates and trade liberalization. They claimed that trade liberalization is strongly irrelated to total tax revenue while there was negative relationship between high inflation and tax revenue. Same GMM method technique also used by Gupta (2007) to expand the scope of empirical literature on the determinants of tax revenue with various estimation methods, comprising both random and fixed effects, by using Prais-Winsten regression and estimating data from 105 developing countries over 25 years. First time GMM method with cross sections effects to find out the buoyancy of independent variables is analyzed by Mahdavi (2008) based on 43 developing countries and Shows that Total tax revenue has a positive impact on value of international trade, variations in the urban population, size of the development estimating from the per capital income and adult literacy rate. On the other hand, an expansion in foreign aid, Variation of the old age population, the degree of monetization, population density and the inflation rate lead to lesser tax revenue.

Buoyancy in long run over all tax system is estimated by Asmah *et al.* (2008) by using dummy variable technique for time series data and results shows that in long run overall tax system in Ghana was buoyant and elastic while co-efficient of buoyancy and elasticity are less than unity but after reforms become more. The elasticity was estimate to be 1.03. Researcher telling that awareness of a tax system to a unit change in GDP was more than unity .The study mentioned that tax enhancements should be made. Later on Bonga et al. (2015) analyzed the Tax Elasticity, Buoyancy and Stability in Zimbabwe using same dummy variables technique and finds that Tax buoyancy in all over the given time period is greater than one as well, Only excise duty and individual tax head are significant while customs duty, carbon tax and value added tax are insignificant. While considering the manufacturing sector and service sector Muhammad and Ahmed (2010) estimate buoyancy by using least square technique and finds that growth of agricultural sector has insignificant effect on tax buoyancy. The buoyancy of direct indirect and total taxes is 1.18, 1.29 and 1.25 respectively.

Sheikh (2012) estimated tax buoyancy of direct taxes for Pakistan by used simple co-integration technique and time series data from 1974-2009 and shows tax buoyancy was more than unity which shows a minor improvements over previous estimates. Research also recommends that on this estimation certain policy which included increase in tax base, reduction in tax-rates reducing tax evasion. Considering the foreign trade direct, indirect, and tax on gross revenue a time series approach and co integration technique is used by Tadele Bayu (2015) and shows that in case of short run tax on foreign trade, direct, indirect taxes was non buoyant while in long run only tax on foreign trade was buoyant. Later a similar study in Nigeria is carried out by Musa *et al.* (2016) by using vector error correction model (VECM) in case of cross sectional data and results shows tax revenue is elastic and buoyant in Nigeria.

A study on buoyancy in case of advanced, emerging and low-income is carried out by Dudine and Jalles (2017) by using Fully-Modified OLS and (Pooled) Mean Group estimators and results shows that long-run and short- run buoyancies in advanced economies shows not a huge difference. In case of long run CIT tax buoyancy exceeds one for advanced economies, PIT and SSC in emerging markets, and TGS for low income countries. In case of advanced countries (emerging market economies) CIT buoyancy is larger during contractions than during times of economic expansions. A similar study on developing countries carried out by Ashfaq and Sarwar (2016) by using pooled ordinary least Square method and demonstrates that democracy is positively and autocracy having the negative impact in each case i.e. direct, indirect or total tax revenues. Moving towards economy having large population and emerging economy like India Sharma and Kulsrestha (2015) shows by using OLS method that Fiscal Services, General Services, Economic Services and Grants-in Aids are significant while Dividends and Profits, Social Services are insignificant. Research also reveals that non-tax revenue buoyancy value is less than one which shows that for the revenue capacity generating for non-tax revenue (NTR) source is insignificant.

Mawia and Nzomoi (2013) empirically investigate the tax buoyancy for Kenya by using Engel Granger Co-integration technique and finds that overall tax sounds well but the individual taxes are not behaving positively as changes in their respective bases. Tax buoyancy has computed for income tax, value added tax, import duty, excise duty and total tax. Only the excise duty is buoyant in furtherance of their base which means that as private consumption changes excise duty reacting positively. Moreover, the government has to analyze the quantity and structure of tax evasion. Similarly Omondi et al. (2014) also inspected the impact of tax reforms on elasticity and buoyancy in Kenya’s tax system and investigates that Tax Modernization Program (TMP) shows a gradual increase in tax revenue at the given time period while buoyancy coefficient under the Revenue Administration Reform and Modernization Program (RARMP) shows more impact than TMP reforms. The elasticity coefficient of TMP and RARMP having the positive impact on GDP but TMP is more than the RARMP.

CHAPTER 3

THEORETICAL FRAMEWORK

3.1 Theoretical Background

Tax buoyancy is an indicator used by fiscal policy makers to measure efficiency and responsiveness of revenue to growth in the Gross domestic product or National income. For tax buoyancy, unlike tax elasticity, we make no adjustment for discretionary polices measures. A tax is said to be buoyant if the revenue obtain from it increase more than proportionate rise in national income or output. A vast amount of literature is available on tax buoyancy, both for individual and group of countries. For instance, Choudhry (1979) estimate tax elasticity and buoyancy for UK, US, Malaysia and Kenya. Osorio (1993) worked on tax buoyance and elasticity for Tanzania and Ariyo (1997) for Nigeria. In 1998 Kusi studied tax reforms and its effect on tax revenue in Ghana. Bilquees (2004) estimate tax buoyancy and elasticity for Pakistan and Upender (2008) for India.

Generally tax buoyancy can be estimated by using two different approaches. One of them based on analytical expressions while the other depends on time series or panel techniques (Yota.D.et.al 2018). The first method has been used by Girouard and Andre (2005) for OECD tax buoyancy estimates and Acheson et.al (2017) for income tax buoyancy in Ireland. The analytical method is a little bit complicated and need a detail information and micro data regarding the national tax code system. As we are working with panel data for 58 countries so it is inconvenience for us to use analytical approach. In the second approach we use time series or panel data techniques to estimate tax buoyancy by regressing the natural logarithm of tax revenue on natural logarithm of GDP. This approach is too much easy and widely used by researchers. In this approach other potential factors, besides GDP, that effect the buoyancy can be put into the model. In this study we are using the second approach with empirical Bayesian methodology. Mourre et.al. (2013) and Koester and Preismeier (2017) have used three different concepts for estimating tax revenue buoyancy, that as buoyancy with respect to out gap, macro-economic base and with respect to GDP. Buoyancy with respect to output gap, proportionate change in tax revenue in response to 1% change in output gap, can be decomposed into two components: elasticity of tax revenue with respect to its base and the elasticity of revenue base with respect to output gap. One problem with this approach is that it used unobserved base. In the second concept, buoyance with respect to macroeconomic base, an appropriate national account category is used as proxy for relevant tax base. The last one, buoyance with respect to GDP, is frequently used and more advantageous because it allows for comparison across countries and across different tax revenue components given that tax base is observed and same. As we are interested in estimating cross countries tax buoyance, therefore we will lean toward the third concept. In short, in this study we will use empirical Bayesian techniques for estimating tax revenue components buoyance with respect to GDP.

3.2 Econometric Model

As mentioned earlier, we are interested in estimating short and long run buoyancy for different countries in panel and to find structural factors affecting tax buoyance. Therefore, we are taking different tax revenue components and GDP as our core variables along with inflation and output volatility as structure factors, beside GDP, which we assume have effect on buoyancy. The different tax components will use as a response variable for the model while GDP, output volatility and inflation as covariates. The same model was used by Belinga.v.et al. (2014) and Dudine and Jalles (2017). $\ln TR_{it} = \alpha_i + \gamma i_{ij} \ln Y_{it} + \delta_{ij} IN_{it} + \beta_{ij} OV_{it} + u_{it}$ (3.1)

In equation 3.1 the dependent variable, TR_{it} is tax revenue for i^{th} country with time series length of t and α_i shows the intercept term for each country separately. The covariates on right hand side of equation 3.1 are GDP, inflation and output volatility with coefficients γi_{ij}, δ_{ij} and β_{ij} respectively. Both tax revenue and GDP are log transform. In this study we are trying to estimate the buoyance of different components of tax revenue, therefore, we will replace TR_{it} in 3.1 by its components such as PIT, CIT, SSCT and TGS.

CHAPTER 4

METHODOLOGY

Methodology comprises of three sections, the first one explain data and source of data and the second one present theoretical framework of the study along with structural model for tax buoyance. The third section consist of different types of estimator, convention panel data and empirical Bayesian, and its formal derivation. As we mentioned earlier in this study that empirical Bayesian estimators, which outperform classical panel and OLS estimators, have different choices for prior selection. Therefore, at the end of this chapter we will specify a comparison criteria for empirical Bayesian estimators using different prior densities.

4.1 Categorization of Countries

In this manuscript we have taken a total of 58 countries, because of limitation and non-availability of data we have missed the reaming countries, for analysis and categorize as advance, emerging and low income countries based on their per capita GNI. To maintain compatibility with similar classification used elsewhere, the threshold levels of GNI per capita are those established by World Bank. Countries with less than $995 GNI per capita income are classified as low-income countries, those with between $996 and $ 12,055 as emerging countries, and with income of more than $12055 as advance countries.

4.2 Data

Balanced panel data set of yearly frequency has been collected for all AE, EME and LIC from 2001 to 2016 The data has been collected on four core tax revenue components that is PIT, CIT, TGS, and SSC which use as a dependent variable in the model and on inflation, GDP and output volatility used as independent variables. The source of data is the organization for economic co-operation and development, world development indicator and global revenue statistics database.

4.3 Empirical Bayesian methodology

According to the Bayesian opinion, all information about unknown parameters must be represented in density form. Initial information about parameters, before analyzing the data, is represented by prior density while information from data is extracted by running likelihood function over it. Bayes formulae used to combine both types of information, prior and information from data, in posterior density form which immediately further yield Bayesian estimates for regression parameters. As we mentioned earlier there are two types of Bayesian estimators, classical or frequentist and empirical Bayes. In frequentist Bayesian approach natural conjugate priors are used which are not sufficiently flexible to adequately represent the initial information. However, they form the foundation for empirical Bayesian approach which is more improved method for linear regression. Empirical Bayesian estimators depends on the estimated parameters of prior density and regression model. The general form of Bayes rule is give bellow

$$\boldsymbol{f}\left(\boldsymbol{\theta}/\boldsymbol{y}\right) = \boldsymbol{f}\left(\boldsymbol{y}/\boldsymbol{\theta}\right)\boldsymbol{f}(\boldsymbol{\pi})$$

$\boldsymbol{f}\left(\boldsymbol{\theta}/\boldsymbol{y}\right)$, shows the posterior density or the updated information about the unknown regression parameters, $\boldsymbol{f}\left(\boldsymbol{y}/\boldsymbol{\theta}\right)$ is the likelihood function and $\boldsymbol{f}(\boldsymbol{\pi})$ indicate the prior density.

Let's assume the conditional density of $\hat{\beta_i}$ given β_i is

$$\beta_i^{\wedge}/\beta_i \sim N\left(\beta_i,\ \sigma_i^{\wedge}(X_i'X_i)^{-1}\right) \qquad 4.1$$

and prior or marginal density of β_i is

$$\beta_i \sim N(u, \grave{\text{U}}) \qquad 4.2$$

The marginal density for $\beta_i^{\wedge}$ is

$$\beta_i^{\wedge} \sim N\left(\beta_i,\ \sigma_i^{\wedge}(X_i'X_i)^{-1} + \grave{\text{U}}\right) \qquad 4.3$$

Having the densities in 3.2 and 3.3, prior and conditional, we can easily get the posterior density, which is multivariate normal with mean

$$\text{Å}\left(\beta_i/\beta_i^{\wedge}\right) = \left(\frac{1}{\sigma_i^{\wedge}}(X'_iX_i) + \grave{\text{U}}^{-1}\right)^{-1}\left(\frac{1}{\sigma_i^{\wedge}}(X'_iX_i)\beta_i^{\wedge} + \grave{\text{U}}^{-1}u\right) \qquad 4.4$$

and covariance matrix

$$cov\left(\beta_i/\beta_i^{\wedge}\right) = \left(\frac{1}{\sigma_i^{\wedge}}(X'_iX_i) + \grave{\text{U}}^{-1}\right)^{-1} \qquad 4.5$$

The hyper parameters Ù and u can be estimated either by maximum likelihood estimation or method of moment. The mean of the posterior density, which is the precision weight average of OLS estimates for individual's cross section and prior, is the empirical Bayesian estimates for regression parameters. The precision of empirical Bayesian estimator is the sum of the precisions of individuals cross section and prior information and is given by

$$\frac{1}{\sigma_i^{\wedge}}(X'_i X_i) + \grave{\text{U}}^{-1}$$

Therefore, given this precision, we can says that empirical Bayesian estimates are more precise than classical Bayesian estimate, which assume an arbitrary value to represent the commonality among countries.

In order to choose prior density for parameters in empirical Bayesian methodology, there are three feasible choices D-prior, G-prior and hierarchical prior. Due to the computational complexity the last one cannot be used routinely. In this work we are using D-prior and G-prior for prior density of parameters in order to estimate hyper parameters. In subsequence sections we are going to succinctly explain these methods.

4.3.1 D-Prior for empirical Bayesian estimation

In this special case of prior, the prior density of parameters is given by

$$\beta_i \sim N(u, \ddot{\text{E}})$$

Where, u indicate the population mean and Ë the variance covariance matrix of population. In D-prior, as the name indicate, Ë is a diagonal matrix. Estimating too many hyper parameters, as usual in simple empirical Bayes, may cause instability in empirical Bayesian estimation especially when the number of hyper parameters is large relative to data points. In this case, it is worthy to keep the covariance matrix as a diagonal matrix. Earlier we derived the empirical Bayes estimator for population mean β_i as shown in 3.5. In D-prior we make a slight changes in 3.5 by replacing Ù with Ë, which is a diagonal matrix. Then the Bayesian estimator for $\beta_i$seem something like this

$$\beta_i = \left(\frac{1}{\sigma_i^{\wedge}}(X_i' X_i) + \ddot{\text{E}}^{-1}\right)^{-1} \left\{\frac{1}{\sigma_i^{\wedge}}(X_i' X_i)\beta_i^{\wedge} + \ddot{\text{E}}^{-1} u\right\} \qquad 4.6$$

In equation 3.7 both hyper parameters, u and Ë , are unknown. We have to estimate these parameters as required for EB estimation. The simple average of individual's country OLS estimates can be use an estimate for prior mean u . However, unfortunately due to country specific heterogeneity the estimated parameters for each country have different level of precision. Owing to this, it is not feasible to use simple average of OLS estimates for each country as prior mean. Therefore, the EB framework suggest to use precision weight average as the estimate of prior mean. We assume Ë is known, then

$$u = \left(\sum_{i=1}^{T} (\sigma_i^2 (X_i' X_i)^{-1}) + \text{Ë} \right)^{-1} \left\{ \sum_{i=1}^{T} (\sigma_i^2 (X_i' X_i)^{-1} + \text{Ë})^{-1} \beta_i^{\wedge} \right\} \qquad 4.7$$

There are several different approaches available for estimation of Ë. We are using the one recommended by Carrington and Zaman, which is

$$\lambda_i^{\wedge} = \frac{1}{T-1} \sum_{i=1}^{T} \left(\left(\beta_{ij}^{\wedge} - u_j^{\wedge}\right)^2 - \hat{\sigma}_i^2 a_{ij} \right)^{+} \qquad 4.8$$

In 3.9 $\lambda_i^{\wedge}$ is the estimate of Ë, $\left(\beta_{ij}^{\wedge} - u_j^{\wedge}\right)^2$ shows the variance of $\beta_{ij}^{\wedge}$around $u_j^{\wedge}$ and $\beta_{ij}^{\wedge}$ is the coefficient of jth regressor for ith country. The coefficient $u_j^{\wedge}$ indicate the aggregate mean of all countries estimate for jth repressor. $\hat{\sigma}_i^2$ is the individual country variances with diagonal matrix of $\left(X_i' X_i\right)^{-1}$ denoted by a_{ij}. The value of $\lambda_i^{\wedge}$ can comes out negative which is impossible for variance, therefore the + sign indicate that we must replace the negative value of $\lambda_i^{\wedge}$ with zero. As we can see in equation 3.8 and 3.9 both $\lambda_i^{\wedge}$ and $\hat{u}$ are interrelated that is $\lambda_i^{\wedge}$ depends on having an estimate for $\hat{u}$ while $\hat{u}$ rely on having an estimate for $\lambda_i^{\wedge}$. Therefore, we can iterate these values until convergence.

4.3.2 G-Prior for empirical Bayesian estimation

An alternative way to select prior density for EB estimate, Zellner and Ghosh et al introduced and justly G-prior. They justify that G-prior is computationally convenience and provide good results in empirical application. The EB estimates for $\beta_i^{\wedge}$ using G-prior is

$$\beta_i = \frac{\gamma_i^2}{\sigma_i^2+\gamma_i^2}\beta_i^{\wedge} + \frac{\sigma_i^2}{\sigma_i^2+\gamma_i^2}\widehat{u_\iota} \qquad 4.9$$

In G-prior the hyper parameters can be estimate without using E-M algorithm.[2]

In this special case the marginal density of $\widehat{\beta_i}$ is $\sim N(u, \sigma_i^2 + \gamma_i^2)$. let's, from variance of $\widehat{\beta_i}$ about u, $Æ_i = |\widehat{\beta_i} - u|^2$, which follow chi square distribution with k degree of freedom and covariance matrix $\sigma_i^2 + \gamma_i^2$, we can obtain an unbiased estimate for hyper parameter γ_i^2

$$\gamma_i^2 = {}^{Æ_i}/_{T} - \sigma_i^2$$

If u is known, $\left(\hat{E} - 2\right)\frac{\sigma_i^2}{Æ_i}$ is an unbiased estimate of $\frac{\gamma_i^2}{\sigma_i^2+\gamma_i^2}$

Putting this value into 3.10 we obtain an estimate of β_i which is given below

$$\beta_i = u_0^{\wedge} + \left(1 - \frac{(k-3)\sigma_i^2}{(\widehat{\beta_\iota} - u_0^{\wedge})' X_i' X_i (\widehat{\beta_\iota} - u_0^{\wedge})}\right)\{\widehat{\beta_\iota} - u_0^{\wedge}\} \qquad 4.10$$

–

[2] E-M algorithm use for iteration back and forth in order to achieve convergence

4.4 Unit Root Test

This study design for panel data set which have both time series and cross section dimension. Therefore, there may be trend component which leads to biasness and spurious results if not corrected for. In order to resolve this probable issue we have to check for unit roots of all series. There are different types of test available in econometrics for checking unit roots in panel data set such as Levin and Lin (1992), Maddala and Wu (1999) and Im–Pesaran–Shin(2003) etc. We can also check stationary separately for each individual countries through DF and ADF unit root test but panel unit root tests are more powerful than that. The recent and improved one, which allows for heterogeneity in coefficients, is the Im–Pesaran–Shin (2003) unit root test. Therefore, in this study we are going to employ IFS unit root test.

The general IFS model for panel unit root test is

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + \sum_{k=1}^{n} \varphi_k \, \Delta y_{i,t-k} + \delta_i t + u_{i,t} \qquad 4.11$$

with null and alternative hypothesis

$$H_0 \ : \ \rho_i = 0 \ \text{ for all i}$$

$$H_A \ : \ \rho < 0 \ \text{ for at least one i}$$

If p-value for IFS test statistic is high, we cannot reject H_0 and conclude that the series is non-stationary, otherwise we will reject H_0 in favor of H_A.

4.5 Panel Co-Integration Test

Mostly in time series and panel data analysis we are interested to find out long run association among variables. The problem of spurious regression, which exist due to non-stationary attributes of variables, can be detected by using Co-integration test. The co-integration concept was initially introduced by Engle and Granger (1987).

According to them, if variables are non-stationary and their linear combination is stationary then co-integration exist, otherwise not. There are several different possible tests for co-integration in panel data analysis such as Kao (1999), McCoskey and Kao (1998) and Pedroni (1997, 1998 and 2000) etc. In this case we are using the Kao co-integration test which is computationally easy to employ.

4.5.1 Kao co-integration test

Kao (1999) introduce Dicky Fuller and Augmented Dicky Fuller type tests for panel co-integration. Consider the multivariate regression model for homogeneous panel data set

$$y_{i,t} = X_{ij,t}\beta_{ij} + \varepsilon_{i,t} \quad \ldots \quad 4.12$$

The Kao DF type test is a residuals base co-integration test and can be applied to the residuals from equation 44

$$\hat{\varepsilon}_{i,t} = \rho_i \hat{\varepsilon}_{i,t-1} + v_{i,t}$$

Now the null and alternative hypothesis for this test can be specify as

$$H_0:\ \rho = 1$$

$$H_A:\ \rho < 1$$

Kao presented two types of DF test for endogenous and exogenous repressors respectively which is given below

$$DF_p = \frac{\sqrt{N}T(\hat{\rho}-1) + 3\sqrt{N}\hat{\sigma}^2{}_{\cdot v}/\hat{\sigma}^2{}_{\cdot 0v}}{\sqrt{3 + 36\hat{\sigma}^4{}_{\cdot v}/\hat{\sigma}^4{}_{\cdot 0v}}} \qquad 4.13$$

$$DF_t = \frac{t_p + \sqrt{6N}\hat{\sigma}^{\cdot}{}_{\cdot v}/\widehat{2\sigma}^{\cdot}{}_{\cdot 0v}}{\sqrt{\hat{\sigma}^2{}_{\cdot 0v}/(2\hat{\sigma}^2{}_{\cdot v}) + 3\hat{\sigma}^2{}_{\cdot v}/10\hat{\sigma}^2{}_{\cdot 0v}}} \qquad 4.14$$

$$DF_p = \frac{\sqrt{N}T(\hat{\rho}-1) + 3\sqrt{N}}{\sqrt{10.2}}$$

$$DF_t = \sqrt{1.25}t_p + \sqrt{1.875}N$$

If the P-value is very high for Kao test then we cannot reject the null of no co-integration. Contrary to this if it is very low then we reject the null in favor of co-integration.

4.6 Root Mean Square Errors

One of the objectives of this study is to compare the forecast performance of empirical Bayesian G-prior and D-prior. Different statistical methods can be used for this purposes. The root-mean-square error measure (RMSE) is widely used method for comparing forecast performance. Therefore, we have chosen this criteria for the required job. It shows the square root of a sum of square difference between actual values and predicted values.

$$\text{RMSE} = \sqrt{\frac{\sum_{i=1}^{n}(yi-\hat{y}i)^2}{n}} \qquad \mathbf{4.15}$$

CHAPTER 5

RESULTS AND DISCUSSION

This chapter present the estimated results of tax buoyancy for various type of taxes, such as personal income tax, corporate income tax, tax on goods and services, and social security contribution tax, in advance, emerging and low income economies using empirical Bayesian techniques with “D-prior” and “G-prior” prior density. As we are dealing with panel data set of 58 countries from 2000-2016. It is necessity to check for the non-stationarity of the data and the existence of Co-integration among the variables. If Co-integration happens among the variables, then D- prior and G-prior will be applied both in long run and short run. Following the introduction, section 4.2 provides the results of unit root test for variable under consideration while section 4.3 confirmed the existence of Co-integration among the variables. In section 4.4 we have explored the results of long run and short run buoyancy of tax and at the end RMSE are calculated for forecast performance of D- prior and G- prior.

5.1 Unit root and Co-Integration Results

As we mentioned earlier, in all models with time series dimension if there exist the non-stationarity properties this will cause spurious regression results. Therefore, it is necessary to test the co-integration and unit root for exploring the long run relationships. The IPS unit root and Kao co-integration tests has been employed for this purposes and their results and interpretation are given below

5.1.1 Unit root test of all data series

Table 5.1 presents IPS test statistics and their estimated p-values for all variables in the model in advance, emerging and low income economies. The results indicate that we cannot reject the null hypothesis of unit root for all variables in AE, EC and LIC. It is because their probability values are very high. On first difference all variables are stationary as indicated by the p-value. The p-values for all variables lies extremely below the usual criteria of 5% and thus we reject the null hypothesis in favor of alternative. So according to results there is no unit root on first difference. The presence of unit root may indicate the existence of Co-integration among the variables.

Table 5.1 IPS unit root test results

Variables	AE		EC		LIC	
	Level	**First diff**	**Level**	**First diff**	**Level**	**First diff**
PIT	0.2091 (0.583)	-9.140 (0.000)	1.2832 (0.900)	12.352 (0.000)	0.2957 (0.616)	23.995 (0.000)
CIT	-0.9096 (0.181)	-13.705 (0.000)	-1.1591 (0.123)	-9.966 (0.000)	1.6581 (0.9513)	12.956 (0.000)
SSCT	1.0101 (0.156)	-11.135 (0.000)	2.1774 (0.985)	-9.5233 (0.000)	3.2096 (0.999)	11.897 (0.000)
TGS	0.8237 (0.794)	-11.675 (0.000)	1.7828 (0.962)	10.866 (0.000)	3.4270 (0.999)	12.5046 (0.000)
GDP	1.3657 (0.913)	-8.342 (0.000)	2.4335 (0.9925)	-7.2474 (0.000)	2.4335 (0.9925)	9.9432 (0.000)
OV	-6.7489 (0.000)	-9.801 (0.000)	9.0731 (0.000)	-13.466 (0.000)	-9.0731 (0.000)	15.263 (0.000)
INF	-5.9090 (0.0000)	18.888 (0.0000)	-7.5731 (0.0000)	-9.566 (0.0000)	7.5731 (0.0000)	10.228 (0.0000)

P value is in parenthesis

5.1.2 Kao Co-integration test results

Table 5.2 provided Co-integration test results for all AE, EC and LIC. Kao co-integration test was run over equation 3.1 for PIT, CIT, SSC and TGS respectively. The p-values of Kao test for four different types of taxes indicate that the null hypothesis of no-integration is rejected in favor of alternate, and thus, co-integration exist. Which imply that long run relationship exist between tax revenue and independent covariates. These results happened for all AE, EC and LIC.

Table 5.2 Kao co-integration test

$$\ln TR_{it} = \alpha_i + \hat{a}_{1i} \ln GDP_{it} + \beta_{3i} OG_{it} + \beta_{3i} IN_{it} + u_{it}$$

Variables	AE	EC	LIC
	Kao-Stat	**Kao-Stat**	**Kao-Stat**
PIT	-5.936	-2.7463	1.7170
	(0.000)	(0.0031)	(0.043)
CIT	-4.357	-0.6617	5.8783
	(0.000)	(0.000)	(0.000)
SSCT	-13.347	-2.9773	3.2543
	(0.000)	(0.001)	(0.000)
TGS	-1.1178	-2.2103	6.0009
	(0.0345)	(0.001)	(0.000)

P-Values are in parentheses.

5.2 Engel Granger co-integration test summary

In this study we are interested to find the tax buoyancy of various taxes like personal income tax, corporate income tax, tax on goods and services and social security contribution for each country and taking their prior from their respective regions. Therefore, for countries specific analysis we have preferred the Engle Granger Co-integration test on the set of time series variables i.e. tax revenues (PIT, CIT, SSC, and TGS), GDP, output volatility and inflation. In Engle Granger two step procedure first we estimate the regression of tax revenues as a function of GDP, output volatility and inflation by OLS method and get the residuals. Then ADF auxiliary regression is applied on the estimated residuals. The estimated values of parameters associated with the lag of residuals is divided with its standard error i.e. the calculated value of Engel Granger t statistics which is provided in tables 5.3, 5.4 and 5.5.

5.2.1 Engle Granger Co-integration results for advance economies

Table 5.3 depict co-integration results for advance economies. Comparing the tau statistic for estimated residuals with the critical values it is concluded that for advanced economies and in case of PIT, SSC, and TGS twenty-five out of twenty-eight countries shows the long run Co-integration relationship. In case of corporate income tax twenty-six out of twenty-eight countries shows the long-run Co-integration relationship.

Table 5.3 Engel Granger Test Summary for advance economies

Countries	PIT	CIT	SSC	TGS
Australia	-3.07*	-4.83***	-3.02*	-3.941***
Austria	-4.28***	-8.12***	-5.95***	-4.394***
Belgium	-3.50**	-1.50	-3.59**	-5.769***
Canada	-3.86***	-5.13***	-2.98*	-2.937*
Cz Republic	-2.35	-5.12***	-3.11*	-4.397***
Denmark	-3.29**	-4.28***	-2.93*	-5.583***
Estonia	-3.23**	-6.27***	-2.49	-1.312
Finland	-4.16***	-3.99***	-3.60***	-3.179**
France	-2.65	-2.71*	-2.53	-1.916
Germany	-3.81***	-6.12***	-2.96***	-0.581
Greece	-4.47***	-3.46**	**-.96*** **	-3.738***
Iceland	-3.29**	-5.93***	-4.29***	-5.263***
Ire land	-3.27**	-1.76	-3.76***	-3.279**
Israel	-4.11***	-4.02***	-2.81***	-4.623***
Italy	-3.62**	-3.37**	-.61***	-3.693***
Japan	-3.82***	-6.00***	-2.37	-2.891*
Korea	-3.82***	-5.96***	-3.14***	-4.791***
Lux	-5.96***	-3.91***	-3.62**	-5.284***
Netherland	-3.07*	-3.94***	-4.08***	-3.807***
Norway	-4.65***	-3.47**	-2.83***	-5.004***
Portugal	-4.00***	-3.19**	-3.83***	-3.839***
Slovak Rep	-4.31***	-3.06*	-2.91*	-3.425**
Slavonia	-3.45**	-6.49***	-3.70**	-5.840***
Spain	-3.75***	-6.87***	-2.88***	-4.555***
Sweden	-3.11*	-4.92***	-3.71**	-4.529***
Switzerland	-4.94***	-5.56***	-2.15	-4.794***
U kingdom	-2.55	-3.69**	-2.39***	-4.632***
U stat	-2.98*	-4.30***	-3.50**	-4.966***

***, ** and * show statistical significance of coefficients at 1%, 5% and 10%,

5.2.2 Engle Granger Co-integration results for emerging economies

Table 5.4 have been stuffed with Engle Granger co-integration results for emerging economies. In emerging economies, for PIT fifteen out of seventeen countries showed Co-integration relation while CIT are co-integrated for all countries. The estimated results also shows that SSC and TGS are co-integrated for twelve and eleven out of total selected countries respectively.

Table 5.4: Engel Granger Summary for Emerging market

Countries	PIT	CIT	SSC	TGS
Brazil	-5.04***	-5.41***	-3.23**	-4.21***
Chile	-1.95	-3.39**	-2.73	-2.76
Colombia	-5.25***	-4.97***	-4.09***	-3.82***
Dominican	-3.36**	-3.74***	-3.53**	-4.10***
Egypt,	-5.24***	-5.84***	-5.38***	-5.41***
Hungary	-3.20**	-3.42**	-3.51**	-5.02***
Indonesia	-4.07***	-3.09*	-4.69***	-2.79
Kazakhstan	-3.35**	-3.43**	-4.41***	-3.43**
Mexico	-3.96***	-4.24***	-2.45	-2.20
Morocco	-2.64	-5.37***	-3.58**	-4.90***
Peru	-4.43***	-4.03***	-2.72	-4.11***
Philippines	-3.85***	-3.61**	-1.65	-3.17**
Poland	-4.13***	-3.61**	-3.63**	-3.35**
South Africa	-3.40**	-3.47**	-3.35**	-1.91
Thailand	-4.52***	-3.61**	-5.53***	-2.23
Turkey	-7.07***	-4.95***	-5.01***	-5.93***
Uruguay	-4.18***	-3.76***	1.45	-2.74

***, ** and * show statistical significance of coefficients at 1%, 5% and 10%.

5.2.3 Engle Granger Co-integration results for low income economies

In table 5.5 we have put co-integration results for less developed/low income countries. The results shows that PIT is co-integrated for all counties except Estonia and Kenya while CIT and SSC both shows co-integration for ten out of a total of thirteen countries.

The co-integration results for TGS indicate that co-integration exist in nine out of total of selected countries.

Table 5.5: Engel Granger Test Summary for low income countries

Countries	PIT	CIT	SSC	TGS
Bolivia	-3.07*	-4.83***	-3.02*	-3.94***
Burkina F	-4.28***	-8.12***	-3.95***	-4.39***
Cameroon	-3.50**	-1.50	-3.59**	-5.77***
Cote d'I	-3.86***	-5.13***	-2.88	-2.84
Estonia	-2.35	-5.12***	-3.11*	-4.40***
Ghana	-3.29**	-4.28***	-2.93*	-5.58***
Guyana	-3.23**	-6.27***	-2.49	-1.31
Honduras	-4.16***	-3.99***	-4.60***	-3.16*
Kenya	-2.65	-2.71	-2.53	-1.92
Mali	-3.81***	-6.12***	-5.96***	-0.58
Niger	-4.47***	-3.46**	-4.96***	-3.74***
Rwanda	-3.29**	-5.93***	-5.29***	-5.26***
Senegal	-3.27**	-1.76	-3.76***	-3.10*

***, ** and * show statistical significance of coefficients at 1%, 5% and 10%

5.3 Empirical Bayesian prior's estimates for long run

Table 5.6 present the estimated hyper parameters for mean, also known as the empirical Bayesian prior information, of empirical Bayesian estimators for different components of tax revenue in advance, emerging and low income economies. These priors indicate the commonality of countries belonging to advance, emerging and low income economies. The results shows that the prior estimate for PIT is non-buoyant for advance economies but it is buoyant for emerging and low income economies. The reason for this as noted by Belinga.V.*et.al* (2014) and Stock hammer (2013) is the declining labor income share in GDP growth over the past decade in advance economies. In Table 4.6 we can see that the prior estimate for CIT is buoyant for all advance, emerging and low income economies as the value of coefficient γ_i is significantly greater than one. The results for CIT comply with empirical results of Dudine.P.*et.al* (2017) and Belinga.V.*et.al* (2014). The estimated results also shows that TGS prior is buoyant for both emerging and low income economies but not for advance economies. The coefficient value "1.1746" of log GDP for low income economies is greater than that of the emerging economies, it means that TGS is more buoyant for low income economies and this results is also in line with the results of Dudine.P.*et.al* (2017). The last part of the table 4.6 shows the estimated prior results for SSCT, which indicate that SSCT prior is buoyant for all types of economies.

Table 5.6 Empirical Bayesian prior's estimates for long Run

Coefficients	Advance Eco	Emerging Eco	Low income Eco
PIT			
α_i	14.6255	-10.9757	0.3549
γ_i	0.5877	1.4424	1.0428
δ_i	-0.0080	0.0092	-0.0032
β_i	0.0144	0.0049	0.0152
CIT			
α_i	8.6985	-12.2352	-27.0023
γ_i	2.3289	1.4625	2.0036
δ_i	0.0033	0.0091	0.0093
β_i	0.0270	0.0065	-0.0051
TGS			
α_i	5.6761	-0.2361	-2.5547
γ_i	0.6661	1.0764	1.1746
δ_i	0.0044	-0.0013	-0.0036
β_i	0.0064	0.0025	-0-0004
SSCT			
α_i	-2.2546	-11.0627	-15.949
γ_i	1.4134	1.3839	1.5916
δ_i	-0.0014	-0.0045	-0.0007
β_i	0.0130	-0.0066	-0.0012

5.4 Summary of Tax Components Buoyancy in Long run

Table 5.7 shows summary of Long run buoyancy for different types of taxes, such as PIT, CIT, TGS and SSCT, estimated by empirical Bayesian D-prior and G-prior. We first shedding light on the empirical d-prior estimates and after then on g-prior.

The estimated results of empirical Bayesian d-prior for PIT revenue shows buoyancy in 15 out of a total of 28 advance countries while for the remaining 13 countries it is not-buoyant. PIT revenue shows buoyancy in 15 out of 17 emerging and in 9 out of 13 low incomes economies. Similarly for 13 out of 28 advance economies the CIT revenue is buoyant while for the rest of 15 countries it is not. CIT is more buoyant in emerging and low incomes economies as compare to advance economies. For emerging economies CIT is buoyant in 13 out of a total selected 17 countries while it is buoyant in 10 out of a total 13 poor countries.

SSCT and TGS are buoyant in 21 and 17 advance countries out of a total 28 respectively. Out of a total 17 selected emerging economies SSCT shows buoyance in 14 of them while TGS shows buoyant results in 13. In low income economies both SSCT and GST is buoyant in 12 out of a total of 13 countries.

The empirical Bayesian G-prior results indicate that PIT is buoyant in 16 out of a total selected 28 advance economies. For emerging and low income countries PIT shows buoyance in 14 emerging and 8 poor countries out of a total 17 emerging and 13 poor countries. Corporate income tax is buoyant for 12 out of 28 advance countries. Both for emerging and poor nation the CIT buoyancy are 13 and 10 respectively. SSCT is buoyant in 15 advance economies, 14 emerging and 11 low income countries. In Case of TGS advance, emerging and poor economies shows buoyance in 16, 13 and 10 countries respectively.

Table 5.7 Summary of Long-Run buoyancy by D-prior and G-prior

	D-prior		G-prior		D-
	<1	≥1	<1	≥1	<1
Personal income tax					
AE	13	15	12	16	
EE	2	15	3	14	
LI	4	9	5	8	
Corporate income tax					
AE	15	13	16	12	
EE	4	13	5	13	
LI	3	10	3	10	
Social Security contribution					
AE	7	21	13	15	
EE	3	14	3	14	
LI	1	12	2	11	
Tax on Goods and services					
AE	11	17	12	16	
EE	4	13	4	13	
LI	1	12	3	10	

Note: there are 28 AE, 17 EC 17 and 13 LIC.

5.4.1 Posterior estimates of PIT long run buoyancy for advance economies

We have estimate long run PIT buoyancy for advance economies using two different Bayesian estimators D-prior and G-prior. In this special case of PIT buoyancy for advance economies both of the selected Bayesian estimation methods showed different results,s as shown in table 1 to appendix. It is a general criterion for tax buoyancy that the coefficient of log GDP, γ, should be greater than or equal to one. When the co-efficient of GDP has a value greater than one it shows a buoyant, means that the tax revenues increase more than proportionately in response to a rise in national income or output. Whereas the converse is true for non-buoyant in which the tax revenue increase less than proportionately in response to a rise in national income.

The posterior results of empirical Bayesian D-prior estimator indicate that for most of the advance economies the PIT is buoyant, for Estonia, Cz Republic, Finland, Germany, Iceland, Ireland, Israel, Italy, Japan, Netherland, Portugal, Sweden, Switzerland, Slovak Republic and Slavonia, because the estimated coefficients of log GDP is lie above the value of one. The empirical results for advance economies are in accordance with the results of Belinga, V,et.al (2014) and Dudine .P. et.al (2017). The impact on PIT of inflation is different in advance economies. For some advance economies it shows a negative and significant relation with PIT revenue while for others it is positive. The influence on PIT revenue of output volatility is negative for a bunch of countries while positive for few of them as shown in the table 1 given in appendix. While using the empirical Bayesian g-prior one more country, apart from those which was shown buoyant by d-prior, Norway, come into the premise of buoyancy. The impact on PIT revenue of other independent covariates like inflation and output volatility is different for different advance economies. For some of these countries it is positive while for others it show negative link. These effect are shown in appendix table1.

5.4.2 CIT Posterior estimate for long run buoyancy in advance economies

Using empirical Bayesian d-prior and g-prior, posterior estimated results for CIT buoyancy are given in appendix table 2. Both of the methods, g-prior and d-prior, gives totally different posterior results for CIT buoyancy. The d-prior estimated results for CIT buoyancy indicate that in long run Australia, Canada Cz Republic, Denmark, Estonia, France, Germany, Greece, Italy, Japan, Korea, Netherland, Portugal, Slovak Rep, Slavonia, Spain, Switzerland and United State are CIT buoyant .In case of G-prior Australia, Cz Republic, Denmark, Estonia, Germany, Ice land Greece, Korea, Netherland, Spain and Switzerland shows buoyancy of CIT because the estimated coefficient value is greater than one and also significant. Inflation has a negative and significant effect on CIT revenue for some countries and positive for others but for most of the countries its impact is insignificant. Similarly the impact on CIT revenue of output volatility is significant and negative for some countries and significantly positive for others, as shown in table 2 to appendix.

5.4.3 Posterior estimates of SSCT long run buoyancy for advance economies

For most of the advance economies especially in long run SSCT is buoyant, as reflected by the coefficient of log GDP in table 3 of appendix, but for few of them such as Canada, CZ-republic, Greece, Italy, Lux, Slavonia and UK, tax for social security contribution is not buoyant. In determination of SSCT, the inflation play a positive and significant role for CZ-republic and Germany while its impact is negative and significant for Estonia, Lux, Netherland, Slavonia and Spain. The effect of inflation on tax revenue is insignificant for the remaining of countries. Similarly in case of Sweden, Greece, Italy, Lux and UK the output volatility is positively and significantly related to the SSCT revenue whereas it is negatively related to the SSCT revenue for Austria, Austria, Belgium, Germany, Denmark, Estonia, Iceland Ireland, Korea, Netherland, Norway, Slavonia and US. SSCT of rescue of the countries are not significantly affected by output Volatility. On the other hand the results estimated by the second empirical Bayesian estimator, the g-prior estimator, is different from d-prior. Using empirical Bayesian g-prior estimator SSCT is buoyant for Australia, Austria, Belgium, Estonia, Finland, France, Germany, Iceland, Ireland, Israel, Korea, Netherland, Norway, Slavonia, Spain, and United State while for the rest of the countries it is not. For most of the countries inflation has no significant role in determining SSCT but for few of them such as Cz Republic, Denmark, Germany, Lux, Netherland, Slavonian, and Spain it plays a significant role.

5.4.4 Posterior estimate of TGS long run buoyancy for advance economies

The empirical Bayesian D-prior estimates, given in table 4 to appendix, for long run buoyancy shows that TGS are buoyant for more than half of the advance economies except Australia, Austria, Canada, CZ-republic, France, Greece, Italy, Japan, Netherland, Portugal and Spain as their estimated coefficients of log GDP lies far below the value of one. This empirical results for TGS buoyancy contradict the results of Dudine .P. et.al (2017). Dudine (2017) found that TGS is mostly buoyant for low income counties but here our empirical results indicate that TGS is also buoyant for some of the advance economies. The one possible reason for this may be the different estimation techniques[3]. For counties like Austria, Belgium, Estonia, Israel and Slavonia the inflation has positive and significant role in determining the TSG revenue while for Australia, Finland and Netherland it is significantly negative. For the remaining countries it not different from zero. Similarly the effect on TSG revenue of output volatility is positive and significant for Canada, CZ-republic, Greece, Italy, Japan, Sweden and Slavonia. The output volatility is negatively related to the TGS revenue for Austria, Denmark, Estonia, Ireland and US. On the other hand, empirical Bayesian g-prior estimates for TGS long run buoyancy shows that for Belgium, Denmark, Estonia, France, Germany, Iceland, Ireland, Israel, Korea, Portugal, United Kingdom and United states TGS is buoyant but for the remaining of advance economies it is not buoyant. Like for all other types of taxes discuss above the impact of inflation on TGS is also negative for some countries and positive for others.

[3] Dudine .P. et.al (2017) have used full modified ordinary lest square (FMOLS) estimation method

5.4.5 Posterior estimates of PIT long run buoyancy for emerging economies

Table 5 in appendix present the posterior estimated results for PIT in emerging economies. The results shows that PIT is buoyant for most of the emerging economies while it is not buoyant for two of them that is Kazakhstan and Hungary. These empirical results for emerging economies and PIT revenue are in accordance with the results of Dudine .P. et.al (2017). The impact on PIT revenue of inflation is significant and negative for some emerging economies while positive and significant for others. Similarly the output volatility covariate has positive and significant effect on PIT revenue for Chile, Egypt, Hungary Indonesia, Kazakhstan, Mexico, Morocco, Peru, Philippines, South Africa, Thailand and Turkey and negative significant effect for Brazil, Colombia, Dominican rep, Poland and Uruguay. The results estimated by empirical g-prior for PIT revenue and emerging economies is similar to that of the d-prior results. For most of the countries it shows buoyancy.

5.4.6 Posterior estimates of CIT long run buoyancy for emerging economies

Table 6 in appendix to this work has estimated results for CIT buoyancy in emerging economies. The discoveries of EB D-prior shows that CIT is buoyant for most of the emerging economies except Kazakhstan, Hungary, and Indonesia. The only positive and significant effect on CIT of inflation is for Thailand. While for Uruguay and Brazil it shows negative relation with CIT. For the remaining countries like Chile, Colombia, Dominican Republic, Egypt, Hungary, Indonesia, Kazakhstan, Mexico, Morocco, Peru, Philippines, South Africa, Thailand and Turkey it show insignificant relation with CIT.

Similarly the effect on CIT of output volatility is positive and significant for Hungary, and Kazakhstan but negative for Brazil, Indonesia, Uruguay and Turkey. Mostly the g-prior estimates are similar to that of d-prior.

5.4.7 Posterior estimates of SSCT long run buoyancy for emerging economies

In case of emerging economies, both empirical Bayesian d-prior and g-prior shows approximately same results for long run buoyancy of SSCT. It shows that for some countries like Dominican Republic, Egypt and Uruguay long run SSCT is non buoyant while for the remaining emerging economies it is buoyant. In case of Turkey, inflation shows positive and significant effect in the determination of the SSCT while for Dominican Republic, Indonesia, and Kazakhstan, Philippines, South Africa, and Brazil it shows negative relation with SSCT. The countries left behind like Chile, Colombia, Egypt, Hungary, Mexico, Morocco, Peru, Thailand and Turkey gets insignificant effect of inflation on SSCT revenue. Similarly the effect on SSCT of output volatility is positive and significant for, Morocco, and Philippines. The output volatility is negatively related to the SSCT revenue for Brazil, Indonesia, Thailand, Kazakhstan, Dominican rep, and Turkey. For the rest of the countries it is futile. These results are shown in appendix A table 7.

5.4.8 Posterior estimates of TGS long run buoyancy for emerging economies

Posterior estimates of TGS long run buoyance for emerging economies are same for using both d-prior and g-prior Bayesian estimators as shown in appendix table 8. The results indicate that for most of the emerging economies the TGS is more buoyant but only few countries like Egypt, Brazil, Chile, and Peru shows that TGS is non buoyant.

Only in case of Turkey inflation shows positive and significant role in determining the TGS while Dominican Republic, Indonesia, and Kazakhstan, Philippines, South Africa, and Brazil shows negative relation with TGS. For the rest of the counties it has no impact. The effect on TGS revenue of output volatility is positive and significant for Morocco, and Philippines. The output volatility is negatively related to the SSCT revenue for Brazil, Indonesia, Thailand, Kazakhstan, Dominican rep, and Turkey. And all countries which has left over shows insignificant effect of output volatility on GDP.

5.4.9 Posterior estimates of PIT long run buoyancy for low Income country

Similar to the results of d-prior and g-prior Bayesian estimators for emerging and advance economies, the estimated results of both of them is also same for low incomes economies. The EB d-prior results, in table 9 to appendix for LIC, indicate that for most of the low income countries PIT is buoyant. But some countries like Bolivia, Burkina Faso, Cameroon, Kenya, and Mali shows PIT non buoyancy. The estimated empirical results for LIC are in accordance with the results of Dudine .P. et.al (2017). In case of Guyana, inflation shows positive and significant role in determining the PIT while for remaining countries it shows negative relation with PIT. By following the results the effect on PIT revenue of output volatility is positive and significant for Cote d'Ivoire, Niger and Cameroon. The output volatility is negatively related to the PIT revenue for Senegal, Kenya, Burkina Faso, and Bolivia. Some country shows insignificant effect of Output volatility on PIT like Guyana, Ghana, and Ethiopia.

5.4.10 Posterior estimates of CIT long run buoyancy for low income economies

The estimated results, given in table 10 to appendix, shows that CIT is buoyant for all LIC countries. For all countries the estimated coefficients of log GDP cross the limit one which required for buoyancy. For Kenya and Cote d'Ivoirea inflation shows positive and significant role in determining the PIT while for remaining countries like Bolivia, Burkina Faso, Cameroon, Rwanda, Mali, Honduras, Ethiopia, Guyana, Ghana, Niger and Senegal it has no statistically significant role. Similarly, output volatility has positive and significant impact on CIT for Burkina, Faso, Kenya Rwanda and Ghana. The output volatility is negatively related to CIT for Cote d'Ivoire, Niger, and Kenya. Bolivia, Cameroon, Mali Estonia and Senegal shows insignificant effect of Output volatility on CIT.

5.4.11 Posterior estimates of SSCT long run buoyancy for low income economies

Estimated results of D-prior and G-prior are approximately same for SSCT in LIC, so we interpreted them generally. Table 11 in appendix shows that SSCT is buoyant for Bolivia, Burkina Faso, Cameroon, Rwanda, Mali, Honduras, Ethiopia, Cote d'Ivoirea, Ghana, Niger and Senegal. Only two of the total thirteen countries shows no buoyancy for SSCT. The impact of inflation for some of the countries is positive while for other it is negative. The impact on SSCT of output volatility is positive and significant for Rwanda and Bolivia while for Niger it is negatively significant. Other remaining countries like Burkina Faso, Cameroon, Kenya, Mali, Honduras, Ethiopia, Cote d'Ivoirea, Guyana, Ghana, and Senegal shows insignificant impact of Output volatility on SSCT.

5.4.12 Posterior estimates of TGS long run buoyancy for low income economies

Both d-prior and g-prior estimates of TGS buoyancy are approximately same as shown in table 12 to appendix A. The table shows that TGS are buoyant for more than half of the low income economies. For some low income economies inflation has positive and significant role in determining the TSG while for others it is significantly negative. For the remaining countries it not different from zero. Similarly the impact on TSG of output gap is positive and significant for a group of countries while negative for others as depicted in table 12 to appendix A.

5.5 Empirical Bayesian Prior's Estimates For Short Run

Table 5.8 present the hyper parameters of prior density for different components of tax revenue in advance, emerging and low income economies. These priors estimates indicate the common attributes for all type of economies in short run. The results shows that in short run PIT is buoyant for advance economies but it is non-buoyant for emerging and low income economies. We can see from table given below, that in short run CIT is buoyant for all advance, emerging and low income economies as the value of coefficient "γ_i " for log GDP is significantly greater than one. The results for CIT comply with the short run empirical results of Dudine.P.et.al (2017) and Belinga.V.et.al (2014). The estimated results also shows that TGS is non-buoyant for both emerging and high income economies but buoyant for low income economies. It means that TGS is more buoyant for low income economies and this results is also in line with the results of Dudine.P.et.al (2017). The last part of the table 4.8 which shows the estimated results for SSCT are non-buoyant for all types of economies in short run.

Table 5.8 Empirical Bayesian prior's estimates for short Run

Coefficients	Advance Eco	Emerging Eco	Low income Eco
PIT			
α_i	0.0011	-0.0047	0.0031
γ_i	2.5689	0.7287	-1.0458
δ_i	-0.0018	0.00001	0.00001
β_i	0.00001	-0.0023	-0.0008
CIT			
α_i	0.0053	-0.0560	0.0002
γ_i	4.4797	1.6018	1.2483
δ_i	-0.0086	-0.0073	0.0001
β_i	0.00001	-0.0011	-0.0001
TGS			
α_i	0.0050	-0.0264	0.0387
γ_i	-3.2524	0.6928	12.7554
δ_i	-0.0018	-0.0001	-0.0010
β_i	0.00001	-0.0001	-0.0077
SSCT			
α_i	0.0058	0.00001	0.0009
γ_i	-8.1160	0.00001	0.8954
δ_i	0.0016	0.00001	0.00001
β_i	0.00001	0.00001	0.00001

5.6 Summary of Tax Components Buoyancy In Short Run

Table 5.9 shows summary of short run buoyancy for different taxes estimated by D-prior and G-prior. Empirical Bayesian D-prior results for advance economies shows that in short run PIT and CIT are buoyant for 8 and 16 countries out of a total of 28 advance countries respectively. SSCT is buoyant for 21 out of 28 countries while TGS is not buoyant even for a single advance economy. In case of emerging economies PIT, CIT, SSCT and TGS shows buoyant results for 10, 8, 2 and 5 countries out of a total of 17 countries respectively. For low income economies, the number of countries for which PIT, CIT, SSCT and TGS shows buoyant results are 0,4,5,7 respectively out of a total of 13 countries. The estimated results of G-prior are different from that of D-prior. The G-prior estimates shows that in case of advance economies in 12 out of 28 countries PIT is buoyant. For 8 countries out of a total of 28 CIT shows buoyancy. SSCT shows short run buoyance just for one country out of 28 and TGS for 9 out of 28. For emerging economies the number of countries shows buoyant results for PIT, CIT, SSCT, TGS components of taxes are 3,1,0,0 out of 17 countries respectively. In case of low income economies the number of countries shows buoyant results for PIT, CIT, SSCT, TGS are 3,7,5,4 out of 13 countries respectively.

Table 5.9 Summary of Short-Run buoyancy by D-prior and G-prior

	D-prior		**G-prior**		**D-**
	<1	≥1	<1	≥1	<1
Personal income tax					
AE	20	8	16	12	
EE	7	10	14	3	
LI	13	0	10	3	
Corporate income tax					
AE	12	16	20	8	
EE	9	8	16	1	
LI	9	4	4	7	
Social Security contribution					
AE	8	21	17	1	
EE	15	2	17	0	
LI	8	5	8	5	
Tax on Goods and services					
AE	28	0	19	9	
EE	12	5	17	0	
LI	6	7	9	4	

Note: there are 28 AE, 17 EC 17 and 13 LIC.

5.6.1 Posterior estimate of PIT short run buoyancy for advance economies

The D-prior results, given in table 1 to appendix A, for short run buoyancy indicate that in short run Australia, Austria, Estonia, Norway, Spain, Sweden, United kingdom, and united State shows significant and buoyant results for PIT tax. Inflation and output volatility shows insignificant impacts on PIT for some countries and significant for others. Using G-prior estimators some countries like Australia, Belgium, Canada, Cz Republic, Denmark, Finland, Germany, Iceland, Ireland, Lux, Norway and Switzerland are buoyant. The reaming countries shows non buoyant results. Most of the countries shows significant relation of inflation and PIT but some of them like Australia, Austria, Denmark, Finland, Korea, Netherland, Portugal, Slovak Republic, United Kingdom, and United State did not. The estimated coefficient of output volatility is significant for some countries while insignificant for others.

5.6.2 Posterior estimate of CIT short run buoyancy for advance economies

The result in table 2 to appendix A, indicate that in short run d-prior estimates shows that CIT is buoyant for Australia, Belgium, Cz Republic, Denmark, France, Ireland, Italy, Japan, Korea, Lux, Netherland, Spain, Slavonia, U kingdom, U Stat and Switzerland. Inflation and output volatility shows insignificant effect for most of the countries. The results obtained by g-prior estimators shows that CIT is buoyant in short run for countries like Greece, Iceland, Italy, Netherland, Slovak Rep, Slavonia, Spain and U kingdom. Reaming countries shows no buoyancy. Most of the countries shows significant relation of inflation and CIT. output volatility has significant impact on CIT for most of the countries.

5.6.3 Posterior estimates of SSCT short run buoyancy for advance economies

The D-prior estimated results for SSCT, as shown in table 3 to appendix A, are non-buoyant for all advance countries. Inflation and output volatility shows insignificant impact on SSCT for most of the countries. on the other hand G-prior results shows that for some countries like Australia, Canada, Denmark, France, Iceland, Ireland, Spain, United State and U kingdom SSCT is buoyant. The impact of inflation and output volatility on SSCT is significant for most of the countries.

5.6.4 Posterior estimates of TGS short run buoyancy for advance economies

In table 4 to appendix A, we have shown short run D-prior and G-prior estimated results for TGS. The D-prior results indicate that TGS is buoyant for Italy, Japan, Solavoke Republic while it is non-buoyant for the remaining of countries. For most of the countries inflation and output volatility has no impact on TGS. The G-prior estimates shows that for Austria, Iceland, Japan and Korea TGS is buoyant. Both of the methods shows completely different results. The impacts of inflation on TGS for Austria, Austria, Belgium, Canada, Denmark, Estonia, Finland, France, Greece, Iceland, Ireland, Israel, Korea, Lux, Norway, Spain, Sweden, Switzerland and United States are significant. Similarly output volatility shows significant impact for countries like Belgium, Canada, Denmark, Estonia, France, Iceland, Israel, Italy, Japan, Lux, Neither land, Norway, Norway, Portugal, Sweden and united kingdom.

5.6.5 Posterior estimates of PIT short run buoyancy for emerging economies

For emerging economies, short run posterior results for PIT buoyancy using both D-prior and G-prior techniques is given in table 5 to appendix A. Short run results indicates that PIT is buoyant for Chile, Indonesia, Kazakhstan, Peru, Philippine, Poland, South Africa, Thailand, Turkey and Uruguay while for remaining emerging economies it is not buoyant. The impact of inflation and output volatility on PIT is different for different countries. For some countries it is positive and significant while for others it is negative. Empirical G-prior results shows that only for three countries, that is Kazakhstan, Hungary and Chile, PIT is buoyant. Inflation has significant roles in determining PIT for Brazil, Colombia, Dominican Republic, Egypt, Hungry, Mexico, Morocco, Peru, South Asia, and Thailand. On the other hand output volatility shows significant impact for countries like Brazil, Dominican Republic, Indonesia, Mexico, Morocco Philippine, Thailand and Turkey.

5.6.6 Posterior estimates of CIT short run buoyancy for emerging economies

For countries like Chile, Egypt, Indonesia Kazakhstan, Philippines, Peru, Poland, and South Africa CIT is buoyant, as shown in table 6 to appendix A. For some countries CIT is effected significantly by inflation while for other not, as given in table 6 to appendix A.

Bayesian G-prior estimator shows totally different results from D-prior. The G-prior estimated results shows that CIT is buoyant only for Morocco. It also indicate that both inflation and output volatility have significant impact on CIT for all emerging economies.

5.6.7 Posterior estimates of SSCT short run buoyancy for emerging economies

D-prior estimates for emerging economies, as shown in table 7 to appendix A, shows that SSCT is buoyant for Mexico and Uruguay only. While for remaining developing countries it is non-buoyant. Inflation has a significant impact on SSCT for Brazil, Mexico, Morocco, Peru, Philippine, Poland and Uruguay. Output volatility significantly influence the SSCT for Indonesia, Hungry, Egypt, Brazil, Dominican Republic, and Thailand. The results of G-prior indicate that none of the emerging countries have SSCT buoyancy.

5.6.8 Posterior estimates of TGS short run buoyancy for emerging economies

Table 8 to appendix A, shows the estimated results for short run buoyancy of TGS in emerging economies. The D-prior estimates of TGS is buoyant for Colombia

Khuzestan, Indonesia, Peru and Poland. For most the countries control variables shows insignificant impact. Contrary to D-prior G-prior results shows that TGS is not buoyant for all of the countries.

5.6.9 Posterior estimates of PIT short run buoyancy for low income countries

Short run estimated results for PIT in low income countries in given in table 9 to appendix A. The results indicate that no one country is lie in the range of buoyancy, because the value of GDP coefficient is less than one and mostly insignificant. The G-prior estimated results is approximately same to D-prior. This also shows that PIT is not buoyant for all of the LIC. The impact of inflation and output volatility on short run PIT is insignificant for most of the countries.

5.6.10 Posterior estimates of CIT short run buoyancy for low income countries

In case of CIT, Ghana, Honduras, Mali and Senegal shows buoyant result by using empirical D-prior as depicted in table 10 to appendix A. Inflation has significant influence on CIT for LIC, like Bolivia, Guyana, Kenya and Rwanda. For Bolivia, Burkina Faso, and Rwanda the impact of output volatility on CIT is significant. While using G-prior shows that more countries lie in the limit of buoyancy than D-prior. Some countries shows significant impact of covariates on CIT while others not.

5.6.11 Posterior estimates of SSCT short run buoyancy for low income countries

Short run estimated results for SSCT are put into the table 11 to appendix A. the results shows that using EB D-prior SSCT is buoyant for countries like Bolivia, Ethiopia, Mali, Niger and d'Ivoirea. On the other hand in case of G-prior, Cameroon, Ghana, Guyana and Senegal are buoyant and all the remaining countries are non-buoyant. While using EB G-prior, for most of the countries inflation and out volatility have significant role in determining SSCT.

5.6.12 Posterior estimates of TGS short run buoyancy for low income countries

The estimate result for short run TGS buoyancy is given in table 12 to appendix A. TGS is buoyant for Italy, Japan and Solavoke Republic by using EB D-prior estimator while for the remaining LIC it is not buoyant. For most the LIC inflation and output volatility have no significant role on TGS. Contrary to D-prior, G-prior results shows that TGS is buoyant for Austria, Iceland, Japan and Korea. In short run inflation has significant impact on TGS for Austria, Austria, Belgium, Canada, Denmark , Estonia ,Finland , France, Greece, Iceland, Ireland , Israel, Korea, Lux, Norway, Spain, Sweden , Switzerland and united states. Output volatility shows significant impact on TGS for most of the countries like Belgium , Canada, Denmark, Estonia , France , Iceland , Israel , Italy , Japan, Lux , Netherlands , Norway , Norway , Portugal , Sweden and united kingdom.

5.7 Comparison of Empirical D-prior and G-prior

Judgement about techniques is one of the objective of this Study. We have used two EB estimators, D-prior and G-prior and tried to compare their forecast performance both in short run and long run for all components of tax revenue and all countries. RMSE is taken as a performance criteria. The RMSE for both estimators, given in tables to appendix B, shows that EB D-prior outperform the G-prior both in short run.

CHAPTER 6

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Summary

Most of the world economies use government expenditure as a key determinant for raising economic growth and expect that the ensuing income will keep the fiscal balance. Unfortunately several of these countries are unable to generate enough revenue and thus resorted to internal and external borrowing to finance budget deficit. To know whether economic growth lead to increasing tax revenue or not, depends on tax buoyancy. Tax buoyancy is a concept used in economics to know the response of tax revenue to change in economic growth. It help the policy makers to formulate tax policies in such a manner to attain fiscal sustainability in long run and economic stabilization in short run. Therefore, in this research we have focused on individual's tax buoyancy such as PIT, CIT, SSCT and TGS in order to highlight the strong and weak spots of government tax revenue system for stabilization and sustainability. Additionally, we also try to find out the structural factors that influence tax buoyancy. For this study we have taken three different types of economies, advance, emerging and low income countries. Panel data for the period 2000-2016 is used for a total of 28 advance economies, 17 emerging and 13 less developed countries. We can use single country OLS regressions and convention panel data regression but because of ignoring commonality and cross countries heterogeneity respectively the results of these estimators could be misleading. Therefore, to resolve these problems and get more improved and reliable results we have considered empirical Bayesian estimators, particularly D-prior and G-prior. In empirical Bayesian estimators the hyper parameters, prior information, are estimate by D-prior and G-prior and then the posterior estimates are obtain by combining the data and prior information. This study found out short run and long run tax buoyancies by employing EB D-prior and G-prior. In long run D-prior and G-prior results are approximately same but in short run it is quite different. Therefore, it is necessary to find out the one estimator with comparatively low root mean square forecast error. The analysis showed that D-prior is the more efficient one with lowest possible RMSFE. In addition, we have also used Kao panel co-integration test for advance, emerging and low income countries and Engle Granger for individual's country in order to know long run association among variables. The results showed that for most of the individual countries and panels co-integration exist.

6.2 Conclusion

Co-integration results for all panels of economies, advance, emerging and low income, shows that long run relationship exist between different components of tax revenue and its determents. By going more granular into individual's country in advance economies all countries shows long run relation except Cz Republic for PIT, Estonia for SSCT and TGS, France for PIT, SSCT and TGS, Germany for TGS, Ireland for CIT and Japan and Switzerland both for SSCT. Similarly in emerging economies, Chile, Uruguay and Mexico have no long run relationship for SSCT and TGS, and Pilipino and Pero for SSCT. For South Africa, Thailand and Indonesia the results indicate no long run relationship for TGS. In case of low income economies, the results indicate that Cameroon and Senegal have no long run relationship for CIT, Cote d'I and Guyana for SSCT and TGS, Estonia for PIT and Mali for TGS. The only country Kenya have no long run association for all components of tax.

From the estimated results we can conclude that long run prior information, common attributes, of CIT and SSCT are buoyant for advance economies. Contrary to this, for emerging and less developed countries prior information about all components of tax revenue are buoyant. The short run prior information, commonality, shows that both PIT and CIT are positively buoyant for advance economies and SSCT and TGS are buoyant with negative coefficient. For emerging economies only CIT prior information is buoyant while for low income countries both CIT and TGS shows buoyancy.

Using the empirical Bayesian techniques, we found that in short run PIT is buoyant for all of the advance economies. While in long run most of the advance nations shows PIT buoyance except few. In case of emerging economies, PIT shows long run buoyance for all emerging countries except Hungry, Poland, Turkey and Kazakhstan while in short run most of the countries are buoyant. In short run PIT is buoyant for all low income countries while in long run it shows buoyancy except for Bolivia, Burkina Faso, Cameroon, Kenya and Mali. Corporate income tax is highly buoyant both in short run and long run for advance economies. Similar to advance countries, in short run, for all of the emerging economies the CIT is also buoyant while in long run some countries like Indonesia, Turkey, Poland, Kazakhstan, Hungry are non-buoyant. In low income countries, CIT long run buoyancy exist for all countries but for few of them it is not non-buoyant in short run. In long run SSCT is buoyant for all developed economies except Lux, Canada, Greece, Italy, Japan, Portugal, Slovak republic, Sweden and U kingdom. In short run all of the countries are buoyant with some having negative coefficient for buoyancy. For emerging economies the SSCT is buoyant except for Poland, Kazakhstan, Egypt and Uruguay while in short run most of the countries is non-buoyant. In long run SSCT is buoyant for all of the low income economies leaving Kenya and Guyana while in short run for most the countries it is not buoyant. In long run tax on goods and service are not buoyant for most of the advance economies except few countries which shows buoyant results. From the short run results we conclude that TGS is highly buoyant for most of the advance countries with few of them having negative buoyancy. Similarly in emerging economies, TGS is buoyant for half of the selected countries both in log run and short run. Some countries like South Africa and Peru shows buoyance for TGS in long run but not in short run. Similarly countries like Poland, Hungry, Peru, Mexico and Morocco shows only short run buoyancy. In case of less developed countries TGS is buoyant for all of the countries in short run while in long it shows buoyancy except for Mali, Kenya and Honduras. The impacts of inflation and output volatility on tax revenue buoyance are significant for most of the countries in advance, emerging and low income countries. Most of the countries tax revenue, except few, shows negative response to change in inflation and output volatility. It means that output volatility and inflation have adverse effect on tax revenue. At the end, we conclude from the estimated results for all components of tax revenue in advance, emerging and less develop economies that empirical Bayesian D-prior is the most efficient technique with lowest root mean square forecast error.

6.3 Recommendations

The study has found the strong and weak spots of tax revenue for each individual country in advance, emerging and less developed economies in order to maintain long run sustainability and short run stabilization. For most of the advance economies we recommend PIT, CIT and SSCT as output stabilizer, because in short run all these components of tax revenue are buoyant, but in long run only CIT and SSCT should be encourage to keep the economy sustainable[6]. Increasing tax revenue is probably the most fundamental challenge faced by developing countries, which not only used to adequately finance public investment

[6] in long run for most of the advance economies PIT is non-buoyant

and reduce fiscal deficit but also to establish a fairer society. From the estimated results we can recommend for emerging economies PIT, CIT and SSCT as instruments for sustainability in long run and PIT & CIT for stabilization in short run.

For less developed countries, PIT and TGS are buoyant in short run while CIT and TGS in long run, therefor, they should focus on PIT and TGS for stabilization in short run and on CIT along with TGS for sustainability in long run.

REFERENCES

Adkins, William. (2017). Relationship Between Total Revenue and GDP. Bizfluent. Retrieved from

Ahmed, Qazi Masood, and Sulaiman D. Muhammad. (2010). Determinant of tax buoyancy: empirical evidence from developing countries. *European Journal of Social Sciences*, 13(3), p. 408.

Akbar, Mohammad, and Qazi Masood Ahmed (1997). Elasticity and buoyancy of revenues and expenditure of Federal Government. *Pakistan Economic and Social Review*, 35 (1), 43-56.

Appiah-Kusi, J., & Pescetto, G. M. (1998). Volatility and volatility spill-overs in emerging markets: the case of the African stock markets. *Ekonomia*, *2*(2), 171-185.

Ariyo, A. (1997). Productivity of the Nigerian tax system: 1970-1990 , 34(39)

Ashraf, M. and Sarwar, S. (2016). Institutional Determinants of Tax Buoyancy in Developing Nations. Journal of Emerging Economies and Islamic Research, 4(1), 01-12.

Bayu, T. (2015). Analysis of tax buoyancy and its determinants in Ethiopia (co integration approach). *Journal of Economics and Sustainable Development*. 6(3), ISSN 2222-1700.

Bilquees, F. (2004). Elasticity and Buoyancy of the Tax system in Pakistan. *Pakistan Development Review*, *43*(1), 73-94.

Bird, R. M., Martinez-Vazquez, J., & Torgler, B. (2008). Tax effort in developing countries and high income countries: The impact of corruption, voice and accountability. *Economic analysis and policy*, *38*(1), 55-71.

Bonga, W.G., Gwaendepi, N.L.D., Strien, F. M.V. (2015). Tax Elasticity, Buoyancy and Stability in Zimbabwe. Journal of Economics and Finance, 6(1), 21-29.

Dudine, P., & Jalles, J. T. (2017). How buoyant is the tax system? New evidence from a large heterogeneous panel. *Journal of International Development*, *30*(6), 961-991.

Ebeke, C., and Ehrhart, H., (2010). Is VAT Stabilizing? *CERDI*, *Etudes et Documents*, ISSN: 2114-7957.

Eltony, M. N. (2002). The determinants of tax effort in Arab countries. *Arab Planning Institute Working Paper*, 207.

Friedman, E., Johnson, S., Kaufmann, D., & Zoido-Lobaton, P. (2000). Dodging the grabbing hand: the determinants of unofficial activity in 69 countries. *Journal of public economics*, 76(3), 459-493.

Gupta, A. S. (2007). Determinants of Tax Revenue Efforts in Developing Countries. *International*

Hsiao, C., 2007, Panel Data Analysis-Advantages and Challenges, *Test*, 16, 1-22

Hsiao, C., Appelbe, T. W. and Dineen, C. R. (1993) A general framework for panel data analysis with an application to Canadian customer dialed long distance service, *Journal of Econometrics,* 59, pp. 63–86.

Karran,T.(1985). The Determinants of Taxation in Britain: An Empirical Test. *Journal of Public Policy,* 5(3), 365-386.

Khattry B., Rao J. M. (2002). Fiscal Faux Pas: An Analysis of the Revenue Implications of Trade

Liberalization. *World Development*, 30, 1431−1444.

Mahdavi, S. (2008). The level and composition of tax revenue in developing countries: Evidence from unbalanced panel data. *International Review of Economics & Finance,* 17, 607-617.

Mawia, M. & Nzomoi, J. (2013). An empirical investigation of Tax Buoyancy in Kenya. African Journal of Business Management, 7(40), 4233-4246.

McConnell, C. R., Brue, S. L., & Flynn, S. M. (2009). *Economics: Principles, problems, and policies*. Boston McGraw-Hill/Irwin.

Mukarram, Fauzia (2001). "Elasticity and Buoyancy of Major Taxes in Pakistan."." *Pakistan Economic and social review*, 39(1), 43-56.

Musa, O. D., Bulus, A., Nwokolo, C. C., & Yuni, D. N. (2016). Tax buoyancy and elasticity in

Nigeria: The case of aggregate tax. *International Journal of Development and Economic Sustainability*, *4*(4), 20-31.

Omondi, O.V., Wawire, N.H.W., Manyasa, E.O. & Thuku, G.K. (2014). Effects of Tax Buoyancy and Elasticity of the tax system in Kenya: 1963-2010. International Journal of Economics and Finance, 6(10), 97-111.

Robbins, H. (1956). A sequential decision problem with a finite memory. *Proceedings of the National Academy of Sciences of the United States of America*, *42*(12), 920.

Shaikh, S. A. (2012). Estimating the Federal Direct Tax Buoyancy for Pakistan in Post-1973 Era.

Sharma, R. K., & Kulshrestha, S. K. (2015). An Analysis of Non Tax Revenue Buoyancy in India. International Journal of Research in Economics and Social Sciences, 5(5), 1-7. 22

Siddiqui, A., & Rehman, A. U. (2017). The human capital and economic growth nexus: in East and South Asia. *Applied Economics*, *49*(28), 2697-2710.

Tagkalakis, A. O. (2015). Estimating the elasticity of personal income tax to gross earnings from income tax statements in Greece: implications for tax buoyancy. *Public Finance and Management*, *15*(1), 47.

Twerefou, D. F., Fumey, A., Osei-Assibey, E., & Asmah, E. E. (2010). Buoyancy and elasticity of tax: evidence from Ghana. *Journal of Monetary and Economic Integration*, 10(2), 1-35.

Upender, M. (2008). Degree of tax buoyancy in India: An empirical study. *International Journal of Applied Econometrics and Quantitative Studies*, *5*(2), 59-70.

APPENDIX A

Table A1: PIT Posterior estimate for long run & short run buoyancy in advance economies

S. No	Country	Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
1.	**Australia**	α_i	13.01***	12.599***	-0.096**	-0.01**
		γ_i	0.635***	0.649***	137.736***	24.164*
		δ_i	-0.019	-0.017	-0.022**	-0.0051
		β_i	0.038*	0.036*	0.000***	0.000*
2.	**Austria**	α_i	21.143***	20.612***	-0.042	0.0538*
		γ_i	0.306*	0.3253*	61.278***	-66.41***
		δ_i	-0.021	-0.019*	0.001	-0.005
		β_i	0.027**	0.0266**	0.000**	0.000**
3.	**Belgium**	α_i	15.504***	14.5917***	-0.011	0.074*
		γ_i	0.512***	0.54607***	-16.561	124.887*
		δ_i	0.003	0.00420	0.007	-0.059*
		β_i	-0.01*	-0.01699**	0.000	0.000
4.	**Canada**	α_i	10.481**	5.992***	0.032	-0.126*
		γ_i	0.716***	0.872***	-20.945	104.675*
		δ_i	-0.018*	0.003	-0.011	0.036
		β_i	0.011*	0.0061*	0.000*	0.000***
5.	**Denmark**	α_i	17.120**	16.102***	-0.002	0.004
		γ_i	0.484**	0.520**	-16.3**	24.601**
		δ_i	-0.007	-0.004	0.003	-0.007
		β_i	0.006	0.0061	0.000	0.000*
6.	**Finland**	α_i	-0.944	-1.7445	0.015	-0.386
		γ_i	1.103*	1.1342*	-5.906	232.743**
		δ_i	0.062***	-0.059***	0.003	-0.110
		β_i	0.009	0.00829	0.000	0.000**
7.	**Germany**	α_i	26.79***	-16.77***	0.004	-0.001
		γ_i	2.018***	1.6688***	-10.57*	12.607**
		δ_i	0.021**	0.02140**	0.008	-0.009*
		β_i	-0.01**	-0.007*	0.000**	0.000
8.	**Iceland**	α_i	-24.3***	-23.653***	-0.002	0.013
		γ_i	1.939***	1.9141***	-13.41*	58.401**
		δ_i	0.002	0.0033	0.017*	-0.068**
		β_i	-0.008**	-0.0077**	0.000	0.000
9.	**Italy**	α_i	118.795***	148.717***	0.000	0.012
		γ_i	-3.164***	-4.2291***	14.517	-186.56**
		δ_i	0.012**	0.0139**	-0.006	0.071**
		β_i	0.057***	0.0716***	0.000	0.000
10.	**Japan**	α_i	91.067***	86.734***	0.003	-0.001
		γ_i	-1.613***	-1.485***	6.534	-0.680
		δ_i	-0.022*	-0.019*	-0.0**	0.014*
		β_i	0.049***	0.046***	0.000	0.000

S. No	Country	Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
11.	**Korea**	α_i	3.016*	2.992*	0.025	0.005
		γ_i	0.975***	0.975***	-36.2***	-3.278
		δ_i	-0.005	-0.0050	0.002	-0.001
		β_i	-0.008	-0.0079*	0.000	0.000
12.	**Lux**	α_i	7.346***	7.057***	0.043*	-0.077*
		γ_i	0.789***	0.801***	-16.637	38.399**
		δ_i	0.014*	0.014*	-0.017*	0.026*
		β_i	0.010***	0.009***	0.000**	0.000*
13.	**Netherland**	α_i	-11.72*	-11.449*	0.004	-0.048
		γ_i	1.509***	1.498***	-1.321	64.587
		δ_i	-0.03**	-0.030**	0.001	-0.037
		β_i	-0.017**	-0.016**	0.000	0.000
14.	**Norway**	α_i	11.607*	-3.3781	0.060	0.016
		γ_i	0.681*	1.19733***	102.61***	26.985*
		δ_i	-0.022	0.0470*	-0.053**	-0.014**
		β_i	0.042**	-0.021*	0.000***	0.000
15.	**Portugal**	α_i	-15.522	-5.185	-0.025	0.207*
		γ_i	1.686*	1.2897*	29.533	-202.1***
		δ_i	0.014*	0.0196*	0.005	-0.053
		β_i	-0.001	-0.00006*	0.000	0.000***
16.	**Slovak Rep**	α_i	8.581***	-8.441***	0.010	-0.018
		γ_i	1.423***	1.417***	41.451	-56.034
		δ_i	0.004	0.004	-0.009	0.010
		β_i	0.011**	0.010***	0.000*	0.000*
17.	**Slavonia**	α_i	-6.919*	-6.703*	0.042	-0.267*
		γ_i	1.402***	1.392***	34.702	-194.89**
		δ_i	-0.019*	-0.018*	-0.025	0.146*
		β_i	0.003	0.0026	0.000	0.000**
18.	**Spain**	α_i	36.080***	34.8664***	0.054**	-0.023*
		γ_i	-0.197	-0.154	17.873*	-4.415
		δ_i	-0.006*	-0.004	-0.0***	0.004*
		β_i	0.036***	0.03455***	0.000	0.000
19.	**Sweden**	α_i	18.113***	17.178***	0.014	-0.142*
		γ_i	1.443**	0.475**	6.280*	-36.67**
		δ_i	0.0001	0.0003	-0.011	0.100*
		β_i	0.024**	0.022**	0.000	0.000*
20.	**Switzerland**	α_i	11.917**	11.472**	0.059*	-0.126**
		γ_i	1.635***	0.6519***	-8.761*	27.422**
		δ_i	-0.014*	-0.012*	-0.013*	0.024*
		β_i	0.016*	0.015*	0.000*	0.000**
21.	**U kingdom**	α_i	51.513***	35.165***	-0.091*	0.208*
		γ_i	-0.749***	-0.167*	73.451**	-157.09*
		δ_i	-0.006	0.002	-0.006	0.009
		β_i	0.045***	0.030***	0.000	0.000*

S. No	Country	Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
22.	**U stat**	α_i γ_i δ_i β_i	33.159*** -0.026 -0.020* 0.038***	32.07** 0.0103 -0.018* 0.036***	-0.024** 30.552*** -0.001 0.000**	-0.007 11.262 -0.001 0.000

Table A2: CIT Posterior estimate for long run & short run buoyancy in advance economies

S. No	Country	Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
1.	**Australia**	α_i γ_i δ_i β_i	30.88** 10.724* 0.009 0.13***	28.552* 9.811* 0.010 0.12***	-0.36559*** 428.73863*** -0.04314* 0.00000***	-0.0214 35.55469 -0.01110* 0.00000
2.	**Austria**	α_i γ_i δ_i β_i	23.749 -8.444 0.022 0.021	13.394 -4.173 0.027 0.016	-0.23949* 88.710 0.10334 0.00000	0.65834*** -215.038* -0.30852** 0.00000
3.	**Belgium**	α_i γ_i δ_i β_i	4.447 2.133 -0.006 0.047**	16.945 -5.554 0.188** -0.251***	-0.14143*** 155.828*** 0.03200* 0.00000	0.02214 -12.87528 -0.01322* 0.00000
4.	**Canada**	α_i γ_i δ_i β_i	24.566* 8.306* -0.034* 0.021*	-26.116 11.806 0.074 0.005	0.10130* 33.07708 -0.07327* 0.00000	-0.45983*** -130.31900 0.30362* 0.00000
5.	**Cz Republic**	α_i γ_i δ_i β_i	76.672* 29.157* -0.050* 0.022*	-94.695 39.225* 0.084 0.002	-0.06408 170.41712*** 0.00069 0.00000*	0.04191 -83.1315*** -0.01343 0.00000***
6.	**Denmark**	α_i γ_i δ_i β_i	214.2** 87.09** 0.087** 0.078**	165.960*** 67.140*** 0.063*** 0.061***	-0.06068 94.07036** -0.02644 0.00000	-0.00638 20.31802 -0.01173 0.00000
7.	**Estonia**	α_i γ_i δ_i β_i	-142.93 57.967* -0.066** 0.023***	-115.286 47.034* -0.050 0.021**	-0.45205* 155.62222 0.21189 0.00000	1.39180** -449.56385* -0.67611* 0.00000*
8.	**Finland**	αi γi δi βi	19.885 -6.927 0.073* -0.012	-0.588 1.820 -0.041 0.040	0.02235 18.21685 -0.04073 0.00000	-0.1128 -80.329 0.190** 0.0000*

S. No	Country	Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
9.	**France**	α_i	12.503	74.399	-0.00786	0.0385
		γ_i	61.33*	-28.256	66.16594*	-165.2**
		δ_i	0.05***	-0.005	-0.00889	-0.0096
		β_i	-0.027	0.056	0.00000	0.0000
10.	**Germany**	α_i	48.797***	27.591**	-0.15505*	0.77564***
		γ_i	19.278***	10.269*	37.64701	-153.66458*
		δ_i	-0.009	0.002	0.04955	-0.28824***
		β_i	0.037**	0.027*	0.00000	0.00000**
11.	**Greece**	α_i	3.067	73.253	-0.04460***	-0.0240*
		γ_i	35.33*	-25.842	211.07174	124.2060***
		δ_i	0.085**	-0.011	0.00206	-0.0026
		β_i	0.005*	0.021***	0.00000	0.00000*
12.	**Iceland**	α_i	70.445***	69.174***	0.06662**	-0.376
		γ_i	-28.120***	-27.588***	-19.14014**	20.416**
		δ_i	-0.015	-0.015	-0.03350***	0.007
		β_i	-0.004	-0.003	0.00000***	0.00000*
13.	**Ire land**	α_i	80.666*	94.478	-0.24626	1.1819***
		γ_i	-30.105*	-35.648	212.77745*	-970.97*
		δ_i	-0.087*	-0.079	0.04312	-0.2531*
		β_i	-0.011*	-0.008	0.00000	0.00000
14.	**Israel**	α_i	7.280	-7.421	-0.11065	0.2828*
		γ_i	-1.476	4.427	116.34810	-268.72**
		δ_i	0.003	0.032	-0.02437	0.0295
		β_i	0.039***	-0.019	0.00000	0.00000
15.	**Italy**	α_i	32.234*	23.980	-0.13551***	-0.04723*
		γ_i	12.273*	-8.773	122.06468***	48.33707***
		δ_i	-0.033*	-0.022	-0.01488*	-0.01091*
		β_i	0.131***	0.108***	0.00000***	0.00000***
16.	**Japan**	α_i	12.687	-13.672	0.05375	0.0118
		γ_i	3.586*	6.890	59.27378**	12.48388
		δ_i	-0.026	0.128*	-0.09241***	-0.02086***
		β_i	0.042*	-0.060	0.00000	0.00000
17.	**Korea**	α_i	-65.500***	-52.531***	-0.05084	0.0673*
		γ_i	27.958***	22.712***	71.79844***	-72.35724*
		δ_i	0.032*	0.032	0.03337***	-0.05776**
		β_i	0.005	0.007	0.00000**	0.00000
18.	**Lux**	α_i	61.435**	-8.940	0.03021	-0.23664
		γ_i	-23.144**	5.024	6.45217*	-14.61289
		δ_i	0.002	0.019	-0.02618	0.16256*
		β_i	0.025**	0.012***	0.00000	0.00000

S. No	Country	Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
19.	**Netherland**	α_i	91.562*	16.589	0.26594**	0.15515*
		γ_i	35.119*	5.175	256.70692***	147.78615**
		δ_i	-0.015	0.011	-0.22452***	-0.13229***
		β_i	0.034*	0.016*	0.00000	0.00000
20.	**Norway**	α_i	154.069***	27.467	0.01162	0.00805
		γ_i	-60.987***	-9.680	-15.33370***	-4.16346**
		δ_i	-0.042*	0.004	-0.03931	-0.02197
		β_i	0.076***	0.021**	0.00000	0.00000
21.	**Portugal**	α_i	18.401	11.649	-0.02380	0.18334
		γ_i	6.087*	-3.086	17.83136	-78.35386*
		δ_i	0.094**	-0.080	0.00100	-0.06740
		β_i	-0.036*	0.071*	0.00000	0.00000***
22.	**Slovak Rep**	α_i	-10.087	-35.191	0.14936*	-0.27452**
		γ_i	5.180*	14.978	-0.18799	13.54779***
		δ_i	0.005	0.021	-0.07560*	0.12166**
		β_i	0.007	0.007	0.00000	0.00000
23.	**Slavonia**	α_i	-24.504**	53.383***	0.06832	-0.18802
		γ_i	10.461***	-18.225***	2.46796**	10.64897***
		δ_i	0.021*	0.006	-0.01868	0.02253**
		β_i	0.014***	0.012	0.00000	0.00000
24.	**Spain**	α_i	-92.091**	-105.271**	0.14291*	-0.77183***
		γ_i	38.089**	43.410**	4.41870***	4.82615*
		δ_i	-0.031	-0.021	-0.03681*	0.15101***
		β_i	0.024	0.014	0.00000	0.00000***
25.	**Sweden**	α_i	6.665	2.822	0.15940	-0.42488*
		γ_i	-1.133	0.355	9.68473	-9.60957
		δ_i	0.021**	0.018	-0.03486	0.06482
		β_i	0.037	0.024**	0.00000	0.00000*
26.	**Switzerland**	α_i	-67.823***	-69.651**	0.07131	-0.06960
		γ_i	30.413***	31.213***	3.63724***	5.43573
		δ_i	-0.019	-0.013	-0.03883*	0.02580
		β_i	-0.037**	-0.042	0.00000	0.00000
27.	**U kingdom**	α_i	-2.859	11.805	0.06469	-0.35171**
		γ_i	2.603	-3.320	4.03241**	7.17344*
		δ_i	0.006	0.038	-0.01084	0.00522
		β_i	0.050**	-0.066**	0.00000	0.00000**
28.	**U stat**	α_i	-27.635	-65.723	-0.04673	0.14782
		γ_i	12.962*	29.166	7.75879***	-4.50357*
		δ_i	0.006	0.030	0.01911	-0.08432***
		β_i	0.109***	0.076**	0.00000	0.00000

Table A3: SSCT Posterior estimate for long run & short run buoyancy in advance economies

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
1.	**Australia**	α_i	1.671*	1.720*	0.0408**	-0.089*
		γ_i	1.089***	1.085***	-30.01**	50.822**
		δ_i	-0.002	-0.003	-0.0027	0.0134**
		β_i	-0.018***	-0.018***	0.0000**	0.0000*
2.	**Austria**	α_i	0.984	1.066	0.0037	0.0058*
		γ_i	1.158***	1.150***	-20.6229	-6.95***
		δ_i	0.003	0.003	0.0041	0.0014*
		β_i	-0.01246**	-0.012**	0.0000	0.0000
3.	**Belgium**	α_i	-2.608*	-2.451*	0.0204***	0.0091***
		γ_i	1.502942***	1.488***	-32.1995	-13.59***
		δ_i	0.001	0.001	0.0006	0.0013
		β_i	-0.020***	-0.020***	0.0000***	0.0000*
4.	**Canada**	α_i	6.799***	7.129***	0.0341*	-0.0651*
		γ_i	0.519**	0.489**	-30.7968*	44.4552*
		δ_i	-0.022	-0.023	-0.0059	0.0217
		β_i	0.004	0.005	0.0000	0.0000
5.	**Cz Republic**	α_i	30.174***	54.168***	0.0108	0.2620
		γ_i	-1.560***	-3.416***	-102.3693	-289.673
		δ_i	0.183	0.072***	-0.0723	0.2019
		β_i	-0.024***	0.011	0.0000	0.0000
6.	**Denmark**	α_i	-20.076***	5.739***	0.0172**	-0.04**
		γ_i	2.775***	0.746***	-19.8***	43.50***
		δ_i	0.001	-0.020****	-0.0022	0.0178*
		β_i	-0.025***	0.000	0.0000	0.0000
7.	**Estonia**	α_i	2.577***	2.581***	0.0214	-0.0016
		γ_i	1.006***	1.005***	-29.6297***	2.3403
		δ_i	-0.008	-0.009	-0.0065	0.0053
		β_i	-0.003***	-0.003***	0.0000	0.0000
8.	**Finland**	α_i	-0.817	-0.081	-0.0278	0.0571*
		γ_i	1.304***	1.236***	4.9159	-27.7***
		δ_i	0.004***	0.001	0.0092	-0.0102
		β_i	-0.004	-0.004	0.0000	0.0000
9.	**France**	α_i	-30.054	-41.001	-0.0174	0.2535**
		γ_i	4.051**	5.111**	-66.1589	599.0726***
		δ_i	-0.007	0.003	0.0116	-0.1038***
		β_i	-0.055	-0.081	0.0000	0.0000
10.	**Germany**	α_i	-6.890***	-3.971***	0.0165*	-0.0262*
		γ_i	1.906***	1.625***	-9.9324**	-2.3281
		δ_i	0.020**	0.009**	0.0012**	0.0026
		β_i	-0.016***	-0.012***	0.0000	0.0000

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
11.	**Greece**	α_i γ_i δ_i β_i	11.813*** 0.042 0.028 0.013*	10.143*** 0.215 0.015 0.010*	0.0208*** -8.9918 0.0024 0.0000*	0.0208 -7.2345 0.0024 0.0000**
12.	**Iceland**	α_i γ_i δ_i β_i	-3.071 1.352*** -0.007 -0.009***	-2.179 1.296*** -0.009 -0.008***	0.0453* -26.8854*** -0.0036 0.0000	-0.232** 105.0763* 0.0326 0.0000*
13.	**Ire land**	α_i γ_i δ_i β_i	-2.460* 1.475*** 0.014 -0.008***	-1.160* 1.351*** 0.007 -0.007***	0.0967* -94.5576** -0.0227 0.0000	-0.1457* 135.9070** 0.0425* 0.0000
14.	**Israel**	α_i γ_i δ_i β_i	-4.324*** 1.556*** 0.003 -0.009***	-4.263*** 1.551*** 0.003 -0.009***	0.0778* -41.6923* -0.0051 0.0000	-0.35*** 156.0612*** 0.0356** 0.0000*
15.	**Italy**	α_i γ_i δ_i β_i	12.596*** -0.023 -0.003 0.008**	12.858*** -0.049 -0.002 0.008**	0.0153 -4.1968 0.0000 0.0000	-0.0154 -16.5** 0.0050* 0.0000*
16.	**Japan**	α_i γ_i δ_i β_i	2.036 0.990*** -0.003 -0.011	3.233 0.911*** -0.004 -0.010	0.0043 -17.33** 0.0071 0.0000	0.0076 204041 -0.0048 0.0000
17.	**Korea**	α_i γ_i δ_i β_i	-11.949** 1.810*** -0.031 -0.042**	-11.675*** 1.794*** -0.031 -0.041**	0.0635 -34.8776 -0.0094 0.0000	-0.478** 109.4839 0.0685* 0.0000**
18.	**Lux**	α_i γ_i δ_i β_i	9.130*** 0.356 -0.025* 0.010*	9.725*** 0.303 -0.024* 0.010*	-0.0027 -2.7064 0.0009 0.0000	0.2283 -148.0* -0.0128 0.0000
19.	**Netherland**	α_i γ_i δ_i β_i	-3.999*** 1.645*** -0.007* -0.012***	-3.963*** 1.641*** -0.007* -0.012***	0.0000 -14.45** 0.0064* 0.0000	0.0153* 2.4719 -0.006* 0.0000
20.	**Norway**	α_i γ_i δ_i β_i	-11.455 2.067** -0.011 -0.028*	-4.332 1.524** -0.015 -0.016*	0.0137 -2.5670 -0.0066 0.0000	-0.0442 -140.33 0.0953 0.0000*

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
21.	**Portugal**	α_i γ_i δ_i β_i	2.592 0.986*** 0.004 0.000	2.596 0.988*** -0.001 0.000	-0.0025 3.6431 -0.0002 0.0000	0.0109** -15.4*** 0.0027* 0.0000
22.	**Slovak Rep**	α_i γ_i δ_i β_i	3.615*** 0.810*** -0.005 0.002	3.625*** 0.809*** -0.005 0.002	0.0008 -18.7997 0.0029 0.0000	0.1601 51.8435 -0.0356 0.0000
23.	**Slavonia**	α_i γ_i δ_i β_i	-22.748*** 3.516*** -0.034*** -0.034***	-22.663*** 3.508*** -0.034*** -0.034***	0.0565* -13.8175 0.0002 0.0000	0.0158 -8.8543 0.0013 0.0000
24.	**Spain**	α_i γ_i δ_i β_i	-39.234*** 5.034*** -0.022*** -0.060***	-50.076*** 6.115*** -0.023*** -0.073***	0.0321 -47.8*** 0.0050 0.0000	-0.0595 88.9274*** -0.0068 0.0000
25.	**Sweden**	α_i γ_i δ_i β_i	2.754*** 0.994*** 0.000 0.004**	2.775*** 0.993*** 0.000 0.004**	0.0062 -0.4831 -0.0022 0.0000	0.0057** -7.16*** 0.0012 0.0000
26.	**Switzerland**	α_i γ_i δ_i β_i	-4.925 1.652*** -0.001 -0.009	5.450 0.744*** -0.025 -0.002	0.0340* -17.0806 -0.0029* 0.0000	-0.0189 -0.0624 0.0054 0.0000*
27.	**U kingdom**	α_i γ_i δ_i β_i	6.760*** 0.497*** -0.002 0.008***	6.940*** 0.480*** -0.002 0.009***	0.0255* -18.83** -0.0026 0.0000	-0.09*** 44.8961** 0.0224*** 0.0000
28.	**U stat**	α_i γ_i δ_i β_i	-0.763 1.317*** -0.002 -0.015**	-0.539 1.296*** -0.002 -0.014**	0.0060 -12.6*** 0.0019 0.0000*	0.0045 10.4203* 0.0001 0.0000***

Table A4: TGS Posterior estimate for long run & short run buoyancy in advance economies

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
1.	Australia	α_i	16.3625***	16.115***	0.0595	-0.1651*
		γ_i	-0.2853*	-0.263*	0.2350	-50.0507
		δ_i	-0.0362***	-0.035***	-0.02**	0.0853***
		β_i	0.0071	0.007	0.0000	0.0000
2.	Austria	α_i	4.8945***	4.849***	-0.0098	0.0177**
		γ_i	0.766033***	0.770***	-20.0***	11.0650**
		δ_i	0.012429*	0.012*	0.0091*	-0.0110**
		β_i	-0.01242**	-0.012**	0.0000	0.0000
3.	Belgium	α_i	0.723572	0.819	-0.0094	0.1583***
		γ_i	1.158094	1.148***	7.0857	-116.5***
		δ_i	0.002509***	0.004	0.0022	-0.043***
		β_i	-0.00351	-0.003	0.0000	0.0000**
4.	Canada	α_i	18.21254***	17.757***	0.0228	-0.0196
		γ_i	-0.49527	-0.452	14.7571	-30.3675*
		δ_i	-0.00764	-0.007	-0.021*	0.0260*
		β	0.018411*	0.018*	0.0000**	0.0000***
5.	Cz Republic	α_i	5.7625***	5.723***	0.0029	0.0178
		γ_i	0.762746***	0.766***	7.3227	-65.3***
		δ_i	-0.0034	-0.003	-0.0054	0.0190
		β_i	0.007342***	0.007***	0.0000	0.0000
6.	Denmark	α_i	-10.6763	-10.828	-0.0180*	0.0213**
		γ_i	2.045829***	2.056***	6.5258	-10.365*
		δ_i	-0.00664	-0.004	0.0138**	-0.01***
		β_i	-0.01722*	-0.017*	0.0000***	0.0000***
7.	Estonia	α_i	1.52147***	1.555***	-0.0379*	0.0422**
		γ_i	1.08404***	1.080***	-1.6891	-4.8540
		δ_i	0.01179*	0.012	0.0245**	-0.024**
		β_i	-0.0027***	-0.003*	0.0000	0.0000*
8.	Finland	α_i	3.694	3.019	-0.0051	0.0291
		γ_i	0.894	0.952	5.7864	-24.4***
		δ_i	-0.040*	-0.027**	0.0039	-0.0151*
		β_i	0.002	0.001	0.0000	0.0000
9.	France	α_i	40.693	-48.299**	-0.06***	0.0639***
		γ_i	-2.717**	5.893***	-29.8254	16.2276
		δ_i	-0.000	0.040*	0.0136*	-0.0143**
		β_i	0.064*	-0.094*	0.0000*	0.0000*
10.	Germany	α_i	-1.140	-0.560	0.0080	-0.0125
		γ_i	1.345**	1.286***	4.3568	-59.0***
		δ_i	-0.021	-0.013	-0.0054	0.0235

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
		β_i	0.009	0.007	0.0000	0.0000
11.	Greece	α_i	13.462***	13.417***	0.0160*	0.0046***
		γ_i	-0.197	-0.192	-3.6866	-3.2759
		δ_i	0.015	0.015	0.0351***	-0.0030*
		β_i	0.018***	0.018***	0.0000	0.0000
12.	Iceland	α_i	-1.526	-1.447	-0.0303	0.2599**
		γ_i	1.248***	1.244***	-14.3123*	71.2237**
		δ_i	0.011	0.012	0.0209*	-0.162***
		β_i	-0.006	-0.006	0.0000*	0.0000**
13.	Ire land	α_i	-0.427	-0.235	-0.0119	0.1405*
		γ_i	1.274***	1.254***	-9.6704	8.2877
		δ_i	-0.005	-0.003	0.0121	-0.0960***
		β_i	-0.004**	-0.004**	0.0000	0.0000
14.	Israel	α_i	-0.724	-0.605	0.0092	-0.0008
		γ_i	1.279***	1.268***	-0.7169	-46.1028
		δ_i	0.020*	0.019*	-0.0075	0.0470**
		β_i	-0.010	-0.009	0.0000	0.0000**
15.	Italy	α_i	7.528	7.264	-0.0194	0.0376*
		γ_i	0.512	0.537	22.1019**	-37.0***
		δ_i	0.003	0.004	-0.0039	0.0011
		β_i	0.018**	0.018**	0.0000*	0.0000**
16.	Japan	α_i	14.714	13.406	-0.0690**	-0.0244*
		γ_i	0.179	0.266	97.0322***	36.462***
		δ_i	-0.030	-0.026	-0.0052	-0.0030
		β_i	0.052***	0.047***	0.0000***	0.0000*
17.	Korea	α_i	1.549***	1.557*	0.0073	0.0022
		γ_i	1.056***	1.056***	-16.3796	14.5173*
		δ_i	0.004	0.004	0.0056**	-0.012**
		β_i	-0.006	-0.006	0.0000	0.0000
18.	Lux	α_i	-3.946	4.426	0.1142*	-0.2***
		γ_i	1.566***	0.810**	-17.2403	23.0714
		δ_i	-0.009	0.025*	-0.0457*	0.1138***
		β_i	-0.010	0.002	0.0000*	0.0000***
19.	Nether land	α_i	4.634***	4.343***	0.0046	0.0098
		γ_i	0.788***	0.814***	-0.1039	-29.2742
		δ_i	-0.014**	-0.011*	-0.0040	0.0142
		β_i	-0.003	-0.003	0.0000	0.0000***
20.	Norway	α_i	2.650	2.515	-0.0093	0.0869**
		γ_i	0.981**	0.99***	12.9586	-95.7***
		δ_i	-0.008	-0.005	0.0028	-0.0276*
		β_i	0.004	0.003	0.0000	0.000***

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
21.	**Portugal**	α_i	3.603	1.203	-0.0082	0.0496
		γ_i	0.86***	1.10***	13.1015	-68.013*
		δ_i	-0.002	0.020	0.0006	-0.0076
		β_i	-0.014	0.003	0.0000*	0.000***
22.	**Slovak Rep**	α_i	2.07***	2.07***	-0.0052	0.0102
		γ_i	0.93***	0.93***	23.25**	-16.05**
		δ_i	0.000	0.000	-0.0050	-0.0003
		β_i	0.000	0.000	0.0000	0.0000
23.	**Slavonia**	α_i	7.976***	7.870***	-0.0199	0.3487***
		γ_i	0.388***	0.400***	14.9879	-265.2***
		δ_i	0.012*	0.012*	-0.0022	0.0072
		β_i	0.007***	0.007***	0.0000	0.0000
24.	**Spain**	α_i	21.688	19.307	0.0770***	-0.023*
		γ_i	-0.899	-0.677	-4.5266	-3.0092
		δ_i	-0.004	0.005	-0.0182***	0.0049*
		β_i	0.041	0.030	0.0000	0.0000
25.	**Sweden**	α_i	-5.376***	-4.274**	0.0177	-0.093**
		γ_i	1.606***	1.520***	-1.8473	-14.53*
		δ_i	-0.008	-0.005	-0.0037	0.0134**
		β_i	-0.013***	-0.011***	0.0000	0.0000***
26.	**Switzer land**	α_i	-5.566**	-5.414**	0.0759	-0.1***
		γ_i	1.728***	1.714***	-8.1292	5.8519
		δ_i	-0.016***	-0.015***	-0.0158	0.0251**
		β_i	0.007	0.006	0.0000	0.0000
27.	**U kingdom**	α_i	1.753	1.737	-0.0035	0.0537*
		γ_i	1.071***	1.072***	8.2580	-67.3984**
		δ_i	0.000	0.000	-0.0028	0.0038
		β_i	0.001	0.001	0.0000	0.0000*
28.	**U stat**	α_i	-6.539	-6.868	0.0102	-0.0023
		γ_i	1.847***	1.877***	-8.6148**	4.1893
		δ_i	0.004	0.005	0.0004	-0.00**
		β_i	-0.015**	-0.015**	0.0000	0.0000

Table A5: PIT Posterior estimate for long run & short run buoyancy in emerging economies

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
1	**Brazil**	α_i γ_i δ_i β_i	-6.861** 1.305*** -0.007* -0.009**	0.094 1.06*** -0.005* -0.001	-0.02757 0.41675 -0.00445 0.004078	0.103175 0.672627 0.016966** -0.022***
2	**Chile**	α_i γ_i δ_i β_i	-21.04** 1.708*** 0.016 0.045*	23.22*** 0.338* -0.014 -0.03**	-0.2997*** 8.21118*** -0.03259** 0.001111	-0.13601** 4.14810*** -0.01441 -0.0015
3	**Colombia**	α_i γ_i δ_i β_i	-22.254*** 1.705*** -0.014* -0.006	-14.69*** 1.483*** -0.011* -0.004	-0.0377 1.851203 -0.00889 -0.00389	0.560196* -16.4513*** 0.139668*** 0.007607
4	**Dominican Republic**	α_i γ_i δ_i β_i	-9.620* 1.387*** -0.003 0.003	-8.969* 1.366*** -0.003 0.002	0.030127 0.640691 -0.00744 -0.0054**	-0.29233* -0.85706 0.117431*** 0.022428***
5	**Egypt**	α_i γ_i δ_i β_i	-3.244 1.178** 0.022** -0.008	2.846*** 0.970*** -0.003* 0.002	-0.0597 1.498883 -0.0279** 0.000367	0.098926 -0.67165 0.039739*** -0.00892
6	**Hungary**	α_i γ_i δ_i β_i	28.916* 0.130 0.021* 0.030***	27.458* 0.177 0.013* 0.025***	-0.00186 -0.30928 0.012568* -0.00306	0.064953 4.927749** -0.0566*** -0.004
7	**Indonesia**	α_i γ_i δ_i β_i	-5.548*** 1.195*** 0.018*** -0.028***	-2.205* 1.104*** 0.010** -0.017*	-0.39355** 6.173071** 0.022245 0.011135	0.67321*** -8.5357** -0.03306 -0.0297***
8	**Kazakhstan**	α_i γ_i δ_i β_i	11.253* 0.694*** 0.014 0.070**	5.723* 0.875*** 0.001 0.023**	-0.4508*** 3.996257*** -5.21E-05 0.021044*	-0.17061*** 1.848368*** 0.001108 0.006198*
9	**Mexico**	α_i γ_i δ_i β_i	-45.659*** 2.557*** 0.010 -0.011*	-43.77*** 2.496*** 0.009 -0.011**	0.323642*** -1.11233*** 0.009104 -0.06504***	0.138344*** -0.18157 0.004763* -0.02855***
10	**Morocco**	α_i γ_i δ_i β_i	-14.113*** 1.589*** 0.077** -0.016	-3.296*** 1.195*** 0.023* -0.006	-0.1312** 1.593381 -0.0500** 0.04659**	0.072465*** 0.036648 0.024521* -0.02656**

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
11	**Peru**	α_i	-3.763***	-19.54***	-0.10171	0.042583
		γ_i	1.956***	1.802***	3.812932***	-0.50804
		δ_i	0.036	0.014	-0.02892**	0.010889*
		β_i	-0.020*	-0.015	-0.02718	0.003805
12	**Philippines**	α_i	-4.533***	-3.989***	-0.12758***	0.058457***
		γ_i	1.216***	1.198****	2.009695***	-0.05992
		δ_i	0.008*	0.007*	-0.0014	0.002774
		β_i	0.014***	0.013***	0.007611*	-0.0073***
13	**Poland**	α_i	3.698*	3.739*	-0.08079**	0.061684**
		γ_i	0.937***	0.936***	3.00196***	-0.93982*
		δ_i	-0.019*	-0.015*	-0.00545	0.005741
		β_i	0.040**	0.029**	-0.0138*	0.002381
14	**South Africa**	α_i	-3.649*	-3.650*	0.029	-0.01014
		γ_i	1.218***	1.218***	0.505481	0.466099
		δ_i	0.008*	0.008*	0.019456***	-0.01***
		β_i	0.016**	0.016***	-0.00693	0.000332
15	**Thailand**	α_i	-7.132***	-13.58***	-0.06579	0.165366**
		γ_i	1.637***	1.519***	0.649802	0.188073
		δ_i	0.038***	0.030**	-0.01341	0.033422*
		β_i	-0.004	-0.003	0.024311**	-.06134***
16	**Turkey**	α_i	1.845*	1.879*	0.081761***	-0.00676
		γ_i	0.992***	0.991***	-0.9326**	0.814358***
		δ_i	0.006***	0.006***	0.005586	0.000768
		β_i	-0.004*	-0.004*	-0.00425***	-0.00326***
17	**Uruguay**	α_i	-6.342***	-55.41***	0.106863	-0.04416
		γ_i	3.149***	3.116***	1.964032	-0.22977
		δ_i	-0.031**	-0.031**	-0.02367	0.014578
		β_i	-0.022**	-0.022**	-0.014	0.002328

Table A6: CIT Posterior estimate for long run & short run buoyancy in emerging economies

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
1	**Brazil**	α_i	-16.44***	19.308***	-0.0913	0.0997*
		γ_i	1.613***	0.367***	1.92307	-0.3023
		δ_i	-0.023	-0.001	-0.0107	0.001**
		β_i	-0.019	0.020	0.01021	-0.03**
2	**Chile**	α_i	-41.1**	-3.877***	-0.288*	0.1166*
		γ_i	2.31***	1.161***	8.375**	-3.7443
		δ_i	-0.001	-0.013	-0.0308	0.001**
		β_i	0.049	0.003	-0.0033	0.002**

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
3	**Colombia**	α_i	-24.1**	-18.34***	-0.05307	-0.585
		γ_i	1.76***	1.583***	2.69213	-9.3904
		δ_i	-0.022	-0.021	-0.01492	0.0875*
		β_i	-0.006	-0.005	-0.0078	0.1553*
4	**Dominican Republic**	α_i	-12.491	-8.287	-0.1282	-0.05**
		γ_i	1.46***	1.319***	3.34852	-3.121
		δ_i	-0.002	-0.006	-0.0351	0.1888
		β_i	0.004	0.001	-0.0056	0.045**
5	**Egypt**	α_i	-11.235	-8.854	-0.118	0.21875
		γ_i	1.44***	1.363***	4.128*	-6.6799
		δ_i	0.028	0.026	-0.039*	0.1082*
		β_i	0.000	0.000	-0.0049	0.003**
6	**Hungary**	α_i	26.554	56.664	0.0707	-0.4912
		γ_i	0.159	-0.809	1.2798	3.81567
		δ_i	0.022	-0.001	0.0224	-0.101*
		β_i	0.05***	0.06***	-0.025	0.0963*
7	**Indonesia**	α_i	8.709	7.308	-0.60**	-0.086*
		γ_i	0.79***	0.83***	8.118**	1.6792
		δ_i	0.008	0.003	-0.0017	-0.01**
		β_i	-0.042	-0.034	0.02***	0.07***
8	**Kazakhstan**	α_i	8.770	9.500	-0.43**	-0.05**
		γ_i	0.77***	0.74***	4.69***	1.09322
		δ_i	0.011	0.008	0.00226	-0.004*
		β_i	0.08***	0.07***	0.01335	-0.001*
9	**Mexico**	α_i	-72.3**	-69.6***	0.494**	-0.36
		γ_i	3.407**	3.319***	0.10192	2.174
		δ_i	0.000	0.000	-0.0076	-0.006*
		β_i	-0.001	-0.001	-0.10**	0.0682*
10	**Morocco**	α_i	-30.7**	-22.9***	-0.24**	0.019**
		γ_i	2.17***	1.885***	3.05708	0.9165*
		δ_i	0.091	0.066	-0.066*	0.010**
		β_i	-0.025	-0.020	0.0887*	-0.03**
11	**Peru**	α_i	-31.0**	-14.88**	-0.1911	0.027**
		γ_i	2.215**	1.603***	6.11***	-1.202
		δ_i	0.028	0.008	-0.04**	0.016**
		β_i	-0.039	-0.020	-0.0400	0.028**
12	**Philippines**	α_i	-12.2**	-11.28**	-0.15**	0.1806*
		γ_i	1.460**	1.428***	1.8503*	0.2549
		δ_i	0.019	0.016	0.00521	-0.03**
		β_i	0.005	0.005	0.018**	-0.04**

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
13	**Poland**	α_i	3.376	5.021	-0.14**	0.29669
		γ_i	0.90***	0.84***	4.10***	-7.8878
		δ_i	0.004	-0.004	-0.0149	0.023**
		β_i	0.033	0.035	-0.0043	0.010**
14	**South Africa**	α_i	-16.825	-13.134	-0.15**	-0.02**
		γ_i	1.64***	1.512***	4.42***	0.8928
		δ_i	0.007	0.005	0.01172	-0.00**
		β_i	0.038	0.033	0.00519	-0.00**
15	**Thailand**	α_i	-25.2**	-23.4***	-0.11**	0.039**
		γ_i	1.89***	1.835***	1.3916	1.16265
		δ_i	0.05***	0.052***	-0.029	0.015**
		β_i	-0.010	-0.009	0.038**	-0.04**
16	**Turkey**	α_i	2.801	3.008	0.0486	-0.04**
		γ_i	0.91***	0.91***	-1.12**	1.53363
		δ_i	0.000	0.000	-0.006	-0.0***
		β_i	-0.01**	-0.011	0.00043	-0.00**
17	**Uruguay**	α_i	-13.181***	-8.016***	0.11912	-0.4443
		γ_i	1.536***	1.342***	1.03678	2.13542
		δ_i	-0.044***	-0.033***	-0.0229	0.031**
		β_i	-0.024***	-0.015***	-0.0180	0.042**

Table A7: SSC Posterior estimate for long run & short run buoyancy in emerging economies

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
1	Brazil	α_i γ_i δ_i β_i	-8.921*** 1.381*** -0.003*** -0.005***	-8.822*** 1.377*** -0.003*** -0.005***	0.029456* -0.01744 -0.00265* -0.00274	-0.00645 0.00382 0.000581 0.000601
2	Chile	α_i γ_i δ_i β_i	0.903 0.982*** 0.003 -0.003	0.919 0.981*** 0.003 -0.003	-0.00894 -0.41441 0.003155 0.007637**	-0.00281 -0.13019 0.000991 0.002399
3	Colombia	α_i γ_i δ_i β_i	-3.108 1.111*** 0.023 0.005	8.905 0.762*** -0.020 0.005	0.22928*** -2.4491** 0.013254 -0.02363**	-0.04887 0.522011 -0.00283 0.005036
4	Dominican Republic	α_i γ_i δ_i β_i	696.8412 -23.99*** -0.527** -0.519***	63.474 -1.206*** -0.063** -0.035***	1.80E-08 2.50E-15 9.31E-18 -5.45E-17	-5.53E-07 1.01E-14 3.08E-18 -2.15E-16
5	Egypt	α_i γ_i δ_i β_i	22.556*** 0.230 -0.002 -0.016	22.730*** 0.224 -0.002 -0.016	0.091363 -0.34947 0.004271 -0.01196	-0.13797 0.527752 -0.00645 0.018057*
6	Hungary	α_i γ_i δ_i β_i	-14.128 1.537*** 0.004 -0.001	-14.438 1.547*** 0.005 -0.001	0.00423 0.159343 0.00402 -0.00025	-0.00585 -0.22037 -0.0055* 0.000346
7	Indonesia	α_i γ_i δ_i β_i	-59.067*** 2.605*** -0.052** -0.131***	-60.579*** 2.646*** -0.046** -0.121***	0.223477 -1.70979 -0.07215 -0.0101	-0.46447 3.553606 0.149948 0.020984
8	Kazakhstan	α_i γ_i δ_i β_i	0.942 0.996*** -0.005** -0.009**	0.952 0.995*** -0.005** -0.009**	0.077657* -0.56704* -0.00046 -0.00511	-0.21274*** 1.553393** 0.001269 0.014003**
9	Mexico	α_i γ_i δ_i β_i	-29.786*** 2.028*** 0.012 -0.019	-20.875*** 1.737*** 0.006 -0.012	-0.065 1.655*** -0.0251*** 0.008874	-0.03094 0.786029* -0.012*** 0.004224
10	Morocco	α_i γ_i δ_i β_i	-8.509*** 1.335*** -0.009 0.045***	-8.531*** 1.336*** -0.008 0.046***	-0.06142* 0.865011 0.021062* 0.021705*	-0.00258 0.036402 0.000886 0.000913

11	**Peru**	α_i	-2.710	-2.649	0.121213***	0.062841***
		γ_i	1.131***	1.129	-1.36786***	-0.70914***
		δ_i	-0.019	-0.018	0.014287***	0.007407***
		β_i	0.008	0.008	-0.0105**	-0.00544
12	**Philippines**	α_i	5.482***	5.477***	-0.00354	-0.00062
		γ_i	0.900**	0.900**	0.489869	0.086216
		δ_i	-0.013***	-0.013***	-0.0064*	-0.00113
		β_i	0.015***	0.015***	-0.00732**	-0.00129
13	**Poland**	α_i	2.800***	2.831***	-0.0186***	-0.01079***
		γ_i	0.988***	0.986***	0.360182***	0.208969***
		δ_i	0.003	0.003	-0.00175*	-0.001
		β_i	-0.002	-0.002	0.000836	0.000485
14	**South Africa**	α_i	-40.830***	-41.527***	0.058337	-0.10086
		γ_i	2.430***	2.455***	1.05627	-1.82615
		δ_i	-0.042***	-0.041***	-0.03396	0.058706*
		β_i	0.006	0.008	-0.00783	0.013542
15	**Thailand**	α_i	-21.154***	-17.516***	0.007289	-0.01628
		γ_i	1.773***	1.651***	-0.72669	1.623087
		δ_i	0.007	0.004	-0.01177	0.026297
		β_i	-0.030**	-0.026**	0.019445*	-0.04343**
16	**Turkey**	α_i	-27.525***	-26.878***	0.124429***	-0.00758
		γ_i	2.053***	2.031***	-0.57531	0.035034
		δ_i	0.011***	0.010***	0.003349	-0.0002
		β_i	-0.006***	-0.006***	-0.00561***	0.000342
17	**Uruguay**	α_i	2.439	2.621	-0.34212	0.29684
		γ_i	0.902	0.896	4.207891**	-3.65098
		δ_i	-0.016	-0.008	-0.00482	0.00418
		β_i	0.018	0.023	0.0107***	-0.00928

Table A8: TGS Posterior estimate for long run & short run buoyancy in emerging economies

Country		**Cof**	**Long run**		**Short Run**	
			D-prior	**G-prior**	**D-prior**	**G-prior**
1	**Brazil**	α_i	6.883***	7.184***	-0.05302***	0.117962***
		γ_i	0.854***	0.844***	0.878785***	-0.53784***
		δ_i	-0.006	-0.006	0.000182	-0.0124
		β_i	0.003	0.003	0.003486	-0.01725
2	**Chile**	α_i	6.383**	6.246**	-0.08681***	-0.00284***
		γ_i	0.875***	0.879***	0.585265	0.646172
		δ_i	0.010	0.008	-0.00118	-0.00238
		β_i	-0.001	-0.001	0.017959***	-0.005***
3	**Colombia**	A_i	-1.176	-1.034	-0.10295***	0.245909***
		γ_i	1.095	1.091	1.955512***	-3.80795***
		δ_i	-0.010***	-0.00***	-0.00612	0.011435
		β_i	-0.003	-0.003	0.00457	-0.0163

	Country	Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
4	**Dominican Republic**	α_i	-0.750	-0.292	-0.12739	-0.09034
		γ_i	1.104***	1.089***	2.511823	1.844348
		δ_i	-0.002	-0.002	-0.00383	-0.0031*
		β_i	0.008	0.007	0.000678	0.000364
5	**Egypt**	α_i	11.164***	12.371***	-0.0954**	0.436637**
		γ_i	0.664***	0.621***	0.732637	1.030754
		δ_i	0.009	0.010**	-0.00581	0.023723
		β_i	0.004	0.004	0.005688	-0.04152
6	**Hungary**	α_i	-9.228*	-17.026*	-0.0029	-0.01537
		γ_i	1.388***	1.639***	-0.4471*	0.245233*
		δ_i	-0.006	-0.001	-0.00283	-0.00225
		β_i	-0.014***	-0.01***	0.005509	0.001699*
7	**Indonesia**	α_i	-4.331	-5.357	-0.54287***	1.099592***
		γ_i	1.162***	1.190***	9.890727***	-19.1257***
		δ_i	0.007	0.008	0.028059*	-0.07568*
		β_i	-0.031**	-0.029*	0.004856	-0.01271
8	**Kazakhstan**	α_i	-4.199	4.423**	-0.43489***	-0.01***
		γ_i	1.221***	0.929***	3.651739***	0.581949***
		δ_i	-0.019	0.001	-0.01899*	-0.0018*
		β_i	0.037	-0.007	0.024683***	-0.00052***
9	**Mexico**	α_i	-2.122	4.423	0.213691	-0.213**
		γ_i	1.124***	0.929***	-0.4787***	1.560001
		δ_i	-0.009	0.001	0.006561***	-0.00912
		β_i	0.001	-0.007	-0.04674	0.037194**
10	**Morocco**	α_i	0.153	1.145	-0.05062*	-0.00892*
		γ_i	1.084***	1.047***	0.197613	0.919742
		δ_i	0.017	0.011	-0.03189*	0.013943**
		β_i	0.020	0.012	0.020142*	-0.01187**
11	**Peru**	α_i	6.656***	6.704***	-0.11615***	0.013041***
		γ_i	0.831***	0.829***	1.002821***	0.489877**
		δ_i	0.000	0.001	-0.0004***	-0.0027
		β_i	0.001	0.001	0.014349**	-0.00586*
12	**Philippines**	α_i	-0.399	-0.398	-0.10435	0.542487*
		γ_i	1.076***	1.076***	1.408335	-4.20767*
		δ_i	0.007	0.007	-0.00052*	-0.02044
		β_i	0.015**	0.015**	0.008419**	-0.06654
13	**Poland**	α_i	4.351	4.755	-0.02774***	-0.01929
		γ_i	0.934***	0.920***	1.499313***	-0.22***
		δ_i	-0.009	-0.010	-0.00383*	-0.00025
		β_i	0.009	0.009	-0.01401	0.014133***

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
14	South Africa	α_i	-10.476***	-6.824	0.078876	-0.028**
		γ_i	1.448***	1.321***	-0.12946	0.668917
		δ_i	-0.010	-0.007	-0.00377	-0.00192
		β_i	-0.003	-0.004	-0.01089	0.000456***
15	Thailand	α_i	0.117	4.309**	-0.03789	0.025627*
		γ_i	1.074***	0.933***	1.484133	-2.316***
		δ_i	-0.010	0.001	-0.00957	0.023681
		β_i	0.018	-0.010*	-0.0062*	0.021972
16	Turkey	α_i	3.966*	3.726***	-0.04988***	0.02127*
		γ_i	0.945***	0.953***	0.396996	1.065983
		δ_i	-0.002*	-0.00***	-0.00689	0.006038*
		β_i	-0.002	-0.002	0.002632***	-0.00511*
17	Uruguay	α_i	5.150**	5.061**	-0.08162	0.012237
		γ_i	0.905***	0.907***	0.59559	0.64276
		δ_i	-0.012*	-0.010	-0.00553	9.94E-05
		β_i	-0.009**	-0.008*	0.004939	-0.00323

Table A9: PIT Posterior estimate for long run & short run buoyancy in low income countries

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
1	Bolivia	α_i	8.849	9.4216	-0.02232	0.313671***
		γ_i	0.679***	0.6549***	13.21483	-178.907***
		δ_i	0.012	0.0114	0.000228	-0.00145
		β_i	-0.019	-0.0193	0.00079	-0.00891
2	Burkina Faso	α_i	16.673	17.2029	0.026897	-0.04448
		γ_i	0.467***	0.4482***	-11.5098	16.58723
		δ_i	-0.044*	-0.0435*	-0.00076	0.002667
		β_i	-0.092*	-0.0925*	-0.00591	0.017578*
3	Cameroon	α_i	22.363	24.0012	0.005895	0.077745
		γ_i	0.299***	0.2442***	2.434077	-93.5189
		δ_i	-0.049	-0.0525	-0.00262	0.018733
		β_i	0.094*	0.0933*	0.003913	-0.0256*
4	Cote d'Ivoire	α_i	-12.148	-10.4554	-0.00313	0.144169**
		γ_i	1.445***	1.388***	3.330546	-106.164***
		δ_i	0.022	0.0213	0.000242	-0.00414
		β_i	0.050*	0.0503*	-0.00035	0.007575
5	Ethiopia	α_i	-8.952	-8.8052	-0.0068	0.064094**
		γ_i	1.374***	1.3685***	2.938435	-27.612***
		δ_i	0.013	0.0122	-7.29E-05	0.000881
		β_i	0.013	0.0127	-0.0009	0.004986

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
6	**Ghana**	α_i	1.175	1.4335	-0.01496	0.241966***
		γ_i	1.021***	1.0106***	5.100369	-84.5514***
		δ_i	-0.024*	-0.0238*	0.000324	-0.00374*
		β_i	0.015	0.0156	-0.00126	0.014423
7	**Guyana**	α_i	-18.196	-17.318	-0.00768	0.127537
		γ_i	1.732***	1.699***	3.125763	-55.9012**
		δ_i	0.049*	0.048*	0.001217	-0.01227**
		β_i	0.003	0.003	0.00059	-0.00581**
8	**Honduras**	α_i	-8.765	-7.814	-0.00671	0.172286**
		γ_i	1.395***	1.359***	-2.53637	4.617323
		δ_i	0.014	0.012	0.001775	-0.02616**
		β_i	0.052*	0.053*	-0.00002	0.001651
9	**Kenya**	α_i	8.002	8.306	0.022323	-0.29383***
		γ_i	0.972***	0.762***	-8.7595	108.5378***
		δ_i	-0.001	-0.001	-0.00057	0.010352**
		β_i	-0.035*	-0.035*	-0.00159	0.028739
10	**Mali**	α_i	7.870	8.200	0.004602	0.000682
		γ_i	0.779***	0.767***	-3.48972	4.2446
		δ_i	0.000	0.000	0.000433	-0.0011
		β_i	0.088**	0.088**	0.000843	-0.0024*
11	**Niger**	α_i	0.789	0.947	0.016145*	-0.0400***
		γ_i	1.033***	1.027***	-4.62296	8.555919*
		δ_i	-0.011	-0.011	-0.00069	0.002703*
		β_i	0.067*	0.067*	-0.00052	0.001962
12	**Rwanda**	α_i	-5.051	-4.934	-0.01255	0.070427**
		γ_i	1.232***	1.228***	6.085896	-33.0031**
		δ_i	0.004	0.004	-0.00061	0.002796
		β_i	0.019	0.019	-0.0008	0.003373
13	**Senegal**	α_i	-7.995	-7.623	0.024992**	-0.02126*
		γ_i	1.331***	1.319***	-20.445***	20.44578***
		δ_i	-0.027*	-0.027*	0.000435	-0.00042
		β_i	-0.056*	-0.056*	0.001623	-0.0018

Table A10: CIT Posterior estimate for long run & short run buoyancy in low income economies

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
1	**Bolivia**	α_i	-42.301***	-35.796***	0.0007	-0.0003
		γ_i	2.802***	2.535***	0.7358	1.7244
		δ_i	0.016	0.011	0.0008**	-0.0006**
		β_i	-0.042	-0.038	-0.0013*	0.0013*
2	**Burkina Faso**	α_i	-34.088***	-27.455***	0.0021	-0.0065
		γ_i	2.212***	1.983***	-1.1409	8.8231
		δ_i	-0.007	-0.010	0.0005	-0.0012*
		β_i	0.069**	0.056**	-0.0023**	0.0065***
3	**Cameroon**	A_i	-18.57**	3.541***	0.0061	-0.1236***
		γ_i	1.647***	0.909**	-2.356*	75.9149***
		δ_i	0.010	-0.024*	0.0001	0.0006
		β_i	-0.019	-0.009	0.0013	-0.0258***
4	**Cote d'Ivoire**	α_i	-23.891*	0.590**	-0.004*	0.014**
		γ_i	1.810***	1.006**	0.4729	3.81*
		δ_i	0.087**	-0.008**	0.0014	-0.004**
		β_i	-0.035**	-0.012	-0.009*	0.0029***
5	**Ethiopia**	α_i	-7.69***	-6.62***	0.0024	-0.0575***
		γ_i	1.314***	1.276***	0.6342	16.9637***
		δ_i	-0.008	-0.010	-0.0001	0.0040*
		β_i	-0.002	-0.003	0.0000	0.0008*
6	**Ghana**	α_i	-18.66***	-17.34***	-0.0030	0.0191*
		γ_i	1.775***	1.724***	2.8401***	-8.59***7
		δ_i	-0.006	-0.007*	0.0000	0.0007
		β_i	0.019***	0.018***	-0.0002	0.0011
7	**Guyana**	α_i	-5.280*	-4.930*	0.0024*	-0.0033**
		γ_i	1.254***	1.241***	0.3124	2.6799***
		δ_i	0.005	0.004	-0.003*	0.0007***
		β_i	-0.019**	-0.019**	-0.0003	0.0005
8	**Honduras**	α_i	-29.21***	-27.12***	-0.0038*	0.0073*
		γ_i	2.176***	2.096***	3.8743***	-3.436**
		δ_i	0.001	-0.001	0.0002	-0.0001
		β_i	0.022**	0.021**	-0.0001	0.0001
9	**Kenya**	α_i	-15.85***	-14.82***	-0.0019	0.0028
		γ_i	1.573***	1.538***	-0.5915	3.5646**
		δ_i	0.018***	0.016***	0.0006***	-0.005**
		β_i	-0.026***	-0.025***	0.0007	-0.0009*
10	**Mali**	α_i	-87.34***	-88.12***	-0.0036*	0.0054
		γ_i	4.038***	4.065***	8.6104***	-9.706*
		δ_i	-0.009	0.002	-0.0012	0.0020*
		β_i	-0.030	0.009	-0.0005	0.0006

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
11	**Niger**	α_i	-55.45***	-42.01***	0.0010	-0.0038
		γ_i	2.975***	2.504***	-1.6742	14.4619***
		δ_i	0.017	0.008	0.0008	-0.0030***
		β_i	-0.054***	-0.045*	0.0001	-0.0003
12	**Rwanda**	α_i	-9.27***	-6.610**	0.0039	-0.0028
		γ_i	1.344***	1.254***	-0.9354	2.9048*
		δ_i	0.009	0.003	0.0013***	-0.008**
		β_i	0.035***	0.027**	0.0011*	-0.0008*
13	**Senegal**	α_i	-9.500**	-7.588*	-0.0023	0.0170*
		γ_i	1.337***	1.274***	3.4478**	-13.866**
		δ_i	-0.007	-0.009	-0.0001	0.0015***
		β_i	0.016	0.013	-0.0006	0.0040

Table A11: SSCT Posterior estimate for long run & short run buoyancy in low income countries

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
1	**Bolivia**	α_i	-47.92***	-48.331***	-0.003***	0.0229
		γ_i	3.009***	3.026***	4.5621***	-18.1411*
		δ_i	-0.018	-0.017	0.0000	0.0004
		β_i	0.087*	0.086*	-0.0009	0.1088
2	**Burkina Faso**	α_i	-15.89***	-15.951***	0.0029	-0.0188*
		γ_i	1.550***	1.552***	0.4889	5.0083
		δ_i	0.001	0.001	-0.0001	0.0016**
		β_i	-0.011	-0.011	-0.0003	0.1116
3	**Cameroon**	A_i	-1.736	-2.398	0.0023	-0.0024
		γ_i	1.056***	1.078***	-0.7542	4.5391*
		δ_i	-0.008	-0.006	0.0000	0.0000
		β_i	-0.010	-0.009	-0.005*	0.0130*
4	**Cote d'Ivoire**	α_i	-32.41***	-32.814***	-0.0009	0.0015
		γ_i	2.089***	2.102***	3.1716***	0.1513
		δ_i	0.002	0.002	0.0000	0.0000
		β_i	0.007	0.007	-0.0001	0.0046
5	**Ethiopia**	α_i	0.932	0.876	-0.0003	0.0019**
		γ_i	1.054***	1.056***	0.9556***	0.8591***
		δ_i	-0.002	-0.001	0.0000	0.0000
		β_i	0.000	0.000	0.0000	-0.0054
6	**Ghana**	α_i	-5.372**	-5.550**	0.0030	-0.0296
		γ_i	1.223***	1.230***	-0.5428	20.6783***
		δ_i	0.004	0.004	0.0001	-0.0012
		β_i	-0.02***	-.023***	0.0003	0.2120*

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
7	**Guyana**	α_i	6.704	5.781	0.0022*	-0.0008
		γ_i	0.981***	0.815***	0.5092	1.3974*
		δ_i	-0.007	-0.006	-0.003*	0.0005**
		β_i	-0.003	-0.002	0.0001	0.0409
8	**Honduras**	α_i	-19.08**	-20.456**	0.0017	-0.116*
		γ_i	1.779***	1.831***	0.8868*	8.9111
		δ_i	-0.002	0.002	0.0000	0.0061
		β_i	-0.018	-0.020	0.0000	-0.5266
9	**Kenya**	α_i	8.662	3.066	0.0043***	-0.0494
		γ_i	0.636	0.830	-2.6208**	49.8859***
		δ_i	0.009	0.010	0.0003	-0.0030
		β_i	-0.042	-0.040	0.0018	0.1040***
10	**Mali**	α_i	-23.65***	-4.062***	0.0027	-0.0032
		γ_i	1.830***	1.844***	0.9724*	0.7692
		δ_i	-0.001	-0.001	-0.006**	0.0014***
		β_i	-0.004	-0.004	-0.0002	0.0527
11	**Niger**	α_i	-23.40***	23.419***	0.0020***	-0.0002
		γ_i	1.872***	1.872***	1.1213***	0.6992**
		δ_i	-0.003	-0.003	-0.0001*	0.0001**
		β_i	-0.008***	-0.008***	0.0001	0.0008
12	**Rwanda**	α_i	-17.81***	-7.961***	-0.0073**	0.0417***
		γ_i	1.600***	1.604***	4.2787***	-15.964***
		δ_i	-0.003	-0.003	-0.0003*	0.0016*
		β_i	0.024***	0.024***	-0.0007*	0.0735**
13	**Senegal**	α_i	-36.28***	36.485***	-0.006***	0.0456***
		γ_i	2.211***	2.217***	4.4220***	-20.704***
		δ_i	0.018***	0.018***	0.0004*	-0.0023***
		β_i	-0.015	-0.015	-0.0013**	0.0675***

Table A12: TGS Posterior estimate for long run & short run buoyancy in low income countries

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
1	**Bolivia**	α_i	-5.960**	-4.050**	0.077515**	0.033365
		γ_i	1.354***	1.275***	3.941702	8.781236*
		δ_i	0.006	0.004	-0.0134***	-0.00325*
		β_i	0.007	0.006	-0.01665**	-0.00601*
2	**Burkina Faso**	α_i	-13.29***	-12.37***	0.1055*	-0.0339*
		γ_i	1.541***	1.509***	-5.360	27.80318**
		δ_i	-0.001	-0.001	-0.0020	0.002665
		β_i	-0.026*	-0.025*	-0.0083	0.000763
3	**Cameroon**	α_i	-7.42***	-6.80***	-0.0016	-0.11629
		γ_i	1.314***	1.294***	53.6338*	17.29343
		δ_i	0.005	0.005	-0.0110	0.033377***
		β_i	0.007	0.007	-0.0133*	0.016144
4	**Cote d'Ivoire**	α_i	-2.260	-1.036	-0.0476	0.116466***
		γ_i	1.153***	1.112***	19.8275	27.55027
		δ_i	-0.005	-0.005	0.0254*	-0.06435***
		β_i	0.000	0.000	-0.0078	0.020835
5	**Ethiopia**	α_i	0.182	0.324	0.0391	0.002403
		γ_i	1.088***	1.083***	7.1687	16.16132**
		δ_i	-0.008**	-0.009**	0.0073*	0.002256**
		β_i	0.000	0.000	-0.006***	-0.0002***
6	**Ghana**	α_i	-2.639	-1.200	0.1616	-0.69645
		γ_i	1.191***	1.136***	-22.321	192.1784***
		δ_i	0.000	-0.001	-0.0012	0.016438
		β_i	-0.016*	-0.014*	0.0031	-0.01173***
7	**Guyana**	α_i	-8.859	-2.44	-0.0783*	0.099108***
		γ_i	1.427***	1.18***	25.8330	25.74608
		δ_i	-0.017*	-0.01*	0.0213***	-0.02871
		β_i	-0.021	-0.01	0.0105	-0.01879
8	**Honduras**	α_i	3.291*	5.09*	0.1271**	-0.02074
		γ_i	0.965***	0.90***	29.1311*	16.04863
		δ_i	-0.007	-0.01	-0.018***	0.005121***
		β_i	0.020*	0.02*	-0.0167**	0.002407
9	**Kenya**	α_i	9.242***	9.01***	-0.0027	-0.00762
		γ_i	0.758***	0.77***	28.1681*	14.38356
		δ_i	0.003	0.00	-0.0021	0.004877
		β_i	0.003	0.00	-0.020***	0.012751*
10	**Mali**	α_i	4.851***	5.03***	-0.0595	0.061428
		γ_i	0.98***	0.90***	72.2328***	-52.5719**
		δ_i	-0.010**	-0.01**	-0.0046	0.012842
		β_i	0.015	0.00	-0.0423***	0.061511***

Country		Cof	Long run		Short Run	
			D-prior	G-prior	D-prior	G-prior
11	**Niger**	α_i	-7.668	-4.15	0.0386	-0.10622
		γ_i	1.348***	1.23***	16.1224	42.33481
		δ_i	0.002	0.00	0.0035	-0.00342
		β_i	-0.006	0.00	0.0137	-0.0344***
12	**Rwanda**	α_i	-2.944*	-2.24*	-0.0669	-0.18368
		γ_i	1.175***	1.15***	55.1230*	38.51113
		δ_i	-0.005	-0.01	-0.0030	0.003812
		β_i	0.004	0.00	-0.0121	0.022621
13	**Senegal**	α_i	-5.313	-2.61	0.0350	-0.02435
		γ_i	1.250***	1.16***	-2.4716	30.4872***
		δ_i	-0.003	0.00	0.0019	0.002259**
		β_i	0.003	0.00	-0.0146*	0.006398

APPENDIX B

Table B1: Root Mean square Error for Personal Income Tax

No	Countries	Long Run		Short Run	
		D-prior	G-prior	D-prior	G-prior
1	Australia	0.00166	0.05346	0.00005	0.03995
2	Austria	0.00972	0.03497	0.00019	0.34485
3	Belgium	0.00039	0.02184	0.00004	0.05632
4	Canada	0.00012	0.00332	0.00005	0.15425
5	Cz Repu	0.00004	0.01671	0.00007	0.00782
6	Denmark	0.00006	0.05826	0.00013	0.18387
7	Estonia	0.00027	0.26438	0.00054	0.19587
8	Finland	0.00005	0.50745	0.00038	1.03354
9	France	0.00063	0.01055	0.00005	0.13953
10	Germany	0.00002	0.16632	0.00010	0.16780
11	Greece	0.00006	0.00131	0.00002	0.00566
12	Iceland	0.00017	0.08039	0.00007	0.42085
13	Ire land	0.00442	0.32014	0.00022	0.77747
14	Israel	0.00672	0.19231	0.00008	0.15169
15	Italy	0.00048	0.03656	0.00007	0.08261
16	Japan	0.01817	0.12426	0.00005	0.05125
17	Korea	0.00022	0.00597	0.00003	0.09831
18	Lux	0.00001	0.06981	0.00005	0.34514
19	Netherland	0.00002	0.02426	0.00009	0.01439
20	Norway	0.00006	0.01044	0.00013	0.03573
21	Portugal	0.05366	0.03141	0.00021	0.13698
22	Slovak Rep	0.00002	0.10556	0.00026	0.22122
23	Slavonia	0.00181	0.00287	0.00009	0.40687
24	Spain	0.00137	0.03189	0.00029	1.12799
25	Sweden	0.00017	0.01121	0.00056	1.16752
26	Switzerland	0.00033	0.10613	0.00011	0.02528
27	U kingdom	0.00045	0.03387	0.00017	0.86660
28	U stat	0.00005	0.01864	0.00018	0.36108

Table B2: Root Mean square Error for Corporate Income Tax

		Long Run		Short Run	
No	**Countries**	**D-Prior**	**G-Prior**	**D-Prior**	**G-Prior**
1	**Australia**	0.00678	0.05350	0.00005	0.04000
2	**Austria**	0.00097	0.03500	0.00019	0.34490
3	**Belgium**	0.00039	0.02180	0.00004	0.05630
4	**Canada**	0.00012	0.00330	0.00005	0.15420
5	**Cz Repu**	0.00004	0.01670	0.00007	0.00780
6	**Denmark**	0.00079	0.05830	0.00013	0.18390
7	**Estonia**	0.00027	0.26440	0.00054	0.19590
8	**Finland**	0.00005	0.50750	0.00038	1.03350
9	**France**	0.00633	0.01050	0.00005	0.13950
10	**Germany**	0.00277	0.16630	0.00010	0.16780
11	**Greece**	0.00065	0.00130	0.00002	0.00570
12	**Iceland**	0.00179	0.08040	0.00007	0.42080
13	**Ire land**	0.00442	0.32010	0.00022	0.77750
14	**Israel**	0.00672	0.19230	0.00008	0.15170
15	**Italy**	0.04826	0.03660	0.00007	0.08260
16	**Japan**	0.18173	0.12430	0.00005	0.05120
17	**Korea**	0.00246	0.00600	0.00003	0.09830
18	**Lux**	0.00183	0.06980	0.00005	0.34510
19	**Netherland**	0.00108	0.02430	0.00009	0.01440
20	**Norway**	0.00016	0.01040	0.00013	0.03570
21	**Portugal**	0.00053	0.03140	0.00021	0.13700
22	**Slovak Rep**	0.00274	0.10560	0.00026	0.22120
23	**Slavonia**	0.00018	0.00290	0.00009	0.40690
24	**Spain**	0.00013	0.03190	0.00029	1.12800
25	**Sweden**	0.00017	0.01120	0.00056	1.16750
26	**Switzerland**	0.00033	0.10610	0.00011	0.02530
27	**U kingdom**	0.00045	0.03390	0.00002	0.86660
28	**U stat**	0.00090	0.01860	0.00002	0.36110

Table B3: Root Mean square Error for Social Security Contribution Tax

		Long Run		Short Run	
No	**Countries**	**D-prior**	**G-prior**	**D-prior**	**G-prior**
1	**Australia**	0.00295	0.05350	0.00002	0.04000
2	**Austria**	0.01083	0.03500	0.00001	0.34490
3	**Belgium**	0.00630	0.02180	0.00001	0.05630
4	**Canada**	0.07148	0.00330	0.00012	0.15420
5	**Cz Repu**	0.00402	0.01670	0.00390	0.00780
6	**Denmark**	0.00577	0.05830	0.00004	0.18390
7	**Estonia**	0.00150	0.26440	0.00004	0.19590
8	**Finland**	0.00060	0.50750	0.00030	1.03350
9	**France**	0.00143	0.01050	0.00019	0.13950
10	**Germany**	0.00230	0.16630	0.00003	0.16780
11	**Greece**	0.00348	0.00130	0.00005	0.00570
12	**Iceland**	0.00337	0.08040	0.00014	0.42080
13	**Ire land**	0.00890	0.32010	0.00036	0.77750
14	**Israel**	0.00908	0.19230	0.00029	0.15170
15	**Italy**	0.00070	0.03660	0.00007	0.08260
16	**Japan**	0.00379	0.12430	0.00017	0.05120
17	**Korea**	0.00747	0.00600	0.00073	0.09830
18	**Lux**	0.00578	0.06980	0.00038	0.34510
19	**Netherland**	0.00660	0.02430	0.00001	0.01440
20	**Norway**	0.00466	0.01040	0.00058	0.03570
21	**Portugal**	0.00697	0.03140	0.00003	0.13700
22	**Slovak Rep**	0.00284	0.10560	0.00034	0.22120
23	**Slavonia**	0.00142	0.00290	0.00013	0.40690
24	**Spain**	0.00230	0.03190	0.00096	1.12800
25	**Sweden**	0.00075	0.01120	0.00005	1.16750
26	**Switzerland**	0.00226	0.10610	0.00014	0.02530
27	**U kingdom**	0.00492	0.03390	0.00006	0.86660
28	**U stat**	0.00890	0.01860	0.00004	0.36110

Table B4: Root Mean square Error for Tax on goods and services Tax

		Long Run		Short Run	
No	**Countries**	**D-prior**	**G-prior**	**D-prior**	**G-prior**
1	**Australia**	0.00804	0.05157	0.00027	0.10118
2	**Austria**	0.00956	0.01343	0.00002	0.01561
3	**Belgium**	0.00167	0.00277	0.00006	0.04832
4	**Canada**	0.00311	0.02355	0.00016	0.06267
5	**Cz Repu**	0.00024	0.00095	0.00009	0.14037
6	**Denmark**	0.00224	0.02488	0.00009	0.02416
7	**Estonia**	0.00040	0.00094	0.00006	0.00183
8	**Finland**	0.00002	0.10289	0.00035	0.19093
9	**France**	0.00052	0.18938	0.00067	0.21535
10	**Germany**	0.00029	0.00106	0.00014	0.13876
11	**Greece**	0.00176	0.02884	0.00019	0.05078
12	**Iceland**	0.00016	0.02064	0.00052	0.02530
13	**Ire land**	0.00031	0.12581	0.00021	0.16014
14	**Israel**	0.00039	0.01162	0.00033	0.21254
15	**Italy**	0.00099	0.01286	0.00030	0.08916
16	**Japan**	0.00068	0.00144	0.00045	0.00138
17	**Korea**	0.00092	0.00170	0.00004	0.01629
18	**Lux**	0.00093	0.04643	0.00062	0.11817
19	**Netherland**	0.00020	0.00407	0.00003	0.07345
20	**Norway**	0.00068	0.00886	0.00006	0.04501
21	**Portugal**	0.00080	0.00157	0.00027	0.00047
22	**Slovak Rep**	0.00054	0.01524	0.00004	0.01017
23	**Slavonia**	0.00052	0.01613	0.00022	0.31119
24	**Spain**	0.00058	0.04597	0.00057	0.06812
25	**Sweden**	0.00031	0.01794	0.00023	0.35833
26	**Switzerland**	0.00014	0.03439	0.00052	0.17048
27	**U kingdom**	0.00092	0.01242	0.00012	0.09210
28	**U stat**	0.00160	0.00608	0.00005	0.06210

Table B5: Root Mean square Error for PIT in emerging economies

		Long Run		Short Run	
No	**Countries**	**D-prior**	**G-prior**	**D-prior**	**G-prior**
1	**Chile**	0.00747	0.03047	0.00038	0.02543
2	**Colombia**	0.03982	0.04501	0.00027	0.65038
3	**Dominican Republic**	0.02999	0.05086	0.00034	0.76801
4	**Egypt**	0.00588	0.01464	0.00027	0.18028
5	**Hungary**	0.00269	0.00561	0.00036	0.49231
6	**Indonesia**	0.00308	0.00494	0.00019	0.08767
7	**Kazakhstan**	0.00468	0.07147	0.00028	0.09663
8	**Mexico**	0.00182	0.06827	0.00005	0.05773
9	**Morocco**	0.00964	0.05048	0.00017	0.01146
10	**Peru**	0.00000	0.02630	0.00038	0.09986
11	**Philippines**	0.00106	0.06935	0.00004	0.07067
12	**Poland**	0.00114	0.05475	0.00087	0.09382
13	**South Africa**	0.00015	0.05237	0.00005	0.00120
14	**Thailand**	0.00066	0.00088	0.00206	0.06943
15	**Turkey**	0.00040	0.01336	0.00011	0.07933
16	**Uruguay**	0.00529	0.05261	0.00073	0.49784

Table B6: Root Mean square Error for CIT in emerging economies

		Long Run		Short Run	
No	**Countries**	**D-prior**	**G-prior**	**D-prior**	**G-prior**
1	**Brazil**	0.00008	0.03900	0.00000	0.05557
2	**Chile**	0.00086	0.09397	0.00001	0.00029
3	**Colombia**	0.00052	0.05239	0.00060	0.01238
4	**D Republic**	2.22430	3.01364	0.00000	0.00000
5	**Egypt**	0.00006	0.09967	0.00014	0.36518
6	**Hungary**	0.00089	0.02236	0.00002	0.08879
7	**Indonesia**	0.00217	0.22540	0.00100	1.23862
8	**Kazakhstan**	0.00005	0.00526	0.00002	0.00000
9	**Mexico**	0.00206	0.00715	0.00002	0.01875
10	**Morocco**	0.00010	0.01996	0.00002	0.02523
11	**Peru**	0.00091	0.00582	0.00001	0.01608
12	**Philippines**	0.00086	0.01372	0.00001	0.01105
13	**Poland**	0.00764	0.01670	0.00000	0.00454
14	**South Africa**	0.00075	0.06578	0.00027	0.47288
15	**Thailand**	0.00031	0.06144	0.00007	0.22887
16	**Turkey**	0.00029	0.04074	0.00005	0.10019
17	**Uruguay**	0.00014	0.27263	0.00087	0.64728

Table B7: Root Mean square Error for SSCT in emerging economies

No	Countries	Long Run		Short Run	
		D-prior	G-prior	D-prior	G-prior
1	Brazil	0.00008	0.03900	0.00000	0.05557
2	Chile	0.00086	0.09397	0.00001	0.00029
3	Colombia	0.00052	0.05239	0.00060	0.01238
4	D Republic	2.22430	3.01364	0.00000	0.00000
5	Egypt	0.00006	0.09967	0.00014	0.36518
6	Hungary	0.00089	0.02236	0.00002	0.08879
7	Indonesia	0.00217	0.22540	0.00100	1.23862
8	Kazakhstan	0.00005	0.00526	0.00002	0.00000
9	Mexico	0.00206	0.00715	0.00002	0.01875
10	Morocco	0.00010	0.01996	0.00002	0.02523
11	Peru	0.00091	0.00582	0.00001	0.01608
12	Philippines	0.00086	0.01372	0.00001	0.01105
13	Poland	0.00764	0.01670	0.00000	0.00454
14	South Africa	0.00075	0.06578	0.00027	0.47288
15	Thailand	0.00031	0.06144	0.00007	0.22887
16	Turkey	0.00029	0.04074	0.00005	0.10019
17	Uruguay	0.00014	0.27263	0.00087	0.64728

Table B8: Root Mean square Error for TGS in emerging economies

No	Countries	Long Run		Short Run	
		D-prior	G-prior	D-prior	G-prior
1	Brazil	0.00024	0.00242	0.00009	0.00712
2	Chile	0.00172	0.00292	0.00021	0.03456
3	Colombia	0.00016	0.00025	0.00020	0.00164
4	Dominican Republic	0.00002	0.00074	0.00010	0.00331
5	Egypt	0.00006	0.11405	0.00046	0.29935
6	Hungary	0.00027	0.00091	0.00015	0.05265
7	Indonesia	0.00018	0.00339	0.00080	0.11557
8	Kazakhstan	0.00003	0.08662	0.00018	0.07480
9	Mexico	0.00160	0.20690	0.00037	0.13972
10	Morocco	0.00852	0.03669	0.00019	0.03538
11	Peru	0.00007	0.02705	0.00027	0.17385
12	Philippines	0.00012	0.05931	0.00036	0.27765
13	Poland	0.00205	0.03370	0.00015	0.00779
14	South Africa	0.00029	0.00355	0.00016	0.08812
15	Thailand	0.00081	0.02692	0.00025	0.06398
16	Turkey	0.00330	0.01015	0.00051	0.05163
17	Uruguay	0.00021	0.01466	0.00015	0.05252

Table B9: Root Mean square Error for PIT in LIC

No	Countries	Long Run		Short Run	
		D-prior	G-prior	D-prior	G-prior
1	**Bolivia**	0.00004	0.01546	0.00001	0.00559
2	**Burkina Faso**	0.00008	0.06939	0.00021	0.00672
3	**Cameroon**	0.00006	0.10169	0.00003	0.01394
4	**Cote d'Ivoire**	0.00018	0.03279	0.00001	0.13555
5	**Ethiopia**	0.00007	0.04918	0.00020	0.11188
6	**Ghana**	0.00024	0.00200	0.00001	0.09497
7	**Guyana**	0.00015	0.01093	0.00007	0.02546
8	**Honduras**	0.00007	0.01805	0.00001	0.02548
9	**Kenya**	0.00006	0.00143	0.00001	0.14617
10	**Mali**	0.00016	0.00068	0.00000	0.01578
11	**Niger**	0.00013	0.02887	0.00000	0.02017
12	**Rwanda**	0.00022	0.03661	0.00000	0.03689
13	**Senegal**	0.00004	0.00508	0.00000	0.01785

Table B10: Root Mean square Error for CIT in LIC

No	Countries	Long Run		Short Run	
		D-prior	G-prior	D-prior	G-prior
1	**Bolivia**	0.00023	0.00289	0.00000	0.01434
2	**Burkina Faso**	0.00003	0.00028	0.00000	0.00119
3	**Cameroon**	0.00003	0.00099	0.00032	0.04045
4	**Cote d'Ivoire**	0.00002	0.01045	0.00055	0.01555
5	**Ethiopia**	0.00000	0.00228	0.00067	0.02929
6	**Ghana**	0.00000	0.00429	0.00002	0.01819
7	**Guyana**	0.00003	0.00175	0.00023	0.00542
8	**Honduras**	0.00002	0.00106	0.00005	0.00504
9	**Kenya**	0.00004	0.00068	0.00006	0.00495
10	**Mali**	0.00027	0.00220	0.00001	0.05259
11	**Niger**	0.00012	0.00713	0.00000	0.02642
12	**Rwanda**	0.00043	0.00070	0.00009	0.00067
13	**Senegal**	0.00082	0.00598	0.00002	0.02265

Table B11: Root Mean square Error for SSCT in LIC

No	Countries	Long Run		Short Run	
		D-prior	G-prior	D-prior	G-prior
1	**Bolivia**	0.00900	0.64134	0.00072	0.05629
2	**Burkina Faso**	0.00993	0.01712	0.00060	0.01811
3	**Cameroon**	0.01085	0.18064	0.00004	0.00928
4	**Cote d'Ivoire**	0.00994	0.01401	0.00008	0.00075
5	**Ethiopia**	0.00313	0.11910	0.00002	0.00578
6	**Ghana**	0.00652	0.01048	0.00041	0.00088
7	**Guyana**	0.00499	0.07376	0.00004	0.00719
8	**Honduras**	0.00162	0.10147	0.00032	0.25517
9	**Kenya**	0.01023	0.38488	0.00016	0.04569
10	**Mali**	0.00645	0.04776	0.00009	0.00450
11	**Niger**	0.00750	0.05971	0.00001	0.00459
12	**Rwanda**	0.00322	0.02830	0.00002	0.01043
13	**Senegal**	0.01792	0.06864	0.00002	0.01813

Table B12: Root Mean square Error for TGS in LIC

No	Countries	Long Run		Short Run	
		D-prior	G-prior	D-prior	G-prior
1	**Bolivia**	0.00309	0.00871	0.03087	0.00871
2	**Burkina Faso**	0.00148	0.04559	0.01478	0.04559
3	**Cameroon**	0.00110	0.05459	0.01103	0.05459
4	**Cote d'Ivoire**	0.00199	0.06589	0.01986	0.06589
5	**Ethiopia**	0.00056	0.04996	0.00561	0.04996
6	**Ghana**	0.00028	0.11976	0.00279	0.11976
7	**Guyana**	0.00210	0.00507	0.02097	0.00507
8	**Honduras**	0.00480	0.03685	0.00480	0.03685
9	**Kenya**	0.00163	0.00860	0.01625	0.00860
10	**Mali**	0.00472	0.12870	0.00472	0.12870
11	**Niger**	0.00254	0.00144	0.00539	0.00144
12	**Rwanda**	0.00139	0.04936	0.01394	0.04936
13	**Senegal**	0.00211	0.06541	0.00211	0.06541