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The role of structural factors in real interest rate behaviour: A cross-country study

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Abstract

Real Interest Rate (RIR) has a profound impact on the well-functioning of any economy hence a good understanding of its behavior is a key policy element. Using a Keynesian framework, we model and empirically test the relationship of RIR to selected structural variables namely inequality, dependency, financial depth, and institutional set up. We employ a panel dataset comprised of 115 countries with annual frequency from the period 2000 to 2018. Considering the structure of the dataset and possible endogeneity in the model; System GMM is used to estimate regressions parameters. We found that inequality and dependency do not have a significant influence on RIR. Financial development contributes to improving efficiency while institutional set up has a quadratic relationship with RIR. The better institution first increases RIR; after passing a certain cut off; further institution development would improve efficiency. RIR is found to be significantly procyclical. Further elaboration on the model; also revealed two different global RIR regimes with 2008 as threshold. There is also a significant counter cycle impact of financial development: negative interaction effect with the business cycle.

Kata kunci:
Studi lintas negara; Sistem GMM; Suku bunga riil, Faktor-faktor struktural

Abstrak

Suku Bunga Riil (RIR) memiliki dampak yang besar pada berfungsinya perekonomian manapun, oleh karena itu pemahaman yang baik tentang perilakunya adalah elemen kebijakan utama. Menggunakan kerangka Keynesian, kami memodelkan dan menguji secara empiris hubungan RIR dengan variabel struktural terpilih yaitu ketidaksetaraan, ketergantungan, kedalaman keuangan, dan pengaturan kelembagaan. Kami menggunakan kumpulan datapanel yang terdiri dari 115 negara dengan frekuensi tahunan dari periode 2000 hingga 2018. Mempertimbangkan struktur kumpulan data dan kemungkinan endogenitas dalam model; GMM sistem digunakan untuk memperkirakan parameter regresi. Kami menemukan bahwa ketidaksetaraan dan ketergantungan tidak memiliki pengaruh yang signifikan terhadap RIR. Perkembangan keuangan berkontribusi pada peningkatan efisiensi sementara pembentukan kelembagaan memiliki hubungan kuadrat dengan RIR. Institusi yang lebih baik pertama-tama meningkatkan RIR; setelah melewati cut-off tertentu; pengembangan institusi lebih lanjut akan meningkatkan efisiensi. RIR ditemukan sangat prosiklikal. Elaborasi lebih lanjut tentang model; juga mengungkapkan dua rezim RIR global yang berbeda dengan 2008 sebagai ambang batas. Ada juga dampak siklus berlawanan yang signifikan dari perkembangan keuangan: pengaruh interaksi negatif dengan siklus bisnis.

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1. Introduction

Real interest rate (RIR) is a critical variable in any country growth episodes. Though this concept might be complex and multi-dimensional; but in this paper we could simply consider it as cost of unemployed capital (opportunity cost of money) - we use formulation from World Bank World Development Indicator Database in which RIR is nominal deposit interest rate minus inflation. That is our study is focused more on short term interest rate. It has a critical role as signaling device to where (which economic sectors) and by how much scarce capital is allocated. In globalized world like today, the allocation range is greatly expanded to include which countries. Allocated capital in turn will determine the shape and pace of a country growth. Therefore, it should be in prime interest of every government to understand the behavior of RIR so, they can monitor, and policy managed its RIR.

There are quite substantial competing theories on behavior of RIR (Schmelzing, 2020). Here, we emphasize the role of structural factors on real interest rate equilibrium determination. We have a strong belief that the structural factors have substantial explanation power to explain the behavior of real interest rate. Our belief is shared among others by Carvalho, Ferrero, & Nechio (2016) and Lunsford & West (2017).

In this study we mainly contribute to existing literature through more elaborated empirical model and estimation that highlight the role of key structural factors namely Inequality, Dependency, Financial Depth and Institutional Set Up. These variables of interest are among most important structural factors in determining RIR (Bean et al., 2015 and Borio et al., 2017). The variables of interest are then complemented with control variables; standard in RIR modelling namely Business Cycle, Inflation Risk and Current Account Balance. This regression structure constitutes our baseline model.

We elaborate the model by estimation of (a) impact from country income classification, (b) interaction terms between business cycle and structural factors and (c) including possibility two global interest rate regimes. The study period includes Global Financial Crisis episode: year 2008; that would serve as cut off for two RIR regimes (as pointed out by Blanchard, Furceri, & Pescatori, 2014 and Taylor & Wieland, 2016). The first regime is perhaps the more "normal" regime; the other is "relatively" low interest rate regime. To the best of our knowledge, this paper offers one of the most elaborate and comprehensive design on RIR empirical works. This elaborate empirical scheme would enable us to comprehend RIR behavior from various perspectives.

We assemble our annual frequency dataset to cover 115 countries from period: 2000 to 2018 (2185 observations). We employ a variant of Dynamics Panel Data (DPD) econometrics technique called System GMM (Blundell & Bond, 1998) to estimate the regression parameters. This technique is chosen since endogeneity and RIR time persistence might be present in the empirical design; hence standard least squares-based panel econometrics would potentially lead to bias result (Nickell, 1981).

The paper will be structured as follows; after this introduction we present a brief recent literature on equilibrium real interest rate (and the research questions) in section 2. Dataset and Methodology will be described in section 3. In section 4, we will report and discuss key empirical findings including diagnostic statistics and robustness check. Lastly, conclusion will be presented in section 5.

2. Hypotheses Development

Real Interest Rate (RIR) is quite an old concept in economics. Perhaps one of earliest systematic study on this topic could be traced back to famous Fisher (1930) equation in which real interest rate is the difference of nominal interest rate with inflation. Wicksell (1936) proposed the idea of natural short-term interest rate (RIR which is aligned with a full employment output) which has become one of critical concept in macroeconomics.

We can also relate the real interest rate to the theory of neutrality of money. From perspective of neutrality of money; RIR should be constant and be determined by real factors and the role of monetary factors should be zero on average. The theoretical foundation of neutrality of money could be traced to Hume (1955). Patinkin (2016) emphasized the "still" relevancy of neutrality of money in modern context. Analyzing real interest rate behavior assuming neutrality of money could be viewed as a character of classical school of economics.

Another perspective is Keynesian; this school of thought emphasizes non neutrality of money due to market imperfection. The most common cited cause of imperfect mechanism is price rigidity; both in goods and labor market (Stiglitz & Greenwald, 2003). Woodford (2003) and Gali (2015) proposed equilibrium real rate concept as the real rate of return to keep the economy's output to its potential. Holston, Laubach, & Williams (2017) further defined natural short-term interest rate as real short-term interest rate that aligned with natural rate and constant inflation expectation.

The neutrality of money assumption; a key determinants of equilibrium real interest rate behavior is still hotly debated (Walsh, 2010). Theoretical and empirical literature on real interest rate from both schools is quite extensive. One can view from Classical, Keynesian or even hybrid perspective (Borio et al., 2017 and Schmelzing, 2020). There is a wide spectrum to view the mechanic of real interest rate, hence the topic is well open for further investigation.

In this paper, we study real interest rate (RIR) in Keynesian perspective since we believe there is significant market imperfection stemming especially from structural factors. This market imperfection could arise from various factors, this paper focus on Inequality, Dependency, Financial Development and Institutional Set Up. However, we still must consider the heavy influence of macro-economic factors as shown by a host of empirical works (Garratt et al., 2006).

Justiniano & Primiceri (2010) studied the behavior of equilibrium real interest rate using New Keynesian model and US quarterly macro-economic data (covering period from 1962 to 2008). They found the RIR behavior to be stylized with a substantial degree of time variation (and sometimes can be negative). Similar finding is also found by Holston et al. (2017) using greater data coverage: four developed countries (US, UK, Euro and Canada) and quarterly macro data from 1972-2016. Their study added insights that there exists a common driver of RIR globally (akin to spill over mechanism) in addition to country specific factors.

Integration to global market is another important business cycle factor. Bernanke (2005) forwarded saving glut hypotheses; in which the tendency of developing economies to save more has caused declining trend in global interest rate. Caballero, Farhi, & Gourinchas (2008) provide theoretical ground of this hypothesis. Subsequent works by Gourinchas & Rey (2016) and Del Negro et al. (2017) provide empirical supports for possible different RIR regimes. Holston et al. (2017) point out that policy response to Global Financial Crisis might accelerate the process of transition to lower RIR equilibrium at least for advanced countries. Despite global trend toward moderation, RIR remains a time persistence phenomenon domestically (Rudebusch, 2002; Schmelzing, 2020).

H_1: RIR exhibits time persistence behavior and possibly regime variant relationship with macro-economic variables

Rachel & Smith (2015) argued that rising inequality should have ambiguous effect to real interest rate. One transmission is negative to RIR in which rising inequality could reduce demand of capital as voters would push political agenda for increased tax to improve wealth distribution. On the other hand, Inequality could push people to work harder and take more risky ventures. This would increase demand of capital hence put upward pressure to

RIR. Empirical works in this topic also reported mixed findings, see Cingano (2014) and Berg et al. (2018).

Demographic especially dependency ratio is an important structural factor. Higher dependency ratio lowers saving; reducing supply of idle capital hence put upward pressure to RIR (Bean et al. 2015; Borio et al., 2017; Lunsford & West, 2019). Nevertheless, Carvalho et al. (2016) based on their simulations study argued that once factoring the population growth, there might be an offsetting effect on RIR rendering the overall impact of dependency ratio ambiguous.

H_2: inequality and dependency factors have ambiguous effect to RIR

Institutional set up and financial development have been considered as major factors in reducing asymmetric information problem in finance (Levine, 2004). Better institutional set up and developed financial sector decrease informational related cost such as adverse selection and moral hazard that subsequently improve financial sector performance (notably its efficiency: cost of intermediation). Improved financial sector efficiency in turn would positively contribute to economic growth. Recent literature highlighted possible nonlinear: inverse u-shaped relationship between financial development; that is the impact is only positive up to a certain point (Shen & Lee, 2006; Cecchetti & Kharroubi, 2012; Law, Kutan, & Naseem, 2018).

H_3: institutional set up and financial development has negative effect to RIR

3. Method, Data, and Analysis

This study use following sources to construct the dataset: (1) World Development Indicators (WDI): Real Interest Rate (RIR), Real GDP (local currency), Inflation, Current Account Balance, GINI ratio, Dependent Ratio, Financial Depth. (2) World Governance Indicators (WGI): Voice and Accountability, Government Effectiveness, Political Stability, Regulation Quality, Control of Corruption, Rule of Law,

Both sources are from the latest version, as time of writing is October 2019, available in World Bank website. In addition; we also use the ratio of income share of top 20 to the rest of population: TB20. The data is obtained from World Income Inequality Database (WIID) from United Nations University (UNU WIDER).

The dataset is of annual frequency. There are 214 countries serves as cross section unit and 19-time unit (years); 4066 observations to begin with. We applied cleansing based on criteria of (a) data availability in each country and (b) outliers. We take out country in which data availability for both dependent variable and regressors are less than 70 percent. Next, we do winsorizing at 1 percent level to remove outliers. The final data consists of 115 countries and 19-time unit, 2185 observations.

Real Interest Rate (RIR) is the dependent variable in this study. It is measured by subtracting deposit interest rate with inflation rate (measured by year on year percentage change of CPI). Variables of Interest (VIR) regressors are explanatory variables (right hand side of the regression) that are the focus of the study. Our variables of interest are Inequality (*GINI* or *TB20*), Demographic Burden (*DEPEND*), Financial Depth (*FIN_DEPTH*) and Institutional set up (*INSTITUTION*).

The GINI Index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Thus, a Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality. *TB20* is the ratio income share of top 20 percent of population compared to the rest. Age dependency ratio (*DEPEND*) is the ratio of dependents cohorts—people older than 64 and younger than 15—to the working-age population—those ages 15-64. Data are shown as the

proportion of dependents per 100 working-age population. *FIN_DEPTH* is calculated by dividing credit to private sector to nominal GDP.

We use 7 alternative proxies for country level institutional set up from World Governance Indicators database (constructed based on a methodology developed by Kraay, Kaufmann, & Mastruzzi, 2010). Six of them are dimensions of governance: Voice and Accountability (*V_ACC*), Government Effectiveness (*G_EFF*), Political Stability (*POL_STAB*), Regulation Quality (*REG_QUA*), Control of Corruption (*CONT_COR*), Rule of Law (*R_LAW*). One indicator: *INSTITUTION* is calculated as simple sum of the six dimensions (this is our baseline indicator). These indicators summarize the views on the quality of governance provided by many enterprises, citizen and expert survey respondents in industrial and developing countries. These data are gathered from several survey institutes, think tanks, non-governmental organizations, international organizations, and private sector firms.

To better identify and measure the role of variables of interests to dependent variable; we use the following control variables (*CONTROL*): log of Real GDP constant local currency (*RGDP_L*), Inflation risk- measured by skewness of inflation; 5 years moving (*INF_RISK*) and Current Account Balance measured as percentage of GDP (*CAB*). We take control of possible endogeneity of *RGDP_L* and *CAB*. Standard macro econometric modelling considers these variables as endogenous (Garratt et al., 2006).

This regression model assumes the persistence of real interest rate (possibly in lag 1 or 2) and time fixed effect - the time fixed effect specified as time dummies matrix; i.e. D_2001=1 if year=2001 and 0 otherwise. We model the relationship between dependent variable, lag of dependent variable, variables of interests, control variables and time dummies as linear form. We model the relationship as a linear dynamic form as follows

$$y_{it} = \alpha_0 + \alpha_1 y_{it-1} + X_{it}\beta + W_{it}\beta + u_{it}$$
$$u_{it} = v_i + e_{it} \quad (1)$$

Where y_{it} is the dependent variable, X_{it} is the vector of possibly endogenous regressors and W_{it} is the vector of (assumed) exogenous regressors. The residual of regression is a composite error term comprised of v_i is cross section residual component (Fixed and/or Random Effect) and idiosyncratic residual component (e_{it}). Nickell (1981) shows that estimation of this model using standard panel techniques: OLS, Fixed Effects and/or Random Effect would produce bias result. This is due to inherent demeaning process that creates correlation between regressors and residual. The bias become more pronounced in small T and large N like our dataset.

To overcome the problem, we estimate the model using Dynamic Panel Data (DPD) technique. Considering the nature of our data, the estimation of our equations was carried out using the system generalized method of moments: System GMM (Blundell & Bond, 1998). System GMM was chosen since the structure of our dataset is of small T (=19) and large N (115) and there is possibly dynamics pattern of the dependent variable. The use of system GMM also enable to perform estimation on time invariant variables like income category and interest rate regime. The procedure applied in this paper follows closely Roodman (2009).

We will conduct and report diagnostic tests to ensure the reliability of estimations. The tests would cover Hansen over identification test, Arrelano-Bond autocorrelation test and number of instruments. As robustness check we will compare the baseline results with various specification in terms of lag structure, variables transformation, types of standard errors and one or two step estimation.

Equation 1 would be the baseline model. We will elaborate the analysis further as (1) possible different regime before and after Global Financial

Crisis 2007-2008 (GFC). It will be treated using Dummy variables before and after GFC as effect to the constant (*D_2008* = 1 if year = 2008 or above; zero otherwise). Our treatment on regime dating based on Holston et al. (2017). (2) The impact of different level of country income categories. We reduced the World Bank five Country income categories (Low, Low-Middle, Middle, Upper Middle and High) into three: Low, Middle and High. This is done as to preserve degree of freedom. Only two dummy variables used: Low Income category is used as a reference. We treat country income category as effect to the constant. (3) we will include interaction terms to capture the moderating or accelerating effect between variables. Specifically, we are interested to find the interaction effect between significant control (business cycle) regressor with significant variables of interests.

4. Results

In this section we present and discuss the estimation results. First, we show descriptive statistics and correlation analysis of the variables used in the study. Second, we present the baseline regression results which subsequently followed by their robustness check. Finally, we show the extended model result in the last subsection.

Descriptive statistics and correlation

Table 1 presents descriptive statistics of variables used in the study. The statistics are number of observations, average, median, standard deviation and percentiles (1 percent, 5 percent, 95 percent and 99 percent). By performing this preliminary analysis on the data, we could anticipate or take notes on potential problems in subsequent advanced work.

The table consists of two parts; the upper part describes descriptive statistics for main variables while the lower part presents the alternative proxies. Here we can see that all the variables are reasonably well behaved. We don't observe outliers (or leveraged observations) that we should care about.

There are slight variations in number of observations with *REAL_RATE* is the most complete (2185 observations). Of main variables; *FIN_DEPTH* and *INSTITUTION* exhibit somewhat positive skewness: the mean is greater than the median, while *REAL_RATE* shows a negative skewness. In alternative proxies' part, variables: *GOV_EFF*, *REG_QUAL*, *CONT_CORRUPT* and *RULE _LAW* are all show positive skewness.

Correlation analysis results in Table 2 convey several notes. Pairwise (Pearson) correlation between *FIN_DEPTH* and *INSTITUTION* is remarkably high: around 0.723. Another somewhat high pairwise correlation also observed between *FIN_DEPTH – DEPEND* and *INSTITUTION – DEPEND*. The correlation is -0.541 and -0.522 respectively. This situation seems to have caused multicollinearity problem. Nevertheless, since the main estimator we use is System GMM with orthogonal transformation, it seems that the multicollinearity problem can be manageable. Pairwise correlation in other main variables pose no problem, they are in the range of -0.195 to 0.174. High correlation presents between alternative proxies; it is also not a problem since we only use the variable as substitutes.

Baseline regressions

Our empirical estimates on *GINI* and *DEPEND* do not support our hypothesis. They are not statistically significant (Table 3). Further it is interesting that System GMM estimator managed to disentangle the effect of two multicollinearity variables: *FIN_DEPTH* and *INSTITUTION* to *REAL_RATE*. Estimates of *FIN_DEPTH* is negative and statistically significant (at 10 percent level) in the range -0.016 - -0.014. This is aligned with our (and the widely accepted) financial development hypotheses.

Table 1. Descriptive statistics

	REAL-RATE	RGDP_L	RISK_INF	CAB	GINI	DEPEND	FIN_DEPTH	INSTITUTION
Obs.	2,185	2,182	2,146	2,185	2,164	2,166	2,099	2,181
Mean	0.127	12.006	0.341	-2.830	39.799	62.854	49.549	-0.478
Median	0.219	12.117	0.404	-2.660	39.019	56.271	32.756	-1.685
Standard Deviation	6.241	1.460	0.976	9.556	8.405	18.960	46.475	5.001
Min.	-47.575	8.817	-2.216	-65.029	16.290	26.991	0.403	-10.510
Max.	48.604	16.018	2.235	48.210	73.250	111.939	308.986	11.338
1%	-22.166	8.931	-1.976	-29.549	19.955	31.365	2.414	-9.190
5%	-9.132	9.527	-1.355	-16.474	28.097	39.473	5.617	-6.918
95%	5.323	13.486	1.464	3.632	48.374	87.801	100.244	5.493
99%	13.873	15.765	2.124	27.539	61.660	107.783	192.849	10.916

	VOICE_ACC	GOV_EFF	POL_STAB	REG_QUAL	CONT_CORRUPT	RULE_LAW	TB20
Obs.	2,185	2,172	2,168	2,171	2,183	2,185	2.137
Mean	-0.070	-0.042	-0.156	-0.004	-0.100	-0.108	8,634
Median	-0.099	-0.240	-0.139	-0.194	-0.399	-0.346	7,175
Standard Deviation	0.854	0.933	0.897	0.887	0.983	0.918	5,138
Min.	-2.233	-2.271	-2.810	-2.626	-1.673	-2.009	2,050
Max.	1.801	2.437	1.622	2.261	2.470	2.096	47,821
1%	-1.722	-1.613	-2.192	-1.639	-1.436	-1.548	3,020
5%	-1.383	-1.283	-1.689	-1.208	-1.215	-1.250	3,860
95%	0.987	1.086	0.918	1.102	1.119	1.007	12,770
99%	1.628	2.114	1.480	1.949	2.322	1,966	29,221

This table reports descriptive statistics of variables used in the study. Statistics reported are number of observations, mean, median, standard deviation, minimum and maximum and percentiles (1 percent, 5 percent, 95 percent, and 99 percent). Upper panel is for main variables, lower panel is for alternative proxies.

Table 2. Corration analysis

	REAL_RATE	*RGDP_L*	*RISK_INF*	*CAB*	*GINI*	*DEPEND*	*FIN_DEPTH*	*INSTITUTION*
REAL_RATE	1.000							
RGDP_L	-0.008	1.000						
RISK_INF	-0.080	0.021	1.000					
CAB	-0.027	0.118	-0.063	1.000				
GINI	0.114	-0.026	-0.069	0.033	1.000			
DEPEND	0.011	-0.042	0.003	-0.195	0.147	1.000		
FIN_DEPTH	-0.035	0.154	-0.043	0.174	-0.073	-0.541	1.000	
INSTITUTION	0.016	-0.073	-0.067	0.182	-0.072	-0.522	0.723	1.000

	VOICE_ACC	*GOV_EFF*	*POL_STAB*	*REG_QUAL*	*CONT_CORRUPT*	*RULE_LAW*	*TB20*
VOICE_ACC	1.000						
GOV_EFF	0.734	1.000					
POL_STAB	0.643	0.681	1.000				
REG_QUAL	0.756	0.929	0.645	1.000			
CONT_CORRUPT	0.770	0.929	0.723	0.867	1.000		
RULE_LAW	0.790	0.950	0.737	0.911	0.949	1.000	
TB20	0.060	-0.049	-0.050	-0.010	-0.033	-0.083	1.000

This table reports simple (Pearson) correlation of variables used in the study. Upper panel is for main variables, lower panel is for alternative proxies.

Table 3. Baseline regression results

Variables	Model 1a		Model 1b		Model 1c		Model 1d		Model 1e		OLS		FE		RE	
	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
REAL_RATE (-1)	0.573***	0.135	0.567***	0.132	0.567***	0.131	0.501***	0.117	0.553***	0.104						
REAL_RATE (-2)	-0,008	0.189	-0,041	0.202	-0.041	0.200	-0.059	0.193	-0.117	0.168						
RGDP_L	1.064**	0.467	1.077**	0.463	1.077**	0.457	1.306**	0.572	1.299**	0.550	0.128	0.089	0.381	2.929	0.029	0.236
RISK_INF	-0.285**	0.131	-0.310**	0.131	-0.310**	0.129	-0.328**	0.153	-0.344***	0.132	-0.463***	0.154	-0.194	0.165	-0.206	0.165
CAB	-0.053*	0.030	-0.310	0.131	-0.046	0.029	-0.049	0.035	-0.046	0.032	-0.002	0.017	0.039	0.028	0.035	0.027
GINI	0.035	0.031	-0.046	0.029	0.024	0.031	0.032	0.034	0.022	0.030	0.046***	0.017	0.053	0.081	0.058	0.047
DEPEND	-0.004	0.017	0.010	0.019	0.010	0.019	0.010	0.021	0.010	0.019	0.015	0.011	0.108*	0.056	0.043*	0.026
FIN_DEPTH	-0.018**	0.008	-0.014*	0.008	-0.014*	0.008	-0.014*	0.008	-0.016*	0.008	-0.001	0.003	0.010	0.017	0.004	0.010
INSTITUTION	0.142*	0.080	0.184*	0.099	0.184*	0.098	0.208*	0.106	0.224**	0.100	0.126***	0.046	0.102	0.178	0.116	0.091
INSTITUTION^2			-0.019*	0.012	-0.019*	0.090	-0.024*	0.014	-0.021*	0.066	-0.035***	0.007	-0.018	0.024	-0.028**	0.013
Const																
Specifications																
Small Sample Correction	Yes		Yes		No		No		No							
Orthogonal Transform	Yes		Yes		Yes		No		No							
Time Dummies	Yes		Yes		Yes		Yes		Yes							
Two Step GMM	Yes		Yes		Yes		Yes		No							
F/Wald Stats - p Value	9.290***	0.000	7.420***	0.000	212.970**	0.000	259.680***	0.000	308.840***	0.000	10.940***		1.120		11.800	
Hansen - p Value	72.700	0.126	72.490	0.129	72.490	0.129	73.140	0.119	73.140	0.119						
No. Instruments	88		89		89		89		89							
R2											0.038		0.006		0.027	
LR Stats													10.377***	0.000		
Hausman Test															15.680***	0.000
AR(1) stats - p Value	-2.420**	0.016	-2.360**	0.018	-2.36**	0.018	-2.380**	0.017	-3.52***	0.000						
AR(2) stats - p Value	-0.850	0.395	-0.650	0.513	-0.650	0.513	-0.590	0.557	-0.430	0.666						

This table reports System GMM estimates on baseline regression complemented with relevant diagnostic test: dependent variable is REAL_RATE. Coefficients and standard error (SE) of regressors are presented along with statistical significance used: * at 10 percent level, ** at 5 percent level, *** at 1 percent level respectively.

Table 4. Robustness check - sequential inclusion

Variables	Model 2a		Model 2b		Model 2c		Model 2d		Model 2e	
	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
REALRATE (-1)	0.567***	0.132	0.566***	0.142	0.558***	0.130	0.426***	0.098	0.599***	0.137
REALRATE (-2)	-0.041	0.202	-0.040	0.201	-0.024	0.205	0.042	0.199	0.039	0.202
RGDP_L	1.077**	0.463	1.041**	0.460	0.909**	0.407	0.960*	0.491	0.826**	0.409
RISK_INF	-0.310**	0.131	-0.332**	0.131	-0.315**	0.127	-0.295**	0.122	-0.252**	0.120
CAB	-0.310	0.131	-0.036	0.027	-0.049*	0.029	-0.050	0.032	-0.051*	0.028
GINI	-0.046	0.029			0.023	0.028	0.029	0.025	0.026	0.023
DEPEND	0.010	0.019	0.012	0.022			0.018	0.019	-0.013	0.013
FIN_DEPTH	-0.014*	0.008	-0.012	0.007	-0.015**	0.007			-0.008	0.005
INSTITUTION	0.184*	0.099	0.181*	0.096	0.163*	0.090	0.137*	0.074		
INSTITUTION^2	-0.019*	0.012	-0.022*	0.013	-0.017*	0.010	-0.023**	0.011		
F Stat - p Value	7.420***	0.000	8.500***	0.000	8.120***	0.000	11.530***	0.000	12.560***	0.000
Hansen - p Value	72.490	0.126	70.820	0.160	72.230	0.134	71.200	0.153	71.610	0.145
No. Instruments	89		88		88		88		87	
AR(1) stats - p Value	-2.360**	0.016	-2.310**	0.021	-2.300**	0,021	-2.420**	0.015	-2.440**	0.015
AR(2) stats - p Value	-0.650	0.395	-0.660	0.508	-0.720	0.469	-1.140	0.253	-1.020	0.308

This table reports System GMM estimates on robustness check – sequential inclusion regression complemented with relevant diagnostic test: dependent variable is *REAL_RATE*. Coefficients and standard error (SE) of regressors are presented along with statistical significance used: * at 10 percent level, ** at 5 percent level, *** at 1 percent level respectively.

Initially we hypothesize the relationship of *REAL_RATE* with *INSTITUTION* in a linear form. We obtain a somewhat counterintuitive result for *INSTITUTION* estimate. The coefficient is positive (0.142) and statistically significant at 10 percent (see Model 1a). We further contemplate that the result might be due to incorrect specification. Perhaps it should be modeled as a quadratic form. At low level, improvement of institution set up would enhance market mechanism which subsequently provide fairer return to the investors. Nevertheless, once the institutional set up cross a cut off level; competition take over hence improve market efficiency. This mechanism works to prevent investors to get excessive return. Sahay et al. (2015) also confirmed the above conjecture in their extensive macro cross country study

Considering this later view, we find the estimates support our alternative hypotheses. Estimates of *INSTITUTION* conform a parabolic function: the linear part is positive, while the quadratic part is negative. Coefficients of the linear part is in the range of 0.184 - 0.224; while the quadratic part is in the range -0.024 - -0.019. Estimates of both terms are statistically significant at 10 percent.

All system GMM estimation report significant coefficients (at 1 percent statistical level) of *REAL_RATE* lag 1. Coefficients of *REAL_RATE* at lag 2 are not significant. These results have given support to our initial assumption that *REAL_RATE* exhibits persistence behavior of order 2 at maximum.

We also obtain evidence a strong macro econometric model style relationship between *REAL_RATE*, *GDPR_L* and *RISK_INF*. Coefficients of *GDPR_L* are positive in the range of 1.077 – 1.306 and statistically significant at 5 percent level. *RISK_INF* estimates are negative and statistically significant at 5 percent in the range of -0.44 - -0.310. Evidence of positive estimates of *GDPR_L* and negative estimates of *RISK_INF*; support the Keynesian feature of macroeconomic model in which price level is sticky.

In baseline regressions we also estimate using least squares technique: pooled, fixed effect (FE) and random effect (RE) as comparison purpose. The likelihood ratio statistics of null hypotheses redundant FE (country dummies) is clearly rejected; meaning we should take care for possible effect in the residual. Furthermore, the Hausman statistics of null hypotheses of no correlation between regressors and residuals is also strongly rejected. That means we should cast the regression in a manner that account for possible endogeneity; thus, application of System GMM is warranted.

Diagnostic check for system GMM shows that current specification is appropriate. The F statistics as a measure of overall goodness of fit present a convincing evidence of the statistical importance of regressors in explaining *REAL_RATE*. The number instruments used is 89; less than number of cross section groups (115). Hansen Overidentification Test report that endogeneity is no longer a statistically significant issue. Lastly, the non-rejection of autocorrelation test at lag 2; provide support to our dynamic specification. All dynamic coefficients of lag dependent variable are less than one in absolute term; hence the proposed dynamic model is stable.

Robustness check

We employ two types of robustness check in this paper. First, we use sequential inclusion of variables of interest and observe whether it has caused substantial changes in the regression results. Secondly, we replace two variables interest: *GINI* and *INSTITUTION* with comparable proxies. We replace *GINI* with *TB20* and for *INSTITUTION* we use 6 alternatives: *V_ACC*, *G_EFF*, *POL_STAB*, *REG_QUA*, *CONT_COR*, and *R_LAW*.

Table 4 reports the result of type one diagnostic check. We think our result is quite robust. Estimates and statistical significance for the macroeconomic control variables (*R_GDPL*, *INF_RISK* and *CAB*) are qualitatively unaltered. There is a change in algebraic sign in GINI estimate. Nevertheless, since they are all still not statistically significant; we can address this situation as due to sampling variation.

Table 5. Robustness check-alternative proxies

Variables	Model 3a		Model 3b		Model 3c		Model 3d_1		Model 3d_2		Model 3e		Model 3f		Model 3g	
	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
REAL_RATE (-1)	0.576**	0.153	0.572***	0.135	0.584***	0.140	0.568***	0.139	0.571***	0.141	0.582***	0.135	0.584***	0.138	0.584***	0.135
REAL_RATE (-2)	-0.080	0.235	-0.018	0.223	0.019	0.195	0.007	0.177	-0.005	0.188	-0.033	0.217	0.029	0.186	0.020	0.188
RGDP_L	1.081**	0.579	1.121**	0.456	0.856**	0.414	0.974**	0.399	0.940**	0.390	0.934**	0.453	0.964**	0.455	0.938**	0.434
RISK_INF	-0.321**	0.139	-0.302**	0.144	-0.271**	0.125	-0.287**	0.129	-0.297**	0.137	-0.293**	0.142	-0.259**	0.119	-0.263**	0.123
CAB	-0.031	0.029	-0.051*	0.029	-0.054*	0.029	-0.048*	0.026	-0.044	0.027	-0.053*	0.029	-0.053*	0.029	-0.051*	0.029
GINI			0.042	0.037	0.030	0.026	0.037	0.030	0.030	0.029	0.032	0.030	0.028	0.025	0.030	0.026
TB20	0.037	0.051														
DEPEND	0.024	0.026	-0.012	0.016	-0.003	0.017	-0.004	0.016	-0.004	0.015	-0.001	0.018	-0.010	0.014	-0.007	0.016
FIN_DEPTH	-0.012	0.009	-0.015**	0.007	-0.015*	0.008	-0.013**	0.006	-0.012**	0.006	-0.015**	0.008	-0.015*	0.008	-0.015*	0.008
INSTITUTION	0.195*	0.114														
INSTITUTION^2	-0.020	-1.360														
V_ACC			0.551	0.376												
G_EFF					0.591	0.410										
POL_STAB							0.681**	0.323	0.421	0.310						
POL_STAB^2									-0.332	0.208						
REG_QUA											0.679	0.455				
CONT_COR													0.469	0.318		
R_LAW															0.511	0.362
F Stat - p Value	7.340**	0.000	8.390**	0.000	10.430***	0.000	8.880***	0	9.000***	0.000	8.580***	0.000	11.450***	0.000	10.770***	0.000
Hansen - p Value	72.8	0.124	71.24	0.152	72.46	0.13	69.81	0.181	69.79	0.182	74.59	0.097	72.46	0.13	72.69	0.126
No. Instruments	91		88		88		88		89		88		88		88	
AR(1) stats - p Value	-2.250**	0.024	-2.270**	0.023	-2.430**	0.015	-2.38**	0.018	-2.290**	0.022	-2.270**	0.023	-2.490**	0.013	-2.470**	0.013
AR(2) stats - p Value	-0.470	0.638	-0.700	0.486	-0.960	0.336	-0.96	0.339	-0.840	0.399	-0.650	0.516	-1.050	0.295	-0.990	0.320

This table reports System GMM estimates on robustness check – alternative proxies inclusion regression complemented with relevant diagnostic test: dependent variable is *REAL_RATE*. Coefficients and standard error (SE) of regressors are presented along with statistical significance used: * at 10 percent level, ** at 5 percent level, *** at 1 percent level respectively.

Table 6. Extended model

Variables	Model 4a		Model 4b		Model 4c		Model 4d		Model 4e		Model 4f		Model 4g		Model 4h	
	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE
REALRATE (-1)	0.140	0.101	0.562***	0.131	0.541***	0.139	0.565***	0.135	0.567***	0.130	0.562***	0.133	0.565***	0.131	0.563**	0.134
REALRATE (-2)	-0.095	0.089	-0.053	0.201	0.010	0.202	0.045	0.207	-0.040	0.195	-0,036	0.200	-0.037	0.202	-0.045	0.227
RGDP_L	1.574**	0.660	1.132**	0.521	1.515**	0.693	0.736	0.668	1.086**	0.467	1.077**	0.450	1.054**	0.487	1.076**	0.545
RISK_INF	-0.432*	0.229	-0.308**	0.132	-0.263**	0.113	-0.258**	0.116	-0.461**	0.200	-0,297	0.198	-0.313**	0.129	-0.302**	0.136
CAB	-0.033	0.037	-0.048	0.031	-0.039	0.025	-0.043	0.033	-0.046	0.029	-0,046	0.029	-0.051	0.039	-0.072	0.063
GINI	0.043	0.040	0.024	0.033	0.013	0.024	0.014	0.018	0.022	0.032	0,022	0.031	0.022	0.033	0.025	0.036
DEPEND	0.024	0.033	0.017	0.020	0.009	0.018	0.005	0.018	0.010	0.019	0,010	0.019	0.010	0.019	0.011	0.022
FIN_DEPTH	-0.015	0.012	-0.014	0.009	0.210**	0.099	-0.006	0.005	-0.014	0.008	-0,013	0.008	-0.013	0.009	-0.012	0.009
INSTITUTION	0.276*	0.145	0.188*	0.103	0.083	0.073	-0.173	0.416	0.179*	0.099	0.173*	0.095	0.178*	0.103	0.159	0.122
INSTITUTION^2	-0.030*	0.016	-0.018	0.012	-0.021*	0.013	0.185	0.217	-0.020*	0.012	-0.020*	0.011	-0.020*	0.011	-0.019	0.015
D_2008	-0.609*	0.352														
D_M			0.465	0.814												
D_H			0.328	1.128												
*RGDP_L*FIN_DEPTH*					-0.017**	0.008										
*RGDP_L*INSTITUTION*							0.021	0.036								
*RGDP_L*INSTITUTION^2*							-0.016	0.019								
*RISK_INF*FIN_DEPTH*									0.003	0.003						
*RISK_INF*INSTITUTION*											0.000	0.006				
*RISK_INF*INSTITUTION^2*											0.000	0.006				
*CAB*FIN_DEPTH*													0.000	0.000		
*CAB*INSTITUTION*															-0.003	0.006
*CAB*INSTITUTION^2*															0.001	0.001
Const	-20.062**	8.623	-11.183	7.466												
F Stat - p Value	2.230**	0.018	6.950***	0.000	11.600***	0.000	10.360***	0.000	7.380***	0.000	7.570***	0.000	7.550***	0.000	7.240***	0.000
Hansen - p Value	85.250	0.027	72.950	0.122	69.150	0.196	71.560	0.146	73.850	0.108	73.660	0.111	73.100	0.119	72.040	0.137
No. Instruments	74		91		90		91		90		91		90		91	
AR(1) stats - p Value	-3.100***	0.002	-2.400**	0.016	-2.240**	0.025	-2.38**	0.017	-2.410**	0.016	-2.37**	0.018	-2.390**	0.017	-2.350**	0.019
AR(2) stats - p Value	-1.010	0.314	-0.610	0.540	-0.870	0.382	-1.020	0.309	-0.690	0.492	-0.690	0.488	-0.670	0.501	-0.590	0.557

This table reports System GMM estimates on extended model regression complemented with relevant diagnostic test: dependent variable is *REAL_RATE*. Coefficients and standard error (SE) of regressors are presented along with statistical significance used: * at 10 percent level, ** at 5 percent level, *** at 1 percent level respectively.

Estimates on *DEPEND* also experienced a change in algebraic sign as we sequentially include the variables of interests. Again, these estimates are not statistically significant hence do not bear significant consequence to the analysis. There are remarkable stable estimates for *FIN_DEPTH* and *INSTITUTION*. These estimates still conform with the findings reported in the baseline model.

We could see that even after replacing proxy *GINI* with *TB20*, inequality variable remains statistically significant (Table 5). From six alternative proxies for *INSTITUTION*, only *POL_STAB* that is statistically significant (at 5 percent level). However, this estimate is also not aligned with hypotheses hence we test for possible quadratic form. In the latter model, *POL_STAB* estimates are not statistically significant. This finding provides us with an important insight. *INSTITUTION* seems to be a complex construct with no component proved to be dominant. Only when it is treated as an integration then the impact to *REAL_RATE* can be observed (and inferred).

Lastly, we also observed that diagnostic statistics (F statistics, Hansen OIR and Autocorrelation) are also unaltered. Therefore, regressions results could be said relatively robust in specification.

Extended model

There are three ways in which the previous baseline results will be elaborated. First, we test for significance of possible low interest regime after global financial crisis. Second, we include for possible effect of country income categories: low, middle and high. Third, we specify models with interaction terms of macro variables (*RGDP_L*, *RISK_INF* and *CAB*) with (statistically) significant variables of interest (*FIN_DEPTH* and *INSTITUTION*).

The results are summarized and reported in Table 6. Here we obtain estimate of the Interest Regime Dummy (*D_2008*) is negative (-0.609) and statistically significant at 10 percent level. It is interesting to find that the resulting constant due to *D_2008* = 0 is also negative (-20.062) and significant (at 5 percent level). This finding doesn't change our conjecture that real interest rate should be lower in years following 2008. However, it seems to suggest that there is already mechanism working to reduce equilibrium real interest rate across country.

Nevertheless, we should take a note on robustness of this regressions. Including Interest Regime Dummy has increased the Hansen OIR statistics to 85.25 that has caused inability to reject no endogeneity null hypotheses at a convenient 1 percent level.

We find that coefficients of country income categories to be positive but not statistically significant (both the dummies and reference constant: low income countries). This situation could be due to possible correlation with following variables: *GDPR_L*, *FIN_DEPTH* and *INSTITUTION*.

From nine interaction terms we estimated; only one that is statistically significant. Interaction terms coefficient of *RGDP_L*FIN_DEPTH* is negative (-0.017) and significant at 5 percent. It suggests there exist a dampening mechanism of equilibrium real interest rate from rising due to increasing economic activity; provided by developed financial sector.

Conclusion

Adopting a Keynesian framework; we model and estimate variables affecting Real Interest Rate (RIR). We emphasize the role of structural variable: Inequality (*GINI* or *TB20*), *DEPEND*, *FIN_DEPTH* and *INSTITUTION* to the behavior of RIR in addition to standard macro modelling approach.

Both Inequality proxies (*GINI* or *TB20*) and *DEPEND* do not statistically significant influence RIR behavior. The inability of both Inequality and Dependency proxies to significantly explain RIR behavior might be an evidence of ambiguous effect manifestation as outlined by existing literature. Never-

theless, we could not also dismiss the possibility of inadequate empirical design as our study limitation. Perhaps better-quality proxies and better econometric techniques could improve estimates; this is an avenue for future research.

Financial development helps improving efficiency as shown by negative and statistically significant *FIN_DEPTH* coefficients. The impact of *INSTITUTION* to RIR follows an inverted U shape. Initially growing institutional set up would increase the return on unemployed capital (opportunity cost of money); working as improving investor protection. After a certain threshold then the impact *INSTITUTION* will be negative to RIR (ie. efficiency improving).

Our estimates show that financial sector and institution development could help to reduce RIR; hence improve financial system efficient functioning. Government and regulator should gear their policy toward accelerating developing these two aspects to reach "efficiency" level. Attaining this level would be necessary to lower RIR possibly due to competition effect. In addition, we also find that there is a negative (and statistically) significant interaction term between *RGDP_L* with *FIN_DEPTH*. It means higher financial development could have an offsetting effect to procyclicality of RIR.

Analysis on control variables reveals that RIR is a persistent variable and highly pro cyclical. Sticky price hypothesis explains Real Rate behavior better as shown by negative and statistically significant coefficient of *RISK_INF*. These findings call for prudent macro economy management. RIR is strongly procyclical variable and substantially laggard to inflation realization (sticky price). Therefore, imprudent macro economy policies could have prolonged undesired capital allocation effect (due to higher RIR).

Lastly, there seems to be two different global real interest rate regimes in the study period with year 2008 as a cut off. RIR after 2008 can be considered as the lower RIR regime. This could be beneficial to economic development especially in emerging countries. Emerging countries could tap to the global debt market now to close financing gap that exists domestically.

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