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Research article

The impact of saving rate on economic growth in Asian countries

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Abstract: The success of East Asian countries in economic growth since the 1960s and the rapid development of China's economy in the past four decades have caused debates on whether these countries have found a new path of development and the role of government in economic growth. The present study investigates whether orthodox growth theories can explain East Asian growth by examining the impact of saving rates on economic growth in Asian countries. Using panel data analysis based on a dataset of 46 Asian countries and regions during the period 1969–2021, we find that gross domestic saving rate, GDP per capita, and urban population growth rate all significantly impact the annual GDP growth rates of Asian countries. The positive effect of the gross saving rate is very significant in the period 1960–1990 but insignificant in 1991–2021, while the positive impact of the urban population growth rate is more significant in the period 1991–2021 than in 1960–1990, and GDP per capita has a very significant negative effect during both 1960–1990 and 1991–2021. We further find that the saving rate has a very significant positive impact on economic growth in East and South Asian countries during 1960–2021. GDP per capita has a significant negative impact in East, South, Southeast, and West Asian countries; the urban population growth has a significant positive impact on GDP growth in East and West Asian countries during 1960–2021. The saving rate has a very significant positive impact on GDP growth in high-income countries, a significant positive impact in upper-middle-income countries, and an insignificant impact in lower-middle-income countries. Our present results show that a high saving rate is one of the critical factors for rapid economic growth in developing countries. Urban population growth and GDP per capita also have significant impacts on economic growth.

Keywords: saving rate; economic growth; investment; GDP per capita; urban population

JEL Codes: O47, E21, R11

1. Introduction

The rapid economic growth in East and Southeast Asian economies during the 1960s and 1970s and the spectacular economic growth experienced by China since 1978 have resulted in intense debates among economists about growth models and the role of government in economic growth (Halper, 2010; Huang, 2010; Ortmann, 2013). Some economists advocate the China Model or "Beijing consensus", which was coined by Ramo (2004) to suggest that China has found new rules for developing countries to achieve rapid growth and stability. To them, the "Washington consensus", which emphasizes the importance of property rights, the rule of law, and the free market (Williamson, 2000), appears ineffective in promoting growth in many developing countries (Lin, 2016; Zhang, 2006). Some economists who might not be convinced of the "Beijing consensus" also think that China's rapid economic growth challenges the established economic theories (Chow, 1997).

Those economists holding conventional views on economic growth generally attribute the rapid growth of Asian tigers and China to high savings and capital stock investment. Krugman (1994) argues that the growth of East Asian economies depends heavily on a massive increase in input with only a small improvement in productivity. Huang (2008) maintains that capitalism with Chinese characteristics is only successful because of the new freedoms in the market. To them, China's rapid economic growth arises because of the institutional changes in China that allow institutions to converge with those of non-socialist market economies (Woo, 1999). China's fast growth has been accompanied by rapid capital accumulation (Chow & Li, 2002; Wang & Yao, 2003). Ma (2017) argues that a high saving rate is the primary factor of China's rapid growth, with low interest rates that promote capital investment. What makes China distinct is its institutions that have maintained a high saving rate and social stability for several decades (Ma, 2019, 2020).

According to Ma (2020), developing countries might be able to "catch up" with rich countries because they can follow the technological (T) path found by developed countries. If they set rapid growth as their social objective (O), perform (P) with high efficiency in achieving the objective and maintain long-term social stability (S), their economy will grow rapidly. In this TOPS framework, good performance (P) designates mainly a high saving rate or high capital formation. Therefore, the Harrod-Domar model (Domar, 1946; Harrod, 1939) or the Solow-Swan growth model (Solow, 1956; Swan, 1956) still applies to Asian tigers and China. The success of Asian tigers and China in economic growth is mainly due to their high saving rates and social stability during their rapid growth years (Ma, 2020).

The Harrod-Domar model considers economic growth rate g as a function of the saving rate s,

$$g = \frac{\Delta Y}{Y} = s\frac{Y}{K} - \delta \tag{1}$$

where Y is the output, K is the capital stock, and δ the depreciation rate of the capital stock, while the Solow-Swan model views saving rate as the key determinant of an economy's growth rate before it reaches its dynamic equilibrium within the constraints of contemporary production technologies. Therefore, saving rate is a key factor that underlies economic growth in both models.

Empirical studies show that economic growth is significantly correlated with gross saving rate (Aghion, Comin, Howitt, & Tecu, 2016; Levine & Renelt, 1992; Mason, 1988), but research on causality between them has not produced an unambiguous conclusion. Campbell (1987) reports that saving Granger causes growth in the US economy with a negative sign. Deaton and Paxson (1994) find growth Granger causes saving in Taiwan's economy with a positive sign. Using data from OECD countries, Carroll and Weil (1994) find that growth Granger causes saving, but saving does not Granger cause growth. Analyzing seven Asian economies with vector autoregression (VAR) and vector error correction model (VECM), Agrawal (2001) shows that growth Granger causes saving, and there is also evidence of saving causing growth in some countries. Singh (2010) shows that saving has a long-run effect on income, and that innovation accounting indicates bidirectional causality between saving and growth. In contrast, Jangili (2011) finds that saving and investment Granger cause growth in the Indian economy, and the reciprocal causality is not observed.

The ambiguous causality between saving and growth reflects their complicated relationship. When GDP per capita is low, a large proportion of income is used for subsistence and little can be saved for investment (Lewis, 1954). As GDP per capita grows, a larger proportion of income can be saved for investment in capital stock. Saving and capital formation in turn promote economic growth. Whether and how much to save are partly determined by government fiscal and monetary policies as well as cultural traditions. In the Ramsey model, the social objective determines the optimal saving rate subject to the constraints of resources and production technologies (Ramsey, 1928). Growth probably provides the opportunity or upper limit for saving and investing in capital stock rather than causes or determines saving.

Since saving and growth have a complicated relationship between them, the Granger causality from growth to saving found by many studies is likely to be the limiting role of growth on saving. Our present study does not intend to find out their causal relations. Instead, the aim of the present study is to understand in more depth the impact of national saving on economic growth by examining differences in the saving-growth relationship among Asian regions across different time periods. Firstly, we want to examine how previously fast growing Asian economies perform in terms of the saving-growth relationship after the 1990s since some economists argued earlier that those economies would slow down as their per capita incomes reach a high-income level (Krugman, 1994). Secondly, while previous studies tend to focus on East and Southeast countries, especially the newly industrialized countries, we think that a comparative study on countries at different growth stages and in different regions may shed more light on the role of saving in economic growth of Asian countries. Thirdly, we want to investigate whether orthodox growth theories can explain East Asian growth by examining the impact of saving rates on economic growth in Asian countries, contributing to the Beijing consensus versus Washington consensus debate (Ma, 2019; Ramo, 2004; Williamson, 2000). The rest of the paper is organized as follows: section 2 describes data and research methods; section 3 presents results; section 4 discusses the implications of the present findings and concludes.

2. Data and methods

2.1. Data source

The data for 46 Asian countries and territories from 1960 to 2021 are sourced from the World Bank Development Indicators Database (World Bank, 2022). They are classified into five regions

according to the United Nations Statistics Division's standard country or area codes for statistical use (M49): East Asia (mainland China, Hong Kong, Japan, Macao, Mongolia, and South Korea), Southeast Asia (Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Timor-Leste), South Asia (Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan, and Sri Lanka), Central Asia (Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan) and West Asia (Armenia, Azerbaijan, Bahrain, Cyprus, Georgia, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Turkey, United Arab Emirates, and West Bank and Gaza). Afghanistan, North Korea, Taiwan, Vietnam and Yemen are not included because of insufficient data on these economies in the database.

2.2. Variables

The dependent variable in the present regression analysis is the GDP growth rate (GDP_growth), which is the annual percentage growth rate of GDP at market prices based on constant local currency. The main explanatory variable is the saving rate (Savings), which is measured by gross domestic savings as a percentage of GDP. We use GDP per capita (GDPPC) as a control variable, because in the Solow-Swan growth model the saving rate has a smaller impact on economic growth as GDP per capita approaches the steady-state level (Solow, 1956; Swan, 1956). We also control for the urban population growth rate (Urban_growth) because it may serve as a proxy for technological change or industrialization. One important feature of industrialization is that the labor force moves from rural areas to cities and from agriculture to industry (Lewis, 1954). Bertinelli and Black (2004) argue that urbanization can promote human capital accumulation which is an important factor for economic growth. A detailed description of all variables is provided in Appendix. In order to reduce the impact of extreme values and measurement errors present in the annual data, we follow Aghion et al. (2016) and use the average of the values in year *t* and its previous four years (*t*-1 to *t*-4) for the value in year *t* in the following regressions for all the variables.

2.3. Regression models

Our first model is to regress GDP_growth on Saving. Since our panel is comprised of 46 Asia economies over 61 years, there may exist heterogeneity across countries and years. Different economies may follow diversified growth path with different public policies at the same time, making the contributions of saving to growth varies widely. To address the country and time heterogeneity issues, we add country fixed effect and year fixed effect in the model. Previous studies have documented the potential endogeneity problem between economic growth and saving. To mitigate the endogeneity concerns, we lagged all explanatory variables by one period,

$$GDP\_growth_{i,t} = \alpha + \beta_1 Savings_{i,t-1} + \mu_i + \nu_t + \varepsilon_{i,t} \quad (2)$$

In Equation 2, $GDP\_growth_{i,t}$ is the GDP growth rate of country *i* in year *t*; α the intercept term; $Savings_{i,t-1}$ the saving rate of country *i* in year *t-1*; μ_i country fixed effect; ν_t year fixed effect; and $\varepsilon_{i,t}$ is the random error term.

To control the influences from factors that may also impact on economic growth, we add control variables in the regression model,

$$GDP_{growth_{i,t}} = \alpha + \beta_1 Savings_{i,t-1} + \beta_2 GDPPC_{i,t-1} + \beta_3 Urban\_growth_{i,t-1} + \mu_i + \nu_t + \varepsilon_{i,t} \quad (3)$$

In Equation 3, $GDPPC_{i,t-1}$ is the GDP per capita of country *i* in year *t-1*, and $Urban\_growth_{i,t-1}$ the urban population growth rate of country *i* in year *t-1*. Equation 3 was selected after comparison with models that include net capital flow, international trade, foreign direct investment, labor participation rate, and age-dependent ratio or their different combinations as well as the three independent variables in Equation 3.

According to the Solow-Swan model (Solow, 1956; Swan, 1956), the saving rate influences income growth only before the economy reaches its steady state. To test whether the impact of saving rate on economic growth has changed over time, we divide the period 1960–2021 into two sub-periods, 1960–1990 and 1991–2021, and estimate parameters of Equation 3 for the two sub-periods.

Previous studies on the relationship between saving and growth are often performed on a few countries selected from East Asia, South Asia or Southeast Asia. The obtained results could simply be features of those selected countries. In the present study, we estimate the parameters of Equation 3 for each of the five regions (East Asia, Southeast Asia, South Asia, Central Asia and West Asia) over the two sub-periods, 1960–1990 and 1991–2021.

Since countries in each of the five regions are quite diverse in their economic growth stage and there is great heterogeneity among them, we further divide the whole sample into four income groups based on World Bank's categorization. The World Bank categorizes countries into four income groups: low, lower-middle, upper-middle, and high income according to their gross national income (GNI) per capita data. We test the impact of saving on growth for each income group.

2.4. Validity and robustness tests

Since ordinary least square (OLS) estimation assumes homoscedasticity and no autocorrelation in the error term, heteroscedasticity is tested by a modified Wald statistic; and serial correlation by the Wooldridge test. Non-stationary time series may lead to spurious regression if they are not cointegrated. So, stationarity is examined by the augmented Dickey-Fuller unit-root test; and cointegration by the Kao test, Pedroni test and Westerlund test. Remedial measures will be taken if the above tests reveal any validity problems.

3. Results

3.1. Descriptive statistics

Our sample covers an unbalanced dataset for 46 Asian countries during 1960–2021. As shown in Table 1, the GDP growth rate varies substantially among countries, with an average annual growth rate of 4.92%. Iraq experienced the fastest GDP growth in 1991 with an annual growth rate of 81.89%; whereas Oman in 1968 had the slowest growth rate of −64.05%. The average gross domestic saving rate is 24.54% of GDP for all Asian countries. Timor-Leste had the lowest saving rate of −136.86% of GDP in 2002, whereas Turkmenistan had the highest saving rate of 87.83% in 2010. The GDP per capita ranges from $160 to $101,489.38 (in constant 2015 US$), which shows a great disparity among Asian countries. Myanmar had the lowest GDP per person in the 1960s. Macao, China records the

highest GDP per capita in 2013. The urban population growth rate ranges from −6.51% to 17.76%, with a mean of 3.09% and standard deviation of 2.23%.

Table 1. Descriptive statistics.

Variables	Frequency	Mean	SD	Min	Max
GDP_growth	1,910	4.92	7.60	−64.05	81.89
Savings	1,910	24.54	20.54	−136.86	87.83
GDPPC	1,910	10.26	14.50	0.16	101.49
Urban_growth	1,910	3.09	2.23	−6.51	17.76

Note: GDPPC is in constant 2015 thousand US$.

Table 2 shows the correlations between variables examined in this study. The correlations between gross domestic saving rate and GDP per capita is high. Other correlations are relatively low although many of them are significant.

Table 2. Correlations between variables.

	GDP_growth	Savings	GDPPC	Urban_growth
GDP_growth	1.000			
Savings	0.138***	1.000		
GDPPC	−0.022	0.516***	1.000	
Urban_growth	0.209***	0.116***	0.010	1.000

Note: N=1910. * indicates P < 0.1, ** indicates P < 0.05, *** indicates P < 0.01.

3.2. All Asian countries and territories

When the GDP growth rate is regressed on gross domestic saving rate, country fixed effect and year fixed effect for all Asian countries and territories, gross domestic saving rate has a significant positive influence on growth rate; for a one percentage point increase in gross saving rate the GDP growth rate increases by 0.045 percentage points (P < 0.01). When control variables are included in the regression function, the impact of the gross saving rate is still significantly positive; for a one percentage point increase in gross saving rate the GDP growth rate increases by 0.052 percentage points (P < 0.01). GDP per capita has a significantly negative influence (P < 0.01); for a $1000 increase in GDP per capita the GDP growth rate decreases by 0.134 percentage points. The urban population growth rate has a significantly positive influence on GDP growth (P < 0.01); for a one percentage point increase in the urban population the GDP growth rate increases by 0.559 percentage points (Table 3).

When the GDP growth rate is regressed on gross domestic saving rate, GDP per capita, urban population growth rate, country fixed effect and year fixed effect for all countries and territories over periods 1960–1990 and 1991–2021 separately, the gross saving rate has a very significant positive influence on growth rate during 1960–1990 (P < 0.01) but not significant influence during 1991–2021 (See Table 4). For a one percentage point increase in the gross saving rate, GDP growth increases by 0.186 percentage points during 1960–1990. GDP per capita has significant negative influences on the GDP growth rate in both models (P < 0.01). For a $1000 increase in GDP per capita, GDP growth decreases by 0.364 percentage points during 1960–1990 and 0.114 percentage points during 1991–

2021. Urban population growth has a weakly significant and positive influence on GDP growth during 1960–1990 (P < 0.1), and a very significant and positive influence during 1991–2021(P < 0.01). For a one percentage point increase in the urban population growth rate, the GDP growth rate increases by 0.384 percentage points pre-1990 and 0.618 percentage points after 1990.

Table 3. Impact of saving rate on GDP growth in Asia.

Variables	(1)	(2)
Savings	0.045***	0.052***
	(2.87)	(3.51)
GDPPC		−0.134***
		(−7.65)
Urban_growth		0.559***
		(6.51)
Constant	8.625***	1.400
	(5.24)	(0.79)
Observations	1,714	1,698
R-squared	0.286	0.339
Number of countries	46	46
Country FE	Yes	Yes
Year FE	Yes	Yes

Note: Robust t-statistics in parentheses. * indicates P < 0.1, ** indicates P < 0.05, *** indicates P < 0.01.

Table 4. The impact of saving rate on GDP growth during 1960–1990 and 1991–2021.

Variables	(1) pre-1990	(2) post-1990
Savings	0.186***	0.022
	(3.97)	(1.10)
GDPPC	–0.364***	–0.114***
	(–2.68)	(–3.81)
Urban_growth	0.384*	0.618***
	(1.80)	(6.14)
Constant	4.477***	8.163***
	(2.85)	(3.35)
Observations	484	1,214
R-squared	0.396	0.354
Number of countries	28	46
Country FE	Yes	Yes
Year FE	Yes	Yes

Note: Robust t-statistics in parentheses. * indicates P < 0.1, ** indicates P < 0.05, *** indicates P < 0.01.

3.3. Different regions

When the GDP growth rate is regressed on gross domestic saving rate, GDP per capita, urban population growth rate, country fixed effect and year fixed effect for different regions separately, the

gross domestic saving rate has no significant influence on GDP growth in Central Asia, Southeast Asia and West Asia, but it has significant positive impacts in East Asia ($P < 0.01$) and South Asia ($P < 0.01$), as shown in Table 5. For a one percentage point increase in gross domestic saving rate, the GDP growth rate increases by 0.163 and 0.106 percentage points respectively in East Asian and South Asian countries.

Table 5. The impact of saving rate on GDP growth in different regions.

Variables	(1) Central Asia	(2) East Asia	(3) South Asia	(4) Southeast Asia	(5) West Asia
Savings	0.037	0.163***	0.106***	0.009	0.041
	(1.34)	(5.71)	(3.94)	(0.46)	(1.47)
GDPPC	–0.914***	–0.140***	–0.906*	–0.053***	–0.224***
	(–3.53)	(–4.38)	(–1.78)	(–2.63)	(–4.04)
Urban_growth	0.728**	1.166***	0.219	–0.284*	0.630***
	(2.33)	(8.08)	(1.63)	(–1.79)	(5.30)
Constant	–2.539	2.872	4.459***	8.611***	15.272***
	(–1.18)	(1.34)	(3.03)	(4.45)	(3.74)
Observations	116	286	350	357	589
R-squared	0.844	0.710	0.254	0.633	0.356
Number of countries	5	6	8	10	17
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Note: Robust t-statistics in parentheses. * indicates $P < 0.1$, ** indicates $P < 0.05$, *** indicates $P < 0.01$.

GDP per capita has a very significant negative impact on GDP growth in all the regions ($P < 0.01$) except South Asia, where its impact is weakly significant ($P < 0.1$). Urban population growth has a significantly positive impact on GDP growth in Central, East and West Asian countries ($P < 0.01$), whereas a weakly significant and negative impact in Southeast Asia ($P < 0.01$) and no impact in South Asia. For a $1000 increase in GDP per capita, the GDP growth rate decreases by 0.914, 0.140, 0.906, 0.053, and 0.224 percentage points across the five regions respectively. For a one percentage increase in the urban population growth rate, the GDP growth rate increases by 0.728, 1.166 and 0.630 percentage points in Central, East and West Asian countries and decreases by 0.284 percentage points in Southeast Asian countries (Table 5).

When the GDP growth rate is regressed on gross domestic saving rate, GDP per capita, urban population growth rate, country fixed effect and year fixed effect for different regions separately over the period 1960–1990 (Central Asia is not included because of insufficient observations in the World Development Indicators database), the gross saving rate has a significantly positive influence on GDP growth rate in South Asia ($P < 0.01$), Southeast Asia ($P < 0.01$), and West Asia ($P < 0.05$), but its influence is insignificant in East Asia (Table 6). For a one percentage point increase in gross saving rate, GDP growth increases by 0.559 percentage points in South Asian countries, 0.116 percentage points in Southeast Asian countries, and 0.214 percentage points in West Asian countries. GDP per capita has a significantly negative impact on GDP growth in South Asian countries ($P < 0.01$), Southeast Asia countries ($P < 0.01$), and West Asian countries ($P < 0.05$). For a $1000 increase in GDP per capita, GDP growth decreases by 3.781 percentage points in South Asian countries, 0.478 in Southeast Asian countries, and 0.494 percentage points in West Asian countries. Urban population

growth has a significantly positive influence on the GDP growth rate in East Asian countries ($P < 0.01$) and South Asian countries; for a one percentage point increase in urban population, GDP growth rate increases by 1.060 and 1.353 percentage points, respectively.

Table 6. The impact of saving rate on GDP growth in different regions during 1960–1990 and 1991–2021.

Variables	East Asia		South Asia		Southeast Asia		West Asia	
	pre-1990	post-1990	pre-1990	post-1990	pre-1990	post-1990	pre-1990	post-1990
Savings	0.048	0.216***	0.559***	0.072**	0.116***	–0.006	0.214**	0.034
	(0.99)	(4.94)	(4.73)	(2.51)	(2.94)	(–0.26)	(2.59)	(0.85)
GDPPC	0.038	–0.187***	–3.781***	–1.776***	–0.478***	–0.087***	–0.494**	–0.287***
	(0.38)	(–4.43)	(–3.63)	(–5.51)	(–3.70)	(–4.21)	(–2.22)	(–3.00)
Urban_growth	1.060***	1.538***	1.353***	0.482***	0.027	–0.329*	–0.422	0.684***
	(5.17)	(4.45)	(3.27)	(5.08)	(0.08)	(–1.77)	(–0.72)	(5.34)
Constant	0.504	–1.638	1.875	12.405***	16.933**	7.942***	11.750*	16.548**
	(0.40)	(–0.93)	(0.42)	(4.63)	(2.47)	(3.89)	(1.68)	(2.54)
Observations	100	186	136	214	112	245	136	453
R-squared	0.787	0.663	0.341	0.625	0.689	0.638	0.454	0.337
Number of countries	6	6	6	8	7	10	9	17
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust t-statistics in parentheses. * indicates $P < 0.1$, ** indicates $P < 0.05$, *** indicates $P < 0.01$.

When the GDP growth rate is regressed on gross saving rate, GDP per capita, urban population growth rate, country fixed effect and year fixed effect for different regions separately over periods 1991–2021 (Central Asia is not included because of insufficient observations), the gross saving rate has a significantly positive influence on growth rate in East Asia ($P < 0.01$) and South Asia ($P < 0.05$), but its influence is insignificant in Southeast Asia and West Asia (Table 6). For a one percentage point increase in gross saving rate, GDP growth increases by 0.216 percentage points in East Asian countries, and 0.072 percentage points in South Asian countries. GDP per capita has a very significant negative impact on GDP growth across all regions ($P < 0.01$). For a $1000 increase in GDP per capita, GDP growth decreases by 0.187, 1.776, 0.087, and 0.287 percentage points in East, South, Southeast, and West Asian countries respectively. Urban population growth has a very significant positive influence on GDP growth rate in East, South and West Asian countries ($P < 0.01$) but a weakly significant negative influence in Southeast Asian countries ($P < 0.1$). For a one percentage point increase in urban population, GDP growth increases by 1.538, 0.482, and 0.684 percentage points in East, South, and West Asian countries respectively, while decreasing by 0.329 percentage points in Southeast Asian countries.

3.4. Different income groups

To test the impact of saving rate on GDP growth among different income groups in Asian countries, we regress GDP growth rate on gross domestic saving rate, GDP per capita, urban population

growth rate, country fixed effect and year fixed effect for different income groups separately. As shown in Table 7, the gross domestic saving rate has no significant influence on GDP growth for lower-middle-income countries in Asia but has a significant positive influence on GDP growth for upper-middle-income and high-income countries (low-income Asian countries are not included because of insufficient observations in the World Development Indicators database). For a one percentage point increase in the gross domestic saving rate, the GDP growth rate increases by 0.082 and 0.066 percentage points for upper-middle- and high-income Asian countries respectively.

Table 7. The impact of saving rate on GDP growth for different income-groups.

Variables	(1) Lower-Middle	(2) Upper-Middle	(3) High
Savings	0.001	0.082**	0.066***
	(0.03)	(2.53)	(3.24)
GDPPC	–1.062**	–0.887***	–0.065***
	(–2.55)	(–3.79)	(–2.74)
Urban_growth	0.560***	0.185	0.400***
	(3.79)	(0.87)	(4.22)
Constant	2.964***	5.184**	8.158***
	(2.59)	(2.29)	(4.24)
Observations	667	443	535
R-squared	0.296	0.359	0.565
Number of countries	19	12	14
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: Robust t-statistics in parentheses. * indicates $P < 0.1$, ** indicates $P < 0.05$, *** indicates $P < 0.01$.

GDP per capita has a significant negative impact on GDP growth across all three income groups ($P < 0.05$ for lower-middle group and $P < 0.01$ for the other two groups). For a $1000 increase in GDP per capita, GDP growth decreases by 1.062, 0.887, and 0.065 percentage points for lower-middle-income, upper-middle-income and high-income Asia countries respectively. Urban population growth has very significant positive influences on the GDP growth rate for lower-middle-income and high-income Asian countries ($P < 0.01$) but insignificant influence for upper-middle income Asia countries. For a one percentage point increase in urban population, GDP growth increases by 0.560 percentage points for lower-middle income countries and 0.400 percentage points for high-income Asia countries.

3.5. Validity and robustness tests

The modified Wald test reveals that there is heteroscedasticity in the OLS estimation, so robust standard error estimators are used. Wooldridge test shows no serial correlation in the residuals. Augmented Dickey-Fuller unit-root test finds no unit root. Kao test, Pedroni test and Westerlund test all indicate the cointegration of variables used in the regression. F-test shows that individual heterogeneity exists such that individual effect panel data analysis should be used. Hausman test indicates that individual effects are correlated with independent variables, therefore the fixed effect model is used to estimate the regression parameters.

4. Discussion and conclusions

In this study, we re-examine the relationship between the gross domestic saving rate and annual GDP growth rate in Asian countries, which has been investigated by many previous studies. In addition to the gross domestic saving rate, we also include GDP per capita to account for the effect of the reduced impact of the saving rate when the economy approaches its steady state as described by the Solow-Swan model (Solow, 1956; Swan, 1956). In the TOPS framework proposed by Ma (2020), the transition from one steady state to another advanced steady state is initiated by a change in the dominant production technology. The rapid economic growth during industrialization is caused by a change in the dominant production technology from agriculture with mainly manual tools to an industry with machines. In the present study, we use urban population growth as a proxy for technological change. For countries at the beginning of their industrialization, the supply of labor force to the new industrial sectors is not a limiting factor for economic growth (Lewis, 1954).

In the present study, the independent variables are lagged by one period, which deviates somewhat from the original format of the Harrod-Domar model or Solow-Swan model. Both models express the relationships with contemporary variables. Although our primary motivation to lag the independent variables is to mitigate the potential endogeneity issue, the regression model also considers the dynamic process of transforming savings into capital stock. Savings in the current year are likely to contribute more to the next year's GDP growth than the current year's GDP growth, because savings are made over the whole course of the current year and it needs time to transform savings into capital stock to generate production capacity. Therefore, the present study is an investigation of the relationship between GDP growth and the saving rate inspired by the Harrod-Domar model and Solow-Swan model, but it is not a test of the original Harrod-Domar growth model.

Our present results generally confirm previous studies that show a positive impact of saving on economic growth (Aghion et al., 2016; Levine & Renelt, 1992; Mason, 1988) and the prediction of the Solow-Swan model. Our investigation into different periods shows that the saving rate has a much stronger impact on GDP growth during 1960–1990 than during 1991-2021, which is consistent with the prediction of the Solow-Swan model that the saving rate has a smaller influence on GDP growth as GDP per capita approaches its steady state level. The lack of significant impact of gross domestic savings on GDP growth may also reflect the influence of globalization in recent decades, that is, capital inflow might have reduced the importance of domestic savings in promoting GDP growth in many Asian countries. GDP per capita has a significantly negative impact on GDP growth for both periods, which is also consistent with the Solow-Swan model.

Our investigation into different regions produced some interesting new findings. Although the saving rate has a strong effect in promoting GDP growth in South Asian countries over the whole period 1960–2021, its effect becomes weaker during 1991–2021, which may also reflect the impact of globalization in recent decades. South Asian countries such as India gradually reformed its government-guided economy and opened its market in the 1990s (Ahluwalia, 2002), which decreased the importance of domestic savings. In contrast, the saving rate has a significant impact on GDP growth in East Asia countries over the whole period 1960–2021 and during 1990–2021 but is not significant during 1960–1990. Its lack of impact on GDP growth during 1960–1990 might be explained by heterogeneity in their economies. Mainland China, Hong Kong, Macao, Japan, Mongolia, and South Korea were in very different development stages during 1960–1990. While centrally planned economies like China may have a high saving rate but low GDP growth, some open economies may

rely heavily on capital inflow for capital formation. During 1991–2021, almost all Asian countries adopted a market economy, and domestic saving became one of the most important contributors to capital formation and economic growth.

The saving rate does not have a significant impact on GDP growth in the Southeast and West Asian countries over the whole period 1960–2021, but its effect is significant during the period 1960–1990. Its lack of impact during 1991–2021 in Southeast Asian countries might be explained by the diversity in their economies which are at far different stages of development as well as the impact of globalization. Some Southeast Asian countries borrowed heavily for capital investment and experienced debt-crisis and economic volatility, which might reduce the significance of the impact of saving rate on GDP growth (Arestis & Glickman, 2002). During 1960–1990, Southeast Asian countries might be less heterogeneous and hence had small variance in regression parameters and a significant impact on GDP growth. Many West Asian countries grew rapidly before 1990 taking advantage of their rich oil resource, which may explain the significant impact of their domestic savings on GDP growth during 1960–1990. High GDP per capita in some oil-rich countries and social instability in others may explain its lack of impact during 1990–2021 in West Asian countries. In the TOPS framework, social stability is a key factor for sustained economic growth (Ma, 2020). The saving rate has no significant impact on GDP growth in the Central Asian countries over the whole period 1960–2021, which might be due to the relatively high GDP per capita before 1991 and the economic chaos following the disintegration of the Soviet Union in 1991 (Pomfret, 2012; Spechler, 2008).

The present results on different income groups show that domestic savings have the most significant positive impact on GDP growth in the high-income group and a significant positive impact in the upper-middle-income group, but have no significant impact on the lower-middle income group. Since the groups are based on latest categorization, these findings reflect how domestic savings affect their GDP growth during 1960–2021. The high-income countries have grown fast because their domestic saving has significantly promoted their GDP growth, and this is also true in the upper-middle income countries. The lower-middle income countries have not grown as fast perhaps because they have not saved enough or they rely more on capital inflow.

When investigated separately into different regions, periods, and income groups, the impact of GDP per capita on GDP growth is consistently negative and significant, with only one exception. These results are consistent with the Solow-Swan growth model (Solow, 1956; Swan, 1956). As the economy approaches its steady state, the impact of the saving rate on the GDP growth decreases. The only exception is East Asia during 1960–1990, which might be explained by heterogeneity in their economies, as we also find that the saving rate has no significant impact on GDP growth during the same period in East Asian countries. In the present study, one-period lagged GDP per capita rather than the current GDP per capita is used to mitigate the potential endogeneity issue. Given their high correlation between two adjacent periods, one-period lagged GDP per capita can also represent the current level of output per capita, and it is used as a measure of how close an economy is to its steady state.

Urbanization has been considered an important factor for economic growth (Bertinelli & Black, 2004). Nguyen and Nguyen (2018) report that urbanization and economic growth have a nonlinear relationship, with urbanization at lower levels promoting economic growth and at higher levels hindering economic growth. Bloom, Canning, and Fink (2008), however, find no evidence that the level of urbanization affects the rate of economic growth, although the proportion of a country's population living in urban areas is highly correlated to its level of income. In the present study, we

have included urban population growth as a proxy for technological change. For the whole period 1960–2021, urban population growth has a very significant positive impact on GDP growth. When investigated in different periods, its impact is weakly significant during 1960–1990, but very significant during 1991–2021. In contrast, the impact of saving is very significant during 1960–1990, but not significant during 1991–2021. Combining these two results, we might hypothesize that an increased saving rate is more important in driving economic growth at the early stage of development, whereas accelerated technological change is more important at the late stage of development.

When investigated in different regions, urban population growth has a very significant positive impact on GDP growth in East Asian countries and West Asian countries, but its impact is weakly significant and negative in Southeast Asian countries and insignificant in South Asia countries. Based on our aforementioned hypothesis, these findings might suggest that East Asian countries and West Asian countries on average are relatively more advanced in their development stages. When investigated in different regions over different periods, urban population growth has a very significant positive impact on GDP growth during 1960–1990 and 1991–2021 in East and South Asian countries, suggesting that its insignificance in South Asian countries during the whole 1960–2021 period is due to heterogeneity in its impacts over different time segments rather than a lack of impacts. Urban population growth also has a significant positive impact during 1991–2021 in West Asian countries. These findings are consistent with our early hypothesis. In Southeast Asian countries, its impact is negative and weakly significant during 1991–2021, which is inconsistent with our prediction, and insignificant during 1960–1990. Nguyen and Nguyen (2018) report that urbanization at higher levels hinders economic growth, but it is not clear whether this could explain the negative impact of urban population growth on GDP growth found in the present study. Although the negative impact of urban population growth in Southeast Asian countries is only weakly significant, it might still be worth further investigation.

Many previous studies have shown that instead of saving causing growth, economic growth Granger causes saving (Agrawal, 2001; Carroll & Weil, 1994; Deaton & Paxson, 1994). These findings are inconsistent with the Solow-Swan model (Solow, 1956; Swan, 1956), which considers the saving rate as a driving force of economic growth during the transitional stage. According to the Ramsey model (Ramsey, 1928), a social planner can choose the level of saving to meet the social objective. Cass (1965) and Koopmans (1969) show that the market outcome is the same as that of an optimal social planner. It might be preferable to incorporate a saving mechanism or a saving theory into a growth model. Individual and household savings are often explained by Modigliani's life cycle theory of consumption (Modigliani & Brumberg, 1954) and Friedman's permanent income theory (Friedman, 1957). Modigliani (1970) shows that high growth causes high saving and tries to derive the national saving rate from the life cycle model of saving, but Carroll and Summers (1991) disprove Modigliani's description of the relationship between aggregate and individual income growth with a range of evidence. Carroll and Weil (1994) find that households with predictably higher income growth save more than households with predictably low growth. They argue that the standard permanent income models cannot explain their findings, but that a model of consumption with habit formation may.

From the Ramsey-Cass-Koopmans model, we understand the role of economic growth in providing the opportunity or upper limit of saving in the growth-saving relationship. Ma (2020) emphasizes the importance that developing countries follow the technological path in their economic growth as described by the TOPS framework. From the TOPS framework, there is a certain level of saving rate at the previous steady state with the existing dominant production technology. When this

level of saving (or borrowed capital) is used for adopting new production technology, it will lead to an increased output which enables a higher level of saving. The higher level of saving can be further invested in new production technology which enables an even higher level of saving. By this virtuous circle, growth may appear to cause saving.

In conclusion, the saving rate has a significant positive impact on GDP growth in Asian countries, but this impact varies across different countries and different periods and appears more important at the early stage of economic growth. GDP per capita has a negative impact on GDP growth, but its impact also varies across different countries and different periods. Urban population growth, considered a proxy for technological change, has a significant positive impact on GDP growth and its impact appears to be more important at the relatively late stage of economic growth.

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Conflict of interest

All authors declare no conflicts of interest in this paper.

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