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Abstract

This paper suggests a new testing procedure to systematically examine the middle-income trap (MIT). To empirically demonstrate this procedure, one high income and 14 middle-income countries are examined using newly developed unit root tests - Fourier ADF with structural break (FADF-SB) and Seemingly Unrelated Regressions Fourier ADF (SUR-FADF). The FADF-SB test incorporates unknown nonlinearity and smooth break in the time-series, while the SUR-FADF test accounts for cross-sectional dependency. The empirical findings produced mixed results: 10 countries have a relatively high possibility of facing the MIT problem, while only one country has a relatively low possibility of facing the problem. For the remaining three countries, it is uncertain whether they will face the problem of MIT. These empirical findings have significant policy implications.

Keyword: Cross-sectional dependency; Fourier approximation; Income convergence; Middle-income trap; Structural break; Unit root

JEL Classification: C19, C22, N17

1. Introduction

Over the last decade, growth slowdowns of middle-income countries or prolonged periods of stagnation have received increasing interests (Glawe and Wagner, 2019). This is because the

standard growth theory suggests that middle-income countries are more likely to grow faster than high-income countries (Gill, Kharas, and others, 2007; Otsuka, Higuchi and Sonobe, 2017; Yılmaz, 2016). This paradox in growth theory or the growth slowdowns of the middle-income countries is known as the middle-income trap (MIT) (Yee and Robertson, 2016; Aiyar et al., 2018; Saner at al., 2014). The MIT could be described as a situation where developing countries get stuck at middle-income levels and fail to advance into high-income countries. While rapid growth has permitted a significant number of developing countries to achieve middle-income rank since the 1970s, only a few have made the additional rise that is necessary to become high-income economies.

Poverty trap or low-income trap (LIT) is an income stagnation of low-income countries due to lack of key ingredients for economic growth, such as production inputs, infrastructure, public goods and sufficient savings. MIT typically occurs after a developing country attains these key ingredients and achieves high economic growth for a sustained period of time, but later gets stuck in a bad path-dependent equilibrium (Agénor and Canuto, 2015). Furthermore, the MIT is a critical issue for consumers in middle-income countries because their middle-class consumers are in their earlier stage of economic growth, without a certainty of becoming wealthier in the latter stage of their economic development (Ozturk, 2016). Policymakers are often more interested in the risks and opportunities arising from growth turning points than in the long-run drivers of growth. In practice, concerns about growth slowdowns have been, particularly, acute in middle-income countries (Aiyar et al., 2018).

Moreover, according to previous literature, developing countries that failed to technologically upgrade and modernize their sectors appeared to have ended up being stuck in the MIT. In other words, the main economic problem in the MIT countries is the failure to boost their productive capacities through innovations and inventions (Lavopa and Szirmai, 2018; Otsuka et al., 2017). Furthermore, one important finding in the previous literature on

MIT is that institutions are important determinants of long-run economic development. In other words, developing countries with good institutions are not likely to face the problem of MIT (Kar, Roy and Sen, 2019).

In the history of economic growth, the rapid growth in most developing countries is perhaps the single most important economic development factor that has affected the world's population in the last two and a half decades. However, the question is: how long will it last? According to Lavopa and Szirmai (2018), more than one-third of the 140 countries examined in their study have been identified as either being in a LIT or an MIT, stressing the considerable challenges faced along the process of economic development. Interests in this question have been intensified, with the deterioration in the global outlook, following the onset of the global economic crisis since the end of the 2000s. Even China, the largest and most dynamic emerging market in the world, has experienced slower economic growth, due to the global economic crisis (Eichengreen, Park and Shin, 2014), even though the country has the possibility of escaping the MIT (see World Bank, 2013).

It is important to note that the MIT is a global concern and therefore, growth slowdown will have a significant impact on the world economy if it occurs in large middle-income economies like China and other developing countries. In other words, if the slowdown prolongs and worsens due to inadequate responses, its detrimental impacts on the world economy would be huge (Otsuka et al., 2017; Aiyar et al., 2018; Yang, 2019). Against such background, the current paper examines, systematically and empirically, the MIT hypothesis. Some previous studies offered interesting theoretical insights (Agénor and Canuto, 2015; Schiopu, 2015). Other studies applied sophisticated statistical methods to examine the MIT (Eichengreen et al, 2014; Ye and Robertson, 2016; Otsuka et al., 2017; Aiyar et al., 2018) or used some descriptive statistics to examine the MIT hypothesis (Yusuf, 2017). Ye and Robertson (2016) applied ADF-like unit root tests to investigate MITs in a battery of countries, while their approach only

considered short-run dynamics, stochastic trends and instantaneous structural breaks which led to fewer MIT countries, detected in their findings. In a more recent similar approach, Yavuz-Tiftikcigil, Guris and Yasgul (2018) considered the ADF test and some first-generation linear panel unit root tests to investigate the MIT of the US with some E7 countries.

The current study applies smooth breaks instead of the instantaneous breaks as applied in Ye and Robertson (2016). The study also considers cross-correlations of country panels of time series in panel unit root tests, of which such applications are rare in MIT investigations. This new test procedure consists of three different stages. In the first stage, a falsifiable hypothesis is developed from an income convergence theory (Bernard and Durlauf, 1996). In the second stage, a battery of unit root tests, such as the Fourier ADF (FADF) test (Enders and Lee, 2012b), the ADF with structural break (ADF-SB) test (Perron and Vogelsang, 1992) and the FADF with structural break (FADF-SB) test (Furuoka, 2017a), are used to test the MIT. In the final stage of the test procedure, a powerful panel unit root test, the Seemingly Unrelated Regression Fourier ADF (SUR-FADF) test (Furuoka, 2017b), is used to test the MIT. The Fourier function of low frequency in the SUR-FADF model system allows for modelling nonlinearity in the model system, thus the SUR-ADF test is its linear version, earlier proposed in Breuer, McNown and Wallace (2002). The Fourier function-based approximator allows for both nonlinearity and unattended multiple structural breaks in the deterministic component of the test regression in form of smooth breaks other than instantaneous breaks induced by other unit root tests as given in Perron and Vogelsang (1992), Zivot and Andrews (1993), among others. The Fourier function in sine and cosine functions of time have been used to capture smooth structural breaks of unknown forms in Enders and Lee (2012a, 2012b), even when the time series sample is small. The authors noted that exponential functions, as in Leybourne, Newbold and Vougas (1998) and Kapetanios, Snell and Shin (2003) can only capture instantaneous break, and the function is more applicable when the series at hand is large

enough. Using nonlinear function has overcome the approach of using dummy variables in describing breaks, irrespective of whether such breaks are instantaneous or smooth. Both SUR-ADF and SUR-FADF tests are robust to small sample sizes since augmentation lag in the ADF structures are usually set to 1 other than information criteria-determined which takes up certain sample sizes for lag lengths. The use of panel unit root testing is suggested in order to have a unit root testing framework with increased power of unit root test over the single equation unit root tests. The panel framework is used to improve the power performance of the unit root test in the Seemingly Unrelated Regression (SUR) framework. Breuer et al. (2002) have shown an increase in power performances of the SUR-ADF unit root test over the single equation DF and ADF tests of Dickey and Fuller (1979). The SUR framework allows for the interdependence of panel data and allows for variations of inter-correlations in a simple manner. Furuoka (2017b) considers the first nonlinear form of the panel unit root test using a Fourier form of low frequency as the SUR-FADF test.

There are three main contributions to the current paper. First, it proposes a testable hypothesis for the analysis of the MIT hypothesis. Second, it employs the FADF-SB test that incorporates nonlinearity and structural break in the estimation model, to test the MIT hypothesis. Finally, it uses both the SUR-ADF and SUR-FADF tests, that take account of cross-sectional dependencies in the panel settings, which lead to obtaining consistent estimates as noted in Breuer et al. (2002) and Furuoka (2017b), respectively.

2. Literature Review

Largely due to economic liberalization in the decade before the economic and financial crisis, the world has seen unprecedented convergence in incomes between developed and developing economies. Asian countries have become attractive destinations for foreign investment during the period. After experiencing a continuous and remarkable economic growth in the 1980s and

early 1990s, some of the Asian countries have reached middle-income status.

Due to the slowdown caused by the economic crisis of 1997, middle-income countries as at then began to realize the difficulty of catching up with high-income countries. The concept of MIT essentially captures the period when countries strive to recover from growth slowdown. Once the countries reach the middle-income status, economic growth may slow down as compared to previous decades (Aiyar et al., 2018).

Otsuka et al. (2017) define the MIT as a growth slowdown of a middle-income economy, aggravated by inadequate convergence. The main theoretical background to this is foundational to the economic assumption of capital's diminishing returns in production function (see Desli and Gkoulgkoutsika, 2019). The theory predicts that economies with lower per capita GDP will grow faster over time than their counterparts with higher per capita GDP (Völlmecke et al., 2016). The reason is that lower-income countries can benefit from technology transfer from advanced countries (Waqas et al., 2015). After some time, the countries themselves may need to strive for a deeper technological innovation and development, which requires a pool of highly skilled workers. The MIT occurs when the countries fail to catch-up with such technological ladder (Eichengreen et al., 2014).

There is quite a number of literature on the growth development of middle-income countries, especially Latin America and Asian countries. Basically, the relevant research can be divided into three parts: (1) those which aim to detect the existence of MIT; (2) those that discuss the factors that cause the MIT; and (3) those that identify policy recommendations to remedy and free up countries from the MIT.

For the first strand of literature, Yusuf (2017) states four ways to identify countries that might be in danger of falling into the MIT – (1) The per capita income, (2) The number of years countries have GDP level below a certain absolute value, (3) The per capita income of the country relative to the United States, and (4) The period such a country is suffering from lower

economic growth. Normally, if a country falls into shrinkage for a longer period, then it might suffer from the MIT. The middle-income countries may experience two slowdowns. Rather than at a single point in time, the growth in the middle-income countries may also slow down in a succession of stages (Eichengreen et al., 2014). The catching-up process is not continuous due to heterogeneity across countries, with some breaks and divergence episodes in between the path (Desli and Gkoulgkoutsika, 2019).

The second strand of literature investigates the common factors that cause the MIT to occur. These are: labour force, productivity fall, diminishing export-led growth, insufficient economic complexity, red tape, sex ratio imbalance, macroeconomic instability, weakening private consumption, high public debt, and unstable banking systems. In developing economies, poor governance and institutional quality, income inequality, relative low initial income level, limited global supply chain, large manufacturing scope and small service share, insufficient foreign direct investment, public infrastructure deficiencies, and inadequate skill labour are among the additional factors that increase the probability of countries to fall into the MIT. Due to these reasons, some developing countries are unable to make a timely transition from resource-driven growth to productivity-driven growth and to escape from the MIT (Yusuf, 2017). External factors including financial crises and terms-of-trade shocks may raise the likelihood of falling into the MIT (Eichengreen et al., 2014). Countries are less likely to fall into the MIT if the population has better quality tertiary education and large production of technology-oriented exports. It is because high-quality human capital can help the countries to move into modern high value-added activities such as business service. Agénor and Canuto (2015) examine some major factors or possible causes for the MIT using a two-period overlapping generations model of economic growth. The paper finds that improving access to advanced infrastructure may also facilitate escape from MIT overall. They also claimed that the core factor and crucial cause for the MIT is the relationship between education and

innovation. Countries may be stuck in the middle due to lack of innovation activities.[1]

Due to the large population in the Asian region, the demographic influences found out the importance of Asia's economic convergence towards the US. Ha and Lee (2016) showed that the speed of convergence in Asian countries to the US in terms of GDP is closely influenced by the share of working-age population and fertility, which in turn is affected by the very high cost of human capital investment. The Asian countries might fall into the demography-driven MIT if fertility eventually turns down before the relative per capita GDP fully converges to the US. The relative per capita income relative to the US may diverge or stagnate for at least some period, or even in the long run. The influence of political forces on the economy cannot be ignored either for the Asian region. Political elites in developing countries always have little incentive to enact institutional reforms needed for structural transformation and higher growth, thus limiting the two countries in freeing up from the MIT. Political settlement may, therefore, slow down the economic growth, as evidenced by Sen and Tyce (2019) in Malaysia and Thailand. Labour quality, capital accumulation, and a number of years of schooling can explain nearly half of the variation in the long-run economic growth (Tamura et al., 2019). To accelerate out of the MIT, therefore, the third strand of literature commonly agrees on these policy suggestions: (1) Improving institutional quality; (2) Increasing the quality of human capital from primary to tertiary levels; (3) Innovation-led research and development; (4) Increase of foreign direct investment (FDI) and trade openness; (5) Increasing investment in productivity sectors and physical infrastructure; (6) Strengthening financial institutional; (7) Building a positive business climate; and (8) Increasing resource productivity.

For developing countries, the level of economic development is very much related to the level of institutional sophistication, thus additional growth policies are therefore suggested.

[1] The authors are very grateful to reviewer who kindly suggested importance of the education-innovation factor.

These are: (1) Introducing property rights among private companies; (2) Contract enforcement for skilled labor; (3) Minimizing bureaucracy and increasing government effectiveness; and (4) Ruling out corruption. Once the developing countries reach the status of middle-income status, investment in technological assimilation and productivity rise can activate to their full potential and cross to the high-income threshold. Having investigated both supply and demand sides, a combination of high savings and slow population growth are found to be among the two important reasons for stagnation in the Japanese economy (Nakatani and Skott, 2007).

The third strand of literature is on policy recommendation. The country may work out on industrial changes and financial reforms to regain labour productivity. At the same time, the reallocation of workers from unproductive to productive enterprises by domestic small and medium enterprises may be necessary to build dynamic privatization. The return of human capital depends on the quality of education. human capital accumulation as a multi-stage process, that is primary education builds basic skill human capital, and advanced education produces skilled human capital. Investment in advanced education can further determine the direction of technology adoption and therefore free up the MIT. The increasing dominance of knowledge-intensive services especially in high and medium-high technology industries can help expedite the convergence process and therefore economic development. Otsuka et al. (2017) support this point through its empirical findings that public infrastructure, institutional quality, education level, trade openness, and research and development would be required to avoid aggravating the growth slowdown in the East Asian countries. The developing countries in the Asia region, therefore, would need to develop and upgrade infrastructure in power generation, public transit systems, freight and ports, and at the same time improving institutional quality among Asian middle-income countries. At the same time, globalization has provided unprecedented opportunities for some countries to catch up towards high-income status. In tandem with the globalization, Poland and Turkey have benefited from economic

integration, reinforced with economic institutions and private entrepreneurship (Raiser, Wes and Yilmaz, 2016). The strategic location with other European countries and Asia has offered Turkey additional potential for foreign direct investment and additional economic growth. Export and marketability have helped many countries especially China to transfer their economic situations into another stage, therefore escaping them from the middle-income trap.

Yet, the related research has yet to come up with policy recommendations specific to MIT countries entirely from the challenge. The policy suggestions offered in the literature are rather of the generic variety applicable to both developed economies and developing economies.

3. Data and Methods

Growth has often been measured by GDP per capita values at constant US dollars for 2010, even though authors have criticized this proxy variable.[2] Meanwhile, for world country comparison, per capita growth is widely used. We extracted the dataset from the World Development Indicator (WDI) database of the World Bank (https://data.worldbank.org). Fourteen countries were selected for empirical analysis. The selection of the countries is based on the three overlapping criteria, namely major developing economies or the G20 member countries (i.e. China, South Korea, Turkey, Indonesia, India, Saudi Arabia, South Africa, Argentina, Brazil and Mexico), emerging economic powers or the "next eleven" countries (i.e. South Korea, Mexico, Indonesia, Nigeria, Turkey) and the Asian miracle economies or high-performing Asian economies (i.e. Hong Kong, Indonesia, Malaysia, South Korea, Singapore). Some countries which met these criteria are excluded due to the lack of sufficient data. The

[2] GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars (World Bank Group, https://data.worldbank.org).

geographic distribution of selected countries is as follows: East Asia (3), China, Hong Kong, South Korea; West Asia (1): Turkey; Southeast Asia (3): Indonesia, Malaysia, Singapore; South Asia (1): India; Middle-East (1): Saudi Arabia; Africa (2): Nigeria and South Africa, and Latin America (3): Argentina, Brazil and Mexico, with US as the benchmark country. Each country series spans from 1968 to 2017.[3]

There are two possible reasons for the MIT problem being investigated in this paper. The first reason could be that slowdowns of economic growth in middle-income countries could prevent income convergence between high-income countries and middle-income countries. The second reason could be that rapid economic growths in high-income countries could cause income convergence between high income and middle-income countries. Based on existing literature (Bernard and Durlauf, 1996; Greasley and Oxley, 1997), income convergence between high-income country *i* and middle-income country *j* would take place if the long-term forecasted per capita income in high-income country *i* and middle-income country *j* are equal, that is:

$$\lim_{k\to\infty} E(y_{i,t+k} - y_{j,t+k} \mid I_t) = \lim_{k\to\infty} E(IG_{ij,t+k} \mid I_t) = 0 \quad (1)$$

where E is expectation operator, I_t is available information at year, t, $IG_{ij,t}$ is income difference between country i and country j in year t, $y_{i,t}$ is natural log of real per capita income in country i, and $y_{j,t}$ is natural log of real per capita income in country j. In this context of income convergence framework, the MIT could be examined by testing the following null hypothesis: H_{MIT}^{0}*: There would be an absence of income convergence between high-income country i and middle-income country j.*

The alternative hypothesis could be formulated as:

[3] As at 18 May 2019 when the writing of this paper commenced, 2017 datasets were the recent GDP per capita in WDI.

H_{MIT}^{1}: *There would be a presence of convergence between high-income country i and middle-income country j.*

From an applied econometric perspective, the absence of income convergence could be equivalent to the presence of unit root in the natural log difference in per capita income between high-income country *i* and middle-income country *j*. Similarly, the presence of income convergence could be equivalent to the absence of unit root in the natural log difference in per capita income between high-income country *i* and middle-income country *j*. In this context of the unit root framework, the MIT could be examined by testing this modified null hypothesis:

H_{MIT}^{0}: *There would be a presence of unit root in the time-series of the income difference between high-income country i and middle-income country j.*

Furthermore, the alternative hypothesis also could be re-formulated as:

H_{MIT}^{1}: *There would be an absence of unit root in the time-series of the income difference between high-income country i and middle-income country j.*

The presence of the MIT would be substantiated if the unit root test would identify the presence of unit root in the time-series of income difference. Alternatively, the absence of the MIT would be substantiated if the unit root test would identify the absence of unit root in the time-series of income difference.

Four different unit root tests, namely, the augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979); the Fourier ADF (FADF) test (Enders and Lee, 2012b); the ADF with structural break (ADF-SB) test (Perron and Vogelsang, 1992) and the Fourier ADF with structural break (FADF-SB) test (Furuoka, 2017a) are used to test the MIT null hypothesis. The ADF test is based on Equation 2, the FADF test is based on Equation 3, the ADF-SB test is based on Equation 4 and the FADF-SB test is based on Equation 5:

$$\Delta y_t = \mu + \beta t + \rho y_{t-1} + \sum_{i=1}^{p} c_i \Delta y_{t-i} + \varepsilon_t \quad (2)$$

$$\Delta y_t = \mu + \beta t + \gamma_1 sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 cos\left(\frac{2\pi kt}{T}\right) + \rho y_{t-1} + \sum_{i=1}^{p} c_i \Delta y_{t-i} + \varepsilon_t \quad (3)$$

$$\Delta y_t = \mu + \beta t + \delta DU_t + \theta D(T_B)_t + \rho y_{t-1} + \sum_{i=1}^{p} c_i \Delta y_{t-1} + \varepsilon_t \quad (4)$$

$$\Delta y_t = \mu + \beta t + \gamma_1 sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 cos\left(\frac{2\pi kt}{T}\right) + \delta DU_t + \theta D(T_B)_t + \rho y_{t-1} + \sum_{i=1}^{p} c_i \Delta y_{t-i} + \varepsilon_t \quad (5)$$

where y_t is the time series variable of interest that is the univariate log difference of income time series, μ is deterministic term, ε_t is the error term, β is the slope coefficient for the deterministic trend, t; T is the sample size of the series, γ_1 and γ_2 are slope coefficients for the trigonometric terms, π is 3.14159, k is frequency in the Fourier approximation function, *sin* is the sine operator, *cos* is the cosine operator, δ is the slope coefficient for the structural break dummy, $DU_t = 1$ if $t > T_B$ and $DU_t = 0$ if otherwise, T_B is the breakpoint where structural break occurs, θ is the slope coefficient for the one-time break dummy, $D(T_B)_t = 1$ if $t = T_B$ and $D(T_B)_t = 0$ if otherwise, ρ is the slope coefficient for the lagged dependent variable, c is the slope coefficient for the lagged differenced dependent variable, p is the lag length which would be set to one due to limited number of observations. The ADF-SB test is a modified ADF test that could take account of an unknown structural break in its analysis while the FADF-SB is another modified ADF test that could take account of unknown nonlinearity and structural break. To test the null hypothesis of MIT, the slope coefficients ρ for the lagged dependent variable y_{t-1} should be non-zero if the time-series of per capita GDP difference would not contain a unit root. For this purpose, the t-statistic is used to test the null hypothesis $\rho = 0$ for all four estimation models in (2)-(5). For the ease of calculations, the optimal lag length for all four tests could be set at one and the maximum frequency for the FADF test and the FADF–SB test could be set at two (Furuoka, 2017a).

Next, we give a brief overview of panel unit root tests. The classical univariate Dickey-Fuller (DF)-like test lacks power in the presence of panel alternatives, thus the newer testing

procedure was introduced. With the initial application given in Abuaf and Jorion (1990), other developments of the tests have been given in Levin and Lin (1992, 1993), Im, Pesaran and Shin (1997), Sarno and Taylor (1998), Banerjee (1999), Baltagi and Kao (2001), Choi (2006, 2015), among others. These panel unit root tests have been applied in testing Purchasing Power Parity (PPP) hypothesis (e.g. Oh, 1996), growth and convergence (e.g. Estrin, Urga and Lazarova, 2001), inflation rate convergence (e.g. Culver and Papell, 1997), hysteresis in unemployment (e.g. Song and Wu, 1997). In these tests, the linearity of the time data sets is assumed (with possible abrupt structural break) according to the regression specification.

By extending (3) to panel settings, Furuoka (2017b) proposed a Seemingly Unrelated Regression Fourier ADF (SUR-FADF) unit root test which is a nonlinear Fourier adaptation of linear SUR-ADF unit root test of Breuer, McNown and Wallace (2002). The nonlinearity induced by the Fourier function behaves similarly as in the FADF regression model of Enders and Lee (2012b) for the case of univariate in (3). The SUR system of regression allows for cross-sectional dependence and joint testing of $\rho_i (i = 1,...,m)$ parameters for unit root testing in *m* panels of time series. The Fourier function in the system of equations allows for smooth breaks as in Bai and Perron (2003). The SUR-FADF system is given as,

$$\Delta y_{it} = \mu_i + \rho_i y_{i,t-1} + \gamma_{i,1} \sin\left(\frac{2\pi kt}{T}\right) + \gamma_{i,2} \cos\left(\frac{2\pi kt}{T}\right) + \sum_{j=1}^{p} c_{ij} \Delta y_{i,t-j} + \varepsilon_{it} \qquad (6)$$

where $u_{it} \sim iid(0, \sigma_i^2)$ for every *i* and *t*. note, y_{it} is the log differences of income (GDP per capita), with panel dimension *m*; μ_i is the model intercept; $\gamma_{i,1}$ and $\gamma_{i,2}$ are the slope parameters in the Fourier form and the coefficient of augmentation component is given with parameter c_{ij}. Thus, the null hypothesis for the panel unit root test is then,

$$H_0 : \rho_i = 0 \quad \forall\, i \qquad (7)$$

which is carried out using the t-test. Since this work uses a restricted number of time observations, the lag length (*p*) and frequency (*k*) were fixed at 1 (see Furuoka, 2017b). The

regression system of equations in (1) reduces to SUR-ADF once nonlinearity induced by Fourier form is absent, that is, the series seems to be linear. Critical values of both SUR-ADF and SUR-FADF are found in Furuoka (2017b), while other critical values for ADF, FADF, ADF-SB and FADF-SB are found in Furuoka (2017a).

3. Empirical Results

In the first stage of the empirical analysis, the ADF and FADF tests are used to examine the MIT hypothesis in 14 selected countries that are compared with the US, which is a high-income country. The FADF test is a modified ADF test, which could take account of unknown nonlinearity in its analysis. The empirical findings from the ADF test and the FADF test are reported in Table 1. With the exception of Malaysia, the ADF test failed to reject the null hypothesis of a unit root in the time series of the income differences for all the examined countries, tested at 10% level of significance. It would mean that the ADF test identified the presence of unit root in the income gap time-series in almost all these countries. On the other hand, the FADF test also failed to reject the null hypothesis for all fourteen countries, except Saudi Arabia. It would imply that the FADF test identified a presence of unit root in the income gap time-series in almost all these countries. In other words, both the ADF test and the FADF test pointed out that these fourteen countries seem to face the problem of MIT.

INSERT TABLE 1 ABOUT HERE

In the second stage of the empirical analysis presented in Table 2, the ADF-SB test and the FADF-SB test are used to test the MIT hypothesis, by considering the fact that structural breaks exist in the series, leading to low power of ADF test. The structural breaks could be instantaneous or smooth. The empirical findings from the ADF-SB test and the FADF-SB test are reported in Table 2. The ADF-SB test rejected the null hypothesis of a unit root in the time series of income differences for Brazil, China, Hong Kong, Indonesia, Malaysia, Nigeria, Saudi Arabia and Singapore. It would mean that the ADF-SB test identified an absence of unit root

in the income gap time series in the majority of these countries. On the other hand, the FADF-SB test rejected the null hypothesis of unit root for all countries, except only three countries, namely Argentina, India and South Korea. It would imply that the FADF-SB test also identified the absence of unit root in the income gap time-series in the majority of these countries. In other words, both the ADF-SB test and the FADF-SB test pointed out that these fourteen countries do not seem to face the problem of MIT.

INSERT TABLE 2 ABOUT HERE

In the third stage of empirical analysis, the SUR-ADF test and the SUR-FADF test are used to test the MIT hypothesis in order to accommodate cross-correlations of model residuals as in SUR framework. The empirical findings from the SUR-ADF test and the SUR-FADF test are reported in Table 3. The SUR-ADF test failed to reject the null hypothesis of a unit root in the time-series of income difference for all countries, except only three countries, namely South Korea, Singapore and South Africa. It would mean that the SUR-ADF test identified the presence of unit root in the income gap time-series in the majority of these countries. On the other hand, the SUR-FADF test failed to reject the null hypothesis for all countries, except four countries, namely Brazil, South Korea, Nigeria and Singapore. It would imply that the FADF-SB test also identified the presence of unit root in the income gap time-series in the majority of these countries. In other words, both the SUR-ADF test and the SUR-FADF test pointed out that these fourteen countries seem to face the problem of MIT.

INSERT TABLE 3 ABOUT HERE

The empirical findings from six different unit root tests are summarised into Table 4. As the findings in the table indicated, four different unit root tests rejected the null hypothesis of a unit root in the income difference time-series for Singapore. It means that the time-series of income difference in this country is the least likely to contain the unit root. Three different unit root tests reject the null hypothesis of unit root for four countries, namely Brazil, Malaysia,

Nigeria and Saudi Arabia. It implies that the time-series of income differences in these three countries are less likely to contain the unit root. Two different unit root tests rejected the null hypothesis of a unit root in the income difference time-series for five countries, namely China, Hong Kong, Indonesia, South Korea and South Africa. It could be interpreted that the time-series of income difference in these five countries is neither more nor less likely to contain the unit root. Only one unit root test rejected the null hypothesis of a unit root in Mexico and Turkey. It means that the time-series of income difference in Mexico and Turkey is more likely to contain the unit root. No unit root test could reject the null hypothesis for the two countries, namely Argentina and India. It implies that the time-series of income difference in these countries is the most likely to contain the unit root.

This paper used the ten percent level of significance for empirical studies. If the five percent level of significance would be used for the empirical studies, there are minor discrepancies in the empirical findings. According to the five percent level of significance, four different unit root tests rejected the null hypothesis of a unit root in the income difference time-series for Singapore. Two different unit root tests reject the null hypothesis of unit root for five countries, namely Brazil, Malaysia, Nigeria, Saudi Arabia and South Africa. One unit root test rejected the null hypothesis of unit root for four countries, namely Indonesia, India, Mexico and Turkey. Despite these minor discrepancies in four countries, there are some consistencies in findings from different levels of significance.

INSERT TABLE 4 ABOUT

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In short, the findings showed some mixed results. According to the empirical findings, there are nine countries, namely Argentina, China, Hong Kong, Indonesia, India, South Korea, Mexico, South Africa and Turkey that would have a higher possibility to face the problem of MIT. On the other hand, there is one country (only Singapore) that would have a lower possibility to face the MIT problem. There are also the remaining four countries, namely Brazil,

Malaysia, Nigeria and Saudi Arabia that are uncertain whether these countries would face the problem of MIT.

4. Conclusion

This paper proposed a new testing procedure for the analysis of the middle-income trap (MIT) by means of some new unit root tests, which incorporate unknown nonlinearity/smooth breaks in each time series and cross-sectional dependency across panels of time series. These are the Fourier ADF with structural break (FADF-SB) and the Seemingly Unrelated Regressions Fourier ADF (SUR-FADF) unit root tests, respectively.

The empirical findings could be interpreted that there could be three groups of countries, which could be separated by the likelihood of a given country to face the MIT problem. Firstly, the first group, consisting of nine countries, includes Argentina, China, Hong Kong, Indonesia, India, South Korea, Mexico, South Africa and Turkey. These countries could be considered as MIT countries, given that they appear to be more likely to face the MIT problem. In other words, empirical findings indicate that these nine countries could achieve a high level of economic growth when they were at low-income level. However, their income level would be stagnated at the middle-income level. Secondly, the second group, consisting of just Singapore, could be considered as non-MIT (NMIT) country, given that it is less likely to face the MIT problem. In other words, empirical findings indicate that this country successfully achieved high economic growth at the low-income level and its income level would be further improved at the middle-income level. Thirdly, the final group consists of four countries, namely Brazil, Malaysia, Nigeria and Saudi Arabia. These are countries with no clarity as to whether they would face the MIT or NMIT problem. In other words, empirical findings could not offer unambiguous findings for these countries whether they will face the MIT problem or may overcome the MIT problem by continuing high-income growth at the middle-income level.

The empirical findings from the new unit root test gave mixed results; classifying nine countries as having a relatively higher possibility to face the MIT problem, one country as having a relatively lower possibility to face the problem, while the remaining four countries do not show consistent stances of whether, or not, they would face the problem of MIT. These findings are largely consistent with previous empirical findings that Singapore is least likely to face the problem of MIT, Malaysia and Saudi Arabia are less likely to face the MIT problem, Indonesia and India are more likely to face the MIT problem (Ha and Lee, 2016). Furthermore, current empirical findings confirmed the previous study that Singapore successfully escaped the MIT problem (Saner at al., 2014).

There are three main policy implications. Firstly, policymakers in the nine MIT countries, namely Argentina, China, Hong Kong, Indonesia, India, South Korea, Mexico, South Africa, and Turkey, may need to understand the dangers of income divergence between their countries and high-income countries. In other words, they may need to come up with appropriate economic policies to stimulate economic growth in order to escape from the MIT problem. More specifically, they may need to encourage innovation activities in order to stimulate economic growth in the long run. Secondly, the policymakers in Singapore may need to take a measure to ensure the sustainability of the income convergence between their country and high-income country. They may need to take appropriate policies to encourage further innovation activities or build better infrastructure in order to sustain long-run economic growth. Thirdly, the policymaker in the remaining four countries, namely Brazil, Malaysia, Nigeria and Saudi Arabia, may need to be aware of the possibility of relapsing to become an MIT country. In other words, without appropriate policy, these countries could easily reverse back to a situation in which there would be a wider income gap between their country and high-income country. More importantly, these countries also may invest more money for the R&D and innovation activities in order to stimulate economic growth.

This paper used some innovative testing procedures for the analysis of the MIT. The main problem of this study is the lack of sufficient data on the income level. Future studies may re-examine this phenomenon using quarterly data or longer historical data on per capita income. Future studies may employ a fractional unit root test for the analysis of the MIT. The findings from these studies could offer valuable insight into the thorny issue of MIT and a well thought out policy to escape from this trap.

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Table 1: Findings from the ADF test and FADF test

Country	*ADF statistics*	*K*	*FADF statistics*
Argentina	-1.709	1	-3.113
Brazil	-2.992	1	-1.465
China	-2.215	1	-2.886
Hong Kong	-1.918	2	-2.525
Indonesia	-2.696	2	-3.326
India	-0.400	1	-2.365
South Korea	-0.550	1	-3.301
Mexico	-2.941	1	-3.225
Malaysia	-3.361*	2	-3.258
Nigeria	-1.388	1	-3.711
Saudi Arabia	-2.869	1	-4.532**
Singapore	-3.103	1	-3.731
South Africa	-1.258	1	-3.634
Turkey	-0.755	1	-2.839

Notes: * indicates significance at the ten percent level; ** indicates significance at the five percent level; *** indicates significance at the one percent level. *K* is the frequency for the Fourier approximation function; Critical values for the ADF test and the FADF test are obtained from Furuoka (2017a)

Table 2: Findings from the ADF-SB and the FADF-SB test

Countries	*TB*	*ADF-SB statistics*	*TB*	*K*	*FADF-SB statistics*
Argentina	2005 [76]	-3.466	2006 [78]	2	-3.974
Brazil	2006 [78]	-4.372**	1980 [26]	2	-4.929**
China	1975 [16]	-3.545**	1975 [16]	2	-4.094*
Hong Kong	1997 [60]	-3.559*	1997 [60]	1	-4.566*
Indonesia	1997 [60]	-5.082***	1997 [60]	1	-6.697***
India	2005 [76]	-1.591	1971 [8]	1	-3.656
South Korea	1985 [36]	-2.008	1997 [60]	1	-4.062
Mexico	1985 [36]	-2.008	1985 [36]	1	-5.793***
Malaysia	1997 [60]	-3.803***	1997 [60]	2	-5.239**
Nigeria	1980 [26]	-4.084**	1980 [26]	2	-5.787***
Saudi Arabia	1981 [28]	-8.773***	1982 [30]	2	-9.527***
Singapore	1997 [60]	-4.435**	1997 [60]	2	-4.787**
South Africa	2005 [76]	-3.265	2014 [94]	1	-4.924**
Turkey	2010 [86]	-2.874	1998 [62]	1	-4.835**

Notes: Numbers in bracket indicate the break-point (λ); * indicates significance at the ten percent level;
** indicates significance at the five percent level; *** indicates significance at the one percent level;
TB indicates time-series breakpoint; *K* is the frequency for the Fourier approximation function;
Critical values for the ADF-SB test and the FADF-SB test are obtained from Furuoka (2017a).

Table 3: Findings from the SUR-ADF test and SUR-FADF test

Country	*SUR-ADF statistics*	*SUR-FADF statistics*
Argentina	-2.316	-2.827
Brazil	-2.259	-3.834*
China	0.820	-0.178
Hong Kong	-2.186	-1.725
Indonesia	-0.229	-0.840
India	2.548	0.189
South Korea	-4.777**	-3.949*
Mexico	-1.325	-3.775
Malaysia	-0.802	-1.309
Nigeria	-3.298	-3.998*
Saudi Arabia	-2.091	-3.275
Singapore	-3.637**	-4.086***
South Africa	-3.448**	-1.683
Turkey	-0.481	-1.406

Notes: * indicates significance at the ten percent level; ** indicates significance at the five percent level; *** indicates significance at the one percent level. Critical values for the SUR-ADF test are obtained from Breuer *et al.* (2002) and those of the SUR-FADF test are obtained from Furuoka (2017b).

Table 4: Summary of empirical findings

Country	*ADF*	*FADF*	*ADF-SB*	*FADF-SB*	*SUR-ADF*	*SUR-FADF*
Argentina	MIT	MIT	MIT	MIT	MIT	MIT
Brazil	MIT	MIT	No MIT	No MIT	MIT	No MIT
China	MIT	MIT	No MIT	No MIT	MIT	MIT
Hong Kong	MIT	MIT	No MIT	No MIT	MIT	MIT
Indonesia	MIT	MIT	No MIT	No MIT	MIT	MIT
India	MIT	MIT	MIT	MIT	MIT	MIT
South Korea	MIT	MIT	MIT	MIT	No MIT	No MIT
Mexico	MIT	MIT	MIT	No MIT	MIT	MIT
Malaysia	No MIT	MIT	No MIT	No MIT	MIT	MIT
Nigeria	MIT	MIT	No MIT	No MIT	MIT	No MIT
Saudi Arabia	MIT	No MIT	No MIT	No MIT	MIT	MIT
Singapore	MIT	MIT	No MIT	No MIT	No MIT	No MIT
South Africa	MIT	MIT	MIT	No MIT	No MIT	MIT
Turkey	MIT	MIT	MIT	No MIT	MIT	MIT

Notes: MIT means the presence of the middle-income trap; No MIT means the absence of the middle-income trap