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Productivity Growth Recovery Mechanisms: An ARDL Approach Lessons from the United States, Japan and South Korea

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Abstract

Productivity growth is an essential ingredient for achieving long-term economic growth and sustainable development. In the absence of such growth, economic growth is not achievable. Accordingly, this paper examines economic resilience through multiple productivity channels within the United States, Japan and South Korea. Adopting a Kaleckian post-Keynesian approach, productivity growth is constructed as a function of investment, capacity utilisation, indicators of financial development, and an indicator of fiscal policy. Utilising annual historical data from 1980-2019, this paper adopts Autoregressive Distributed Lag (ARDL) models, Vector Autoregressive-based Impulse Response Functions (IRF) and Variance Decompositions (VD) to examine the resilience of productivity growth through the speeds of adjustment after an external shock. Results show that long and short-run unidirectional causality between productivity growth and the explanatory variables exists amongst all economies through the error-correction terms (ECT) and ARDL models. When imposing a simulated one-time S.D. shock upon the explanatory variables, differing speeds of adjustment and recovery processes in the long-run are present. As such, the strength of causal relationships amongst productivity growth and the explanatory variables ultimately affects speeds of adjustment and hence recovery.

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Keywords: Economic Resilience, Productivity Growth, Kaleckian post-Keynesian, Autoregressive Distributed Lag (ARDL), Impulse Response Functions (IRF), Variance Decomposition (VD).

1 Introduction

While productivity measures how efficiently an economy operates, such a measure is considered a strong determinator of long-run economic growth (Productivity Commission, 2009). Total factor productivity (TFP), measuring how much output is produced from a certain level of inputs, has significantly slowed in advanced economies since the early 1970s, contributed by the slowing of human capital accumulation, aging populations, structural transformation limits and capital misallocations (Wronski, 2019). In addition to this, global economic growth has been destabilised by several exogenous shocks over the last couple of decades, including the commodity crisis, Global Financial Crisis (GFC) and COVID-19, to name a few.

As shown in Bolt et al. (2018), productivity growth in the United States has steadily slowed since the 1970s, with the total number of hours worked today the same as a century ago. Output per capita has

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grown more than six-fold, substantially increasing living standards through new technological innovations. Regardless, the pace of outputs per hour has grown by only 1.4% between 2004-2018, half the pace in the 30 years post World War II. As such, changes in labour composition and capital were incapable of driving labour productivity growth through the addition of machines, education, and training in the long-run. Regardless, the global decline in labour productivity growth suggests that the previous factors were unlikely to be responsible (Moss et al., 2020). Regardless, labour productivity growth within the United States has grown slightly faster than other mature economies as of 2019, while TFP simultaneously declined, reducing from 0.8% growth in periods 2000-2007, to -0.3% in 2018 (The Conference Board, 2019).

Japan has experienced a slowdown in productivity growth since the 1990s due to a shrinking and rapidly aging population, decreasing labour inputs, technological stagnation and decelerated investments towards intangible assets (Nakamura et al., 2018). Regardless, Japan exhibited strong labour market growth in 2019, in combination with weak output growth conditions. Growth in output per hour worked averaged 1% annually until 2019, with TFP declining -1.4% in 2018 (The Conference Board, 2019). South Korea, being heavily dependent upon key growth-leading manufacturing industries with the promotion of light industry in the 1960s, heavy machinery and chemical industries in the 1970s, has also experienced a downward trend in productivity growth post-1970 (Pai, 2016). While regarded as a mature economy, South Korea has shown strong output per hour worked growth rates prior to 2019, despite TFP growth rates falling 1.4% from 2000-2007 to 2018 (The Conference Board, 2019).

The selected economies form part of the Asia-Pacific Economic Cooperation (APEC). This 21-member based platform aims to create greater prosperity for the regions' people by promoting balanced, sustainable, innovative, secure and inclusive growth by accelerating regional economic integration (APEC, 2021). Each economy is unique, presenting an opportunity to test and compare productivity growth recovery mechanisms. In exploring shock absorbing/counteracting factors of the selected economies, Briguglio et al. (2005) provides a resilience index, relating such factors via social development, good governance, microeconomic market and macroeconomic stability. Of the 102 countries analysed, the United States was ranked the 5th most resilient economy in 2001-2003, Japan ranked 25th, and South Korea held no tested ranking. With the United States and Japan exhibiting a vast difference in resilience during the periods and South Korea holding no ranking, each economy presents an opportunity to extend testing periods to test the strength, adaptability, and absorbability of productivity growth towards exogenous shocks. Also, private and government decision-makers could benefit from understanding the causal relationships between productivity growth and the explanatory variables.

Following Bhaduri and Marglin (1990) and Stockhammer and Onaran (2004), who place the functions of investment and capacity utilisation as determining factors of productivity growth as derived from the works of Michael Kalecki within a Kaleckian post-Keynesian framework, this paper intends to augment such a model through the inclusion of financial development and fiscal policy indicators. Such augmentation is inspired by Chaiechi (2012) works, who provided evidence that the incorporation of financial development and fiscal policy within such a framework has been largely ignored within the literature. As such, the aims of this study are to: (1) estimate and analyse the impacts of financial development (*fd*) and fiscal policy (*fp*) within a Kaleckian post-Keynesian macroeconomic framework, and (2) explore the resilience of productivity growth against exogenous shocks. Accordingly, the structure of the article is as follows: section 2 provides an overview of the literature, section 3 discusses the empirical model, section 4 and 5 provides a description of the data sources and methodology, section 6 analyses the estimation techniques and results, and section 7 summarises the main findings of the paper through a discussion and conclusion.

2 Literature Review

Throughout history, economic schools of thought have provided differing viewpoints as to the influence of productivity growth. Classical growth theory postulates that economic growth is hampered by a combination of limited resources and population increases while ignoring the role of advancements in technical processes (TP), being one instrument to induce productivity growth, while also assuming total wages do not shift away from subsistence levels (see Smith 1776; Malthus 1806; and Ricardo 1817 as pioneering work). Counter to this, neoclassical growth models postulate that economic growth is simulated via three economic forces: capital, technology and labour. The Solow-Swan model presents the simplest version, as introduced within exogenous growth theory via Solow and Swan (1956), adding labour as a factor of production and defining diminishing returns of labour and capital as separate, introducing a time-varying variable in the form of technology through constant returns to scale. The capital-output and capital-labour ratios are not fixed within the model, allowing for any increase of capital intensity to be uniquely distinguished from any technological processes. In an opposing view, endogenous growth theory explains the overall process of long-run economic growth, arguing that technical change and factors of production can positively influence growth. Relaxing the assumption of diminishing returns to capital, a set of long-run economic models were created to explain this process endogenously (Parjiono, 2009).

In exploring the concept of economic resilience, Chaiechi and Nguyen (2021) argue that since classical economics is primarily concerned with equilibrium conditions, such a framework is not suitable, instead suggesting that post-Keynesian economics provides a more appropriate approach. The established methods and frameworks for out-of-equilibrium phenomena in contemporary economic theories are commonly utilised in the works of post-Keynesian economists. While post-Keynesian distribution growth theorists developed different methods to endogenise technical change, Kaldor (see Kaldor, 1957 & 1961 as pioneering work) endorses a technical progress function, whereby productivity growth is positively affected by capital stock and intensity. In later works, Kaldor (1966) applies Verdoorns' law (see Verdoorn, 1949), whereby the growth rate of labour productivity positively affects output growth, explained by economies of scale. While Kalecki emphasised the importance of technical progress via investment frameworks (see Kalecki, 1968), little was written regarding the determinants of such progress, referring to such progressions as 'semi-autonomous' and 'exogenous' in nature.

In overcoming this barrier, Bhaduri and Marglin (1990) and Stockhammer and Onaran (2004) follow Kaldorian lines in establishing a productivity growth model, determined by the functions of investment and capacity utilisation. Derived from the works of Kalecki and Kaleckian debates, both functions are placed within a Kaleckian post-Keynesian framework. In such a model, technical progress is implemented via new machinery and hence investment, increasing the ratio of capital/labour, whereby capacity utilisation is determined by the extent to which existing machinery is utilised, influencing the measurement of labour productivity. As such, Kaldor's productivity growth model has been well-received due to its analytical tractability, alongside its ability to reproduce the salient features found in long-run growth (Duernecker et al., 2020). Kaldor summarised the growth model through the following indicators: growth rates of real GDP per worker and real capital per work exhibit no trend, the gross return of capital, the capital-to-output ratio, and the GDP share of payments to capital exhibit no trend growth.

As highlighted previously, this paper firstly sets to augment a Kaleckian post-Keynesian productivity growth model by incorporating financial development and fiscal policy indicators. Financial development can positively influence productivity growth by increasing the marginal productivity of capital (Goldsmith, 1969) and improve capital allocation efficiencies, resulting in increases in savings and investment (McKinnon, 1973 & Shaw, 1973). Investigating the impact of financial development upon productivity growth, Demmou et al. (2019) found non-uniformity across the sectors, depending upon country-specific institutional settings and characteristics such as financial structure, external dependence on financing and intangible asset intensity, utilising an empirical analysis towards a panel of 32 countries and 30 industries during periods 1990-2014.

Government expenditure is found to hold either a positive or negative causal relationship with productivity growth. In the way of positive causal effects, Kaldor (1966) argues that a high utilisation rate positively influences long-run productivity growth. Myrdal (1960) argues that greater government involvement can influence economic growth and reduce inequalities. Arguments towards adverse influences include the crowding out of private investment and production, alongside institutional sclerosis and rent-seeking (Hansson & Henrekson, 1994). Hansson and Henrekson conclude that government expenditure did not affect productivity growth in 14 OECD countries between 1965-1987. On the contrary, Chu et al. (2020) examined the compositions of government expenditure from 37 high-income and 22 low-to-middle-income economies from periods 1993-2012. The authors find high-income economies that shift government expenditure towards more productive means held a positive relationship with economic growth, with 39% of total spending in high-income countries focused on non-productive components.

Secondly, this paper intends to explore productivity growth impacts from external simulated industry/country shocks, utilising time-series analysis and estimation techniques. In reviewing the causes of the slowdown of labour productivity in the United States during periods 2005-2020, Moss et al. (2020) provide detailed explanations of the causes, including the mismeasurement of productivity growth, a shifting industry mix, limits to innovation/productivity growth, recession hangovers, insufficient R&D, infrastructure/public capital implications, challenges to intellectual property, regulation impediments, decreased market competition, the slowing of human capital and finally labour force growth. The authors provide policy recommendations towards restarting innovation and productivity growth within the United States, including focused macroeconomic policies to reach full employment, reversing declining R&D/public capital spending, improving intellectual property systems, removing regulations that hamper growth, and improving educational and training mechanisms.

In summarising Japan's productivity growth in the long-run, Nakamura et al. (2018) argue that encouraging flexible reallocation of resources such as labour and capital would improve such growth. In analysing the slowdown in TFP growth in Japan, through the role of damaged balance sheets of non-financial firms and intermediaries due to the banking crisis shocks of the 1990s, Muto et al. (2016) show that productivity growth holds poor resilience towards exogenous shocks. In examining the resilience of productivity growth in South Korea towards exogenous shocks during periods 1995-2012 of 37 key manufacturing industries after two financial crises, Pai (2016) finds TFP growth was driven mainly by technical processes (TP). As such, deteriorating technical efficiencies proved to affect TFP growth and allocation inefficiencies negatively. In terms of TP, 36 of the 37 manufacturing industries proved to be resilient after the Asian Financial Crisis (AFC) and Global Financial Crisis (GFC). The empirical results showed that the steadily high rate of TP was the driving force behind the resilience of TFP growth in 21 growth-leading industries.

In concluding this section, while the literature makes clear that all three selected economies have experienced a downturn in productivity growth from the 1970s onwards, due to various forces, financial development and fiscal policy have been shown to influence productivity growth. As such, the augmentation of the Kaleckian post-Keynesian macroeconomic framework to incorporate such indicators is of interest in this study, alongside exploring the resilience of productivity growth against exogenous shocks. Such a study will provide unique empirical and theoretical contributions, providing implications for policymakers and professional practitioners.

3 The Empirical Model

Following Kaldorian lines, Bhaduri and Marglin (1990) and Stockhammer and Onaran (2004) model the growth of labour productivity as a function of investment and capacity utilisation. Technical progress is implemented via new machinery, resulting in investment, which increases productivity growth (Chaiechi, 2012). Capacity utilisation is determined by the utilisation factors of existing machinery, hence allowing for the measurement of labour productivity. If a company exhibits less than 100% utilisation, production increases can be achieved without increasing production expenses (Dutt, 1995). This paper will incorporate the indicators of financial development (*fd*) and fiscal policy (*fp*) in extending such a model. Capturing the exogenous technical process as τ_0, such a model is presented as:

Productivity Growth: $$pg_t = \tau_0 + \tau_1 I_t + \tau_2 ut_t + \tau_3 fd_t + \tau_4 fp_t + \varepsilon_t, \qquad \text{(Eq 1)}$$

pg_t: Productivity growth (i)
I_t: Investment (ii)
ut_t: Capacity utilisation (iii)
fd_t: Financial development indicator (vi)
fp_t: Fiscal policy indicator (v)
ε_t: Random disturbance term with certain properties
τ_i, i = 0, 1, 2, 3, and 4 are unknown parameters to be estimated
t: Time index

The dependant variable, productivity growth, is calculated through the *K/L* ratio, whereby *K* is the stock of capital and *L* is labour. Investment is calculated as a ratio of *I/Y*, whereby *Y* is nominal GDP. Following Dutt (1992), capacity utilisation will be calculated as the ratio of *Y/K*. Financial development will be defined via the following indicators: 1) stock market turnover ratio (SMTR), calculated as the total value of shares traded during the period divided by average market capitalisation, measuring the concentration, volatility, size and impacts upon the real sector (El-Wassal, 2005), 2) monetisation ratio (MR) calculated as M2/*Y*, measuring the depth of money supply within the economy and 3) domestic credit (DC) calculated as private sector credit, expressed as *DC/Y*, often incorporated to analyse the 'backflow of financial resources to corporate sectors' (Liebscher et al., 2006). Fiscal policy is defined as government expenditure (GE), expressed as *GE/Y*. The original indicators hold a positive relationship towards productivity growth, while financial development and fiscal policy can hold either sign. While the monetisation ratio and domestic credit are considered more traditional measures of financial development, stock market turnover provides a more intuitive measure of capturing such developments.

4 Data Sources

Relevant annualised data sets were obtained from the trusted sources as described in Table 1, during periods 1980–2019, yielding 40 observations. Descriptive statistics for all variables are shown via Appendix 1. While most data sources, such as the World Bank and the Penn World Table, offer pre-calculated data sets, some required manual calculation, including investment, capacity utilisation, and productivity growth. The Global Financial Development Database, via the World Bank, offers data sets for a listed group of financial development indicators. While the database contains characteristics for 214 economies, analysing 109 distinct indicators individually, only a small selection spanned the full length of this study. All data sets were analysed via EViews 10 software, considered one of the most prevalent packages available for econometrics and time-series analysis.

Table 1: Data Sources. 1980-2019

Variables	Calculation	Data Sources
Productivity Growth	Stock of Capital/Labour Ratio	IMF Fiscal Affairs Department, World Development Indicators: World Bank, Penn World Table
Investment	Investment/Nominal GDP Ratio	World Development Indicators: World Bank
Capacity Utilisation	Nominal GDP/Stock of Capital Ratio	World Development Indicators: World Bank, IMF Fiscal Affairs Department
Financial Development Indicator: Stock Market Turnover Ratio (SMTR)	Total Value of Shares Traded/Average Market Capitalisation Ratio	World Development Indicators: World Bank
Financial Development Indicator: Monetisation Ratio (M.R.)	M.R./Nominal GDP Ratio	World Development Indicators: World Bank
Financial Development Indicator: Domestic Credit (D.C.)	D.C./Nominal GDP Ratio	World Development Indicators: World Bank
Fiscal Policy Indicator	Government Expenditure/Nominal GDP Ratio	World Development Indicators: World Bank
Nominal GDP	Nominal Gross Domestic Product (NGDP)	World Development Indicators: World Bank

5 Methods

This paper adopts Auto-Regressive Distributed Lag (ARDL) modelling, as introduced by Pesaran et al. (1996), Pesaran and Pesaran (1997), and Pesaran and Shin (1995 & 1999). The ARDL method contains advantages of use, including the ability to incorporate small sample sizes, allowing for various lag lengths in a single model equation, the distinction between dependent and explanatory variables through a simple linear formulation of the derived error correction model (ECM), and the non-requirement of unit-root testing in the pretesting phase (Narayan & Smyth 2005). Narayan and Smyth (2005), Narayan and Narayan (2006), and Pan and Mishra (2018) propose the following steps: (1) establishing the existence of a long-run relationship via the F-test, (2) long-run estimation, and (3) ECM and short-run dynamic estimation. Pesaran and Shin (1995 & 1999) describe the F-test as a non-standard distribution, dependent upon a regression number, whereby the model contains *I(0)* or *I(1)* series and trend and/or intercept identification. The null hypothesis of no cointegration against the alternative of the existence of cointegration is tested via the critical bounds test (Narayan & Smyth, 2005). If the F-statistic is higher than the upper bound, the null of no cointegration is rejected. In such a case step two is introduced, whereby the appropriate lags are selected, and the selected model is estimated by ordinary least squared techniques (Narayan & Smyth, 2005). The ARDL approach to cointegration requires estimating the ECM, as per Pesaran et al. (2001). Productivity growth and its determinates can be defined as, where j = (1, 2, 3, 4):

$$\Delta PG_t = \tau_0 + \sum_{i=1}^{n} \tau_{ji}\, \Delta PG_{t-i} + \sum_{i=0}^{n} \tau_{ji}\, \Delta UT_{t-i} + \sum_{i=0}^{n} \tau_{ji}\, \Delta fd_{t-i} + \sum_{i=0}^{n} \tau_{ji}\, \Delta fp_{t-i} + \tau_5 PG_{t-1} + a_6 UT_{t-1} + a_7 fd_{t-1} + a_8 fp_{t-1} + \varepsilon_t. \quad \text{(Eq 2)}$$

Following Narayan and Smyth (2005) and Narayan and Narayan (2006), each variable is placed as the dependent by estimating the unrestricted error correction regressions. If only one cointegrating relationship exists, the F-test indicates which variable should be normalised and reported. Pearsons' bound F-test is incorporated upon equation (2) in testing whether a long-run relationship exists. The null hypothesis of no cointegration contained within the variables is H_0: $a_5 = a_6 = a_7 = a_8 = 0$ against the alternative of H_1: $a_5 \neq a_6 \neq a_7 \neq a_8 \neq 0$. If the F-statistic falls outside the upper critical bound, evidence of a long-run relationship exists. If the F-statistic falls below the critical bound, there is no evidence of a long-run relationship, i.e., no cointegration. If the F-statistic falls within the lower and upper bounds, an inconclusive result is evident. If cointegration exists, an ARDL(*m, n, p, q*) model can be described as:

$$PG_t = \tau_0 + \sum_{i=1}^{m} \tau_1\, PG_{t-i} + \sum_{i=0}^{n} \tau_2\, UT_{t-i} + \sum_{i=0}^{p} \tau_3\, fd_{t-i} + \sum_{i=0}^{q} \tau_4\, fp_{t-i} + \varepsilon_t. \quad \text{(Eq 3)}$$

The model is then estimated by the ordinary least squared method, whereby the short-run dynamics can be derived by the construction of the productivity growth model via the following ECM:

$$\Delta PG_t = \beta_0 + \sum_{i=1}^{n} \beta_1\, \Delta PG_{t-i} + \sum_{i=0}^{n} \beta_2\, \Delta UT_{t-i} + \sum_{i=0}^{n} \beta_3\, \Delta fp_{t-i} + \sum_{i=0}^{n} \beta_4\, \Delta fd_{t-i} + \theta ECM_{t-1} + \varepsilon_t, \quad \text{(Eq 4)}$$

whereby the ECM can be defined as:

$$ECM_t = PG_t - \tau_0 - \sum_{i=1}^{m} \tau_1\, PG_{t-i} - \sum_{i=0}^{n} \tau_2\, UT_{t-i} - \sum_{i=0}^{p} \tau_3\, fd_{t-i} - \sum_{i=0}^{q} \tau_4\, fp_{t-i}. \quad \text{(Eq 5)}$$

The short-run dynamics are illustrated via equation (4) coefficients, showing the convergence to the equilibrium through the speed of adjustment via the ECM.

6 Estimation Techniques and Results

Utilising EViews 10 software, this paper adopts time-series analysis techniques and processes, including preliminary tests for stationarity, lag selection, cointegration, along with ARDL models. Furthermore, to capture productivity growths' resilience against external shocks, IRFs and VDs are adopted.

6.1 Selected Model Equations

In selecting the *fd* indicator for each economy, five indicators were tested through variable addition and omission processes via econometric analysis. The selected *fd* indicators for analysis included the three previously mentioned, alongside credit to government and state-owned enterprises and liquid liabilities. As such, stock market turnover was incorporated for the model equation of United States, the monetisation ratio for Japan and domestic credit for South Korea. Each selected *fd* was based upon economic theory, coefficient significance, the goodness of fit and model stability. Each of the equations was tested utilising the Hendry (1993) "General to Specific Approach" to obtain model equations that contain parsimonious specifications. The selected model equations are illustrated in Table 2.

Table 2: Selected Model Equations

Productivity Growth	Model No.	Equation
United States	(1)	PG = *f*(INV, UT, SMTR, GE)
Japan	(2)	PG = *f*(INV, UT, MR, GE)
South Korea	(3)	PG = *f*(INV, UT, DC, GE)

1 = Model one, 2 = Model two, 3 = Model three. PG = Productivity Growth, INV = Investment, UT = Capacity Utilisation, SMTR = Stock Market Turnover Ratio, MR = Monetisation Ratio, DC = Domestic Credit, GE = Government Expenditure.

6.2 Testing for Stationarity

Prior to cointegration testing, unit-root testing is of interest, whereby the results are shown in Appendix 2. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) testing methods analysed whether the series are stationary at the 10% level. Each method holds advantages and disadvantages, with the ADF utilising a simpler method that is valid in the presence of serial correlation of unknown forms, while PP tests are non-parametric unit-root tests that are corrected for serial correlation and heteroskedasticity (Dickey-Fuller, 1979 & 1981; Phillips-Perron, 1988). While the results show slight conflict between the ADF and PP unit-root testing methods, both methods show no *I(2)* series, thus satisfying the previously discussed requirement of the ARDL process.

6.3 Lag Length Selection

The selected productivity growth model equations (1), (2) and (3) in Table 2 first require undergoing a lag selection process prior to cointegration testing. Table 3 illustrates the selected lag lengths for all economies, showing that a lag of 3 is selected utilising the AIC criteria. Any more included lags could result in the possible consequence of multicollinearity, serial correlation within the error terms and misspecification errors, implemented by a loss in the degrees of freedom.

Table 3: VAR Lag Lengths Productivity Growth Model Equation: Lags 3

United States						
PG = *f*(INV, UT, SMTR, GE)						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	372.29	NA	0.00	-19.85	-19.64	-19.78
1	564.63	322.30	0.00	-28.90	-27.59*	-28.43*
2	591.98	38.43*	1.87e-19*	-29.03	-26.63	-28.18
3	619.65	31.41	0.00	-29.17*	-25.69	-27.94
Japan						
PG = *f*(INV, UT, MR, GE)						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**

0	442.32	NA	0.00	-23.64	-23.42	-23.56
1	561.37	199.49*	2.34e-19*	-28.72	-27.41*	-28.26*
2	583.76	31.47	0.00	-28.58	-26.19	-27.74
3	613.73	34.02	0.00	-28.85*	-25.37	-27.62
South Korea						
PG = *f*(INV, UT, DC, GE)						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	297.87	NA	0.00	-15.83	-15.61	-15.75
1	446.43	248.94	0.00	-22.51	-21.20*	-22.04*
2	473.90	38.60*	1.11e-16*	-22.64	-20.25	-21.80
3	501.46	31.29	0.00	-22.78*	-19.30	-21.55

* Indicates lag order selected by the criterion. PG = Productivity Growth, INV = Investment, UT = Capacity Utilisation, SMTR = Stock Market Turnover Ratio, MR = Monetisation Ratio, DC = Domestic Credit, GE = Government Expenditure. AIC = Akaike criterion, SC = Schwarz information criterion, HQ = Hannan and Quinn information criterion.

6.4 F-Statistic

The ARDL process requires testing for long-run relationships between the explanatory variables and productivity growth. As the series contain 40 observations, this paper utilises the Narayan (2004) finite sample critical bounds test. Illustrated in Table 4, all F-statistics show results above the *I(1)* critical bound of 5.45 at the 1% level. The null hypothesis of no cointegration cannot be accepted for all model equations, meaning there are cointegrating relationships.

Table 4: F-Statistic of Cointegration Relationship

Country	Model No.	Model Equation	ARDL Model	F-Stat	CB 1%	Result
United States	(1)	PG = *f*(INV, UT, SMTR, GE)	(3, 3, 3, 3, 3)	5.70***	I(0): 3.96 I(1): 5.45	Cointegration
Japan	(2)	PG = *f*(INV, UT, MR, GE)	(1, 2, 1, 0, 2)	8.88***	I(0): 3.96 I(1): 5.45	Cointegration
South Korea	(3)	PG = *f*(INV, UT, DC, GE)	(3, 2, 2, 2, 2)	12.36***	I(0): 3.96 I(1): 5.45	Cointegration

Null Hypothesis: No levels relationship. 1 = Model one, 2 = Model two, 3 = Model three. F-statistic based on Narayan (2004), where *** Significant at 1%, ** Significant at 5%, * Significant at 10%. CB 1% = Critical bounds at 1%. PG = Productivity Growth, INV = Investment, UT = Capacity Utilisation, SMTR = Stock Market Turnover Ratio, MR = Monetisation Ratio, DC = Domestic Credit, GE = Government Expenditure.

6.5 Long-term dynamics: an ARDL analysis

Long-run coefficients and their empirical results are presented in Table 5. Interpretation of the estimated coefficients can be described simply; for example, the United States data shows that a 1% increase in investment leads to an 0.99% increase in productivity growth in the long-run, at the 1% statistical significance level. Other long-run coefficients via the United States data shows statistically significant coefficients throughout, with stock market turnover the only indicator showing a negative unidirectional causal relationship towards productivity growth. Japan data shows individual positive long-run statistical significance amongst all coefficients, besides government expenditure. South Korea data shows, as a whole, less statistically significant coefficients, with capacity utilisation showing positive significance, while government expenditure shows negative causality towards productivity growth.

Table 5: Long-Run Model. Dependent Variable: Productivity Growth

Coefficients	1 - United States	t-Stat.	2 - Japan	t-Stat.	3 - South Korea	t-Stat.
INV	0.99***	4.24	0.46***	4.50	-0.25	-0.98
UT	0.18**	2.21	1.16***	6.31	0.93*	2.05
SMTR	-0.02**	-2.79				
DC					0.09	1.37
MR			0.02*	2.38		
GE	0.41**	2.31	-0.01	-0.12	-1.10***	-2.94
C	-0.32***	-2.93	-0.54***	-11.14		

*** Significant at 1%, ** Significant at 5%, * Significant at 10%. 1 = Model one, 2 = Model two, 3 = Model three. INV = Investment, UT = Capacity Utilisation, SMTR = Stock Market Turnover Ratio, DC = Domestic Credit, MR = Monetisation Ratio, GE = Government Expenditure.

6.6 Short-run dynamics: an ARDL analysis

Short-run coefficients and their empirical results are presented in Table 6. The ECT for model equation 1, the United States, shows the speed to which the model returns to equilibrium following an exogenous shock, whereby 93% of departures from long-run equilibrium is corrected in each period, being annual, after some disturbance in the system. As such, joint unidirectional long-run causality running from the explanatory variables towards productivity growth exists. At the 10% level, the short-run lagged dynamics towards productivity growth for United States data can be interpreted as follows: investment in absolute terms of the non-lagged, first and secondary-order lags hold negative statistical significance while the non-lagged coefficient shows a significant yet positive relationship, capacity utilisation holds negative statistical significance, stock market turnover holds weak positive and negative significance between non-lagged and lagged coefficients, and government expenditure holds negative significance at lag one, counter to the long-run result.

Table 6: Error-correction Model. Dependent Variable: Productivity Growth.

Coefficients	1 - United States	t-Stat.	2 - Japan	t-Stat.	3 - South Korea	t-Stat.
ECT	**-0.93*** **	**-6.66**	**-0.94*** **	**-7.95**	**-0.75*** **	**-6.37**
D(PG(-1))	0.14	1.21			-0.41***	-5.35
D(PG(-2))	0.02	0.64			-0.23***	-3.82
D(INV)	1.75***	6.16	0.05	0.34	-0.47	-1.69
D(INV(-1))	-0.81**	-2.60	-0.59***	-3.80	0.54*	1.97
D(INV(-2))	-1.09***	-3.19				
D(UT)	-1.68***	-8.82	0.17	0.55	-1.70***	-7.78
D(UT(-1))	-0.20	-0.54			-0.63*	-1.80
D(UT(-2))	-0.16	-0.66				
D(SMTR)	-0.01**	-2.17				
D(SMTR(-1))	0.00	-0.17				
D(SMTR(-2))	0.01***	3.44				
D(DC)					-0.16**	-2.44
D(DC(-1))					0.08	1.29
D(GE)	0.12	0.62	-0.31**	-2.30	-0.22	-0.80
D(GE(-1))	-0.67***	-3.30	-0.33**	-2.68	0.03	0.12
D(GE(-2))	-0.20	-1.04				
The Goodness of Fit and Diagnostic Tests						
	1 - United States		**2 - Japan**		**3 - South Korea**	
Adj. R	0.91		0.71		0.84	

S.E.	0.00	0.01	0.02
LM test	0.06	0.13	0.08
Normality	0.40	0.78	0.54
ARCH test	0.08	0.40	0.05
RESET	0.36	0.72	0.11
CUSUM		No structural Break	
CUSUM. SQ		No structural Break	

*** Significant at 1%, ** Significant at 5%, * Significant at 10%. LM test is the F-statistic of Breusch-Godfrey test for serial correlation, normality test is the Jarque-Bera statistic test for normality, ARCH test is the F-statistic of White heteroskedasticity testing, RESET test is the Ramsey regression specification error test, CUSUM test is the cumulative sum control chart test, CUSUMSQ test is the cumulative sum squared test. ECT = Error-correction Term, D(PG) = Differenced Productivity Growth, D(INV) = Differenced Investment, D(UT) = Differenced Capacity Utilisation, D(SMTR) = Differenced Stock Market Turnover Ratio, D(DC) = Differenced Domestic Credit, D(GE) = Differenced Government Expenditure.

Japan data shows the least inclusive short-run parsimonious model. However, it displays the strongest ECT. Investment and government expenditure are the only significant coefficients, showing a negative yet significant causal unidirectional relationship towards productivity growth. As estimated via EViews 10, the parsimonious model shows that the non-inclusion of the explanatory variables indicates the non-presence of statistical significance for Japan's data. South Korea data also shows a strong ECT result, with a more inclusive parsimonious model when compared to Japan. In line with Japan data, overall short-run coefficient results differ from the long-run results. All short-run models pass diagnostic tests for serial correlation, normality, omitted variables/functional form and heteroskedasticity. Observation of the CUSUM and CUSUMSQ results show stability, whereby no systematic changes were detected.

6.7 Long and short-run dynamic results discussion: an ARDL analysis

As all economies show differing long and short-run causal relationships towards productivity growth, an analysis of those results showing relationships against the economic theory is of interest. Investment and capacity utilisation align with economic theory when a positive unidirectional relationship towards productivity growth exists. Analysing the United States data in Table 6, investment shows mixed results in the short-run, holding a positive non-lagged unidirectional relationship towards productivity growth, in line with the long-run result and economic theory. In contrast, the lagged coefficients show results against the economic theory. Carey (1996) finds a negative relationship between inventory investment and TFP growth, utilising panel data techniques for 450 U.S. manufacturing industries from 1958-1991. Carey concludes that industries with higher productivity growth tend to have lower than average inventory investment as sales growth decumulates inventory stock.

The United States data shows a non-lagged capacity utilisation also held a negative causal unidirectional short-run relationship towards productivity growth in Table 6, suggesting that industry is unable to improve efficiencies immediately without a short-run negative cost. The long and short-run results of stock market turnover show two possible conclusions: the financial market shows strong efficiency in allowing investors to buy and sell shares easily, and the volume of shares traded holds a significant yet weak unidirectional relationship towards productivity growth, suggesting that either the indicator may be a weak measurement of financial development impacts, or financial development holds a weak influence upon productivity growth solely. Regarding government expenditure, policymakers should be aware of the positive effect in the long-run, shown in Table 5, and a negative in the short-run, as per the coefficient results in Table 6. The coefficient results suggest that changes in government expenditure will not influence productivity growth immediately, however previous spending will hold a negative influence.

Japan data shows coefficients in line with the economic theory in the long-run, with only government expenditure showing no causal relationship towards productivity growth in Table 5. Due to a limited parsimonious ARDL model, the opportunity to analyse the short-run dynamics is limited in Table 6; however, the ECT result shows a strong joint causal relationship between the explanatory variables and productivity growth in the long-run. While Table 5 shows no long-run causal relationship between government expenditure and productivity growth, short-run dynamics show that government spending policies hold moderate causal negative impacts, as per Table 6. Therefore, policymakers should be aware that targeted government spending may negatively impact economic growth in the short-run.

South Korea data shows conflicting long and short-run results, as per Table 5 and 6, whereby capacity utilisation and government expenditure are in line with the economic theory in the long-run, while short-run results show that capacity utilisation holds a negative causal relationship towards productivity growth, and government expenditure holds no relationship. While South Korea can incorporate efficiency improvements in the long-run without any negative cost, results show such improvements are paired with negative costings in the short-run. Domestic credit holds a weak negative causal unidirectional relationship towards productivity growth in the short-run, suggesting that no long-run influence exists. In other words, credit to the private sector, being the backflow of financial resources to corporate sectors, holds a negative and immediate impact upon productivity growth. In terms of government expenditure, policymakers should be aware of strong negative implications in the long-run as shown in Table 5. In contrast, Table 6 shows no relationship towards productivity in the short-run.

6.8 Impulse Response Analysis

In analysing the resilience of productivity growth, this paper explores IRFs to investigate the strength of productivity growths' adaptability and absorbability mechanisms towards assimilating an exogenous shock. The recovery speed is measured by variance decomposition (shown in section 6.9). Variance decomposition indicates the magnitude of the predicted error variance for the series. It shows how much of the forecast error variance of productivity growth is explained by exogenous shocks to the explanatory variables. Following Duasa (2007), this paper utilises an estimated Vector Autoregression (VAR) model with differenced series, evaluating the dynamic interactions of causal relations among variables in the system. As such, this paper incorporates a one-time S.D. shock upon the explanatory variables, illustrated through Graphs 1-3. This paper sets to analyse the immediate, short-run and long-run as years 2, 5, and 20, to gain a broader view of the results. Productivity growth will be deemed more resilient towards the responses of impulses closest to zero. Table 7 shows the yearly responses of productivity growth to a one-time shock upon the explanatory variables, while Table 8 ranks those responses from most resilient to least.

As illustrated in Graph 1, productivity growth is seen to immediately be influenced by the orthogonal shocks in the case of the United States data. As illustrated in Table 7, a shock in investment leads to a 0.0061% increase in productivity growth in year 2, the highest impulse response of all explanatory variables. This suggests productivity growth is least resilient to a one-time shock towards investment into year 2, or the immediate year that impulses can be measured after a shock. The least resilience is due to the response of innovations being least close to zero. In analysing the results of Table 8, productivity growth for United States data is most resilient in order of stock market turnover, government expenditure, capacity utilisation and investment in year 2, most resilient in order of government expenditure, capacity utilisation, stock market turnover and investment in year 5, and most resilient in order of stock market turnover, capacity utilisation, government expenditure and investment into year 20.

Table 7: Responses of D(PG) to Cholesky One S.D. (d.f. adjusted) Innovations

United States				
Years	D(INV)	D(UT)	D(SMTR)	D(GE)
1	0	0	0	0
2	0.006163	0.005939	-0.001002	-0.002095
5	-0.001918	-5.76E-05	0.001046	4.69E-05
20	-4.97E-06	-9.78E-07	6.71E-07	-1.36E-06
Japan				
Years	D(INV)	D(UT)	D(MR)	D(GE)
1	0	0	0	0
2	0.002741	0.005877	-0.001762	0.000187
5	8.09E-05	-0.001378	0.000595	0.002046
20	-5.00E-07	-7.05E-07	3.74E-06	5.74E-06
South Korea				
Years	D(INV)	D(UT)	D(DC)	D(GE)
1	0	0	0	0
2	0.015367	0.007021	0.005431	-0.007536
5	-0.007778	0.001691	-0.003208	0.004712
20	1.01E-05	-3.39E-05	-4.17E-05	6.98E-06

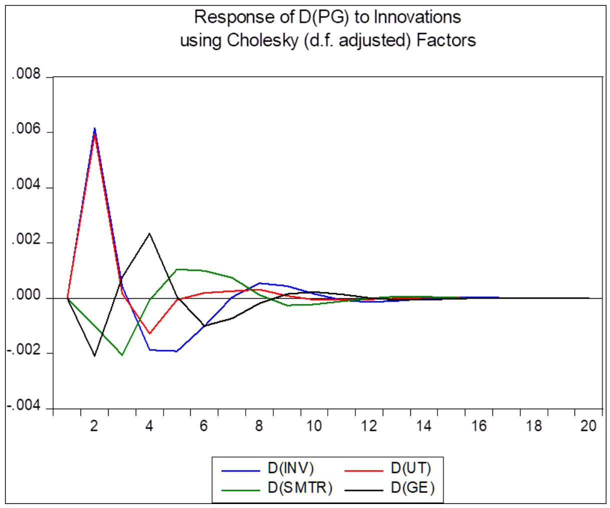
D(PG) = Differenced Productivity Growth, D(INV) = Differenced Investment, D(UT) = Differenced Capacity Utilisation, D(SMTR) = Differenced Stock Market Turnover Ratio, D(MR) = Differenced Monetisation Ratio, D(DC) = Differenced Domestic Credit, D(GE) = Differenced Government Expenditure.

Table 8: Responses of D(PG) to Cholesky One S.D. (d.f. adjusted) Innovations

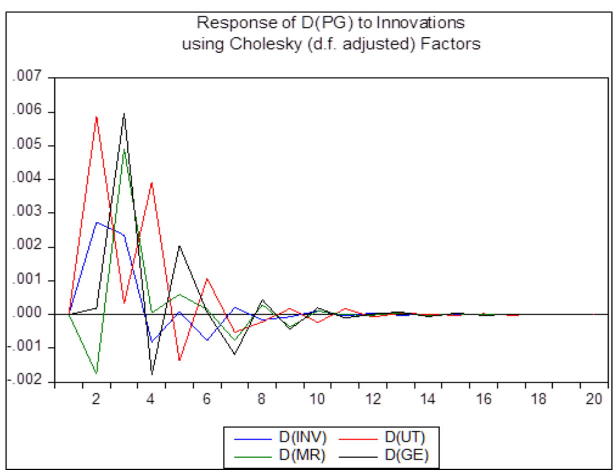
	Most Resilient			**Least Resilient**
United States Years				
2	SMTR	GE	UT	INV
5	GE	UT	SMTR	INV
20	SMTR	UT	GE	INV
Japan Years				
2	GE	MR	INV	UT
5	INV	MR	UT	GE
20	INV	UT	MR	GE
South Korea Years				
2	DC	UT	GE	INV
5	UT	DC	GE	INV
20	GE	INV	UT	DC

PG = Productivity Growth, INV = Investment, UT = Capacity Utilisation, SMTR = Stock Market Turnover Ratio, MR = Monetisation Ratio, DC = Domestic Credit, GE = Government Expenditure.

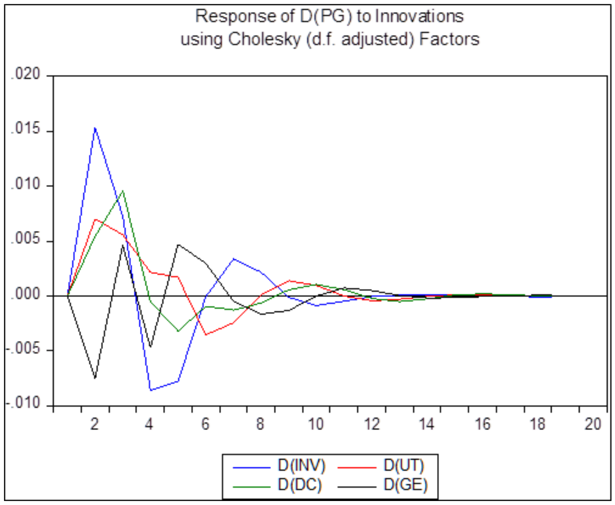
In analysing Japan data via Table 8, productivity growth is most resilient in order of government expenditure, monetisation ratio, investment and capacity utilisation in year 2, most resilient in order of investment, monetisation ratio, capacity utilisation and government expenditure in year 5, and most resilient in order of investment, capacity utilisation, monetisation ratio and government expenditure into year 20. Productivity growth via South Korea data shows opposite results, showing most resilience towards a shock in order of domestic credit, capacity utilisation, government expenditure and investment in year 2, most resilient in order of capacity utilisation, domestic credit, government expenditure and investment in year 5, and most resilient in order of government expenditure, investment, capacity utilisation and domestic credit into year 20. In summary, United States data, compared to Japan, contains higher response impulses in years 2, 5 and 20, with at least three out of four explanatory variables of higher value, while South Korea data exhibits the most powerful impulse reactions of all economies.



Graph 1: Responses of D(PG) to Innovations. United States: 1980-2019. D(PG) = Differenced Productivity Growth, D(INV) = Differenced Investment, D(UT) = Differenced Capacity Utilisation, D(SMTR) = Differenced Stock Market Turnover Ratio, D(GE) = Differenced Government Expenditure.



Graph 2: Responses of D(PG) to Innovations. Japan: 1980-2019. D(PG) = Differenced Productivity Growth, D(INV) = Differenced Investment, D(UT) = Differenced Capacity Utilisation, D(MR) = Differenced Monetisation Ratio, D(GE) = Differenced Government Expenditure.



Graph 3: Responses of D(PG) to Innovations. South Korea: 1980-2019. D(PG) = Differenced Productivity Growth, D(INV) = Differenced Investment, D(UT) = Differenced Capacity Utilisation, D(DC) = Differenced Domestic Credit, D(GE) = Differenced Government Expenditure.

6.9 Variance Decomposition

As per Sims (1980), variance decomposition indicates the magnitude of the predicted error variance for the series, accounted for by innovations from each independent variable over different time-periods (Shahbaz, 2012). This method shows proportional contribution in one variable due to innovative stemming in other variables (Pesaran & Shin, 1999). Chaiechi and Nguyen (2021) argue that such impulse responses could measure the recovery or adjustment speed (an important aspect of resilience) after orthogonal uncorrelated shocks. As such, time- series data is incorporated with Sim's Cholesky decomposition techniques to the variables' compositional speed adjustments in response to simulated shocks.

Analysing the results of Table 9, each of the columns contained in each tested economy shows orthogonal shocks as a percentage of the forecast variance, decomposing total variances into percentages attributable to each shock to the sum of 100%. The United States data shows the share of the forecast-error variance attributable to productivity growth varies between 0.59%-60.13%. In analysing investment at year 5, the fluctuation in the investment itself explained 80.46% of its total variance, whereas productivity growth accounted for 0.67%. In analysing investment at year 20, the fluctuation in the investment itself explained 55.93% of its total variance, whereas productivity growth accounted for 2.74%. The results suggest productivity growth is not sensitive to changes in the investment, whereby external shocks in investment will not influence the stability of productivity growth into year 20. Similar to the investment results, productivity growth does not react strongly to stock market turnover or changes in government expenditure. Instead, productivity growth is strongly sensitive to changes in capacity utilisation, with changes in fluctuation in capacity utilisation itself explaining 8.87% of its total variance in year 20. In contrast, productivity growth accounted for 32.43% in year 20. Using the same methodology, Japan data shows productivity growth is strongly sensitive to changes in the order of monetisation ratio, investment, and government expenditure. In contrast, productivity growth via South Korea data is highly sensitive towards changes in investment levels and capacity utilisation.

Table 9: Variance Decomposition of the Productivity Growth Components

United States

Variance Decomposition of INV:

Period	S.E.	PG	INV	UT	SMTR	GE
1	0.00	0.64	99.36	0	0	0
2	0.01	0.60	94.73	2.29	2.16	0.21
3	0.01	0.66	84.55	2.47	10.04	2.28
4	0.01	0.71	81.25	2.16	13.37	2.50
5	0.01	0.67	80.46	2.15	14.15	2.56
20	0.02	2.74	55.93	5.80	11.89	23.65

Variance Decomposition of UT:

Period	S.E.	PG	INV	UT	SMTR	GE
1	0.01	48.12	38.08	13.80	0	0
2	0.01	53.49	27.15	16.47	2.05	0.85
3	0.01	56.75	21.32	15.18	3.21	3.53
4	0.01	60.13	20.18	13.55	2.61	3.53
5	0.02	59.53	23.21	12.26	2.16	2.85
20	0.03	32.43	30.98	8.87	2.19	25.53

Variance Decomposition of SMTR:

Period	S.E.	PG	INV	UT	SMTR	GE
1	0.28	0.59	0.00	13.73	85.68	0
2	0.38	0.87	2.24	7.53	85.95	3.41
3	0.42	0.85	4.26	6.10	78.75	10.03
4	0.45	0.75	6.55	5.46	71.03	16.21
5	0.49	0.89	10.71	6.45	61.59	20.36
20	0.57	7.03	15.76	8.94	45.99	22.29

Variance Decomposition of GE:

Period	S.E.	PG	INV	UT	SMTR	GE
1	0.01	15.78	31.37	1.95	0.74	50.16
2	0.01	8.22	38.50	3.61	10.38	39.30
3	0.01	5.90	34.13	2.59	24.42	32.96
4	0.01	5.40	29.27	2.26	32.03	31.03
5	0.01	5.87	26.66	2.06	32.46	32.95
20	0.02	3.77	38.52	5.54	14.45	37.72

Japan

Variance Decomposition of INV:

Period	S.E.	PG	INV	UT	MR	GE
1	0.01	0.13	99.87	0	0	0
2	0.01	1.04	90.23	6.45	1.87	0.42
3	0.02	8.42	78.51	7.31	4.56	1.20
4	0.02	9.33	74.05	8.17	4.63	3.82
5	0.02	9.75	73.25	9.42	4.12	3.47
20	0.04	14.76	43.22	18.02	14.80	9.21

Variance Decomposition of UT:

Period	S.E.	PG	INV	UT	MR	GE
1	0.01	5.29	32.95	61.76	0	0
2	0.01	2.72	32.39	58.38	3.26	3.24
3	0.01	2.38	24.64	59.65	4.93	8.40
4	0.01	2.03	19.49	58.18	5.52	14.79
5	0.01	1.76	18.80	54.27	5.41	19.76
20	0.01	2.02	31.47	40.45	3.97	22.09

Variance Decomposition of MR:

Period	S.E.	PG	INV	UT	MR	GE
1	0.08	0.09	17.15	0.03	82.74	0
2	0.11	0.76	19.97	1.07	69.23	8.97
3	0.15	1.53	21.55	5.99	58.86	12.06
4	0.17	7.15	23.36	7.88	52.30	9.31
5	0.18	10.48	25.04	8.95	47.41	8.13
20	0.54	15.98	37.48	16.16	18.99	11.39

Variance Decomposition of GE:

Period	S.E.	PG	INV	UT	MR	GE
1	0.01	12.49	15.80	1.55	27.14	43.02
2	0.01	9.15	22.87	1.10	29.83	37.05
3	0.02	9.45	22.92	1.22	32.62	33.79
4	0.02	9.33	23.64	2.21	32.45	32.37
5	0.02	9.70	23.96	2.40	31.69	32.26
20	0.02	11.56	26.31	10.68	24.28	27.17

South Korea

Variance Decomposition of INV:

Period	S.E.	PG	INV	UT	DC	GE
1	0.01	8.13	91.87	0	0	0
2	0.02	15.85	81.57	0.24	1.88	0.46
3	0.02	19.39	73.52	2.21	4.44	0.44
4	0.03	28.13	62.07	4.24	4.12	1.44
5	0.03	37.27	48.78	5.04	3.94	4.97
20	0.04	29.97	37.29	13.10	8.29	11.35

Variance Decomposition of UT:

Period	S.E.	PG	INV	UT	DC	GE
1	0.02	58.17	0.43	41.40	0	0
2	0.03	59.05	3.43	37.08	0.16	0.28
3	0.03	48.58	12.07	35.54	3.17	0.64
4	0.04	36.79	19.05	34.43	7.61	2.11
5	0.04	28.95	25.11	33.83	9.00	3.11
20	0.06	21.32	41.43	23.17	6.09	8.00

Variance Decomposition of DC:

Period	S.E.	PG	INV	UT	DC	GE
1	0.06	1.00	20.26	35.90	42.84	0
2	0.09	1.10	17.55	43.51	37.49	0.36
3	0.12	4.15	19.17	49.34	27.05	0.29
4	0.14	3.32	20.49	54.00	21.81	0.38
5	0.15	4.89	19.93	56.25	18.54	0.39
20	0.35	7.35	51.08	31.49	5.80	4.28

Variance Decomposition of GE:

Period	S.E.	PG	INV	UT	DC	GE
1	0.01	1.25	1.46	1.88	18.15	77.25
2	0.02	3.30	1.31	1.63	17.89	75.86
3	0.02	3.41	1.97	1.53	19.60	73.49
4	0.02	3.61	2.51	2.89	18.99	72.00
5	0.02	4.93	4.43	6.61	18.41	65.62
20	0.03	4.56	41.25	24.98	8.70	20.51

Cholesky Ordering - United States: PG INV UT SMTR GE, Japan: PG INV UT MR GE, South Korea: PG INV UT DC GE. PG = Productivity Growth, INV = Investment, UT = Capacity Utilisation, SMTR = Stock Market Turnover Ratio, MR = Monetisation Ratio, DC = Domestic Credit, GE = Government Expenditure.

7 Discussion and Conclusions

This paper aimed to investigate the resilience of productivity growth in the United States, Japan and South Korea, in the presence of exogenous shocks, utilising a Kaleckian post-Keynesian approach. To better capture the roles of financial markets and governments in influencing production decisions, stock market turnover, monetisation and domestic credit were incorporated as a measure of financial development within the model equations, chosen via variable addition and omission processes, combined with a more traditional fiscal policy measure. Utilising time-series annual data (1980–2019), this paper incorporated ARDL estimation techniques to test for dynamic interactions between the incorporated productivity growth model variables, after the F-test showed cointegration among all model equations, with the more notable results showing significant ECTs in all three cases. After preliminary analysis and performing appropriate diagnostic testing, the resilience of productivity growth was analysed, utilising impulse response analysis and variance decomposition to test adaptability, absorbability, and recovery speeds from shocks.

The incorporation of a financial development and fiscal policy indicator within such a productivity growth model, more so to test adaptability and absorbability against external shocks, has improved upon traditional frameworks, contributing to the literature empirically and theoretically. Government expenditure was found to be the more powerful mechanism, suggesting that such a permanent incorporation should be considered in future modelling. While the error-correction terms suggest that the incorporation of financial development indicators is warranted, their causal effects upon productivity growth is found to be either very weak or non-existent in the long-run, while showing very weak/moderate or non-existent behaviours in the short-run. As such, policy makers, investors and producers in the United States, Japan and South Korea should be aware that while financial development can influence productivity growth either in the long or short-run, those influences are mostly weak.

While the relationships running from financial development towards productivity growth is mostly weak in influence, government spending holds moderate to strong causal effects towards productivity growth. In the way of implications for the United States, policymakers should be aware of a positive effect in the long-run, and a negative in the short-run. The coefficient results suggest that changes in government expenditure will not influence productivity growth immediately, however previous spending will hold a negative influence. In Japan, policy makers should be aware that government spending holds no long-run influence upon productivity growth. However, short-run dynamics show moderate causal negative impacts in both the current and previous period. In South Korea, policy makers should be aware of conflicting results, whereby government expenditure holds negative causal long-run influence towards productivity growth, with no short-run causality. This suggests that while government spending programs may not influence productivity directly in the short-run, programs that continue into the long-run will negatively influence productivity growth.

In testing for absorbability and recoverability of productivity growth in the face of external shocks, impulse response analysis was adopted. The response of productivity growth toward a one S.D. shock upon the explanatory variables offered mixed results in both the short and long-run for all economies. The United States data shows productivity growth was more resilient towards a shock in stock market turnover in both the short and long-run, being year 2 and 20, while being least resilient towards a shock in investment in all time periods. Japan data shows productivity growth was most resilient towards a shock in government expenditure in the short-run, while showing similar resilience towards a shock in investment in the long-run. South Korea data, however, shows stronger resilience towards a one S.D. shock towards domestic credit in the short-run, and government spending in the long-run.

Furthermore, the variance decomposition technique was used to determine the influence of model variables on productivity growth and their ability in explaining variability over time. Productivity growth via United States data was strongly sensitive to capacity utilisation changes, while showing weak sensitivity in order of stock market turnover, government expenditure and investment into year 20. Productivity growth via Japan data was moderately sensitive to changes in the order of monetisation, investment and government expenditure, while showing weak sensitivity towards changes in capacity utilisation. Productivity growth via South Korea data was strongly sensitive to investment and capacity utilisation changes, while less sensitive to domestic credit and government expenditure changes. As such, the evidence-based information within this paper provides decision-makers with an understanding of the channels through which productivity growth is affected within all economies in the long and short-run, alongside the causal strength of financial development and fiscal policy towards productivity growth.

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Appendix 1

Descriptive Statistics. United States: 1980–2019					
Statistics	**PG**	**INV**	**UT**	**SMTR**	**GE**
Mean	0.03	0.21	0.45	1.30	0.22
Median	0.02	0.21	0.47	1.25	0.21
Maximum	0.11	0.24	0.55	2.93	0.26
Minimum	-0.06	0.18	0.31	0.31	0.18
Std. Dev.	0.03	0.01	0.06	0.68	0.02
Skewness	0.44	-0.20	-0.58	0.47	0.39
Kurtosis	7.20	1.96	2.24	2.28	3.45
J-B.	30.72	2.06	3.19	2.35	1.33
P-value.	0.00	0.36	0.20	0.31	0.51
Ob.	40	40	40	40	40

Descriptive Statistics. Japan: 1980–2019					
Statistics	**PG**	**INV**	**UT**	**MR**	**GE**
Mean	0.02	0.27	0.33	2.02	0.16
Median	0.02	0.27	0.33	1.99	0.16
Maximum	0.13	0.35	0.36	2.53	0.20
Minimum	-0.03	0.23	0.31	1.40	0.14
Std. Dev.	0.03	0.03	0.01	0.30	0.01
Skewness	1.32	0.71	0.72	-0.16	0.50
Kurtosis	6.18	2.89	3.12	2.25	2.66
J-B.	28.45	3.33	3.53	1.11	1.84
P-value.	0.00	0.19	0.17	0.57	0.40
Ob.	40	40	40	40	40

Descriptive Statistics. South Korea: 1980–2019					
Statistics	**PG**	**INV**	**UT**	**DC**	**GE**
Mean	0.10	0.33	0.45	0.87	0.17
Median	0.08	0.32	0.43	0.69	0.15
Maximum	0.50	0.40	0.56	1.54	0.25
Minimum	-0.06	0.29	0.37	0.40	0.12
Std. Dev.	0.09	0.03	0.05	0.48	0.04
Skewness	1.98	0.79	0.53	0.26	0.78
Kurtosis	9.39	2.22	2.01	1.30	2.49
J-B.	94.12	5.14	3.52	5.11	4.53
P-value.	0.00	0.08	0.17	0.08	0.10
Ob.	40	40	40	40	40

PG = Productivity Growth, INV = Investment, UT = Capacity Utilisation, SMTR = Stock Market Turnover Ratio, MR = Monetisation Ratio, DC = Domestic Credit, GE = Government Expenditure.

Appendix 2

Stationarity Results. United States								
Variable	**ADF**				**PP**			
	Level		First Difference		Level		First Difference	
	Intercept	Trend	Intercept	Trend	Intercept	Trend	Intercept	Trend
PG	-2.15 (0.22)		-4.15*** (0.00)		-6.40*** (0.00)		-13.17*** (0.00)	
INV		-3.82** (0.02)		-4.17** (0.01)		-2.26 (0.44)		-3.47* (0.05)
UT		-2.08 (0.53)		-4.24*** (0.00)		-1.35 (0.85)		-4.15** (0.01)
SMTR		-2.41 (0.36)		-5.46*** (0.00)		-2.64 (0.26)		-5.46*** (0.00)
GE		-2.60 (0.27)		-3.85*** (0.00)		-1.90 (0.62)		-3.93** (0.02)

Stationarity Results. Japan								
Variable	**ADF**				**PP**			
	Level		First Difference		Level		First Difference	
	Intercept	Trend	Intercept	Trend	Intercept	Trend	Intercept	Trend
PG		-2.04 (0.56)		-4.87*** (0.00)		-4.15** (0.02)		-8.46*** (0.00)
INV		-2.97 (0.15)		-4.39*** (0.00)		-3.48* (0.06)		-5.03*** (0.00)
UT	-1.45 (0.45)		-4.75*** (0.00)		-1.85 (0.35)		-4.77*** (0.00)	
MR		-2.21 (0.47)		-5.69*** (0.00)		-2.21 (0.47)		-5.67*** (0.00)
GE	-2.71* (0.08)		-7.42*** (0.00)		-2.71* (0.08)		-7.44*** (0.00)	

Stationarity Results. South Korea								
Variable	**ADF**				**PP**			
	Level		First Difference		Level		First Difference	
	Intercept	Trend	Intercept	Trend	Intercept	Trend	Intercept	Trend
PG		-3.06 (0.13)		-4.31*** (0.00)		-6.49*** (0.00)		-9.10*** (0.00)
INV	-2.35 (0.16)		-5.25*** (0.00)		-2.00 (0.29)		-4.77*** (0.30)	
UT		-2.25 (0.45)		-5.31*** (0.00)		-2.32 (0.41)		-5.31*** (0.00)
DC		-2.29 (0.43)		-4.54*** (0.00)		-1.98 (0.59)		-4.41*** (0.00)
GE		-2.65 (0.26)		-7.12*** (0.00)		-2.65 (0.26)		-7.18*** (0.00)

*** Significant at 1%, ** Significant at 5%, * Significant at 10%, MacKinnon (1996) one-sided p-values. PG = Productivity Growth, INV = Investment, UT = Capacity Utilisation, SMTR = Stock Market Turnover Ratio, MR = Monetisation Ratio, DC = Domestic Credit, GE = Government Expenditure.