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INVOLUNTARY UNEMPLOYMENT IN A NEOCLASSICAL GROWTH MODEL WITH PUBLIC DEBT AND HUMAN CAPITAL

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Abstract: Even more than eight decades since the publication of Keynes' "General Theory of Employment, Interest, and Money" modern macroeconomists disagree on the notion of "underemployment equilibrium" with so-called "involuntary unemployment". While the majority of macro theorists trace involuntary unemployment back to frictions and rigidities in the adaptation of wages and output prices to market imbalances, a minority position holds that even under perfectly flexible output prices and wage rates involuntary unemployment might occur. Morishima in "Walras' Economics" and more recently Magnani presume that contrary to the majority view aggregate investment is not perfectly flexible but governed by "animal spirits" of investors. The aim of the present paper is to integrate the Morishima-Magnani approach into a Diamond-type overlapping generations' (OLG) model with internal public debt subsequently extended by human capital accumulation. It turns out that in spite of perfectly flexible real wage and interest rate involuntary unemployment occurs in intertemporal general equilibrium when aggregate investor sentiments are too pessimistic regarding the rentability of investment in real capital. In the model extended by human capital a higher public debt to output ratio decreases unambiguously involuntary unemployment, if initially the endogenous output growth rate is higher than the real interest rate.

JEL classification: D91, E13, E24

Keywords: Underemployment equilibrium, involuntary unemployment, aggregate investment function, overlapping generations' model, human capital

1. Introduction

At first sight, involuntary unemployment in a neoclassical growth model seams to be a contradiction in terms, at least from the viewpoint of Diamond's (1965) seminal work on "National debt in a neoclassical growth model". Similarly as in

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Solow's (1956) neoclassical growth model, Diamond (1965) assumed full employment of the work force for the overlapping generations' (OLG) economy with production and capital accumulation. Thus, in this economy with exogenous growth unemployment is purely voluntary.

As is well-known, involuntary unemployment is usually associated with Keynesian macroeconomics (Keynes (1936); Hicks (1937)). Involuntary unemployment is traced back to lacking aggregate demand (aggregate demand failures). But on the reasons why aggregate demand remains below full employment output in a perfectly functioning market economy there is no consensus among mainstream economists to this date. The majority of mainstream macro-economists adhered in the past to the macroeconomic disequilibrium or quantity rationing approach of Clower (1965), Barro and Grossman (1971), Malinvaud (1977) and in an overlapping generations context Rankin (1986, 1987) which presumes that rigid nominal price and wage levels are too high (in comparison to Walrasian price and wage levels) such that aggregate demand falls short from full employment supply. Due to the rationing rule that the short side of the market determines the quantity traded both on output and labor market demand determines the quantity produced and labor input into production. More recently, mainstream macroeconomists follow the New Keynesian approach in which prices and wages adapt sluggishly to market imbalances due to imperfect competition and other market failures (see Taylor (1979, 1980); Mankiw (1985), Akerlof and Yellen (1985); Blanchard and Kiyotaki (1987); Ball and Romer (1990); for a survey see Dixon (2000)).

In contrast to the majority, a minority of macroeconomists follow the lead of Morishima (1977) and more recently Magnani (2015) who attribute aggregate demand failures to not perfectly flexible aggregate investment determined by pessimistic "animal spirits" of investors independently from aggregate savings of households. In contradistinction to the older fixed-price and the newer imperfectly flexible price approach of the majority view, Morishima (1977) and Magnani (2015) assume perfectly flexible and perfectly competitive output prices, wages and interest rates. The reason why in spite of these strong assumptions full employment does not occur is that with an independent macro-founded investment function the system of general equilibrium equations is overdeterminate. Overdeterminacy disappears only if at least one market clearing condition is cancelled, and it is the labor market clearing condition which is lost.

Magnani (2015) - without noting precursor Morishima (1977) - proposes to integrate these static macroeconomic reasoning into Solow's (1956) neoclassical growth model without public debt. Since we utltimately want to study the effects of public debt on capital accumulation, output growth and involuntary unemployment in the long run, we stick to Diamond's (1965) OLG model with non-neutral internal public debt. However, output growth in Diamond's (1965) OLG model is exogenous which precludes the steady-state (long run) investigation of public debt variations on output growth and involuntary unemployment. Thus, we shall introduce in a second step human capital accumulation à la Glomm and Ravikumar (1992) and Lin (2000) in order to be able to endogenize the output growth rate. The first step is - as already suggested by Magnani (2015) - to introduce involuntary unemployment into Diamond's exogenous growth model to parallel Magnani's (2015) integration of an endogenous unemployment rate into Solow's neoclassical growth model.

The purpose of this article is two-fold: First, we intend to show how the structure of the intertemporal equilibrium dynamics derived from household's and firm's optimization problems, from government's budget constraint and the intertemporal market clearing conditions changes when aggregate investment is determined by an independent macro investment function and the unemployment rate is endogenized in a log-linear utility and Cobb-Douglas production function version of Diamond's (1965) OLG model with internal public debt. Our contribution to the literature consists here in reiterating Magnani's (2015) modification of Solow's neoclassical growth model within an OLG framework. In line with Magnani (2015) we will show analytically how a higher saving rate or more pessimistic animal spirits of investors affect the unemployment rate along the intertemporal equilibrium path. Our second purpose is to investigate the effects of a higher public debt to output ratio on the output growth rate, on the capital output ratio and on the unemployment rate in a steady state of the Diamond OLG model extended by human capital accumulation which are financed by public human capital investment expenditures. Our contribution to literature consists here in introducing involuntary unemployment into Lin's (2000) and Farmer's (2014) OLG model with human capital accumulation and public debt and exploring analytically and numerically the steady state effects of a higher public debt to output ratio on output growth, the capital output ratio and the unemployment rate. In particular, we will demonstrate on which factors it depends whether a higher public debt to output ratio decreases/increases the growth rate and increases/decreases the unemployment rate.

The remainder of the article is organized as follows: Section 2 outlines the basic model: Diamond's log-linear utility, Cobb-Douglas production function example (as in Farmer (2006)) of an OLG economy with internal public debt and involuntary unemployment. Section 3 extends the basic model by introducing human capital accumulation in line with Glomm and Ravikumar (1992) and Lin (2000) and explores how a higher public debt to output ratio affects the output growth rate, the capital output ratio and the unemployment rate. Section 4 summarizes the main results and concludes.

2. The basic model: The log-linear Cobb-Douglas OLG model with internal public debt and involuntary unemployment

Consider as in F (2006) an infinite-horizon economy composed of perfectly competitive firms, finitely lived households, and a non-optimizing government. A new generation, called generation t, enters the economy in each period $t = 0,1,2,....$ Generation t is composed of a continuum of $L_t > 0$ units of identical agents. It is assumed that the growth rate of the population is $g^L > -1$ which implies that $L_{t+1} = G^L L_t, G^L = 1 + g^L$.

The Household Sector

Households, each consisting of one agent, are non-altruistic: The old do not care for the young and the young do not care for the old. They live a maximum of two periods, youth (adult) and old age. In youth, each agent is endowed with one

unit of labor, which is supplied inelastically to firms. In exchange for the labor supply, each agent of generation t obtains the real wage rate w_t, which denotes the units of the produced good per unit of labor. However, in contrast to the original Diamond (1965) OLG model, not the whole labor supply is employed but only $(1-u_t)L_t$, where $0<u_t<1$ denotes the unemployment rate. The government collects taxes on wages quoted as a fixed proportion of wage income, $\tau_t w_t(1-u_t)$, $0<\tau_t<1$. Young agents split the net wage income $(1-\tau_t)(1-u_t)w_t$ each period between current consumption c_t^1 and savings s_t. Savings are invested into real capital in period t per capita, I_t^D/L_t, demanded by households in youth, and into real government bonds per capita, B_{t+1}^D/L_t, also demanded by housholds in youth. For simplicity we assume a depreciation rate of one with respect to real capital. Thus, in old age, the household supplies inelastically K_{t+1}^S/L_t to firms, whereby $K_{t+1}^S/L_t = I_t^D/L_t$, and B_{t+1}^S/L_t to young households in period $t+1$, whereby $B_{t+1}^S/L_t = B_{t+1}^D/L_t$. Thus, the per-capita savings are invested as follows: $s_t = K_{t+1}^S/L_t + B_{t+1}^S/L_t$. In old age, households consume their gross return on assets: $c_{t+1}^2 = q_{t+1}K_{t+1}^S/L_t + (1+i_{t+1})B_{t+1}^S/L_t$, where c_{t+1}^2 is consumption in old age, q_{t+1} denotes the gross rental rate on real capital, and i_{t+1} denotes the real interest rate on government bonds in period $t+1$. For simplicity, there are no taxes on rental and interest income.

The intertemporal preferences of the typical two-period lived household are represented by a log-linear intertemporal utility function slightly generalized in comparison to Diamond's (1965, p. 1134) leading example. As usual, this simple specification aims at closed form solutions for the intertemporal equilibrium dynamics (see e.g. de la Croix and Michel (2002, pp. 181-184)).

The typical younger household maximizes the following intertemporal utility function subject to the budget contraints of the active period (i) and the retirement period (ii):

$$\text{Max} \rightarrow \varepsilon \ln c_t^1 + \beta \ln c_{t+1}^2$$

subject to:

$$(i)\ \ c_t^1 + I_t^D/L_t + B_{t+1}^D/L_t = (1-\tau_t)(1-u_t)w_t,$$
$$(ii)\ c_{t+1}^2 = q_{t+1}K_{t+1}^S/L_t + (1+i_{t+1})B_{t+1}^S/L_t,\ K_{t+1}^S = I_t^D,\ B_{t+1}^S = B_{t+1}^D.$$

$0<\varepsilon\leq 1$ denotes the utility elasticity of consumption in youth, while $0<\beta<1$ depicts the subjective future utility discount factor. As is well-known, the log-linear intertemporal utility function ensures the existence of a unique, interior solution of the above optimization problem. Hence, we are entitled to solve the old-age budget constraint for B_{t+1}^S/L_t and insert the result into the young-age budget constraint (i), and we obtain:

$$c_t^1 + c_{t+1}^2/(1+i_{t+1}) + [1 - q_{t+1}/(1+i_{t+1})]K_{t+1}^S / L_t = (1-\tau_t)(1-u_t)w_t. \quad (1)$$

Obviously, a strictly positive and finite solution of maximizing the intertemporal utility function subject to constraint (1) requires that the following no-arbitrage condition holds:

$$q_{t+1} = 1 + i_{t+1} \quad (2)$$

The no-arbitrage condition (2) implies that K_{t+1}^S / L_t is optimally indeterminate, and the first-order conditions for a maximum solution read as follows:

$$c_t^1 + c_{t+1}^2/(1+i_{t+1}) = (1-\tau_t)(1-u_t)w_t, \quad (3)$$

$$(\beta/\varepsilon)c_t^1 = c_{t+1}^2/(1+i_{t+1}). \quad (4)$$

Solving equations (3) and (4) for c_t^1 and c_{t+1}^2 yields the following optimal consumption in youth and old age:

$$c_t^1 = \varepsilon/(\varepsilon+\beta)(1-\tau_t)(1-u_t)w_t, \quad (5)$$

$$c_{t+1}^2 = \beta/(\varepsilon+\beta)(1+i_{t+1})(1-\tau_t)(1-u_t)w_t. \quad (6)$$

Since $s_t = K_{t+1}^S / L_t + B_{t+1}^S / L_t$, we find for the utility maximizing savings:

$$s_t = \beta/(\varepsilon+\beta)(1-\tau_t)(1-u_t)w_t. \quad (7)$$

The Production Sector

All firms are endowed with an identical (linear-homogeneous) Cobb-Douglas production function: $Y_t = (a_t N_t)^{1-\alpha}(K_t)^{\alpha}$, $0 < \alpha < 1$. Here, Y_t denotes aggregate output or gross domestic product (GDP), a_t features the efficiency level of employed laborers N_t, while K_t denotes the input of capital services, all in period t, and $1-\alpha$ (α) depicts the production elasticity (production share) of labor (capital services). The profit of the production sector (in terms of the single output) is $Y_t - w_t N_t - q_t K_t$. In addition, it is assumed that labor efficiency grows at the exogenously given rate $g^a \geq 0$ such that $a_{t+1} = G^a a_t$ with $G^a = 1 + g^a$ and $a_0 = \overline{a} > 0$. Following normal practice in growth theory, $G^n \equiv G^L G^a$ is called the natural growth factor.

Maximization of $Y_t - w_t N_t - q_t K_t$ subject to the Cobb-Douglas production implies the following first-order conditions:

$$(1-\alpha)a_t[K_t/(a_tN_t)]^{\alpha} = w_t, \tag{8}$$

$$\alpha[K_t/(a_tN_t)]^{(\alpha-1)} = q_t. \tag{9}$$

However, since the number of employed workers is $N_t = L_t(1-u_t)$, we can rewrite the profit maximization conditions (8) and (9) as follows:

$$(1-\alpha)a_t[K_t/(a_tL_t(1-u_t))]^{\alpha} = w_t, \tag{10}$$

$$\alpha[K_t/(a_tL_t(1-u_t))]^{(\alpha-1)} = q_t. \tag{11}$$

Finally, the GDP function can be rewritten as follows:

$$Y_t = (a_tL_t(1-u_t))^{1-\alpha}(K_t)^{\alpha}. \tag{12}$$

The Public Sector

The government does not optimize but is subject to the following constraint period by period:

$$B_{t+1} = (1+i_t)B_t + \Gamma_t - \tau_t(1-u_t)w_tL_t, \tag{13}$$

where B_t denotes the aggregate stock of real public debt at the beginning of period t and Γ_t indicates total government expenditures during period t.

Magnani's (2015) macro-founded investment function

Magnani (2015, pp. 13-14) rightly claims that in Solow's (1956) neoclassical growth model investment in real capital is not micro- but macro-founded since aggregate investment is determined by aggregate savings. This is also true in Diamond's (1965) OLG model of neoclassical growth in which perfectly flexible aggregate investment is determined by aggregate savings of households in youth age. In contrast to these neoclassical growth models, Morishima (1977) in "Walras' Economics" and more recently Magnani (2015, p. 14) assume that "investments are determined by an independent investment function." This function is specified in discrete time as follows:

$$I_t^D = \varphi L_o(G^L)^t a_o(G^a)^t(1+i_t)^{-\theta},\ \varphi > 0, \theta \geq 0. \tag{14}$$

For ease of exposition and for the sake of closed-form solutions, we assume in line with Magnani's (2015, p. 14) base model the simpler version of equation (14) with $\theta = 0$ which implies that aggregate investment is exogenous as in simple Keynesian good market models. The positive parameter φ reflects "Keynesian investors' animal spirits". (ibid)

Market clearing conditions

In addition to the restrictions imposed by household and firm optimization and the above government budget constraint, markets for labor and capital services as well as for the assets have to clear in all periods (the market for the output of production is cleared by means of Walras' Law[1]).

$$L_t(1-u_t) = N_t, \forall t \tag{15}$$

$$K_t^S = K_t, \forall t \tag{16}$$

$$B_t = B_t^D = B_t^S, \forall t \tag{17}$$

Unemployment rate period t

Before deriving the intertemporal equilibrium dynamics it is apt to determine the unemployment rate in period $t,\ t = 0,1,,2,...$. To this end, we use the output market clearing identity

$$Y_t = L_t c_t^1 + L_{t-1} c_t^2 + I_t^D + \Gamma_t . \tag{18}$$

Inserting into (18) equations (12), (5), (ii) for period t , (14) and the market clearing conditions (16) and (17), we obtain the following equation:

$$(A_t)^{1-\alpha}(1-u_t)^{1-\alpha}(K_t)^{\alpha} = L_t\left(\frac{\varepsilon}{\varepsilon+\beta}\right)(1-\tau_t)(1-u_t)w_t + L_{t-1}[q_t K_t + (1+i_t)B_t] + \varphi A_t + \Gamma_t, \tag{19}$$

with $A_t \equiv a_t L_t$ as potential effective labor. Dividing equation (19) on both sides through A_t , the following equation turns out:

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[1] The proof of Walras' law proceeds as follows: Denote by $P_t > 0$ the nominal price (level) of GDP. Then, the current period budget constraint of households in youth age can be rewritten as follows: $P_t L_t c_t^1 + P_t I_t^D + P_t B_{t+1}^D = (1-\tau_t)P_t w_t (1-u_t)L_t$ (F.1). Moreover, the budget constraint of households in old age reads as follows: $P_t L_{t-1} c_t^2 = P_t q_t K_t^S + P_t(1+i_t)B_t^S$ (F.2). In addition, maximum profits are zero, which implies: $P_t Y_t = P_t w_t N_t + P_t q_t K_t$ (F.3). Finally, government's budget constraint is rewritten as follows: $P_t B_{t+1} = P_t(1+i_t)B_t + P_t\Gamma_t - P_t\tau_t w_t L_t(1-u_t)$ (F.4). Adding up the left and right hand side of equations (F.1) and (F.2) yields: $P_t L_t c_t^1 + P_t I_t^D + P_t L_{t-1} c_t^2 = (1-\tau_t)P_t w_t (1-u_t)L_t - P_t B_{t+1}^D + P_t q_t K_t^S + P_t(1+i_t)B_t^S$ (F.5). Considering (14), (15) and (16) in (F.5) we get: $P_t L_t c_t^1 + P_t L_{t-1} c_t^2 + P_t I_t^D = P_t w_t N_t + P_t q_t K_t - P_t\tau_t w_t N_t - P_t B_{t+1} + P_t(1+i_t)B_t$ (F.6). Inserting (F.3) into (F.6) and taking account of (F.4) in (F.6) yields: $P_t L_t c_t^1 + P_t L_{t-1} c_t^2 + P_t I_t^D = P_t Y_t - P_t\Gamma_t$, which represents production output market clearing. Since this equation is always true, P_t is indeterminate and can be fixed as $P_t = 1$. Q.E.D.

$$(1-u_t)^{1-\alpha}(k_t)^{\alpha} = \left(\frac{\varepsilon}{\varepsilon+\beta}\right)(1-\tau_t)(1-u_t)\frac{w_t}{a_t} + (G^L)^{-1}[q_t k_t + (1+i_t)b_t] + \varphi + \Gamma_t / A_t \,, \quad (20)$$

with $k_t \equiv K_t /(a_t L_t)$ denoting capital per potential unit of effective labor (= potential capital intensity) and $b_t \equiv B_t / A_t$ as public debt per potential unit of effective labor.

On account of the linear-homogeneity of the production function we can rewrite the profit-maximizing conditions (10) and (11) as follows:

$$w_t / a_t = (1-\alpha)(k_t)^{\alpha}(1-u_t)^{-\alpha}, \quad (21)$$

$$q_t = \alpha(k_t)^{\alpha-1}(1-u_t)^{1-\alpha} \,. \quad (22)$$

Considering the no-arbitrage condition (2), defining $\gamma_t \equiv \Gamma_t / A_t$ and inserting (21) and (22) into (20) we obtain the following equation:

$$\begin{aligned}(1-u_t)^{1-\alpha}(k_t)^{\alpha} &= \left(\frac{\varepsilon}{\varepsilon+\beta}\right)(1-\tau_t)(1-\alpha)(k_t)^{\alpha}(1-u_t)^{1-\alpha} \\ &+ (G^L)^{-1}[\alpha(k_t)^{\alpha-1}(1-u_t)^{1-\alpha}k_t + \alpha(k_t)^{\alpha-1}(1-u_t)^{1-\alpha}b_t] + \varphi + \gamma_t \,.\end{aligned} \quad (23)$$

Next we have to specify how the government determines its intertemporal policy profile. In accordance with the established literature, we assume that the government sticks to a policy of time-stationary ("constant") tax rates and expenditure rates. This means that $\tau_t = \tau_{t+1} = \tau, \quad \gamma_t = \gamma_{t+1} = \gamma$ hold where $0 < \tau < 1$ respectively $\gamma > 0$ are exogenously fixed by the government. Under this proviso (23) can be rewritten as follows:

$$(1-u_t)^{1-\alpha} = \frac{\varphi + \gamma}{(k_t)^{\alpha}\left[1 - \left(\frac{\varepsilon}{\varepsilon+\beta}\right)(1-\tau)(1-\alpha) - (G^L)^{-1}\alpha(1+b_t/k_t)\right]} \quad (24)$$

Equation (24) shows the intertemporal equilibrium unemployment rate in period t as determined by structural and policy parameters and historically given potential capital and public debt intensity.

Intertemporal equilibrium dynamics

In order to derive the intertemporal equilibrium dynamics we use $K_{t+1}^S = I_t^D$, market clearing conditions (16) and (14), and after dividing the resulting equation on both sides through A_t we obtain:

$$K_{t+1} / A_{t+1}(A_{t+1} / A_t) \equiv k_{t+1} G^n = I_t^D / A_t = \varphi \,. \quad (25)$$

Next we divide government's budget constraint (13) through A_t, and we get the following equation:

$$b_{t+1}G^n = (1+i_t)b_t + \gamma - \tau(1-u_t)w_t / a_t . \tag{26}$$

Considering again the no-arbitrage condition (2) and the first-order conditions for maximum profit (18) and (19) equation (26) can be rewritten as follows:

$$b_{t+1}G^n = \alpha(k_t)^{\alpha-1}(1-u_t)^{1-\alpha} b_t + \gamma - \tau(1-\alpha)(k_t)^{\alpha}(1-u_t)^{1-\alpha} \tag{27}$$

Introducing the new variable $\eta_t \equiv b_t / k_t$ (see Michaelis (1989)), which can be termed the debt to output ratio, equation (27) is changed to the following equation:

$$\eta_{t+1}k_{t+1}G^n = (k_t)^{\alpha}(1-u_t)^{1-\alpha}[\alpha\eta_t + \gamma - \tau(1-\alpha)]. \tag{28}$$

Respecting equations (24) and (25) we obtain eventually the following two-dimensional system of the intertemporal equilibrium dynamics:

$$k_{t+1}G^n = \varphi , \tag{29}$$

$$\eta_{t+1} = \frac{\varphi + \gamma}{\varphi[1 - \left(\frac{\varepsilon}{\varepsilon+\beta}\right)(1-\tau)(1-\alpha) - (G^L)^{-1}\alpha(1+\eta_t)]}[\alpha\eta_t + \gamma - \tau(1-\alpha)]. \tag{30}$$

The intertemporal equilibrium unemployment rate reads as follows:

$$u_t = 1 - \left\{ \frac{\varphi + \gamma}{(k_t)^{\alpha}[1 - \left(\frac{\varepsilon}{\varepsilon+\beta}\right)(1-\tau)(1-\alpha) - (G^L)^{-1}\alpha(1+\eta_t)]} \right\}^{1/(1-\alpha)} \tag{31}$$

Existence and dynamic stability of non-trivial steady states

As usual, the steady states of the intertemporal equilibrium dynamics (29) and (30) are defined as $\lim_{t->\infty} k_t = k$ and $\lim_{t->\infty} \eta_t = \eta$. It is obvious that a trivial steady state does not exist. Thus, we are entitled to focus on non-trivial steady state solutions.

Proposition 1. Suppose that $\tau(1-\alpha) > \gamma$. Then, exactly two non-trivial steady state solutions (η_1, k) and (η_2, k) exist. Thus, the solutions read as follows:

$$\begin{aligned} (\eta_1, k) &= \{\text{-E1} + [\text{E1}^2 + 4\,\text{E0}\,\text{E2}]^2)/(2\,\text{E0}), \varphi/\text{G}^n\}, \\ (\eta_2, k) &= \{\text{-E1} - [\text{E1}^2 + 4\,\text{E0}\,\text{E2}]^2)/(2\,\text{E0}), \varphi/\text{G}^n\}, \end{aligned} \tag{32}$$

with $\mathrm{E0} \equiv \alpha(\mathrm{G^L})^{-1}\varphi$, $\mathrm{E1} \equiv (\varphi+\gamma)\alpha + \mathrm{E0} - \varphi[1-(\varepsilon/(\varepsilon+\beta))(1-\tau)(1-\alpha)]$,
$\mathrm{E2} \equiv (\varphi+\gamma)[\tau(1-\alpha)-\gamma]$ and $\eta_1 > 0, \eta_2 < 0$ and $k > 0$.

Proof. Immediate.

Remark 1. While in the first steady state solution the debt to output ratio is larger than zero, and the government is a debtor of the private sector, in the second steady state the debt to output ratio is less than zero and the government is a lender to the private sector.

The next step is to consider the local dynamic stability of the steady state solutions (η_1, k) and (η_2, k), respectively.

Proposition 2. The non-trivial steady state solution (η_1, k) in (32) of the equilibrium dynamics (29) and (30) is asymptotically unstable, while (η_2, k) in (32) is asymptotically stable.

Proof. Differentiating (30) with respect to η_t yields:

$$\frac{d\eta_{t+1}}{d\eta_t} = \frac{\alpha[(\gamma+\varphi)/\varphi + (G^L)^{-1}\eta)}{[1-\left(\frac{\varepsilon}{\varepsilon+\beta}\right)(1-\tau)(1-\alpha) - (G^L)^{-1}\alpha(1+\eta)]} = \frac{\alpha[(\gamma+\varphi)/\varphi + (G^L)^{-1}\eta)\varphi\eta}{(\varphi+\gamma)[\alpha\eta+\gamma-(1-\alpha)\tau]} \quad (33)$$

The total derivative in (33) evaluated at $\eta_1 > 0$ is certainly larger than zero since the denominator is larger than zero and it is also larger than unity since $\eta_1 > 0$ and $\alpha[(\gamma+\varphi)/\varphi + (G^L)^{-1}\eta_1)\eta_1 > (\gamma+\varphi)/\varphi(\alpha\eta_1+\gamma-(1-\alpha)\tau) \Leftrightarrow \alpha(G^L)^{-1}(\eta_1)^2 > \gamma-(1-\alpha)\tau$ since $\gamma-(1-\alpha)\tau < 0$ on account of the assumption in Proposition 1.

The total derivative in (33) evaluated at $\eta_2 < 0$ is certainly larger than zero since both the numerator and the denominator are smaller than zero and it is also smaller than unity since $\eta_2 < 0$ and $\alpha[(\gamma+\varphi)/\varphi + (G^L)^{-1}\eta_2)\eta_2 /(\gamma+\varphi)/\varphi(\alpha\eta_2+\gamma-(1-\alpha)\tau) < 1 \Leftrightarrow \alpha[(\gamma+\varphi)/\varphi + (G^L)^{-1}\eta_2)\eta_2 > (\gamma+\varphi)/\varphi(\alpha\eta_2+\gamma -(1-\alpha)\tau) \Leftrightarrow \alpha(G^L)^{-1}(\eta_2)^2 > \gamma-(1-\alpha)\tau$ since $\gamma-(1-\alpha)\tau < 0$ on account of the assumption in Proposition 1. Q.E.D.

In view of economic reality the second steady state solution (η_2, k) although dynamically stable can be disregarded. Thus, we focus on the unstable first steady state solution (η_1, k). In order to overcome the problem of dynamic instability we focus on the following specific intertemporal equilibrium path:

$$k_{t+1} = k,\ t = 0,1,2,...,\ k_0 = \bar{k} > 0, \quad (34)$$

$$\eta_t = \eta_1,\ t = 0,1,2..., \quad (35)$$

$$b_t = \eta_1 k_t, t = 0,1,2.... \quad (36)$$

Usually, the economy commences with historically given capital intensity $k_0 = \bar{k} > 0$ and debt intensity $b_0 = \bar{b} > 0$. However, equation (36) then transpires that the dynamic system (43)-(35) becomes overdeterminate. In order to restore determinacy the initital debt intensity b_0 must be accidentally such that $\eta_0 = b_0 / \bar{k} = \eta_1$. Where this is (realistically) not the case, one of the policy parameters in η_1 has to become endogenous. The natural candidate is either the tax rate τ or the expenditure rate γ. To avoid overdeterminacy or a break down of the equilibrium dynamics within a finite number of periods, the government is no longer free to choose any feasible tax or expenditure rate if $\eta_0 = \bar{b} / \bar{k} = \eta_1$ but must rather choose the following tax rate (given γ):

$$\tau_0 = \frac{[(\varepsilon/(\varepsilon+\beta))(1-\alpha)+\alpha(G^L)^{-1}(1+\eta_0)-1]\varphi\eta_0 + (\gamma+\varphi)(\gamma+\alpha\eta_0)}{(1-\alpha)(\gamma+\varphi)+[\varepsilon/(\varepsilon+\beta)](1-\alpha)\varphi\eta_0}. \tag{37}$$

By sticking to τ_0 in (37), the government ensures that a historically given $\bar{b} > 0$ (and $\bar{k} > 0$) can be maintained indefinitely. On the contrary, if the government fails to fix the tax rate exactly at the value of τ_0 in (37), the economy breaks down in finite time or it converges to the dynamically stable second steady state where the government is a lender to the private sector.

Comparative Steady State Analysis: *How More Optimistic Investor's Animal Spirits or a Lower Saving Rate Affect the Unemployment Rate*

We are now prepared to investigate how more optimistic investor's animal spirits or a lower saving rate of households affect the equilibrium unemployment rate.

Suppose first that in the initial period $t = 0$ investor's animal spirits become more optimistic, i.e. $d\varphi > 0$ while the OLG economy commences with $\eta_0 = \bar{k} / \bar{b}$. To obtain the requested answer we use in addition to equation (37) the equation (31) rewritten as follows:

$$u_0 = 1 - \left\{ \frac{\varphi + \gamma}{(k_0)^{\alpha}\left[1 - \left(\frac{\varepsilon}{\varepsilon+\beta}\right)(1-\tau_0)(1-\alpha) - (G^L)^{-1}\alpha(1+\eta_0)\right]} \right\}^{1/(1-\alpha)} \tag{38}$$

Totally differentiating u_0 with respect to φ yields after simplification:

$$\frac{du_0}{d\varphi} = -\frac{[\beta+\varepsilon(1+\eta_0)]\left\{\frac{G^L(k_0)^{\alpha} - \alpha[\beta(\gamma+\varphi(1+\eta_0)}{(\beta+\varepsilon\gamma)G^L - \alpha(1+\eta_0)(\beta+\varepsilon(1-G^L)}\right\}^{1/(1-\alpha)}}{(1-\alpha)[\beta(\gamma+\varphi)+\varepsilon(\gamma+\varphi(1+\eta_0))]} \tag{39}$$

Since the term in curled brackets is certainly larger than zero we are assured that $du_0 / d\varphi < 0$, or in other words that more optimistic animal spirits of investors reduce the equilibrium unemployment rate. In view of the right hand side of equation (38) this unique analytical result is the consequence of more aggregate demand due to better investor's expectations, i.e. $d\varphi > 0$ and a dampening effect on the tax rate which ensures that the historically given ratio of the debt to capital intensity can be maintained indefinitely. A lower tax rate raises disposable income of households in youth age and hence aggregate demand. Thus, we are able to confirm the unemployment reducing effect of more optimistic investor's expectations of Magnani (2015, p. 14) in our more complicated OLG model with internal public debt.

It remains to be seen whether Magnani's (2015) second main result in regard to the unemployment increasing effect of a higher saving rate (= a larger old-age utility weight $d\beta > 0$) can also be confirmed within our more elaborated OLG model. Differentiation of u_0 in (38) with respect β reads as follows:

$$\frac{du_0}{d\beta} = \frac{\{\varepsilon G^L (k_0)^{-\alpha}[\gamma G^L (1-\alpha-\gamma-(\varphi+\alpha\eta_0)) + (1+\eta_0)\varphi(G^L(1-\alpha)-\alpha\eta_0)]\}\Theta}{(1-\alpha)[(\beta+\varepsilon\gamma)G^L - \alpha(1+\eta_0)(\beta+\varepsilon(1-G^L))]^2} \quad (40)$$

with $$\Theta \equiv \left\{ \frac{G^L (k_0)^{\alpha} - \alpha[\beta(\gamma+\varphi)+\varepsilon(\gamma+\varphi(1+\eta_0))]}{(\beta+\varepsilon\gamma)G^L - \alpha(1+\eta_0)(\beta+\varepsilon(1-G^L)} \right\}^{\alpha/(1-\alpha)}.$$

The numerator on the right hand side of (40) and Θ is certainly larger than zero which is also true for $(1-\alpha-\gamma-(\varphi+\alpha\eta_0))$ and $(G^L(1-\alpha)-\alpha\eta_0)$ as extensive simulation of feasible parameter sets comprising both terms shows. Thus, the term in curled brackets in the numerator of the ratio on the right hand side of (40) is strictly larger than zero and hence $du_0 / d\beta > 0$. A larger weight of old-age consumption utilty raises the equilibrium unemployment rate. Intuitively, a larger β decreases the marginal propensity to consumption and hence aggregate demand while it also decreases τ_0 which raises young-age consumption and aggregate demand. However, the tax reducing effect of a higher β is weaker than the decreasing effect on the marginal propensity to consumption. As a consequence, we are prepared to confirm also Magnani's (2015, p. 15) second main result regarding the unemployment raising effect of a higher saving rate in our more complex OLG model with internal public debt.

3. The basic model extended by human capital accumulation: The Log-linear Cobb-Douglas OLG model with endogenous growth and involuntary unemployment

In the basic OLG model of the previous section growth was exogenous. Fiscal policy was unable to affect the output (GDP) growth rate. Of particular interest is the question whether a higher public debt can raise GDP growth and decrease unemployment in the long run. In order to address this question we extend in this

section the basic OLG model by introducing human capital accumulation. In order to point out most clearly the growth enhancing effects of human capital accumulation we assume in this section no population growth ($g^L = 0 \Leftrightarrow G^L = 1$) and no exogenous growth in labor efficiency, i.e. $G^a = 1$. As a consequence of the first assumption the number of households remains constant over time: $L_t = L_{t-1} = L$.

The Household Sector

The optimization problem of the two-period lived household which enters the economy in period t is essentially the same as in the basic model in the previous section with the exception of human capital h_t which the household accumulated in the period $t-1$ and which enters her labor supply and wage income.

Thus, the typical younger household maximizes the following intertemporal utility function subject to the budget contraints of the active period (i) and the retirement period (ii):

$$\text{Max} \rightarrow \varepsilon \ln c_t^1 + \beta \ln c_{t+1}^2$$

subject to:

$$(i)\ \ c_t^1 + I_t^D / L_t + B_{t+1}^D / L_t = w_t h_t (1-\tau_t)(1-u_t),$$
$$(ii)\ c_{t+1}^2 = q_{t+1} K_{t+1}^S / L_t + (1+i_{t+1}) B_{t+1}^S / L_t,\ K_{t+1}^S = I_t^D,\ B_{t+1}^S = B_{t+1}^D.$$

Obviously, the utility maximizing consumption and savings function read as follows:

$$c_t^1 = \varepsilon /(\varepsilon+\beta)(1-\tau_t)(1-u_t) w_t h_t, \tag{41}$$
$$c_{t+1}^2 = \beta /(\varepsilon+\beta)(1+i_{t+1})(1-\tau_t)(1-u_t) w_t h_t, \tag{42}$$
$$s_t = \beta /(\varepsilon+\beta)(1-\tau_t)(1-u_t) w_t h_t. \tag{43}$$

The Production Sector

All firms are now endowed with an identical (linear-homogeneous) Cobb-Douglas production function: $Y_t = A(h_t N_t)^{1-\alpha}(K_t)^{\alpha}$, $0 < \alpha < 1, A > 0$. Maximization of $Y_t - w_t h_t N_t - q_t K_t$ subject to the Cobb-Douglas production function implies the following first-order conditions:

$$(1-\alpha) A[K_t /(h_t N_t)]^{\alpha} = w_t, \tag{44}$$
$$\alpha A[K_t /(h_t N_t)]^{(\alpha-1)} = q_t. \tag{45}$$

However, since the number of employed workers is $N_t = L(1-u_t)$ we can rewrite the profit maximization conditions (8) and (9) as follows:

$$(1-\alpha)A[K_t/(h_tL(1-u_t))]^{\alpha} = w_t, \quad (46)$$

$$\alpha A[K_t/(h_tL(1-u_t))]^{(\alpha-1)} = q_t. \quad (47)$$

Finally, the GDP function can be rewritten as follows:

$$Y_t = A(h_tL(1-u_t))^{1-\alpha}(K_t)^{\alpha}. \quad (48)$$

The Public Sector

Similarly as in the basic model, the government does not optimize but is subject to the following constraint period by period:

$$B_{t+1} = (1+i_t)B_t + \Delta_t + \Gamma_t - \tau_t(1-u_t)w_th_tL, \quad (49)$$

where Γ_t denotes now human capital investment (HCI) expenditures and Δ_t denotes all non-HCI expenditures of the government during period t.

Human Capital Accumulation and GDP Growth

In line with Glomm and Ravikumar (1992, 1997), human capital in period t is determined by human capital of the generation which entered the economy in period $t-1$ and by government HCI spending in period $t-1$, Γ_{t-1}:

$$h_t = H_0(h_{t-1})^{\mu}(\Gamma_{t-1}/L)^{1-\mu}, H_0 = \overline{H} > 0, 0 < \mu < 1, \quad (50)$$

where H_0 represents a level parameter, μ denotes the production elasticity of human capital, and $1-\mu$ features the production elasticity of public HCI spending. Multiplying equation (50) on both sides by L, we obtain the aggregate version of (45):

$$Lh_t \equiv H_t = H_0(Lh_{t-1})^{1-\mu}(\Gamma_{t-1})^{\mu} \equiv H_0(H_{t-1})^{1-\mu}(\Gamma_{t-1})^{\mu}. \quad (51)$$

The economy grows, even in the absence of population growth and exogenous progress in labor efficiency. The growth factor (= gross growth rate) of GDP is defined as follows:

$$G_{t+1}^{Y} = \frac{Y_{t+1}}{Y_t} \tag{52}$$

Using equations (48) and (51), equation (52) can be rewritten as:

$$G_{t+1}^{Y} = \frac{H_{t+1}}{H_t}\frac{(1-u_{t+1})^{1-\alpha}}{(1-u_t)^{1-\alpha}}\frac{(k_{t+1})^{\alpha}}{(k_t)^{\alpha}},\ k_t \equiv \frac{K_t}{H_t}. \tag{53}$$

Magnani's Macro-founded Investment Function

It is easy to see that Magnani's (2015) macro-founded investment function reads in our new model context as follows:

$$I_t^D = \varphi H_t (1+i_t)^{-\theta},\ \varphi > 0, \theta \geq 0. \tag{54}$$

In order to obtain closed-form solutions we assume as above $\theta = 0$.

Since the market clearing conditions remain as in the basic model, we do not explicitely mention them again.

The Intertemporal Equilibrium Dynamics in Terms of per GDP ratios

In order to be able to calibrate the present model to empirical data we first transform main endogenous variables into per GDP ratios.

To start with, the government budget constraint (49) is rewritten as follows:

$$\begin{aligned} \frac{B_{t+1}}{Y_{t+1}}\frac{Y_{t+1}}{Y_t} &\equiv b_{t+1}G_{t+1}^{Y} = (1+i_t)\frac{B_t}{Y_t} + \frac{\Delta_t}{Y_t} + \frac{\Gamma_t}{Y_t} - \frac{\tau_t(1-u_t)w_t h_t L}{Y_t} \\ &\equiv (1+i_t)b_t + \gamma_t + \delta_t - \frac{\tau_t(1-u_t)w_t h_t L}{Y_t}, \end{aligned} \tag{55}$$

with $b_t \equiv B_t / Y_t$, $\delta_t \equiv \Delta_t / Y_t$ and $\gamma_t \equiv \Gamma_t / Y_t$.

Since the profit maximizing condition (41) can rewritten as

$$w_t h_t L(1-u_t) = (1-\alpha)(K_t)^{\alpha}(h_t L(1-u_t))^{1-\alpha} = (1-\alpha)Y_t, \tag{56}$$

government's budget constraint can be written as follows:

$$b_{t+1}G_{t+1}^{Y} = (1+i_t)b_t + \delta_t + \gamma_t - \tau_t(1-\alpha). \tag{57}$$

In line with the initial assumption in the previous section we assume that the government sticks to time-stationary wage tax rates $\tau_t = \tau_{t+1} = \tau$ and non-HCI expenditure ratios: $\delta_t = \delta_{t+1} = \delta$. Moreover, in accordance with the empirical reality in most advanced countries before the global financial crisis 2007/2008 we assume time-stationary government debt to GDP ratios: $b_{t+1} = b_t = b$. Acknowledging these assumptions the budget constraint of the government reads eventually as follows:

$$\gamma_t = b[G_{t+1}^Y - (1 + i_t)] + \chi \,, \tag{58}$$

with $\chi \equiv \tau(1-\alpha) - \delta$ denoting the primary surplus ratio (excluding government HCI-expenditures) of the government.

The next dynamic variable we want to transform into a per GDP ratio is the real capital stock K_t. The capital stock to GDP ratio is known as capital output ratio denoted as v_t. The relationship to the real capital to human capital ratio k_t is as follows:

$$v_t \equiv \frac{K_t}{Y_t} = \frac{K_t}{A(H_t)^{1-\alpha}(1-u_t)^{1-\alpha}(K_t)^{\alpha}} = \frac{(K_t)^{1-\alpha}}{A(H_t)^{1-\alpha}(1-u_t)^{1-\alpha}} = \frac{(k_t)^{1-\alpha}}{A(1-u_t)^{1-\alpha}} \,. \tag{59}$$

Using the relationship between v_t and k_t in (59), we can rewrite the profit maximizing condition (42) as follows:

$$q_t = \frac{\alpha}{v_t} \,. \tag{60}$$

The growth factor of human capital reads in terms of the transformed variables as follows:

$$\begin{aligned} &\frac{H_{t+1}}{H_t} = H_0 (H_t)^{\mu-1} (\gamma_t)^{1-\mu} (Y_t)^{1-\mu} = \\ &H_0 (H_t)^{\mu-1} (\gamma_t)^{1-\mu} A^{(1-\mu)} (K_t)^{\alpha(1-\mu)} (H_t)^{(1-\alpha)(1-\mu)} (1-u_t)^{(1-\alpha)(1-\mu)} \\ &= H_0 A^{(1-\mu)/(1-\alpha)} (\gamma_t)^{1-\mu} (v_t)^{\alpha(1-\mu)/(1-\alpha)} (1-u_t)^{(1-\mu)} . \end{aligned} \tag{61}$$

The GDP growth factor in terms of the capital output ratio can be rewritten as follows:

$$\begin{aligned} G_{t+1}^Y &= \frac{H_{t+1}}{H_t} \left(\frac{v_{t+1}}{v_t} \right)^{\alpha/(1-\alpha)} \frac{(1-u_{t+1})}{(1-u_t)} \\ &= H_0 A^{(1-\mu)/(1-\alpha)} (\gamma_t)^{1-\mu} (v_{t+1})^{\alpha/(1-\alpha)} (v_t)^{-\alpha\mu/(1-\alpha)} (1-u_{t+1})(1-u_t)^{-\mu} . \end{aligned} \tag{62}$$

In order to derive the intertemporal equilibrium dynamics we again use $K_{t+1}^S = I_t^D$, market clearing condition (16) and (14), but dividing the resulting equation on both sides now through Y_t such that we obtain by using (54) and (59):

$$\frac{K_{t+1}}{Y_{t+1}} G_{t+1}^Y \equiv v_{t+1} G_{t+1}^Y = \frac{I_t}{Y_t} = \varphi \frac{H_t}{K_t} \frac{K_t}{Y_t} = \varphi \frac{1}{k_t} v_t = \varphi A^{\frac{-1}{(1-\alpha)}} (v_t)^{\frac{-\alpha}{(1-\alpha)}} (1-u_t)^{-1} \quad (63)$$

The intertemporal equilibrium unemployment rate can be derived analogously to the derivation in the basic model by using the output market identity (18) and inserting the optimal consumption of youth- and old-age consumers, the investment function and government expenditures as a proportion of GDP yields:

$$Y_t = \varepsilon/(\varepsilon+\beta)(1-\alpha)(1-\tau)Y_t + (\alpha/v_t)(K_t + B_t) + \delta Y_t + \gamma_t Y_t + \varphi H_t \quad (64)$$

Dividing equation (64) on both sides through Y_t, we obtain after introducing the capital output and the debt to GDP ratio the following intertemporal equilibrium unemployment rate:

$$u_t = 1 - \frac{\varphi}{[1-\varepsilon/(\varepsilon+\beta)(1-\alpha)(1-\tau) - \alpha(1+b/v_t) - \delta - \gamma_t] A^{\frac{1}{(1-\alpha)}} (v_t)^{\alpha/(1-\alpha)}} \quad (65)$$

The final steps needed to obtain the equation of motion for the capital output ratio entail inserting the GDP growth factor equation (62) into equations (58) and (63). This procedure yields:

$$\gamma_t = b[H_0 A^{\frac{(1-\mu)}{(1-\alpha)}} (\gamma_t)^{1-\mu} (v_{t+1})^{\frac{\alpha}{(1-\alpha)}} (v_t)^{\frac{-\alpha\mu}{(1-\alpha)}} (1-u_{t+1})(1-u_t)^{-\mu} - \frac{\alpha}{v_t}] + \chi, \quad (66)$$

$$H_0 A^{\frac{(2-\mu)}{(1-\alpha)}} (\gamma_t)^{1-\mu} (v_{t+1})^{\frac{1}{(1-\alpha)}} (1-u_{t+1}) = \varphi (v_t)^{\frac{\alpha(\mu-1)}{(1-\alpha)}} (1-u_t)^{\mu-1} \quad (67)$$

Solving (62) for γ_t, we obtain:

$$\gamma_t = [\varphi/(A^{\frac{(2-\mu)}{(1-\alpha)}} H_0)]^{\frac{1}{(1-\mu)}} (v_{t+1})^{\frac{-1}{(1-\alpha)(1-\mu)}} (1-u_{t+1})^{\frac{-1}{(1-\mu)}} (1-u_t)^{-1} (v_t)^{\frac{-\alpha}{(1-\alpha)}} \quad (68)$$

Inserting γ_t from (68) into equations (66) and (65), we obtain two implicit non-linear dynamic equations with v_t and u_t as dynamic variables:

$$\left[\frac{\varphi}{(H_0 A^{\frac{2-\mu}{(1-\alpha)}})}\right]^{\frac{1}{(1-\mu)}} (v_{t+1})^{\frac{-1}{(1-\alpha)(1-\mu)}} (1-u_{t+1})^{\frac{-1}{(1-\mu)}} = \left[\frac{(\varphi b)}{A^{\frac{1}{(1-\alpha)}}}\right] (v_{t+1})^{-1} + [\chi - \frac{\alpha b}{v_t}](v_t)^{\frac{\alpha}{(1-\alpha)}} (1-u_t), \tag{69}$$

$$\left[\frac{\varphi}{(H_0 A^{\frac{1}{(1-\alpha)}})}\right]^{\frac{1}{(1-\mu)}} (v_{t+1})^{\frac{-1}{(1-\alpha)(1-\mu)}} (1-u_{t+1})^{\frac{-1}{(1-\mu)}} = \left[1 - \frac{\varepsilon(1-\alpha)(1-\tau)}{(\varepsilon+\beta)} - \delta - \alpha(1+\frac{b}{v_t})\right] A^{\frac{1}{(1-\alpha)}} (v_t)^{\frac{\alpha}{(1-\alpha)}} (1-u_t) - \varphi. \tag{70}$$

Equating the left hand sides of equations (69) and (70) we obtain after rearranging an explicit solution for v_{t+1} by using the short hand $w_t \equiv 1-u_t$ as follows:

$$v_{t+1} = \frac{\varphi b}{\left[1 - \frac{\varepsilon(1-\alpha)(1-\tau)}{(\varepsilon+\beta)} - \alpha - \tau(1-\alpha)\right] A^{\frac{1}{(1-\alpha)}} (v_t)^{\alpha/(1-\alpha)} w_t - \varphi} \tag{71}$$

Inserting the v_{t+1} from equation (71) into the left hand side of equation (70) we obtain after rearraging also an explicit solution for w_{t+1} as follows:

$$w_{t+1} = \frac{\left\{[1 - \frac{\varepsilon(1-\alpha)(1-\tau)}{(\varepsilon+\beta)} - \alpha - \tau(1-\alpha)] A^{\frac{1}{1-\alpha}} (v_t)^{\frac{\alpha}{(1-\alpha)}} w_t - \varphi\right\}^{\frac{1}{(1-\alpha)}}}{H_0 b^{\frac{1}{(1-\alpha)}} \varphi^{\frac{\alpha}{(1-\alpha)}} A^{\frac{1}{(1-\alpha)}} \left\{\left[1 - \frac{\varepsilon(1-\alpha)(1-\tau)}{(\varepsilon+\beta)} - \delta - \alpha\left(1+\frac{b}{v_t}\right)\right] A^{\frac{1}{(1-\alpha)}} (v_t)^{\frac{\alpha}{(1-\alpha)}} w_t - \varphi\right\}^{(1-\mu)}}. \tag{72}$$

Thus, we finally arrive at a two-dimensional system of first-order difference equations embracing the dynamic variables v_t and w_t.

Existence and dynamic stability of non-trivial steady states

As above, the steady states of the equilibrium dynamics depicted by the difference equations (71) and (72) are defined as $\lim_{t->\infty} v_t = v$ and $\lim_{t->\infty} w_t = w$. In contrast to the basic model, explicit steady state solutions are now impossible. Thus, we have to resort to an intermediate value theorem in order to prove the existence of at least one feasible steady state solution $v_{\min} < v < \infty$ and $0 < w < 1$.

To this end, let us first define for given structural and policy parameters (with the exception of φ) that maximal investor's animal spirits parameter denoted as $\varphi^{\max}$ and that minimal capital output ratio $v_{\min}$ which ensure full employment. Using the steady state version of equation (66) which can be explicitely solved for w as follows:

$$w = \frac{\varphi(b+v)}{[1-\varepsilon(1-\alpha)(1-\tau)/(\varepsilon+\beta)-\alpha-\tau(1-\alpha)]A^{1/(1-\alpha)}v^{1/(1-\alpha)}} \tag{73}$$

and setting $w = 1$ in equation (68), we get immediately:

$$\varphi^{\max} = \frac{[1-\varepsilon(1-\alpha)(1-\tau)/(\varepsilon+\beta)-\alpha-\tau(1-\alpha)]A^{1/(1-\alpha)}(v_{\min})^{1/(1-\alpha)}}{b+v_{\min}}. \tag{74}$$

Using the steady state version of equation (72), setting $w = 1$ and inserting for $\varphi^{\max}$ the right hand side of equation (74) we obtain the following equation in order to determine $v_{\min}$:

$$\begin{aligned}
&H_0 b^{\frac{1}{(1-\alpha)}}\{\frac{[1-\varepsilon(1-\alpha)(1-\tau)/(\varepsilon+\beta)-\alpha-\tau(1-\alpha)]A^{1/(1-\alpha)}(v_{\min})^{1/(1-\alpha)}}{b+v_{\min}}\}^{\frac{\alpha}{(1-\alpha)}} A^{\frac{1}{(1-\alpha)}} \\
&\{[1-\frac{\varepsilon(1-\alpha)(1-\tau)}{(\varepsilon+\beta)}-\delta-\alpha(1+b/v_{\min})]A^{\frac{1}{(1-\alpha)}}(v_{\min})^{\frac{\alpha}{(1-\alpha)}} - \\
&\frac{[1-\varepsilon(1-\alpha)(1-\tau)/(\varepsilon+\beta)-\alpha-\tau(1-\alpha)]A^{1/(1-\alpha)}(v_{\min})^{1/(1-\alpha)}}{b+v_{\min}}\}^{(1-\mu)} = \\
&\{[1-\frac{\varepsilon(1-\alpha)(1-\tau)}{(\varepsilon+\beta)}-\alpha-\tau(1-\alpha)]A^{\frac{1}{1-\alpha}}(v_{\min})^{\frac{\alpha}{(1-\alpha)}} \\
&-\frac{[1-\varepsilon(1-\alpha)(1-\tau)/(\varepsilon+\beta)-\alpha-\tau(1-\alpha)]A^{1/(1-\alpha)}(v_{\min})^{1/(1-\alpha)}}{b+v_{\min}}\}^{\frac{1}{(1-\alpha)}}.
\end{aligned} \tag{75}$$

Now we are prepared to state the following parameter restriction (PR):

PR: Let $0<\alpha<1, 0<\varepsilon<1, 0<\beta<1, 0<\tau<1, 0<\mu<1, b>0, H_0>0$, $A>0$ such that equation (75) can be solved for a real and strictly positive $v_{\min}$.

Moreover, for the proof of the following proposition it is useful to define the following continuous real-valued functions $LHS(v)$ and $RHS(v)$:

$$LHS(v) \equiv H_0 A^{\frac{1}{(1-\alpha)}} b^{\frac{1}{(1-\alpha)}} \varphi^{\frac{\alpha}{(1-\alpha)}} \{[1 - \frac{\varepsilon(1-\alpha)(1-\tau)}{(\varepsilon+\beta)} - \delta - \alpha(1+\frac{b}{v})] A^{\frac{1}{(1-\alpha)}} v^{\frac{\alpha}{(1-\alpha)}} w - \varphi\}^{1-\mu}, \tag{76}$$

$$RHS(v) \equiv \frac{\left\{[1 - \frac{\varepsilon(1-\alpha)(1-\tau)}{(\varepsilon+\beta)} - \alpha - \tau(1-\alpha)] A^{\frac{1}{(1-\alpha)}} v^{\frac{\alpha}{(1-\alpha)}} w - \varphi\right\}^{\frac{1}{(1-\alpha)}}}{w}. \tag{77}$$

Proposition 3. Suppose that PR holds with $1/(1-\alpha) > \mu$ and $\chi > 0$. Then, at least one steady state solution $v_{\min} \le v < \infty$ and $0 < w \le 1$ of the equilibrium dynamics (71) and (72) exists.

Proof.

For $\varphi = \varphi^{\max}$ we know from PR that $w = 1$ and $v = v_{\min}$. Thus, let be $\varphi < \varphi^{\max}$. Under this presumption, we want to show that $v_{\min} < v < \infty$ and $0 < w < 1$. From equation (73) and $dw/dv = -A^{-1/(1-\alpha)}(\varepsilon+\beta)\varphi v^{(\alpha-2)/(1-\alpha)} /[(1-\alpha)^2 \beta(1-\tau)] < 0$ follows immediately $0 < w < 1$. In order to show that $v_{\min} < v < \infty$ whereby v is the solution of $LHS(v) = RHS(v)$ we apply an intermediate value theorem. To this end, we have to show that $LHS(v_{\min}) < RHS(v_{\min})$ and $\lim_{v->\infty} LHS(v) > \lim_{v->\infty} RHS(v)$. In order to show $LHS(v_{\min}) < RHS(v_{\min})$ note first that $RHS(v_{\min}) = \{A^{1/(1-\alpha)}(1-\alpha)b\beta(1-\tau)(v_{\min})^{\alpha/(1-\alpha)} /[(\varepsilon+\beta)H_0(b+v_{\min})]\}^{1/(1-\alpha)}$ which does not depend on φ. In contrast, $LHS(v_{\min})$ does depend on φ and one can show for $1/(1-\alpha) > \mu$ that $\partial \mathrm{LHS}(\mathrm{v}_{\min})/\partial\varphi > 0$. By definition we know that $LHS(v_{\min})(\varphi^{\max}) = RHS(v_{\min})(\varphi^{\max})$. Since $RHS(v_{\min})$ does not change with $\varphi < \varphi^{\max}$ while $LHS(v_{\min})(\varphi) < LHS(v_{\min})(\varphi^{\max})$ because of $\partial \mathrm{LHS}(\mathrm{v}_{\min})/\partial\varphi > 0$ we are ensured that $LHS(v_{\min})(\varphi) < RHS(v_{\min})(\varphi)\ \forall \varphi < \varphi^{\max}$. In order to show $\lim_{v->\infty} LHS(v) > \lim_{v->\infty} RHS(v)$ note that $\lim_{v->\infty} LHS(v) = A^{1/(1-\alpha)} b^{1/(1-\alpha)} \varphi^{1/(1-\alpha)-\mu} H_0 \{(\beta+\varepsilon)\chi/[(1-\alpha)\beta(1-\tau)]\}^{1-\mu} > 0$ while $\lim_{v->\infty} RHS(v) = 0$. Thus, $\lim_{v->\infty} LHS(v) > \lim_{v->\infty} RHS(v)$. Since both $LHS(v)$ and $RHS(v)$ are continuous functions on the interval $(v_{\min}, \infty)$ we are ensured that $LHS(v) = RHS(v)$. Q.E.D.

The next step is to investigate the local dynamic stability of steady state solutions $\{(v,w)\}$. To this end, we do, however, not directly differentiate the first-order difference equation system (71) und (72) with respect to v_t and w_t but use the intertemporal equilibrium equations (58) (62), (63) and (65) and differentiate these equations totally with respect to all endogenous variables $v_{t+1}, v_t, w_{t+1}, w_t, G^Y_{t+1}, \gamma_t$. Then, we form the Jacobian matrix of partial differentials evaluated at a steady state solution (v,w) as follows:

$$J(v,w) \equiv \begin{bmatrix} \frac{\partial v_{t+1}}{\partial v_t}(v,w) & \frac{\partial v_{t+1}}{\partial w_t}(v,w) \\ \frac{\partial w_{t+1}}{\partial v_t}(v,w) & \frac{\partial w_{t+1}}{\partial w_t}(v,w) \end{bmatrix}, \tag{78}$$

with

$$\frac{\partial v_{t+1}}{\partial v_t}(v,w) \equiv j_{11} = -\frac{\alpha[v+b]}{(1-\alpha)b} < 0,$$

$$\frac{\partial v_{t+1}}{\partial w_t}(v,w) \equiv j_{12} = -\frac{v[v+b]}{bw} < 0,$$

$$\frac{\partial w_{t+1}}{\partial v_t}(v,w) \equiv j_{21}$$

$$= \frac{\alpha w\left\langle v^2[\gamma-(1-\alpha)(1-\mu)bG^Y]+b\{\gamma v[\alpha+\mu(1-\alpha)]-(1-\alpha)^2(1-\mu)b\}\right\rangle}{(1-\alpha)^2 b\gamma v^2},$$

$$\frac{\partial w_{t+1}}{\partial w_t}(v,w) \equiv j_{22}$$

$$= \frac{[\gamma-(1-\alpha)(1-\mu)bG^Y]+b\gamma[\mu+\alpha(1-\mu)]}{(1-\alpha)b\gamma}.$$

While obviously the first row of the Jacobian (78) exhibits negative entries, the sign of the first element in the second row is in general unkown while $j_{22} > 0$. In order to investigate the dynamic stability of steady state solutions following from $LHS(v) = RHS(v)$, we need to know the signs and the magnitudes of the eigenvalues of Jacobian (78). As is well-known the eigenvalues of the 2x2 Jacobian matrix (78) are defined as follows: $\lambda_{1,2} \equiv [trJ(v,w) \pm \sqrt{\Delta(v,w)}]/2$ with $trJ(v,w)$ denoting the trace of the Jacobian matrix (78) and $\Delta(v,w)$ being the discriminant of this matrix defined as $\Delta(v,w) \equiv trJ(v,w)^2 - 4\det J(v,w)$, respectively, where $\det J(v,w)$ denotes the determinant of the Jacobian matrix (78).

The algebraic calculation of the trace and of the determinant of the Jacobian matrix (78) yields the following results:

$$trJ(v,w) = \mu + \frac{[\gamma - (1-\mu)bG^Y]v}{b\gamma} > 0\,, \tag{79}$$

$$\det J(v,w) = -\frac{\alpha(1-\mu)(b+v)}{\gamma\, v} < 0\,. \tag{80}$$

Obviously, the determinant of the Jacobian is for at all feasible steady state solutions less than zero where the trace is certainly larger then zero if $\gamma - (1-\mu)bG^Y > 0$. Using the trace (79) and the Jacobian (80), the eigenvalues of the Jacobian (78) read as follows:

$$\begin{aligned}\lambda_{1,2} = \frac{1}{2}\Bigg\{ & \mu + \frac{[\gamma - (1-\mu)bG^Y]v}{b\gamma} \\ & \pm \Bigg[\left(\mu + \frac{[\gamma - (1-\mu)bG^Y]v}{b\gamma}\right)^2 + \frac{4\alpha(1-\mu)(b+v)}{\gamma v}\Bigg\}^{\frac{1}{2}}.\end{aligned} \tag{81}$$

A glance on the eigenvalue formula (81) reveals immediately that both eigenvalues are real since the term under the square root is certainly larger than zero. It is also clear from formula (81) that for $\gamma > (1-\mu)bG^Y$ the first eigenvalue is strictly larger than zero while the second eigenvalue is less than zero. To obtain information on the magnitudes of the eigenvalues we make use of Lemma A1 in the Appendix of Galor (1992, p. 1383) which says inter alia: $\lambda_1 > 1$ and $-1 < \lambda_2 < 0$ if and only if $trJ(v,w) \geq 2 \vee 1 - trJ(v,w) + \det J(v,w) < 0$ and $trJ(v,w) > -2 \wedge 1 + trJ(v,w) + \det J(v,w) > 0 \wedge \det J(v,w) < 0$. We know for sure that $\det J(v,w) < 0$ and $trJ(v,w) > -2$ for $\gamma - (1-\mu)bG^Y > 0$. It is also true that $1 - trJ(v,w) + \det J(v,w) < 0$ and $1 + trJ(v,w) + \det J(v,w) > 0$ at least for a broad set of feasible parameter combinations.

Thus, these results suggest the following proposition:

Proposition 4. Suppose the assumptions of Proposition 3 hold. Then, the algebraic calculation of the eigenvalues λ_1 and λ_2 of the Jacobian at a steady state solution $v_{\min} < v < \infty$ and $0 < w < 1$ brings forth that $\lambda_1 > 1$ and $-1 < \lambda_2 < 0$.

In other words: steady state solutions represent oscillating saddle points with v_t as slowly moving variable and w_t as jump variable. With $v_0 = \overline{v} > 0$ historically given, w_0 jumps on the saddle-path along which both variables converge in oscillations towards a steady state solution.

Being assured that steady state solutions of the equilibrium dynamics (71) and (72) exist and are saddle-point stable we are entitled to perform comparative steady analysis.

Comparative Steady State Analysis*: *How a Larger Government Debt to GDP ratio affects the Unemployment Rate

In this section we want to explore how a larger government debt to GDP ratio affects the GDP growth rate and the unemployment rate in a steady state. Lin (2000) finds in a comparable OLG model with endogenous growth and full employment that a higher government debt to GDP ratio raises the GDP growth rate if the growth rate is larger than the real interest rate in the initial steady state while a larger government debt to GDP ratio lowers the GDP growth rate if the real interest rate is higher than the GDP growth rate in the initial steady state. It will be interesting to see whether the growth rate effect of more government debt will in our model with an independent aggregate investment function also depend on the initial GDP growth rate and interest rate difference or not. Moreover, of particular interest is the public debt effect on the unemployment rate which could not be explored by Lin (2000).

In order to be ready to answer these open questions, we use now the steady state version of the intertemporal equilibrium equations (58) and (62), (63) and (65) and differentiate the resulting static equation system totally with respect to γ, G^Y, v, w and b. We obtain the following linear equation system with respect to the total differentials $d\gamma, dG^Y, dv, dw, db$:

$$d\gamma = (G^Y - q)db + bdG^Y + \alpha b / v^2 dv\,, \tag{82}$$

$$dG^Y = (1-\mu)G^Y\left(\frac{d\gamma}{\gamma} + \frac{\alpha}{(1-\alpha)}\frac{dv}{v} + \frac{dw}{w}\right), \tag{83}$$

$$\frac{dG^Y}{G^Y} + \frac{dw}{w} + \frac{dv}{(1-\alpha)v} = 0\,, \tag{84}$$

$$\frac{dw}{w} + \left[\frac{1}{(1-\alpha)} + \frac{b}{(G^Y v^2)}\right]qdv - \frac{d\gamma}{(G^Y v)} = \frac{qdb}{G^Y v}\,. \tag{85}$$

Solving simultaneously equations (82) and (83) for $d\gamma$ and dG^Y and inserting the resulting equations into equations (84) and (85) we obtain after rearranging the following two-dimensional linear equations system:

$$\begin{aligned}(1 - j_{11})dv - j_{12}dw &= j_{13}db,\\ -j_{21}dv + (1 - j_{22})dw &= j_{23}db,\end{aligned} \tag{86}$$

with

$$j_{13} = \frac{\alpha + (G^Y - q)v}{bG^Y}\,,$$

$$j_{23} = -\frac{\{\alpha[\gamma-(1-\mu)bG^Y]+(1-\mu)\alpha^2 bG^Y+\gamma(G^Y-q)v\}w}{(1-\alpha)b\gamma G^Y v}.$$

In order to get dv/db and dw/db we apply Cramer's rule to the linear equation system (86) the result of which reads as follows:

$$\frac{dv}{db} = \frac{\begin{vmatrix} j_{13} & -j_{12} \\ j_{23} & 1-j_{22} \end{vmatrix}}{\{1-\mu-\frac{[\gamma-(1-\mu)bG^Y]v}{b\gamma}+DetJ\}} \tag{87}$$

and

$$\frac{dw}{db} = \frac{\begin{vmatrix} 1-j_{11} & j_{13} \\ -j_{21} & j_{23} \end{vmatrix}}{\{1-\mu-\frac{[\gamma-(1-\mu)bG^Y]v}{b\gamma}+DetJ\}} \tag{88}$$

Using the elements of the Jacobian matrix (78) and the additional coefficients of the linear equation system (86) to calculate the determinants in (87) and (88) we obtain the following results:

$$\frac{dv}{db} = \frac{\alpha\{[\gamma(2-\mu)-(1-\mu)bG^Y]+(G^Y-q)v[(1-\mu)G^Y v+(2-\mu)\gamma]\}}{b\gamma G^Y\{1-\mu-\frac{[\gamma-(1-\mu)bG^Y]v}{b\gamma}+DetJ\}}, \tag{89}$$

$$\begin{aligned}\frac{dw}{db} = &\Big\langle\{(G^Y-q)w\{\alpha(1-\mu)G^Y v^3+\alpha(1-\alpha)(1-\mu)bv+\gamma[1+\alpha(1-\mu)]v^2\} \\ &+\{(1-\alpha)(1-\mu)\alpha^2 b+\alpha v[\gamma-(1-\mu)bG^Y]+\alpha^2\gamma(1-\mu)\}v\}\Big\rangle \\ &/\Big\langle(\alpha-1)b\gamma G^Y v^2\{1-\mu-\frac{[\gamma-(1-\mu)bG^Y]v}{b\gamma}+DetJ\}\Big\rangle.\end{aligned} \tag{90}$$

The right hand side of the differential quotient (89) shows that a higher public debt to GDP ratio affects the capital output ratio unambiguously negatively if $\gamma > (1-\mu)bG^Y$ and dynamic inefficiency prevails, i.e. the GDP growth factor is larger than the real interest factor since $1-TrJ+DetJ<0$. Under dynamic efficiency, i.e. the real interest factor is larger than the GDP growth factor the response of the capital output ratio to a higher public debt to GDP ratio becomes in general ambiguous. Depending on the numerical values of structural and policy parameters there are dynamic efficient parameter combinations at which the capital

output ratio decreases when the debt to GDP ratio increases and other dynamic efficient parameter combinations which induce an increasing capital output ratio with a higher debt to GDP ratio.

More interesting from a policy point of view is the response of the unemployment rate to a higher government debt to GDP ratio which is shown by the term on the right hand side of equation (90). Again, when $\gamma > (1-\mu)bG^Y$ and dynamic inefficiency prevails the response of unity minus the unemployment rate is unambiguously positive and hence a higher public debt to GDP ratio reduces the unemployment rate. Why this is so is partly explained by a look on the output market equilibrium equation (65). It shows that unity minus the unemployment rate balances the fixed investment to GDP ratio with the other aggregate demand to GDP ratios. When due to a higher debt to GDP ratio old consumers demand on account of higher wealth a larger proportion of the GDP the unemployment must fall. Moreover, higher public debt raises the real interest rate which necessitates a decline of the capital output ratio due to profit maximization which additionally increases labor demand and hence reduces unemployment.

While the negative response of the capital output ratio and the unemployment rate to a higher public debt ratio can for dynamic inefficiency demonstrated analytically (see equations (89) and (90)) it is interesting to know whether this is also possible for the HCI expenditure ratio and the GDP growth factor.

The calculation of the steady state HCI expenditure ratio differential from equations (82) and (83) brings forth the following result:

$$d\gamma = \frac{\gamma\{(1-\alpha)(G^Y-q)vw\,db + (1-\alpha)(1-\mu)bvG^Y dw + bqw[G^Y v(1-\mu)+(1-\alpha)]dv\}}{(1-\alpha)[\gamma-(1-\mu)bG^Y]vw}. \quad (91)$$

While on the right hand side of equation (91) all coefficients in front of the differentials dv, dw and db are unambiguously positive for the case of dynamic inefficiency the total reaction of the steady state HCI expenditure ratio to a change in the government debt to GDP ratio cannot be unambiguously stated in general because under dynamic inefficiency w increases while v decreases with a higher debt to GDP ratio. This ambiguity cannot even be resolved if one solves equations (82)-(86) simultaneously with respect to $dv, dw, d\gamma, dG^Y$, and calculates $d\gamma / db$ which yields:

$$\frac{d\gamma}{db} = \frac{\gamma[(G^Y-q)v - qb]}{[\gamma - b(1-\mu)G^Y]v + b(1-\mu)[\alpha + bq - \gamma]}. \quad (92)$$

A similar observation pertains to the steady state response of the GDP growth factor to a higher government debt to GDP ratio which shows the following result from the simultaneous solution of equations (82) und (83):

$$dG^Y = (1-\mu)G^Y\{(1-\alpha)vw(G^Y-q)\,db + (1-\alpha)\gamma v\,dw + qw[(1-\alpha)b+\gamma v]dv\}/\{(1-\alpha)[\gamma-(1-\mu)bG^Y]vw\}. \quad (93)$$

Again, the ambiguity of the sign of dG^Y/db does not vanish if one calculates dG^Y/db from the simultaneous solution of equations (82)-(86) which yields:

$$\frac{dG^Y}{db} = \frac{(1-\mu)G^Y[(G^Y-q)v+\gamma-qb]}{[\gamma-b(1-\mu)G^Y]v+b(1-\mu)[\alpha+bq-\gamma]}. \quad (94)$$

Because even in case of dynamic inefficiency both the response of the HCI ratio and the GDP growth factor is in general ambiguous we resort now to four typical numerical parameter sets in line with the assumptions of Proposition 3 in order to obtain unambiguously numerical results. The first parameter set (denoted as parameter combination A) induces a dynamic inefficient steady state while the remaining parameter sets (denoted as parameter combinations B, C and D) imply dynamic efficiency.

Parameter combination A: $\beta = 0.6, \varepsilon = 0.2, \alpha = 0.25, \tau = 0.35, \mu = 0.5,$ $A = 10, H_0 = 2$, $\delta = 0.2$, $\varphi = 3.6, b = 0.024$. Parameter combination B is identical to A with the exception that $\alpha = 0.3, \tau = 0.4, \varphi = 3.$ Parameter set C ist identical to parameter set B with the exception that $\tau = 0.5, \varepsilon = 0.4, \varphi = 1.4$. Finally, parameter set D is identical to parameter set C with the exception of $\alpha = 0.4, \varphi = 1.5$. Parameter set A can be characterized as exhibiting a relatively low tax rate, a high labor income share and an optimistitic animal spirits scenario. Parameter set B exhibits also optimistic animal spirits but the wage tax rate is higher and the labor income share lower than in the case before. Both parameter sets A and B comprise a relatively low youth age propensity to consume. In contrast, the youth age propensity to consume is significantly higher in parameter sets C and D: Moreover, the latter parameter sets exhibit the highest wage tax rate and relatively low animal spirits parameter. The main difference between parameter set C and D is the relatively high capital income share in the latter. The calculation of the steady state solutions for the capital output ratio v, the GDP growth factor G^Y, the HCI expenditure ratio γ, unity minus the unemployment rate w and the real interest factor under all parameter combinations are depicted in the following Table 1.

Table 1. Steady solutions under parameter combinations A-D before the policy shock.

	capital-output ratio	GDP growth factor	One minus unemployment rate	HCI expenditure ratio	Interest factor
A	0.179660	1.79527	0.918128	0.072190	1.39151
B	0.148516	1.82593	0.933794	0.0753423	2.01999
C	0.083712	1.94965	0.925716	0.110782	3.58374
D	0.109539	1.34792	0.956043	0.0447103	3.65165

For the policy shock, assume that b is increased from $b = 0.024$ towards $b = 0.03$. How the steady state solutions change after the policy shock is delineated in the following Table 2.

Table 2. Steady solutions under parameter combinations A-D after the policy shock.

	capital-output ratio	GDP growth factor	One minus unemployment rate	HCI expenditure ratio	Interest factor
A	0.168313	1.84368	0.975277	0.073251	1.48533
B	0.143287	1.81779	0.987242	0.071723	2.09369
C	0.082018	1.87478	0.991294	0.096505	3.65796
D	0.118573	1.21152	0.932070	0.035142	3.37344

The comparison of the steady state solutions before and after the policy shock depicted in Table 1 und Table 2 shows two extreme scenarios from a policy perspective: while the results of higher public debt under parameter combination A can be termed Keynesian, those under parameter combination D resemble neo-classical policy expectations. Higher public debt under dynamic inefficiency in Keynesian case A increases the HCI expenditure ratio, accelerates GDP growth and the real interest rate while it reduces the capital output ratio and the unemployment rate. On the contrary, higher public debt under dynamic efficiency in neo-classical case D reduces the HCI expenditure ratio, the GDP growth and the real interest rate, while it raises the capital output ratio and the unemployment rate. The latter is remarkable because only in case D higher public debt raises the unemployment rate. Parameter combination C is close to parameter combination D with the expception of a lower capital income share which is associated with the unemployment reducing effect of higher public debt. Parameter combinations B and C are both dynamically efficient scenarios (as combination D) with rather optimistic animal spirits but the wage tax rate and youth age marginal propensity to consumption are lower in case B than in case C. As a consequence, a higher public debt triggers in both cases qualitatively the same response of main endogenous variables: the HCI expenditure ratio, the GDP growth rate, the capital output ratio and the unemployment rate decline while the real interest rate rises.

An empirical application: Debt reduction in Euro Area and selected European countries

Before concluding, we apply the theoretical framework of a large closed economy presented in previous section on economic areas with approximately balanced current accounts. We present both a dynamically inefficient scenario, i.e. the real interest factor is smaller than the GDP growth factor, and a dynamically efficient scenario, i.e. the real interest factor is larger than the GDP growth factor. The first sample is called the “dynamic inefficiency sample” (Sample DYNIE) which consists of 19 Euro Area countries. The second sample is called the „dynamic

efficiency sample“ (Sample DYNE) and consists of 12 selected European countries, i.e. Austria, Bulgaria, Croatia, Germany, Greece, Hungary, Italy, Netherlands, Portugal, Romania, Slovenia, and Spain. For our empirical application, we mainly use data from the AMECO database of the European Commission. Data on average labor income tax rates come from the OECD tax database and the annual reports on taxation trends of the European Commission. Regarding the closed economy feature of our modeling framework, note that the current account of the Euro Area has been roughly balanced over the period 2008 to 2016. The same holds true for the selected European countries of the second sample as a whole.

The numerical specification of all model parameters proceeds in several steps. First, we identify the numerical values of the fiscal policy parameters and the unemployment rate corresponding to DYNIE as follows: the HCI expenditure ratio, the tax rate on labor income and the unemployment rate in the Euro Area exhibit on average 5.26%, 37.37% and 9.20%, respectively. For the numerical values of the fiscal policy parameters and the unemployment rate corresponding to the DYNE we encounter an average HCI expenditure ratio of 5.26%, an average tax rate on labor income of 37.37% and an average unemployment rate of 9.20% in the selected European countries.

Second, we fix in the DYNIE the GDP growth factor at 1,711239. This corresponds to a yearly growth rate of 2.17% in the Euro Area. The DYNE GDP growth factor is fixed at 1,511787. This corresponds to a yearly growth rate of 1.67% in the selected European countries. We set the DYNIE real interest factor at 1,669357 and the DYNE real interest factor at 1,719198, which is equivalent to an average annual real interest rate of 2.07% in the Euro Area and of 2.19% in the selected European countries respectively. The DYNIE public debt to GDP ratio is fixed at 0,024706. This corresponds to a yearly Euro Area public debt to GDP ratio of 61.77%. The public debt to GDP ratio DYNE is fixed at 0,027157. This corresponds to a yearly average public debt to GDP ratio of the selected countries of 67.89%.

Third, there are some structural parameter values, which we take from the relevant literature. These include the total factor productivity A, the utility elasticity of consumption in youth ε, the level parameter H_0 and the human capital production elasticity μ. The total factor productivity in DYNIE is set at 17, that in DYNE is set at 14.5 (see the similar values in Auerbach and Kotlikoff, 1998). The utility elasticity of consumption in youth ε, the level parameter H_0 and the human capital production elasticity μ is set in both samples at 0.5, 1.65 and 0.45 respectively (for the numerical value of the utility elasticity of consumption in youth see Auerbach and Kotlikoff, 1987, for the level parameter as well as for the human capital production elasticity see Lin, 2000).

Forth we calibrate the remaining structural and policy parameters α, β and δ such that the steady state versions of the equations (58), (62) and (71) hold and get the following calibration results for DYNIE: $\alpha = 0.260379,\ \beta = 0.903367,\ \delta = 0.224878$ and for DYNE: $\alpha = 0.285637,\ \beta = 0.938301,\ \delta = 0.228447$. The calibrated parameter values for the capital income share, the future utility discount factor und the non-HCI government expenditure ratio correspond roughly to the parameters values found in the literature (see e.g. De la Croix and Michel (2002)).

Given all parameter values so far we are able to calculate the benchmark solutions for the capital-output-ratios from the steady state version of equation (71). The calculation yields a DYNIE capital-output-ratio of 0.155976 and a DYNE capital-output-ratio of 0.166146 which corresponds to a yearly capital-output-ratio of 3.90 in the Euro Area and to a yearly capital-output-ratio in the selected European countries of 4.15, respectively. Finally, the animal spirits parameter results from equation (65) and is equal to 5.807785 in DYNIE and equals 4.681602 in DYNE.

Knowing the benchmark solution for both samples, we are now in a position to quantify the steady state impacts of an increase in public debt from $b = 0.024$ to $b = 0.03$, i.e. an increase of 25%. Table 3 reports the results for DYNIE.

Table 3. Steady solutions before and after the policy shock in DYNIE.

Benchmark solution		Public debt increased by 25%	
Capital output ratio	0.155976	Capital output ratio	0.150248
GDP growth factor	1.711239	GDP growth factor	1.715358
Unity minus unemployment rate	0.908034	One minus unemployment rate	0.952856
HCI expenditure ratio	0.052570	HCI expenditure ratio	0.051006
Interest factor	1.669357	Interest factor	1.732998

Comparing the benchmark case to the policy case of an increased public debt we see that the overall effects on the capital output ratio, the GDP growth factor, the unemployment rate and the real interest rate are the same as under parameter combination A. Higher public debt increases the GDP growth factor and the real interest rate while it reduces the capital output ratio and the unemployment rate. Only the HCI expenditure ratio declines whereas under parameter combination A a higher public debt to GDP ratio increases the HCI expenditure ratio. The reason is that the numerical values of the GDP growth factor and the real interest factor in DYNIE are too close to each other such that the positive impact of the bracket term $\left(G^{Y} - q\right)$ in equation (82) is too small to boost the HCI expenditure ratio due to higher public debt as under parameter combination A.

Finally, we present the steady state solutions before and after the policy shock for DYNE. The results are reported in Table 4.

Table 4. Steady solutions before and after the policy shock for DYNE.

Benchmark solution		Public debt increased by 25%	
Capital output ratio	0.166146	Capital output ratio	0.164577
GDP growth factor	1.511787	GDP growth factor	1.501886
One minus unemployment rate	0.904402	One minus unemployment rate	0.922534
HCI expenditure ratio	0.047899	HCI expenditure ratio	0.046521
Interest factor	1.719198	Interest factor	1.735585

In DYNE a higher public debt to GDP ratio boosts the real interest rate and impacts negatively the capital output ratio, the GDP growth factor, the unemployment rate and the HCI expenditure ratio. Thus, we can observe the same response of endogenous variables as under parameter combination B.

4. Conclusions

As outlined in the introduction this paper seeks to integrate involuntary unemployment in a neoclassical growth model with internal public debt and human capital accumulation. In contrast to mainstream new-Keynesian macro models in which involuntary unemployment is traced back to inflexible wages, output prices and interest rates vis-à-vis market imbalances, real wages and real interest rates are perfectly flexible in our basic neo-classical growth model with internal public debt à la Diamond (1965). The real wages and the real interest rate are also perfectly flexible in the subsequent OLG model extended by human capital accumulation. In both growth models involuntary unemployment occurs since in line with Morishima (1977) and Magnani (2015) aggregate investment is inflexible due to investors' animal spirits.

Both for the functionally specified Diamond (1965) and the extended OLG model with inflexible aggregate investment we demonstrate analytically the existence and saddle-path stability of a steady state solution of the intertemporal equilibrium dynamics. While in the basic model the government has to choose a certain tax rate such that with historically given public debt and private real capital stocks a steady state solution exists and is immediately reached, in the extended model the capital output ratio converges in damped oscillations from a historically given towards its steady state level.

Being assured of the existence and dynamic stability of steady state solutions we performed comparative steady state analysis for both models. For the basic model we could show analytically that less optimistic animal spirits of investors and thriftier youth age households raise the unemployment rate as in Keynesian macro models. Hereby we confirm the main results which Magnani (2015) obtains in his Solow (1956) growth model with inflexible aggregate investment. Due to the exogenity of growth and full employment Magnani (2015) could not investigate the effects of public debt on GDP growth and unemployment in Solow's neo-classical model. What Magnani (2015) was not able to do we investigated in the OLG model extended by human capital accumulation and an exogenously fixed government debt to GDP ratio. Only for the case of dynamic inefficiency where the initial GDP growth rate is higher than the real interest rate we could demonstrate analytically that a higher public debt raises the real interest rate while both the capital output ratio and the unemployment rate decline. The effect on the real GDP growth rate as well as on the HCI expenditure ratio is in general ambiguous.

With dynamic efficiency the effects of higher public debt on main endogenous variables are in general ambiguous. However, for a parameter set with a rather high capital income share, a high wage tax rate and a high youth-age propensity to consume we obtained results in line with neo-classical policy expectations: higher public debt raises the unemployment rate and the capital output ratio while it reduces the HCI expenditure ratio, the GDP growth rate and (somewhat

unexpected) the real interest rate. Two other dynamically efficient scenarios in between the extreme scenarios A and D demonstrate that higher public debt is associated with lower unemployment although GDP growth and HCI expenditures are lower. The main reason for this result is that higher public debt creates a positive wealth effect with old-age consumers which raises aggregate demand and hence reduces unemployment.

The limitations of the present research results are obvious. First, a more general interest-rate dependent aggregate investment function as indicated above could be used in order to see whether the main results we obtained carry over to the more general case. Second, stock-market foundations for the aggregate investment function in line with Farmer's (2012, 2013) investor's belief function should be provided in order to overcome the purely macro-foundation of the aggregate investment function. Both subjects are left to future research.

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DETERMINANTS OF FDI IN BRICS COUNTRIES: PANEL DATA APPROACH

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Abstract: We empirically investigates the factors that affect Foreign Direct Investment (FDI) inflows in five BRICS countries for the period 1990–2015. We address the selection bias and unobserved heterogeneity by estimating a panel Heckman selection method and attempts to account for both selection and endogeneity within the new two-stage method. After addressing the above mentioned econometric issues, the infrastructure and GDP per capita variables under the new two-stage method remain positive and significantly similar to the coefficient of infrastructure and GDP per capita under the panel Heckman selection model. In addition, the inverse Mills ratio maintain its level of statistical significance, confirming the presence of both sample selection bias and endogeneity.

JEL classification: C22; F21; O16

Keywords: endogeneity; heterogeneity; FDI; BRICS, infrastructure

1. Introduction

BRICS[1] countries are increasingly becoming a force to reckon within the global economy (Cakır and Kabundi, 2013a, 2013b, 2017). Officially recorded foreign direct investment inflows to Brazil, Russian, India, China and South Africa (BRICS) countries reached an estimated $277 billion in 2016, growing by 7 per cent compared with 2015 (World Investment Report, 2017). A significant proportion of BRICS's FDI outflows increase tends to go to low income countries. For example,

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[1] BRICS is an acronym for Brazil, Russia, India, China, and South Africa -- emerging economies

"FDI flows from BRICs to LICs reached about US$2.2 billion in 2009, about 2–3 percent of total FDI flows from BRICs. Of this total, Sub-Saharan Africa (SSA) LICs received about US$0.9 billion" Mlachila, and Takebe (2011). BRICS FDI also exerts a significant, positive impact on growth in low-income countries and SADC exports (Clus-Rossouw et al 2015). Needless to say that this relative increase in the proportion of FDI flows from BRICs to LICs can potentially encourage beneficiaries to adopt FDI-friendly policies.

The literature concerning the factors that affect Foreign Direct Investment on various groups of countries is vast (Asiedu (2006) for Africa; Asiedu (2002) for Developing Countries; Lucas (1993) for East and South Asian economies; Beven and Estrin (2000) for transition economies (Central and Eastern Europe); Akpan, et al (2014) for BRICS and MINT; Xaypanya et al (2015) for ASEAN; Nunnenkamp & Spatz (2002) for developing countries, Sahoo (2006) for South Asian countries; Tintin (2013) for Central and Eastern European Countries). However, the empirical evidence on the determinants of Foreign Direct Investment in BRICS countries (i) remains thin and far from conclusive (ii) the statistical inference of some of these studies (such Kishor et al (2015) and Vijayakumar et al, 2010) relies heavily on panel data methods such as random effect (RE) and fixed effects (FE). While FE and RE can help to mitigate issues caused by omitted variables, these techniques do not address two other sources of endogeneity—potential reverse causality from the dependent variable (such FDI) to the explanatory variables (such as GDP), and possible error in the measurement of the variables resulting in biased estimated coefficients.

Thus, we contribute and improves on the existing literature by first investigating the determinants of FDI in the BRICS context. Secondly, we make use of appropriate panel data models (such as panel Heckman selection models and a new two-stage framework developed by Semykina and Wooldridge (2010)) in order to provide more robust estimates and address the potential bias stemming from problems such as endogeneity, heterogeneity and selection bias that may have affected previous empirical work on the determinants of FDI (Akpan, et al, 2014)

The remainder of this article is organized as follows: Section two reviews the literature on the effects of various economic factors affecting foreign direct investment. Section three discusses the methodology, database and variables and Section four presents the results. The last section provides some concluding remarks.

2. Literature review

Using Dunnings (1973) eclectic paradigm as theoretical lenses, several studies have used different explanatory variables as determinants of inward FDI. Though many variables have been used in the empirical literature, most studies we surveyed have used the following as main determinants of inward FDI: Market size (Ranjan and Agrawal, 2011; Lokesha and Leelavathy; 2012; Forte and Santos, 2015), trade openness (Demirhan and Masca, 2008; Sekkat and Venganzones-Varoundakis, 2007; Phung, 2016; Ranjan and Agrawal, 2011), The quality and cost of labor force (Ranjan and Agrawal, 2011; Forte and Santos, 2015; Bevan and Estrin,

2004; Sharma, Nayagam and Chang, 2012; Carstensen and Taubal, 2003), quality of infrastructure (Sharma, Nayagam and Chang, 2012; Demirhan and Masca, 2008; Vijayakumar, Sridharan and Sekhara Rao, 2010) and macroeconomic stability (Ranjan and Agrawal, 2011; Lokesha and Leelavthy; 2012).

Starting with the host country market size, most studies we surveyed found that the size of the host country market (measured by GDP or GDP per capita) is significant in attracting inward FDI (see for example Phung, 2016; Ranjan and Agrawal, 2011 and Mottlaled and Kalirajan, 2010). In support of a host country market size, Phung (2016) investigated the determinants of FDI inflows in developing countries using OLS, fixed effect and random effect panel data models. He found that GDP (used as proxy for country market size) was an important determinant of FDI inflows. Obtaining similar results, Mottlaled and Kalirajan (2010) used a panel random effect generalized least square model to investigate the determinants of FDI inflows in a panel of 68 developing countries. They found that the size of countries GDP (also used as proxy for country market size) was important in determining FDI inflows in developing countries. These empirical results seem to also hold in developed countries as well (see for example Bevan and Estrin, 2004; Carstensen and Toubal, 2004). A study by Carstensen and Toubal (2003) employed a dynamic panel data to examine the determinants of FDI inflows in Central and East European countries. They found that country market size was significant in explaining FDI inflows.

Infrastructure, like market size, has been found to be a significant driver of FDI inflows, this is besides different proxies used to measure infrastructure. On theoretical grounds, infrastructure reduces transportation cost and improves efficiency in a host country. Ang (2008) employed 2SLS technique to investigate the determinants of inward FDI in Malaysia for the period 1960-2005. He found that infrastructure is a significant driver of FDI inflows in Malaysia. Similar results were obtained by Kumur (2001), using different proxies of infrastructure Kumur (2001) found that infrastructure development contributes to the attraction of inward FDI. Others studies that found infrastructure to be significant include Demirhan and Masca (2008), Ranjan and Agrawal (2011), Phung (2016) and Sharma, Nayagam and Chang (2012).

In contrast to country market size and infrastructure, empirical results on trade openness are mix. Montero (2008) employed a panel data econometric technique in fifteen Latin America countries over the period 1985-2003 and found that trade openness has no significant impact on FDI inflows. Similarly, Taylor (2000) found that trade openness has no significant impact in the USA manufacturing sector. In contrast, trade openness is significant in the studies of Shahmoradi and Baghbanyan (2011), Ranjan and Agrawal (2011), Williams (2015), Al-Sadig (2009).

Macroeconomic stability (measured by inflation), like trade openness, has received mix empirical results. While there are studies that found macroeconomic stability to be a significant driver of FDI inflows (see Ranjan and Agrawal, 2011, Williams, 2015; Al-Sadig, 2009) some found macroeconomic stability to be insignificant (Adams, 2010; Montero, 2008). Using fixed effect estimation technique on a panel of 117 countries (both developing and developed countries) over the period 1984-2004, Al-Sadig (2009) found that macroeconomic stability is significant in determining FDI inflows. In contrast, Adams (2010) surveyed the significance of macroeconomic

stability in 75 countries and found that it was insignificant in countries he studied. Notwithstanding these mix empirical results, most studies we reviewed found macroeconomic stability to be significant.

Another FDI candidate variable that has received mix empirical results is labor force. While the cost of labor force has been found to drive FDI inflows to countries that have low unit labor cost (see for example Bevan and Estrin, 2004; Carstensen and Toubal, 2003), the importance of quality of labor in explaining FDI inflows has received mix empirical result (Ranjan and Agrawal, 2011; Phung, 2016). For example, a study by Phung (2016) found that quality of labor force was insignificant in explaining FDI. In contrast, a study by Carstensen and Toubal (2003) found that quality of labor force was a significant determinant of FDI inflows. Perhaps the mix results are due to different proxy used to measure the quality of labor force.

3. Data and methodology

3.1 Methodology

We extend the cross-sectional Heckman two-step estimator to a panel data setting (i.e. panel Heckman two-step estimator). The panel Heckman two-step estimator is similar the cross-sectional method in that it is estimated in two stages. First it estimates a probit equation (choice of whether to invest or not) and a Pooled OLS (investment levels), including the Mills ratio.

Thus, the panel Heckman two-step estimator can be expressed as follows:

Participation equation:

$$I_{it}^{*} = x_{1it}\beta_1 + \forall_i + \varepsilon_{1it} \tag{1}$$

The first stage describes the choice of whether to invest or not (I_{it}^{*}) as influenced by a set of independent variablesX_{it} (such as trade openness, and General Government Expenditures, etc). $\forall_i$ represents time-invariant unobservables. The first stage is estimated by a probit model. I_{it}^{*} is a dichotomous variable that takes a value of 1 if the firms decide to invest, and 0 otherwise. More formally, we have

$$\begin{matrix} I_i = 1 \; if \; I_i^{*} > 0 \\ 0 \; if \; I_i^{*} \leq 0 \end{matrix} \tag{2}$$

Outcome equation:

$$Y_{it}^{*} = x_{2it}\beta 2 + \forall_i + \varphi_{it} + \varepsilon_{2it} \tag{3}$$

$$\begin{pmatrix} \varepsilon_{1,i} \\ u_i \\ \varepsilon_{2,it} \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho\sigma_u & 0 \\ \rho\sigma_u & \sigma_u^2 & 0 \\ 0 & 0 & \sigma^2 \end{pmatrix}\right] \quad (3.1)$$

The outcome equation (eq 3) describes the determinants of the level of investment. Y_{it}^* shows our dependent variable (the logarithm of investments), x_{2it}indicate the factors affecting the FDI, and φ_{it} shows inverse Mills ratios estimated in the first selection stage using the probit model for each year ε_{1it} and ε_{2it} follow a normal distribution – N (0,1) and N (0,σε), respectively. Moreover the disturbance terms in equation 3.1 (ε_{1i} and ε_{2i}) are assumed to be independent – the decisions of whether or not to invest (participation decision) and the amount of investment are made sequentially rather than simultaneously.

The Heckman selection model with independent error terms can be estimated by the following log-likelihood function.

$$LL = \sum_0 \ln\left[1 - \Phi\left(\frac{x_{2i}\beta_2}{\sigma_i}\right)\right] + \sum_+ \ln\left[\Phi(x_{1i}\beta_1)\frac{1}{\sigma_i}\phi\left(\frac{y_i - x_{2i}\beta_2}{\sigma_i}\right)\right] \quad (4)$$

The estimation of equations (1) to (3) presume strict exogeneity of the regressors. This assumption is implausible because the GDP variable is likely to be endogenous and failure to address this problem, can result in biased estimates. So we employed a recent two-stage Heckman selection procedure proposed by Semykina and Wooldridge (2010) in an attempt to account for the possible endogeneity of the GDP. Their method employs a two-stage Heckman selection procedure approach to correct for the selection bias, and then explicitly addressing the problems caused by the endogenous explanatory variable. In the first stage, a probit model was estimated for each time period to derive inverse Mills ratios. In the second stage, a pooled instrumental variable regression was used to estimate the effects of the explanatory variables on FDI, with the inverse Mills ratios from the first stage's probit models included as covariates to control for selection effects.

3.2. The database

We employ annual data for the period 1990–2015 for BRICS countries – Brazil, Russia, India, China and South Africa. The time period and the number of countries used in this study is carefully chosen based on the availability of data. All the variables used in this paper are sourced from World Development Indicators of World Bank. Following prior studies (Williams, 2015; Al-Sadig, 2009; Ranjan and Agrawal, 2011; Lokesha and Leelavthy; 2012; Forte and Santos, 2015, Demirhan and Masca, 2008; Sekkat and Veganzones-Varoudakis, 2007; Phung, 2016; Ranjan and Agrawal, 2011 and others), we include the following variables in the models: TRADE OPENNESS – ratio of imports plus exports to GDP, (Montero (2008), Shahmoradi Baghbanyan (2011), Ranjan and Agrawal (2011), Williams (2015), Al-Sadig (2009)); INFRASTRUCTURE – measured by fixed number of telephones per

100 persons, (Asiedu (2006) ,Ang (2008), Kumur (2001), Ranjan and Agrawal (2011), Phung (2016), Demirhan and Masca (2008)); INFLATION – measure of macroeconomic stability, (Adams (2010), Montero (2008), Ranjan and Agrawal, (2011)); GDP PER CAPITA – measure of country market size, (Phung (2016), Mottlaled and Kalirajan (2010), Carstensen and Taubal, (2003), Bevan and Estrin, (2004)); GOVERNMENT EXPENDITURE (General government final consumption expenditure).

4. Empirical analyses

Before reporting the empirical results, we start first by reviewing some descriptive statistics. Figure 1, 2 and 3 plots a log of foreign direct investment variable against log of infrastructure development, log of inflation and log of economic growth variables respectively in BRICS countries for the period 1990 to 2015. Though there are number of variables identified as determinants of FDI in the literature, we only provide descriptive analysis of infrastructure, inflation and economic growth as there are mostly used variables in the FDI literature.

Unsurprisingly, figure 1 depicts a neat positive relationship between foreign direct investment and infrastructure. Countries that have a good quality infrastructure are more likely to attract inward FDI due to lower production cost and increased efficiency of doing business. The availability of good physical infrastructure such as road, railways and ports makes it easy for goods to be transported between cities quickly and more efficiently while the availability of intangibly infrastructure such as Information and Communication Technology (ICT) has increased efficiency of doing business (Rehman, Ilyas and Akram, 2011; Ranjan and Agrawal, 2011; Phung, 2016)

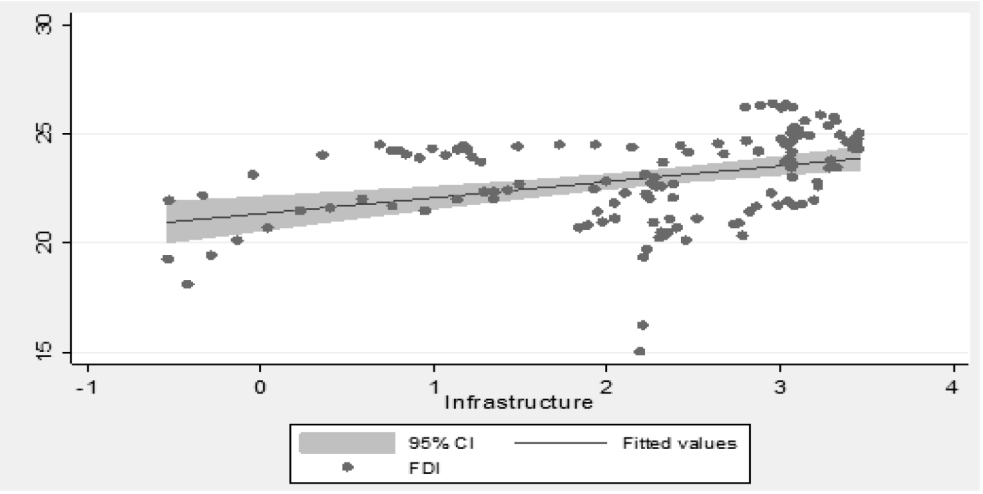

Fig. 1. FDI and infrastructure in BRICS countries, 1990-2015

Figure 2 depicts a negative relationship between FDI and inflation. The reason for this is twofold: firstly, lower inflation leads to macroeconomic stability and reduce uncertainty in the host country. Secondly, lower inflation reduces real interest rate, making it easy for international firms (MNC) to raise capital in the host country (Adams, 2010; Al-Sadig, 2009; Montero, 2008)

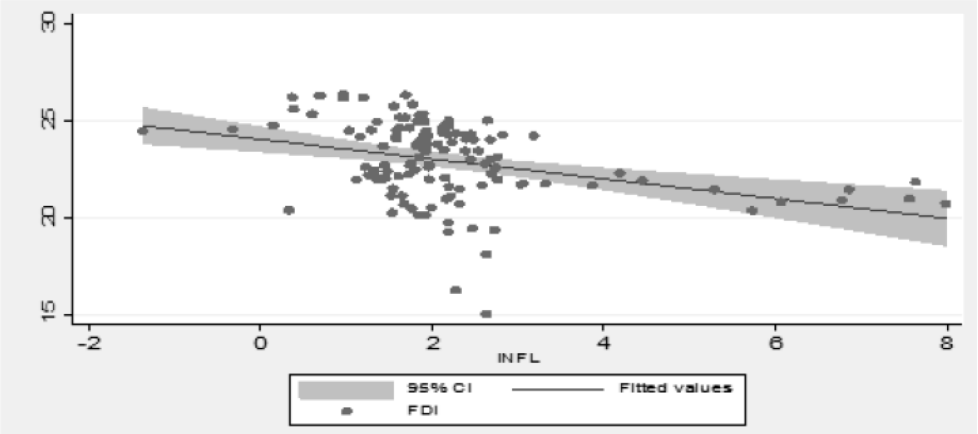

Fig. 2. Inflation and FDI in BRICS countries, 1990-2015

Interestingly, figure 3 shows a strong positive relationship between FDI and economic growth. High and increasing economic growth is an indication of growing market size in the host country. This implies an increasing local demand for goods and services in a host country some of which can only be produced by MNC (Phung, 2016; Bevan and Estrin, 2004; Mottlaled and Kalirajan, 2010).

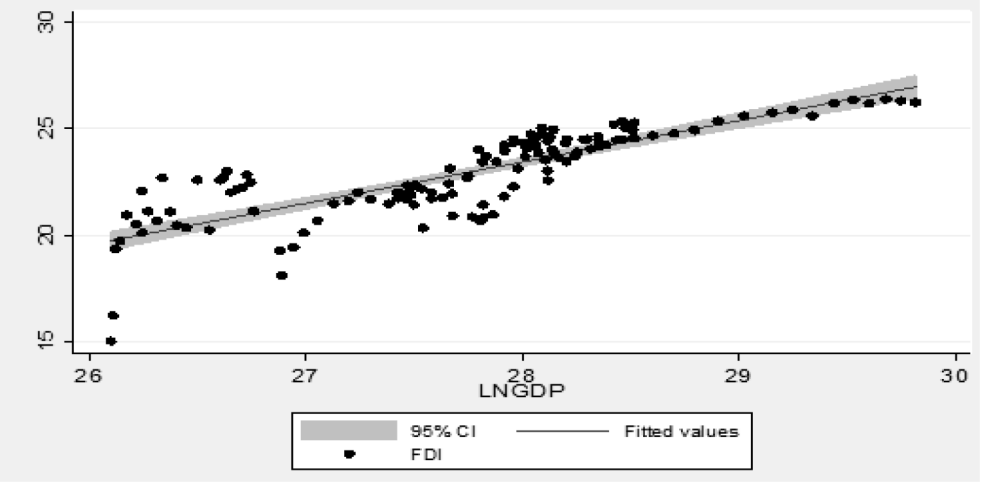

Fig. 3. Growth and FDI in BRICS countries, 1990-2015

5. Empirical Results

This section discusses the empirical results of both Panel Heckman Selection model and Semykina and Wooldridge models. Our first round of results, obtained when we estimate Panel Heckman Selection model, is reported in Table 1. As explained in the methodology section, Heckman Selection model is estimated in two stages, the first stage is a selection equation (likelihood of FDI inflow) and the second stage is an outcome equation (volume of FDI inflow).

Selection equation estimates

All specified variables from the first stage (selection equation) have expected signs with few being statistically insignificant (inflation and trade openness). The coefficient of infrastructure is positive and statistically significant as expected. This implies that availability of infrastructure in BRICS countries increases the likelihood of FDI inflow. This result is consistent with most studies in this field (see for example, Rehman, Ilyas, Alam and Akram, 2011; Ahmad, Ismail and Nordin, 2015; Oqunjimi and Amune, 2017). Moreover, beside methodological differences our results are also consistent with most studies conducted in BRICS countries (see for example, Narender and devi, 2013; Ranjan and Agrwal, 2011).

Perhaps unsurprisingly, we found that the likelihood of FDI inflow is influenced by the level GDP per capita. This result is expected because the level of GDP is an indicator of a host country market size, thus GDP per capita is an important driver of FDI inflows. Our results are consistent with those found in the relevant literature (see for example, Phung, 2016; Ranjan and Agrawal, 2011 and Mottlaled and Kalirajan, 2010).

As just noted above, inflation (a measure of macroeconomic stability) is negative as expected but insignificant. Our results suggest that the likelihood of FDI inflow in BRICS is not influenced by the level of inflation, in line with the works of Ranjan and Agrawal (2011), Williams (2015), Al-Sadig (2009) and contrary to those found by Adams, (2010), Montero (2008).

Although not significant, the coefficient of trade openness is positive – trade openness increases the likelihood of FDI inflow, similar to those of Montero (2008). In contrast, Shahmoradi and Baghbanyan (2011), Ranjan and Agrawal (2011), Williams (2015), Al-Sadig (2009) found trade openness to be significant.

Outcome equation estimates

Having discussed the factors that influence the likelihood of FDI inflow, we now turn to the factors responsible for the volume of FDI inflow. With a few exceptions, estimates of the outcome equation retain the same direction and magnitude to those discussed above. Most of the parameters (such as infrastructure, GDP per capita and government expenditure) remain significant in the outcome equation of the panel Heckman selection model.

Regarding the effect of infrastructure, we find the results from the outcome equations to be consistent with those from the selection equations. In other words, infrastructure is shown to be important in determining of both the likelihood of FDI inflow and the volume of FDI inflow. Similarly, GDP per capita is found to be positive in both the outcome and selection equations.

The noticeable difference between the selection and outcome equation estimates relate to inflation variable. The estimated coefficient for inflation, which was negative and insignificant in the selection equation, is now negative and significant in the outcome equation, indicating that inflation affect the volume of FDI inflow.

Table 1: Panel Heckman selection estimates of the effects of infrastructure on FDI in BRICS countries, 1990-2015

Outcome Equation		
FDI inflow	Coef.	Robust Std. Err.
Infrastructure	0.595295*	0.309764
Inflation	-0.34455***	0.062178
GDP_PC	0.000435***	7.69E-05
GGOVT	-0.45905***	0.088827
IMR	-7.06839*	7.093007
Selection Equation		
Infrastructure	0.904827*	0.35831
Inflation	-0.01139	0.094463
GDP_PC	0.000525*	0.000206
GOVT EXP	-0.8065***	0.249923
OPEN	0.469549	0.436461

Significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors, adjusted for clustering at the individual level, are given in parentheses

To delve deeper into the determinants of FDI in BRICS countries, Table 2 reports Semykina and Wooldridge estimates which address both selection and endogeneity concerns, with lag of GDP per capita used as an instrument for the current value. As discussed in the methodology section, while Panel Heckman selection model controls for individual-specific heterogeneity and sample selection bias, it fails to control for endogeniety problem. From Table 2, the estimate of inverse mill ratio estimated in the selection stage of the model is significant, implying the presence of selection bias. Moreover, the Cragg-Donald Wald F statistic for the first stage is large (2417) indicating there is not a weak instruments problem.

Interestingly, some estimates of selection equation from Semykina and Wooldridge selection model are similar to those of Heckman selection model both in terms of signs and significance. The infrastructure variable is positive and significant in both equations of two models. These results confirm that improvement of infrastructure is an important driving force of increasing the probability of FDI inflows in BRICS countries.

Also consistent with estimates obtained from the Heckman selection model is the level of inflation – not statistically significant in influencing either likelihood of FDI and the volume of FDI inflow. In contrast, the government expenditure exerts a negative impact both the likelihood of FDI inflow and the volume of FDI inflow. However, its impact is significant only for the likelihood of FDI. Though the level of GDP per capita has a positive impact on the volume of FDI, it is not a statistically significant determinant of the likelihood of FDI.

Table 2: Semykina & Wooldridge (2010) estimates of the effects of infrastructure on FDI in BRICS countries, 1990-2015

Outcome equation		
FDI inflow	Coef.	Robust Std. Err.
Infrastructure	0.373958***	0.0355905
Inflation	-0.11622	0.120889
GDP_PC	0.000449***	9.62E-05
GGOVT	0.07082	0.116844
IMR	-9.4275***	2.64792
Cragg-Donald Wald F	2417	
Chi-sq(1) P-val	0.000	
Selection equation		
Infrastructure	.62279***	.076351
Inflation	-0.34913	0.191846
GDP_PC	-0.0003	0.00016
GOVT EXP	-1.13548*	0.455155
OPEN	2.70621*	1.223476

Significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors, adjusted for clustering at the individual level, are given in parentheses

5.1. Discussion

Some important findings and associated policy implication emerge from our paper. When accounting for sample selection bias and endogeneity, the coefficient of infrastructure under Semykina and Wooldridge (2010) remain positive and significantly similar to the coefficient of infrastructure under the panel Heckman selection method. The results on infrastructure and FDI is consistent with those found in the relevant literature (see for example, Rehman, Ilyas, Alam and Akram, 2011; Ahmad, Ismail and Nordin, 2015; Oqunjimi and Amune, 2017). Moreover, beside methodological differences our results are also consistent with most studies conducted in BRICS countries (see for example, Narender and devi, 2013; Ranjan and Agrwal, 2011).

This particular finding offers useful policy implications towards promoting FDI inflows into BRICS countries. Given the importance of infrastructure in enhancing FDI inflows, the government should prioritize infrastructure development and its quality for foreign firms. Furthermore, each member country should establish country specific factors that might hinder FDI. For example, a country like South Africa, could attract more FDI (particularly from Western industrialised countries, traditionally the major source of FDI to the country) by reducing policy uncertainty generated by the South African government.

In line with many studies in this field we found that the likelihood of FDI inflow is influenced by the level GDP per capita. This is not surprising because the level of GDP is an indicator of a host country market size – GDP per capita is an important driver of FDI inflows. Our results are consistent with those found in the relevant literature (see for example, Phung, 2016; Ranjan and Agrawal, 2011 and Mottlaled and Kalirajan, 2010). Implicit from this finding is that each member country should try to find mechanisms to stimulate their economic activities if they are serious about attracting FDI. They could learn a great deal from one of the member countries like China which has been growing at the average of more than 7% for the past years and have a large share of FDI inflows.

As expected our finding suggest that the degree of trade openness is important in determining the total amount of FDI inflows into BRICS countries, similar to those of Montero (2008). While Brazil, Russia, South Africa and India have long open their doors to international markets, China which recently open its door has improved significantly in attracting FDI inflows. However, trade and investment barriers still exist in BRICS countries. Perhaps reduction in trade and investment barriers can be an important tool for attracting FDI inflows.

6. Conclusion

We have explored the factors that affect Foreign Direct Investment inflows in 5 BRICS countries for the period 1990–2015. To this end, we have used the estimator (or panel Heckman selection) proposed by Wooldridge (1995) and corrected for both selection and endogeneity within the new two-stage framework developed by Semykina and Wooldridge (2010). The baseline empirical estimates carried out using the panel Heckman selection has provided some evidence on the determinants of Foreign Direct Investment.

Our Semykina and Wooldridge analyses, which were performed to reduce endogeneity bias, and selection bias produced qualitatively similar results (in terms of direction), although the level of significance of some variables were larger compared to those obtained using panel Heckman selection. This highlights the importance of controlling for sample selection bias and endogeneity in order to infer a less-biased determinants and FDI. Failing to do so may lead to spurious inferences, as indicated by the results. Therefore, future studies on the on the determinants of Foreign Direct Investment should take into account these econometric complications.

While our results shed some important light on the determinants of FDI in the BRICS countries, it should be highlighted that our findings are not without limitation. The main limitation of this paper was the failure to include data for the period 2016 and 2017 – data constraint. Therefore future research including the most recent periods would shed light more light on the determinants of FDI.

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INSIGHTS ON CONSUMER ONLINE PURCHASE DECISIONS OF WOMEN'S FOOTWEAR

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Abstract: Shoes are probably one of the most difficult products to sell online due to the high need-for-touch (NFT) displayed: people need to experiment the product before buying it, more than in any other item. On another hand, women are more prone than men to buy fashion and apparel products through the web channel. This paper investigates the factors driving women consumers to shop footwear products online. A qualitative research method was used grounded on semi-structured, in-depth interviews that were conducted to corroborate the constructs defined in the proposed conceptual model namely: convenience, recreation, NFT and social e-shopping. The interviews were focused on the demand side to understand the female consumers' perspective and on the top managers of women's shoes companies representing the suppliers' viewpoint. The results show that women highly appreciate the convenience that shopping shoes online provides as well as its recreational nature. The NFT also stands out in the shoe market context mainly due to the particularities related to shoe size. Additionally, social e-shopping was found not be as important for women as anticipated as they see social networks more as a communication platform for brands, and less as a factor that influences their predisposition to shop shoes online. On the suppliers' side, the interviews revealed that managers believe in bloggers and social media influence and its consideration as part of the overall marketing strategy.

JEL classification: M30, M31, M160;

Keywords: Marketing, Online Shopping; Shoes; Women preferences

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1. Introduction

The strong development of the e-commerce industry has led to an enormous number of transactions and changes on consumer buying behaviour in the transition from the physical store to the online store (Kwak, Fox, & Zinkhan, 2002; Raman, 2014). This has triggered the interest of many researchers trying to understand what drives consumers to shop online. This change is simultaneously challenging the traditional commerce and reshaping consumers' shopping habits (Chiang & Dholakia, 2003; Rigby, 2011).

Several studies have explored the gender differences in online shopping, the majority (e.g. Hasan, 2010; Lian & Yen, 2014; K. Z. K. Zhang, Cheung, & Lee, 2014; L. Zhang, Xu, Ye, & Wang, 2012) concluding for the existence of differences between women and men. According to Rodgers & Harris (2003), more men than women engage in online shopping activities and make more online purchases. Dittmar, Long & Meek (2004) claim that men's attitude is almost the same in both traditionally and online shopping formats, while women's attitude suffer a significantly variation as they become less favourable toward online shopping. Getting to know the reasons behind women online shopping behaviour is of major importance for marketers that aim to target a female audience in the online channel. One of the reasons for this may be due to higher level of need-for-touch (NFT) displayed by women (Workman, 2010; Cho, Workman, 2011). This seems to be acuter in products also displaying higher NFT, as it is the case of experiential goods, such as clothing and shoes, which require a direct and physical experience of touch (Lynch, Kent, Srinivasan, 2001; Rodrigues, Silva, Duarte, 2017; Chiang, Dholakia, 2003).

The attempt to sell online experience goods with high NFT nature, like shoes, particularly to a female audience, tends to be a difficult task for companies. Therefore, trying to shed some insights on this issue, this paper uncovers the main factors that lead female consumers to engage in the online purchase of shoes market and seeks to understand the demand side of this market. Concurrently, focusing on the suppliers' opinion it also looks to understand the offer perspective and how firm's online business strategy incorporates these factors. Therefore, the following research questions drive the study: What are the main factors driving female consumers to purchase shoes online? How does the demand side and supply sides acknowledge these factors?

2. Literature review

2.1. Factors influencing consumers' online shopping

Online consumers can purchase products from any place at any time they want, so time and cost of traveling to and from shops are virtually eliminated (Chiang, Dholakia, 2003). The ability to shop without leaving home or office and having the products brought to the door is of major interest to many consumers (Chen, Chang, 2003). Online shopping allows consumer to have more control and bargaining power since they have access to large amounts of easy and free information (Javadi, Dolatabadi, Nourbakhsh, Poursaeedi, Asadollahi, 2012). Consequently, this allows shoppers to engage in more efficient shopping activities, once the search cost is

reduced, and brings advantages for both consumers and vendors (Alba, Lynch, Weitz, Janiszewski, Lutz, Sawyer, Wood, 1997; Kalakota, Whinston, 1997). Nevertheless, this shopping format may have some drawbacks when compared to brick-and-mortar stores, since consumers cannot see, touch, taste or smell the products they are buying (Peck, Childers, 2003). This can drive them to develop low trust and high levels of risk, mainly due to the lack of face-to-face communication (Javadi et al., 2012).

Chen and Chang (2003) highlight three common components of the online shopping process that are crucial to its success: interactivity, transaction and fulfilment. To improve the consumers' shopping experience, it is necessary that companies invest on a well-design website, easy to navigate and to provide the right level of interactivity (Chen, Chang, 2003). These web features also enhance the recreation aspects of online shopping. Likewise, Swinyard, Smith (2003) state that online shoppers are more entertainment-oriented, thus reinforcing the need to pay special attention to the interactivity and indulgency. According to Girard, Korgaonkar, Silverblatt (2003), convenience and recreational consumers' orientations relate positively to online shopping preferences, in what concerns experience goods, such as clothing or shoes. Therefore, convenience and recreation are extremely important factors regarding the motivations that drive consumers to shop experience goods online, namely shoes.

2.2. Gender differences in online shopping: women motivations

In the online shopping environment, men seem to be more likely than women to engage in buying activities and in purchasing more online (Kwak, Fox, Zinkhan, 2002; Rodgers, Harris, 2003). Although studies regarding gender differences in online shopping are somehow inconsistent (Chang, Cheung, Lai, 2005; Zhou, Dai, Zhang, 2007), Zhou et al. (2007) suggest that men tend to favour convenience over social contact, in opposition to women, which seem to be more motivated by emotional and social interaction. The social interaction and face-to-face communication that women seem to appreciate, is a constant in the online shopping context. In the same line, Dittmar et al. (2004) suggest that women's attitude suffers a considerably change when comparing the two environments: offline with online, having a less favourable attitude towards the second one. Men attitude's, on another hand, remain almost the same in both shopping atmospheres. Another interesting finding is that the preference for physically evaluate products seems to be a women's characteristic: they reveal a preference for seeing and feeling the products before buying them (Dittmar et al., 2004), especially when we are talking about products with high NFT.

Footwear can be considered as more than a simple means of foot protection, particularly women's footwear, which may be seen as a symbol of power and social status as well as of comfort and personal preferences (Seferin, Van Der Linden, 2012). Consequently, we can consider that the social interaction inherent to shopping and the NFT displayed in experience goods are both factors that highly impact women's predisposition to shop shoes offline. So, it's very important to understand how companies may deal these setbacks and enhance other features of the online context, so that they can overcome these limitations.

The following sections will focus on the above cited main factors that look like to influence women's predisposition to shop shoes online: convenience, recreation, NFT and social e-shopping.

Convenience

Online shopping is claimed to be a time saving opportunity for consumers (Bellman, Lohse, Johnson, 1999). It reduces not only the travel time to the physical store, but also the time spent in lines (Donthu, Garcia, 1999). It eliminates the frustrations linked with the traditional shopping formats, such as fighting traffic, looking for parking space, and, at the same time, it eliminates the trouble of having to travel to a variety of stores (Childers, Carr, Peck, Carson, 2001). Closely related to the notion that online shopping is a time saver, is the convenience characteristic. Copeland (1923) first introduced this concept in the marketing literature in 1923, as an approach to classify goods - convenience, shopping, or specialty goods. Convenience is described as the minimization of the cognitive, physical and emotional activities that consumers must bear to purchase goods and services (Berry et al, 2002). So, when the barriers of undertaking an activity are reduced or eliminated, convenience occurs (Bell, Ho, Tang, 1998). Shopping convenience has been pointed as one of the main motivation regarding consumers' intention to shop online (Beauchamp, Ponder, 2010; Colwell, Aung, Kanetkar, Holden, 2008). It offers the consumers the opportunity to shop anytime and anywhere, giving them the chance to work and shop at the same time, saving a lot of valuable time. It also reduces the frustration associated with the shopping process by decreasing the psychological costs, which in turn makes the shopping experience more enjoyable (Childers et al., 2001). Given this, it is expected that convenience is a factor that influences women consumers' predisposition to shop shoes online.

Recreation

Recreational consumer orientation relates positively to online shopping preferences concerning experience goods (Girard et al., 2003). The results of a research regarding online shopping orientation towards high NFT products, indicates that when people experience more enjoyment in their shopping activity, they are more likely to purchase the product online (Chen, Hung, 2015). Therefore, turning online shopping into a more interactive activity increases customers' recreational value and purchasing behaviour (Chen, Hung, 2015). Additionally, the interactive nature of websites has been recognised as a positive factor influencing consumers' responses, such as increasing the desire to browse and purchase online, proving to be crucial to foster hedonic pleasure (Gehrke, Turban, 1999; Mathwick, 2002; Fiore, Jin, 2003).

Some studies (Liu and Arnett, 2000; Koufaris, 2002) suggest that enjoyment influences the consumers' intention to return to a retailers' website and that it has a positive influence on consumer behaviour towards the e-retailers' website (Fiore et al., 2005; Jayawardhena and Wright, 2009). Hence, consumers' attitude regarding e-shopping seems to be positively influenced by enjoyment (Childers et al., 2001; Heijden, Verhagen, 2004). Once shopping is considered an enjoyable experience, consumers tend to concern less about the amount of time spent searching for product information or deals (Jensen, 2012). In consequence recreation is expected to be a factor that influences women's predisposition to shop shoes online.

Need-for-Touch (NFT)

Even though online retailing is considered to be a very promising sector (Agardi, Dornyei, 2011), it still faces some limitations, such as the lack of sensorial elements, as scent or touch, which can have a strong influence on consumers' decision-making process (Weathers, Makienko, 2006; Grewal, Iyer, Levy, 2004; Dholakia, Zhao, 2010). NFT is described as "a preference for the extraction and utilization of information obtained through the haptic system" (Peck, Childers, 2003, p.431). The need to feel the product is prevalent in high-involvement product categories such as clothing or shoes, in which consumers need to see, try and touch the product to evaluate it (Workman, 2010).

Shoes can be considered "experience goods" which means that "full information on dominant attribute can only be known with direct experience and information search for such attribute is more difficult than direct product experience" (Chiang, Dholakia, 2003, p. 179). Thus, it is possible to say that consumer's intention to shop online is lower for experience goods than search goods (Chiang, Dholakia, 2003). This seems to be enhanced in the fashion environment, where consumer behaviour is considered a multi-sensory experience involving many senses, including the sense of touch (Workman, 2010; Rodrigues et al. 2017). Nevertheless, it has been argued that the profusion of information available online is reducing the gap between search and experience products (Huang, Lurie, Mitra, 2009) due to improvements in online shopping technologies, such as description and pictures (Rodrigues et al., 2017) or video clips. It is very important for companies to provide as much detail and variety of information to reduce the uncertainty that consumers have towards experience goods. Given this, it is expected that NFT represents a factor that negatively influences women's predisposition to shop shoes online.

Social E-shopping

Shopping is a social activity that overcomes the simple act of obtaining products; it is about the whole experience, enjoyment and entertainment (Martineau, 1958; Tauber, 1972). Especially for women, shopping is considered a leisure and social activity (Miller, 1998). Dennis, Morgan, Wright and Jayawardhena (2010) suggest that e-retailers have a major opportunity to combine social networking with e-shopping, giving the fact that the internet is a new social context for many young women. Thus, social e-shopping can be a valuable strategy for e-retailers, especially for those whose main target is the female audience (Dennis et al., 2010)

Additionally, we can say that social networking has become a part of people's daily lives (Boyd, Ellison, 2007) and young females are overrepresented as users of social network sites (Social Networks,2007). Lenhart and Madden (2007) report that 70% of young women use social network sites (SNS's). Moreover, DEI Worldwide (2008), informs that 60% of social network users are likely to pass along information they receive online and two-thirds of these users see online recommendations from other users as a credible source, representing a large influence on brand perceptions and possible on consumers' purchase decisions (Noori, Hashim, Yusof, 2016). Fashion brands know that blogs are a new marketing power (Hsu, Tsou, 2011; Ferreira, Silva, 2018) and are investing in this method as a communication-marketing tool that can be used as a form of user-generated content (Kulmala, Mesiranta, Tuominen, 2013). This way, brands establish collaboration with fashion bloggers. Bloggers provide sponsorship posts that try to captivate audience, considering that individuals lean towards following the suggestions

and references of bloggers they trust. Therefore, social SNS's and bloggers' influence will be explored as part of the social e-shopping factor. This factor can be considered as a factor that influences women's predisposition to shop shoes online.

Table 1 presents a systematization of the major factors influencing online shopping addresses in the literature reviewed and their findings.

Table 1. Major factors influencing online shopping

Factors Studied	Authors	Major Findings
Convenience, Product Type and Perceived Price	Chiang, Dholakia (2003)	Convenience and product type influence consumer intention to engage in online shopping.
Interactivity, Transaction and Fulfillment	Chen, Chang (2003)	Online shopping experience is found to be influenced by various factors related to interactivity, transaction, and fulfilment.
Price, Convenience, Recreation, Variety Seeking, Impulsiveness, Demographics & Product Categories	Girard, Korgaonkar, Silverblatt (2003)	Shopping orientations such as convenience and recreational shopper and demographic variables such as gender, education, and household income were significantly related to consumer's online purchase preference; Relationships of shopping orientation and demographic variables with purchase preference for shopping online significantly differ by product category - convenience and recreational orientations were positively related to preference for shopping online for experience good
Demographics, Computer Literacy and Use, Intemet Lifestyles	Swinyard, Smith (2003)	Compared with online non-shoppers, online shoppers are younger, wealthier, better educated, have higher computer literacy, spend more time on their computer, spend more time on the Internet, find online shopping to be easier and more entertaining and are more fearful of financial loss from online shopping
Shopping convenience, Information Seeking, Immediate Possession, Social Interaction, Retail Shopping Experience, Variety Seeking	Rohm, Swaminathan (2004)	Four types of online shoppers: convenience shoppers, variety seekers, balanced buyers, and store-oriented shoppers.
Financial Risk, Product Risk, Convenience Risk, Non-delivery Risk, Return Policy, Service, Infrastructure Variables	Javadi, Dolatabadi, Nourbakhsh, Poursaeedi, Asadollahi (2012)	Financial risks and non-delivery risk negatively affected attitude toward online shopping; Attitude towards online shopping positively affects online shopping behaviour of consumers; E-retailers should make their website safer and assure customers for delivery of their products.
Privacy, Risk, Time, Convenience, Ease of Use, Vendor Reputation, Delivery Time and Cost, Product Quality and Variety, Product Returns	Raman (2014)	Convenience is considered the most important factor for female consumers to shop online; Risk of doing transactions, preference towards traditional shopping and reliability issues were the biggest setbacks.
Convenience, Recreation and Price	Chen, Hung (2015)	Males have higher convenience orientation than females; Recreation relates positively and price negatively to purchase behaviour; When people experience more enjoyment shopping, they are more likely to purchase online.

Proposed Model

Based on literature review, we propose the following conceptual theoretical model that aims to portrait the factors driving women consumers to shop shoes online. This model will further explored during the interviews.

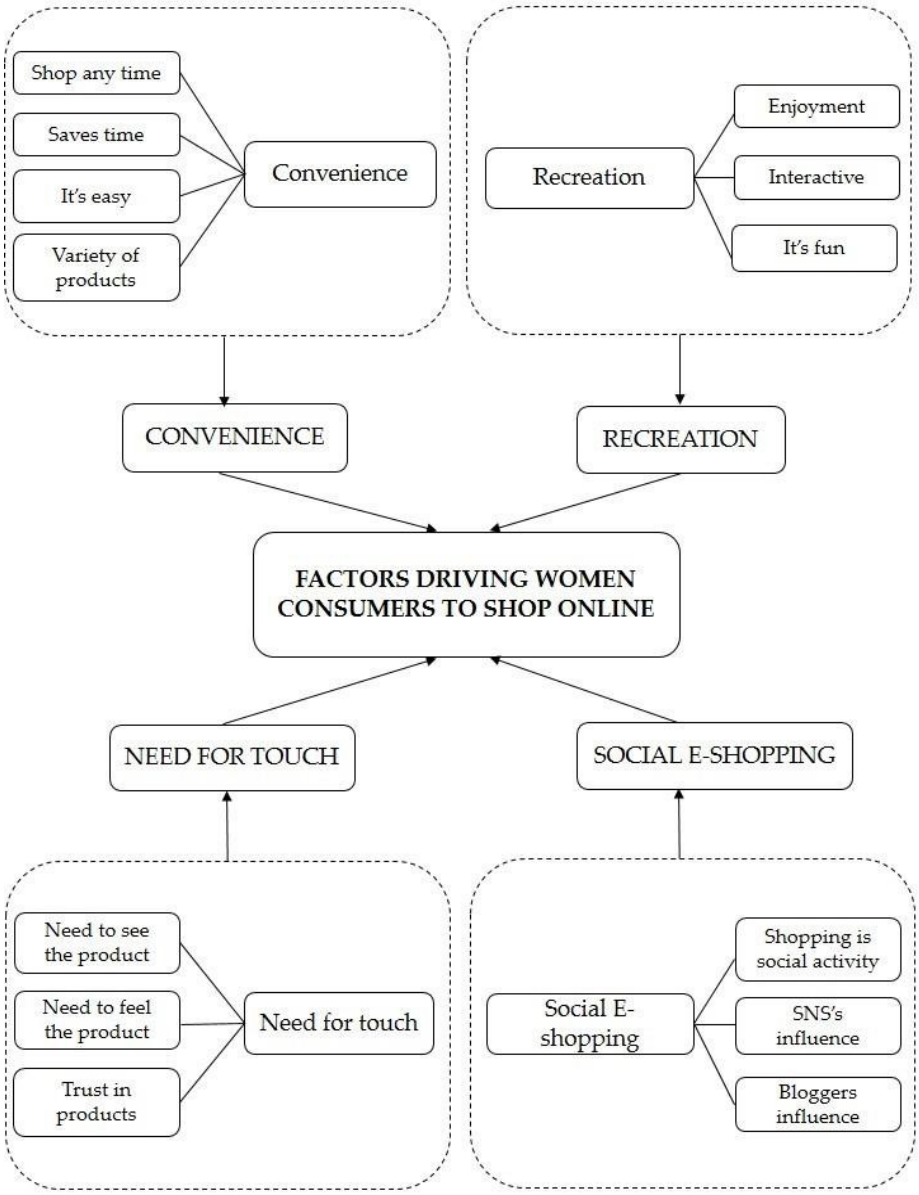

Figure 1. Conceptual model

3. Methodology

Research Scope and Data Collection a qualitative approach with twelve in-depth interviews (ten consumes and two managers of women's shoes companies) was applied to analyse the dimensions proposed in the conceptual framework (Figure 1). Semi-structured interviews were conducted, each one lasting approximately 60 minutes, on the basis of a guideline previously developed. The semi-structured interviews ensure that the key issues of this study are addressed through a list of questions to explore and permit a certain level of flexibility by the presence of open-ended questions with the possibility to ask follow-up questions (Bryman, Bell 2015). The guideline contained a list of questions in a logical sequential order. The interviews to consumers were conducted to female individuals that have already bought shoes online. A brief description of each informant is provided to ensure the transparency and credibility (Table 2).

Table 2. Female Consumers Interviewed Profile

NAME	AGE	PROFESSION	NATIONALITY
Consumer 1	20	Student	British
Consumer 2	22	Planning Intern	Portuguese
Consumer 3	23	Journalist	Spanish
Consumer 4	23	Fundraising Intern	French-American
Consumer 5	23	Audit Analyst	Portuguese
Consumer 6	24	Medical Doctor	Portuguese
Consumer 7	24	Pharmaceutical Intern	Portuguese
Consumer 8	25	Digital Marketing	Portuguese
Consumer 9	26	Commercial Manager	Portuguese
Consumer 10	26	Sales Assistant	Portuguese
Producer 1	36	CEO of a Women Shoes brand	Portuguese
Consultant 1	52	Consultant of Woman Shoes brand	Portuguese

4. Research findings

4.1. Factors Driving Women Consumers to Shop Shoes Online

The "convenience" factor was mentioned by all the ten participants as the main motivation to shop shoes online. Women consider that online shopping is easy and saves them time. They also appreciate the fact that they can shop at any

time and from any location, 24 hours a day. Another aspect mentioned was the wide variety of products available online and the possibility to find all the sizes and shoes' models they want, which are not, often, available at the physical stores.

"It's easy and convenient. When you already know the style and the size that fits you, online shopping saves you a trip to the store."

"It gives me the facility to see several stores in less lime, it's 24hours opened and I have the possibility to do all of this without leaving home. So it is more comfortable and convenient than going to a physical store."

"What I appreciate is the facility to see all the models and sizes that the physical store has, organized by sizes and types to shoes, without all the mess you see in real life. Also, I like the fact that I can buy them at home: that is very convenient and saves me a lot of time."

"It is easier to buy shoes online because usually there is more stock, so I can easily find my size. Moreover, I can have a better experience while shopping online because I can see the whole catalogue without going into the physical store, where sometimes the products can be sold out."

"Women are becoming busier everyday so it actually saves time not having to go to a suitable shop, park the car, try different sizes, and choose one that, at the end, may be sold out, and make you to return to the store (or another one) again."

It is noticeable how convenience is a crucial aspect that motivates women to shop shoes online. Additionally, the trouble of having to travel to a variety of stores is eliminated – they can check all the products they want from one single location. They also find online shopping to be an easy task, enhancing the convenience aspect, supporting previous findings regarding online shopping convenience (e.g. Donthu, Garcia, 1999; Childers et al. 2001).

Recreation

Participants agreed that online shopping is a recreational activity. They found it to be a fun experience that provides enjoyable time. Some of the participants said that when they realised the website design to be more appealing, they tended to spend more time exploring it, searching for new products and consequently buying more.

"If you don't know the brand/size/how the shoes look and you don't mind because you are a risk taker as I am, then it's fun to shop and then see if shoes look good (as long as it's possible to return them, of course)."

"I love exploring websites looking for new shoe' models, especially when I enjoy its design, it's really exciting. I also like to read reviews from other customers, it gives me a better vision of the products I am buying."

"When I am surfing a webpage that has an interesting design and lot of cool features like photos or videos, I tend to forget about time and start to get lost in the whole online experience."

We can say that responses confirm the importance of the "recreation" construct proposed in the model. Sampled women find online shopping to be an enjoyable experience, stressing the relevance of the interactivity and design of the website. They appreciate retailers' websites with high quality images, charming features, solid descriptions of the products and an area for feedback and reviews from other customers. These outcomes are in line with the literature regarding recreational consumers' orientations (e.g. Girard et al., 2003; Fiore et al., 2005; Chen, Hung, 2015).

Need-for-touch

All the participants agreed that touching and seeing the product was very important for them. Most of them mentioned that they were a bit concern with the fact that the shoe size might not be the right one, and the pictures might not correspond to the reality. Some referred that whenever they had the chance, they preferred to go the physical store and try the shoe first, and only then order it online.

"Online I don't buy as impulsively as I do in-store because I don't try the shoes and it is always risky to purchase something you do not see."

"When we are talking about shoes, it is a bit complicated not to try them because the sizes change from one brand to another, so the best thing to do would be to try the shoes in real life."

"You can't really try the product, and sometimes is not like in the pictures, or it might not fit you properly, but usually this can be fixed with a good return system."

"Not knowing how the product will fit or look like, without trying it, is always a concern, but that can be solved with returning it, which I consider as a safe way to act."

The participants' responses confirm that the NFT construct is a factor that influences their intention to purchase shoes online. Women tend to trust more products they touch, see and try. Even with all the pictures available at the retailers' website, a lot of them go to the store first to try the product, especially to be sure of the size, and then order it comfortably and easily online. Providing high quality images, detailed information and descriptions can reduce the gap between the virtual and the real world. Likewise, some consumers mentioned the importance of a good product return system to overcome this setback. It is believed that product returns can lead to an opportunity for the online retailer to enhance customer loyalty and relationship (Raman, 2014). So, high-involvement and experience goods, tend to have a higher NFT characteristic that needs to be surpassed by online retailers (Workman, 2010).

Social E-shopping (SNS's and Bloggers Influence)

All interviewees confessed that they did spend a lot of time browsing through SNS's (Facebook and Instagram were the ones most frequently mentioned) and that they also followed bloggers. However, many of them do not acknowledge the fact that this is a motivating factor that drives them to shop shoes online, specially the social network pages of the companies. Some admitted that, unconsciously, bloggers might influence their search for some products. But, they do not recognize the direct influence this factor has on their online shopping predisposition.

"I follow some bloggers on social media and what they wear tends to be similar to the style that I like. These bloggers also show where the product is available, how it looks like and which outfits will match that type of shoes. This gives me an extra motivation to buy. Nevertheless, I do not feel influenced by the pressure of SNSs."

"Nowadays, I think that both social media and bloggers influence our buying decision. Most of the clothes they wear are available online, and it is tempting not to buy them as soon as we see someone wearing it and nailing it. It becomes almost like a mechanism of buying without the necessity of trying it, because someone already tried and proved us that it will work out. However, as for their Facebook page, I don't think it increases my predisposition to buy in itself."

"I spend a lot of time online, especially on Instagram, and I follow a lot of bloggers. Most of the time I click on the tags labelled in their photos and that redirects me to the brands' pages, giving me the opportunity to search for different kinds of products."

Interviewees admitted that social networking has become a part of their daily lives but they use it more as a social platform to express their individual beliefs and day-to-day moments with friends and family, rather than using it as a shopping lever.

"I don't really like to share my shopping moments. I prefer to save it to myself."

So, women consumers see SNS's more as a communication platform for brands, than they see it as a factor motivating them to purchase online. They also recognised that bloggers are an inspiration for them and that seeing them wearing the shoes on and matching it with the whole outfit, influences them to buy products more impulsively. Thus, bloggers are a key factor for marketing strategies of e-retailers, especially for brands that sell fashion products online.

5. The Suppliers' Overview: A Company's Perspective

To provide the suppliers' perspective regarding the factors that drive women consumers to shop online, we will present two managers' opinion over these factors and see how the shoes companies they work for, incorporate this information in their online strategy. Companies are both Portuguese digital-born brands of women shoes created less than ten years ago, and with more than 4,000 clients each. One manager stated that it was a natural step to start in the digital world:

"We are a company that works globally and sells to the entire world, so the online strategy was the most natural one to start and develop this business."

The strategy that the company pursues started international from day one:

"As soon as you enter the online world, you're selling to the entire world. It was just a matter of understanding the logistics of the business and turning this operational. There are very few countries where we haven't sold to, but the most relevant markets we sell to are Portugal and USA."

The brand expanded digitally through social media and influencers that provided credibility and quality. The brand follows a premium strategy because we wanted to be considered a top-quality brand associated to Portuguese shoes' excellence. The luxury brand consultant interviewed stated:

"When we are talking about top quality, the price is not the decisive factor - that goes to the background. Some brand have a differentiated product in terms of quality, so it's expected that the price is also differentiated."

The brand first physical store opened on 2016 in NYC. They chose this location because USA is the brand largest market and the origin of the majority of their frequent clients. Also it is a very important market in the fashion business.

"Consumers do not buy strictly online or offline, so this was the natural next move of the brand. We want to be at the centre, where everything is happening and become a reference in the fashion world. It was all about the marketing strategy and the relationship we wanted to build with our customers."

Convenience

The ability to shop online represents convenience. It is possible to have access to higher diversity of products, which is especially appreciated by women. Women like exclusivity and online shopping enables them to buy a product that

probably other consumers cannot find in a near physical store. Additionally, they can buy products from all over the world, which makes them unique. In terms of convenience features that the e-retailers can offer, the easiness of search and comparison of products are not a priority for both brands researched in this study, since they consider that people do not buy their products because they are easy to search, but because they are involved with the product.

"We don't even have a search bar. We always have a "storytelling" behind each product; consumers can navigate through special collections and find the products that way. We want people to understand our concept and enter into the brand. "

Regarding the variety of products available online, these brands act differently from mass manufacturers. Since their products are handmade and they work with optimized stocks. This way, they do not have all shoes' sizes and models available to order immediately. On the consumers' side, this might be a little disappointing, but on the companies' perspective, this helps to manage the stock more efficiently. The interviewed made the following comments:

"We do not have all the products available; we work with optimized stock. We only have in warehouse the most frequently sold products since our products are all handmade. Sometimes clients have to wait a while to get the product delivered to their homes... But, if the client has already a relationship with the brand, that won't be an obstacle. The time of delivery can go from 15 days to 3 months."

"Our brand wants to be seen as an accessible luxury product with a premium market positioning. As so, scarcity creates more appetite for the product. Consumers have to wait longer for the product they want, but when they receive it, the pleasure is higher."

Recreation

Brands need to cultivate the brand desirability in people's mind, so that consumers can understand the added value they are being offered. It's imperative for these companies to involve the consumer with their brands and products. The website is the main tool of communication and interaction, so it needs to have an appealing design and interactive features like videos and images. Additionally, consumers value the opinion of peers, which improves their perception of trust towards the products.

"Our "storytelling" is told with videos that try to captivate the audience; we don't have a lot of written descriptions. Our major recreational strategy is definitely the storytelling we put behind every product. Here we want to take the customer into a journey where she can understand where the products came from, who made it, which story is behind it."

"Our website has a space for feedback and reviews from our customers, mostly derived from social media channels. We want to make sure that people know how customers fell about our products."

NFT

It has been massively argued that consumers feel the need to touch and see the products before buying them and that necessity tends to be higher in certain product categories. The sensorial elements are more relevant for fashion goods, where consumers have concerns regarding the mismatch between what they see virtually

and the real products. When brands have a physical store, it is common that the consumer goes the store to try the product and then orders it online. Some brands even encourage their customers to do that, while they are still at the physical store.

"We are aware of the fact that shoes have a high NFT and that people are afraid to order the wrong shoe size or that pictures don't correspond to the reality, so we have a free return policy in Portugal and USA, and in other countries we charge a low fee."

"Some brands send two or three pairs of shoes to their customers so they can choose the right one for them, but our brand can't do that because our products are handmade and some are customized for that specific order. We know that the main factor causing NFT is definitely the size. We try to work with trusted sizes in order to minimize this problem."

Social e-shopping

On the companies' perspective, this factor is closely linked with the recreational aspect. The product involvement is imperative and it can be highly improved through social networks and bloggers, reducing the gap between the virtual and the real worlds. Seeing day-to-day people wearing the products will improve trust. Therefore, social media and bloggers are key to overall marketing strategy.

"We are present in the main SNSs, but the most relevant ones are Instagram and Facebook, especially Instagram. Facebook has more relevance in Portugal than in other countries. Instagram is the social network that reflects better our brand image and it is mostly used by young women. We try to interact as much as we can with our customers though social media by replying to each comment or emailing; we have a 100% rate of replies."

"The e-WOM around our brand is all organic. We have celebrities asking us to send them our products, but we do not do that unless we believe that person truly identifies with our values."

"We do "gifting" and send the products to some celebrities that we believe will reflect our brand image. Bloggers and celebrities have millions of brands asking them to share their products, so sometimes it is hard to reach the ones we want. But when they really like our products, they share it organically."

"We choose those bloggers or celebrities if we think they are a "Brand's Woman", the ones that believe in the women empowerment."

"Our PR is in permanent contact with bloggers from all over the world; we want to create a customized relationship with them. We give them first hand news and share ideas."

6. Conclusions

6.1. Theoretical implications

This research contributes for the understanding of the main factors that drive women to purchase shoes online, by fulfilling a gap in the literature regarding real insights from customers and managers on this topic. The main findings indicate that women highly appreciate the convenience feature that shopping shoes

online provides them. Convenience was found to be the key factor driving women consumers to shop online. Consumers value the easiness and time-saving aspect as well as the variety of products offered. The importance of the recreational attribute to stimulate online shopping was also confirmed in this research. Women interviewed stated that online shopping is a fun activity and that they enjoy the interactive features available online, such as the attractive website design, images and videos, reviews and feedback from other customers. This last factor provided them increased trust on the products they are buying, which is especially important in experience goods.

The NFT was considered a very important factor for all the consumers, mainly due to the size issue associated to the product category. NFT is particularly relevant in high-involvement product categories such as clothing or shoes, in which consumers need to see, try and touch the product to evaluate it, hands-on. Many of the participants said they preferred to go the physical store to try the product first and only then buy it online. Others said that this concern could be overcome with a good return policy.

Lastly, social e-shopping was found not to be as significant for women as it was supposed to be, considering the literature reviewed. Participants didn't acknowledge the direct impact of this factor on their predisposition to shop online. They acknowledge, though, having an active presence in the SNS's and they admit to follow bloggers and media influencers online. However, most of them do not consider this to be a motivating factor to purchase shoes online.

6.2. Managerial implications

This study offers some interesting insights for shoes companies' marketers. The understanding of the main factors that stimulate women consumers to shop shoes online provides relevant cues to best target this audience online by using strategies that are aligned with their motivations. Additionally, providing two different overviews of these factors – demand and supply - creates additional value. The convenience aspect of online shopping is imperative for consumers and any brand that has an online presence is automatically providing this to their customers: an online presence automatically provides convenience. Online stores offer the possibility of having a 24 hour, 7 days a week shop available, which is not possible in the physical world. Also, online shopping comprises an infinite number of options (colours, sizes, etc.), all in one "place".

Consumers consider online shopping as a recreational activity that can be enhanced by certain features that online brands can offer. It is very important to have an appealing and interactive website design that simulates their audience, such as good quality videos and images, but also an area for customer's reviews and feedback. This helps consumers to trust the products they are buying. It is also very important that brands stimulate customers' attention by involving them with the products, namely by using the "storytelling" strategy.

NFT is determinant in shoes. Consumers have the necessity to touch and feel before buying products like shoes. This is mainly due to issues such as the right size and the comfort provided. Nevertheless, this matter can easily be overcome by a good return policy. Companies must have it very clearly explained in their websites so that the customers can be more secured about their purchases. Furthermore, a good return policy can be an opportunity to enhance customer satisfaction and loyalty.

Social e-shopping is an imperative for digital brands. Almost every consumer is present in, at least, one social networking site and they are constantly being exposed to brand' stimulus, even without acknowledging it. They follow their favourite celebrities or bloggers online and are unconsciously being highly influenced by them. On the companies' opinion, this factor is directly connected with the recreational factor. They need to stimulate the enjoyment side of online shopping at every stage of the shopping process and most times this starts on social media. This also helps companies to connect and build a stronger relationship with their customers. Therefore, companies must acknowledge the power of social media and develop an active presence in the SNSs to improve customer relationship and eventually increase sales.

6.3. Limitations and future research

There are several research limitations that should be taken into consideration. First, on top of the factors selected to better understand the behaviour of online female customers of footwear, others could have been selected to provide a more complete framework of the factors that drive women's decisions. Factors like price, privacy, risk, delivery time and cost, product returns, product quality and variety, among others, could be added to the conceptual model used in this article. Secondly, the sample of this study is limited and non-random, which may skew the results. This way, conclusions needed to be confirmed with a larger sample and more diversified, namely in terms of ages. Regarding the company's perspective, more managers could have been interviewed to give other viewpoints of the organization and its strategy. Also, more companies could have been included in this study to give a more accurate overview of the suppliers' side. A final problem found, was the difficulty to find articles related with the online shoes market to better understand the implications this specific product characteristics have on consumers' motivations to shop online and on companies' motivations to sell them. Future research should consider a quantitative approach based on these results to further corroborate the findings and ensure its validity and credibility. We also suggest the model to be employed in other setting and the hypothesis to be developed in accordance with additional constructs.

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NON-PERFORMING LOANS, BANKING SYSTEM AND MACROECONOMY

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Abstract: The study builds on previous studies of the consequences of non-performing loans on an economy. Using a seven-by-seven matrix in the impulse response function (IRF) of the structural autoregressive model, we find a long-run impact of an impulse to non-performing loans on the banking system and the macroeconomy in Nigeria. Conversely, non-performing loans also respond to the innovation of all macro-banking variables aside from the exchange rate and the growth rate to GDP. Also, the level of non-performing loans grows in influence in relation to the changes to the exchange rate using the variance decomposition tool of Structural VAR. Hence, a prominent role is assigned to the level of NPLs in linking the friction in the credit market to the susceptibility of both the banking system and the macroeconomy. This study passes the serial correlation tests and the three tests of normality.

JEL classification: E51, G21, O47

Keywords: SVAR, non-performing loans, impulse response function, variance decomposition, macro-banking.

1. Introduction

A major challenge facing the banking sector is the prevalence of non-performing loans (NPLs). The high incidence of such loans has been identified as a factor that limits the effectiveness of the banking sector in promoting economic growth in many countries (Boudriga, Taktak, Jellouli, 2010). In corroborating this view, Schumpeter (1969) writes that a healthy financial system promotes economic growth, but a weak financial system grappling with non-performing loans and insufficient

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capital could undermine growth. Hence, at the heart of credit market friction (Bernanke Gertler, 1989; Guerrieri, Lorenzoni, 2017) are non-performing loans (NPLs), which are viewed as a source of financial pollution that negates social utility in an economy Zeng (2012).Studying the extent of the effect of non-performing loans is of particular importance in developing and emerging market economies such as Nigeria. The significance of non-performing loans is mainly due to the vulnerability of these usually non-diversified economies to external shocks and macroeconomic instability. At a micro level, bank bankruptcy is usually preceded by a build-up of non-performing loans at a systemic level, and banking crises are also preceded by a substantial accumulation of non-performing loans (Jiménez, Ongena, Peydró, Saurina, 2017). This vulnerability can be further exacerbated by the structure of the banking system in sub-Saharan Africa (and Nigeria is not exempted), which is dominated by a few large banks. Bankruptcy or insolvency involving even one major player can have a spiral effect on the entire system in the country.

While the definition of non-performing loans (NPLs) is not uniform across countries, in the global financial stability report of the International Monetary Fund (IMF), a general definition encompasses several formulations (IMF, 2004). According to the IMF definition, a loan is deemed to be non-performing if payments (principal and/or interest) due have not been paid for at least 90 days.

A major challenge confronting the banking sector in Nigeria is the prevalence of NPLs. Nigeria has experienced financial sector problems in the past and NPLs were identified as the main cause of these (Adeyemi, 2011; Bebeji, 2013; Somoye, 2010). The average growth rate of NPLs in Nigeria since 1999 is about 46%. This figure, however, which seems to have declined in recent times is due to the fact that a chunk of it is no longer accounted for by the banking sector. In 2010, the on-going concern regarding NPLs resulted in the Nigerian government opting for a bailout solution; the National Assembly established the Asset Management Corporation of Nigeria (AMCON) to buy from banks, some non-performing loans with an estimated value of five trillion Naira (Kolapo, Ayeni, Oke, 2012). As Kolapo *et al.* (2012) write, these toxic loans (estimated at about $33.3billion) were taken off the balance sheet of banks with public funds in 2010. However, in spite of the depressed official figures, in the preceding three years ending in 2014, the magnitude has grown by 22%. This trend has continued to give the monetary authorities in Nigeria a serious cause for concern as different measures were employed in recent times to rein in the severely increasing trend of non-performing loans. It is commendable that governments in Nigeria have acknowledged this problem, but noteworthy is the fact that policy initiatives have failed to contain NPLs, which have continued to increase in absolute terms between 2011 and 2014 by about 122% in Nigeria as against a 5% maximum benchmark of an annual growth of NPLs (Anderson et al., 2011).Therefore, central to this study is the assessment of the susceptibility of the Nigerian banking system and macroeconomy (referred to in this paper as macro-banking) to the scourge of non-performing loans. This study will help to extend the validation of the serious attention paid by the country's monetary authorities to the broad implications of the growth of NPLs in Nigeria.

But, limited attention has been accorded NPLs in empirical studies as regards to its macro-banking effects in the literature. The disorder that NPLs are capable of orchestrating in relation to the macroeconomy of a country (Barseghyan, 2010), particularly in Nigeria, is the core motivation of this study. The focus on Nigeria stems

from her being regarded both as a regional power in Africa and a middle power in international affairs, has the largest economy in Africa and is ranked within the ten Big Emerging Market (BEM). Also, Nigeria could grow at an average minimum of 5% over the next 35years up to 2050 while established emerging economies such as China is expected to moderate to between 3% and 4% over the same period (PWC, 2015). Their model predicts Nigeria having the highest GDP growth rate over the same period of 5.4% in domestic currency. Given the trend of NPLs in Nigeria, her potential and future role in global economy can be put in jeopardy, hence requiring attention.

Our objective in this paper, therefore, is to investigate how a long and drawn-out dysfunction in the credit market impacts both the banking system and the Nigerian macroeconomy. Identifying responses to systemic shocks will also guide policy, and forecasting future levels will be useful for pre-emptive policies and actions. This study contributes to existing knowledge in this regard and is the first empirical study in Nigeria, as far as we are aware. Therefore, this study will be useful for policy-makers and support future work by researchers.

2. Literature Review

The context of this section, shaped by the three research questions to be answered under the main objective of this paper, which address the feedback dynamics between NPLs levels and some macro-banking indicators in Nigeria; the central nature or otherwise of NPLs to influencing some macro-banking indicators in Nigeria, and the time-nature of this influence, if so; and the reaction of the level of NPLs to sharp movements in the selected macro-banking indicators in Nigeria.
These three research questions, encapsulated in the main objective covered in this study, are defined by the theory of money creation (McLeay, Radia, Thomas, 2014) which is key to the understanding of how non-performing loans arise and its consequences on an economy. The concept of money creation (or credit creation) describes a situation of increase in the money supply of a defined geographical location through lending activities.

Various theories have been advanced to explain why NPLs arise. In discussing the agency theory, Jensen and Meckling (1976) refer to the conflict of interest that occurs between the agent and the principal and the tendency for the agent to work in his/her own best interests rather than those of the shareholders. This may occur when managers offer loans with the primary goal of earning bonuses. Moral hazards refer to the practice of engaging in additional risks after an exchange on the understanding that the consequences of the risks taken in terms of financial burden reside with another party (Mishkin, 2011; Zhang, Cai, Dickinson, Kutan, 2016)

The literature suggests that there is an impact on macroeconomic factors by non-performing loans. For instance, the 2008 global financial crises originated from a sharp increase in mortgage loan defaults in the United States of America (Purnanandam, 2011).

The importance of credit to an economy cannot be over-emphasized. While most macroeconomists examine the impact of assets on aggregate demand by using models similar to the Investment Savings-Liquidity Preference (IS/LM), the LM curve treats money as a special asset, but in the bond market lumps all debt instruments

together. However, since loans granted in an economy are a special case, as its growth or decline can affect aggregate demand and supply (Hicks, 1937). However, loans granted in an economy are a special case as their growth or decline can affect aggregate demand and supply (Bernanke, Blinder, 1988). In their model, Bernanke and Blinder focus on three assets (loans, bonds and money) to analyse equilibrium in the credit market as a major driver of aggregate demand. Friedman (1994) argues that a measure of credit is associated with nominal gross domestic product (GDP), while Stiglitz (1989) maintains that money is important because of its relationship with credit. The institutional link between money and credit is enabled by the development of fractional reserve banking, which combines loans with deposits (Cochran, Call, 2000).

Moinescu (2012) argues that strong increases and decreases in credit are the transmission channels of the dynamics of non-performing loans. This view corroborates the work of Jakubik and Moinescu (2015) who link contracting credit to the growth of NPLs, likening it to inefficient resource allocation by banks. Moinescu further links the dynamics of NPLs to the difference in banks' credit to the private sector, which is measured as a percentage of GDP. He argues that some macroeconomic variables as well as market variables determine the number of NPLs. In his opinion, macroeconomic variables such as economic growth enhance the capacity to repay. Conversely, financial market variables such as the exchange rate and interest rates lower capacity for repayment.

The study of business cycles, which play a role in the theoretical framework of this study, dates back to such empirical works by Mills (1927) and Kuznets (1940). There was a proliferation of studies on business cycles in the early 1930s, particularly after the Great Depression, which was motivated by the aim to avoid future re-occurrence of the depression's consequences.

Later, studies were focussed on investigating the causes of business cycles. Some researchers formulated equilibrium business cycle models that suggest that monetary shocks occur within an environment of economic agents with information asymmetry that cause business cycles (Lucas 1972, 1975). Conversely, the opposite position in the literature is that stochastic disturbances to technologies of production cause 'real' business cycles and that economic agents' willingness to substitute on an intertemporal basis propagate these shocks. But in the real business-cycle world, there is either no role for monetary factors and financial intermediation or monetary factors merely play a production role (that is of transaction services), such as explained in the work of King and Plosser (1984). In their study, real disturbances drive co-movements among money, credit and price level and other real variables in a business cycle. They suggest that correlation between money and output occurs as the endogenous banking system responds to disturbances.

King and Plosser's (1984) model generates co-movements among money, credit, the price level, and other real variables in a business cycle driven by real disturbances and explains observed money-output correlations through the endogenous response of the banking system to these disturbances (Williamson 1987). Considering a business cycle model that explicitly has a role for financial intermediation gives a good foundation for non-performing loans. This is so because it emphasizes the countercyclical nature of credit risk and business failures (Williamson, 1987). Williamson finds that intermediation plays a role in the business cycle.

The consequences of NPLs, which form the fulcrum of this study as it addresses the research questions, are captured in the financial accelerator theory (FAT) developed by Bernanke and Gertler (1989). The FAT is a condition where the initial shocks brought about by changes in credit market conditions extend into the economy (Bernanke, Gertler, Gilchrist, 1996; Kiyotaki, Moore, 1997). The concern of the FAT lies in the puzzle that small shocks bring about large cycles. The framework used to rationalize the FAT is the "principal-agency" view of the credit market, which has been extensively developed. The principal represents the lender and the agent represents the borrower. The main implication of the FAT is that in an economic downturn, a borrower, whose agency cost is significant in the credit market will likely face bigger hardships in his/her quest for access to credit as he/she suffers reduced economic activities relative to others. This is referred to as the "flight to safety" by Bernanke *et al.,* (1996).

The robust results emerging from the extensive literature on features, structures and functioning of the credit market, with diverse findings, depending on assumptions about relevant informational frictions in the market, form the foundation for the FAT. By loosely applying the work of Kiyotaki and Moore (1997) within a two-period two-factor assumption, the purchase of variable input, x_1, and new borrowing, b_1, is linked in an accounting identity:

$$x_1 = a_0 f(x_0) + b_1 - r_0 b_0 \text{ where } a_0 f(x_0)$$

is the entrepreneur's gross cash flow from production in period 0 (or output of that period), $r_0 b_0$represents period 0 debt obligation with $b_0$and r_0 being the borrowing and the gross interest rate on the borrowing, respectively. Even though this model assumes that every external borrowing is collateralized, unsecured lending can also be accommodated in equilibrium. Work such as that of Townsend (1979), with the costly state verification (CSV) arrangement whereby a corporate audit is undertaken, imposes discipline that helps to guard against default. Under the assumption of equality, substituting for $b_1 = \left(q_1/r_1\right)K$, we have

$$x_1 = a_0 f(x_0) + \left(q_1/r_1\right)K - r_0 b_0 \quad (1)$$

This means that spending on variable input x_1 is a function of gross cash flow, $a_0 f(x_0)$ and the net discounted asset of $\left(q_1/r_1\right)K - r_0 b_0$. This implies that the net worth of the borrower, given by his/her liquid assets and the collateral value of his/her illiquid assets, ultimately determines the spending capacity of the borrower (to expend on variable input) and production. This situation, in which fluctuations in the net worth of borrowers cause fluctuation in real activities, is referred to as the financial accelerator. Mises (1971) argues that economic crises are usually the outcome of 'credit creation'.

Thus macrofinancial linkages, explained by the financial accelerator theory (FAT), models NPLs and their direct interlink with macroeconomic performance (Nkusu, 2011), and even though the theory basically assumes aggregate credit and collateralized lending, uncollateralized lending and default can be accommodated within the model (Bernanke and Gilchrist, 1999).

The relevant empirical literature links non-performing loans with macrofinancial conditions, emphasizing the positive impact of non-performing loans on the probability of crises. For instance, Kaminsky and Reinhart (1999) suggest that a sizeable increase in non-performing loans can signal the onset of the crises. Here, non-performing loans are used to explore macrofinancial vulnerability, which may in turn predict crises (Caprio and Klingebiel, 1996; Drees and Pazarbasioglu, 1998). Related to this aspect is the literature that links non-performing loans to macroeconomic performance and how NPLs may be linked to financial vulnerabilities or fragility. The scope of study may focus on one country (Erjavec, Cota, Jakšić, 2012) or a group of countries (Espinoza, Prasad, 2010; Klein, 2013). Even though NPLs may not be the only explanation, they play a role in financial system vulnerabilities (Caprio, Klingebiel. 1996; Drees, Pazarbasioglu, 1998; Kaminsky, Reinhart, 1999).

The vector autoregression (VAR) approach has been used in many financial stability analyses, linking credit quality and macroeconomic conditions, which lends credence to the financial acceleration theory. In their analysis of the Malaysian financial system, Ahmad and Ahmad (2004) reported a significant relationship between credit risk and financial crises and concluded that credit risk had already started to build up before the onset of the 1997 Asian financial crisis, and only deteriorated as NPLs increased.

Marcucci and Quagliariello (2009) rely on the VAR approach to highlight the feedback loop between non-performing loans and macroeconomic performance. They find feedback from the banking sector to macroeconomic performance via the capital channel. In Espinoza and Prasad (2010), non-performing loans worsen as economic growth slows down and the interest rate increases. Nkusu (2011) suggests a nexus between frictions in the credit market and macro-financial vulnerability with NPLs playing a critical role. In order to study interrelationships among variables, a panel vector autoregressive (PVAR) model was used to explore the feedback between shocks to variables, including NPLs and their macro-financial determinants. The work of Nkusu (2011) is found useful in addressing the objective of this study, which seeks to investigate how the banking sector and the Nigerian economy react to changes in NPLs. For instance, as NPLs increased by 100%, macroeconomic conditions, as measured by the GDP growth rate, fall by 18% and 16% using the ordinary least square and generalized method of moments, respectively.

Turning to specific country studies similar to our study, Erjavec et al. (2012) in their study on how the banking system reacts to macroeconomic shocks, in order to stress-test the banking system in Croatia, they used the vector autoregression (VAR) model. Two banking sector variables, the non-performing loans (NPL) and the return on equity (ROE) were used. The four macroeconomic variables used were the Croatian real GDP, the interest rate and the inflation rate and the real GDP of the European Union. Their results suggest that the banking sector in Croatia is sensitive to macroeconomic shocks. Also, in their study on how vulnerable the banking sector is to the Egyptian economy, Love and Ariss (2014) observed the reaction of bank loans to macroeconomic shocks and the feedback effect of bank loans' shocks on the Egyptian macroeconomy.. Using the panel variance autoregression (PVAR) model, they combined a panel of state banks, domestic private banks and foreign banks, utilising the GDP growth rate, the domestic credit to the private sector as a ratio of GDP, lending rate, the exchange rate, and capital inflows as macroeconomic variables. On the other hand, loans to assets, loans growth rate and return on equity (ROE) were

employed as banking sector variables. They find that shocks in the macroeconomy are transmitted to the Egyptian banking system via the credit channel. Finally, Wong, Choi, and Fong (2006), in their study, which set out to analyse the reaction of aggregate loans and mortgage loans on plausible shocks from the macroeconomy of Hong Kong, rates of default in bank loans were found to be significantly sensitive to sudden movements of interest rate, GDP and property prices. The study adopted a framework of Monte Carlo simulation in which different possible combinations of stressed macroeconomic values are obtained given some unfavourable macroeconomic scenarios, from a Monte Carlo simulation. This method allows, under some specific shocks, the generation of distributions for possible bank loans' default rates.

Overall, previous studies have suggested the vulnerability of banking sectors to shocks emanating from the macroeconomy. Major differences have, however, arisen from the use of different proxies used as bank-level and macroeconomic variables.

3. Methodology

Our objectives are addressed using the structural vector autoregressive (SVAR) model. The reasons for the choice of SVAR are:

- The literature has identified structural VAR (SVAR) as a good estimating technique that can help achieve an objective such as in this study (Tang, Nasiopoulos, Ward, 2008).

- Empirical studies of this nature have effectively utilized this approach (Erjavec et al., 2012; Nkusu, 2011) making use of the impulse response function and variance decomposition characteristics of SVAR.

SVAR Approach

The structure of the SVAR for the study combines selected endogenous variables. It incorporates the NPLs, bank credit to the economy, GDP growth rate, lending rate, exchange rate and two other bank-specific variables, namely, the return on assets and the bank liquidity ratio.

Generally, the structural equation for the MINT economy is given as:

$$\mathrm{AY_t} = C_0 + \sum_{l=1}^{p} B_l \, \mathrm{Y_{t-l}} + \ Du_t \qquad (3.1)$$

where A represents an (n x n) invertible matrix, which describes the contemporaneous relationship amongst the variables in the model, B_l represents the (nx1) vector of the coefficient of lagged endogenous variables, Co is the (nx1) vector of constants, p is the lag length, $\mathrm{Y_t}$ represents the (nx1) vector of endogenous variables divided into two blocks for vector of non-policy variables and vector of policy variables (assumed to be controlled by the Central Bank), and u_t represents an uncorrelated vector of error term. u_t, which is the white noise, is assumed to follow a Gaussian distribution with E(u_t| Y1, ..., Yt−1) = 0 and E($u_t u^1{}_t$| Y1, ..., Yt−1) = I and $\mathrm{E}\left(u_{t-i}u'_{t-j}\right)$ is the sum for i=j and $\mathrm{E}\left(u_{t-i}u'_{t-j}\right)$ for i≠j representing the structural economic shock.

As a result of the contemporaneousness inherent in the VAR process (Enders, Hurn, 2007), and the resultant effect of parameters that are unidentified due to unknown coefficients in the model, equation 3.1 cannot be directly estimated. Studying the impulse

response functions of economic shocks is the aim of a structural analysis, but the problem is that u_t is not observed and needs to be estimated or derived. Therefore, we derive these by estimating a reduced form VAR that is implicit in equation 3.1 (Gujarati, 2009; Ngalawa, Viegi, 2011). Multiplying equation 3.1 by A^{-1} gives us

$$Y_t = A^{-1}C_0 + \sum_{l=1}^{p} A^{-1}(B_l Y_{t-l}) + A^{-1}Du_t \quad (3.2)$$

Given that $A^{-1}C_0$ = μ and $A^{-1}B_l = \sigma_i$ for all l= 1 p, $A^{-1}\rho_i = \alpha_i$ and $A^{-1}Du_t = \pi_t$ then equation 3.2 can be re-written as

$$Y_t = \mu + \sum_{i=1}^{p} \sigma_i Y_{t-i} + \pi_t \quad (3.3)$$

The short form of equation 3.3 is given as:

$$Y_t = B(L)Y_t + \pi_t \quad (3.4)$$

Where

Y_t represents the vector of bank non-performing loans, significant macroeconomic variables and other bank-specific variables of interest. This can be denoted:

$$Y_t = (GDPGR, BNPL, BTCR, ROA, BLR, LEDR, EXR) \quad (3.5)$$

From $\pi_t = A^{-1}Du_t$, we find that the VAR residuals π_t and structural shocks are related by

$$Du_t = A\pi_t \quad (3.6)$$

Indicating a full variance-covariance matrix $\sum = E(\pi_t \pi'_t)$.

Equation 3.1 differs from equation 3.4 in that while the former is referred to as the primitive system, the latter is referred to as the reduced or standard-form SVAR. Further, while variables have a contemporaneous relationship in equation 3.1, there is no such relationship amongst variables in equation 3.4.

There are different ways to estimate the parameters in the structural-form equation. However, some restrictions should be imposed on the elements of the matrix in the estimation of structural parameters. Previous studies of VAR models have used various restriction methods based on model preferences and existing theory. In one tranche of literature, the Cholesky decomposition of orthogonalized reduced-form disturbances (Sims, 1980) was used to identify the model. However, only the recursive method is used in this identification approach in which the estimation results obtained change in the ordering of variables. The other tranche of literature uses a non-recursive method, which only imposes restrictions on structural parameters that are contemporaneous in nature. This generalized method has been used by (Sims, 1986); Blanchard and Watson (1986); Bernanke (1986); and Kim and Roubini (2000) in empirical studies.

Using the maximum likelihood estimation technique, we can generate consistent estimates of the structural form parameters contained in equation 3.3 through equation 3.6 by imposing sufficient restrictions on matrices A and D. However, the minimum restriction required on these matrices for system identification is $2n^2 - \lfloor n \times (n-1)/2 \rfloor$(Giannini, 1991). These restrictions are imposed on the basis of economic

theory and previous empirical findings. For our contemporaneous matrix specifically, we impose restrictions on the structural parameters using the work of Kim and Roubini (2000) as a guide. Using the tools provided by the impulse response function (IRF) and the variance decomposition, we will then be able to answer the research questions posed under this objective.

As against a larger SVAR model, which allows for richer interaction, a 7-variable model such as that adopted in this study is likely to be more stable and parsimonious as it utilizes more degrees of freedom (Berkelmans, 2005). The non-zero coefficients 'bij' in equation 3.6 connote an instantaneous effect of variable 'j' on 'i'. From equation 3.6, the matrices formed are in line with the work of Ngalawa and Viegi (2011) and shown below as:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} & a_{36} & a_{37} \\ a_{41} & a_{42} & 0 & 1 & 0 & 0 & 0 \\ a_{51} & a_{52} & 0 & 0 & 1 & a_{56} & 0 \\ 0 & 0 & 0 & a_{64} & 0 & 1 & 0 \\ 0 & 0 & a_{73} & a_{74} & a_{75} & a_{76} & 1 \end{bmatrix} \begin{bmatrix} \pi_t^{GDPGR} \\ \pi_t^{BNPL} \\ \pi_t^{BTCR} \\ \pi_t^{ROA} \\ \pi_t^{BLR} \\ \pi_t^{LEDR} \\ \pi_t^{EXR} \end{bmatrix} = \begin{bmatrix} d_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & d_2 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & d_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & d_4 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & d_5 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & d_6 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & d_7 \end{bmatrix} \begin{bmatrix} u_t^{GDPGR} \\ u_t^{BNPL} \\ u_t^{BTCR} \\ u_t^{ROA} \\ u_t^{BLR} \\ u_t^{LEDR} \\ u_t^{EXR} \end{bmatrix} \quad (3.7)$$

3.1. Variables definition

Bank-specific variables

- $bnpl$ is the total bank non-performing loans, which is the total of non-performing loans by banks measured as a percentage of gross loans;
- $btcr$ is the banks' total credit to the private sector and comprises the financial loans to the private sector of the economy by banks, which is measured as a percentage of the gross domestic product (GDP);
- roa is the banks' return on assets measured as an average period percentage;
- blr is the annual banks' liquidity reserve as a percentage of bank assets.

Macroeconomic variables

- $gdpgr$ is the real GDP per capita expressed in United States (US) dollars and measured in an average period, which is logged in the model to capture percentage changes;
- $ledr$ is the lending rate measured in average period percentage;
- exr is the official exchange rate measured in local currency per US$, period average.

3.2. Data Sources and Scope

Data on the Nigerian banking sector's NPLs, GDP growth rate, total bank credit to the domestic economy, return on assets, the bank liquidity ratio, lending rate and exchange rate are sourced from the World Bank Tables 2014 edition and the Central Bank of Nigeria. The scope of data is 17 years (1998-2014. This period was selected because data were available. The data were captured on a quarterly basis and data available annually were interpolated, as in Chow and Lin (1971) and Tang et al. (2008), to quarterly data for data uniformity. Thus, we have a total of 68 quarters.

4. Empirical Findings and Discussions

Lag Length

This study tested various lag lengths for different selection criteria. These include the final prediction error (FP), Akaike information criterion (AIC), Schwarz information criterion (SIC), Hannan-Quinn information criterion (HIC) and the sequential modified LR test statistic with each test at 5% level.

In line with Table 1, all the lag selection criteria selected lag length 5 as the ideal, which is utilized in the following analyses.

Table 1. Lag Length selection

VAR Lag Order Selection Criteria
Endogenous variables: GDPGR BNPL BTCR ROA BLR LEDR EXR
Exogenous variables: C
Date: 06/24/16 Time: 09:26
Sample: 1998Q1 2014Q4
Included observations: 63

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1357.52	NA	1.53e+10	43.318	43.556	43.412
1	-759.237	1044.615	413.659	25.880	27.786	26.630
2	-656.165	157.063	78.573	24.164	27.736	25.569
3	-627.423	37.450	173.575	24.807	30.046	26.868
4	-581.518	49.549	260.794	24.905	31.811	27.621
5	-245.632	287.902*	0.051*	15.798*	24.370*	19.169*

** indicates lag order selected by the criterion*
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

5. Findings

Impulse Response Function

Response of BNPL (Bank Non-performing Loans)

We find that the GDP growth rate and exchange rate do not result in a significant response of non-performing loans. Shocks to bank total credit, return on assets, bank liquidity ratio and lending rate, however, evoke a significant response from NPLs. Similarly, the innovation to return on assets (ROA) significantly reduces the level of NPLs. Turning to the shock to the bank liquidity ratio, this evokes a significantly flat response of NPLs Finally, a lending rate shock initially significantly reduces non-performing loans before reversing again.

Response of Macro-banking Indicators to NPLs' Shock

We find that the shock to non-performing loans significantly impacts other macro-banking indicators but with varying trends. Also, the shock to NPLs did not show a significant impact on bank credit until later in the time horizon. Further, an innovation to non-performing loans has a significant impact on ROA for only a period. However, a non-performing loans' shock increases bank liquidity over a period. In addition, a shock to NPLs slowly but significantly reduces the lending rate but reverses later in the time horizon covered by our study. Finally, a shock to NPLs significantly reduces the exchange rate at a later stage of the time covered.

Variance Decomposition of BNPL (Bank Non-Performing Loans)

Under the variance decomposition of the banks' non-performing loans in Nigeria, we find that in the third quarter, it is observed that 68.8% of the variation in the level of NPLs is explained by itself. Also, the other top two variables in explaining variations in the level of NPLs are the bank total credit to the private sector and the return on assets. This influence, however, wanes in the long run.

Variance Decomposition of Exchange Rate

Conversely, we observed the variance decomposition of the exchange rate within the context of other selected variables in Nigeria. In the third quarter, it can be observed that about 11% of the variations in the exchange rate can be explained by a shock to itself. Also, shocks to the GDP growth rate, the bank non-performing loans, the bank liquidity ratio and lending rate had lower levels of explanation of the variations in the exchange rate. However, there are higher levels of explanation to the variations in the exchange rate by shocks to the bank total credit to the private sector and ROA. We also find that the impact of ROA has grown even bigger of the variations in the exchange rate, while that of NPLs and the bank liquidity ratio have also grown to the second and third highest respectively. Lending rate, exchange rate and the bank total credit have reduced in impact over the twelve quarters covered in this study. Also, the impact of the growth rate of GDP grows marginally in explaining

the variations to the exchange rate over a long-term horizon. In all, ROA consistently has the highest singular impact in the explanation of the fluctuations in the exchange rate in both the short run and the long run. In Nigeria, among the selected variables, it is the most closely related to the exchange rate.

6. Discussion

Impulse Response Function

Figures 1 and 2 represent the response of each of the variables when there is a shock from each of the other variables in the model.

Response of BNPL (Bank Non-performing Loans)

Figure 1 shows that shocks to the GDP growth rate and exchange rate do not result in a significant response of non-performing loans. This contrasts with the more popular findings such as those of Klein (2013) and Balgova, Nies, Plekhanov (2016). In his study of Central and Eastern and South-Eastern Europe (CESEE), he finds that the rise in NPLs culminates in the slowdown of the economy. Shocks to bank total credit, return on assets, bank liquidity ratio and lending rate, however, evoke a significant response from NPLs. For instance, a shock to bank total credit significantly reduces NPLs for one quarter to the second quarter when they bottom-out and start increasing significantly. This trend also slows down around the eighth quarter when it starts to flatten out. This may imply that after the initial very short-term reduction of NPLs for two quarters, from the shock to bank total credit, non-performing loans begin to increase. Over time, as the impact of the shock transmits to NPLs, non-performing loans begin to rise. A shock to the bank credit to the private sector may actually signal a boom and a lowering of lending standards, which will adversely affect the trend of NPLs in the future (Rajan, Dhal, 2003). Similarly, the innovation to return on assets (ROA) significantly reduces the level of NPLs up until the third quarter when it bottoms out and begins to increase over the period of the observation. Turning to the shock to the bank liquidity ratio, this evokes a significantly flat response of NPLs up to the fourth quarter when they begin to fall until about the eighth quarter when they start rising slowly. In theory, when the liquidity ratio rises, loanable funds receive a boost (Schnabl, 2012), which may increase NPLs. Finally, a lending rate shock initially significantly reduces non-performing loans until the second quarter when they begin to rise to the eighth quarter before reversing again. This aligns with empirical evidence that lending rate impulses tend to worsen loan repayment capacity and increase the economic burden, which makes it increasingly difficult to service obligations (Cecchetti, Kharroubi, 2015).

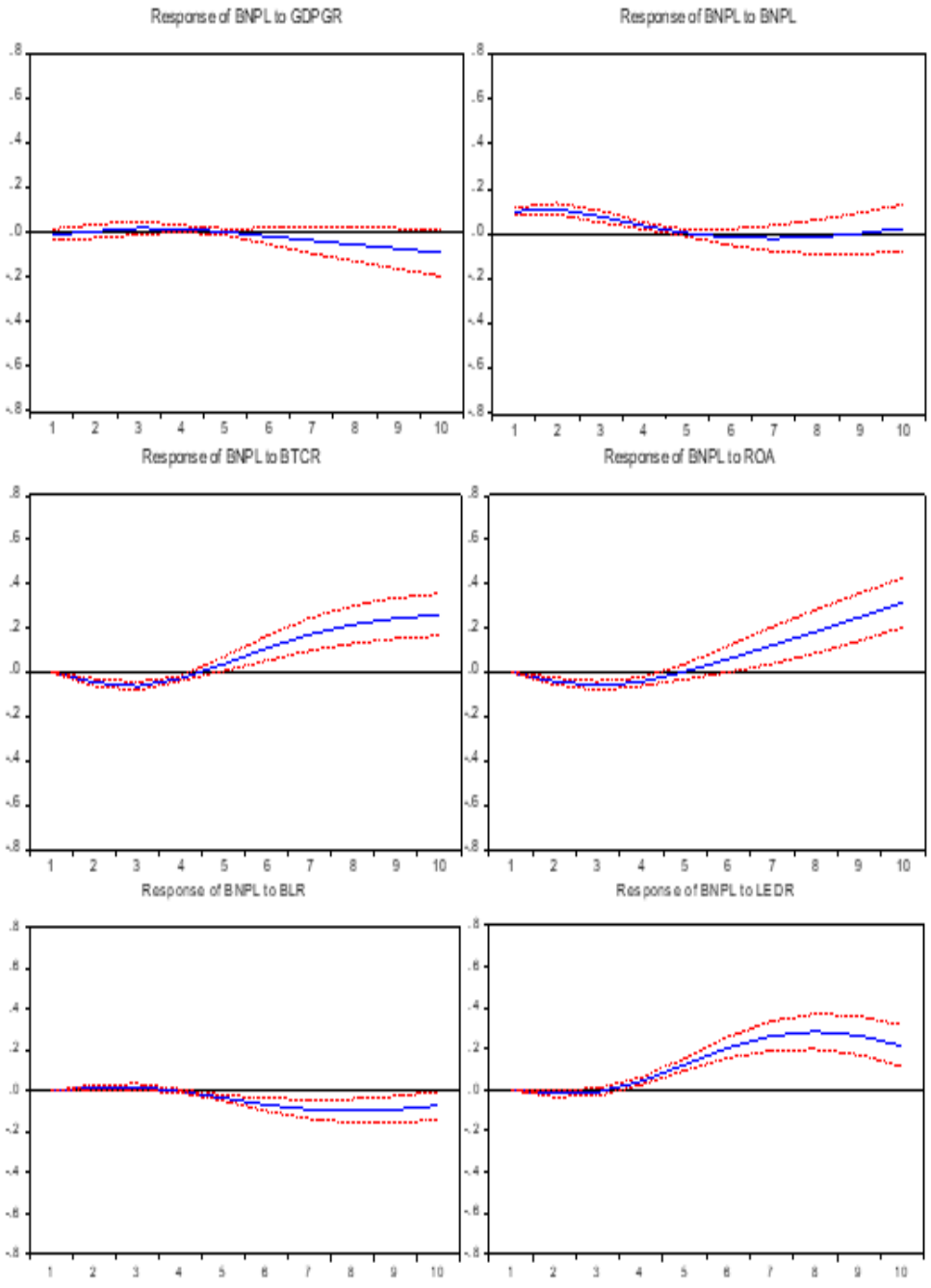

Fig. 1. Response of BNPL (Bank Non-performing loans)

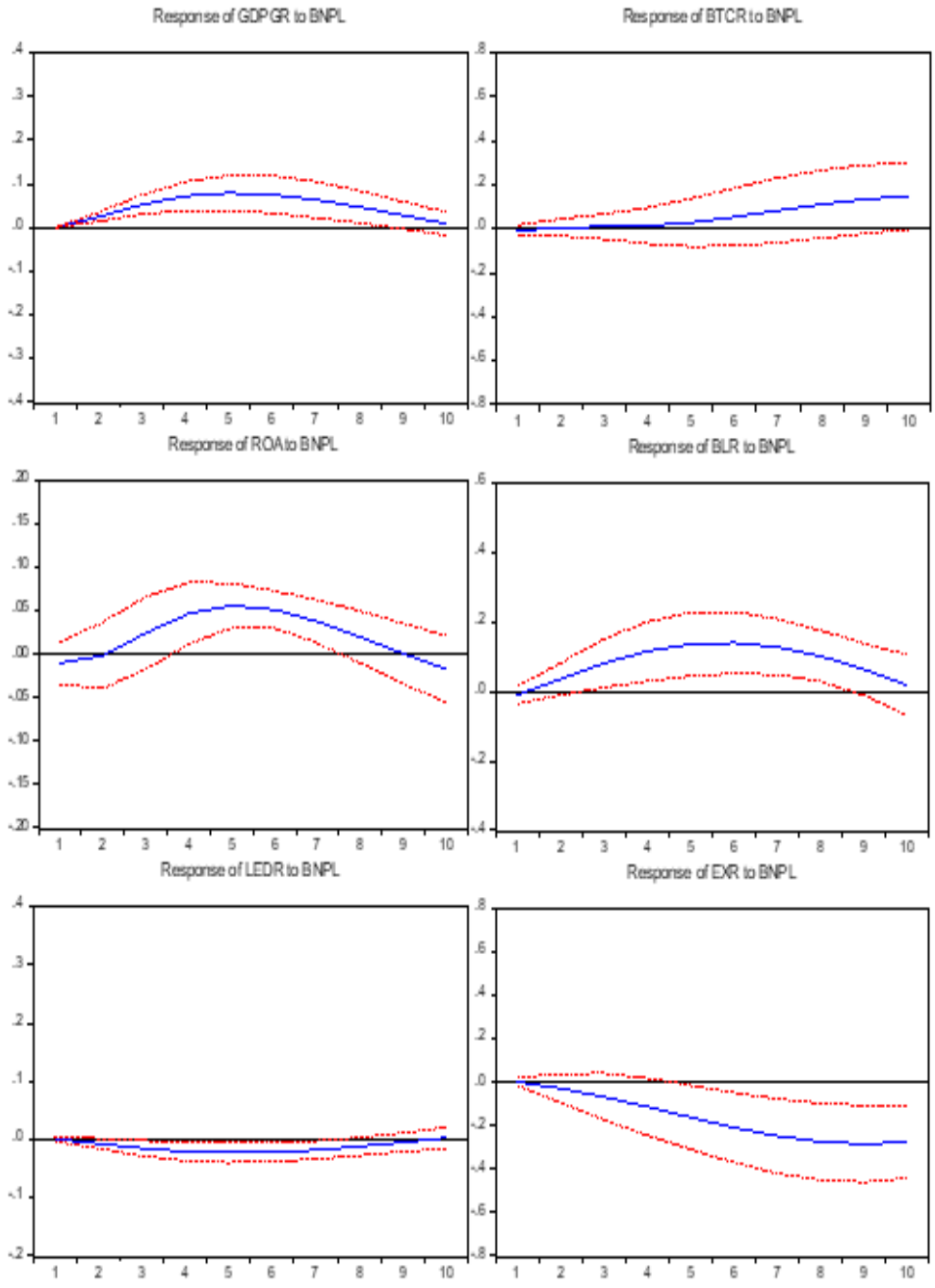

Fig. 2. Impulse Response of BNPL (Bank Non-performing loans)

Response of Macro-banking Indicators to NPLs' Shock

In Figure 2, we find that the shock to non-performing loans significantly impacts other macro-banking indicators but with varying trends. For instance, a 1% standard deviation shock to non-performing loans increases the GDP growth rate slowly until the fourth quarter when it begins to return to equilibrium. Previous empirical evidence and theory align with this result (Balgova, Nies, Plekhanov (2016).

Also, the shock to NPLs only shows a significant impact on bank credit (Louhichi, Boujelbene, 2016) from the tenth period by increasing it. This may occur in a situation where bank management creates more loans to cover up for the adverse impact on the profitability of previous NPLs. In the literature, when the Central Bank allows the flow concept in dealing with the treatment of NPLs, forbearance over time allows management to realize profit over time to neutralize the effect of toxic loans on the capital of the bank. In this situation, more loans are booked to realize more profit, which helps the bottom line of banks.

Also, an innovation to non-performing loans has a significant impact on ROA between the fourth and the eighth quarter but no impact in the very short and long run. An increase for a quarter, up until the fourth quarter, and a decrease thereafter towards equilibrium is the outcome of NPLs' shock on ROA. The decline is more prolonged than the increase and this may imply that ROA decreases when there is a standard deviation innovation to NPLs. This is expected since a growth in NPLs translates into a reduction in ROA, which is a function of profitability (Anastasiou, Louri, Tsionas, 2016).

However, a non-performing loans' shock increases bank liquidity from the second to the sixth quarter when it begins to decline. Also, a shock to NPLs slowly but significantly reduces the lending rate up until the fifth quarter when it begins to increase towards equilibrium. This reduction occurs in the short run and increases from the medium term to the long run. This may imply that a drop in interest is an outcome of an innovation to NPLs, which may also signal a trough in the business cycle. This situation, however, reverses in the long run. Finally, a shock to NPLs significantly reduces the exchange rate from the fifth quarter. This may imply that the domestic currency appreciates as a result of a shock to NPLs. Indeed, a growth in NPLs may signal economic hardship and this is expected to lead to currency appreciation as the demand for foreign goods falls.

Variance Decomposition of BNPL (Bank Non-Performing Loans)

Table 2 depicts the variance decomposition of the banks' non-performing loans in Nigeria. In the third quarter, it is observed that 68.8% of the variation in the level of NPLs is explained by itself. Also, the other top two variables in explaining variations in the level of NPLs are the bank total credit to the private sector (Konstantakis, Michaelides, Vouldis, 2016) and the return on assets, which account for 14.36% and 12.7%, respectively. This may imply that these variables exert influence in the variation in the level of NPLs in the short run. However, the GDP growth rate, the bank liquidity ratio, lending rate and exchange rate account for 1.27%, 1.33%, 1.2% and 0.29% of fluctuations in the level of NPLs, respectively. This may imply that the level of toxic loans in Nigeria may not be seriously influenced by these variables in the short run. By the medium term in the sixth quarter, the

lending rate has become the individual most influential variable in the explanation of fluctuations in the level of NPLs. For instance, while the NPLs level explains 23% of its own variation, the lending rate explains about 46% of the fluctuations in the level of NPLs. This influence, however, wanes in the long run since by the twelfth quarter, while 24.6% of the variations in the level of problem loans are explained by the lending rate, about 40% of the variations are then explained by the return on assets. By this period, the bank total credit to the private sector, which is one of the variables that grows in influence over the period, now accounts for about 26% in the explanation of fluctuations in the level of NPLs.

Table 2: Variance decomposition of BNPL

Period	S.E	GDPGR	BNPL	BTCR	ROA	BLR	LEDR	EXR
3	0.203	1.271	68.850	14.357	12.697	1.332	1.205	0.288
6	0.360	0.848	22.999	15.648	8.316	4.926	46.349	0.915
9	0.800	1.647	4.751	24.568	19.137	5.141	43.822	0.935
12	1.191	3.217	2.949	25.691	39.887	2.830	24.634	0.792

Source: Author's computation

Variance Decomposition of Exchange Rate

Table 3 shows the variance decomposition of the exchange rate within the context of other selected variables in Nigeria. In the third quarter, it can be observed that about 11% of the variations in the exchange rate can be explained by a shock to itself. Also, shocks to the GDP growth rate, the bank non-performing loans, the bank liquidity ratio and lending rate explain about 4.5%, 1.5%, 3.7% and 10%, respectively, of the variations in the exchange rate (Maigua, Mouni, 2016). However, there are higher levels of explanation of 23.4% and 46% to the variations in the exchange rate by shocks to the bank total credit to the private sector and ROA, respectively. It can then be inferred that in the short run, all of the selected variables explain more than 1%. By the twelfth quarter, however, the impact of ROA has grown even bigger to over 61% of the variations in the exchange rate, while that of NPLs and the bank liquidity ratio have also grown to the second and third highest of about 11% and 8%, respectively. Lending rate, exchange rate and the bank total credit have reduced in impact over the twelve quarters covered in this study. Also, the impact of the growth rate of GDP grows marginally to over 5% in explaining the variations to the exchange rate in the long run. In all, ROA consistently has the highest singular impact in the explanation of the fluctuations in the exchange rate in both the short run and the long run. In Nigeria, among the selected variables, it is the most closely related to the exchange rate.

Table 3: Exchange rate (EXR)

Period	S.E	GDPGR	BNPL	BTCR	ROA	BLR	LEDR	EXR
3	0.579	4.458	1.516	23.414	45.994	3.742	9.979	10.896
6	1.234	5.638	5.701	16.758	63.535	1.366	3.398	3.604
9	1.811	5.668	9.232	9.723	64.586	3.976	4.977	1.839
12	2.113	5.586	10.873	7.257	61.987	7.928	4.991	1.379

Source: Author's computation

7. Conclusion

This study investigates the role of non-performing loans (NPLs) in the Nigerian banking system and macroeconomy. Using a seven-by-seven matrix in the structural autoregressive model, the impulse response function (IRF) shows a long-run impact of an impulse to NPLs on the banking system and the macroeconomy. The Nigerian banking system and the economy seem to be very vulnerable to frictions in the credit market, which is occasioned by sudden movements in the level of non-performing loans as the effects of shocks on NPLs are prolonged on the banking system and the economy. Utilizing quarterly data spanning 17 years (1998-2014), results suggest the central nature of NPLs in influencing some macro-banking indicators in Nigeria. This is consistent with Nkusu (2011) and Bernanke and Gertler (1989) that a market dysfunction such as represented by NPLs can have a long-lasting effect on the macroeconomy. In Nigeria, these responses are either spontaneous or delayed. For instance, whereas responses are spontaneous in the growth rate of GDP, the liquidity ratio, and lending rate, they are delayed in the bank total credit to the private sector, return on assets and the exchange rate. Meanwhile, the NPLs' level does not significantly respond to an exchange rate shock, but responds to shocks to the GDP growth rate, the bank liquidity ratio, return on assets, lending rate and the bank total credit to the private sector. Turning to the variance decomposition, at least 5% variations in the bank liquidity ratio is consistently explained by NPLs. Similarly, only in the third quarter does the NPLs' level explain less than 5% in the variations of the return on assets and the exchange rate. In the twelfth quarter, the NPLs' level explains about 11% of the variations in the exchange rate. The impulse response and variance decomposition thus show the level of centrality of the level of NPLs in determining or influencing some macro-banking indicators employed in this study.

Hence, on policy, based on the observed importance of the lending rate, it is recommended that the effectively monitors and utilizes the Repo rate, which is the rate at which a country's central bank lends to her commercial banks and in turn, is the indicative rate for the lending rate. This occurs as the commercial banks, in turn, lend to their customers at a margin. Hence, the higher the Repo rate, the higher the lending rate. Policies should be geared towards sustaining low rates so that the economic burden of economic agents is moderated to create a scenario of enhanced ability to honour financial obligations. Households and manufacturing concerns should be encouraged to access loans at relatively low rates. Overall, the monetary authorities should assign a key role to the level of NPLs in linking the friction in the credit market to both the banking system and the macroeconomy in Nigeria.

The first limitation of this study relates to the reliability of data, particularly on NPLs arising from representative bias. This is so because BankScope publishes and aggregates for a country if data from at least four banks has been received (Breuer, 2006). Therefore, the most accurate data for NPLs are available from 1996 (Greenidge, Grosvenor, 2010; Hasan, Wall, 2004). The succor in our study, which helps mitigate this limitation, is that the data set employed starts from 1998. The second limitation relates to the use of structural variance autoregression (SVAR).The Structural VAR is the tool employed in this paper to show how variables in Nigeria behave in comparison to economic theories. Hence, the choice of apriori assumptions for the Nigerian economy may be a limitation of this study which requires further research. Further research should examine the 'true' model for Nigeria.

The main contribution of this paper is the inclusion of non-performing loans amongst variables focused on and the use of a structural variance autoregression (SVAR) model that observes how vulnerable the banking system is to the Nigerian macroeconomy.

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PUBLIC AND PRIVATE INVESTMENT AND ECONOMIC GROWTH: AN EMPIRICAL INVESTIGATION

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Abstract: This paper provides new evidence to contribute to the current debate on the relative impact of public and private investment on economic growth and the crowding effect between the two components of investment in South Africa. Using annual data from 1970 to 2017, the study applies the recently developed Autoregressive Distributed Lag (ARDL)-bounds testing approach to cointegration. The study finds that private investment has a positive impact on economic growth both in the long run and short run, while public investment has a negative effect on economic growth in the long run. Further, in the long run, gross public investment is found to crowd out private investment, while its infrastructural component is found to crowd in private investment. The results of the study also reveal that both gross public investment and non-infrastructural public investment crowd out private investment in the short run. Overall, the study finds private investment to be more important than public investment in the South African economic growth process and that the importance of infrastructural public investment in stimulating private investment in the long run cannot be over-emphasized.

JEL classification: E22, O47, P12

Keywords: South Africa; Public Investment; Private Investment; Economic Growth; Crowding Effect.

1. Introduction

While economists and policymakers generally agree that investment is important to the economic growth process, it is still open to debate over which type of investment is more important for driving economic growth and whether the two

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types of investment crowd in or crowd out each other. The ongoing discussions on the subject have focused on two main issues. The first issue centers on the indirect contribution of public investment to economic growth through its crowding effect on private investment. The second is whether public investment contributes more to economic growth than does the equivalent private investment.

Empirical evidence from previous studies on the above raised concerns is varied and sometimes conflicting. For example, Mitra et al. (2012) reported that public investment in core infrastructure stimulates total factor productivity in the Indian manufacturing sector. This is in contrast to the empirical findings by Dash (2016), who reported the crowding-out effect of public investment on private investment for the Indian economy. The existing empirical studies on developing countries, including South Africa, are scanty and inconclusive.

The need to re-direct economies on the sustainable growth path on one hand and the scanty and inconclusive empirical evidence on the subject on the other hand underscores the need for a further empirical examination. Therefore, this paper empirically examines the relative contribution of public and private investment to economic growth and estimate the crowding effect of public investment on private investment in South Africa. The paper uses the recently developed ARDL bounds testing approach in exploring the long-run and short-run impact of these two components of investment on economic growth.

The paper contributes to the literature on investment and economic growth in South Africa in several ways. Firstly, it is among the first to disentangle investment into public and private components and empirically examine the relative contribution of each investment component to economic growth. The few available studies for South Africa, such as those by Perkins et al. (2005) and Tchouassi (2014), have only examined the impact of public investment or its components on economic growth. Secondly, some of the previous studies on this subject have largely relied on cross-sectional studies. Yet it is agreeable that the cross-sectional data analysis poses some difficulties in prescribing country-based policy implications (see Odhiambo, 2010). This paper addresses this challenge by employing the time series approach, which takes into account country-specific effects in detail. Lastly, unlike most previous studies on the subject which estimated the economic growth model only, this paper also estimates the crowding-out or crowding-in effect of public investment on private investment; and this has important policy implications. For example, if both private and public investments are found to be equally important in stimulating economic growth and when public investment has a crowding-out effect, private investment-led economic growth can be prescribed.

An empirical study on public and private investment and economic growth focusing on the South African economy is important for economies in the Southern African Development Community (SADC). South Africa plays a vital role in the growth of SADC economies in several ways. Firstly, it is the biggest economy in the region with a GDP of USD 426,768 billion in 2017; secondly, it is one of the major sources of the region's foreign direct investment (FDI); and lastly, it is among the major export markets for economies in this community (World Bank, 2017). Thus, through this economic interconnectedness, improved economic growth in South Africa stands to benefit member states in SADC.

The remaining part of the paper is structured as follows: Section two reviews the related literature, while the methodology is presented in section three.

The empirical results for the study are presented in section four, while section five discusses the previous empirical studies on public and private investment and economic growth. Lastly, section six concludes the paper.

2. Literature review

Studies on the relative importance of public and private investment on economic growth have generally been centered on the crowding effect of public investment on private investment. Theoretically, public investment can stimulate private investment growth when it is confined to the provision of core infrastructure such as water, communications, health, energy, transport and education (Berndt and Hansson, 1992). The justification for public investment in such projects is that they are typically lumpy, they have widespread positive externalities and they do not compete with the private sector as the private sector cannot undertake such investment to the same degree (Nazmi and Ramirez, 1997). Public investment can also retard private investment growth and slow down economic growth if: (i) it is debt financed, which crowds out the potentially more efficient private sector projects; (ii) it produces goods that pose direct competition with the private sector when is it established that the latter is more productive; and (iii) it is undertaken by state enterprises that are inefficient and are heavily subsidized by the state (Devarajan et al., 1996).

Thus, the effect of public investment on private investment and its resultant impact on economic growth is uncertain and can only be empirically determined. Yet economists and policymakers are generally in agreement that private investment is more efficient than public investment in the economic growth process. This consensus rests on the early empirical study by Khan and Reinhart (1989) which reported the superiority of private investment over public investment for a sample of 24 developing countries. The follow up studies on the subject also have agreed with the findings. For instance, Khan and Kumar (1997) re-examined the relative contribution of public and private investment on economic growth using an expanded sample of 95 developing countries. Their findings confirmed the earlier results from Khan and Reinhart (1989) that while both components of investment are crucial to economic growth, private investment contributes more. Several other studies also reported similar results (Phetsavong, Ichihashi, 2012; Hague, 2013; Ponce, Navarro, 2016; Yovo, 2017).

However, there are some empirical studies that reported evidence to the contrary (see, Bèdia, 2007; Sahoo et al., 2010; Abiad et al., 2015; Fournier, 2016). For example, Sahoo et al. (2010) reported that the high Chinese economic growth rates were achieved against a backdrop of high public investment in core physical infrastructure which promoted private investment growth – which points to the superiority of public investment over private investment in the growth process.

The empirical evidence on the crowding effect of public investment also varied across economies. Studies reporting the crowding-in effect of public investment on private investment are quite extensive (Bom, Ligthart, 2014; Calderón et al., 2015; Kalyvitis, Vella, 2015; Beifert, 2016; Tong et al., 2016). In particular, Bom and Ligthart (2014) found public investment in core infrastructures to have a stimulating effect on private investment growth in the organization for economic co-operation and development (OECD) countries. This was also consistent with the findings by Beifert (2016), who reported that government investment in airports promotes private investment growth in the Baltic Sea Region through enhancing the movement of raw materials and access to the regional and international markets for the finished goods.

Yet there are also some economies where public investment has been less beneficial to economic growth as it has had a crowding-out effect on private investment (Cavallo and Daude, 2011; Afonso and Aubyn, 2016; Mallick, 2016; Dash, 2016). In the case of Mallick (2016), government investment had a crowding effect on private investment growth in India mainly as a result of the prevalence of a high non-infrastructural public investment component.

3. Methodology

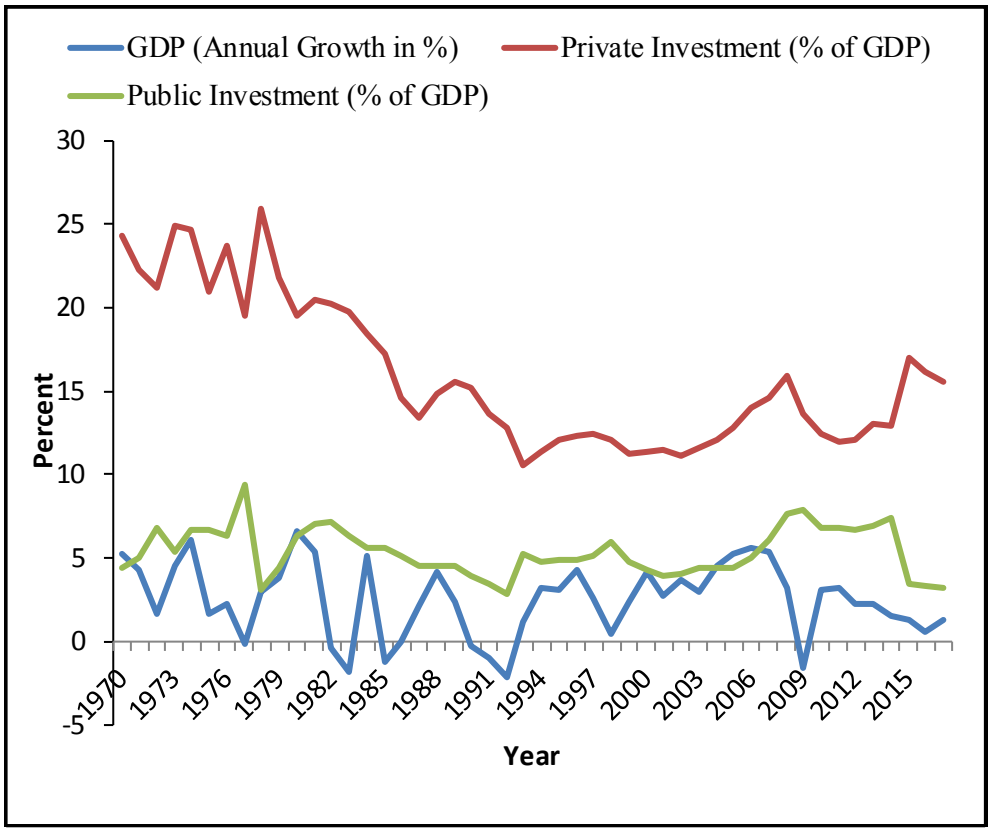
3.1. An overview of investment and economic growth trends in South Africa

During the Apartheid period in South Africa before 1994, the economy was sustained by high public investment in physical infrastructure. Initially, to support an economy based on mining, agriculture, railways and ports, construction became important. Later, a number of state enterprises were formed in order to add value on available natural resources. These included Eskom and Sasol in the energy sector and Iscor in the manufacturing sector (Department of Public Enterprise (DPE), 2012). Cumulatively, this resulted in the creation of a strong state economic management system during the Apartheid years.

Nevertheless, private investment during the period grew to unprecedented levels, especially in the 1960s and 1970s, taking advantage of the presence of public investment in core infrastructure. Growth in private investment also benefited from growing domestic absorption as a result of the inward-looking economic policy adopted by the Apartheid government. However, a limit to this buoyant growth was reached at the height of the international economic isolation of the regime (Clark, 1994). Partly for this reason, coupled with the growing inefficiency of state enterprises, the government initiated the neoclassical economic policies which were centered on privatization.

In 1994, the new government initiated a privatization programme, as enshrined in the Reconstruction and Development Programme (RDP) and the Growth, Employment and Redistribution (GEAR) strategy in 1996. The privatization programme was later focused on the four largest state enterprises – Eskom for energy, Denel for defence, Telkom for communications and Transnet for transport. As a result, private investment grew sharply from its low in 1994 to economic dominance in 2004 (DPE, 2012). To sustain the adopted market economy, state enterprises were once again repositioned to provide the necessary physical infrastructure. This was also aimed to absorb labor in the spirit of the creation of a developmental agenda and to address market failure (DPE, 2012).

The economic growth strategies, among others the Accelerated and Shared Growth Initiative for South Africa (ASGISA), the New Growth Path Framework and the National Development Plan 2030, also underscored the need for a concurrent growth in public investment in sectors such as communications, water, energy, transport, health and education (National Planning Commission, 2011). This economic philosophy has been credited with the growth in private sector business and high economic growth rate in South Africa. Figure 1 presents a summary of public and private investment and economic growth trends in response to the various economic policies implemented.



Source: Own processing based on World Bank (2017) databank

Fig. 1. Trends in public and private investment and economic growth in South Africa (1970 - 2017)

As can be seen in Figure 1, private investment growth maintained economic dominance from 1970 to 2017. The growth in private investment benefited especially from the high infrastructural public investment that was initiated before 1970. The economic growth rates, however, oscillated between -2% and 5% during the 1970 to 2017 period (DPE, 2012; World Bank, 2017).

Although private investment maintained economic dominance over public investment during the review period, it is still not certain which investment component had the higher contribution to economic growth; and this can be determined empirically.

3.2. Cointegration-ARDL bounds testing procedure

In this study, the newly proposed ARDL bounds testing procedure introduced by Pesaran and Shin (1999) and later popularized by Pesaran et al. (2001) is used to examine the relative contribution of public and private investment on economic growth

and the crowding effect of public investment on private investment in South Africa. The approach has several advantages over the traditional cointegration procedures such as the residual-based approach by Engle and Granger (1987) and the full maximum likelihood approach by Johansen and Juselius (1990). Firstly, the variables of interest are not restricted to being integrated of the same order – a mixture of the order of integration up to a maximum of 1 can be employed. Secondly, unlike the traditional cointegration approaches that are sensitive to sample size, the ARDL procedure can be applied even when dealing with small samples. Thirdly, the ARDL procedure can determine a long-run relationship using a reduced form equation, unlike the traditional cointegration procedures which use a system of equations (Shrestha and Chrowdhury, 2007). Lastly, the ARDL procedure gives valid t-statistics and unbiased long-run estimates (Pesaran, Shin, 1999; Odhiambo, 2008).

3.3. Relative contribution of public and private investment to economic growth

This study uses the empirical model based on Khan and Reinhart (1989), Phetsvavong and Ichihashi (2012), Ponce and Navarro (2016) and Yovo (2017), among others, to explore the relative impact of public and private investment on economic growth in South Africa. The ARDL expression of the model (Model 1) in this study is as follows:

Model 1

$$\begin{aligned}\Delta EGRO_t = {} & \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta EGRO_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta GI_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta PI_{t-i} \\ & + \sum_{i=0}^{n} \alpha_{4i} \Delta LBR_{t-i} + \sum_{i=0}^{n} \alpha_{5i} \Delta CRED_{t-i} + \sum_{i=0}^{n} \alpha_{6i} \Delta TOT_{t-i} \\ & + \beta_1 EGRO_{t-1} + \beta_2 GI_{t-1} + \beta_3 PI_{t-1} + \beta_4 LBR_{t-1} \\ & + \beta_5 CRED_{t-1} + \beta_6 TOT_{t-1} + \mu_{1t}\end{aligned} \tag{1}$$

Where EGRO, the dependent variable, is economic progress; GI is public investment; PI is private investment; LBR is labour; CRED is private sector credit; TOT is the terms of trade; α_0 is the intercept; $\alpha_1 - \alpha_6$ and $\beta_1 - \beta_6$ are short-run and long-run elasticities of output with respect to above identified variables; μ_{1t} is the error term; Δ is the difference operator; and *n* is the lag length.

The error correction model based on Model 1 is expressed as follows:

$$\begin{aligned}\Delta EGRO_t = {} & \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta EGRO_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta GI_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta PI_{t-i} \\ & + \sum_{i=0}^{n} \alpha_{4i} \Delta LBR_{t-i} + \sum_{i=0}^{n} \alpha_{5i} \Delta CRED_{t-i} \\ & + \sum_{i=0}^{n} \alpha_{6i} \Delta TOT_{t-i} + \varphi_1 ECM_{t-1} + \mu_{2t}\end{aligned} \tag{2}$$

Where φ_1 is the coefficient of the *ECM*; ECM_{t-1} is the error correction term lagged by one period; μ_{2t} is the error term and the other variables are defined as in equation (1).

3.4. The crowding effect of public investment on private investment

While the impact of public and private investment on economic growth can be estimated as in Model 1, it is also important to determine the public investment's indirect contribution to economic growth through its effect on private investment. Firstly, estimating the crowding effect of public investment on private investment addresses the potential simultaneous bias in estimation since private investment is an endogenous variable. Previous studies such as Bèdia (2007) are prone to such bias. Secondly, estimates of the crowding effect of public investment have important policy implications. For instance, if the two components of investment have an identical contribution to economic growth when the crowding out relationship between them is determined, a market economy can be prescribed.

In estimating the crowding effect of public investment, this study follows the approach by Blejer and Khan (1984) and later Odedokun (1997). Three separate private investment models are estimated where gross public investment, infrastructural public investment and non-infrastructural public investment would each enter separately as independent variables, one at a time. The private investment models in the ARDL are expressed as follows:

Model 2: Private investment and gross public investment

$$\begin{aligned}\Delta PI_t = \alpha_0 &+ \sum_{i=0}^{n}\alpha_{1i}\Delta GI_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta INFL_{t-i} + \sum_{i=0}^{n}\alpha_{3i}\Delta EGRO_{t-i} \\ &+ \sum_{i=0}^{n}\alpha_{4i}\Delta CRED_{t-i} + \sum_{i=0}^{n}\alpha_{5i}\Delta TOT_{t-i} + \sum_{i=1}^{n}\alpha_{6i}\Delta PI_{t-i} \\ &+ \beta_1 GI_{t-1} + \beta_2 INFL_{t-1} + \beta_3 EGRO_{t-1} \\ &+ \beta_4 CRED_{t-1} + \beta_5 TOT_{t-1} + \beta_6 PI_{t-1} + \varepsilon_{1t}\end{aligned} \tag{3}$$

Model 3: Private investment and infrastructural public investment

$$\begin{aligned}\Delta PI_t = \alpha_0 &+ \sum_{i=0}^{n}\alpha_{1i}\Delta INFRA_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta INFL_{t-i} \\ &+ \sum_{i=0}^{n}\alpha_{3i}\Delta EGRO_{t-i} + \sum_{i=0}^{n}\alpha_{4i}\Delta CRED_{t-i} \\ &+ \sum_{i=0}^{n}\alpha_{5i}\Delta TOT_{t-i} + \sum_{i=1}^{n}\alpha_{6i}\Delta PI_{t-i} + \beta_1 INFRA_{t-1} \\ &+ \beta_2 INFL_{t-1} + \beta_3 EGRO_{t-1} + \beta_4 CRED_{t-1} \\ &+ \beta_5 TOT_{t-1} + \beta_6 PI_{t-1} + \varepsilon_{2t}\end{aligned} \tag{4}$$

Model 4: Private investment and non-infrastructural public investment

$$\begin{aligned}\Delta PI_t = \alpha_0 + \sum_{i=0}^{n}\alpha_{1i}\Delta NONINFRA_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta INFL_{t-i} \\ + \sum_{i=0}^{n}\alpha_{3i}\Delta EGRO_{t-i} + \sum_{i=0}^{n}\alpha_{4i}\Delta CRED_{t-i} \\ + \sum_{i=0}^{n}\alpha_{5i}\Delta TOT_{t-i} + \sum_{i=1}^{n}\alpha_{6i}\Delta PI_{t-i} \\ + \beta_1 NONINFRA_{t-1} + \beta_2 INFL_{t-1} + \beta_3 EGRO_{t-1} \\ + \beta_4 CRED_{t-1} + \beta_5 TOT_{t-1} + \beta_6 PI_{t-1} + \varepsilon_{3t}\end{aligned} \quad (5)$$

Where PI is private investment; GI is public investment; INFL is the inflation rate; EGRO is economic progress; CRED is private sector credit; TOT is the terms of trade; INFRA and NONINFRA are infrastructural and non-infrastructural public investment, respectively; α_0 is the constant; Δ is the difference operator; $\alpha_1 - \alpha_6$ are the short-run slope coefficients; $\beta_1 - \beta_6$ are the long-run slope coefficients; *n* is the maximum lag length; and $\varepsilon's$ are the white noise error terms.

The error correction model representations of the private investment models are expressed as follows:

Based on Model 2

$$\begin{aligned}\Delta PI_t = \alpha_0 + \sum_{i=0}^{n}\alpha_{1i}\Delta GI_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta INFL_{t-i} + \sum_{i=0}^{n}\alpha_{3i}\Delta EGRO_{t-i} \\ + \sum_{i=0}^{n}\alpha_{4i}\Delta CRED_{t-i} + \sum_{i-0}^{n}\alpha_{5i}\Delta TOT_{t-i} \\ + \sum_{i=1}^{n}\alpha_{6i}\Delta PI_{t-i} + \pi ECM_{t-1} + \varepsilon_{1t}\end{aligned} \quad (6)$$

Based on Model 3

$$\begin{aligned}\Delta PI_t = \alpha_0 + \sum_{i=0}^{n}\alpha_{1i}\Delta INFRA_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta INFL_{t-i} \\ + \sum_{i=0}^{n}\alpha_{3i}\Delta EGRO_{t-i} + \sum_{i=0}^{n}\alpha_{4i}\Delta CRED_{t-i} \\ + \sum_{i-0}^{n}\alpha_{5i}\Delta TOT_{t-i} + \sum_{i=1}^{n}\alpha_{6i}\Delta PI_{t-i} + \rho ECM_{t-1} \\ + \varepsilon_{2t}\end{aligned} \quad (7)$$

Based on Model 4

$$\Delta PI_t = \alpha_0 + \sum_{i=0}^{n} \alpha_{1i} \Delta NONINFRA_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta INFL_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta EGRO_{t-i} + \sum_{i=0}^{n} \alpha_{4i} \Delta CRED_{t-i} + \sum_{i=0}^{n} \alpha_{5i} \Delta TOT_{t-i} + \sum_{i=1}^{n} \alpha_{6i} \Delta PI_{t-i} + \varphi ECM_{t-1} + \varepsilon_{3t} \quad (8)$$

Where PI is private investment; GI is public investment; INFL is the inflation rate; EGRO is economic progress; CRED is private sector credit; TOT is the terms of trade; INFRA and NONINFRA are infrastructural and non-infrastructural public investment respectively; α_0 is the constant; Δ is the difference operator; $\alpha_1 - \alpha_6$ are the short-run slope coefficients; *n* is the maximum lag length; $\varepsilon's$ are the white noise error terms; π, ρ and φ are the respective coefficients of the *ECM*; and ECM_{t-1} is the error correction term lagged by one period.

Following Blejer and Khan (1984) and later Odedokun (1997), this study generates the data on infrastructural and non-infrastructural public investment from gross public investment. According to Blejer and Khan (1984), the main assumption underlying this approach is that infrastructural public investment is more associated than its non-infrastructural counterpart with the long term growth in the ratio of gross public investment to gross domestic product. This emanates from the argument that infrastructural projects undertaken by the government generally have a long completion period and are related to economic growth. Thus, following Blejer and Khan (1984), infrastructural public investment is generated by the following expression:

$$INFRA = GI_0 e^{gt}$$

Where *INFRA* is the infrastructural public investment; *GI* is the gross public investment; *g* is the annual growth rate of gross public investment, GI_0 is the initial value of gross public investment; and *e* is the exponent.

Data on non-infrastructural public investment (NONINFRA) is then given by the difference between gross public investment and infrastructural public investment. While the weaknesses that may arise from using the Blejer and Khan (1984) procedure to generate data on the two components of public investment are acknowledged, the technique has been credited as the most practical option when there is no country data like in this study (see Odedokun, 1997).

The annual time series data for all the variables used in this study is sourced from the World Bank Development Indicators 2017 and the IMF's International Financial Statistics 2017.

4. Empirical results

While the ARDL bounds testing procedure does not require unit root pretesting of the variables, such tests are still necessary to determine whether the approach is applicable. Accordingly, this study conducts the Augmented Dickey-Fuller Generalised Least Squares (ADF-GLS) and the Phillips-Perron (PP) unit root testing procedures. The lag length was automatically selected by the SIC for the ADF-GLS unit root test and for the PP test, the PP truncation lag was also automatically selected on the Newey-West bandwidth. Table 1 presents the ADF-GLS and the PP unit root tests.

Table 1. Stationarity tests of all variables

Dickey-Fuller Generalised Least Square (DF-GLS)				
Variable	**Stationarity of all Variables in Levels**		**Stationarity of all Variables in First Differences**	
	Without Trend	With Trend	Without Trend	With Trend
EGRO	-3.676***	-4.182***	-	-
PI	-1.522	-0.995	-7.893***	-6.176***
GI	-2.889	-2.738	-6.841***	-7.267***
LBR	-0.112	-1.891	-2.895*	-2.259**
CRED	-1.163	-1.170	-3.087**	-2.856***
TOT	-2.456	-2.123	-6.868***	-6.892***
INFL	-1.609	-2.155	-6.375***	-5.678***
INFRA	-3.702**	-2.476**	-	-
NONINFRA	-4.300***	-3.619***	-	-
Phillips Perron (PP)				
Variable	**Stationarity of all Variables in Levels**		**Stationarity of all Variables in First Differences**	
	Without Trend	With Trend	Without Trend	With Trend
EGR0	-4.191***	-4.233***	-	-
PI	-1.170	-1.867	-8.813***	-8.093***
GI	-3.031	-3..094	-7.534***	-7.627***
LBR	-2.711	-0.743	-3.956*	-2.667*
CRED	-0.064	-1.285	-3.054**	-3.117**
TOT	-2.293	-2.393	-7.211***	-7.357***
INFL	-2.085	-3.150	-8.880***	-7.234***
INFRA	-3.210**	-3.059**	-	-
NONINFRA	-4.775***	-4.805**	-	-

Note: *, ** and *** denotes stationary at 10%, 5% and1%, respectively
Source: authors' computation by using EViews 9.0 software

As illustrated in Table 1, all the variables are either integrated of order 0 or 1, so the ARDL procedure is applicable. This sets the stage for testing the existence of a cointegrating relationship between the variables in the economic growth and private investment models. For this purpose, the study employs the bounds F-test, with the results reported in Table 2.

Table 2. Bounds F-test for co-integration

Dependent Variable	Function	F-Statistic	Cointegration Status
EGRO	F(EGRO|PI, GI, LBR, CRED, TOT,)	4.88***	Cointegrated
PI	F(PI|GI, INFL, EGRO, CRED, TOT)	3.82**	Cointegrated
PI	F(PI|INFRA, INFL, EGRO, CRED, TOT)	3.87**	Cointegrated
PI	F(PI|NONINFRA, INFL, EGRO, CRED, TOT)	4.50**	Cointegrated

Asymptotic Critical Values

Pesaran et al. (2001). P.300, Table CI(iii) CaseIII	1%		5%		10%	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	3.41	4.68	2.62	3.79	2.26	3.35

Note: ***and** denotes statistical significance at 1% and 10% level, respectively.
Source: authors' computation by using Microfit 5.0 software

The outcome of the bounds F-test indicates that all the variables in the economic growth and private investment models share a long-run relationship. Following the established cointegration relationship, the long-run and short-run coefficients of the variables in the economic growth and private investment models can now be estimated. Estimating models were chosen based on either the AIC or SBC, guided by the principle of model parsimony. The SBC(2,0,1,0,0,0) based ARDL for Model 1 and the SBC(1,1,0,1,0,2) based ARDL for model 4 were selected, while the AIC(1,1,0,1,1,2) based ARDL for model 2 and the AIC(2,1,0,1,1,2) base ARDL for model 3 were selected. Table 3 gives the long-run and short-run coefficient estimates of the selected models.

Table 3. Estimation of long-run and short-run coefficients

	Model 1 SBC (2,0,1,0,0,0,)	Model 2 AIC (1,1,0,1,1,2)	Model 3 AIC (2,1,0,1,1,2)	Model 4 SBC (1,1,0,1,0,2)
Panel A: Estimated long-run coefficients (Dependent variables: EGRO for Model 1 and PI for Models 2-4)				
Regressors	**Coefficients (t-statistics)**			
C	3.75 (4.013)***	4.672 (6.272)***	5.977 (3.988)***	4.212 (5.023)***
PI	0.1578 (2.448)**	-	-	-
GI	-0.432 (-3.737)***	-0.241 (-1.879)*	-	-
INFRA	-	-	0.721(2.451)**	-
NONINFRA	-	-	-	-0.121 (-1.417)

	Model 1 SBC (2,0,1,0,0,0,)	Model 2 AIC (1,1,0,1,1,2)	Model 3 AIC (2,1,0,1,1,2)	Model 4 SBC (1,1,0,1,0,2)
LBR	-0.103 (-3.911)***	-	-	-
INFL	-	-0.123 (-1.207)	-0.123 (-1.312)	-0.109 (-0.921)
EGRO	-	0.237 (2.317)**	0.103 (1.472)	0.201 (1.872)*
CRED	-0.114 (-0.821)	-0.121 (-3.417)***	-0.027 (-2.321)**	-0.029 (-3.573)***
TOT	-0.132 (-1.317)	-0.375 (-3.371)***	-0.674 (-2.502)**	-0.354 (-2.575)**
Panel B: Estimated long-run coefficients (Dependent variables: DEGRO for Model 1 and DPI for Models 2-4)				
DPI	0.191(1.967)*	-	-	-
DPI(-1)	-	-	-0.231 (-1.402)	-
DGI	0.134(1.412)	-0.175 (-5.754)***	-	-
DINFRA	-	-	-0.028 (-0.210)	-
DNONINFRA	-	-	-	-0.042 (-6.764)***
DINFL	-	-0.010 (-1.201)	-0.062 (-1.411)	-0.023 (-0.894)
DEGRO	-	-0.023 (-1.034)	-0.019 (-0.272)	-0.032 (-0.753)
DEGRO(-1)	0.291 (2.702)**	-	-	-
DLBR	-0.102 (-3.872)***	-	-	-
DCRED	-0.021 (-0.794)	-0.004 (-0.094)	-0.012 (-1.412)	-0.043 (-2.332)**
DTOT	-0.102 (-1.242)	-0.031 (-1.065)	-0.051 (-1.210)	0.083 (2.501)**
DTOT(-1)	-	0.176 (3.471)***	-	-
ECM(-1)	-0.981 (-6.512)***	-0.273 (-3.073)***	-0.376 (-2.572)**	-0.231 (-2.597)**
R-squared	0.843	0.802	0.673	0.863
F-statistic	17.612	18.121	4.977	17.977
Prob(F-statistic)	0.000	0.000	0.000	0.000
DW statistic	2.137	2.098	2.093	1.944

Notes: 1. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.
2. Δ=first difference operator.

Source: authors' computation by using Microfit 5.0 software

The long-run results in Table 3 (Panel A - Model 1) show that the coefficient of private investment (PI) is positive, as expected, and statistically significant at 10%. This indicates that private investment had a positive impact on economic growth in South African during the review period. The results also show that the coefficient of public investment (GI) is negative, as unexpected and statistically significant at 1%. This entails that public investment had a negative impact on economic growth in South Africa.

The other variables show that labour (LBR) negatively affects economic growth, which is unexpected, while credit to the private sector (CRED) and terms of trade (TOT) have no effect on economic progress in the long run in South Africa.

The short–run dynamics of Model 1 are shown in Table 3 Panel B. These results show that the coefficient of private investment is positive and statistically significant at 10%. This entails that an increase in private investment was associated with an increase in economic growth in the short run in South Africa. The short-run results also show that the coefficient of public investment is statistically insignificant, implying that public investment had no immediate effect on economic growth. The other variable that positively affects economic growth in the short run is DEGRO (-1), while DLBR retards growth. The coefficient of the ECM (-1) is negative as expected and is statistically significant at 1%. A coefficient of -0.981 indicates a quick adjustment to equilibrium at an annual rate of 98.1%, when a shock occurs to economic growth in the previous period.

Overall, results from Model 1 show that in South Africa, private investment has a positive impact on economic growth, irrespective of whether the analysis is done in the long run or in the short run. In the long run, public investment was found to have a negative impact on economic growth, but no significant effect in the short run. The results from Model 1 imply that private investment contributes more to economic progress in South Africa than public investment.

Empirical results of Model 2, as shown in Table 3, Panels A and B indicate that the coefficient of gross public investment (GI) is negative and statistically significant both in the long run and short run. This suggests that gross public investment had a crowding-out effect on private investment growth in South Africa under the review period.

The results of Model 3, in Panel A, show that the coefficient of infrastructural public investment (INFRA) is positive as expected and statistically significant. This implies that infrastructural public investment crowds in private investment growth in the long run in South Africa. However, in the short run, as shown in Panel B, the coefficient of infrastructural public investment has no statistically significant effect on private investment growth. Furthermore, estimates from Model 4 reveal that the coefficient of non-infrastructural public investment (NONINFRA) also has no statistically significant effect on private investment in the long run; but in the short run, it crowds out private investment growth.

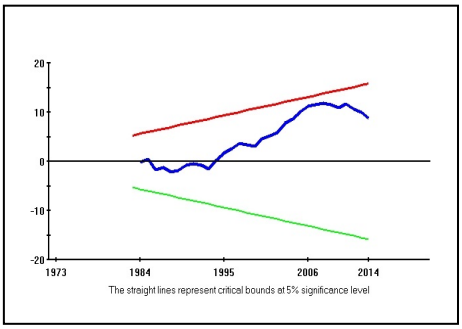
The other variables that affect private investment shown in Table 3 Panel A are EGRO, CRED, and TOT. Economic growth (EGRO) has a positive effect on private investment as expected while credit to the private sector (CRED) and terms of trade (TOT) negatively influence private investment. In the short run, DCRED negatively affect private investment while DTOT and DTOT (-1) are positively associated with private investment. The coefficients of the ECM (-1) terms are negative as expected and are all statistically significant at 1%. This confirms the existence of the long-run relationship between the variables in the private investment models.

Based on the empirical results from the private investment models, gross public investment crowds out private investment growth in the long run and short run, while infrastructural public investment crowds in private investment growth in the long run in South Africa. In addition, non-infrastructural public investment crowds out private investment growth in the short run. The results imply that although the contribution of public investment to economic growth has been negative, public investment in infrastructure is important to economic growth as it stimulates private investment growth.

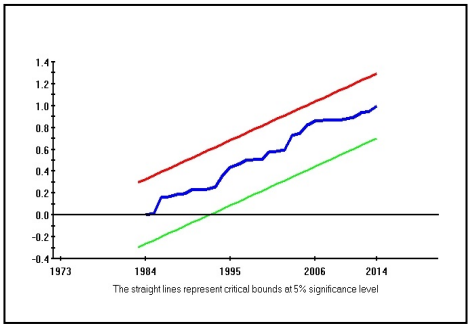
The results of the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMQ) plotted in Figure 2 confirm the stability of both the economic growth and private investment models.

Model 1

Plot of Cumulative Sum of Recursive Residual

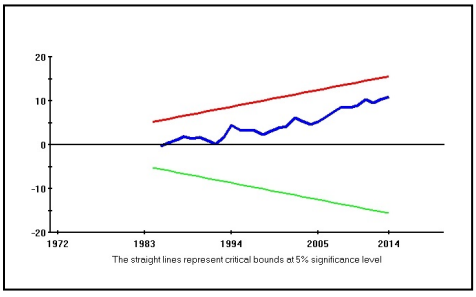


Plot of Cumulative Sum of Squares of Recursive Residual

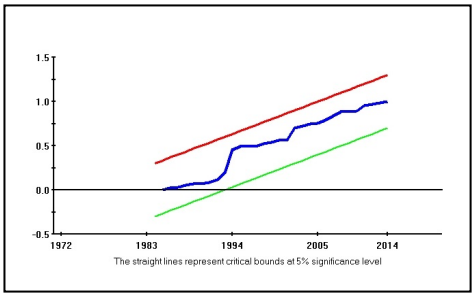


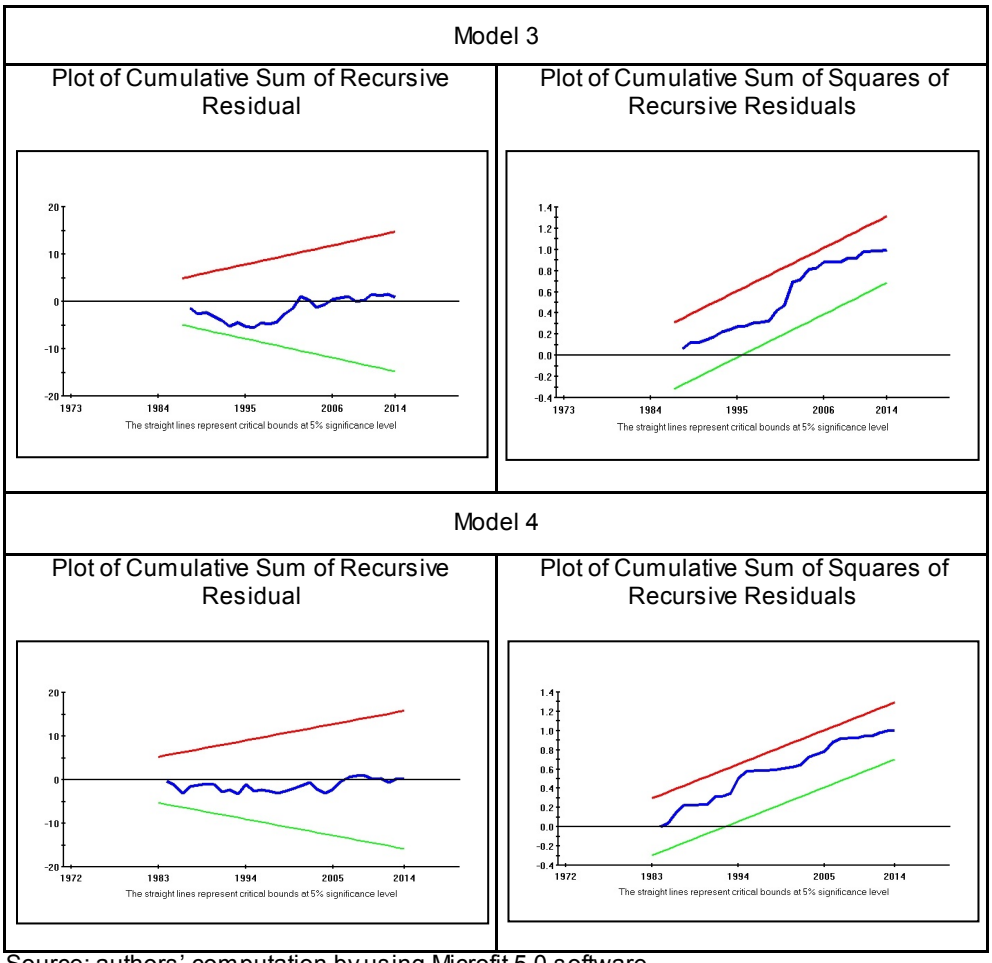
Model 2

Plot of Cumulative Sum of Recursive Residual



Plot of Cumulative Sum of Squares of Recursive Residuals





Source: authors' computation by using Microfit 5.0 software

Figure 2. Plot of CUSUM and CUSUMQ for the economic growth and private investment models

The positive and significant long-run and short-run relationship between private investment and economic growth in South Africa from Model 1 compare favorably with reports from previous studies on the subject, such as those by Khan and Reinhart (1989), Ponce and Navarro (2016) and Yovo (2017). The findings suggest that the various economic policies implemented in South Africa to promote private investment growth have been beneficial to economic growth. Contrary to the results recorded by Perkins et al. (2005) for South Africa, public investment had a significant long-run negative impact on economic growth. The possible factors that could have given rise to this conflicting result are the different sample periods used and the economic infrastructural investment employed by Perkins et al. (2005) as a proxy for public investment. However, this finding is not isolated to this

study only; similar results were reported by Khan and Reinhart (1989) for developing countries, including South Africa, Ghali (1998) for Tunisia and Aremo (2013) for the Economic Community of West Africa States (ECOWAS).

In addition, gross public investment in Model 2 had a crowding out effect on private investment growth in South Africa in the long run. The findings do not support the results by Erden and Holcombe (2005) for developing countries. Although not expected in this study, the results are similar to the findings by Moreno et al. (2003) for the Spain regions. However, when gross public investment was decomposed as infrastructural public investment in Model 3, it was found to stimulate private investment growth in the long run. This finding may be attributable to the initiatives undertaken by the South African government to promote public investment growth in sectors such as energy, communication, water, transport, health and education that are believed to complement private sector growth. The results are in line with various studies on the subject such as Wang (2004), Sahoo et al. (2010) and Pereira and Andraz (2010).

Furthermore, when gross public investment was decomposed as non-infrastructural in Model 4, as expected, it had a significant short-run crowding-out effect on private investment growth in South Africa. This finding may partly be related to the social welfare expenditure that has been growing at an annual rate of 7.3% (Republic of South Africa, 2015). This result is similar to the results that were reported by Mallick (2016) for the Indian economy.

5. Public and private investment and economic growth: Empirical perspectives

Empirical research on public and private investment and economic growth should focus on two related issues. Firstly, whether public investment contributes more to economic growth than private investment and secondly, the crowding effect of public investment on private investment growth. As stated earlier, there is still no consensus in economic empirical literature on the above raised concerns.

Thus, as far back as 1989, Khan and Reinhart argued that private investment is more beneficial to economic growth than public investment for developing countries, including South Africa. This finding was the basis upon which international development institutions such the World Bank and the International Monetary Fund prescribed private sector-led economic growth model for developing countries. Since then, there has been a rapid growth in empirical evidence supporting the market-led growth process. Such literature includes Zou (2006) who confirmed that private investment played a more important role compared to public investment in the USA economic growth. Similarly, Ponce and Navarro (2016) concluded that for the Mexican economy in the period 2006 to 2016, private investment had more impact on economic growth than public investment.

There is also a growing body of empirical studies arguing public investment as having an important role to play in the economic growth process. The literature can be traced to Milbourne et al. (2003) who noted that public investment had a significant impact on economic growth in selected economies, which included South Africa. Until recently, the empirical findings were supported by Sánchez-Juárez and García-Almada (2016) and Nguyen and Trinh (2018), among others. In particular, Nguyen and Trinh (2018) reported that investment by state-owned

enterprises in Vietnam had a leading role in stimulating economic growth during the 1970 to 2016 period. Based on this empirical evidence, most world economies have been persuaded to promote public investment growth to a level enough to stimulate economic growth.

Similarly, empirical literature on the crowding effect of public investment on private investment is extensive, yet inconclusive. There are several studies that have reported the crowding-in effect of public investment on private investment growth. Such studies can be traced to Ramirez and Nazmi (2003) who reported public investment on education and health to have a stimulating effect on private investment growth for nine major Latin American nations for the 1983 to 1993 period. The finding guided policy makers to channel the scarce public sector resources to human capital sectors. Later, Seed et al. (2006) also agreed with this finding when they found that public investment promoted private sector growth in agriculture in case of the Pakistan economy. Even recent studies such as Creel et al. (2015) and Nguyen and Trinh (2018), support the crowding-in effect of public investment on private investment.

However, there is also a growing body of empirical literature supporting the notion that public investment crowd out private investment growth. Such studies include Ramirez and Nazmi (2003) who asserted that public investment growth stifled private investment growth in nine Latin American countries. This unexpected finding could be explained by the aggregation of public investment data which include infrastructural component that, a priori, is expected to stimulate private investment growth. Several recent studies for different economies also reported evidence in support of public investment retarding private investment growth (see Bahal et al, 2015; Creel et al, 2015; Mallick, 2016, among others).

Based on the foregoing discussion, it can be concluded that the debate on public and private investment and economic growth is still not settled. The available empirical evidence on the subject is mixed and varied, and at best inconclusive.

6. Conclusion

The main objective of this study is to empirically examine the relative contribution of public and private investment to economic growth in South Africa from 1970 to 2017. The study attempts to answer two related questions: (i) does public investment spur economic growth more than private investment; and (ii) does public investment crowd in or crowd out private investment? To address the above questions, the study estimates economic growth and private investment models using the recently developed ARDL-bounds testing approach. The empirical results show that private investment positively affects economic growth both in the long run and in the short run. While public investment has a negative effect on growth in the long run, in the short run it has no significant economic growth influence. The results further reveal that in the long run, gross public investment crowds out private investment, while infrastructural public investment crowds in private investment growth. Additionally, both gross public investment and non-infrastructural public investment are found to stifle private investment growth in the short run. Based on these findings, it can be concluded that private investment has a higher contribution to economic growth in South African than public

investment. The empirical results underscore the need to consolidate on the private investment promotion policies in South Africa. However, the importance of infrastructural public investment in stimulating private investment growth can also not be overemphasized.

Lastly, due to the non-availability of data, the study has used the Blejer and Khan (1984) approach to generate infrastructural and non-infrastructural public investment data from gross public investment. While this approach may potentially have some weaknesses, it can reliably estimate the trend and non-trend movements of gross public investment, taken as infrastructural and non-infrastructural public investment, respectively (Odedokun, 1997). When data points for infrastructural and non-infrastructural public investment become available for South Africa, it would be interesting to discover from the future studies on the subject if the results on the crowding-out and crowding-in effects will change significantly.

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