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Permanent Demand and Private Investment in the General Theory: An Empirical Investigation

Demanda permanente e inversión privada en la teoría general: una investigación empírica

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Abstract

We empirically test some Keynes' (and post Keynesians') assertions relative to the multiplier-accelerator principle. By means of the nonlinear causality test proposed by Diks and Wolski (2016), we conclude that in the United States domestic private investment is driven by permanent demand. We explain that this result is consistent with Keynes's principle of effective demand in the long run. We hope this paper helps consolidating the potential consensus among Keynesian, Kaleckian and Sraffian economists initiated by the work of Allain (2015).

Keywords: Permanent demand; Supermultiplier; Economic dynamics.

Resumen

Analizamos empíricamente algunos postulados keynesianos (y post keynesianos) relativos a la interacción multiplicador-acelerador. Mediante el test de causalidad no lineal de Diks y Wolski (2016), sostenemos que en los Estados Unidos existe evidencia a favor de que la inversión privada doméstica es motorizada por la demanda permanente. Argumentamos que este resultado es consistente con el principio de la demanda efectiva en el largo plazo. Esperamos que este trabajo ayude a consolidar el potencial consenso entre economistas Keynesianos, Kaleckianos y Sraffianos que inició el trabajo de Allain (2015).

Palabras Clave: Demanda permanente; Supermultiplicador; Dinámica económica.

Clasificación JEL / JEL classification: B22; B59; C14; E12.

1. Introduction

The General Theory of Employment, Interest, and Money (hereinafter, the GT) is probably the most relevant work in economics. Since its publication in 1936, it has generated both criticism and fascination and has been subjected to endless analysis, giving rise to many different interpretations. In this paper, instead of reviewing these endless controversies, we make a close reading of Keynes's words in relation to the main variables of aggregate demand. Our purpose is not to expose a complete model of income determination from the specification of these variables and their causal relationship, but only to reveal some Keynes' statements in this regard and to connect them with current debates on demand-led growth.

In the Keynesian literature, it is widely known that, since the global propensity to consume of the community is inferior to one, in order to justify a given amount of occupation, there must be an amount of investment expenditure that covers the difference between production at full capacity and aggregate consumption when occupation is in that situation (Keynes, 1936: 27). Therefore, in the GT underinvestment is the main cause of unemployment. The importance of this result lies in its implications for a theory of aggregate investment and economic growth.

Keynes argues that underinvestment occurs when the expected profitability of acquiring a new capital good is below the current real interest rate. But expected profits do not depend on the rate of profit on the already installed capital stock. Instead, companies try to invest an adequate amount to adjust their productive capacity to the expected total demand for ordinary consumption:

> The obstacle to a clear understanding is, in these examples, much the same as in many academic discussions of capital, namely, an inadequate appreciation of the fact that capital is not a self-subsistent entity existing apart from consumption. On the contrary, every weakening in the propensity to consume regarded as a permanent habit must weaken the demand for capital as well as the demand for consumption (Keynes, 1936: 106).

The decision to invest is the decision to demand newly created goods that will become part of the productive process in future periods. Thus, investment depends on the expectation that there will be a demand for consumer goods produced with those capital goods. And the expectation of future consumption is so largely based on the current experience of present consumption that a reduction in the latter is likely to depress the former (Keynes, 1936: 210). Thus, in the GT it is the global propensity to consume that mainly determines investment decisions:

> a relatively weak propensity to consume helps to cause unemployment by requiring and not receiving the accompaniment of a compensating volume of new investment (Keynes, 1936: 370).

Although Keynes' is a short-run analysis, we identify a clear link between the income multiplier and the investment accelerator in the GT. Dynamic Keynesian macroeconomics is born precisely from the conjugation of the income multiplier with the investment accelerator. In fact, as soon as we abandon the short run and the capital stock is not a fixed data anymore, the principle of effective demand faces greater analytical challenges. An investment theory that attempts to incorporate the principle of effective demand into the dynamic analysis is known as the investment accelerator principle (Vercelli and Sordi, 2009). The accelerator implies that investment depends exclusively on expected changes in income. This investment theory, which began to be developed by Ohlin (1934), even before the publication of the TG, is based solely on effective demand.

Growth models that combine the income multiplier with the investment accelerator mechanism are known as multiplier-accelerator models (thereafter, MA models) or Supermultiplier models, a term coined by Hicks (1950). These models are nowadays relevant in current debates on demand-led growth (see Cesaratto, 2015). In this paper, we empirically test some of Keynes' (and post Keynesians') assertions relative to the multiplier-accelerator principle. In Section 2 and 3, we review the literature on MA models and the ways these models deal with dynamic (in)stability. In Sections 4 and 5 we carry out our empirical analysis. Conclusions and future lines of research are exposed in Section 6.

2. Multiplier-accelerator models as a tool to dynamize the General Theory

The first economists who explicitly modelled the interaction between the income multiplier and the investment accelerator were Roy Harrod and Paul Samuelson in 1939. Harrod's (1939) paper became the foundational work of the nowadays abundant literature on economic growth. We state, however, that Keynes himself was already conscious of the potency of combining the multiplier with the accelerator principle; although, as Dejuán (2017: 387) points out, in a letter to Harrod in 1937, Keynes argues that the (rigid) accelerator of investment is a too mechanical mechanism that leaves no room for the expectations of entrepreneurs:

> So far, we have excluded the possibility of changes in expectations. In fact, however, the rate of investment does not depend on current consumption, but on expectations (though the latter are, of course, influenced, perhaps unduly, by current consumption). Thus, unless

expectations are of a constant character, one would anticipate short-period changes in the relation (the accelerator) (Keynes [1937]1973: 172).

With these words, Keynes seems to advocate for a flexible accelerator of investment. A priori, the accelerator appears as the perfect companion of the multiplier, both respond to the principle of effective demand and both help to understand the dynamics of modern capitalism (Dejuán, 2017: 385). However, MA models have not become consolidated in the scientific research programs ascribed to post-Keynesian economics. Probably the main reason for this is that these models proved to be dynamically unstable (Pérez-Montiel and Dejuán, 2019).

The objective of Harrod (1939) was to incorporate the principle of effective demand into the long-term analysis. To this aim, Harrod developed a dynamic model in which the effects that investment has on demand and on productive capacity (supply) could be reconciled, thus maintaining the forces of supply and demand balanced over time.

> [I]t ought to be possible to develop a similar classification and system of axioms to meet the situation in which certain forces are operating steadily to increase or decrease certain magnitudes in the system" (…) "I now propose to proceed directly to the Fundamental Equation, constituting the marriage of the acceleration principle and the multiplier theory (Harrod, 1939: 14-15).

One of the main Harrod's contributions to the theory of economic growth is the warranted rate of growth, G_w. This is a rate that, if it occurs, will leave all parties satisfied that they have produced neither more nor less than the right amount (Harrod, 1939: 16). In general, it is considered that normal production, Y^n, will be less than potential production (production using full capacity), Y^P, since we assume that, under the pressure of competition, firms try to maintain margins of planned spare capacity to avoid the risk of losing market shares for not being able to supply their markets when they are booming (Freitas and Serrano, 2015:4). Thus, firms systematically try to reach and maintain a normal degree of capacity utilization, u_n. Then, companies find that what they have produced in each period has not been "much, not little" only when they produce at their normal degree of capacity utilization.

According to Harrod, the warranted rate of growth is only determined by the marginal (and average, since autonomous expenditure is not considered) propensity to save, s, and the incremental capital output ratio (the amount of capital required to increase each unit of total output), v. However, Harrod's warranted rate of growth proved to be highly unstable, because if, by any disturbance, the evolution of income deviates from it, the system explodes or implodes and never returns to equilibrium:

> "Departure from the warranted line sets up an inducement to depart farther from it. The moving equilibrium of advance is thus a highly unstable one" (Harrod, 1939: 23).

This occurs because investment, which is totally induced by the evolution of effective demand, drives both the creation of productive capacity and that of demand, and also in equal proportion, although with delay, first impulses demand and then supply (Serrano, Freitas, and Bhering 2018: 11). This is the famous problem known as the knife edge (a term coined by Joan Robinson).

If, for example, the effective rate of growth, G, were lower than the warranted rate, G_w, we would be in a situation where the prediction of companies would have been too optimistic and, therefore, there would be an underutilization of installed capacity. Due to the fact that investment is sensitive to the degree of capacity utilization, u, the lower degree of capacity utilization leads to a fall in the rate of growth of investment that results in a further decrease of G and u , and so on; so that u moves further away from the normal rate of capacity utilization, u_n. Thus, it is impossible for the economy to return to its warranted rate of growth. If it were the situation in which the effective rate of growth is greater than the warranted one, we would find ourselves in the opposite situation, but also of increasing imbalance (Harrod, 1939: 22).

On the other hand, the chain of transmission of the simple Keynesian aggregate demand identity ($Y = C + I$) can imply a circularity problem when we introduce it in the multiplier-accelerator identity that characterizes the Keynesian macro dynamics: D Induced Consumption à D Induced Consumption D Induced Investment D output (= multiplier · DI) áD Induced Consumption (= c · DY). To solve the problem of circularity, investment must be independent of current income (and of consumption and savings that derive from it). The most coherent way is to introduce the expected growth of demand as the main determinant of investment.

Serrano (1995), Bortis (1997) and Dejuan (2005), inspired by Hicks' (1950) Supermultiplier model, showed that the Keynesian aggregate demand identity can be generalized to $Y = C + I + Z$; being Z non-capacity-generating autonomous demand. In this more general framework, the expected growth rate of aggregate demand ultimately depends on the expected growth rate of Z. By considering non-capacity-generating autonomous expenditures, these MA models become dynamically stable if changes in producers' growth expectations in the face of changes in the capacity utilization rate are sufficiently slow (See Freitas and Serrano, 2015; Allain, 2015; and Serrano, Freitas, and Bhering, 2018, among others).

As stated, Serrano's (1995) main contribution is the inclusion of non-capacity-generating autonomous demand, Z, that grow over time at a given, exogenous, rate, γ. Autonomous demand is constituted by: All those expenditures that are not financed by wage income generated by production decisions, nor affect (directly) the productive capacity of the economy (Serrano, 1995: 71). In the long run, effective demand determines normal productive capacity; while the autonomous components of final demand generate induced consumption, C, through the multiplier, and induced (capacity creating) investment, I, through the accelerator (Serrano, 1995: 67). The engine of long-run economic growth, therefore, is the non-capacity-generating autonomous demand.

3. Dynamic (in)stability of multiplier-accelerator models

In 1995, Serrano did not explicitly develop a coherent adjustment mechanism that, after a disturbance, allowed his Supermultiplier model to endogenously return to the equilibrium position with normal capacity utilization, u_n. Serrano (1995) just considered that demand expectations of companies are "as a whole and on average" systematically correct, which means that the degree of capacity utilization is "as a whole and on average" equal to the normal one; otherwise, the average degree of effective capacity utilization would persistently deviate from the normal or planned one (Serrano, 1995: 86).

Allain (2012, 2015) argued, however, that what should be a point of arrival in Serrano's model, actually becomes a premise or a starting point (Allain, 2012: 15). The proposal of Allain (2012, 2015) consists in modelling the dynamics of the correction that firms systematically make of their growth expectations (Allain refers to this behaviour as Harrodian) and studying under what conditions the long-run equilibrium (with normal utilization rate) of his neo-Kaleckian growth model with unproductive autonomous expenditures turns out to be dynamically stable. Then, Allain proposes a solution that combines the destabilizing effect of the Harrodian firms' behaviour with the stabilizing effect of the supermultiplier mechanism (Allain, 2019: 87).

Even though Cesaratto et al. (2003) explicitly provide the mechanism that guarantees local stability (under certain conditions) in the Supermultiplier model; due to its repercussion, Allain's (2015) work becomes an authentic seminal contribution and opens the door to a "potential consensus" between certain Kaleckian growth models and the Sraffian Supermultiplier approach (Pérez-Montiel and Manera, 2020). Proof of this is that Serrano himself, along with other authors (Freitas and Serrano, 2015; Serrano and Freitas, 2017; and Serrano et al., 2018), arrive at the same conclusions. Qualitatively similar results are obtained by Lavoie (2016), Fagundes and Freitas (2017), and Jun Nah and Lavoie (2019). For a critique of this form of dealing with dynamic instability see Skott (2017b) and Dejuán (2017), and for a more general critique of these models, see Skott (2017a), Dávila-Fernández et al. (2017), and Nikiforos (2018).

However, despite there have been important advances in terms of providing MA models with mechanisms that make them (potentially) stable, these mechanisms are still not at all reassuring. Allain (2012, 2015) warns that the proposed solution to the problem of Harrodian instability should be taken with caution: As a consequence, it is not possible to formulate an univocal conclusion. The best that can be said is that there is some room, depending on the parameter values, for the system to converge toward its long run equilibrium (Allain, 2015: 1364-65).

The models proposed by Allain (2015), Lavoie (2016), and Fagundes and Freitas (2017) lack the necessary specification to ensure that the model always converges towards the non-Harrodian equilibrium, since they are (potentially) locally stable, but globally unstable. It implies that small perturbations around the non-Harrodian equilibrium decay and the trajectory generated by the system returns to it; but if perturbations are large enough, the system is unable to return to the non-Harrodian equilibrium and becomes dynamically unstable (even in the case where the parametric conditions allow the non-Harrodian equilibrium to be asymptotically stable).

Therefore, from the analytical point of view, these models propose a solution to local Harrodian instability, but not to global Harrodian instability. This point has already been highlighted by Skott (2017b) and rejointed by Lavoie (2017). The other problem with these models, highlighted by Skott (2017b) and Pérez-Montiel et al. (2019), relates to their difficulty to be connected with empirical evidence. For empirically pertinent values of the parameters, these models need hundreds (or even thousands) of years to converge to equilibrium after a modest perturbation. Thus, even though the models can be dynamically locally stable in terms of logical time, they still cannot be considered stable in terms of real time.

On the other hand, Dejuan (2005; 2017) also proposes a MA model with non-capacity-creating autonomous expenditures; but, following Eatwell (1983), he emphasizes that the expected rate of growth of permanent aggregate demand is the key variable in a Supermultiplier system. The distinction between permanent and transient demand allows separating the main economic system, governed by the Supermultiplier, which tries to meet efficiently (at normal capacity) the expected increases in permanent demand, and the auxiliary system, governed by the Multiplier, which is in charge of adjusting capacity to the level required by the new path of growth.

The model proposed by Dejuan (2005; 2017) relates the acceleration of investment just to the permanent increases in demand. Thus, the investment function of Dejuan (2005; 2017) responds to the accelerator principle, but it distinguishes between permanent and transient demand. After an unexpected increase (decrease) in demand, firms adjust to it by raising (reducing) the rate of capacity utilization. If overutilization (infrautilization) persists for several months, entrepreneurs interpret that this is not a seasonal fluctuation, but a durable change. Dejuán (2005, 2017) shows that such MA model is a stable and stabilizing mechanism. Therefore, the GT can be dynamized by means of the interaction between the income multiplier and the investment accelerator without necessarily incurring in problems of dynamic instability.

In what follows, we test the empirical validity of the notion of investment in the MA model of Samuelson (1939), which is a version of Harrod's (1939) model, for the U.S. economy. The investment function of Samuelson (1939) is given by: $I_t=v(C_t-C_{t-j})$, where C is domestic aggregate consumption and v is the incremental capital output ratio. Therefore, investment is an increasing function of expected changes in consumption. Then, we assume that firms only invest at home to adapt their productive capacity to increases of domestic consumption, or, at least, that the evolution of domestic consumption guides domestic investment decisions. However, in order to preserve dynamic stability, following Eatwell (1983) and Dejuán (2005, 2017), we consider that investment only reacts to expected permanent changes in consumption.

We are aware that within the accelerator approach investment also reacts to changes in investment, since investment is a source of final aggregate demand. However, consumption is the primum movens. Thus, we consider that the evolution of domestic consumption acts as a proxy of the evolution of permanent aggregate demand.

By means of the Engle and Granger (1987) approach to dynamic causality, we employ the recently developed nonlinear Granger-causality test of Diks and Wolski (2016) to investigate whether permanent changes in consumption drive changes in investment. To this aim, we will control for final public expenditure. Our hypothesis is that public expenditure guarantees households certain goods and services; and thanks to it, the dynamics of households' private consumption becomes sufficiently permanent to be capable of determining the evolution of private investment.

4. Econometrics methodology

We apply to following methodology. First, we test the stationarity of the variables through different unit root and stationarity tests. Then, we test whether there exists a cointegration relationship among them. Finally, we apply linear and non-linear causality tests through the approach of Diks and Wolski (2016).

4.1. Data

We use Federal Reserve Bank of St. Louis' quarterly data of domestic consumption and domestic investment between 1947:Q1 and 2017:Q4. We control for the wage bill, since changes in its tendency can affect both consumption and investment decisions. We are aware that the three variables under study are simultaneously influenced by the evolution of total aggregate demand; however, if there is cointegration between them, then they share a common long-run trend, and the causality relationships between them are statistically valid, regardless of other variables (specially output) influence them (Johansen, 1995).

We consider aggregate real gross private investment, I_t, aggregate real consumption, C_1, and the real wage bill, W_t, which adopts the role of distributive variable, in the United States. We use Real Gross Private Domestic Investment as proxy variable for I_t, Real Personal Consumption Expenditures as proxy variable for C_1, and Real Compensation of Employees: Wages and Salary Accruals as proxy variable for W_t. All variables are measured in billions of chained 2009 dollars, seasonally adjusted. We use the variables in logs. The data are obtained from the database of the Federal Reserve (https://fred.stlouisfed.org/series/).

We consider that Personal Consumption Expenditures are entirely induced by output. We are aware that a part of aggregate consumption might be autonomous. Most authors consider that credit consumption is the best candidate to be used as proxy of autonomous consumption (see Pariboni, 2016; Lavoie, 2016; and Fiebiger and Lavoie, 2019, among others). However, empirical research has faced problems when including credit consumption as autonomous component of final demand (see Girardi and Pariboni, 2016; Gallo, 2019; Haluska et al., 2019; and Pérez-Montiel and Manera, 2020). Thus, we have decided to consider consumption to be completely induced.

4.2. Stationarity and cointegration analysis

Because the Dicks and Wolski (2016) causality test requires the variables to be stationary, we first check for the stationarity of the variables. A series is stationary if its mean and autocovariances do not depend on time. A non-stationary series that requires to be d times differenced to become stationary is integrated of order d, i.e., is a $I(d)$ process. We apply the Augmented Dickey–Fuller (Said and Dickey, 1984) and the nonparametric method of Phillips and Perron (1988). For robustness, we also present the results of the Dickey-Fuller Test with GLS Detrending (DFGLS) of Elliott et al. (1996). Additionally, we apply three stationarity tests: The test of Kwiatkowski et al. (1992); the Elliot, Rothenberg, and Stock Point Optimal (ERS) test; and the Ng and Perron (2001) test.

After studying the order of integration of the variables, we analyze the existence of cointegration among them (considering that investment is the dependent variable). We apply the autoregressive distributed lag (ARDL) bounds test by Pesaran, Shin, and Smith (2001). This method does not require the variables to be integrated in the same order and is valid for small sample sizes. The ARDL methodology is widely known, thus we will not display it here.

4.3. Nonlinear Granger-causality

After testing for cointegration, we analyze the dynamic linear causal relationship that may exist among the variables through the Engle and Granger (1987) approach. The hypotheses that we test sustain that movements of W_t linearly determine variations of C_t, and that changes of C_t linearly determine variations of I_t.

However, If the variables have a nonlinear structure, it is necessary to use the nonlinear causality approach. There is increasing evidence that financial and macroeconomic variables have nonlinear structures (Ajmi et al., 2015: 167). Additionally, the linear approach to causality cannot detect nonlinear causal relationships between variables (Brock et al., 1991). Baek and Brock (1992) and Hiemstra and Jones (1994) sustain that, by removing the linear predictive power in the VAR model, any remaining incremental predictive power of one residual series on another can be considered to be nonlinear predictive power (Qiao et al., 2009: 162). Therefore, after testing linear causality, we also investigate the causality on the VAR-filtered residuals. If the causal relationships previously found vanish after VAR filtering, then the discovered causality effects are the results of nonlinearities (Diks and Wolski, 2016: 1340). On the other hand, linear methods test the significance of suitable parameters only in a mean equation, thus causality in any higher order structure cannot be explored (Diks and DeGoede, 2001). For this reason, the nonparametric approach to Granger causality is interesting and, thus, we use the nonparametric method of Dicks and Wolski (2016).

After analyzing the existence of nonlinearities, we investigate the presence of nonlinear causality through the test of Diks and Wolski (2016). This is a nonparametric test that allows exploring causality in any higher order structure (instead of exploring causality just in the mean). The test checks the null hypothesis over the conditional densities of the variables of interest; however, to guarantee the consistency of the multivariate test statistic, the densities are evaluated at the sharpened data set (Fang and Wolski, 2019: 3). This allows to remove the problems of misspecification of the model.

The Dicks and Wolski (2016) test is a multivariate extension of the bivariate nonlinear causality test of Dicks & Panchenko (2006). If, following the notation proposed by Diks and Wolski (2016), we consider $X_t = C_t$; $Y_t = (I_t, W_t)$ and $Z_t = I_{t+1}$, the null hypothesis of no causality running from consumption to investment is:

$$H_0 = F\left(Z_t \middle| \left(X_t, \ldots, X_{t-l_X}; Y_t, \ldots, Y_{t-l_Y}\right)\right) \sim F\left(Z_t \middle| \left(Y_t, \ldots, Y_{t-l_Y}\right)\right). \quad (1)$$

The equivalence in the distribution is represented by the symbol '~', and l_i (i = X, Y) reflects the specific number of lags of each variable. Therefore, the null hypothesis states that $X_t, \ldots, X_{t-l_X}$ does not contain information about Z_t that complements the information contained in $Y_t, \ldots, Y_{t-l_Y}$. Diks and Wolski (2016) show that the test statistic of Dicks & Panchenko (2006) is dominated by the bias component, which in a multivariate setting increases disproportionally. The sharpening procedure of Diks and Wolski (2016) reduces the estimator bias by providing more accurate point estimates with asymptotically unchanged variance, which eventually leads to a consistent test statistic (Fang and Wolski, 2019: 10). If, following again the notation proposed by Diks and Wolski (2016), we consider the compact shape ω_t = (X_t, Y_t, Z_t); the sharpened test statistic is:

$$T_n^s(\varepsilon_n) = \frac{n-1}{n(n-2)} \sum_{t=1}^{n} \left(\hat{f}^j_{X,Y,Z}(X_t, Y_t, Z_t) \hat{f}^j_Y(Y_t) - \hat{f}^j_{X,Y}(X_t, Y_t) \hat{f}^j_{Y,Z}(Y_t, Z_t) \right). \quad (2)$$

In the statistic, $\hat{f}^j_\omega(\omega_t)$ is a sharpened form of the local density estimator of a d_ω-variate vector ω: $\hat{f}^j_\omega(\omega_t) = \left((n-1)\varepsilon\right)^{-d_\omega} \sum_{k,k\neq t} K\left(\frac{\omega_t - \varnothing_p(\omega_K)}{\varepsilon_n}\right)$, where $K()$ is a density estimation kernel. $\varnothing_p()$ is a sharpening map used to reduce the bias of the estimator, whose explicit form depends on the order of bias reduction, determined by the subscript p (Fang & Wolski, 2016: 11). Diks and Wolski (2016) prove that a sharpening function of order p, for which there exists a sequence of bandwidths $\varepsilon_n = C_n^{-\beta}\left(C>0, \frac{1}{2p}<\beta<\frac{1}{d_\omega}\right)$, is always found. This assures that their sharpened test statistic satisfies:

$$\sqrt{n}\frac{(T_n^s(\varepsilon_n)-q)}{S_t}\sim N(0,1) \qquad (3)$$

where S_t^2 is a consistent estimator of the asymptotic variance of $\sqrt{n}$ $(T_n^s(\varepsilon_n)-q)$, and q represents $E\left(\hat{f}_{X,Y,Z}(X,Y,Z)\hat{f}_Y(Y)-\hat{f}_{X,Y}(X,Y)\hat{f}_{Y,Z}(Y,Z)\right)$.

5. Empirical results

We check the stationarity of the variables Consumption, Investment, and the Wage Bill. We also check the stationarity of the variable final Public Expenditure, $\mathbf{G_t}$, because we will include it in our analysis later. As proxy variable of G_t we use "Real Government Consumption Expenditures and Gross Investment, measured in Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted Annual Rate".

Table 1 shows that, in general terms, the variables are non-stationary in levels and stationary in first differences, i.e., the variables are integrated of order one. However, the ADF test indicate that public expenditure is stationary in level, and the PP test suggests the same in the model with intercept. Additionally, when we consider only the model with intercept and trend, the ADF and the DFGLS tests indicate that the variable investment is stationary in level. The results are, therefore, inconclusive. Nevertheless, from a holistic view, we can affirm that the variables are trend stationary in first differences.

We proceed now to study whether the variables are cointegrated. For that, we employ the autoregressive distributed lag (ARDL) bounds test by Pesaran, Shin, and Smith (2001), which is robust to different orders of integration in the variables.Table 2A shows that the F-statistic value (18.12) is above the upper-bound critical value (5.85). Thus, the variables I_t, C_t and W_t are cointegrated at the 1% significance level. We show the results of the model with constant and trend, but we obtain the same results for the model with only constant. Table 2B shows that there is also a cointegrating relationship when we include G_t.

TABLE 1. STATIONARITY TESTS RESULTS

Model with intercept						
	ADF	DFGLS	PP	KPSS	ERSPO	Ng-P
C_1	-1.6	3.36	-1.93	1.99***	2921.80***	657.46***
I_t	-1.26	1.44	-1.09	1.97***	153.57***	126.70***
W_t	-2.13	2.85	-2.4	1.97***	1252.15***	472.92***
G_t	-3.19***	1.54	-3.26***	1.90***	397.95***	222.22***
ΔC_t	-8.50***	-4.93***	-15.80***	0.39	0.66	0.69
ΔI_t	-13.51***	-0.87***	-13.86***	0.1	0.78	19.27
ΔW_t	-7.81***	-7.72***	-11.46***	0.45	0.29	0.29
ΔG_t	-6.68***	-6.11***	-8.66***	0.46	0.40	0.40
Model with intercept and trend						
	ADF	DFGLS	PP	KPSS	ERSPO	Ng-P
C_1	-1.13	-1.09	-0.69	0.34***	22.34***	20.14***
I_t	-3.92***	-3.70***	-2.98	0.21***	3.71***	3.68***
W_t	-1.93	-0.94	-1.51	0.35***	30.97***	25.58***
G_t	-3.51***	-0.74	-3.08	0.27***	55.19***	38.20***
ΔC_t	-8.21***	-7.33***	-15.89***	0.06	1.44	1.48
ΔI_t	-13.51***	-6.15***	-14.09***	0.04	1.23	1.57
ΔW_t	-8.07***	-7.79***	-11.53***	0.03	1.06	1.07
ΔG_t	-7.02***	-6.33***	-9.31***	0.07	1.38	1.40

Notes: This tables show the results of the unit root test of the variables in levels and in first differences. Δ denotes first differences. We present two model specifications, one with only intercept and another one with intercept and trend. In the ADF, the DFGLS, and the PP test, the null hypothesis assumes no stationarity, while in the KPSS, the ERSPO, and the Ng-P test, the null hypothesis assumes stationary series. Thus, the asterisks ** and *** indicate stationarity at the 5% and 1% significance levels.

Table 2A. ARDL bounds test for cointegration. Cointegration model: I=f(C,W)

Critical Value Bonds	Significance	10%	5%	2.50%	1%	F-Test Statistic	18.12***		k
	I (0) Bound	3.38	3.88	4.37	4.99				2
	I (1) Bound	4.02	4.61	5.16	5.85				

This table presents the results of the ARDL bounds test by Pesaran, Shin, and Smith (2001). We present the results of the model with intercept and trend; however, we obtain the same results for the model with only intercept. The optimal lag order specification is selected by minimizing the Schwartz information criterion (SIC). The number of lags for the variables I, C, and W on the right-hand side of the equation are 1, 2, and 2, respectively. The lag length is validated by the absence of serial correlation in the residuals. K indicate the number of regressors. The asterisks *** indicate rejection of the null hypothesis of no cointegration at the 1% level.

Table 2B. ARDL bounds test for cointegration. Cointegration model: I=f(C,W,G)

Critical Value Bonds	Significance	10%	5%	2.50%	1%	F-Test Statistic	24.32***		k
	I (0) Bound	2.37	2.79	3.15	3.65				3
	I (1) Bound	3.20	3.67	4.08	4.66				

This table presents the results of the ARDL bounds test by Pesaran, Shin, and Smith (2001). We present the results of the model with intercept and trend; however, we obtain the same results for the model with only intercept. The optimal lag order specification is selected by minimizing the Schwartz information criterion (SIC). The number of lags for the variables I, C, W, and G on the right-hand side of the equation are 1, 2, 2, and 0, respectively. The lag length is validated by the absence of serial correlation in the residuals. K indicate the number of regressors. The asterisks *** indicate rejection of the null hypothesis of no cointegration at the 1% level.

Next, through the error correction representation of the ARDL model, we test for linear Granger-causality among Investment, Consumption and the Wage Bill. For robustness, we apply the granger-causality test of Toda and Yamamoto (1995), which, as the ARDL approach, does not require the variables to have the same order of integration. Finally, we also apply the conventional vector error correction model (VECM).

We found multiple linear granger-causality relationships among the variables, considering that the most notorious is the causal relationship running unidirectionally from Consumption to Investment, both in the short and in the long run. Obviously, we know that Investment affects output and, therefore, Consumption (and the Wage Bill); what the linear Granger-causality test tells us, however, is that Consumption is the primum movens with respect to Investment.

However, the causality relationships previously found vanish after VECM filtering. Thus, the causal relationship running unidirectionally from Consumption to Investment is due to first moment effects (causality in the mean). On the other hand, the BDS test (Broock et al., 1996) reveals a nonlinear structure in the variables. Therefore, we proceed to analyse nonlinear causality among W_t, C_1 and I_t. For reasons of space, we do not present the results of the BDS test, but they are available upon request (together with the different linear Granger-causality tests).

Next, we study the existence of nonlinear causality relationships. Before applying the Diks and Wolski (2016) test, the data are standardized by a normal transformation. Following the two-step process suggested by Diks and Wolski (2016), we first apply the test on the raw data to detect the presence of nonlinear causal relationships among the variables. We focus on pairwise causal relationship conditioning on the influence of the other variables. We use a lag order of one. The bandwidth of the test, estimated by the method recommended by Diks and Wolski (2016), is ϵ=0.94. As can be seen in Table 3, we find nonlinear Granger-causality running unidirectionally from C_1 to I_t, and from W_t to C_1.

The second step consists in applying the test on the filtered residuals of the VECM (because the series are cointegrated, otherwise it would be applied to the filtered residuals of the vector autoregressive regression (VAR)). This second step is aimed at finding out if the nonlinear causality relationships are of a purely nonlinear nature; that is, if they are exclusively due to their nonlinear components. Both causality relationships vanish after VECM filtering, which indicates that they are not genuinely nonlinear causality relationships, i.e. they do not correspond exclusively to the nonlinear components of the variables.

Following again the methodology of Diks and Wolski (2016), we apply the same analysis but conditioning on Government Expenditure, G_t. We use a lag order of one. The bandwidth of the test, estimated by the method recommended by Diks and Wolski (2016), is ϵ=1.01. After conditioning on G_t, the nonlinear causality relationship between C_1 and I_t disappears. According to Diks and Wolski (2016), it means that G_t drives the nonlinear causality relationship between C_t and I_t. In other words, the existence of G_t makes it possible that C_t nonlinearly causes I_t.

What can explain that G_t drives the nonlinear causal relationship running from C_t to I_t? our hypothesis is that the dynamics of C_t are sufficiently permanent thanks to the existence of G_t: public expenditure (medicines, textbooks, transport, accommodation, etc.) ensures households a minimum relatively stable capacity to consume. On the other hand, in Section 3 we hypothesized that investment is driven by permanent demand. Since in our analysis the evolution of demand is proxied by the evolution of consumption, we state that the permanent evolution of consumption guides investment decisions: Thanks to public expenditure, households have certain goods and services guaranteed, thus, the dynamics of their consumption becomes sufficiently permanent to determine the evolution of private investment.

6. Conclusions

We have examined Keynes' notions of, and causal relations among, private consumption and private investment together with their connection with current debates on demand-led growth. These can be summarized as follows:

(i) The level of employment is determined by the level of total expenditure, which is composed of consumption and investment expenditures.

(ii) Investment and consumption are not variables disconnected from each other. Keynes considers that investment, far from being exclusively determined by animal spirits or other exogeneities, is above all an increasing function of consumption. This contrasts with the exogenous treatment given to investment in most macroeconomic models of alleged Keynesian inspiration.

(iii) Aggregate consumption is an increasing function of household's income. he current consumption of a person is determined by its propensity to consume and the number of units of work that it has available. The latter is given by exogenous (political and institutional) factors. Income distribution in the GT, therefore, is an exogenously determined variable. We have explained that, according to Keynes, the propensity to consume is declining with respect to income. Thus, the more unequal the income distribution, the lower the overall propensity to consume of the community; and the greater the investment expenditure necessary to bridge the gap between output and aggregate consumption. But at the same time, the lower the propensity to consume, the lower the inducement to invest is. According to Keynes, this is the fundamental problem of capitalism. His words in this respect are clear:

The remedy [for an insufficient level of investment] would lie in various measures designed to increase the propensity to consume by the redistribution of incomes (Keynes, 1936: 324).

In fact, trough public expenditure, the State modifies secondary income distribution by guaranteeing households the provision of basic public goods and services, thus leading to an adjustment between the propensity to

Table 3. Diks and Wolski (2016) Nonlinear Granger Causality Test

Variables			First differences						VECM residuals				
X	Y		X→Y			Y→X			X→Y			Y→X	
(a) Without conditioning on public expenditure													
			Statistic	P-value		Statistic	P-value		Statistic	P-value		Statistic	P-value
C_1	I_t		2.19**	0.01		1.04	0.15		0.14	0.44		0.13	0.45
W_t	C_1		2.49***	0.00		0.38	0.35		-0.05	0.52		-0.17	0.57
W_t	I_t		0.54	0.29		1.59	0.06		-0.29	0.62		0.12	0.55
(b) Conditioning on public expenditure													
C_1	I_t		1.63	0.05		0.77	0.22		0.11	0.45		0.27	0.39
W_t	C_1		1.68**	0.04		0.51	0.30		0.00	0.50		-0.01	0.50
W_t	I_t		0.55	0.29		1.18	0.12		0.18	0.43		0.05	0.48

Note: this table presents the results of the Diks and Wolski (2016) nonlinear causality rest. → denotes direction of causality. The null hypothesis is of absence of nonlinear causality. The asterisks ** and *** denote rejection of the null hypothesis at the 5% and 1% significance level. The nonlinear causality test is performed on standardized data, transformed to uniform marginals.

consume and the inducement to invest. Therefore, according to Keynes, apart from the necessity of central controls to bring about an adjustment between the propensity to consume and the inducement to invest, there is no more reason to socialize economic life than there was before (Keynes, 1936: 379).

With quarterly data from the US economy, we have tested the empirical accuracy of these assertions: we found cointegration and linear causality relationships among Consumption, C_1, Investment, I_t and the Wage Bill, W_t. However, these linear causal relationships vanish after VECM filtering. It means that these causality relationships are attributed only to first moment effects. On the other hand, the nonlinear analysis has shown that there is nonlinear causality running unidirectionally from W_t to C_1, and from C_1 to I_t.

However, after conditioning on Public Expenditure, G_t, the nonlinear causality relationship running from C_1 to I_t has vanished. According to Diks and Wolski (2016), it implies that G_t drives the nonlinear causality relationship between these two variables: in the absence of G_t, I_t would not be nonlinearly caused by C_1. Our interpretation of this is that without the existence of public expenditure, firms would not consider that the evolution of consumption is sufficiently permanent to guide their investment decisions. In conclusion, by modifying secondary income distribution, public expenditure helps to bring about an adjustment between the propensity to consume and the inducement to invest.

Finally, we recall that the aim of our research was not to fully analyze the Keynesian model of income determination. Our objective was only to expose the relationship between the main variables of aggregate demand suggested by the GT. We are aware of the limitations of our study, since a complete demand-led growth model must consider, in addition to household consumption and private domestic investment, the propensity to import of the community; other (potentially) autonomous demand variables, such as residential and public investments and exports (see Girardi and Pariboni, 2016); and variables related to technological change, financial system and institutional quality (Smith, 2012). However, this research highlights Keynes' concern about the dynamics of investment, which is induced by the (permanent) dynamics of consumption, a question sometimes overlooked.

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