ISSN 1519-4612

Universidade Federal Fluminense

TEXTOS PARA DISCUSSÃO

UFF/ECONOMIA

Universidade Federal Fluminense
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Campus do Gragoatá, São Domingos, Bloco F, Niterói/RJ
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http://www.proac.uff.br/econ/
Editor: Luiz Fernando Cerqueira; lcer@uol.com.br; lfcerqueira@economia.uff.br.

Investment Rate, Growth and Accelerator Effect in the Supermultiplier Model: the case of Brazil

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TD 332
Janeiro/2018

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ABSTRACT

This paper investigates the role of demand in the productive investment evolution in the Brazilian economy. First, it assesses the long-run relationship between investment rate and GDP growth, taking annual data since 1962 until 2015. We then construct a "Final Demand" index and estimate its impact on productive investment growth rate, taking quarterly data since 1996q1 until 2017q2, highlighting a shift in the aftermath of the 2008 world economic crisis. The results support two hypotheses of the Supermultiplier model of Freitas and Serrano (2015) and Serrano, Freitas and Behring (2017) for the Brazilian economy: 1) non-capacity creating expenditures lead productive investment; 2) there is a very slow adjustment of the investment rate to demand growth, as described by the flexible accelerator process.

I Introduction

In 2014 Brazil entered one of the deepest recession of its history, for some the deepest. Brazil suffered a cumulative loss of output leading unemployment almost to double in only four years (ranging from a level of 7% in 2014 to 13% in 2017). A combination of contractionary policies together with world economic depression resulted in a plunge in aggregate demand (Rossi and Mello, 2017). Some states declared public calamity and financial bankruptcy and some even experienced social chaos, like Espírito Santos. In 2017 GDP has started a sluggish recuperation and 2014 GDP level it's not going to be achieved before 2020, even with optimistic forecasts. This scenario motivates our study on the role of demand to economic growth.

The objective of this work is to investigate the accelerator effect in the Brazilian economy, based on the so-called Supermultiplier model. For this purpose, we first analyze the investment rate (in productive capital) and product growth rate, proposing a long run relation between them. With a higher frequency data and a shorter window of time, the second part is a study about productive investment growth and demand growth, which can be seen a short run or cyclical relation.

We adopt a Sraffian version of a Supermultiplier model, as proposed by Serrano, Freitas, and Behring (2017), inspired by the seminal work of Serrano (1995, 1996). The model is a generic demand-led growth model with exogenous distribution of income, in the sense that any autonomous component of the demand (exports, government expenditures, autonomous business expenditure, including R&D and managerial expenses, autonomous consumption, financed by credit to consumers and accumulated wealth) can push the final growth, without necessarily being associated to a specific kind of distribution result.

We opt to econometric tools that consider possibility of structural breaks in the estimations, appropriate to Brazilian time series.

Section 1 address a brief theoretical revision of the Supermultiplier model. Section 2 introduces the long run relationship between investment rate and growth in the Brazilian economy, taking annual data since the 1960's. In section 3 we discuss the accelerator effect of the so-called "Final Demand" on productive investment, taking quarterly data of the last three decades (1990's, 2000's and 2010's). Section 4 provides the main conclusion of the paper.

II Supermultiplier Model

The Supermultlier effect, as is well known, is the combination of the expenditure multiplier in a consumption function with an accelerator investment function. Freitas and Serrano (2015) and Serrano, Freitas and Behring (2017) provide a robust theoretical fundament to a long run demand-led growth model, that has the Supermultplier effect. The model states that economic growth depends on the existence of autonomous non-capacity-creating expenditures and implies a positive relationship between the investment rate and the (expected) rate of growth of the economy. Accordingly, capitalist competition enforces a gradual adjustment of productive capacity to demand while the rate of utilization of the capacity tends to its normal level, even with the distribution given exogenously.

An equivalent, but more restricted, form of the Supermultiplier derived from the Neo-Kaleckian tradition can be found in Allain (2013) and Lavoie (2013). Freitas and Serrano (2015) and Serrano, Freitas, and Behring (2017) provide a formal proof of the stability of the model, overcoming the Harrodian instability, by using a flexible accelerator. Neo-Kaleckian models either don't have the long run relation between investment rate and the growth of demand or, when an accelerator mechanism is included, the model doesn’t obtain stability, in the sense of Harrod's (see Freitas and Serrano, 2015).

In the seminal work of Serrano (1995, 1996) investment level depends on the expected effective demand (D+1) and on the current technical conditions of production (by 'the' normal capital-output ratio (v):

$$I = vD_{+1} \qquad (1)$$

Authors suppose that production is carried out with circulating capital only, ignoring fixed capital. By contrast, the model in Cesaratto, Serrano and Stirati (2003) follows the practice, usual in Keynesian models, of ignoring circulating capital. In this formulation, (gross) investment is a function of the expected average rate of growth of normal effective demand (g^e), the replacement coefficient (d) and the capital-output coefficient, under normal utilization of the capacity, (v):

$$I = v\,(\delta + g^e)Y \qquad (2)$$

What these versions have in common is the dual character of productive investment, that is both a component of the aggregate demand and also an expenditure that creates productive (or supply) capacity in the economy. In equilibrium, the rate of equilibrium investment is given by,

$I / Y = v\ (\delta + g^e)$ (3)

The long-term equilibrium investment rate will depend on technological changes affecting the capital-product ratio and the depreciation rate and by changes in g^e.

After each current growth rate period, capitalists revise their expectations, as in Chenery flexible accelerator (Chenery, 1952), in a slow adjustment of the expected to the current growth rate:

$g^e_t = g^e_{t-1} + \beta\ (g_{t-1} - g^e_{t-1})$ (4)

in which g^e_{t-1} denotes the expectation of demand growth a period ago and $(g_{t-1} - g^e_{t-1})$, an error correction mechanism between the expected and actual rate of demand growth of the past period. The flexible accelerator coefficient ( ) is a small number ranging from zero to one ($0< \beta <1$). In the long-term equilibrium $g^e_t = g^e_{t-1}$ and it's equal to the growth rate of autonomous non-capacity generating expenditures g.

To Freitas and Serrano (2015) elaborate another version for a flexible accelerator, or the capital stock adjustment mechanism, using the marginal propensity to invest (h), that varies to adjust current utilization capacity (u) to its normal level (μ):

$I_t = h_t Y_t$ (5)

$(I_t / Y_t) = h_t$ (6)

$dh / d_t = h\ t\ \gamma\ (u_t - \mu)$ (7)

in which, γ is a model adjustment (positive) parameter. In the steady state there is a positive relationship between the growth rate and the rate of investment:

$h^* = (v/\mu)\ (g_z + \delta)$. (8)

This endogenous determination of the investment rate is due to the existence of autonomous non-capacity creating expenditures, that allows marginal and average propensity to save to have distinct values. Average saving rate adjusts to the investment rate, without any change in the marginal propensity to save, which is exogenously determined by the distribution.

In Serrano, Freitas and Behring (2017) the flexible accelerator is as follow:

$h_t = v g^e_t$ (9)

$g^e_t = g^e_{t-1} + (g_{t-1} - g^e_{t-1})$ (10)

where $0 \leq \beta \leq 1$ is an adjustment parameter in the equation of (adaptive) expectation formation, similar to the equation (4).

Under the restriction that the aggregate marginal propensity to spend, both in consumption and investment, remains lower than one during the adjustment process, the equilibrium of the Sraffian Supermultiplier is dynamically stable. There will be a tendency for the investment share to adjust itself to the trend rate of growth of demand, which will be equal to (and determined by) the rate of growth of autonomous expenditures: $g^e = g^* = g$ and $h^* = v\ g^z$.

In conclusion, all versions of the Supermultiplier implies a positive relationship between investment rate (determined by) the rate of growth of the demand, at steady-state. The only thing that varies is the explanation for the convergence process.

In this framework, technical progress can influence by changing capital-output and replacement coefficients, which alter the magnitude of the propensity to invest. It is also worth noting that R&D expenditures are considered an autonomous component of demand so, theoretically, can also push growth (see Cesaratto, Serrano and Stirati, 2003).

III Investment Rate and GDP growth long-run relationship

The lack of disaggregated data of gross investment in Brazil makes the empirical analysis of growth knotty. Working with aggregate Gross Fixed Capital Formation (GFCF) can be misleading, since the economic motivation for residential investment in structures, for instance, are very different from those taken by a company to expand its capacity. As shown by Hamilton et al. (2016), in last decades of the Brazilian economy, gross investment in structures has a completely different pattern from investment in equipments.

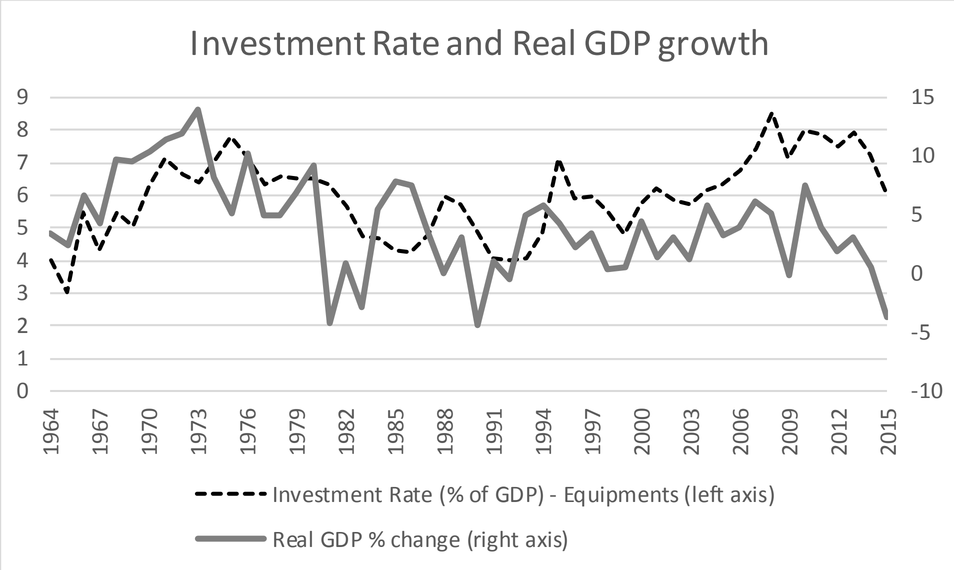
Luporini and Alves (2010) make a survey on the empirical research about investment in Brazil. Authors also estimate an investment function and conclude that demand variables have positive and significant coefficients, whereas cost variables are not statistically relevant. Several of them, adopt private investment series and aim to investigate crowding-out effect. Santos et al. (2014) and Feijó, Corrêa and Braga (2017) concludes that public investment is positively correlated to private investment, rejecting the crowding out effect. Avancini, Freitas, and Braga (2015) found evidence of investment rate being positively determined by GDP growth, using quarterly data from 1996 to 2014.

A meticulous research on the Capital Flow Tables (Miguez et al., 2014) has shed some light on investment data relating GHCF by sector with GHCF by product. In this work, it is used GFCF specific for equipments, as a proxy for the expenditure that directly creates productive capacity for the private sector of the economy. As shown by Miguez et ali. (2013), the major responsible for this kind of GFCF are non-financial companies (comprising approximately 90% of the total), so it's mainly a private investment (see Table 3 of Hamilton et al., 2016), as it should be, in the supemultiplier model.

The investment rate series is built by Gross Fixed Capital Formation (GFCF) specific for equipments (or "machinery and equipment", as it's classified in Brazilian data) as a percentage of GDP. This investment rate and also the Real GDP rate of growth are annual series started in 1962 and ending in 2015, taking the National Accounts of IBGE as the source[1]. The graph 1 shows that these series have a common movement in the long run. Both increase in the mid-1960s, in the Brazilian economic miracle, until the world oil crisis in 1973. Both tend to head down since then, passing through the so-called lost decade of the 1980's, until Brazilian economy reaches monetary stability in 1995. This seems to be a turning point where investment rate changes average level, higher than the past. From 2003 on it rises proportionality faster than would be justified by the pace of GDP growth. After 2008 great world economic crisis, despite the outlier reaction of 2010, GDP growth starts to decline, reaching a negative range in 2015, when investment rate also starts to fall.

[1] GDP real percentage change in the year was taken from Brazilian Central Bank Time Series Management System (code 7326), The GDP at current prices in Brazilian currency (R$) (code 1207) also from this website was used to construct the Investment Rate. In both cases, Instituto Brasileiro de Geografia e Estatística (IBGE) is referred as the main source. GFCF in equipment at current prices were taken from Annual National Account (IBGE) 2010, from 2010 to 2015 (last data available). From 1962 to 2009, using Annual National Account (IBGE) 2000 as the primary source. The proportional variation was used to match the Annual National Account (IBGE) 2010 level.

Graph 1



Since this series can suffer from structural breaks, the unit root test used is the Lee e Strazicich (2003) with two breaks endogenously chosen with maximum lag as suggested by Schwert (1989) and general to specific t-test for the lag choice. Rejection of unit root hypothesis is robust to the determinist type of variable in the test (either level or also a linear trend variable). The real GDP annual rate of growth is also stationary (Table 1).

Table 1

Lee Strazicich Unit Root Test

	Investment Rate	GDP growth
L & S Statistic:	-6.05 ***	-5.265 ***
Critical values for the test statistic:	1% 5% 10%	
	-4.54 -3.84 -3.5	
Determinist regressors: level		

*Indicates rejection of the unit root null hypothesis on 10% *, 5%** or 1%****

General to specific method to the lag choice

Exogeneity is tested by Wald test from a VAR specification, either with dummy variables to model breaks or without them. The dummies are chosen by Bay Perron (2003) test for the year of 1973 (probably related to the oil crisis) and 1995 (that marked the beginning of monetary stability in Brazilian economy). A VAR with just one lag is not sufficient to cope with residual correlation, so we opt for a VAR with two lags. Dummies are statically significant (1995 were significant at investment rate equation while 1973 were significant at GDP equation). The test results are shown in table 2 and indicate a direction of causality from the GDP growth to the investment rate. The result of the exogeneity test with the dummies points a stronger direction of causality.

Table 2

Bai Perron Multiple Breaks Test

Break Test	Scaled F-statistic	Critical Value**
0 vs. 1 *	14.89	13.98
1 vs. 2 *	16.13	15.72
2 vs. 3	7.90	16.83
Break dates:	Sequential	Repartition
	1974	1973
	1995	1995

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Wald Causality Test

	Test based on VAR with dummies	Test based on VAR without dummies
	p Value	**p Value**
GDP Growth does not cause Investment Rate	0.0003 ***	0.0195 **
Investment Rate does not cause GDP Growth	0.4826	0.1323

*Indicates rejection of the null hypothesis on 10% *, 5%** or 1%****
VAR Lag Order 2

A simple regression is illustrative of how these variables bend together. We put the level shift dummies variable, although only 1995 are statistically significant. Residuals are well behaved as shown diagnostic tests (for autocorrelation and heteroskedasticity). This model shows a significant coefficient of 0.097 percentual points in investment rate, as a response of 1 percentual point in the real GDP growth rate.

Table 3

Dependent Variable: IYMAQEQUI
Method: Least Squares

Variable	Coefficient	t-Statistic	Prob.	
C	1.302	2.44	0.019	
G	0.097	3.58	0.001	
IYMAQEQUI(-1)	0.651	7.28	0.000	
DUM1973	0.189	0.60	0.553	
DUM1995	0.601	2.57	0.013	
R-squared				0.70
Adjusted R-squared				0.68
F-statistic				27.18
Prob(F-statistic)				0.00
Durbin-Watson stat				2.25
Breusch-Godfrey Serial Correlation LM Test:		Prob. Chi-Square(1)		0.15
		Prob. Chi-Square(2)		0.17
		Prob. Chi-Square(6)		0.19
Heteroskedasticity Test: White		Prob. Chi-Square(11)		0.25
Heterocedasticity ARCH		Prob. Chi-Square(1)		0.39

The coefficient of GDP growth is a small (0.097), supporting the hypothesis of the capital adjustment mechanism, as put in the Supermultiplier model, that investment rate slowly adjusts to demand.

IV Final Demand and Investment Growth.

Autonomous expenditures are what Garegnani (1962) called 'Final Demand' minus the induced consumption of the wage bill. Since we are only interested in the investment function, there is no estimation of a consumption function, and we use the concept of Final Demand. By definition, they are the expenditures that do not directly create productive capacity for the private sector inside the economy. This include the whole of public expenditures (including public investment), aggregate exports, household consumption and some expenditures that are often classified as private investment but do not create directly productive capacity, such as most of residential investment (purchase of housing for habitation by families) and many managerial discretionary expenditures by firms (R&D expenditures, for instance), as well.

The Final Demand index considers aggregate exports, household consumption, GFCF in structures [2] and public expenditures, that, as is classified by Brazilian National Accounts, comprises only government consumption, not investments. Since there is no disaggregate GFCF in structures by sector, this series includes residential housing, government, and companies' expenditures on buildings. As shown in Miguez et al (2013), in 2009 almost 50% of this kind of GFCF is household's Residential investment and 27% is government investment. So, the difference from what Garegnani (1962) called Final Demand is only public investments in equipment, which in Brazil is a tiny proportion of aggregate investment.[3]

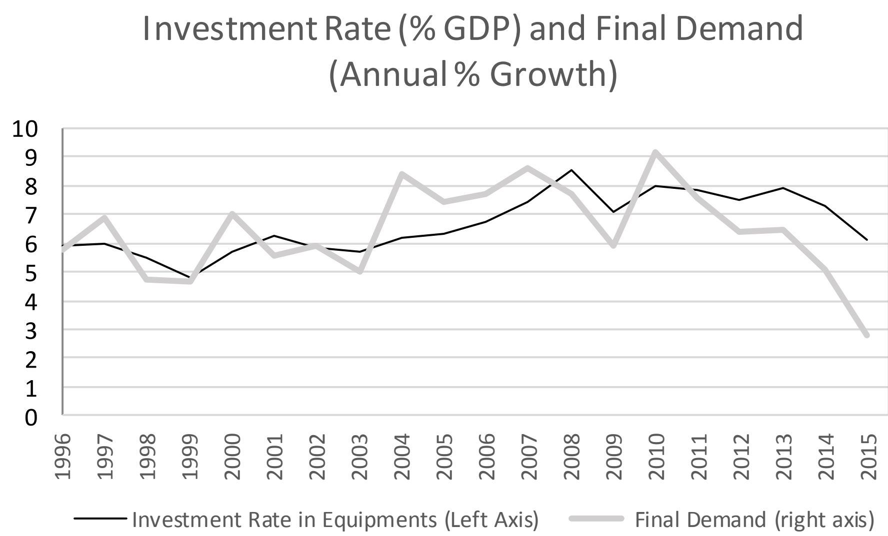
Graph 2 shows the annual growth rate of Final Demand (in right axis) and investment rate in equipment (in the left axis). The visual perception is that both series tend to change together, with investment rate slowly following the Final Demand movement, agreeing with the gradual character of the flexible accelerator process. While between 2003 until 2008 Final Demand suddenly growth at a higher pace,

[2] Final demand index is built by author taken as source the Annual and Quarterly National Account (IBGE), 2010 and 2000 releases. Moving base index of family's consumption, government consumption expenditures, exports and GFCF structures with the same weight of the year before, in their current value sum. The index is then chained to build the quarterly rates of growth from the same quarter of the year before. Since the series suffer from a change in methodology in 1996 they were chained to avoid level breaks. Equipment's GFCF is the quarterly index of (1995=100) taken from Institute for Applied Economic Research (Ipea) (index base 1995=100) last access on November 27th, 2017 in http://www.ipea.gov.br/cartadeconjuntura/index.php/2017/11/17/indicador-ipea-de-fbcf-setembro-e-3o-trimestre-de-2017/.

[3] Others GFCF expenditures released by IBGE is also not considered in this index, since most of them, as shown by Miguel et al (2013) the main responsible for this kind of expenditure are the farms companies, which is actually cattle purchases. Anyway, it's small weigh in total GFCF implies that it would have almost no effect on Final Demand dynamics.

investment rate gradually begins to rise. In 2008 Final Demand falls, followed by investment rate. The countercyclical economic policy[4] influences a punctual reaction of demand that quickly returned to a decline movement, intensified since 2013, and once again with a very smooth (now downhill) reaction of the investment rate.

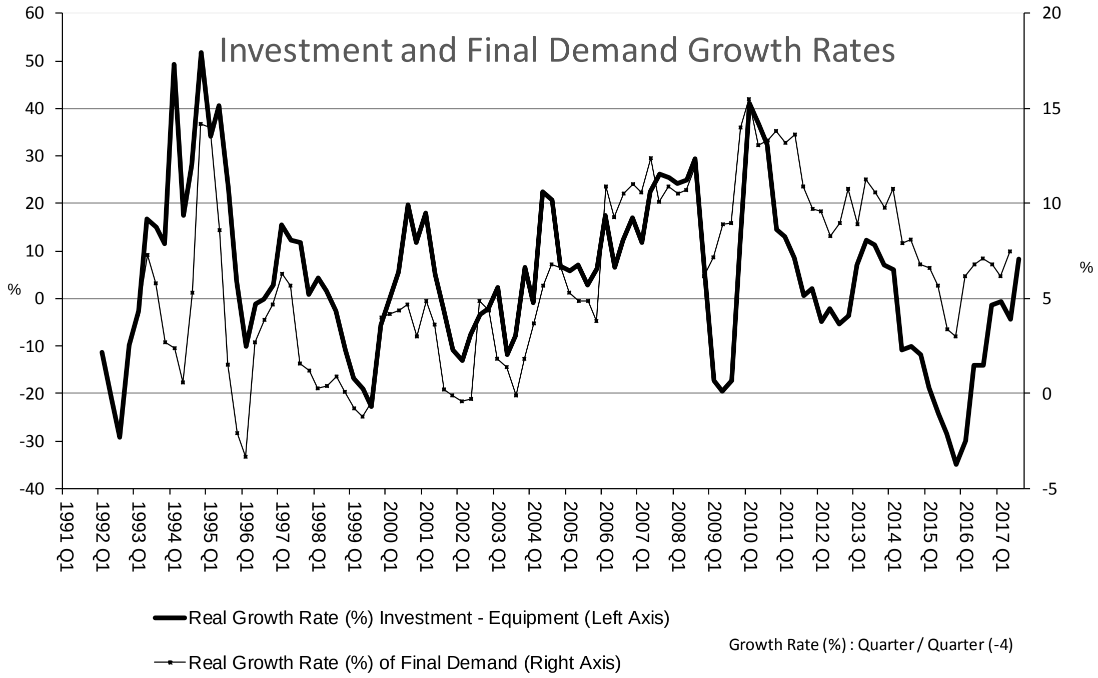
Graph 2



Since this sample is too small to model with econometrics, we opt to investigate the quarterly series of investment growth rate and Final Demand growth rate. Graph 3 shows that the similarity of movement between Final Demand and investment is quite remarkable. Both series fall in the mid-1990s and start to rise together after 2003. The great world financial 2008 crisis has a huge impact on investment growth, lowering its average level but also increasing its variance. After diving in the 2010's, both start to upsurge in 2016. Investment growth rate just steps above negative range in 2017.

[4] Barbosa, N. (2010), "Counter-Cyclical Policy in Brazil: 2008-09", Journal of Globalization and Development 1 (1), Article 13, available at www.bepress.com/jgd/vol1/iss1/art13.

Graph 3



The relation between real investment growth rate and Final Demand growth rate is also a strong one. Since the series presented in graph 2 suffer from a change in methodology in 1996 (although they are chained to avoid level breaks), in the tests and models the sample considered range from the first quarter of 1996 till the second quarter of 2017.

Lee e Strazicich (2003) results indicate non-rejection of the unit root hypothesis. Interesting enough, demand breaks at 2008 third quarter and investment breaks after that, at 2008 fourth quarter. The procedure by Lutkepohl et al. (2004) is used to test for the cointegration rank of a VAR process with a level shift at an unknown time. Results indicate that both series cointegrate.

Table 4

Lee Strazicich Unit Root Test

	Investment	Unproductive Demand
	-2.34	-2.39
Critical values for the test statistic:		
1% 5% 10%		
-4.54 -3.84 -3.5		
Determinist regressors: level		

*Indicates rejection of the unit root null hypothesis on 10% *, 5%** or 1%****

General to specific method to the lag choice

Lutkepohl et all Cointegration Test

	test	10pct	5pct	1pct
r <= 1	2.48	3.00	4.12	6.89
r=0	20.8 ***	10.45	12.28	16.42

Trace statistic , without linear trend in shift correction

Since standard Granger-causal inference is invalid for integrated time series, Todda Yakamoto (1994) procedure is used to test the causality. The results on Table 5 indicates the direction of causality is from Final Demand to investment growth. It's worth noting that this result is robust either if a dummy variable for the 2008 crisis is inserted (as suggested by Lee Strazicich test) or not, or even else if the standard Wald test for stationarity variables is implemented.

Table 5

Causality Test	Todda Yakamoto with dummies	Todda Yakamoto without dummies
	p Value	**p Value**
Final Demand does not cause Investment Hypothesis	0.00 ***	0.00 **
Investment does not cause Final Demand Hypothesis	0.32	0.46

*Indicates rejection of the null hypothesis on 10% *, 5%** or 1%****

VAR Lag Order 9

The Bai-Perron test indicates a break in the relation between demand and investment on the fourth quarter of 2008. This break is modeled by a level dummy and an intercept change in a classical Regression. The results show that world great 2008 crisis lowered dramatically the investment growth level but also increased the elasticity of reaction to Final Demand changes. Residuals are well behaved as shown by diagnostic tests (for autocorrelation and heteroskedasticity).

Table 6

Bai Perron Multiple Breaks Test

Break Test	Scaled F-statistic	Critical Value**
0 vs. 1 *	56.24	13.98
1 vs. 2 *	9.25	15.72
Break dates:	Sequential	Repartition
	2008Q4	2008Q4

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

White heteroskedasticity-consistent standard errors & covariance
Dependent Variable: GIMAQ
Method: Least Squares

Variable		Coefficient	t-Statistic	Prob.
C		-5.686	0.889	0.000
GZIMPROD		2.349	0.206	0.000
DUM2008Q4*GZIMPROD		2.241	0.579	0.000
DUM2008Q4		-37.934	4.599	0.000
AR(1)		0.347	0.174	0.049
MA(4)		-0.825	0.050	0.000
R-squared				0.85
Adjusted R-squared				0.84
F-statistic				87.64
Prob(F-statistic)				0.00
Durbin-Watson stat				1.92
Breusch-Godfrey Serial Correlation LM Test:	Prob. Chi-Square(1)			0.33
	Prob. Chi-Square(2)			0.61
	Prob. Chi-Square(3)			0.42
	Prob. Chi-Square(6)			0.33

Gregory Hansen test confirms the above result. First, it points to a cointegrating relation between investment and Final Demand. Second, it also indicates a huge diminish of the intercept level after the 2008 great crisis and, third, it indicates an increase of the elasticity of investment reaction to Final Demand changes.

Table 7

Gregory-Hansen Cointegration Test
Notrend model
Dependent variable: gImaq

	Estimate	t value	Pr(>|t|)
(Intercept)	-6.29	-3.31	0.00
gzimprod	2.30	7.35	0.00
\`D2009 Q2\`	-41.79	-7.60	0.00
\`D2009 Q2gzimprod\`	2.77	4.51	0.00
Test statistic -7.023948			
Critical values for the test statistic:		1%	5%
		-5.47	-4.95
With 3 chosen from 11 lags			
Method used: BIC			

V Conclusions.

The results strongly confirm the supermultiplier model hypothesis about productive investment**.** Both annual and quarterly data estimations endorse the hypothesis that (non-capacity creating components of the) demand lead productive investment in the Brazilian economy.

For the annual data, exogeneity test shows that GDP growth Granger causes (but is not caused by) investment rate. The coefficient of GDP growth is small (0.097), supporting the hypothesis of the capital adjustment mechanism, as put in the Supermultiplier model, that investment rate slowly adjusts to demand. Bay Perron test finds (changing mean) structural changes in 1973 (probably related to the oil crisis) and 1995 (that marks the beginning of monetary stability in Brazilian economy).

For quarterly data, tests also show that Final Demand growth rate leads productive investment growth rate. There is a break in this relation in 2008. The investment growth average drops intensely and keeps at this new lower level. At the same time, Final Demand-elasticity in investment function rises. The increase in elasticity could be a sign of a stronger reaction to an increase in demand because of counter-cyclical policy measures that intended to boost investments, adopted in the aftermath of the 2008 great world crisis. But, at the same time, a higher elasticity indicates a higher fall of investment when demand drops. Indeed, investment plummets after Brazilian government started restrictive fiscal and monetary policies. This new scenario of the Brazilian economy is not only of lower investment growth but also a more unstable one.

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