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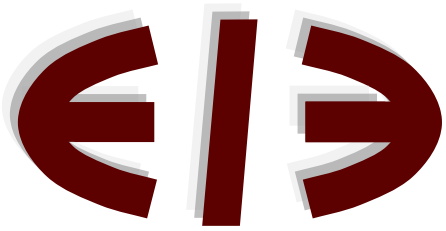

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Public Investment and Growth Accelerations: The Case of Southern Italy, 1951-1995

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Abstract

This paper analyses the contribution of public investment to growth in southern Italy in the second half of the twentieth century (1951-1995). The period saw the only convergence in modern times of the Mezzogiorno towards the Italian average (1951-1973), followed by divergence (1974-1995). Using cointegration analysis we find a statistically significant positive effect of public investment on the growth of the Mezzogiorno in the period 1951-1995. The Bai-Perron tests suggest that economic growth followed two distinct regimes, the first regime of accelerated growth in the years 1951-1973 (average growth rate 5.3%), and the second regime of low growth in the period 1974-1995 (average growth rate 1.6%). This result is confirmed by the testing procedure of Hansen (1992) which indicates a break in the determinants of GDP per unit of labour in 1974. The estimates of the model on time series of the two periods show statistically significant parameters of public investment in the first regime, but not in the second regime, when economic growth is sustained by business investment and technical change. The paper suggests that public capital may have a significant positive role in episodes of growth accelerations if the quality of the institutional environment is high, but it can lose its effectiveness if bureaucratic corruption and rent-seeking strongly affect public policy.

JEL codes: H54, O14, O18, O47

Keywords: Public Investment, Growth Instability, Cointegration, Structural breaks, Southern Italy

1. Introduction

Public capital is one of the main determinants of economic growth in an important strand of the theoretical literature. The traditional exogenous growth model – explored in depth by Arrow and Kurz (1970) among others – underlines the permanent effect of public policies on income per capita and the transitory effect on the growth rate. The recent endogenous growth theory (e.g., Barro, 1990; Barro and Sala-i-Martin, 1992; Glomm and Ravikumar, 1994 and 1998) argues for a permanent effect of policy variables also on the equilibrium growth rate. During the past three decades, the contribution of infrastructure to the productivity of the private sector has been the object of many studies (see the surveys of Sturm et al., 1998; Romp and de Haan, 2007; Bom and Ligthart, 2014). The empirical literature has produced a wide range of estimates.[1] Endogeneity of explanatory variables, time series non-stationarity, and parameters' cross-country heterogeneity are significant econometric issues in this research[2].

Over the same period, the empirical analysis of economic growth has highlighted an important stylized fact on the time path of per capita income of developing countries: growth rates are characterized by large instability and volatility (Pritchett, 2000, Jones and Olken, 2008). The opposite happened in most of the developed countries. Research on the causes of episodes of growth accelerations or decelerations (Hausmann et al., 2005; Jerzmanowski, 2006; Hausmann et al., 2008; Berg et al., 2012) strongly suggests this stylized fact cannot be ignored in the econometric assessment of the determinants of economic growth. Researchers concentrate their investigations on the quality of institutions, openness and other structural factors. A few studies have focused on public capital. In particular, Hausmann et al. (2008) find that telephone mainlines per capita do not explain the probability of a country falling into a crisis; Berg et al. (2012) find the same variable statistically significant in the estimation of a model of the duration of growth episodes. The recent study by Moller and Wacker (2017) analyses the episode of growth acceleration occurred in Ethiopia during the 2000s. The econometric results suggest investments in telecommunications and roads are important explanatory factors. Carrère and De Melo (2012) study the occurrence of growth events after fiscal events – changes in fiscal expenditures – in a panel of 140 countries over 1972–2005. They find the occurrence of the joint event positively correlates with a growing share of transport and communication expenditure.

In this paper, we investigate the causal effects of public capital on both economic growth and its instability in southern Italy after World War II. The historical experience of southern Italy provides

[1] The application of meta-regression analysis to large sets of parameter estimates (e.g., Bom and Ligthart, 2014) supports the view that public capital has a positive effect on private output.

[2] Recent contributions using cross-country panel time series (e.g., Bottasso et al., 2013; Calderon et al., 2015) tackle some of these methodological issues.

an interesting case study because in the fifties and sixties the region rapidly grew catching up with the rest of Italy, while in the following decades the gap widened again. Italy's regional inequalities, especially the origins and evolution of its North-South divide, have been vastly debated since the nineteenth century, in academic circles and beyond, arguably without parallel in any other advanced country – not least, for its international appeal (e.g. Carey and Carey, 1955; Banfield, 1958; Carlyle, 1962; Putnam, 1993). The subject continues to be of the utmost importance: judging from the regions eligible for EU cohesion funds, in the latest cycle (2014-2020) no other Western country presents an internal divide as profound as Italy, where most of the South (Campania, Puglia, Basilicata, Calabria, Sicily) is below the 75% PPP per capita GDP threshold, while the rest of the South (Abruzzi, Molise, Sardinia) lies between 75 and 90%.[3] The North-South divide remains, therefore, unbridged.[4]

But does this mean that it is unbridgeable? The available updated estimates of regional GDP tell a different story (Svimez, 2011; Felice and Vecchi, 2015b). The North-South divide, only mild at the time of unification, increased at a slow pace during the liberal age (1861-1911), but much more rapidly in the interwar years. After reaching its peak in the aftermath of World War II, it decreased during the "golden age". With the oil crisis, however, southern Italy stopped converging and even fell back once again. The changes observed in the second half of the twentieth century – convergence, then paralysis and divergence again – took place at the same time when a massive State intervention, called "extraordinary intervention", was carried out to develop the South, mostly through the State-owned agency *Cassa per il Mezzogiorno* (1950-1984): while in the 1950s the agency focused mainly on infrastructures and agricultural works, in the 1950s, 1960s and early 1970s it concentrated on industrial incentives, which mostly went to capital-intensive sectors through State-owned enterprises (Felice, 2010a; Felice and Lepore, 2017). However, by the mid-1970s it had lost effectiveness due to growing political pressure, so much so that it ended in disrepute, favouring unproductive expenses and even organised crime (e.g., Trigilia, 1992; Baraldi, 2008); after its demise, it was followed but the short-lived *Agensud* (1986–1993). Recent qualitative analysis suggests a strong correspondence between both the rise and fall of the *Cassa per il Mezzogiorno* and the convergence and subsequent falling back of southern Italy (Lepore, 2013; Felice and Lepore, 2017). In addition, the time series on the number of crimes against the public administration in Italy and the Mezzogiorno (Del Monte and Papagni, 2007) highlight a clear change in the trend, that in the early seventies becomes steeper. These suggestions notwithstanding,

[3] See the part about regional policy in the European Commission website: http://ec.europa.eu/regional_policy/fr/ (last access on April 2016). Throughout the paper, the Italian Mezzogiorno is made up of the eight southern regions mentioned above.

[4] Milder though, it can be observed also in social indicators: from human capital to the Human Development Index, to inequality and poverty (Felice and Vasta, 2015; Felice and Vecchi, 2015a).

thus far we lack econometric analyses able to corroborate such a correspondence, via linking empirical evidence to growth theories.

The present paper investigates the long-run causal relationship between public and private investments and real GDP, by adopting the time series approach of cointegration. We provide the first econometric analysis of the factors of the economic development of southern Italy after World War II.

A main feature of this analysis is the focus on structural change as a determinant of economic growth, as suggested by a large literature. The application of Johansen's (1991) multivariate methodology supports the presence of one long-run cointegrating equation that includes a linear time trend. Estimation of the Vector Error Correction Model (VECM) highlights the weak exogeneity of the determinants of output per worker in southern Italy. The estimated equilibrium relationship indicates that both public and business investment Granger cause in the long run the GDP per worker of southern Italy in the period after World War II. Both effects are remarkable, but that of private sector investments is greater than (double) that of government investment. A significant parameter of the trend suggests an important role for technical progress in the same process. These results are confirmed by the estimates we obtain using two alternative single-equation methods which take into account the potential endogeneity of the right-hand variables: Fully Modified OLS (FMOLS) proposed by Phillips and Hansen (1990) and Dynamic OLS (DOLS) advanced in Saikkonen (1992) and Stock and Watson (1993).

The historical period of our analysis allowed us to test the hypothesis of a structural break in the Mezzogiorno's economic growth. This represents another important contribution of the present work. The application of the methods of Bai and Perron (1998; 2003a) highlights two different growth regimes after World War II: that of convergence, 1951-1973, with average growth rate 5.3%, and the following period, 1974-1995, when the average growth rate was much lower, 1.6%, and the gap with the Centre-North widened again. This timing of structural change is confirmed by the implementation of the Hansen (1992) testing methodology to the long-run equation relating GDP per worker to public and business capital accumulation. From application of FMOLS to the same model on the time series of the two distinct regimes, it emerges that during the 1950s and 1960s the successful growth model of the Mezzogiorno was led by infrastructure investments jointly with the contribution of private investments and technical change, while in the following regime structural public intervention lost its efficacy and the economy relied on the business sector, with lower effects. Hence, our estimates support the view that public capital can be an important factor of growth in the context of favourable institutional environments and be responsible for

growth deceleration if its efficiency is low as a consequence of corruption, rent-seeking and other features of bad institutions (Del Monte and Papagni, 2001).

Through the econometric analysis of an important case of economic development, this paper provides three main contributions to the literature on public capital and economic growth.[5] First, we obtain a significant effect of public investment on aggregate productivity with the application of the econometric methods of cointegration and the assessment of the long-run weak exogeneity of the explanatory variables. Second, we study growth transitions, by estimating a model of per worker GDP on time series for each growth regime; in other words, we highlight what has changed in the determinants of growth before and after the transition; this approach is new in the literature, where the available studies, using cross-country panels (see the references above in this section), seek for the determinants of the probability of growth transitions. Third, we find that public investment is an important cause of growth accelerations. Our outcome suggests that infrastructure policy is crucial for successful economic development, and economic research should deeply investigate this factor of growth acceleration.

The paper is organised as follows. Section 2 discusses the main features of southern Italy's economic growth in the second half of the twentieth century and illustrates the explanatory variables. Section 3 presents the econometric model, followed by Section 4 which discusses the main results obtained. A final appendix provides a brief description of the sources, descriptive statistics and correlations for the variables used.

[5] In the literature, several papers concentrate on the effect of public capital on economic growth in southern Italy, using time series starting after the 1960s and different econometric methods (e.g., Picci, 1999; Bonaglia et al., 2000; Destefanis and Sena, 2005; Bronzini and Piselli, 2009). The distinctive approach of this paper is that, unlike previous contributions, it considers the performance of the Mezzogiorno economy in the two decades after World War II and also tackles the issue of the growth acceleration and subsequent slowdown.

2. The historical framework: data and variables

Our empirical analysis refers to the period 1951-1995. Data on GDP, public and private investments and employment for the Italian Mezzogiorno for the period 1951-1983 were published by SVIMEZ (Svimez, 1985). We extend these time series using the rate of change of each variable derived from the regional accounts of the Italian National Institute of Statistics (ISTAT) for the period 1960-1996:[6] we thereby obtain time series for real GDP, real public and private investments at constant prices (1970) in billions of lire. We choose to end our analysis in 1995 because the mid-1990s represent for Italy, and for the development policy of the South, an important watershed: they mark a shift of paradigm, which developed progressively through those years, beginning in 1992 and ending in 1998. At the national level, the strategy of growth based on inflation, devaluation of the national currency and public debt followed in the 1970s and 1980s became no longer possible, due to the decision to join the European Union and thus to adopt the common European currency and a common monetary policy: the change was inaugurated in 1992 with the severe financial measures carried out by the Amato government and culminated in 1998 when, after a series of yearly budget cuts (amounting to 430 billion lire of the time from 1992 to 1998), Italy was admitted to join the European Union and the official parity between the lira and the euro was established (Felice, 2015, pp. 304-305). For what concerns southern Italy, related to this shift is the end the extraordinary intervention in 1992-93, with the dismantling of *Agensud*; it was followed by a vacuum of some years and then by a new policy of development, called «Nuova programmazione», which started in 1998 and was carried out amid severe budget constraints and in coordination with the regional policy of the European Union (Barca, 1998, 2006; Prota and Viesti, 2012).

The time series of (the logarithm of) GDP per worker of southern Italy in the period 1951-1995 is plotted in Figure 1. The graph highlights the important process of economic development that dramatically improved the standard of living in the region, particularly in the first decades after World War II. The pattern of the GDP growth rate per unit of labour (hereafter Δy) in the Italian Mezzogiorno in the time span of analysis is shown in Figure 2. It is evident that the mean GDP growth rate is higher from 1952 to the mid-1970s, and lower in the next period. The divide between the two eras is the economic crisis which began in late 1973. Table 1 below shows the descriptive statistics of Δy for the whole period and for the two sub-periods, 1952-1973 and 1974-1995. The

[6] Let X_t be one of the variables with data in the period 1951-1983, available from SVIMEZ (1985). We calculated X_{1984} using the formula: $X_{1984} = X_{1983}(1 + g_{1984})$, where g_{1984} is the growth rate of X in the year 1983, that we obtained from the ISTAT database on regional accounts, 1960-1996. The values of the time series following X_{1984} were calculated in the same way: $X_t = X_{t-1}(1 + g_t)$.

mean in the first period (1952-1973) is much higher than in the second (1974-1995). For the whole period, the max value is consistently found in the first half, and the min value in the second.

Table 1. *Descriptive statistics of Δy*

	1952-1995	***1952-1973***	***1974-1995***
Mean	0.034	0.053	0.016
Max	0.113	0.113	0.054
Min	-0.046	0.005	-0.046
Standard Dev	0.029	0.025	0.021

Sources and notes: see text and Table A.1.

The picture of growth presented in Figures 1 and 2 is partly related to the GDP growth pattern of Italy as a whole: considerably higher during the so-called "golden age" (the 1950s and 1960s), than in the subsequent "silver age" (1970s and 1980s) (Toniolo, 2013; Felice, 2015). Within this broader national framework, however, it is worth noting that southern Italy performed above the Italian average during the golden age (that is, when the growth rate was also higher Italy-wide) and, conversely, below the average in the subsequent phase (that is, when the Italian growth rate was lower) (Felice and Vecchi, 2015b). This pattern of growth can be interpreted by looking at the post-war structural dynamics in the Mezzogiorno. Figure 3 shows trends of private and public investment that are consistent with the trend of productivity presented in Figure 1.

Throughout this period, a massive scheme of regional development was carried out by the Italian state – the so-called «extraordinary intervention», mostly coinciding with the lifespan of the State-owned agency *Cassa per il Mezzogiorno* (1950-1984) – which was generally regarded as effective in the first part (from the 1950s to the early 1970s), ineffective and even damaging in the second (from the early 1970s to the 1980s). In the first part of its life, the *Cassa* devoted most of its resources to «direct interventions», which included general and sector-specific infrastructures (mostly aqueducts, roads, drainage and agricultural settlements), plus other minor interventions in terms of expenditures (railways, school construction, education and professional training, development assistance, research and development). From 1957 onwards, subsidies to entrepreneurs (grants to agriculture, tourism, craftsmanship, fishing, but above all to industry) grew in importance, reaching about one third of total expenditures from the mid-1960s to the mid-1970s (Felice and Lepore, 2017). Therefore, the activity of the *Cassa* affected both public and private investments. Overall, the total expenditures of the *Cassa* amounted to 0.69 of total Italian GDP in the years 1950-1965, decreased to an average 0.64 in the years 1966-1970, rose again to an average 0.84 in the 1970s, and then finally decreased to an average 0.61 in the early 1980s (Felice and Lepore, 2017). Although in the 1970s the funds allocated through the *Cassa* reached their peak, they lost

productive effectiveness, having come to be strongly affected by political pressure and nepotism. In the same period, the convergence of southern Italy also came to a halt, and never resumed.

One question often raised in the literature on the effects of public capital on economic growth is the direction of causation that could also be reversed. Indeed, although the decision to invest in infrastructures is usually made by policy makers, it can be easily argued that, as the wealth of a country increases, more resources can be spent on public capital. In the context of the present study, the exogeneity of public investment can be justified by important arguments. It is well known (e.g., Lepore, 2013) that in the first phase of its reconstruction after World War II Italy took advantage of funds from international institutions and the USA. A significant share of these resources was allocated to infrastructures in the Mezzogiorno. This applies to financial aid from the World Bank to the *Cassa per il Mezzogiorno* in the 1950s and mid-1960s, after which most of the resources for public investment in southern Italy came from the national budget. In the empirical analysis, we test the hypothesis of long-run causality between public investments and GDP.

3. Econometric model and results

The contribution of public capital to the process of economic development in the long run is usually modelled in the context of production functions (e.g., Aschauer, 1989). In this paper, we assume the aggregate output (*Y*) depends on the state of technology (*A*) and the services of three inputs - private capital (*K*), public capital (K_g) and labour (*N*) - according to the following Cobb-Douglas production function with constant returns to scale[7]:

$$Y = AK^{\alpha}{K_g}^{\beta}N^{1-\alpha-\beta}. \quad (1)$$

Taking logs on both sides of equation (1) yields the following equation:

$$\ln(y) = \ln(A) + \alpha \ln(k) + \beta \ln(k_g), \quad (2)$$

where lowercase letters indicate variables in per worker terms.

Equation (2) represents the basic model of our econometric analysis. In this framework, we choose to approximate the two capital stock variables with investment data for two reasons. The first relates to the integration properties of the time series of investment and capital. Indeed, it can be noted in the literature that aggregate capital is usually integrated of the second order, whereas production and investment are integrated of order one (Everaert, 2003; Haldrup, 1998; Otto and Voss, 1996). Hence, the estimation of model (2) on data of stock variables could produce a "spurious regression". A focus on investment flows has been chosen by the authors of several

[7] This assumption is often made in the literature (e.g., Everaert, 2003; Pina and Aubyn, 2005).

papers closely related to the present (see, amongst others, Sturm et al., 1999; Pereira and Roca-Sagales, 2001; Pereira and Andraz, 2005; Herranz-Loncán, 2007). The second reason concerns the lack of capital stock time series for southern Italy for the period before 1970. Restricting the analysis to the years after 1969 would preclude any statistical approach to the two phases of growth occurred in the economic development of the Mezzogiorno, which is one of the main objectives of this paper.

Our empirical analysis is conducted on time series of the Italian Mezzogiorno in the period 1951-1995. The economic variables included in the model are real gross domestic product per unit of labour (hereafter *y*) which is used as a measure of the economic performance, real gross fixed private investments per unit of labour (hereafter *priv_inv*) and real gross fixed public investments per unit of labour (hereafter *pub_inv*).

3.1 Cointegration analysis

The econometric analysis is based on the following model:

$$\log(y_t) = \gamma + \alpha log(priv\_inv_t) + \beta log(pub\_inv_t) + u_t. \qquad (3)$$

If the data generating process (DGP) of the variables in equation (3) is characterized by a stochastic trend, a cointegration analysis could show the existence of a long-run relationship that can be interpreted as the causal explanation for productivity in the southern Italian economy.

Accordingly, first of all we test for stationarity and order of integration among all variables. We run two unit-root tests: the augmented Dickey–Fuller (ADF) and the Phillips-Perron (PP) test (Phillips and Perron 1988), for both the level and the first differences of all variables (see Table 2). The null hypothesis of both tests is that the variable contains a unit root, and the alternative is that the variable is generated by a stationary process with or without a deterministic trend.

Table 2. *Augmented Dickey-Fuller* and *Phillips-Perron* unit root tests

	Level		First differences	
Variable	ADF	PP	ADF	PP
log(y)	-0.95 (0.94)	-0.74 (0.96)	-1.98 (0.02)	-5.53 (0.00)
log(priv_inv)	-2.36 (0.40)	-2.89 (0.16)	-2.68 (0.00)	-2.80 (0.05)
log(pub_inv)	-0.58 (0.97)	-1.04 (0.93)	-2.82 (0.00)	-7.01 (0.00)

Note: p-values in parentheses. Two lags are used for both the tests. Results are robust to the variation of the lag length. In both ADF and PP tests, the associated regression for all the variables in level contains a time trend.

The test statistics suggest that the hypothesis of a unit root in the DGP cannot be rejected for the levels of the three variables, while it can be rejected in the case of their first differences. Hence, the time series are probably integrated of order one, I(1).

In this case, one or two cointegrating equations could represent the long-run relationships among the three variables. We apply Johansen's (1991) trace test to determine the number of cointegrating equations in a Vector Error Correction Model (VECM) of the relationships among *log(y)*, *log(pub_inv)* and *log(priv_inv)*. In the Johansen procedure, the VAR optimal lag length of one year was chosen by standard information criteria.[8] In the VECM we assume a linear trend in the cointegrating relations.

Table 3. *Johansen multivariate cointegration test*

Hypothesized		
No. of CE(s)	Trace statistic	5% critical value
None	46.26	42.44
*At most 1**	22.17	25.32
At most 2	6.52	12.25

Note: the VAR lag length is one**. *** denotes acceptation of the null hypothesis at the 5% level.

The trace test statistics in Table 3 show we cannot reject the hypothesis of a cointegration rank of one, indicating one cointegrating equation at the 0.05 level. Applying Johansen's (1995) maximum likelihood estimation method to the VECM specified assuming one lag order and one cointegrating relation provides the parameters of the long-run equation shown in Table 4.

Table 4. *Cointegrating equation*

Variable	Coefficient	Std. Error	t-Statistic	P-value
log(y)	1			
log(pub_inv)	-0.181	0.051	-3.54	0.00
log(priv_inv)	-0.362	0.041	-8.76	0.00
trend	-0.019	0.00	-17.42	0.00
constant	-1.176			

This equation can be interpreted as an estimate of model (3):

$$\log(y) = 1.176 + 0.019trend + 0.181\log(pub\_inv) + 0.362\log(priv\_inv)$$

[8] Schwarz's Bayesian information criterion, and the Hannan and Quinn information criterion both indicate one lag order for the VAR, while the Akaike's information criterion suggests a lag order of four. To save degrees of freedom we choose one lag in our VECM. Cointegration analysis was performed using STATA 14 statistical software.

In order to complete the cointegration analysis, table 5 below shows the results of a Lagrange multiplier test for the autocorrelation in the residuals of the VECM that we estimated. The null hypothesis of the test is the absence of autocorrelation that we always accept when the test is performed at lags from 1 to 5.

Table 5*: Autocorrelation test*

lag	χ^2	df	Prob > χ^2
1	10.02	9	0.34
2	10.95	9	0.27
3	14.81	9	0.10
4	13.04	9	0.16
5	7.74	9	0.56

The estimates of the VECM provide further useful information on the long-run relationships among the three variables, and are shown in Table 6. Because the VAR has one lag order, the VECM includes the Error Correction Term (ECT) one year lagged, but does not include the short-run dynamics. The adjustment coefficient of the equation for *Δln(y)* is negative and statistically significant with absolute value lower than 1. The same coefficients in the other two equations are not statistically significant. These results have useful implications for the interpretation of the estimated cointegrating equation in terms of causal effects. Indeed, statistical inference suggests the ECT enters significantly the equation of output per unit of labour, but does not contribute to the explanation of the two investment variables. Hence, both variables can be considered weakly exogenous for the long-run cointegrating equation.

Table 6. Adjustment coefficients in VECM estimates

	Coefficient	t-Statistic	P-value
Equation: *Δln(y)*			
ECT_{t-1}	-0.25	-2.84	0.00
Equation: *Δln(pub_inv)*			
ECT_{t-1}	0.54	1.21	0.22
Equation: *Δln(priv_inv)*			
ECT_{t-1}	0.51	1.38	0.17

The application of the Johansen (1995) framework to cointegration analysis suggests the existence of an equilibrium relationship where both public and business investment Granger cause in the long run the GDP per worker of southern Italy in the period after World War II. Both effects are remarkable, but that of private sector investments is twice that of government investment.

Since the same analysis supports the hypothesis of a single cointegrating equation, in the following we check the robustness of our results by estimating the equilibrium equation (3) using two alternative methods: Fully Modified OLS of Philips and Hansen (1990), and Dynamic OLS proposed by Saikkonen (1992) and Stock and Watson (1993). The FMOLS estimator corrects the single-equation estimates for simultaneity bias and residual autocorrelation that affect OLS in small samples. The same correction is obtained by the DOLS estimator by adding the leads and lags of the first difference of the regressors in the cointegrating equation. Table 7 presents the results of the estimation of equation (3) with both methods.[9] Overall, the estimates confirm the results we obtained by applying Johansen's framework. In this single-equation approach the hypothesis of cointegration can be tested by performing a test of stationarity of the error correction term derived from FMOLS and DOLS estimates. Table 7 presents the KPSS (Kwiatkowski et al., 1992) test statistic that shows the null hypothesis of stationary residuals cannot be rejected.

The results of the cointegration analysis of model (3) highlight the fundamental role that both public and business capital accumulation played in the development process of southern Italy in the period 1951-1995. The private sector seems to lead economic growth with the important contribution of state investments in infrastructures. The statistically significant parameter of a linear trend suggests the Mezzogiorno economy grew following a virtuous circle involving physical capital accumulation and technical progress. This picture is consistent with that offered by the literature on the economic history of Italy where, however, great emphasis is laid on the two main phases of the development process in the post-war era, as already argued above in this paper. One of the main hypotheses advanced in the literature ascribes the transition from the "golden age" to the recent low growth period to the lower effectiveness of government structural policies starting with the "oil crisis". In the following, we investigate structural change in the Mezzogiorno economy with the instruments offered by dynamic econometric analysis.

[9] We performed FMOLS and DOLS estimates using the STATA unofficial command cointreg by Wang and Wu (2012).

Table 7. Dependent variable: Real GDP per unit of labour. FMOLS and DOLS estimates.

	(1) FMOLS	(2) DOLS
ln(pub_inv)	0.117***	0.167**
	(2.887)	(2.442)
ln(priv_inv)	0.390***	0.352***
	(10.267)	(6.256)
trend	0.021***	0.020***
	(20.321)	(15.269)
Observations	44	42
KPSS on residuals	0.231	0.328
KPSS 5% critical value	0.463	0.463
R^2	0.993	0.996

Note. The lead and lag order in DOLS is 1 *t* statistics in parentheses. The KPSS statistic tests the null hypothesis that the residuals of the regression are stationary; the maximum lag was chosen by the Schwert criterion; the long-run variance of the time series was calculated using the Quadratic Spectral kernel. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

3.2 Structural change in the post-war process of development of southern Italy

There is an overwhelming consensus in the literature that the characteristics of economic growth differed before and after 1973, for Italy and the entire Western world: the first oil shock and the abandonment of Bretton Woods heralded a different macroeconomic setting – with lower growth rates amongst other things – and also brought about a different technological regime, so-called post-Fordism (for Italy and for some comparisons, see Battilossi, Foreman-Peck and Kling, 2010; Crafts and Toniolo, 2010; Boltho, 2013; Toniolo, 2013; Felice, 2015). This was also observed in the economic growth of Italy and, above all, of its Mezzogiorno, whose convergence came to a halt in that very decade. In fact, the 1970 crisis and the decline of Fordism affected more severely the industrial plants in the South, more specialized towards heavy sectors (with a high capital/labour ratio) than in the Centre-North (Felice, 2010b, 2011), those very plants that had been financed in the previous years by the *Cassa per il Mezzogiorno*. This led to the crisis of the top-down development model thought for the South. At the same time the characteristics of public investments in southern Italy changed, with increasing misallocation and unproductive expenditures, due to political pressures (Del Monte and Papagni, 2007) following changes in the institutional framework of Italy (as the creation of the regions in 1970) and in the governance of the *Cassa* (as the inclusion of regional representatives in its governing council by the mid1970s) (Felice, 2007).

The bar chart of the time series of the growth rate of real GDP per worker in southern Italy (Figure 2) shows clear evidence of a break in the early 1970s. Indeed, the average growth performance seems to decrease after the first three decades following the end of World War II. This has been widely reported by those concerned with the effects of government policy on development in the Mezzogiorno. A widely accepted explanation relates it to a less effective (and progressively lower) State involvement in public capital formation and in providing incentives for industrialisation (Lepore, 2013; Felice and Lepore, 2017). Given the relevance of this issue to the debate and the aim of this paper, we search for statistical evidence that would corroborate the hypothesis that economic growth in the Mezzogiorno after World War II has been characterized by two regimes. Our strategy first searches for the presence and number of breaks in the time series of southern Italy's growth rate and then concentrates on structural change in the model of economic growth, focusing on the role of capital (public and private) accumulation.

3.2.1 Breaks in the time series of the growth rate of per worker GDP

In this section, we search for breaks in the growth rate of GDP per unit of labour in the period 1951-1995. We apply the methodology proposed by Bai and Perron (1998; 2003a)[10] that allows a general modelling framework to determine multiple breakpoints in Δy_t. Accordingly, we assume the variable Δy_t follows the model:

$$\Delta y_t = \mu + u_t \,, \qquad t = 1, \dots \dots . T, \tag{4}$$

where t is a time index and u_t is the random disturbance that can be autocorrelated and heteroscedastic. Structural change in model (4) means the parameter μ changes because of m breaks:

$$\Delta y_t = \mu_j + u_t \,, \qquad t = T_{j-1} + 1, \dots \dots . T_j, \qquad j = 1, \dots, m+1 \tag{5}$$

where j denotes the regime, and the convention that $T_0 = 0$ and $T_{m+1} = T$ is used. According to model (5), the time series of value added per worker can be subject to m changes of the drift parameter μ. This econometric model presents two fundamental questions. The first is the determination of m. The second is the estimation of the parameter μ_j in each regime, and the estimation of the unknown break points T_j.

Bai and Perron (1998) propose three tests of structural change. The first, $supF_T(k)$, tests the null of no structural break versus the alternative of $m=k$ breaks. The second, called Double Maximum Test, refers to the same null hypothesis against the alternative of an unknown number of breaks given an upper bound M. Two versions of the test statistic are proposed: *UDmax* and *WDmax*. The

[10] The same method has been used by Jones and Olken (2008).

third, $supF_T(l+1|l)$, can be applied to a sequence of tests for *l* versus *l+1* breaks. All these tests allow for serially correlated errors and different distributions for the time series and the errors across regimes. Since these tests do not have a standard distribution, Bai and Perron (1998; 2003b) provide simulated critical values. The whole framework is based on the objective of minimising the sum of squared residuals of the model (5). This optimisation problem is constrained by the restriction that the segments between two break points define regimes with a minimum length, *h*. This constraint has a technical justification (see Bai and Perron, 1998; 2003a) but is also consistent with intuition and econometric practice.[11]

Table 8 presents the results of the application of this procedure to the time series of the rate of growth of productivity in southern Italy. We allow up to three breaks and assume a trimming percentage of 20%, which implies regimes with a minimum length of nine years. Equation (5) is estimated under the assumption of heteroscedasticity and serial correlation of the error in each regime.[12] The three tests suggest the rejection of the null of no structural change in favour of the alternative of one break, at a 1% significance level. The procedure also provides the estimate of the year in which structural change occurs: 1974. The estimated parameters of equation (5) are: $\mu = 0.053$ $(t = 12.37)$ for the years 1952-1973; $\mu = 0.016$ $(t = 3.90)$ for the years 1974-1995.

Table 8. *Bai-Perron tests of structural change*

Test	Statistic	Critical value
$supF_T(1)$	46.31***	11.94
$supF_T(2)$	24.60***	8.77
$supF_T(3)$	13.11***	6.58
UDmax	46.31***	12.02
WDmax	46.31***	13.16
$supF_T(1\|0)$	46.31***	11.94
$supF_T(2\|1)$	3.91	13.61

Note: Critical values from Bai and Perron, 2003b. *** Significance at the 1% level.

3.2.2 Structural change in the model of economic growth

In this section, we investigate structural change in the long-run relationship between public and private investment and output per worker, taking into account the results of the Bai-Perron tests. We follow the approach proposed by Hansen (1992) to test the stability of cointegrated regression

[11] The optimisation problem described above implies complex computations that Bai and Perron simplify by proposing a sequential algorithm based on dynamic programming. We performed all computations using Eviews 8.1.

[12] Andrews's framework (Andrews, 1991) is followed to construct a covariance matrix consistent with heteroscedasticity and autocorrelation using a quadratic spectral kernel and the "pre-whitening" of the residuals with a VAR(1) model.

models. As in Hansen (1992), the estimation method is the fully modified OLS. When the break date is known, the *F* statistic of Hansen (1992) – which corresponds to the classical Chow test - can be used to test the null hypothesis that the parameters of the regression equation do not change. If the timing of the break is unknown, the *SupF* test statistic can be used to test the same null hypothesis. In this case, the sequence of the *F* statistic is calculated for every break year in a subsample derived after the trimming of a share of the first and last observations. In both cases, if the test rejects the null, the alternative is a break in the parameters. The other two statistics proposed by Hansen – *MeanF* and L_c – test the same null hypothesis, but under the alternative hypothesis both assume the parameters can be modelled as a martingale process.

Table 9. Tests for parameter stability

Test	Statistic	P-value	Critical value at 5%
SupF	34.548	0.01	17.3
MeanF	19.596	0.01	7.69
L_c	1.995	0.01	0.778

Note. P-values and asymptotic critical values from Hansen (1992).

The results of the application of Hansen's (1992)[13] testing procedure to the cointegrating equation that we estimated in the previous section are shown in Table 9. The three statistics assume much higher values than the 5% critical values. Figure 4 displays the line of the sequence of *F* statistics that lies above the 5% *SupF* critical value for a large part of the period, and presents its largest value in 1974. Hence, this testing methods for integrated I(1) time series are consistent with those of Bai and Perron (1998) because both suggest that a structural break in the process of economic growth of southern Italy occurred in 1974.

We investigate the transition from the "golden age" to the growth slowdown with the estimation of two distinct models on data of the first regime, 1951-1973, and the second, 1974-1995. The application of FMOLS to the time series of the two periods provides two really different equations displayed in Table 10. In both regressions, the *KPSS* test suggests the level stationarity of the error-correction term in the VECM of the three variables, which means they are cointegrated.

[13] All calculations were performed using the R programs of Bruce Hansen, available at his homepage: http://www.ssc.wisc.edu/~bhansen/progs/jbes_92.html. The trimming region of the time series is [0.2, 0.8].

Table 10. Dependent variable: Real GDP per unit of labour. FMOLS estimates.

	(1)	(2)
	1951-1973	1974-1995
ln(pub_inv)	0.197***	0.011
	(5.510)	(0.348)
ln(priv_inv)	0.152***	0.082*
	(2.821)	(1.752)
trend	0.033***	0.016***
	(5.977)	(18.135)
Observations	22	21
KPSS on residuals	0.132	0.104
KPSS 5% critical value	0.463	0.463
R^2	0.993	0.958

Note. t statistics in parentheses. The KPSS statistic tests the null hypothesis that the residuals of the regression are stationary; the maximum lag was chosen by the Schwert criterion; the long-run variance of the time series was calculated using the quadratic spectral kernel. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In the first equation, the estimates of the parameters of public and private investment are positive and strongly statistically significant. State intervention on infrastructures seems to lead the growth process in the first two decades after World War II: the long-run elasticity of output to public investment is close to 20%, although the private sector shows a comparable contribution to growth. The picture changes dramatically under the second regime, 1974-1995. Indeed, estimates highlight the fact that in the period public capital accumulation strongly loses effectiveness – the parameter is not statistically significant – while productivity increases because of private investment, whose parameter is significant but half of that of post-war years. The estimates of the trend parameter seem consistent with the general impression given by the two equations. Indeed, they are both significant and positive with a value in the first equation twice that in the second. The overall picture that emerges from cointegration analysis tells of a period of sustained growth in southern Italy in the first two post-war decades that is driven by all the main components of long-term growth: public infrastructure, business investment, and technical progress. In the early 1970s, the economic crisis hits Italy as in most of the world. Our regression analysis suggests that in southern Italy the crisis means major inefficiency of State intervention and serious difficulties in the business sector.

4. Concluding remarks

To our knowledge, this paper is the first to estimate the contribution of public and private investment to the economic growth of southern Italy in the second half of the twentieth century (1951-1995). The 45 years under scrutiny can be divided into two different periods: in the first (1951-1973) the growth of per capita GDP in southern Italy was considerably higher, to the extent that those decades were also the only ones, in the entire history of post-unification Italy, when southern Italy managed to converge to the Italian average (Felice and Vecchi, 2015b); in the years 1974-1995, conversely, the growth rate of per capita GDP was lower, and the convergence of southern Italy even came to a halt (although Italy as a whole was also growing at a much slower pace than before) (Toniolo, 2013).

Our results confirm, for the first time on quantitative grounds, the important role played by public investment in the economic growth of southern Italy, and are in line with hypotheses put forward by previous historical and qualitative studies (Del Monte and Giannola, 1978; Felice and Lepore, 2017). Our econometric analysis of structural change in the economic performance of the Mezzogiorno produced estimates of two distinct models of growth before and after the year 1974. In the first period, all the main determinants of economic growth seem to drive southern Italy out of underdevelopment. In this process, state intervention on infrastructures is the leading factor. The same estimates show the dramatic change in the growth process which started with the oil crisis, and the negligible effect of structural public policy on the economic performance of the Mezzogiorno after 1973. This is an important finding, confirming on aggregate and econometric terms what a vast literature, based on case studies or on qualitative grounds, also maintained: that public intervention was effective only during the "golden age", while from the 1970s onward it lost its effectiveness due to misallocations and unproductive uses (Del Monte and Papagni, 2001). This conclusion was drawn with particular reference to the *Cassa per il Mezzogiorno*, which among other things played a significant role in public investments especially in the first period (Felice and Lepore, 2017). It is now confirmed also for public intervention as a whole.

The main conclusion to be drawn from our paper is that public investments can either be positive, ineffectual or even negative for economic growth, crucially depending on the way they are made and the institutional setting they operate in. More specifically for Italy, the literature on public intervention and the economic history of the Mezzogiorno in the second half of the twentieth century (e.g. Trigilia, 1992; Felice and Lepore, 2017) provide useful insights not only into the preconditions for success during the economic miracle – impermeability to clientelistic pressures, separation from and complementariness to ordinary administration, consistency with an encompassing development strategy based on infrastructures and industry – but also into the reasons behind the subsequent ineffectiveness or even counter-productiveness.

It goes without saying that further research would be invaluable in order to corroborate or qualify our findings. At a higher territorial breakdown, it would be possible to replicate the econometric analyses for each region in southern Italy, following recent studies which have pointed out significant differences in the quality and strategies of public intervention in the second half of the twentieth century as well as in the patterns of economic growth among the southern regions.

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Appendix

Table A.1. *Description and sources of the variables*

y	Per unit of labour GDP (at constant prices in Italian lire 1970) in the Italian Mezzogiorno, 1951-1995.. Sources: SVIMEZ, *Extracted 26 New Series Volume XXXVIII-1*, 1985; CRENoS (Centre for North South Economic Research), *University of Cagliari, Regio-It 1960-96. Data-base on Italian regions*, version: March 2000.
pub_inv	Per unit of labour public investments in the Italian Mezzogiorno, 1951-1995 (at constant prices in Italian lire 1970). Sources: SVIMEZ; CRENoS.
pri_inv	Per unit of labour private investments in the Italian Mezzogiorno, 1951-1995 (at constant prices in Italian lire 1970). Sources: SVIMEZ; CRENoS.

Table A.2. *Descriptive statistics of the variables*

Variable	No. obs.	Mean	SD	Min	Max
ln(y)	45	0.84	0.47	-0.11	1.42
ln(pub_inv)	45	-2.71	0.37	-3.49	-2.26
ln(pri_inv)	45	-0.83	0.49	-2.27	-0.10

Figure 1. *GDP of the Italian Mezzogiorno* per *unit of labour, 1951-1995*

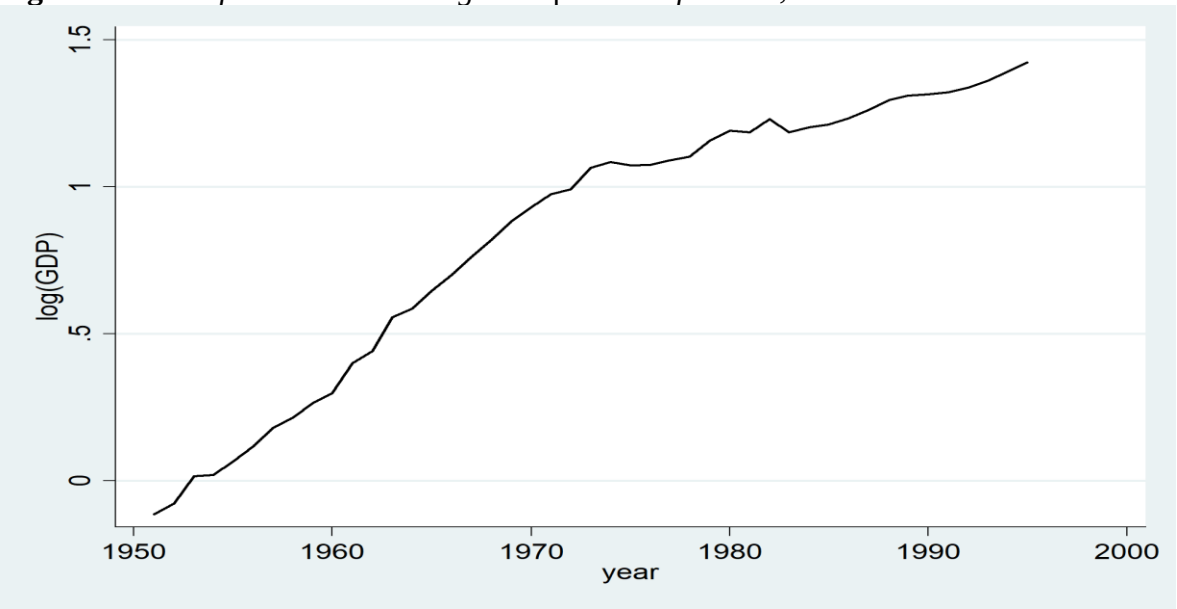
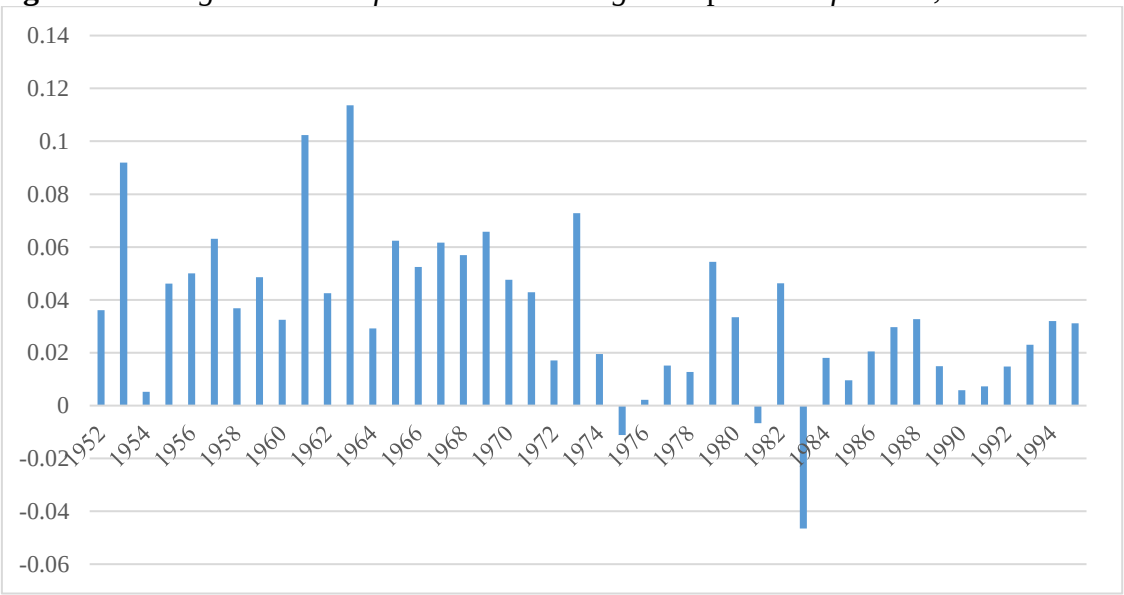


Figure 2. *GDP growth rate of the Italian Mezzogiorno* per *unit of labour, 1952-1995*



Sources and notes: see text and Table A.1.

Figure 3. *Private investment per unit of labour and public investment per unit of labour in the Italian Mezzogiorno, 1951-1995*

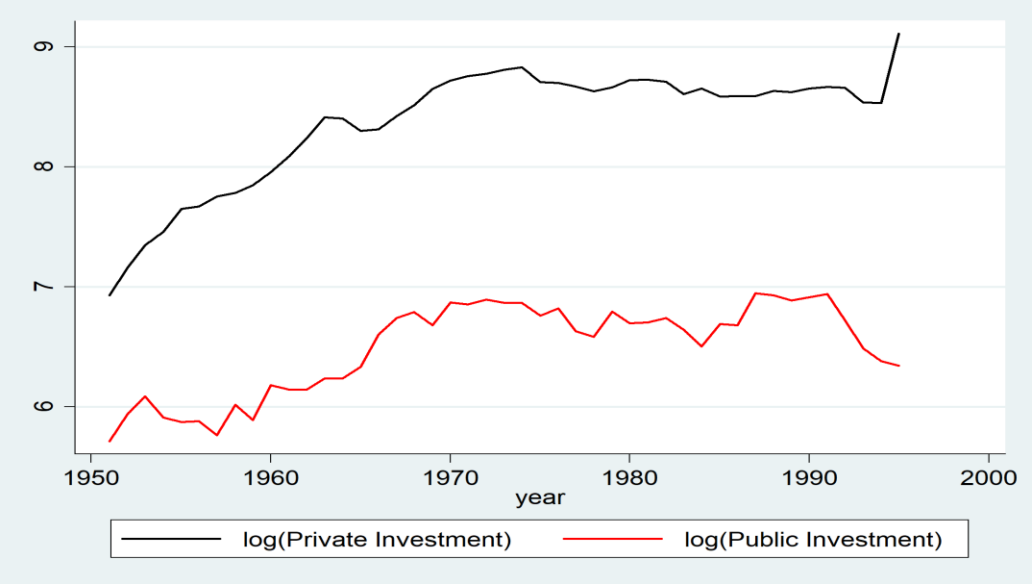


Figure 4. Hansen tests of structural change in the cointegration equation of GDP per worker