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JEL Codes: E20, E22

Keywords: Investment, Capacity Utilization

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The impact of excess capacity over the investment falloff

Exploring the effects based on industry level data

Rodrigo Pérez Artica[1]

ABSTRACT

A widespread decline in the rate of capacity utilization in the US manufacturing industry during the last decades is documented, which parallels a worsening trend of gross capital formation. Several exploratory exercises are conducted to investigate whether utilization rates were actually related to the investment performance during 1952-2014. Vector auto-regressive estimates imply a non-trivial quantitative relationship between utilization rates and investment, which accounts for a decline equivalent to more than 30% of average investment decline over the whole period considered. Finally, firm-level data is used to control for other investment determinants. The relationship remains statistically and economically relevant. In addition, a relationship between past accumulated utilization variation and current investment is found, suggesting that excess capacity might be a relevant force behind current investment weakness.

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I. Introduction

Almost ten years after the financial collapse of 2007-2008, developed economies remain stuck in a prolonged economic stagnation. According to Eggertsson, Mehrotra & Summers (2016), sluggish output growth and below target inflation characterize the current economic situation. While main macroeconomic aggregates, such as GDP and aggregate demand, in most economies exceeded pre-crisis levels, virtually all advanced economies remain well below pre-crisis trends. Moreover, for those Euro area countries most severely affected by the crisis, current levels also remain behind pre-crisis records (International Monetary Fund, 2016).

While economic slack has declined, this obeyed largely to downward revisions in potential output rather than to strengthening aggregate demand. In this framework, investment demand posted the poorest performance among other demand components. Surely, residential investment fell sharply, however business fixed capital formation accounted for the bulk of the decline. The International Monetary Fund (2015) and Organization for Economic Cooperation and Development (2015a) point to slow output growth as the main driver behind the investment falloff, together with financial frictions and policy uncertainty.

Recent studies depict a worsening of business investment performance in a long-term perspective. Pérez Artica, Brufman, & Martinez (2017) show that this has been a pervasive trend for non-financial firms from several developed economies. The literature finds that this prolonged decline obeyed to a variety of reasons such as more stringent financial constraints faced by particular segments of firms, increasing product market and operating volatility, and a declining business dynamism as accounted by a lower entrepreneurship and share of high-growth young firms (Decker, Haltiwanger, Jarmin, & Miranda, 2014). Additional evidence shows that growing industrial concentration and its consequential effect over the degree of product market competition is also contributing to reduce capital expenditures (Philippon & Gutiérrez, 2016).

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Along with this decline in business investment, a number of industries such as automobile, steel and shipbuilding show eloquent signs of excess capacity and have recently prompted official concerns and interventions aimed at carving it (Organization for Economic Cooperation and Development, 2014).

The detrimental effect of excess capacity over capital formation is established at a theoretical level by several strands of the macroeconomics literature. Additionally, a number of empirical studies have addressed the issue of capacity utilization and its relation to business cycles, inflation, and other relevant macroeconomic variables. However, as far as we are concerned, rather few studies intend to portray a broader depiction of the long-term evolution of capacity utilization and its relation with business investment at the industry-level.

In the face of the current private investment inaction, the relation between capacity utilization and investment seems to be a rather crucial issue. Moreover, it can be of interest to answer whether, by historical standards, the current low-investment trap taking place within a background of relatively high or small levels of capacity utilization. Or else to know how utilization has been related to investment in the past across different industries.

This study intends to fill that gap by using industry-level data available for the US manufacturing sector. First, we are interested in assessing the longer-term evolution of capacity utilization, as measured by the Federal Reserve. A negative trend is documented for the whole sample of industries over the entire sample period, 1952-2014. We confirm that this is a robust and widespread result within different sub-samples and sub-periods. Second, we ask whether capacity utilization has had relationship with industry investment. Several time-series methods are employed in order to explore if there is a relationship and to obtain a first hint as to the quantitative relevance of such a relationship. Finally, we aim to capture a more precise measure of the effect of excess capacity over investment by considering a firm-level model, which allows controlling for other theoretically relevant determinants of investment.

Our evidence points to a Granger-causality effect with the positive, theoretically expected sign for a substantial proportion of the manufacturing industries. This implies that the decline in capacity utilization might have had a deterring effect over investment within the sector. Such a result is robust to different specifications and samples considered. Furthermore, our Vector Autoregressive estimates imply a non-trivial quantitative impact of utilization rates over investment, which explains a decline ranging between 28 and 36% of the average investment decline. When using firm-level data and controlling for other determinants, the previous results are confirmed and, in addition, it is shown that capacity utilization variation accumulated in the past is related to current firm-level investment, suggesting that excess capacity may be a significant force behind current investment weakness.

The structure of the article is as follows. In the next section, both facts motivating this study are presented: the secular decay of business investment and capacity utilization. While the literature has extensively documented the former, the latter has been barely addressed. Section III provides a brief review of the theoretical studies dealing with the causal relation between utilization and investment spending. Our empirical exercises regarding the relation between both variables are discussed in Section IV. The firm-level analysis is presented in Section V. Finally, Section VI concludes.

II. Facts: the long term decline of investment and capacity utilization

As mentioned above, this section presents the two main facts motivating our study. Namely, the secular decline in the investment and capacity utilization rates in US manufacturing industries. We use capital formation and utilization rates data at the industry-level from the Annual Investment and Capital Stocks statistics, and Z17 Table, respectively. Both sources are released by the US Federal Reserve. Additionally, the evidence is discussed in the light of other studies and related findings.

a. Declining investment rate

Fixed capital investment in the US private sector has experienced a declining trend over the last decades. Panel A of Table 1 displays the results of regressing the ratio of fixed capital formation to the stock of net fixed capital (including structures and equipment) on time for the whole sample of

85 industries over the period 1952-2014. In addition, the sample is split in deciles of investment rate and the trend coefficients are evaluated within each group.

The results show negative and statistically significant trends for the whole sample of industries and almost every investment decile. Column 1 shows that, for the whole sample, investment rate decreased at an average yearly rate of 0.02 pp, which is equivalent to a decline of 1.2 pp over the whole sample period. Considering that the average investment rate before 1960 amounted to 5.5%, this average trend coefficient represents a contraction of one fifth of total investment rate.

When considering trend coefficients within different investment deciles, groups with considerably higher rates of contraction are identified. For instance, for the tenth decile, investment fell at pace more than twice as fast. However, there is no clear correlation between average investment rates and average investment contraction over the whole period.

[Table 1]

As already stated in the Introduction, the collapse of capital formation is documented at length in the period following the financial breakdown of 2007-8. In fact, most studies tend to focus in the investment weakness occurring in the aftermath of the crisis. Private investment collapsed during the financial disruption and, though housing investment fell particularly abruptly, business capital formation accounted for the bulk of the decline, recovering only partially since then. The fragile corporate investment resumption after the crisis contrasts with increasing profits in most advanced economies, and buoyant equity markets in a number of them. Some observers label this seemingly paradoxical fact as an "investment puzzle" (Furman, 2015).

According to the International Monetary Fund (2015), the accelerator effect plays a prominent role when accounting for the private investment weakness after the crisis. Indeed, given the observed contraction of aggregate output and the historical relation of this variable to capital expenditures, the observed contraction of private investment in the countries analyzed in that study follows the predicted pattern. Similar conclusions regarding the prevalence of the accelerator effect for the post-2008 period are drawn by other studies such as Organization for Economic Cooperation and Development (2015b) and Furman (2015). In addition, a rather small share of the investment failure is also attributed to financial frictions and policy uncertainty.

However, Panel B of Table 1 shows that the investment contraction was in place well before the financial collapse of 2007-8. This is true for the whole sample regression as well as for every investment decile.

Recent studies give a closer look at this long-term nature of the investment decline. Pérez Artica, Martinez & Brufman (2017) provide firm-level evidence that shows a protracted, widespread decline of capital formation across firms from different countries, industries and firm size segments in developed economies. Besides, this contraction seems to have responded to tighter financial constraints, a growing volatility of the operational environment, and the weakening of product markets dynamism. Moreover, partly as a consequence, the corporate net lending position improved consistently during the last two and a half decades. In that sense, Chen, Karabarbounis, & Neiman (2017) show that the rise of corporate savings since the 1980s was mainly due to higher operating profits caused in turn by a declining labor share.

Further research suggests that an increase in industrial concentration and the consequential easing of market competition pressures were also responsible for the investment falloff in the US corporate sector. Moreover, not only does this effect operate through concentration at the product market level, but also through common ownership of firms that would otherwise be natural competitors. Gutiérrez & Philippon (2017), Azar, Raina, & Schmalz (2016), Azar, Schmalz, & Tecu (2017) provide evidence for the US economy as a whole and the banking and airline industries, respectively.

One source of concern that this literature has dealt with is the rise of intangible investment. The measurement problems involved with intangibles may render the overall investment decline misleading, because of the under-estimation of intangible investment.

Nevertheless, Gutiérrez & Philippon, (2017) conclude that properly accounting for intangible investment does not rule out the overall investment contraction. On the contrary, intangible investment exhibits a rather similar weakness as tangible capital expenditures.

At least for the US, this contraction of investment took place in an increasingly worsening business environment. The rate of business startup and the weight of young and dynamic firms have been in decline since the 1960s according to Decker et al. (2014), which points to a prolonged deterioration of business dynamism and entrepreneurship. Furthermore, the decline of high-growth young firms after the year 2000 has coincided with the lower young firm activity in key innovative sectors like the IT industries, and has reduced the pace of employment and productivity growth (Decker, et al 2016).

The increasing survival of old, non-viable firms that experience persistent problems meeting their interest payments may turn to be one of the major causes for this declining dynamism. In ideal competitive conditions, these firms would usually exit the market. However, an incipient literature shows its prevalence, and resources sunk on these "zombie" firms have been growing since the mid-2000s (Plantin & Acharya, 2016). According to McGowan, Andrews, & Millot (2017), this growing market congestion created by "zombie" firms blocks the way in to new and more dynamic entrants, and prevents the expansion of healthier and more productive incumbents. These facts may provide a valuable depiction of the context within which capacity utilization and investment interacted in recent years, since market congestion influence may boost the deterring effects of growing excess capacity over private capital expenditures.

b. Declining rate of capacity utilization

In this section the evolution of the capacity utilization rate on an industry-level basis is discussed. For this purpose, annual capacity utilization rates from the Federal Reserve's Table Z17 are used, which provides estimates at the industry level for 67 industries. The main source of the FRB data is the Survey of Plant Capacity, conducted by the Bureau of Census.

A number of methodological issues have to be addressed on the first place. To begin with, capacity measures intend to quantify sustainable practical capacity, defined as the greatest output a plant can maintain within the framework of a realistic work schedule. Based on the Survey's questionnaires, Nikiforos (2016) argues that the rate of utilization is stationary by construction. Correspondingly, several studies find a stationary level of non-accelerating inflation capacity utilization rate of 82% (Franz & Gordon, 1993; Garner, 1994).

Similarly, according to Morin & Stevens (2004), the scope of the survey evolved over the years, with a significant change occurring in 1982, when respondents began to be asked to complete the forms even when the plant had remained idle. This means that, due to the fact that before 1982 idle plants were undercounted, the series are not straightforwardly comparable before and after that year. Moreover, in part because of these shortcomings, a number of previous studies have resorted to alternative measures of capital utilization (Beaulieu & Mattey, 1998).

Nevertheless, FRB data on capacity utilization have been widely used to study a variety of topics such as inflation, growth dynamics and policy assessment (Franz & Gordon, 1993; Murphy, 2017). Additionally, notwithstanding those caveats, as shown below, our results seem robust enough to believe they reflect a real economic matter. Moreover, these results are particularly pronounced for the period beginning in 1990, thereby avoiding comparability problems between the periods before and after 1982.

[Table 2]

Column 1 of Table 2 shows the results of regressing the rate of capacity utilization on time for the whole sample of industries, which display a negative and statistically significant trend. This is also an economically significant result, with an annual reduction of 0.171 percentage points (pp) and an overall decline of 10.6 pp all through the sample period.

In addition, in order to explore whether this negative evolution is widespread enough or instead is confined to a small number of industries, the evolution of capacity utilization is explored within each group of "normal" capacity utilization rate. That is, we acknowledge that each industry may have a different normal or desired rate of capacity utilization, and thus consider if different groups of normal utilization went through a similar decrease. The normal capacity utilization is estimated by calculating the average rate of capacity utilization for each industry over the whole sample period, and then split the sample in deciles of normal rate of utilization. The results confirm that the decline disseminated across all groups, and show deciles within which the average capacity utilization reduction was even more pronounced, shrinking by more than 16 pp over the whole period (deciles 1 and 2, for instance).

Panels B and C of Table 2 evaluate these trends for two different, shorter periods: one beginning in 1982 because of the methodological break taking place in that year (Panel B of Table 2), and the other beginning in 1991 (Panel C of Table 2). We find that these trends accelerated gradually and were considerably stronger during the last 25 years, with the average industry experiencing a total decline of 11 pp (0.46 pp a year). This implies that most of the decline documented in Panel A for the whole period, concentrated in the last 25 years.

These findings are even more puzzling in the face of the evidence previously discussed, showing a decline of investment rate across all industries. Indeed, lower investment should lead to a decelerating capacity growth, thus pushing utilization rates upwards.

On the other hand, however, these results are consistent with existing evidence of growing excess capacity in specific industries. According to our data, industries which experienced the highest drop in utilization were chemicals (NAICS 3251), primary metal including iron, steel and aluminum manufacturing (NAICS 331), automobile manufacturing (NAICS 3361), among others.

Several other studies spot these industries as undergoing excess capacity, particularly in the aftermath of the global financial turmoil in 2008. In addition to a great deal of press articles dealing with it, Humphrey & Memedovic (2003) and Klein & Koske (2013) discuss several causes leading the automotive industry to overinvestment and excess capacity, particularly in developed economies. In the US, 16 assembly plants closed as a result of the significant decrease of automobile sales during the financial crisis. In addition, the bankruptcy proceedings agreed upon with the government contributed to this result. Consequently, the three main US assemblers reduced their capacity by almost 2.6 million units. Still, the utilization rate remained at 70%, 20 pp below the pre-crisis peak (Klier & Rubenstein, 2013).

In 2014, the OECD Ministerial Council Meeting expressed the need to address excess capacity in industries such as steel and ship-building, which have been on the rise since the financial crisis (Organization for Economic Cooperation and Development, 2014). According to the Organization for Economic Cooperation and Development (2015b), demand in the global steel market recovered after the slump experienced in 2008-9, but this recovery was uneven and did not keep pace with the growth in supply, leading to one of the highest levels of excess capacity in that industry's history.

Critical excess capacity was also built in the shipbuilding industry. Over the five years running up to the financial crisis, however, offshore vessels production had soared in the midst of the oil-price booming years. Despite this, offshore vessels demand collapse as a consequence of falling oil prices particularly in 2014. As a result, utilization rates in the OECD shipbuilding industry scaled back to levels previous to the offshore boom, hovering around a utilization rate of 60%[2].

These studies address several causes for the structural increase in the excess capacity, but government actions hindering adjustments that would theoretically occur in competitive markets are signaled as the main culprit (Organization for Economic Cooperation and Development, 2015b). While interested in alleviating unemployment problems or reducing their dependency on imports, government policies imply subsidies for the creation of new capacity or the maintenance of inefficient capacities. In this way, policies end up contributing to global excess capacity and prevent "optimal" exit of the least productive plants.

[2] In addition, a number of risks were put together as a consequence of reorienting shipyards towards the offshore sector, such as high costs of technological adjustments and research, hard employee training, stringent regulations, etc. (Organization for Economic Cooperation and Development, 2015c).

Furthermore, industry specific studies may provide valuable insights as to the inner mechanisms governing the long-term decrease in utilization rates. In effect, according to the Organization for Economic Cooperation and Development (2015b), adjustment processes can take longer than expected, with regions experiencing extended periods of excess capacity. In turn, this may obey to high exit barriers, such as costs of closure that discourage prompt adjustments.

For instance, capacity closures entail high costs of dismantling structures, and equipment, environmental and labor related costs. Growing market and operational uncertainty at the firm level may push firms to delay exit rather than incur such exit costs.

III. Theoretical approaches to the relation between capacity utilization and investment

A broad theoretical literature deals with this relation. On the one hand, a number of classical studies within heterodox economic traditions address the short-term relationship between capacity utilization and aggregate investment. For the Structuralist, Post-Keynesian models, the investment rate is positively affected by the difference between actual and desired (cost-minimizing) rates of capacity utilization, so that whenever actual utilization exceeds its desired level, firms will be encouraged to invest and build up new capacity. This theoretical rationale is found in Kalecki (1971) and Steindl (1952), and is further formalized by an extensive, more recent literature (Taylor, 2004, Nikiforos, 2016).

Most importantly, the utilization rate plays a central role in these macroeconomic models, since an equilibrium utilization rate can be derived where savings equal investment. A controversy arises from this equilibrium utilization rate and the possibility for it to differ from the desired level (Dumenil & Levy, 1997; Lavoie, Rodríguez, & Seccareccia, 2004; Shaikh, 2009).

On the other hand, in the Neoclassical specification for the investment spending analysis, the accelerator effect referred to above is identified with growing sales or output, rather than to explicit higher utilization rates. Certainly, this mechanism operates by increasing utilization rates, and thus firms' consequential desire to raise its production capacity.

Jorgenson (1971) pioneered this approach, depicting a firm that maximizes its discounted flow of profits over an infinite horizon, while subsequent formulations added to this specification delivery lags, adjustment costs and vintage effects (for a review of this literature see Chirinko, 1993). In this framework, a positive relation arises between the desired stock of capital and the level of output.

The effect of capital overhang over investment spending was inspected more closely in the early 2000s. The investment boom of the 1990s was suspected to have produced a capital overhang, which in turn may have caused the investment weakness observed at the beginning of the cyclical upswing.

Desai & Goolsbee (2004), for instance, evaluate whether a capital overhang caused the low level of investment in the early 2000s. They tackle this question by testing whether those industries facing the largest increases in investment rates during the 1990s boom were in turn those experiencing the weakest investment performance during 2000-2002. Although they do not find strong evidence supporting this relation for the whole economy, a significant negative correlation between the investment rates during the boom and its performance in the 2000-2002 period surfaces for the manufacturing industry.

Mccarthy (2004), in addition, finds that the communication industries had a disproportionate share of total investment in the end of the boom of 2000, reflecting a misperception of future profits within that sector. Moreover, the author identifies that those industries showing the higher investment during the 1990s tended to reduce their investment more sharply during the bust in 2001.

However, as far as we are concerned, none systematic empirical exploration of the long-term dynamic of this relation has been attempted. In the light of the secular trends experienced by both variables, this seems an interesting research objective. In what follows, we address this broad exploratory exercise in several subsequent steps.

IV. An exploratory study of the relation between capacity utilization and business investment

In this section, we present an exploratory study of the long-term effects of the capacity utilization decline over the investment rate at the industry level. We can only attempt to conduct an exploratory enquiry into this long-term relationship given that we draw on industry level data, and cannot control for other theoretically relevant determinants of business investment, such as profitability, financial access, and sales growth, which are not available in our main dataset. In the following section, further firm-level exercises are performed to address this issue more properly.

To begin with, we enquire the extent to which a positive relationship between capacity utilization and investment is found in the sample of manufacturing industries considered. We undertake this through a variety of econometric approaches. Second, we attempt to quantify the magnitude and time persistence of the average effect observed in the data for the whole sample period.

a. Data and methodology

As explained above, annual, industry-level capacity utilization rates from the Federal Reserve's Table Z17 are used, and capital formation data coming from the Annual Investment and Capital Stocks statistics produced by the US Federal Reserve.

Time series properties of the utilization and investment series. We begin by evaluating whether the time series for each industry are stationary or follow a unit-root process instead. First, a number of tests for unit roots or stationarity in panel datasets are used. These are the Levin, Lin, & Chu (2002), Breitung (2000); and Breitung & Das (2005); Harris & Tzavalis (1999); Im, Pesaran, & Shin (2003) and Fisher-type (Choi, 2001) tests, which have as the null hypothesis that all panels contain a unit root. Table 3 summarizes the results of these tests providing the p-values associated to each statistic. All the tests clearly reject the null hypothesis for both variables.

[Table 3]

It is further investigated whether there are specific industries for which a unit-root process cannot be rejected by using the augmented Dickey-Fuller test in three different specifications. First, we test for the presence of a unit-root without trend nor drift terms. Then, we test the stationarity including a deterministic trend. Finally, a drift term is included and also tested. The results are summarized in Table 4. Each column of Table 4 shows the proportion of industries for which the existence of unit root at a 5% confidence level is rejected for each of the specifications. The first line shows the results for the utilization rates, and the second, for the investment rate.

[Table 4]

When including a drift term for each industry, a unit-root process is rejected in all the utilization series, and for all but one industry in the case of the capital formation series. Almost three quarters of the industries are found to be stationary when testing for the presence of unit-root in the specification without trend and drift terms. Overall, considering the test for panel unit-root and the industry-level stationarity with drift, it is fair to consider the variables of interest as stationary and thus a vector auto-regressive analysis is suitable.

Analyzing the utilization-investment through VAR models. In a first step, the relationship between both variables is analyzed by using a reduced form Vector Autoregressive approach. This methodology allows exploring the long-term relation between both variables without imposing an a priori direction of causality, since both variables are considered as jointly endogenous. More concretely, the following model of simultaneous equations for each industry is estimated:

$$gcf_t = c_0 + \sum_{i=1}^{n} \alpha_i \, gcf_{t-i} + \sum_{i=1}^{n} \beta_i \, cap\_util_{t-i} + u_{1t} \qquad \text{[Eq. 2]}$$

$$cap\_util_t = c_1 + \sum_{i=1}^{n} \theta_i \, cap\_util_{t-i} + \sum_{i=1}^{n} \lambda_i \, gcf_{t-i} + u_{2t} \qquad \text{[Eq. 3]}$$

We are particularly interested in the sign and statistical significance of the β_i coefficients, but the evaluation as well of the λ_i significance in order to acknowledge the importance of the reciprocal effect. One VAR model for each industry is computed and the joint statistical significance of the β_is and λ_is, is checked by means of Granger-causality tests. The proportion of industries for which the coefficients β_is and λ_is are statistically significant is identified at different levels of significance.

In order to obtain the optimal lag structure for each industry, the information criterions of Akaike, Hannan-Quinn and Schwarz-Bayesian are used to compare models with up to 5 total lags. The set of optimal lag structures is obtained for every industry according to each of these three criterions. Subsequently, we decide between them by evaluating the residuals' autocorrelation for the VAR models estimated using the set of lag structures suggested by each information criteria.

VAR models are estimated for every industry , using the lag structure suggested by each criteria. Then the autocorrelation of the residuals is tested by using a Lagrange Multiplier test for AR(1) and AR(2). The results are summarized in Table 5., shows the proportion of industries for which residuals autocorrelation is not found at lags 1 and 2. Each column of Table 5 shows this proportion when the VARs are estimated using the optimal lag structure found by each criteria.

[Table 5]

As we see, the proportion of VARs showing residual autocorrelation is minimized when using the lag structure found according to the AIC. Although the VAR models for a small number of industries yield residual autocorrelation, these seem few enough to consider the overall analysis as valid. Consequently, in what follows the estimation results arising from the set of lag structures suggested by the AIC are used.

b. Results

The results shown in Table 6 suggest that the utilization rate has an impact in a fairly large proportion of industries. First, when considering the Granger-causality tests for the whole sample period, the proportion of industries for which a statistically significant effect of capacity utilization on investment rate is detected amounts to 44% at the 5% confidence level, and 56% at the 10% confidence level.

If the sample period is restricted to the years following 1970, a slight increase in the proportions are observed with a 45 and 57% of the industries showing a statistically relevant effect of capacity utilization, at the 5 and 10% confidence level respectively.

On the other hand, the λ_is, the investment rate lags' coefficients in Equation 3 are also jointly statistically significant for 31 and 42% of the industries at the 5 and 10% confidence level, respectively.

[Table 6].

To assess the magnitude of the long-term effect of capacity utilization, the cumulative impulse response function (IRF) is computed for each industry at steps going from 1 to 10. Subsequently, the probability distribution function of these long-term effects is analyzed for different total number of steps. Figure 1 portraits the Kernel probability distributions of the cumulative IRF that emerge for every number of total steps considered, going from 1 to 10.

[Figure 1]

Figure 1 shows that the mean value of the Kernel distribution of the long-term effects is positive for any number of steps. Moreover, most of the probability density function is concentrated at values higher than zero. The number of industries for which the cumulative IRF is higher than zero is no less than 64 (75%) for any number of total steps. For lower number of steps, the mean value of the distribution decreases, but its probability of occurrence is higher. The mean values of the long-term effect seem to be of a substantial order of magnitude, growing as the total number of steps concerned increases, from 0.0006 to 0.0023. Considering the average linear trend decline of 0.6 pp in investment rates since 1970, documented in Section II.b, and the average cumulative IRF for steps 5 and 10, the long-term effect of capacity utilization over industry investment ranged between 28 and 36% of the total decline, which represents between 3.75 and 4.8% of the average investment after the year 2010.

In order to evaluate the distribution of the effect over time, Figure 2 shows the IRF at steps 0 to 10 for industries located at the 25th, 50th and 75th percentiles of the distribution at every step. It is clear that the IRFs converge to zero as the steps increase. Most of the effect takes place within the first two years, and the size of the residual impact decreases in subsequent steps.

[Figure 2]

Summing up thus far, not only a declining trend of capacity utilization is found, but also the theoretically expected relation between utilization and capital formation is detected for a broad proportion of the sample, at least according to these preliminary bivariate exercises. This relation seems economically relevant as well, representing up to 36% of the average decline in investment since 1970. In what follows, we intend to obtain a more accurate measure of this effect during the last decade, first by analyzing the investment performance for industries with different levels of utilization decline. And second, turning to a firm-level analysis so as to add control variables.

V. The impact of excess capacity over investment in the last 15 years

A first intuition of the effect of declining utilization rates over the recent investment falloff emerges when dividing the sample in groups according to their degree of utilization decline. Figure 3 shows the evolution of the median capital formation rate for each quintile of capacity utilization variation between the first half of the 1970s and the first half of the 2000s.

Quintile 1 represents the 20% of the industries for which utilization contracted the most, while Quintile 5 contains the 20% facing the less important decline. The following figure portrays a clear-cut relation: regarding capital formation, industries showing the slightest decline in utilization performed consistently better than the rest, while firms in Quintile 1 posted a consistently poorer investment.

[Figure 3]

Figure 4, on the other hand, focuses in the last 15 years, and is aimed at showing the business cycle dynamics of the relation. Panel A shows the evolution of capital formation for each quintile following the *dot com* financial crisis, with an index equal to 100 in year 2000. Industries in quintile 1 not only showed the worst contraction during the ensuing recession (-45%, compared with -33% for Quintile 5), but also the second weakest recovery during the growth years up to 2007. Moreover, a great deal of the divergence in investment levels between quintiles 1 and 5 over this cycle seems to obey to a weaker increase during the growing face, rather than to a sharper contraction during the recession. In fact, the difference between the indexes of investment for these extreme quintiles climbed to 12% in 2003, but increased further to 17% during the recovery.

[Figure 4]

The recession beginning in 2008 produced a similar result. But this time, the bulk of the difference between both quintiles was generated in the aftermath of the recession, owing to slow recovery of the lowest quintile investment. It can be seen that over the whole 15-year period, the divergence relative to their index levels in 2000 grew up to 25%.

a. A firm level analysis

In this section, we delve further into measuring an effect of utilization rates on capital formation by using firm level data and including control variables. The Compustat North America Fundamentals database is used to obtain accounting data for firms from the United States operating in the 67 three-digit NAICS code industries for which FRB reports capacity utilization rates.

The resulting dataset contains 250000 firm-quarter observations, for 6500 firms from the U.S., and covers the period 1990-2014. In this firm-level context, investment is measured as the ratio of capital expenditures to total assets.

Firm fixed-effects and between panel models are used to identify the effect of utilization rates and utilization variation on investment. A number of variables are included to control for the impact of financial constraints, the accelerator effect, idiosyncratic volatility, and balance-sheet variables such as firm indebtedness and liquid assets holding.

First, firms facing more dynamic demand will experience a higher pressure to increase its capital expenditures. Hence, following the accelerator effect, firms with higher sales growth are expected to invest more.

Second, the finance literature shows that access to external funding fluctuates across firms affecting their investment performance. Firms with more access to external funding will be in a better position to invest; additionally, firms facing financial constraints will show a higher sensibility of investment to internal funding (Fazzari, Hubbard, & Petersen, 1988). It is also a well-established fact that larger firms, with more reputation and pledgeable assets, will be less financially constrained. Consequently, these effects are controlled by adding three variables: the logarithm of firms' total assets, firms' total debt variation and net cash flow at each quarter.

A set of control variables is also included to capture the effects of different firm's financial policies. To begin with, following the financial flexibility literature (Denis, 2011), firms' financial management policy may affect funds available for investing when corporate cash ratios or capital structure differ from the firm's optimal or desired levels, which secure financial flexibility to the firm. A liquidity shortfall or unpredicted cash needs may deviate cash or debt ratios from target levels, leading the firm to pour internal savings toward the accumulation of liquid assets or the reduction in liabilities, thus reducing capital expenditures. In our model, these financial policies are captured by the lagged values of corporate leverage, short-term debt-to-assets ratio, and liquidity holdings to assets. We expect firms with relatively higher leverage and short-term debt to show lower investment, reflecting the need to use internal savings in order to reach lower, targeted levels of debt. Similarly, we expect the cash ratio to have a positive coefficient, reflecting the need for scaling investment down to accumulate more cash when this falls below optimal levels.

Ahn, Denis, & Denis (2006) argue that the level of firms' diversification affects gross capital formation, and therefore ES. Thus, the ratio of non-operating assets is used to total assets and its variation as proxies for the level of diversification to non-core activities.

Finally, a significant number of empirical studies find a negative correlation between firm-level volatility and investment. For instance, higher idiosyncratic return volatility, price volatility and dispersion of subjective probability distribution of the future demand for products are found to have a negative effect over firm investment (Ghosal & Loungani, 2000; Guiso & Parigi, 1999; Leahy & Whited, 1996). As a result, in the exercise below, the effect of idiosyncratic volatility is controlled by adding the coefficient of variation of the return on assets (ROA) ratio. This coefficient of variation is computed for a five-quarter moving window.

Two models are estimated. First, a firm fixed-effects model using data for the whole period 1990-2014. We are interested in capturing the effect of capacity utilization fluctuations over the years; hence our main variable of interest is the annual industry-level utilization rate. Second, a between panel model is computed in order to assess the impact of the previous decline in industry-level capacity utilization over current firm-level investment. We enquire whether firms that had accumulated the greater decline in utilization rates before the beginning of the sample period posted a poorer investment performance afterwards. In this model, our sample period is restricted to the years 2002-2014, and our main variable of interest is the accumulated variation in utilization rate between the first half of the 1970s and the years 1997-1999.

[Table 7]

Column 1 of Table 7 shows the results for the firm fixed-effects model. It shows that the coefficient for utilization rate is, as expected, positive and statistically significant. It also represents an economically relevant impact of utilization rates, for an interquartile change in utilization increases net capital formation by an 18% of the sample median investment.

Column 2 of Table 7, on the other hand, shows the effect of accumulated decline in utilization rates between the early 1970s (a within-industry average for the period 1972-1975) and the early 2000s (2001-2005), over firm investment after that year. Its coefficient is positive and significant, meaning that firms in industries that accumulated a larger increase (decrease) in utilization rates had a higher (lower) investment over the following period. The economic relevance of this coefficient is also clear: with a value of 0.02, it suggests that a firm operating in the percentile 75th of utilization variation between the early 1970s and the early 2000s invested more than a firm operating in the percentile 25th by a magnitude equivalent to 14% of the median investment in the sample.

Moreover, differences in firm investment rates after 2010 continue to have a relation with utilization decline occurred before 2005. This is shown in Column 3 of Table 7, where the same between panel model is run for the period 2010-2014.

A similar result is obtained when the impact of utilization variations between late 1980s (1985-1989) and early 2000s isconsidered, on the one hand, and between late 1990s (1995-1999) and early 2000s. These results are shown in Columns 4 and 5.

To sum up, in this section a strong and economically relevant relationship is found between utilization rates and firm investment, even controlling for other determinants of investment. More specifically, a within-firm relationship is documented indicating that whenever industry-level utilization rates go up, firm investment increases. Importantly, a strong relationship between accumulated decline in utilization rates in the past, and current investment is also found, suggesting that excess capacity may be holding investment back in the last years of our sample.

VI. Summary and Discussion

Sluggish economic growth and below target inflation have stubbornly lingered over advanced economies during the last decade. Indeed, five years after the financial meltdown of 2008/2009, the term `secular stagnation´ became popular to describe a seemingly everlasting weak economy. However, five years afterwards, such a reality has barely changed.

According to a number of studies, aggregate economic weakness obeys mostly to business investment performance. This component of aggregate demand has hardly restored in the aftermath of the crisis, which contrasts with a quick recovery of profits and buoyant financial markets.

In turn, weak aggregate demand-growth arises as the main cause when trying to account for recent developments. However, as soon as the longer-term trend of private capital formation isexamined, it is observed that a persistent worsening has been taking place for several decades now.

Various explanations have been offered in order to rationalize such a long-lasting performance of business investment. The literature points to financial constraints, increasing volatility in the operating environment, declining competition pressures because of higher industrial concentration, and the deterioration of business dynamism, among other reasons. Finally, recent studies find a growing proportion of `zombie´ firms, which, despite their negative profits and high levels of debt, are artificially kept alive as a result of loose monetary policy.

In addition, anecdotal evidence began to gather regarding chronic excess productive capacity in specific industries such as automobile, steel, shipbuilding, etc. In the aftermath of the crisis, this state of affairs even prompted official concerns, with governments struggling to scale capacity down as a means to restoring economic viability and firms' financial situation.

In this context, a first purpose of this article is to evaluate the extent to which this decline in capacity utilization is a phenomenon distressing isolated industries, or instead represents a rather widespread feature in the manufacturing industries. This is addressed by evaluating the Federal Reserve's capacity utilization statistics by industry over the period 1952-2014.

It is found that the decline in capacity utilization rates not only affects the average industry during the aforementioned period, but it is also a rather widespread phenomenon in the sample of manufacturing industries considered. It seems to be an economically relevant decline as well, with the average industry dropping 7pp all over the sample period.

A second purpose is to assess the effect of such a decline in capacity utilization over business investment in the industries considered. A variety of exercises is employed in order to obtain a first hint as to whether there was a Granger-causality effect and which the magnitude of the average effect was.

Granger-causality relationship with the theoretically expected sign are found for a high proportion of industries, hovering around 50% depending on the specification of the test. Further, when trying to measure the magnitude of the impulse-response relationship, our vector autoregressive estimates show that positive cumulative relationship tend to dominate in most of the industries, and detect a rather large total impact of utilization rates over investment, which represents an investment contraction fluctuating between 28 and 36% of average investment decline.

Finally, firm-level data is used to control for other determinants of investment. Firm investment is found to be sensitive to utilization fluctuations when we control for financial constraints and flexibility issues, firm sales-growth rate, idiosyncratic volatility and corporate diversification. More importantly, past accumulated utilization decline shows a strong correlation with firm capital expenditures in the most recent period in our sample, possibly reflecting the detrimental effect of excess capacity over investment.

Overall, the evidence discussed above provides an insight into the factors disturbing investment expenditures that might have gone overlooked in recent academic debates over the investment falloff. This sheds a new light over the structural, long-term obstacles pulling private capital expenditures down, reinforcing the case for a secular stagnation hypothesis.

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Table 1
Trends of investment rate

Panel A. Period 1952-2014

	Whole Sample	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
Trend	-0.000211***	-0.000127***	-2.03e-05	2.99e-05	-0.000368***	-0.000316***	-0.000187***	-0.000134***	-0.000211***	-0.000274***	-0.000520***
	(1.32e-05)	(2.94e-05)	(3.83e-05)	(4.40e-05)	(3.93e-05)	(4.20e-05)	(2.94e-05)	(3.35e-05)	(4.04e-05)	(4.14e-05)	(6.95e-05)
Constant	0.469***	0.284***	0.0801	-0.0158	0.776***	0.675***	0.422***	0.321***	0.478***	0.604***	1.107***
	(0.0262)	(0.0583)	(0.0760)	(0.0873)	(0.0780)	(0.0832)	(0.0583)	(0.0664)	(0.0801)	(0.0821)	(0.138)
Observations	5,418	567	567	504	567	504	567	567	504	567	504
R-squared	0.045	0.032	0.001	0.001	0.136	0.103	0.068	0.028	0.052	0.073	0.102
Number of Industries	86	9	9	8	9	8	9	9	8	9	8

Panel B. Period 1952-2007

	Whole Sample	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
Trend	-0.000223***	-9.48e-05***	-5.45e-05	0.000127**	-0.000415***	-0.000416***	-0.000234***	-0.000156***	-0.000142***	-0.000314***	-0.000543***
	(1.62e-05)	(3.42e-05)	(4.27e-05)	(5.43e-05)	(4.84e-05)	(5.20e-05)	(3.56e-05)	(4.13e-05)	(4.93e-05)	(5.09e-05)	(8.63e-05)
Constant	0.493***	0.220***	0.147*	-0.207*	0.869***	0.872***	0.515***	0.363***	0.340***	0.684***	1.152***
	(0.0320)	(0.0677)	(0.0845)	(0.107)	(0.0958)	(0.103)	(0.0705)	(0.0817)	(0.0976)	(0.101)	(0.171)
Observations	4,730	495	495	440	495	440	495	495	440	495	440
R-squared	0.040	0.016	0.003	0.013	0.132	0.129	0.082	0.028	0.019	0.073	0.084
Number of Industries	86	9	9	8	9	8	9	9	8	9	8

Panel A of Table 1 shows the results of regressing the investment rate on a time trend and industry fixed-effects for the period 1952-2104. The first column of Panel A, shows the results for the whole sample of 86 industries available in the Annual Investment and Capital Stocks database. Columns 2 to 11 show the regression results for each industry-size decile. Industry-size is computed on the basis of the average net capital over the whole period. Panel B of Table 1 shows the same regression results for a reduced sample period covering 1952-2007. Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2

Trends of capacity utilization rates

Panel A. Whole Period 1952-2014

	Whole Sample	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
Trend	-0.171***	-0.264***	-0.277***	-0.224***	-0.253***	-0.133***	-0.439***	-0.186***	-0.0928***	-0.0241	-0.0720***
	(0.00671)	(0.0223)	(0.0184)	(0.0293)	(0.0214)	(0.0118)	(0.0458)	(0.0387)	(0.0115)	(0.0250)	(0.0157)
Constant	418.8***	599.0***	626.4***	523.9***	582.0***	342.1***	953.9***	449.7***	267.1***	130.9***	228.6***
	(13.35)	(44.45)	(36.66)	(58.30)	(42.58)	(23.49)	(91.24)	(77.07)	(22.99)	(49.75)	(31.09)
Observations	4,312	447	530	321	523	739	129	358	446	338	481
R-squared	0.133	0.242	0.303	0.158	0.215	0.148	0.424	0.062	0.130	0.003	0.043
Number of naics	86	9	10	7	11	13	3	8	10	7	8

Panel B. Post-1982 Period

	Whole Sample	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
Trend	-0.252***	-0.353***	-0.560***	-0.410***	-0.0798**	-0.0657**	-0.704***	-0.300***	-0.136***	-0.108**	-0.210***
	(0.0134)	(0.0395)	(0.0416)	(0.0449)	(0.0367)	(0.0280)	(0.0652)	(0.0648)	(0.0179)	(0.0480)	(0.0375)
Constant	582.4***	778.6***	1,194***	896.4***	235.2***	208.8***	1,485***	679.7***	353.9***	299.4***	505.1***
	(26.76)	(78.88)	(83.18)	(89.78)	(73.35)	(56.06)	(130.4)	(129.5)	(35.68)	(95.92)	(74.92)
Observations	2,752	288	320	224	352	416	96	256	320	224	256
R-squared	0.118	0.224	0.369	0.279	0.014	0.013	0.559	0.080	0.158	0.023	0.113
Number of naics	86	9	10	7	11	13	3	8	10	7	8

Panel C. Post-1990 Period

	Whole Sample	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10
Trend	-0.463***	-0.701***	-0.441***	-0.620***	-0.0500	-0.309***	-0.746***	-0.709***	-0.326***	-0.384***	-0.284***
	(0.0225)	(0.0634)	(0.0896)	(0.0861)	(0.0545)	(0.0619)	(0.0816)	(0.0785)	(0.0406)	(0.0789)	(0.0675)
Constant	1,004***	1,476***	957.8***	1,315***	177.9	695.7***	1,571***	1,500***	733.8***	851.3***	655.3***
	(44.98)	(127.0)	(179.4)	(172.4)	(109.1)	(123.9)	(163.5)	(157.3)	(81.33)	(158.0)	(135.2)
Observations	1,608	264	96	144	168	168	144	144	216	120	144
R-squared	0.216	0.326	0.210	0.274	0.005	0.135	0.379	0.373	0.238	0.172	0.115
Number of naics	67	11	4	6	7	7	6	6	9	5	6

Panel A of Table 1 shows the results of regressing the capacity utilization rate on a time trend and industry fixed-effects for the period 1952-2014. Panel B of Table 1 shows the results of regressing the capacity utilization rate on a time trend and industry fixed-effects for the period 1952-1990. The first column of Panel A shows the results for the whole sample of 57 industries available in the Annual Investment and Capital Stocks database. Columns 2 to 11 show the regression results for each industry-size decile. Industry-size is computed on the basis of the average net capital over the whole period. Panel B of Table 1 shows the same regression results for a reduced sample period covering 1990-2014. Standard errors are reported in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3

Panel Unit-Root Tests Results

	Capacity utilization P-value	Gross Capital Formation P-value
Levin-Lin-Chu unit-root test for cap_util	0.0000	0.0000
Levin-Lin-Chu unit-root test with trend	0.0000	0.0000
Harris-Tzavalis unit-root test	0.0000	0.0000
Harris-Tzavalis unit-root test, time trend included	0.0000	0.0000
Breitung unit-root test	0.0000	0.0000
Breitung unit-root test, time trend included	0.0000	0.0000
Im-Pesaran-Shin unit-root test	0.0000	0.0000
Im-Pesaran-Shin unit-root test, time trend included	0.0000	0.0000
Fisher-type unit-root test, based on augmented Dickey-Fuller tests	0.0000	0.0000
Inverse chi-squared(172) P	0.0000	0.0000
Inverse normal Z	0.0000	0.0000
Inverse logit t(434) L*	0.0000	0.0000
Modified inv. chi-squared Pm	0.0000	0.0000
Fisher-type unit-root test, based on Phillip-Perron tests	0.0000	0.0000
Inverse chi-squared(172) P	0.0000	0.0000
Inverse normal Z	0.0000	0.0000
Inverse logit t(434) L*	0.0000	0.0000
Modified inv. chi-squared Pm	0.0000	0.0000

Table 3 shows the results of a variety of tests for unit-root in panel datasets. The first column presents the name of the tests, the second and third columns respectively show the corresponding p-value for capacity utilization and capital formation series. All tests reject the null hypothesis that all panels contain a unit root process.

Table 4

Results of Unit-Root tests by industry

Augmented Dickey-Fuller Test	No trend, no drift	Trend	Drift
Capacity utilization	74,63%	50,75%	100,00%
Capital Formation	73,26%	54,65%	98,84%

Table 4 summarizes the results of the Augmented Dickey-Fuller tests for unit-root in every industry. For each series (capacity utilization and capital formation), it shows the percentage of industries for which the tests reject the presence of unit-root process. Each column presents this proportion for different specification of the test: Augmented Dickey-Fuller tests without trend and drift, with a trend, or with drift.

Table 5

Lag Structure Selection. Autocorrelation tests results

	AIC	SBIC	HQIC
AR(1)	98%	76.74%	88.37%
AR(2)	93.02%	83.72%	90.70%

Table 5 shows the proportion of industries for which residual autocorrelation is rejected at lags 1 and 2 when a VAR model is runned for each industry using the optimal lag structure using the Akaike, Schwartz-Bayesian and Hannan-Quinn Information criterion.

Table 6

Proportion of industries showing statistically significant effects of Capacity Utilization and Investment

	Panel A: Capacity Utilization			Panel B: Capital Formation		
	1%	**5%**	**10%**	**1%**	**5%**	**10%**
Whole Sample	33.72	44.19	55.81	15.12	31.40	41.86
Since 1970	31.40	45.35	56.98	16.28	33.72	46.51
Since 1980	18.60	34.88	47.67	25.58	37.21	48.84
Since 1990	15.12	29.07	43.02	23.26	33.72	39.53

Table 6 shows the results of Granger-Causality tests derived from the estimated VAR models. Panel A columns show the proportion of industries for which a Granger-Causality is found at different confidence levels with variations in capacity utilization preceding variations in capital formation. Panel B columns show the proportion of industries for which a Granger-Causality is found with the opposite direction.

Figure 1

Kernel Probability Density Functions of the Cummulative Effect

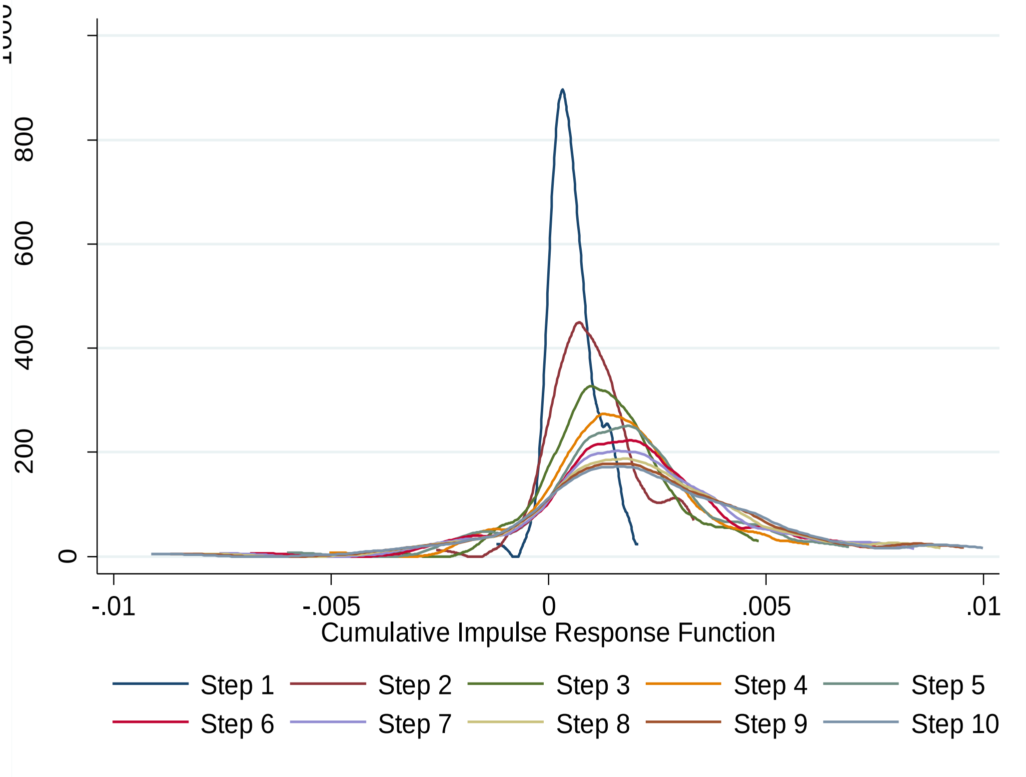

Figure 1 shows the Kernel Probability Density Functions of the total cummulative effect of capacity utilization rate over gross capital formation for the 86 industries considered, and for different lag structures going from 1 to 10 lags.

Figure 2

Impulse-Response Functions

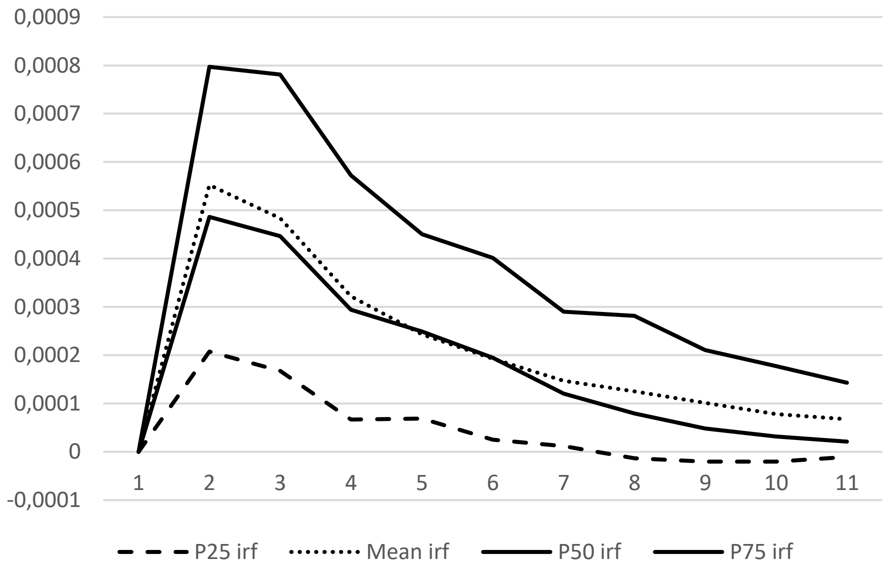

Figure 2 shows the Impulse-Response functions arising from the VARs estimated using the optimal lag structures. The impulse is a one-standard deviation shock in capacity utilization, while responses are variations in gross capital formation at subsequent steps. P25 shows the IRF of the industry at the 25th percentile of the distribution of the response at every step. P50 represents the median response and P75 is the 75th percentile.

Figure 3

Evolution of the capital formation rate by quintiles of utilization variation

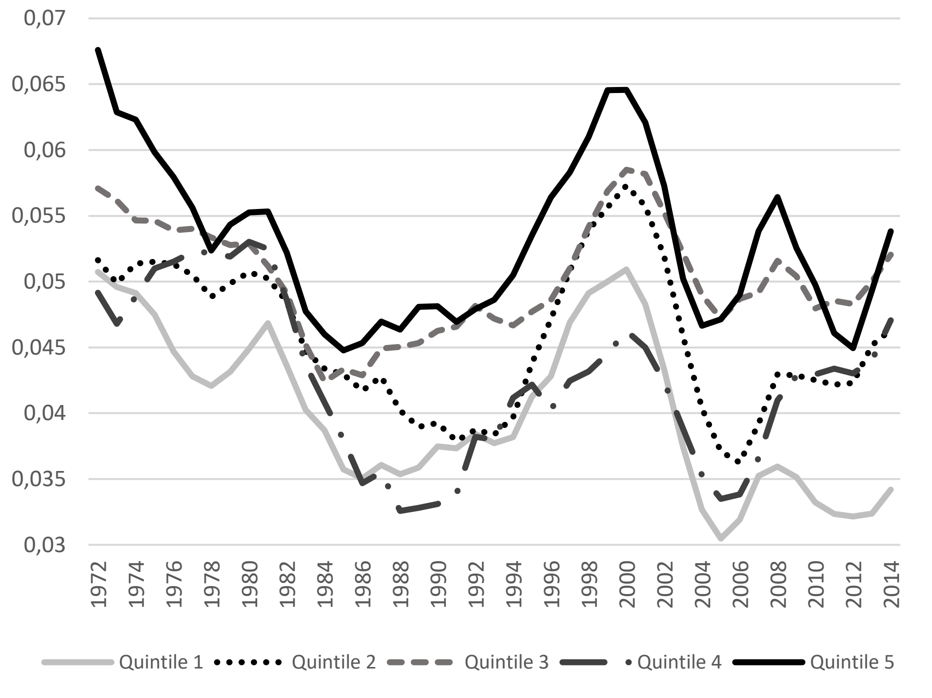

Figure 3 shows the evolution of the median capital formation rate for every quintile of capacity utilization variation between 1972-1977 and 2000-2005.

Figure 4

Evolution of the capital formation rate by quintiles of utilization variation

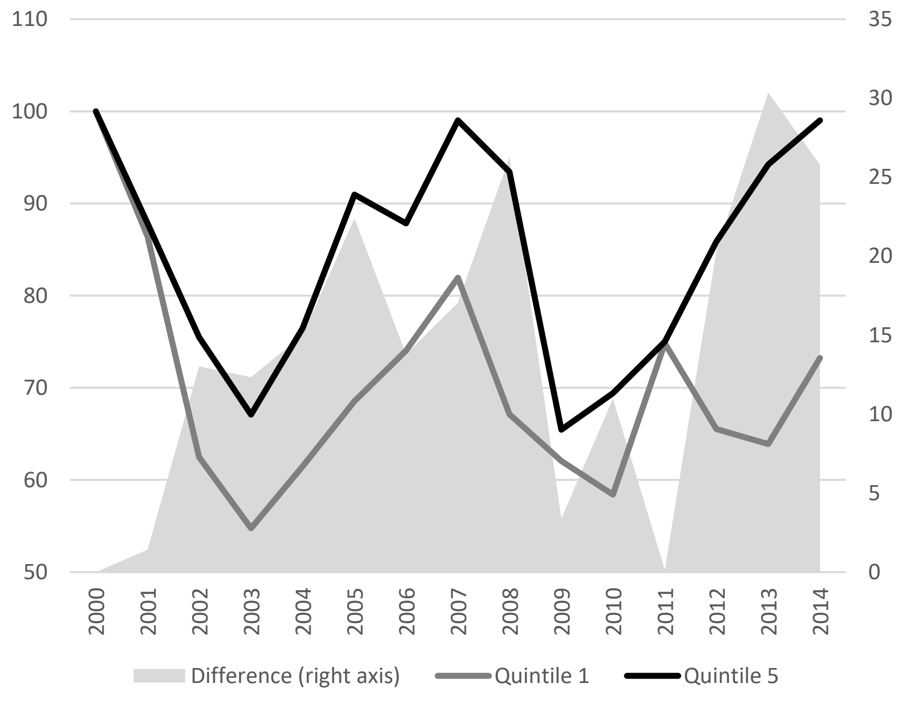

Figure 4 shows the evolution of the median capital formation rate for quintiles 1 and 5 of capacity utilization variation between 1972-1977 and 2000-2005. Each series is shown by an index equal to 100 in year 2000.

Table 7

Firm-level regression results

VARIABLES	(1) FE 1990-2014	(2) BE 1 2006-2014	(3) BE 2 2010-2014	(4) BE 3 2006-2014	(5) BE 4 2006-2014
ln of Total Assets	0.000962***	0.000843***	0.00158***	0.000812***	0.000830***
	(0.000156)	(0.000215)	(0.000207)	(0.000217)	(0.000216)
Net Cash Flow	-0.00167***	-0.000459*	0.000132	-0.000472*	-0.000464*
	(0.000113)	(0.000252)	(0.000209)	(0.000252)	(0.000252)
Leverage	0.000177***	0.000259	0.000274	0.000266	0.000256
	(4.09e-05)	(0.000238)	(0.000351)	(0.000238)	(0.000238)
Short Term Leverage	-0.000236***	-0.000258	-0.000276	-0.000264	-0.000254
	(4.30e-05)	(0.000250)	(0.000369)	(0.000251)	(0.000251)
Liquidity demand	-0.0348***	-0.0292***	-0.0242***	-0.0277***	-0.0283***
	(0.000815)	(0.00226)	(0.00228)	(0.00228)	(0.00226)
Non-Operating Assets	-0.0467***	-0.0464***	-0.0434***	-0.0457***	-0.0461***
	(0.000925)	(0.00291)	(0.00282)	(0.00294)	(0.00292)
Acquisitions	-0.0125***	-0.00780***	-0.0460***	-0.00783***	-0.00788***
	(0.000256)	(0.00130)	(0.00455)	(0.00130)	(0.00130)
Sales Growth	4.88e-06	-2.42e-06	-1.19e-05	-1.60e-06	-2.14e-06
	(3.45e-06)	(1.99e-05)	(2.27e-05)	(1.99e-05)	(1.99e-05)
NCF Volatility	6.02e-07	-7.06e-06	1.65e-05*	-6.96e-06	-7.40e-06
	(4.77e-07)	(1.99e-05)	(8.92e-06)	(2.00e-05)	(2.00e-05)
Capacity Utilization	0.000382***				
	(1.27e-05)				
CU Variation 1		0.0259***	0.0231***		
		(0.00780)	(0.00778)		
CU Variation 2				0.0161**	
				(0.00704)	
CU Variation 3					0.0156**
					(0.00703)
Constant	0.00843***	0.0383***	0.0292***	0.0372***	0.0375***
	(0.00126)	(0.00169)	(0.00167)	(0.00165)	(0.00170)
Observations	170,272	62,533	18,303	62,533	62,533
R-squared	0.045	0.106	0.166	0.105	0.105
Number of firms	6,110	3,209	2,225	3,209	3,209

Table 7 presents the regression results for the firm-fixed effects and between models. Column 1 shows the result for the firm fixed-effects model using data for the whole 1990-2014 period. Columns 2 to 5 present the between panel models assessing the impact of cummulated utilization variation over different periods, on subsequent firm-level investment. In Column 2 and 3, the capacity utilization variation is meassured as that taking place between the early 1970s (average utilization for 1972-1977) and the early 2000s (2000-2005). In Column 4, the CU variation measures the difference between late 1980s (1985-1989) and early 2000s, and in Column 5 CU Variation accounts for the difference in CU between late 1990s (1995-1999) and early 2000s. Time period used for each model is especifed in each Column heading.