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## **Italy’s productivity slowdown: labor market reform vs. managerial incentives**

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### **Abstract**

Italy’s productivity slowdown long predates the 2008-09 crisis. We present micro data evidence for 2001-03, a period of acute productivity slowdown in the Italian economy. We document that firm productivity growth and propensity to adopt product and process innovation is negatively related to two factors stifling managerial propensity to innovate: the initial share of temporary workers in each firm and, less robustly, with the old age and high seniority of top managers and members of the boards. We interpret this result as indicating that both labor market reform and existing managerial practices have contributed to depress the productivity performance of Italian firms in the early 2000s.

## **1. Introduction**

Italy's prolonged productivity slowdown has been a mystery to explain long before the current crisis of 2008 and 2009. In this paper, we take a look backwards in time to 2001-03, a period of particularly acute slowdown in the Italian economy, to learn about the possible determinants of productivity developments at the firm level.

Our micro data evidence indicates that firms with disproportionately higher shares of temporary workers to start with experienced lower productivity growth (or more pronounced declines) than other firms. This result is robust to all changes of specifications. It is suggestive that labor supply developments have been influential in determining productivity developments in Italy.

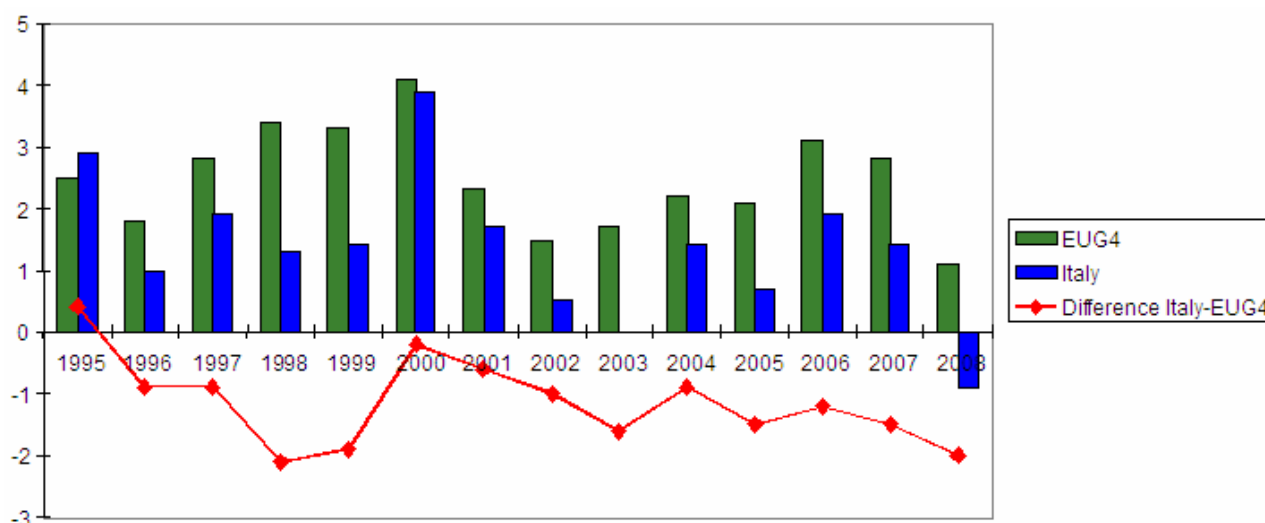
The influence of labor demand factors such as managerial incentives as captured by average age or seniority of the managers actively running the companies at that time is less robustly related to productivity developments. Our WLS (weighted least squares) estimates separately run for innovative and non-innovative companies indicate that seniority do not seem to play a role, while an older managerial age appears to be associated with lower productivity in innovative firms and with higher productivity in non-innovative firms. This is consistent with commonsense that suggests a more positive role of experience in firms with relatively standardized and stable business practices. Our IV results, while confirming the robustness of the partial correlation between the share of temporary workers and productivity, shows that both product and process innovation are positively related with productivity growth. The relation between managerial age and productivity is less tightly correlated than within the WLS framework. The correlation between seniority and productivity varies considerably across specifications.

The paper is structured as follows. In section 2, we present the tale of our paper. In section 3 and, we present its conceptual underpinnings and the model specification. In section 5, we describe the main features of our data set. In section 6, we describe our main statistical results. In section 7, we discuss some outstanding issues. Section 8 concludes.

## **2. The tale of our paper**

After decades of fast growth that led Italian living standards to converge towards European levels by the end of the 1980s, GDP growth in Italy declined substantially since the mid 1990s. The Figure 1 below shows that, since 1995, Italy's GDP has cumulatively lost some twenty percentage points vis-à-vis the GDP of the other four big countries in the European Union (Germany, France, the UK and Spain).

**Figure 1-** GDP growth in Italy and in the other big four European countries, 1995-2008



Source: Francesco Daveri, “Italy, before and after Lehman Brothers”, [VoxEu.org](http://VoxEu.org), June 5, 2009

Italy’s declining growth performance – the continuation of a secular trend only partially shared with other OECD countries - has been the combination of two distinct – though as we will discuss possibly interrelated - labor market developments. There has been a marked decline - from 2.1% in 1980-95 to 0.5% after 1995 - in the growth rate of labor productivity. Yet this productivity slowdown has been paralleled by a marked increase in the growth rate of total hours worked, which turned from negative to positive figures, quite at odds with what had happened in previous decades.

Growth rates of	Per-capita GDP	GDP per hour worked	Hours per working age person	Working age population over total population
1970-80	3.1	3.9	-0.8	0.0
1980-95	1.8	2.1	-0.7	0.4
1995-04	1.3	0.5	1.0	-0.2

**Source:** Daveri and Jona Lasinio (2005)

As shown in Table 2, productivity started its stagnation after 1995 in both manufacturing and service industries. Yet, while the presence of stagnating or even declining productivity is not surprising in the services industries, especially in a country like Italy whose services are still plagued with extensive monopolistic provision, the particularly striking features of these developments has been the zeroing of productivity growth in the Italian manufacturing industries. This is notable because manufacturing industries have been “the” productivity-leading industries in Italy in the past decades. This declining path has been particularly pronounced during the 2001-03

aggregate slowdown, when labor productivity growth has gone down below zero, but it was there even in 1995-00 when the economy was doing relatively well. Italy's productivity slowdown is not the consequence of unfortunate business cycle fluctuations.

<b>Table 2 - Growth of labor productivity in Italy, 1970-2003, main industry groups</b>					
	<b>1970-80</b>	<b>1980-95</b>	<b>1995-03</b>	1995-00	2000-03
Economy	2.4	1.8	0.6	1.1	-0.2
Agriculture	3.1	4.3	2.7	5.2	-1.5
Manufacturing	2.8	3.0	0.2	1.0	-1.0
-- non-durables	2.7	3.1	0.3	0.7	-0.2
-- durables	2.9	2.7	0.0	1.7	-2.7
Utilities	-0.4	0.8	5.5	3.7	8.7
Construction	1.9	1.0	0.1	0.5	-0.5
Business sector services	1.8	1.1	0.1	0.5	-0.5
Public services	1.4	0.7	0.4	0.8	-0.1
<b>Source:</b> Daveri and Jona-Lasinio, 2005					

This sudden productivity turnaround begs an explanation. And here two main views confront each other. A view shared by many Italian entrepreneurs is the so called "Labor Supply" view. The labor supply view is consistent with the ideas expressed by Robert Gordon and Ian Dew-Becker (2008) on the interrelation between labor market reform and productivity developments in Europe. In their paper, they have conjectured that the process of - mostly piecemeal - labor market reform that occurred in many European countries, while helping Europe reverse the past tendencies towards job destruction, has been eventually detrimental to productivity growth. Simplifying their view to an extreme, if labor market reform occurs and labor demand does not shift, labor supply shifts to the right along a given labor demand curve. No wonder that productivity declines as a result. This may have occurred in Europe and in Italy as well following the changes in labor market legislation in favor of more flexibility introduced by the Prodi Government in 1997-98. These legislative changes gave full legal recognition to a host of contractual forms of part-time and temporary jobs, some of which had been in place even before though restricted to the unofficial labor market.

Yet the labor supply view is not the only game in town. Another potential explanation would also stress the role of labor demand, and notably of the interplay between a changing world economy and a largely unchanged domestic managerial environment. The majority of Italian firms, typically agglomerated in industrial districts or involved as sub-contractors by large-scale exporting

companies, simply continued their previous business conducts. Yet the mode and the opportunities of competition around the world had changed meanwhile. There was a technological revolution out there whose fruits could have been reaped by those companies adopting the new technologies as well as adapting their managerial techniques to the changed environment.

A recent empirical by Bandiera, Guiso, Prat and Sadun (2008) shows that the Italian economy was not well equipped for withstanding competition in this changed world. Using a variety of data sets, they analyze the incentive structure that Italian managers face, their career profile and even their use of time. It turns out that only a fraction of firms – especially the non-family owned and multinationals - adopts a performance-based model, whereby managers are hired through formal channels such as business contacts and head-hunting activities, undergo regular assessment procedures and are rewarded, promoted and dismissed on the basis of their assessment results. Most firms – particularly those family-owned and working in the domestic market - follow a fidelity model of managerial talent, so that hire their managers based on personal or family contacts, do not formally assess their performance and promote and reward them based on the quality of their personal relations with the firm's owners. The problem is that the type of managerial model – based on performance or fidelity – is tightly associated with the quality, the conduct and the performance of managers as well as of the firm itself. And here then comes our second interpretation of Italy's productivity slowdown: firms endowed with managers of such poor quality are presumably at a disadvantage when faced with new technological opportunities with respect to foreign competitors less dependent on family-based modes of running a firm.

While there may be some grains of truth in both views, Gordon and Dew-Backer have not contrasted their ideas with micro data, while Bandiera, Guiso, Prat and Sadun have not looked at the interaction of labor market reform with the productivity and innovation counterpart of managerial practices. So there is room for comparing a streamlined version of the two views against the backdrop of the same data set. This is the main goal of our paper.

If the Labor Supply view is correct, we expect to see in the data more pronounced productivity declines in companies with disproportionately higher shares of part-time and temporary workers at the beginning of the period. If the Labor Demand view is correct, we expect to detect stronger productivity declines in companies with older and/or senior managers. *Ceteris paribus*, older CEOs, board members and managers are possibly less prone to introduce new technologies and innovation, because this may change their routines and more importantly if this changes the circulation and transmission of information within the firm and eventually the structure of power within the firm. Yet age as such may not be the crucial or the only element to consider in this respect. As emphasized by Daveri and Maliranta (2007) for a large sample of Finnish manufacturing companies

and workers, seniority may be the really damaging feature, particularly in high-tech companies where a certain attitude towards change is more likely related to short tenure and lack of entrenchment in a given company.

Perhaps both hypotheses have something to say on Italy's productivity decline in the early 2000s. We simply construct our thought experiment to let the data speak on this.

### 3. Conceptual framework

Our empirical analysis takes the firm's production function framework as a benchmark.

We consider a constant-returns-to-scale value-added production function. The full-fledged production function underlying equation (1) below would have (real) output on the left-hand side and capital, labor, intermediate materials and services on the right-hand side. This would allow us to differentially treat the substitutability of such inputs with respect to capital and labor. Specifying the production function in terms of value added, however, lessens the endogenous input choice problem that plagues the estimates of production functions. Under the (untested) assumption of separability between the value added and the intermediates functions, the dependent variable may instead be real output less (real) materials and services. This implies that (the logs of) materials and services are no longer an argument in the production function.

Subject to these preliminary remarks and assumptions, in each period  $t$ , the constant-returns-to-scale value-added-based production function for firm  $i$  at time  $t$  is the following:

$$\ln(Y_{i,t} / L_{it}) = \ln(A_{i,t}) + \beta_K \ln(K_{i,t} / L_{i,t}) \quad (1)$$

Equation (1) stems from a production function where firm value added  $Y$  (in logs) is a log-linear function of the labor input  $L$ , capital services  $K$  and the efficiency parameter  $A$ . Under constant return to scale, this translates into equation (1) by dividing both sides by  $L$ .

In turn, we allow  $A$  to be a function of time and innovation adoption as follows:

$$\ln(A_{it}) = \alpha * t * ADOPTION + error \quad (2)$$

where  $ADOPTION$  is in turn a linear function of a few variables of interest  $X_A$  including firm-averaged managerial age, firm-averaged managerial seniority, the share of full-time and part-time temporary workers in each firm, and a array of regional, size and industry dummies, each affecting the log of  $A$  through a separate parameter.

Under (1) and (2), the log difference (the growth rate) of labor productivity is a linear function of the growth rate of the capital-labor ratio and of the array of variables affecting innovation adoption.

This is the conceptual background underlying equation (3) below.

#### 4. Model specification and estimation

The tests of the Labor Supply and the Labor Demand views mentioned in the previous sections is performed, in turn, through WLS (Weighted Least Squares) and IV (Instrumental Variables) regression analysis of labor productivity growth rate at the firm level on its potential determinants. Equation (1) is our main model specification:

$$\Delta_2 \ln \frac{Y_{it}}{L_{it}} = \kappa + \alpha \Delta_2 \ln \frac{K_{it}}{L_{it}} + \beta \frac{TEMP_{i,t-2}}{L_{i,t-2}} + \gamma \overline{AGE}_i + \delta \overline{SENIORITY}_i + \varpi' x_i + \varepsilon_{it} \quad (3)$$

where  $i$  refers to firm,  $t$  to year of observation,  $\Delta_2$  is a two-year difference (long difference) between 2003 and 2001,  $Y/L$  measures labor productivity and  $K/L$  is the capital/labor ratio.  $TEMP/L$  is the rate of employees with temporary contracts (part time plus fulltime at the beginning of the sample period),  $AGE$  and  $SENIORITY$  variables are the board averages for each firm. We control for size, area and sector characteristics as well ( $x_i$ 's). We obtain results for all firms, as well as for innovating and non-innovating firms separately. We define as “innovating” the firm with at least a process or product innovation introduced in the period of interest.

Given the plausible endogeneity of innovation activity and the capital/labor ratio, we perform an IV-2SLS type of analysis to the following equation (4):

$$\Delta_2 \ln \frac{Y_{it}}{L_{it}} = \kappa + \alpha \Delta_2 \ln \frac{K_{it}}{L_{it}} + \phi Inno_{ih} + \beta \frac{TEMP_{i,t-2}}{L_{i,t-2}} + \gamma \overline{AGE}_i + \delta \overline{SENIORITY}_i + \varpi' x_i + \varepsilon_{it} \quad (4)$$

where  $Inno_{ih}$  is a dummy variable indicating whether firm  $i$  has introduced an innovation of type  $h$  (either process or product) in the period of interest. The instruments used are the log-capital stock per employee at the beginning of the sample period, R&D investment at the beginning of the period or whether the firm has invested in R&D, the number of R&D workers at the beginning of the period, the investment intensity with respect to Capital stock in 2001, firm age and group.

Our identification assumption is that the initial capital-labor ratio ratios, R&D and cash flows only affect productivity through innovation and not along other direct channels. They are thus our excluded instruments. In other words, we assume that it is the output of innovation - and not its input (R&D investments and workers) – that affects directly productivity through a knowledge production function. This assumption has become commonplace in the literature on R&D and productivity since Griliches (1979) and Crepon, Duguet and Mairesse (1998). In particular, R&D and physical investment interact when firms decide to implement an innovation, especially if research is conducted to adapt external technologies. In that case, the firm will have “absorptive capacity” (Parisi, Schiantarelli and Sembenelli, 2006). We also allow for other explanatory

variables, such as the geographical, industry and firm size dummies, to affect productivity in both ways, indirectly through the innovative activity as well as directly.

The cross firm-individual dimension of our quasi-panel requires the use of WLS. This is because we are correlating the average value of labor productivity of each firm in the time interval observed (2001-2003) with an average value of age and seniority of the members of its board. We thus weigh each observation in the regressions with the frequencies used to calculate those averages.

We extend the analysis to evaluate the impact on the level of labor productivity, too. TO BE ADDED.

## 5. The dataset

We collected balance sheet data on Italian manufacturing firms and their board characteristics in the period 2001-2003 from two sources of data. Information about employment characteristics, innovation activity and R&D investment at the firm level come from the IX<sup>th</sup> Survey on Manufacturing Firms by Capitalia/Unicredit. This survey has been run in 2004 through questionnaires distributed to 4177 firms. The questionnaires inquire about location, legal form, group, sales, investments, R&D investments, innovation activity, exports, labor force characteristics, financial status and incentives, balance sheets. Most of the quantitative information relates to the previous three years since the time of the survey, separately. Some qualitative answers, instead, are related to the whole three-year period, i.e. innovation activity.

Information about balance sheets, age and seniority of the board members come instead from the AIDA database.<sup>1</sup> AIDA is updated every week but maintains balance sheet data for the previous years as well. Thus we extracted balance sheet items over the 2001-2003 time span to check and correct for inconsistencies between the two sources. Incidentally, our chosen sub-period - the years between 2001 and 2003 - happens to be a period during which Italy's productivity slowdown has been particularly severe.

While we can extract balance sheet from AIDA in the years of interest to match the two sources, the database registers just the latest board composition, which means that we access information about board members of existing firms on December 31, 2007. We know the year at which the person was nominated but the duration of the service is practically unknown, and her/his function is scarcely available. Thus we take the board composition as if it was present in 2001-2003 as well. For each member with available data, we calculate her/his age at the time of the nomination within the board, as well as the age in the years 2001, 2002, 2003, the duration of the service (i.e. seniority) in 2001,

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<sup>1</sup> AIDA is managed by Bureau Van Dijk. It collects balance sheets, proprietary shares, firm characteristics and board characteristics on about 250000 Italian firms. We accessed the data on firms with at least €800.000 gross sales as of 31 December 2007.

2002, 2003 and for each firm we may calculate an average age and seniority of the board. We excluded from the dataset those firms whose board name appeared to be another company, not a physical person.

Firms in the Capitalia dataset (with info in 2001-2003) existing also in 2007 to match AIDA information are 3562 (that is 85.3% of the sample). Firm-individual observations are 21081. We first test for potential sample selection of these firms, in terms of age, size, location and sector of production (younger, bigger or particular sectors could have a higher survival rate, higher productivity or innovation capacity). The discussion of the potential selection bias is placed in the Appendix section.

The data then need a cleaning procedure because of inconsistencies between birth dates and nomination dates of the individual board members. Only 12348 (58.6% of total observations) distributed in 1228 firms contain sensible information on birth and service dates, which finally becomes our longitudinal or “quasi”-panel dataset with firms as units and board members as the longitudinal dimension, in the years 2001-2003.

**Table 3 - Descriptive statistics of the main variables of interest  
(mean values in 2001-2003)**

<b>Firm level</b>	Observations	Mean	St.Dev.	Min	Max
Product	1228	45.7	49.83	0	1
Process	1228	48.5	49.99	0	1
Product & Process	1228	29.0	45.39	0	1
R&D spending (yes/no)	1178	59.42	49.12	0	1
Incorporation year	1225	1946.764	18.97932	1900	1999
Group	1228	49.76	50.02	0	1
Production value (Th.€)	1225	63667.15	186003	1516.909	4314989
Production per worker	1225	325.9886	280.5385	16.53767	3362.191
ln(Production-pw)	1225	5.559637	.6414284	2.805641	8.120348
$\Delta_2\log(\text{Production-pw})$	1206	.0195536	.3209769	-2.948643	2.937123
Capital Stock (Th. €)	1228	14506.49	48126.19	0	860252.9
Capital Stock per worker	1228	63.41423	91.98117	0	2268.323
Ln(Capital Stock-pw)	1228	3.639517	1.101985	0	7.726796
$\Delta_2\log(\text{Capital Stock-pw})$	1147	.1267867	.4281666	-3.652283	3.485679
R&D investment (€)	576	999981.7	5771039	33.33333	1.28e+08

R&D intensity (/Y)	576	17.40892	39.29299	.0038407	634.2022
R&D intensity (/K) <sup>a</sup>	542	238.8543	2266.019	0	52277.93
Investment intensity (/K)	982	855.7782	18990.44	0	594760.7
Temporary Workers Rate <sup>a</sup>	1214	.0415394	.123155	0	1
R&D Workers <sup>a</sup>	1149	6.573542	32.05995	0	755
Total Workers <sup>a</sup>	1217	220.9647	532.1514	0	12199
<b>Individual level</b>					
Age at the nomination	12348	47.1039	10.15808	18	93
Average Board age	12348	47.1039	4.758232	20	77
Average Seniority <sup>o</sup>	11124	36.7242	7.594177	0	68
Average Board Seniority	11650	35.20841	9.977367	0	57

Note: Dummy variables statistics are expressed in percentages. <sup>a</sup> measured in 2001 only. <sup>o</sup> measured in 2001-2003 period.

**Table 4 - Firm size and area distribution in the final sample**

	Small	Medium	Large	North West	North East	Centre	South
Freq	255	730	243	431	407	191	199
%	20.77	59.45	19.79	35.1	33.14	15.55	16.21

## 6. Results

Table 5 shows the results of WLS, while Table 6 shows the IV-2SLS results. We instrumented the log-Capital Labor ratio and the dummies indicating an introduction of innovation (process or product). Our list of instruments includes the following variables: the log-Labor of Productivity at the beginning of the sample period – 2001; the  $\ln(K/L)$  in 2001, Investment in physical capital intensity as a share of the capital stock in 2001; whether firms invested into R&D; the number of workers employed in R&D activity in 2001; the age of the firm; the group to which the firm belongs to; size and area dummies. We also tried industry dummies, with no major changes of results. As to Innovation, we report results for firms with either process or product innovation, with process innovation only and with product innovation only.

Both WLS and IV estimates show that the share of temporary workers is always statistically significant with a negative sign and a point-wise estimate never too far from -0.2. This is very

precisely estimated, often with a level of significance above 1% and only occasionally with a significance bordering 5%.

The results are more mixed for managerial age and seniority. Results differ across estimation method and across specification. Managerial age is “better measured”, while seniority is measured with a higher degree of approximation. This is why we tend to regard the results concerning managerial age as more reliable.

WLS estimates indicate a negative partial correlation between age and productivity in the whole sample, as well as in the sample of innovative firms. The relation is instead, interestingly positive for the sample of non-innovative firms. This is suggestive of the fact that experience may have a payoff in non-innovative firms not easily reaped in more innovative environments, where rents are more quickly wiped out. This pattern of partial correlation is, however, not confirmed with the IV estimates, where by construction we cannot separate innovative and non-innovative firms.

Finding a consistent pattern of correlation for managerial seniority is harder. Measurement error here probably plays a role which we cannot fully evaluate. The correlation is however essentially zero with the WLS estimates and at times positive and significant with the IV estimates. We intend to explore more deeply the pattern of correlation between these variables and the different types of innovation to achieve a better understanding of the underlying relations.

Finally, as in Parisi, Schiantarelli and Sembenelli (2006), we find evidence of a robust positive partial correlation between product and process innovation and productivity. This is interesting for Parisi, Schiantarelli and Sembenelli found this with properly said panel data, while the source of our correlation is cross-sectional. Hall, Lotti and Mairesse (2008) also look at this correlation, although within a completely different research setting aimed at understanding the creation or destruction effects of the different types of innovation on employment. They report not have found much effect of innovation on productivity. It will thus be interesting to try and understand the source of these differences. This may have to do with the cross-sectional and time series source of variation in our data and their data set.

## **7. Implementation difficulties**

Cross-sectional statistical analysis of long-differences based on firm-averaged data is not problem-free, unfortunately. A big problem is potential reverse causation. The statistical relations we intend to analyze posit that the temporary share of workers, age or seniority variables are the independent variables and productivity the dependent variable. But cross-sectional data as such (be they observed at a given point in time or averaged over time) may only indicate correlation, not

causation. Therefore, if the estimated coefficient linking seniority and productivity is negative, this may not indicate that the firms where aged or senior managers are employed are less productive. Rather, the negative correlation may simply signal that older or senior managers tend to stay along in less productive and older firms, probably featuring outdated machines and methods of production, probably because they managed to put in place successful “relations”, while new, innovative and high-productivity plants may be more often matched to young and brilliant managers. If this is the case, we would be wrongly interpreting what causes what, attributing to seniority or age a causal influence on plant productivity, which may go the other way around.

This is why we implement our IV specification. Our expectation is that by choosing predetermined instruments we may lessen the simultaneity problems.

Surely, a lot of unobserved heterogeneity in plant productivity is still there in the data even once we have augmented the list of productivity determinants with dummies and other control variables. Yet the problem of interpreting the statistical results from cross-sectional estimates arises if and only if the unobserved (therefore unmeasured) firm variables are correlated with the included explanatory variables. For example, if managerial ability – a typically unobserved firm variable – were unrelated to the tenure persistence of managers, then leaving it out of the empirical analysis would not be a major problem. This may or may not be the case though. If managerial ability is not observed and therefore omitted from the analysis but it turns out correlated with some included variable such as the tenure persistence of managers, its effect may be picked up by the negative estimated relation between senior managers and productivity. We would be misperceiving the effect of managerial ability on productivity as if it were the causal effect of managerial seniority on productivity. To tackle this problem, we control for a few dummy variables that captures some, though presumably not all, of the unobserved determinants of firm productivity.

## **8. Conclusions**

Italy’s prolonged productivity slowdown is not a cyclical contingency and deserves careful investigation. In this paper, we give our contribution evaluating two of the main views proposed to explain such slowdown. We find that the Labor Supply view is consistent with our data, while as to the Labor Demand view, our results are instead more mixed and require further investigation.

MORE TO BE ADDED

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## Appendix

We control for sample selection that could actually come up when Capitalia IX survey data are matched with AIDA balance sheet of firms present in 2007. Not all Capitalia firms exist in AIDA register. Nonetheless, we manage to retain almost 86% of the Capitalia sample. Therefore, we check in what type of characteristics do firms in-sample and out-of-sample differ.

**Figure A 1. In and Out Sample distribution of Capitalia firms by size**

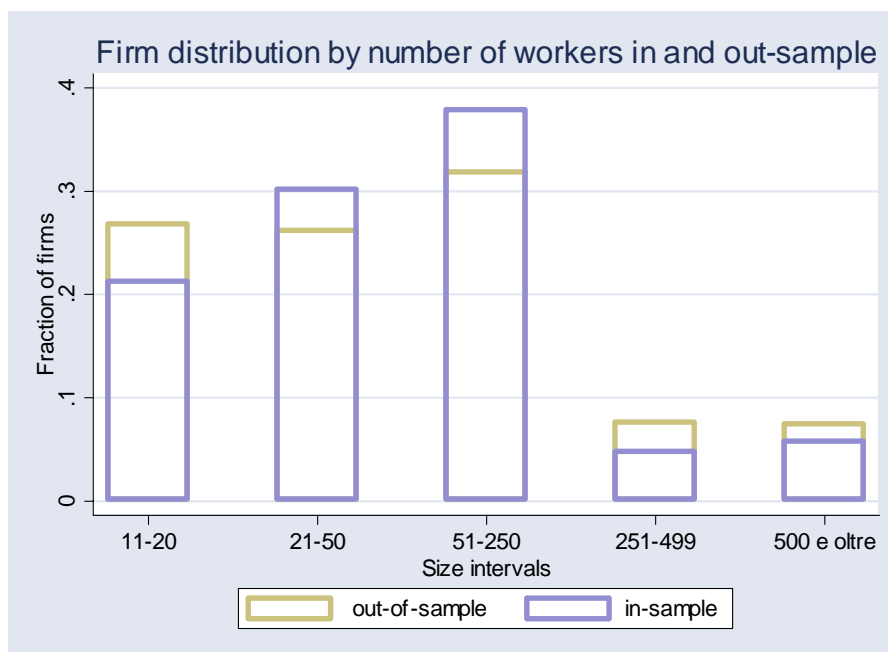
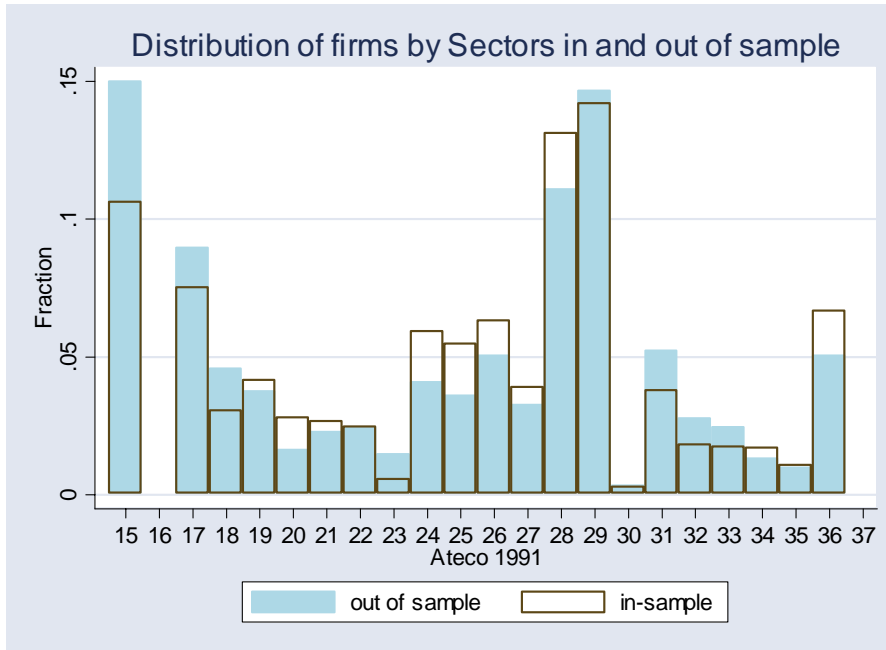


Figure A1 shows the distribution by class of workers of the firms falling in and out of our final panel. The panel tends to maintain medium size firms mainly (87%), while keeping around 79% of the medium-large and large firms. As far as the very small firms, our panel keeps 82% of them. Formally, the test for independence hypothesis rejects the null (Pearson chi-square(4) = 25.7455, p-value = 0.000) meaning that being in or out of sample depends in a certain way on firm size.

We lose 15.6% of firms located in North-West part of Italy (Lombardia, Piemonte, Liguria, Valle d'Aosta), 13.9% of the firms located in the North-East (Trentino A.A., Veneto, Friuli V.G., Emilia Romagna), 13.5% of the firms located in the Centre (Toscana, Umbria, Marche, Lazio) and 15.8% of the firms located in the South. The Pearson chi-square(4) = 3.4150 with p-value = 0.491 says that there is statistical independence between the regional distribution and being in or out of sample.

Traditional sectors with lower Ateco 1991 code, i.e. Food and Beverages, Textiles, Clothes, Tobacco, tend to be underrepresented with respect to the original Capitalia sample, as we can see from Figure A2. In any case if we consider High-Tech versus the others, there is an independent distribution of frequencies in and out of sample (Pearson chi-square(1) test = 0.3952 with p-value=0.530).

**Figure A 2. Distribution of firms by Ateco 1991 classification, in and out-sample**



We then run a two-sample t test with equal variances to test for equality of average firm age between the two groups (in-sample, out-sample). The results highlight that firms outside the sample are on average 3 years older, and the difference in means is statistically significant.

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Out sample	570	31.87	.938	22.41	30.03	33.72
In sample	3469	28.87	.325	19.16	28.24	29.51
Combined	4039	29.29	.309	19.67	28.69	29.90
diff		3.00	.887		1.259	4.742

Degrees of freedom: 4037

$$H_0: \text{mean}(\text{out}) - \text{mean}(\text{in}) = \text{diff} = 0$$

Ha: diff < 0	Ha: diff ≠ 0	Ha: diff > 0
t = 3.3795	t = 3.3795	t = 3.3795
P < t = 0.9996	P >  t  = 0.0007	P > t = 0.0004

Finally, we run an association tests to check for independence between being an innovative firm and being in or out of sample, to evaluate whether less innovative firms are those kicked out of the final panel. The Pearson chi-square tests are listed for different types of innovation activity:

R&D expenditures in 2001-2003 (yes/no)	Pearson chi-square(1) = 3.52 p-value = 0.061
Introducing product innovations (yes/no)	Pearson chi-square(1) = 7.194 p-value = 0.007
Introducing process innovations (yes/no)	Pearson chi-square(1) = 2.189 p-value = 0.139
Introducing both process and product innovations (yes/no)	Pearson chi-square(1) = 2.249 p-value = 0.134

We reject the hypothesis of independence for R&D expenditure and product innovation only. That means that firms investing into R&D and introducing product innovations have a (slightly) higher probability to survive. We cannot reject the null for process innovations or both kinds of innovations, instead. Introducing process innovations or not provide a firm equal probability to remain in our sample.

**Table 5 - Weighted Least Squares of changes in log-labor productivity**

Dep. $\Delta_2 \ln \frac{Y_{it}}{L_{it}}$	all firms	innovative firms	non innovative firms
$\Delta_2 \ln \frac{K_{it}}{L_{it}}$	.25*** (.0219)	.27*** (.0256)	.18*** (.0255)
$\frac{TEMP_{i,t-2}}{L_{i,t-2}}$	-.16*** (.0471)	-.12*** (.0274)	-.20** (.1054)
$\overline{AGE}_i$	-.0012* (.0007)	-.0025*** (.0007)	.0038** (.0018)
$\overline{SENIORITY}_i$	-.00056 (.0019)	.0014 (.0023)	-.0081*** (.0030)
Small	-.06*** (.0112)	-.082*** (.0147)	-.014 (.0181)
Medium	-.08 *** (.0089)	-.09*** (.0117)	-.04*** (.0132)
Centre	-.09*** (.0149)	-.13*** (.0193)	-.001 (.0257)
North East	-.097*** (.0141)	-.17*** (.0192)	.05** (.0233)
North West	-.06*** (.0136)	-.08*** (.0186)	.003 (.0217)
Group	.039*** (.0076)	.052*** (.0090)	.026** (.0134)
Constant	.18** (.0925)	.18 (.1105)	.12 (.1729)
R <sup>2</sup>	.16	.23	.10
Normal Residuals	[0.209]	[0.210]	[0.209]
N observations	8599	5779	2820

**Note: Standard errors in parentheses, p-values of tests in brackets.**

**The regressions are weighted with frequencies of board members within the firm.**

**Table 6 - Instrumental Variables analysis of changes in log-labor productivity**

Dep. $\Delta_2 \ln \frac{Y_{it}}{L_{it}}$	All firms	all firms	all firms	all firms
$\Delta_2 \ln \frac{K_{it}}{L_{it}}$	.14*** (.034)	.14*** (.0280)	.092*** (.0266)	.32*** (.0567)
$\frac{TEMP_{i,t-2}}{L_{i,t-2}}$	-.19*** (.059)	-.21*** (.050)	-.22*** (.0532)	-.13** (.0617)
Innovation whatsoever	.114*** (.0213)	-	-	
Proc innovation	-	.192*** (.0280)	-	1.01*** (.1552)
Prod innovation	-	-	.049*** (.0135)	-.45*** (.0839)
$AGE_i$	-.0002 (.0007)	-.0002 (.0007)	-.0007 (.0007)	.0019 (.0015)
$SENIORITY_i$	.0017** (.0007)	-.001*** (.0003)	.0002 (.0003)	-.0032*** (.0008)
Small	-.02*** (.0126)	-.05*** (.0126)	-.022** (.0115)	-.082*** (.0275)
Medium	-.06*** (.0100)	-.07*** (.0100)	-.051*** (.0094)	-.105*** (.021)
Centre	-.077*** (.0177)	-.077*** (.0177)	-.099*** (.0174)	.046 (.0375)
North East	-.057 *** (.009)	-.027 (.0176)	-.059*** (.0172)	.145*** (.0408)
North West	-.040 *** (.009)	-.02 (.0170)	-.031** (.0166)	.054* (.0301)
Constant	.002 (.0395)	.003 (.0415)	.103*** (.0369)	-.35*** (.1058)
R <sup>2</sup>	.04	.16	.23	.10
Normal Residuals	[0.2095]	[0.2095]	[0.2093]	[0.2225]
N observations	6592	6592	6592	6592

**Note:** Standard errors in parentheses, p-values in brackets. Instruments used for  $\Delta_2 \ln(K/L)$  and Innovation dummies are:  $\ln(Y/L)$  at the beginning of the sample period 2001,  $\ln(K/L)$  in 2001, Investment intensity with respect to Capital Stock in 2001, whether firms invested into R&D, labour force employed in R&D activity in 2001, age of the firm, group belonging, size and area dummies.