

The productivity puzzle: firm, workers, and industry characteristics

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#IstatWebinar

Previously achieved project objectives

Id. 55: Business demography during the great recession: patterns of resilience and productivity dispersion.

○ Survival analysis of manufacturing firms

- Cefis, E., E. Bartoloni and M. Bonati. (2020) Show me how to live: Firms' financial conditions and innovation during the crisis. *Structural Change and Economic Dynamics*, 52, 63-81.
- Bartoloni, E., A. Arrighetti and F. Landini. (2021) Recession and firm survival: is selection based on cleansing or skill accumulation? *Small Business Economics*, 57(4), 1893-1914.

○ Firm size evolution of manufacturing companies

- Bartoloni, E., M. Baussola and L. Bagnato. (2020) Waiting for Godot? Success or failure of firms' growth in a panel of Italian manufacturing firms. *Structural Change and Economic Dynamics*, 55, 259-275.

○ Analysis of the territorial performance of companies: the role of agglomeration factors in the Lombardy region

- Bartoloni, E. and M. Baussola. (2021) Productivity and earnings at the firm-plant level: the case of Lombardy's urban and non-urban agglomerations. *Spatial Economic Analysis*, 16(3), 333-354.

Summary

- The aim
- Motivation
- The italian productivity stagnation: some stylized facts
- Data description
- Microdata descriptive statistics
- Model description
- Variables
- Estimates
- Conclusion

The aim

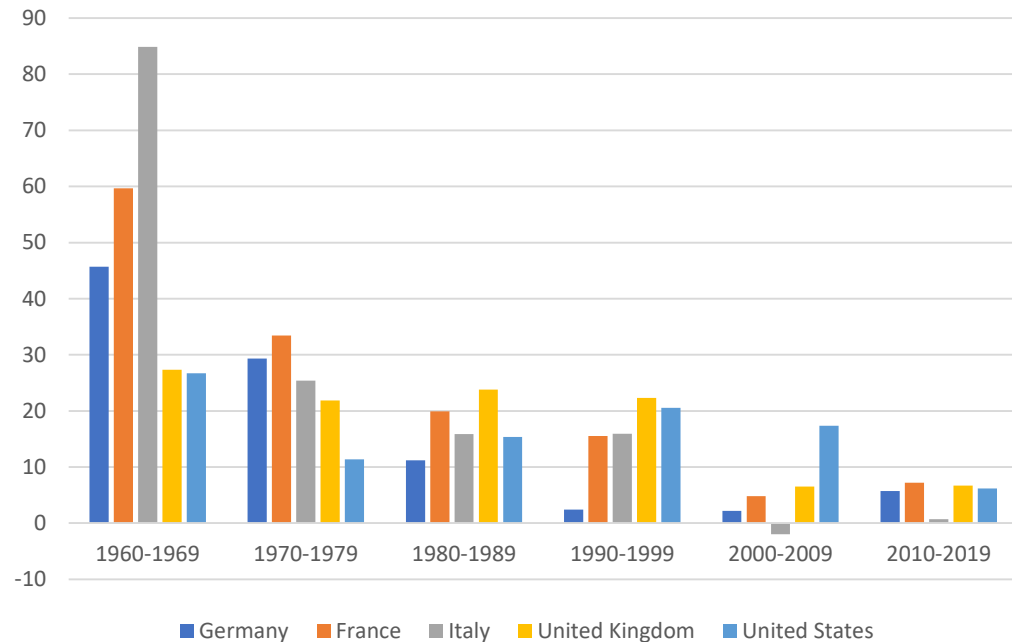
- to **assess the relative impact** of firm, workers, and sectoral characteristics on labor productivity at the firm level by using a matched employer-employee panel of Italian firms during the period 2012-2017.
- Using a **modeling strategy** that enables us to estimate labour productivity from a production function in which workers' age, occupational status, and gender may be considered upward or downward productivity shifts.
- To endogenize **firms' internationalization behavior** by using a more appropriate specification. This modeling strategy enables us to explain the determinants of labor productivity at the firm level and, at the same time, rationalize the macroeconomic implications.

Motivation

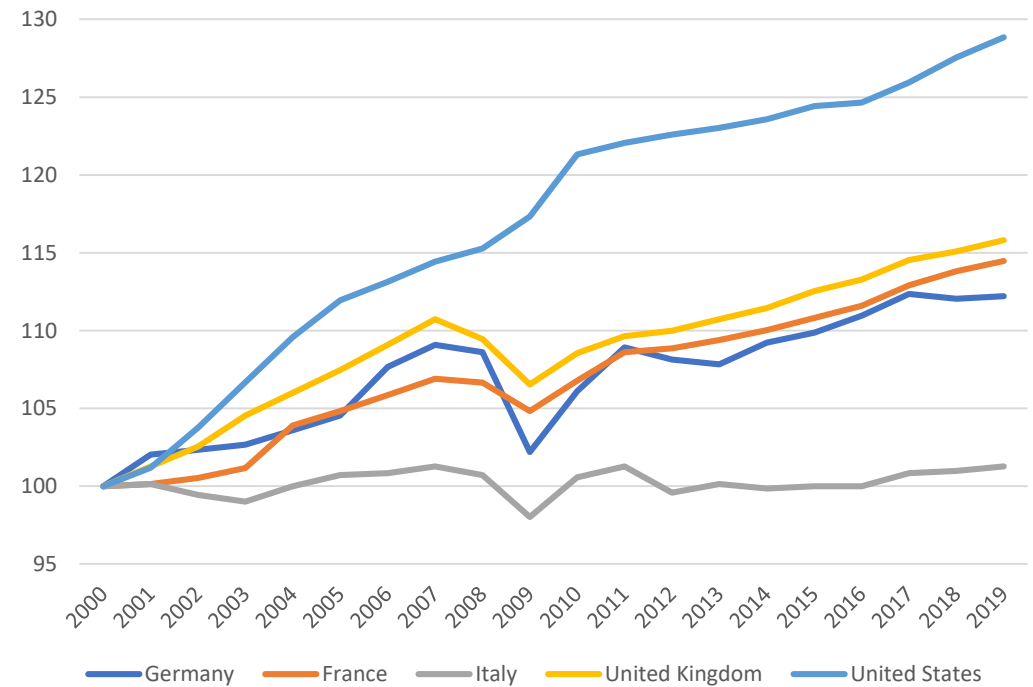
- Labor productivity is recognized as the key driver of economic growth. However, the Italian economy is experiencing an **unsatisfactory productivity growth rate**. Although shared with many developed countries, such a pattern is nevertheless more specific and pronounced in the Italian economy.
- Endogenous growth models that mainly focused on **the role of knowledge** in fostering economic growth. In this framework, knowledge is considered similar to other production inputs; it could be incorporated into labor as human capital (Lucas 1988), fixed capital (Rebelo 1991), or generated by a specific sector (R&D) (Romer 1990).
- **Microeconomic approaches** tried to overcome some of the controversies faced at the macro level by using firm data eventually matched with complementary information and considering firm and industry features to describe the level and variation of labor productivity.
- A great deal of attention has been devoted to the impact of **human capital, age, and occupational characteristics** (Hellerstein et al., 1999; Haltinwanger et al., 1999; Van Ours and Stoeldraijer 2011) also **in conjunction with other firm specific characteristics** (Kampelmann and Rycx 2011) specifically estimate the impact on the productivity of different individual occupation statuses requiring different education levels.
- Our investigation falls within this debate, thus including the **quality augmented component of employment** in analyzing labour productivity in the Italian economy.

The stylized facts of the Italian productivity stagnation

Labor productivity growth for decades in selected Countries, real GDP per employed



Real Labour productivity in selected Countries, base year 2000



Source: European Commission, AMECO database

Data description

We use the **FRAME-SBS** statistical register for the years 2012-2017.

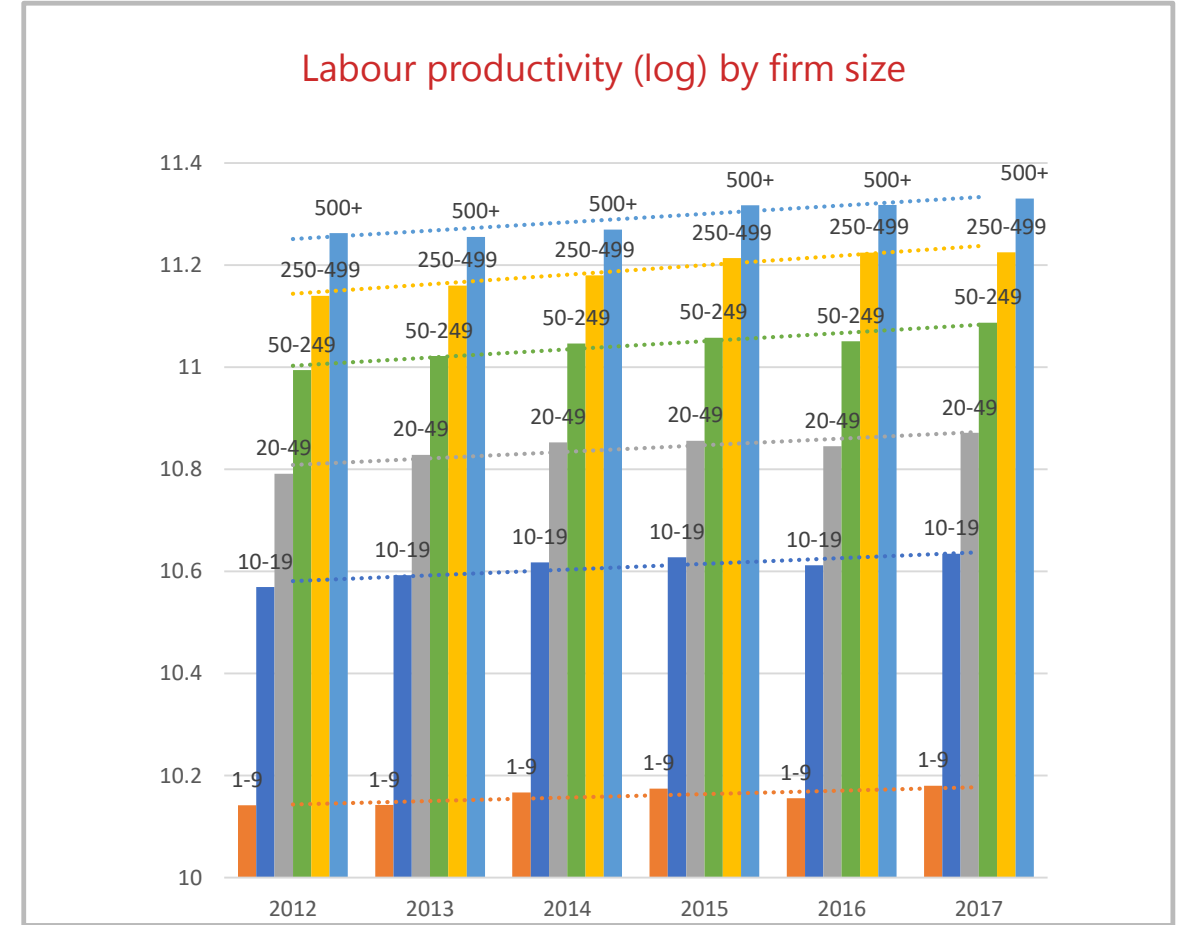
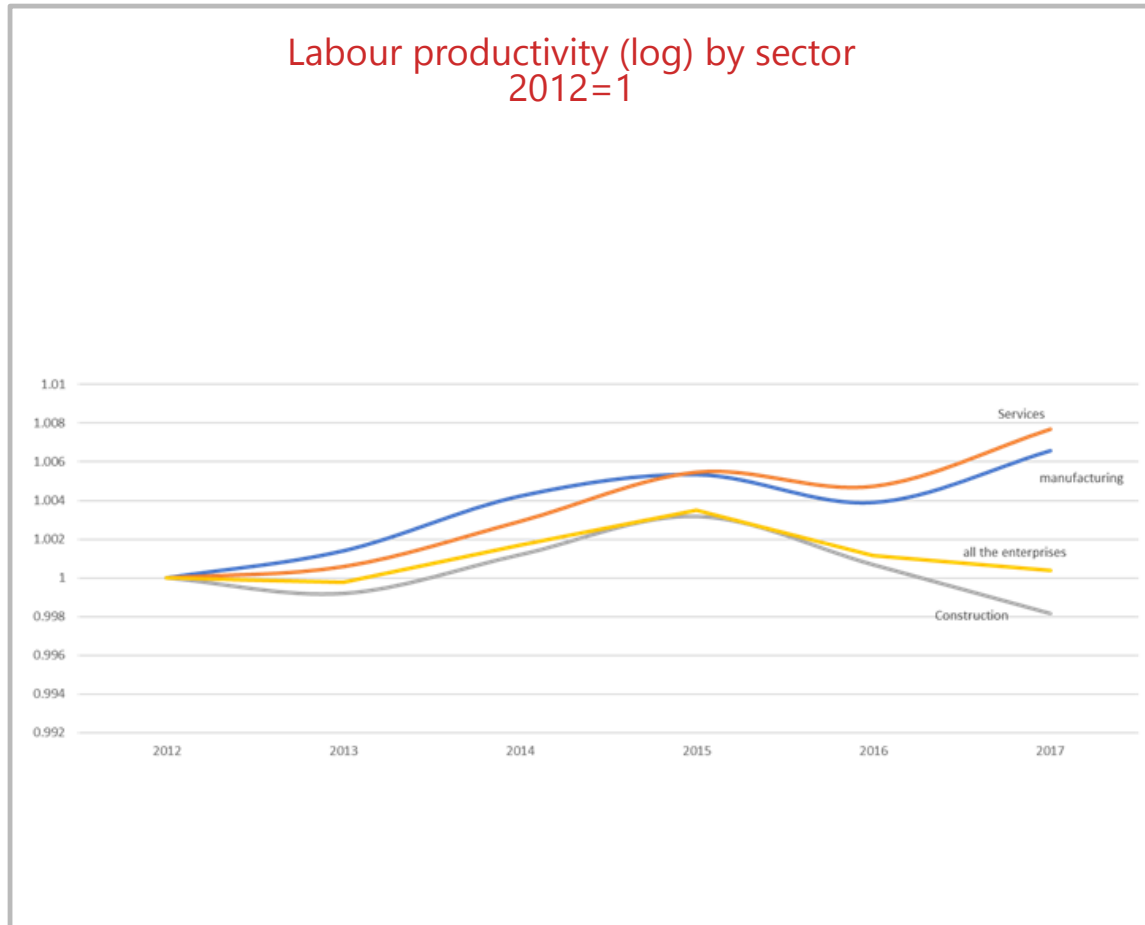
Information on the demographic and job-related employment characteristics at the firm level stems from the **ASIA Employment Archive**, a Linked Employer-Employees Database

The **final database is an unbalanced panel of 7,926,386 firms** that may enter or exit their reference industry during the considered period.

| | 2012 | 2013 | 2014 | 2015 | 2016 | Total |
|-------|-----------|-----------|-----------|-----------|-----------|-----------|
| Firms | 1,357,717 | 1,313,216 | 1,289,692 | 1,295,569 | 1,327,435 | 7,926,386 |

Considering the total sample, 84.6% of the firm has less than ten workers, 9.7% between 10 and 19, and only 1.8% have more than 50 workers. Regarding sectors, 17.3% of firms belong to Industry, 12.5% to Construction, and 70.2% to Services. The distribution of firms by macro regions (NUT1) shows that 49% of them are localized in the North (27.4% North-west; 21.4% North-east); 20.3% and 30% respectively in the Centre and the South.

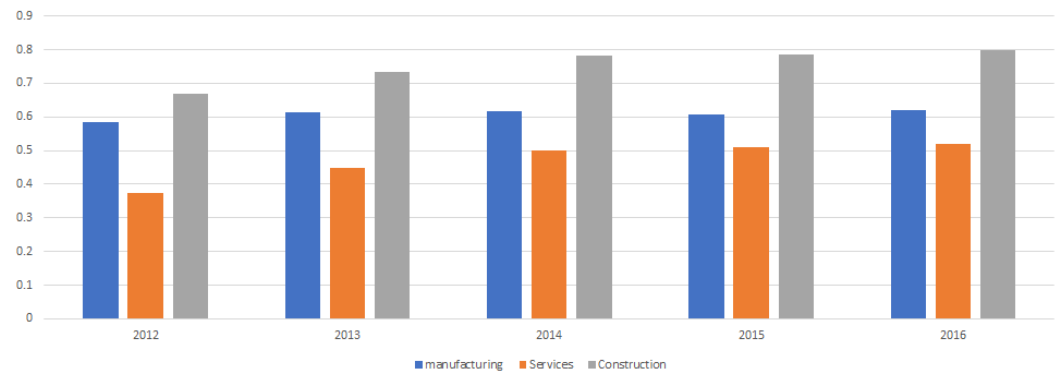
Microdata descriptive statistics – 2012-2017



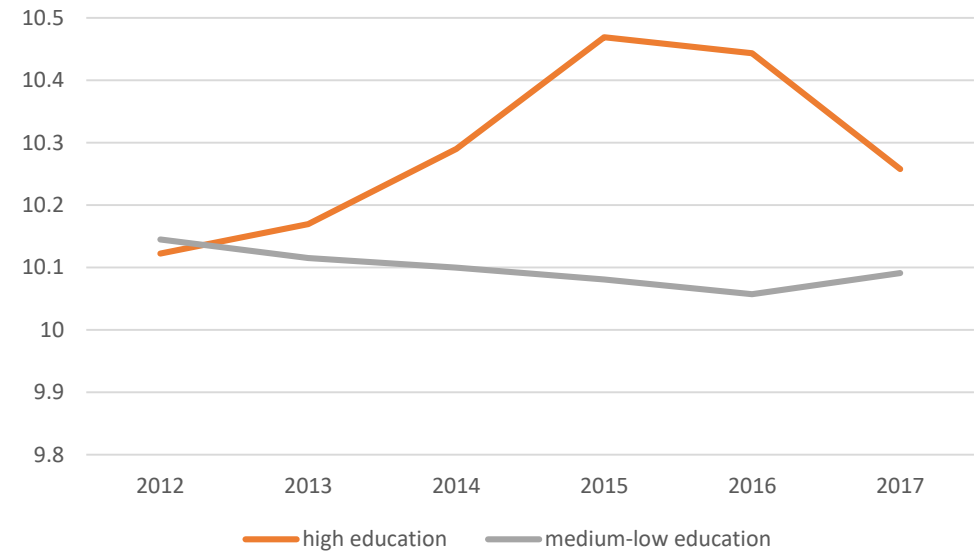
Source: FRAME-SBS integrated with ASIA-employment

Microdata descriptive statistics – 2012-2017

The productivity premium of the persistent exporters



Labour productivity: the educational gap – all the enterprises



Note: Firms above and below the third quartile of the distribution of the *edu_tertiary* variable (share of employees with at least tertiary education (level 4 of ISCED))

Source: FRAME-SBS integrated with ASIA-employment

Model description

We can describe the empirical modeling strategy by considering the following production function:

$$\ln y_{it} = \alpha \ln(\gamma_{it} N_{it}) + \rho E_{it} + \theta S_{it} + \delta Z_{it} + u_{it} \quad \text{where } u_{it} = \mu^i + e_{it}$$

Following Van Ours and Stoeldraijer (2011) and Kamplmann and Rycx (2011), after linearization the **labor input** may be written as in the following:

$$\ln y_{it} = \alpha \ln \gamma_0 + \alpha \ln N_{it} + \sum_{j \neq \{0\}} \alpha \left(\frac{\gamma_j - \gamma_0}{\gamma_0} \right) \left(\frac{N_j}{N} \right)_{it} + \rho E_{it} + \theta S_{it} + \delta Z_{it} + u_{it}$$

where i = firm, j = level of the labour category, and γ_0 is the reference level.

or:

$$\ln y_{it} = c + \alpha \ln N_{it} + \sum_j \alpha_j n_{j,it} + \rho E_{it} + \theta S_{it} + \delta Z_{it} + u_{it}$$

$$c = \alpha \ln \gamma_0; \quad \alpha_j = \alpha \left(\frac{\gamma_j - \gamma_0}{\gamma_0} \right) \quad \text{and} \quad n_j = \frac{N_j}{N}$$

Variables

- Firm's specific characteristics (productivity, labour input, vector E)
 - lny = log labour productivity (the ratio of value added to total employment)
 - $lemp$ = log total employment; 6 size classes (10-; 10-19; 20-49; 50-249; 250-499; 500+)
 - $lage$ = log firm's age (number of years between its foundation and the date of observation)
 - $persexp$ = 0/1 variable, 1 if the firm has had a positive value of export for all the period (persistent exporter) considered
- Sectoral/location characteristics (vectors S and Z)
 - Nace divisions aggregation, according to the Eurostat High-tech industry and knowledge-intensive services (htec) classification: Manufacturing (Htech; MHtech; MLtech; Ltech); Services (KI services; HT services; less KI services; Household services); Construction
 - North-West; North-East; Centre; South of Italy (Nuts1)
- Labour categories
 - Female/male = share of female/male workers in a firm on total employees
 - temporary/permanent = share of employees with a fixed-term/permanent contract in a firm
 - part_time/full time = share of workers with a part-time/full time contract on total employees
 - age_30-; age_30-49; age_50+ = share of employed in each age class on total employees, by firm
 - blue collars; white collars; executives = share of employees in each category (executives = managerial or middle managerial roles) on total employees
 - edu_primary-edu_; secondary; edu_tertiary = share of employees in each category (secondary = level 2-3 of ISCED; tertiary = level 4 of ISCED)

Labour productivity: panel data estimates (re) – firm, sectoral and geographical characteristics

- In the manufacturing productivity increases monotonically with **size** (reference: size 1-9).
- **Geography** matters
- Productivity increases with **sectoral technology and knowledge base**. The increase is **not monotonic in the manufacturing**
- Competing in international markets (**persistent exporter**) has a significant and strong effect

| | <i>Manufacturing</i> | <i>Services</i> | <i>Construction</i> |
|---------------------|------------------------|------------------------|------------------------|
| | (1) | (3) | (4) |
| <i>size_10-19</i> | 0.0668*** [0.00206] | 0.0343*** [0.00143] | 0.0867*** [0.00246] |
| <i>size_20-49</i> | 0.151*** [0.00344] | 0.0566*** [0.00262] | 0.173*** [0.00475] |
| <i>size_50-249</i> | 0.217*** [0.00557] | 0.0476*** [0.00470] | 0.226*** [0.0105] |
| <i>size_250-499</i> | 0.274*** [0.0145] | 0.0278** [0.0110] | 0.223*** [0.0394] |
| <i>size_500+</i> | 0.318*** [0.0227] | 0.0199 [0.0167] | 0.187** [0.0737] |
| <i>North East</i> | 0.295*** [0.00310] | 0.223*** [0.00170] | 0.281*** [0.00259] |
| <i>North West</i> | 0.288*** [0.00314] | 0.227*** [0.00179] | 0.247*** [0.00284] |
| <i>Centre</i> | 0.161*** [0.00328] | 0.131*** [0.00178] | 0.171*** [0.00280] |
| <i>lage</i> | 0.0470*** [0.00110] | 0.125*** [0.000677] | 0.0353*** [0.00107] |
| <i>persexp</i> | 0.258*** [0.00284] | 0.419*** [0.00346] | 0.187*** [0.0143] |
| [.....] | | | |

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Time dummies included

| | <i>Manufacturing</i> | <i>Services</i> | <i>Construction</i> |
|---------------------------|------------------------|-------------------------|-----------------------|
| | (1) | (3) | (4) |
| [.....] | | | |
| <i>HT manu</i> | 0.0473*** [0.00510] | | |
| <i>MH manu</i> | 0.143*** [0.00278] | | |
| <i>ML manu</i> | 0.102*** [0.00257] | | |
| <i>KI Services</i> | | 0.0833*** [0.00297] | |
| <i>HT services</i> | | 0.202*** [0.00185] | |
| <i>Household services</i> | | -0.0457*** [0.00180] | |
| <i>Constant</i> | 9.558*** [0.00544] | 9.311*** [0.00293] | 9.753*** [0.00918] |
| <i>n. obs</i> | 1,246,124 | 4,962,816 | 838,065 |
| <i>n. enterprises</i> | 261,060 | 1,087,555 | 192,074 |
| <i>within</i> | 0.004 | 0.006 | 0.006 |
| <i>between</i> | 0.429 | 0.346 | 0.235 |

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Time dummies included

Labour productivity: panel data estimates (re) – workers characteristics

- The **gender effect**, provided by a firm's share of male employment, is more marked in the manufacturing (pulled by the *part_time* variable correlated with the female share).
- **Labour quality**:
 - education, professional status, **workers' age** (accumulated experience) exert positive and significant effects
 - contract characteristics:
 - part time vs full time: negative impact
 - (**temporary vs permanent**): negative and relevant impact in the services; mild positive in manufacturing and construction

| | <i>Manufacturing</i> | <i>Services</i> | <i>Construction</i> |
|----------------------|------------------------|-------------------------|------------------------|
| | (1) | (3) | (4) |
| <i>male</i> | [0.00110] 0.241*** | [0.000677] 0.131*** | [0.00107] 0.170*** |
| <i>part_time</i> | [0.00377] -0.420*** | [0.00169] -0.347*** | [0.00836] -0.379*** |
| <i>temporary</i> | [0.00303] 0.0801*** | [0.00133] -0.0411*** | [0.00356] 0.0906*** |
| <i>age_30-49</i> | [0.00453] 0.0899*** | [0.00167] 0.100*** | [0.00332] 0.122*** |
| <i>age_50+</i> | [0.00313] 0.0824*** | [0.00137] 0.121*** | [0.00257] 0.140*** |
| <i>executives</i> | [0.00409] 1.378*** | [0.00191] 1.183*** | [0.00365] 1.744*** |
| <i>white collars</i> | [0.0413] 0.373*** | [0.0152] 0.364*** | [0.178] 0.362*** |
| <i>edu_secondary</i> | [0.00528] 0.144*** | [0.00177] 0.161*** | [0.00705] 0.0470*** |
| <i>edu_tertiary</i> | [0.00381] 0.329*** | [0.00254] 0.349*** | [0.00309] 0.183*** |
| | [0.0106] | [0.00358] | [0.0103] |

[.....]
Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Time dummies included

Omitted variable and endogeneity issues

- Implementing **IV estimates that endogenize the export variable**, i.e., the dummy variable reflecting a firm's exporting attitude. This variable is indeed endogenous as it reflects a firm's behavior and attitude that crucially depends on its intrinsic characteristics and sectoral features. For this reason, we decided to estimate equation VI) by 2SLS using a probit estimation, thus enabling us to derive predicted exporting probabilities then used as instruments for the productivity equation
- Including the **proxy for the capital stock** (available for the manufacturing) enables us to consider the OMV issue. Some evidences from other international studies:
 - Microeconomic estimations that use capital input (Hellerstein et al. 1999; Aubert and Crepon 2003; Dostie 2011) show a relatively **low elasticity** attached to it.
 - Van Ours and Stoeldraijer (2011) use **depreciation on fixed assets** as a proxy for capital input. Their baseline results remain, however, unchanged when this proxy is introduced.
 - Kampelmann and Rycx (2012) use, instead, **sector dummy variables** which are indeed a poor proxy, although fixed capital assets are correlated with industry characteristics.

IV estimates: some results

- The magnitude of the impact of k on productivity is generally confirmed.
- The firm's size effect is reduced (picked up by the k variable).
- The technological dummies are also affected (their impact increases significantly).

| | Manufacturing | |
|---------------------------|------------------------|------------------------|
| | (1) | (2) |
| <i>size_10-19</i> | 0.0860*** [0.00321] | 0.0612*** [0.00332] |
| <i>size_20-49</i> | 0.194*** [0.00721] | 0.147*** [0.00747] |
| <i>size_50-249</i> | 0.284*** [0.0121] | 0.209*** [0.0127] |
| <i>size_250-499</i> | 0.354*** [0.0191] | 0.242*** [0.0203] |
| <i>size_500+</i> | 0.404*** [0.0261] | 0.268*** [0.0258] |
| <i>k</i> | | 0.0523*** [0.00194] |
| [.....] | | |
| <i>HT manu</i> | 0.0445*** [0.00510] | 0.148*** [0.00510] |
| <i>MH manu</i> | 0.149*** [0.00316] | 0.244*** [0.00293] |
| <i>ML manu</i> | 0.100*** [0.00256] | 0.159*** [0.00253] |
| <i>KI Services</i> | | |
| <i>HT services</i> | | |
| <i>Household services</i> | | |
| <i>Constant</i> | 9.558*** [0.00554] | 9.085*** [0.0179] |
| <i>n. obs</i> | 1,246,124 | 1,192,506 |
| <i>n. enterprises</i> | 261,060 | 249,516 |
| [.....] | | |

Robust standard errors in brackets
 *** p<0.01, ** p<0.05, * p<0.1
 Time dummies included

Internationalization: positive and significant impact confirmed in manufacturing and services. **Not significant in the construction** (few exporting companies generating poor predictions)

| | Manufacturing | | Services | Construction |
|-----------------------|-----------------------|----------------------|-----------------------|-----------------------|
| | (1) | (2) | (3) | (4) |
| <i>persexp</i> | 0.1003*** [0.0275] | 0.162*** [0.0267] | 0.889*** [0.0259] | -0.0501 [0.162] |
| [.....] | | | | |
| <i>Constant</i> | 9.558*** [0.00554] | 9.085*** [0.0179] | 9.323*** [0.00286] | 9.755*** [0.00918] |
| [.....] | | | | |
| <i>n. obs</i> | 1,246,124 | 1,192,506 | 4,962,816 | 838,065 |
| <i>n. enterprises</i> | 261,060 | 249,516 | 1,087,555 | 192,074 |
| [.....] | | | | |

Robust standard errors in brackets
 *** p<0.01, ** p<0.05, * p<0.1
 Time dummies included

Conclusion

- A *unique data set* for the Italian manufacturing, services, and construction sectors to provide a more precise picture of the mechanisms and interactions that crucially affect productivity.
- *Firm size* is significant in affecting productivity. Its impact implies increasing returns in manufacturing in a specification in which firm's size is described using dummy variables reflecting a firm's reference size class. This effect is robust to different specifications that consider omitted variables and endogeneity bias.
- *Employees' human capital and age* structure positively affect productivity. This result confirms international estimates (Van Ours and Stoeldraijer 2011, Hellerstein et al. 1999) showing a declining impact (although positive) from the age of 50. This pattern prevails in manufacturing, whereas productivity increases after this age threshold in services and construction.
- *Export propensity* is an enabler, but the share of persistent exporters is low (22% in manufacturing; 3% in the services). This attitude is strongly related to firm size. Given the inability of the Italian company to grow, also documented in another work within this project (Bartoloni, E., M. Baussola and L. Bagnato. (2020) *Structural Change and Economic Dynamics*, 55, 259-275.) the critical policy prescription is to create the conditions that enable firms to grow

grazie

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