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POTENTIAL OUTPUT AND MICROECONOMIC HETEROGENEITY

by Davide Fantino*

Abstract

I estimate potential output growth using a production function approach applied to individual firm-level data for Italy. The dataset includes 360,000 non-financial corporations over the period 2004-15. I compare these estimates with those obtained from aggregate data, with a view to extracting additional information on the drivers of potential output in recent years. The approach based on individual firm-level data suggests a more sluggish potential growth before the crisis and a stronger recovery afterwards; the main reason is that estimates based on aggregate data are likely to suffer from aggregation biases and endogeneity problems. I find that the contributions of labour and capital to potential output growth decline over time and that unobserved firms' productivity explains most of the recovery after 2009; turnover has a substantial negative impact during the crisis, but a positive one afterwards. All the main economic sectors are affected by the financial crisis; potential growth in manufacturing is less damaged during the crisis and recovers afterwards; the service sector is recovering slowly, while construction firms are still not recovering.

JEL Classification: D24, E23.
Keywords: potential output, heterogeneity, aggregation bias.

Contents

* Bank of Italy, Directorate General for Economics, Statistics and Research.

1. Introduction[1]

The recent double-dip recession strongly damaged the economic activity of Italy. According to the estimates of Caivano *et al.* (2010) and Busetti and Cova (2013), the two recessions reduced Italian output by about 13% compared to a counterfactual (model based) no crisis scenario. The economy is now showing a gradual strengthening of the recovery, but at the end of 2016 the level of GDP was still about 7 percentage points lower than its pre-crisis peak. Many firms left the market (Mistretta *et al.*, 2016) and the remaining ones lost part of their (human and physical) capital and invested less in their productive inputs, with relevant effects on the structure of the Italian economic system (Monteforte and Zevi, 2016). Quantifying the impact of this prolonged crisis on potential output, and hence computing the output gap, is particularly important in order to correctly calibrate economic policies according to the degree of structural vs cyclical developments.

A common strategy to achieve this aim is the decomposition of the output in a low frequency, more structural component (potential output) and a high frequency, more volatile one (business cycle). There is currently no full agreement in the literature on either the definition of potential output or the methodologies to estimate it. Several methods are currently used at the Bank of Italy (Bassanetti *et al.*, 2010): a Bayesian unobserved component model, a univariate time-varying autoregressive model, an aggregate production function and a structural VAR. Among them, the method based on the aggregate production function has a sounder grounding based on economic theory and also has a firm level analogue; the other approaches are mainly based on statistical tools.

In general, all the traditional methodologies are based on aggregate information, resulting in a loss of potentially crucial information on heterogeneity of firms. On the other hand, accounting for heterogeneities in the characteristics of firms, including sectors of activity, can be quite relevant when there are strong differences in their evolution (Fernald, 2015, Bartelsman and Wolf, 2014). For example, more dynamic sectors increase their weight over time and therefore their contribution to growth can be understated using average estimates based on the whole sample period.

Moreover, one should take into account the so-called aggregation bias. In fact, the relationships between inputs and output existing at firm level are preserved under aggregation on-

[1] I'm grateful to Lorenzo Burlon, Fabio Busetti, Davide Delle Monache, Libero Monteforte and two anonymous referees for useful discussions and comments. The views expressed in the paper are those of the author and do not necessarily reflect those of the Bank of Italy.

ly if quite restrictive conditions hold (e.g. when a production function is homogeneous of degree one and there are no frictions in the accumulation and disposal of inputs); in absence of these conditions, the standard methodologies based on aggregate data fail to capture phenomena such as misallocation of inputs, whose impact on the unobserved productivity has been shown to be relevant by the recent literature (Hsieh and Klenow, 2009, Adamopoulou *et al.*, 2016, Gamberoni *et al.*, 2016, Linarello and Petrella, 2016, Calligaris *et al.*, 2017).

Besides, microeconometric techniques allow for a better correction of several problems in estimation, such as the endogeneity of regressors due to simultaneity and measurement errors (Olley and Pakes, 1996, Levinsohn and Petrin, 2003, Woolridge, 2009, Akerberg *et al.*, 2015, Collard-Wexler and De Loecker, 2016, Kim *et al.*, 2016).

In this work I estimate potential output growth using a production function approach applied to Italian individual firm level data, with the purpose of uncovering possible biases related to the use of aggregate data and of extracting additional information on the drivers of potential output growth in the last ten years[2].

The main source of information is the Company Accounts Data System managed by Cerved; the final dataset includes the balance sheets of about 360 thousand non-financial corporations with positive value added and production factors, while smaller firms such as partnerships are not included. The dataset shows a fairly good overall representativeness of the Italian economy, as the aggregate evolution of value added is qualitatively similar to the National accounts. The accuracy is particularly good when restricting the attention to the manufacturing sector.

The main findings are that, when compared with the standard methodology based on aggregate data, the use of a production function approach on individual firm level data suggests more sluggish dynamics of potential output before the recent crisis and a stronger recovery afterwards. The statistical significance of the difference between the estimates, of a magnitude of about 0.3-0.4 percentage points, cannot be evaluated, as we are not able to calculate the standard errors of the estimates based on individual firm level data, but it seems to be relevant on a historical comparison; it is about one third of the growth rate of Italian potential

[2] Another related firm level approach is Locatelli *et al.* (2016). While that work is based on a sample of about 2000 manufacturing firms with more than 50 employees from the Invind survey, the dataset here used is based on the Cerved database, which includes virtually all the Italian corporations. Moreover, Locatelli *et al.* (2016) exploit in their analysis the answers to a survey question regarding the actual used productive capacity of physical capital, given the current state of employment and technology of the firm, while the analysis of this work wants to capture the potential output growth, depurated of the cyclical components and taking into account the trend evolution of all the inputs (labour, capital and unobserved productivity).

output in 2015. The main reason behind this difference is related to the aggregation bias; the correction for endogeneity is relevant, but relatively less important, while the impact of sectorial heterogeneity appears overall small.

The firm level data estimates presented here show that the contribution of labour and capital to potential output growth declined over time, while most of the recovery after 2009 is explained by unobserved productivity of firms. All main sectors of activity were affected by a contraction of potential growth around 2009; while manufacturing firms recovered relatively soon, the services sector is recovering slowly and construction firms did not yet. Finally, firms' turnover had a substantial negative impact on potential output growth during the crisis, but its contribution became positive in more recent years.

The remaining of the paper is organized as follows: sections 2 and 3 present respectively the dataset and the empirical strategy; I show the main results of the paper, based on a balanced panel of firms, in section 4 and some robustness checks, with small changes in methodology and variables used, in section 5; section 6 enlarges the analysis to the more representative full panel, which takes into account entry and exit of firms; section 7 concludes.

2. Data

The main source of data is the Company Accounts Data System managed by Cerved, which includes yearly information about the balance sheets and the income statements of almost all the Italian non-financial corporations; smaller firms such as partnerships are not included in the dataset.

For each firm, I extracted from Cerved: all the available identifiers, including the fiscal one, the book value amount of physical and immaterial capital, value added, revenues, depreciation, investments and disinvestments, the expenditure in intermediate goods and services, the sector of economic activity according to the Ateco classification (2 digits; Istat, 2009)[3]. All the balance sheet variables from Cerved have been deflated using the relevant National accounts deflators for each economic sector from the National Institute of Statistics (Istat); I also recovered from this source the sector level statistics regarding depreciation of capital.

Unfortunately, Cerved does not include reliable information about firm employment; this additional information was collected from the archives of the National Social Security Institute (INPS), which include details regarding the employment structure of the universe of

[3] Few sectors with too few observations have been merged together; 62 different sectors of economic activity are represented in the dataset.

Italian firms. Moreover, information regarding birth, death and extraordinary transactions such as mergers and acquisitions of firms have been recovered from the Infocamere database, based on the register of firms of the Italian Chamber of Commerce; firms born after 1995 or dead before 2015 have been included in the dataset only if respectively their first or last balance sheet is near the birth or death date declared in Infocamere.

Real physical capital was constructed using the permanent inventory methodology (OECD, 2009); for each firm, I cumulated real investments, at the net of disinvestments and of depreciation of the already accumulated capital:

$$K_{it}^{PI} = (1 - \delta_{st}) * (1 - s_{it}) * K_{it-1}^{PI} + I_{it} \tag{1}$$

where, for firm i active in sector s in period t, K_{it}^{PI} is the amount of real physical capital, I_{it} are real investments in physical capital of the firm, s_{it} is the share of disinvested capital and δ_{st} is the sector level depreciation rate from the National accounts.[4] The permanent inventory methodology is usually preferred to the direct use of the book value amount of capital declared in the balance sheet as it is not plagued by biases deriving from the depreciation policies of each firm[5]. In the robustness checks I alternatively use the book value real amount of net physical capital.

The analysis is restricted to the time window 2004-2015, with additional information about 1995-2003 when helpful to construct capital and to improve estimates and the quality of filtering. I winsorized the first and the last 5 per cent of the distribution of each continuous variable for each year and economic sector to take care of outliers; firms with gaps and missing observations were also removed. Moreover, I checked that the start and the end of the time series of balance sheets of each firm in Cerved was reasonably near to the birth and death date reported by Infocamere as a criterion of inclusion in the dataset. Last, I used the Cobb-Douglas functional form for the production function, which requires a positive value for all the inputs and the output, so observations with non-positive value added or null amount for one or more inputs in the production function were not included in the sample. The final dataset includes about 2.1 million observations regarding 360 thousand Italian firms. A subset of about 40 thousand firms reported their balance sheet each year for the whole time window;

[4] In general, the construction of a reliable capital time series is a complex problem and must be tackled with care, because of the difficulty of correctly taking into account all the extraordinary transactions, particularly when considering big firms in some sectors of economic activity.

[5] Unless the whole history of investments of a firm is available, the initial amount of capital when using the permanent inventory methodology is anyway approximated by the deflated book value of capital; to eliminate possible biases in the initial years of the dataset I used all the available investment data from 1995 to construct capital, but I only observe potential output in the time window between 2004 and 2015.

most of the analysis is based on this balanced panel, as a longer time series dimension allows to improve quality of potential output estimates.

Table 1 shows the descriptive statistics of the main variables used in the analysis for both the full and the balanced panel. The firms included in the balanced panel have broadly similar characteristics to those in the full sample, but they are on average slightly bigger in size, reflecting the fact that bigger firms are more likely to survive for prolonged periods. In the full sample, the entry rate is about 10% while the exit rate is slightly smaller, implying that the number of firms increases over time[6]. The amount of both material and immaterial net assets stated in the balance sheets are generally smaller than those built using the permanent inventory method, implying that the average depreciation rates deduced from the balance sheets are bigger than those reported in the National accounts.

Table 1: Descriptive statistics

	Full sample					Balanced sample				
Variable	Mean	Std. dev.	Min	Median	Max	Mean	Std. dev.	Min	Median	Max
Value added	1.064	7.825	0.001	0.238	1138	2.421	11.937	0.001	0.675	1026
Revenues	4.749	43.901	0.001	0.906	13400	10.900	63.066	0.006	2.566	5645
Material assets (BV)	0.880	20.397	0.001	0.055	10900	1.834	12.445	0.001	0.263	1698
Material assets (PI)	1.530	27.302	0.001	0.130	11000	3.638	25.409	0.001	0.677	3355
Immaterial assets (BV)	0.217	9.589	0	0.004	2586	0.136	1.805	0	0.005	288
Immaterial assets (PI)	0.388	11.600	0	0.014	2805	0.484	4.501	0	0.040	524
Material investments	0.158	3.605	0	0.008	1321	0.341	3.206	0	0.026	600
Immaterial investments	0.038	1.406	0	0	780	0.056	0.952	0	0	333
Overall net investments	0.171	3.836	-881	0.011	1660	0.354	3.578	-338	0.032	609
Employees	20.06	150.03	1	6	48391	39.36	180.70	1	13	13363
Intermediate goods and services purchases	3.668	39.892	0.001	0.585	12600	8.567	57.975	0.001	1.729	7748
Entry rate	0.107	0.309								
Exit rate	0.077	0.266								

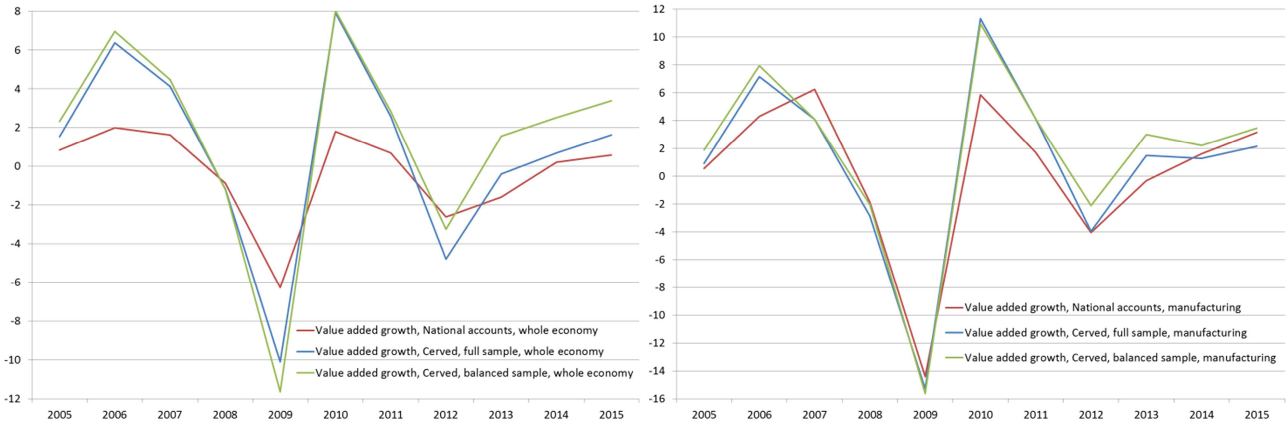
Real million euros, chain linked values with basis 2010, except for employees (units), entry and exit rates (dummy variable). BV: book value; PI: permanent inventory methodology. The full sample includes 2148000 observations about 362130 firms; the balanced sample includes 483876 observations about 40323 firms.

Figure 1 compares the aggregate growth rates of real value added in the National accounts and in the dataset here used, either considering the whole sample of firms or just restricting the attention to the balanced panel. The left panel shows the comparison for the

[6] The entry and exit rates here reported and the corresponding dummy variables in the dataset used in the analysis of section 7 are corrected for mergers and acquisitions and other extraordinary transactions reported in Infocamere.

whole economy, while the right panel only considers the manufacturing sector. The dataset shows a fairly good overall representativeness of the Italian economy, as the evolution is qualitatively similar. Even if changes in the growth rates are usually more noticeable in Cerved than in the National accounts for the whole economy, the correlation in the evolution of aggregate value added respectively in the National accounts for the whole economy and in the firm level dataset here used is greater than 95%. The accuracy of the dataset in representing the dynamics of value added shown in the National accounts increases even more when restricting the attention to the manufacturing sector. Both for the whole economy and just for the manufacturing sector, the dynamics of the balanced panel are substantially the same of those of the full dataset.

Figure 1: Real value added growth in the National accounts and Cerved



3. Empirical strategy

The firm level production function approach to the estimate of the potential output here implemented is based on the relationship linking the production inputs to the output for a generic firm i active in the sector of economic activity s in a period t, which, assuming a Cobb-Douglas specification and the most basic inputs, can be written in logarithmic terms as:

$$ln(y_{it}) = ln(A_{it}) + \alpha_s\, ln(K_{it}) + \beta_s\, ln(L_{it}) \tag{2}$$

where A_{it} is the unobserved (for the econometrician, not for the firm) productivity of the firm, K_{it} is physical capital and L_{it} is the amount of labour employed in production. This relationship has been estimated at firm level on the whole time window 1995-2015, recovering the unobserved productivity as a residual, assuming that the production function is the same for all the firms in each Ateco (2 digits) sector of economic activity and that parameters do not change over time.

Several additional complications arise in the estimation, the main one being that inputs and output are chosen by the firm after knowing its own productivity and therefore there could be some issues of endogeneity between regressors and error term of the equation. Olley and Pakes (1996; OP), Levinsohn and Petrin (2003; LP) and Ackerberg *et al.* (2015; ACF) proposed different methodologies to tackle this issue, mainly based on control function approaches which use the lags of some partially adjustable inputs as instrumental variables to correct the endogeneity bias[7].

OP proposed the use of investments in their original paper, but the following literature (see also Woolridge, 2009, and Collard-Wexler and De Loecker, 2016) showed that intermediate goods expenditure, used by LP, is a better instrument as firms do not necessarily continuously invest over time. Afterwards, ACF showed that also the labour input coefficient may suffer from identification problems in the first stage of the estimation due to functional dependence and proposed an alternative estimation procedure, based on different hypotheses. I used in the second stage ACF estimation procedure the unconditional moments described by ACF in their equation (28), which implies that firms may modify their labour input in the current period. The estimation of value added with the ACF procedure requires the hypothesis that the gross output production function is Leontief in the expenditure in intermediate goods and services.

I used as my main procedure the LP methodology with the real expenditure in intermediate goods and services as instrument and then checked the robustness of the results to the other methods[8]. The estimates of the production function with the LP method, sector by sector, are reported in the Appendix.

After estimating equation (2), I used the standard filtering methodology based on Hodrick and Prescott (1997; HP) to isolate the trend components of the firm level time series: labour, net investments and the unobserved productivity recovered in the previous step from the production function estimates. In the implementation of their filter, HP suggested the use of a smoothness parameter of 100 with yearly data, which I use as a benchmark. To improve

[7] Other possible kinds of endogeneity such as those due to the unobservability of firm level prices of inputs (De Loecker and Goldberg, 2014) and output (Klette and Griliches, 1996 and De Loecker, 2011) may still exist, not corrected by the OP, LP and ACF methodologies. The methodology here used may be modified to take into account the endogeneity due to the unobservability of the prices of outputs, following Klette and Griliches (1996), under stronger hypotheses on the demand function.

[8] I estimated the parameters of the production function with the Stata routines developed by Yasar et al. (2008; for OP), Petrin et al. (2004; for LP), Manjon and Manez (2016; for ACF).

quality of filtering I enlarged the time window of the filtered time series including also the available observations for 1995-2003.

After recovering trend capital from filtered net investments according to equation (1), I applied the estimated production function relationship (2) to the low frequency components of inputs to construct the potential output of the firm. As a final step, I summed up the potential output across firms (y_{it}^T) to create the aggregate time series: $y_t^T = \sum_i y_{it}^T$.

I plot the results based on individual firm level data together with benchmark estimates based on the data deriving from the aggregation of the dataset at the level of whole economy. The procedure applied for these benchmark estimates is the following one: I estimated using OLS the production function relationship based on aggregate data:

$$ln(\sum_i y_{it}) = ln(A_t) + \alpha\, ln(\sum_i K_{it}) + \beta\, ln(\sum_i L_{it}) \quad (3)$$

where A_t is the unobserved productivity for the whole economy. Afterwards, I filtered the aggregate inputs using the HP method with smoothness parameter equal to 100, to isolate the trend components; after recovering trend aggregate capital from filtered net investments according to the aggregate version of equation (1), I applied the estimated production function relationship (3) to the low frequency components of inputs to construct potential output estimates for the whole economy.

The procedure here applied for the benchmark estimates is similar to the aggregate production function approach described in Bassanetti *et al.* (2010), with two main differences: the procedure is applied to the aggregate data of the dataset instead of to those from the National accounts. Moreover, in Bassanetti *et al.* (2010) the coefficients of labour and capital in the production function are calibrated under the assumption of perfect competition and constant returns to scale, using the shares of the income produced by the inputs in the National accounts; here the coefficients are estimated, hence disposing of the assumption of perfect competition.

Estimates based on individual firm level data has several advantages when compared with the benchmark procedure applied to aggregate data. First, the estimation of a production function suffers from problems of simultaneity in the choice of inputs and outputs, which cannot be effectively addressed at an aggregate level.

Moreover, the use of disaggregated information allows to better take into account heterogeneity of agents in the estimates, splitting the sample in different blocks having more homogeneous characteristics, such as the sector of activity.

Then, even within homogeneous blocks of firms, the non-linearity of the general Cobb-Douglas specification implies that aggregating production functions of different firms preserves the relationship existing between inputs and output only under very specific conditions: the production function must be homogeneous of degree one, which implies constant returns to scale, and frictions in the accumulation and disposal of inputs must be absent; without these conditions, the aggregate level estimates of the production function can be misleading, as there can be firms and sectors misallocation of inputs, with negative effects on aggregate productivity (Hsieh and Klenow, 2009, Gamberoni *et al.*, 2016, Adamopoulou *et al.*, 2016, Linarello and Petrella, 2016, Calligaris *et al.*, 2017).

On the other hand, there are two main drawbacks in the use of a production function methodology based on firm level data in the way here described. As a first point, the procedure requires several steps, computationally intensive, and does not allow to calculate the standard errors of the estimates. For this reason, we cannot statistically evaluate the significance of a comparison with other estimates.

Moreover, one word of caution in the interpretation of the estimates based on individual firm level data regards their quality for the firms whose time series are short, usually because of late entry or early exit from the market: both the effectiveness of the filtering procedure to isolate the trend component and the quality of the estimates of the capital with the permanent inventory methodology can be damaged if the time series is too short. There is therefore a trade-off between quality of the potential output estimates, which suggests to restrict the sample only to the firms with long time series, and representativeness of the dataset, which suggests to include as many firms as possible. In next section and in most of the remaining of the paper I want to privilege the methodological robustness of the estimates; hence, I will choose the former solution, restricting the sample to the firms observed for the whole length of the time window. Instead, in the last section I will choose the latter solution, considering the whole sample of firms, as I want to analyze the impact on potential output estimates of entry and exit of firms.

4. The evolution of potential output growth: balanced panel

In the first exercise, I restrict the sample to the balanced dataset of about 40 thousand firms reporting their balance sheets in each year of the time window; firms in this sample do not exit or enter in the market and the evolution of potential output is just due to the accumulation of inputs and the evolution of the unobserved efficiency. Firms included in this panel are relatively more mature: they are among the most resilient to shocks and they have probably already developed most of their potential; I expect therefore their potential output growth to be relatively less volatile.

I plot the estimates of potential output growth resulting from different methodologies, all applied to the same balanced sample: the estimates derived applying the firm level based methodology here presented, estimating the production function parameters with either the LP, the OP or the ACF methods; those deriving from the application of the production function methodology to the aggregate time series of the balanced dataset; the trend component resulting from directly applying the HP filter to the aggregate actual value added time series of the sample.

Figure 2: Comparison of estimates of potential output growth, balanced panel

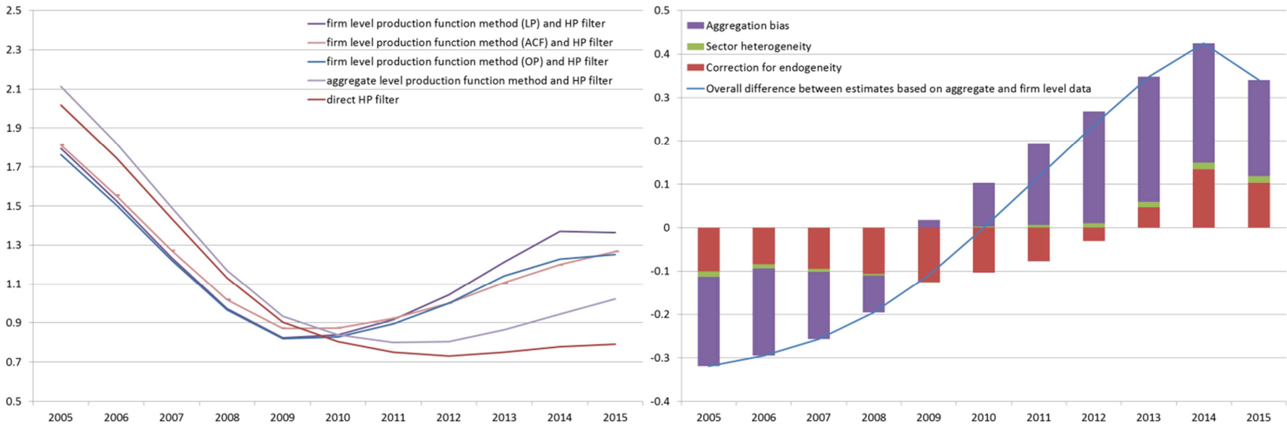


Figure 2 shows the main results. According to production function methods based on individual firm level data and the LP estimation methodology, after aggregating the firm level estimates at the whole economy level, the estimated growth of potential output in the balanced dataset was about 1.8% in 2005, then it decreased until reaching about 0.8% in 2009 and afterwards improved back, up to 1.4%.

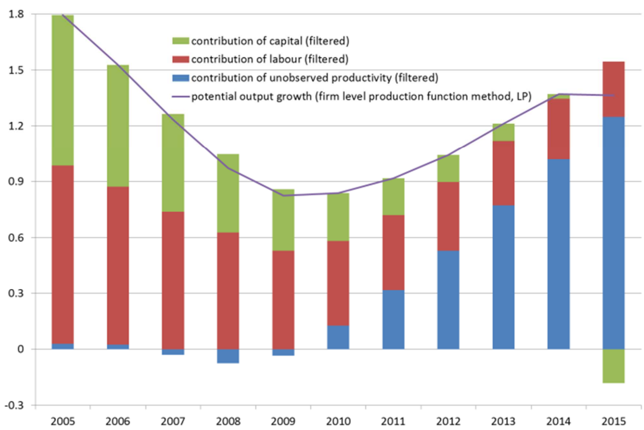
The profile resulting from the production function methodology applied to the aggregate data of the dataset is more sluggish, 0.3% higher until 2009 and 0.4% lower afterwards. This profile of potential output growth is higher than what would be expected applying the aggregate level production function methodology to the National accounts data, as in the dataset only private corporations are included, excluding therefore smaller and public firms. In absence of the standard errors in the estimates based on individual firm level data, we cannot determine the statistical significance of the difference between estimates based on aggregate and on individual firm level data; anyway, it seems to be relevant on a historical comparison and it is about one third of the growth rate of Italian potential output in 2015 based on aggregate level data.

The estimates based on individual firm level data using the ACF and the OP methods are qualitatively similar to those using the LP method, but slightly lower after 2012; they qualitatively confirm the results when compared with the methodology based on aggregate data.

Comparing the methodological aspects, there are three possible reasons explaining the difference between the firm level and aggregate level estimates: potential output estimates based on individual firm level data (i) use production function parameters estimated for more disentangled sectors of economic activity, taking also into account the possible change of weight of sectors over time, (ii) include a correction for endogeneity in the estimate of parameters and (iii) take into account possible aggregation biases such as those due to misallocation of inputs and non-linearity in the relationship between inputs and output.

The right panel of Figure 2 quantifies the impact of each methodological innovation on the estimates, modifying the methodology step by step; the contribution of sector heterogeneity is calculated as the difference between the main estimates based on individual firm level data and similar ones where the parameters are common to all sectors; the contribution of the correction for endogeneity is the difference between these last estimates and OLS ones based on individual firm level data with common parameters to all sectors; finally, the contribution coming from the correction of the aggregation bias is the difference between these last estimates and those based on aggregate data.

Figure 3: Contribution of inputs to potential output growth



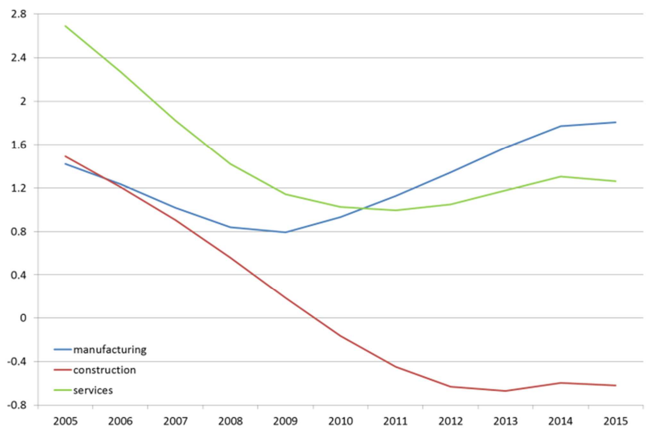
The main driver of the differences between firm level and aggregate level estimates is the aggregation bias; the correction for endogeneity is relevant even if less important, while the impact of sector heterogeneity is very small.

Figure 3 shows the decomposition of the contributions of capital, labour and unobserved productivity to potential output growth. The trend in the accumulation of labour and capital constantly declined over time, explaining the fall in the growth rate of potential output between 2005 and 2009. The contribution of unobserved productivity was substantially negligible until 2009, while it gradually became the main driver afterwards.

The results of Figures 2 and 3 are coherent with the conclusions of Gamberoni *et al.* (2016), which found that misallocation of productive inputs, undetected in the aggregate estimates and whose effects on unobserved productivity are negative, increased in the years immediately preceding the recent crisis and decreased afterwards.

Figure 4 aggregates the firm level estimates of potential output growth, based on 2 digit Ateco sector LP estimation of equation (1), in some selected more aggregate sectors of economic activity: manufacturing, construction and services. Manufacturing firms were less damaged by the crisis than the other sectors and they quickly improved after 2009; the services sector is slowly recovering, while potential output of construction firms is still stagnating.

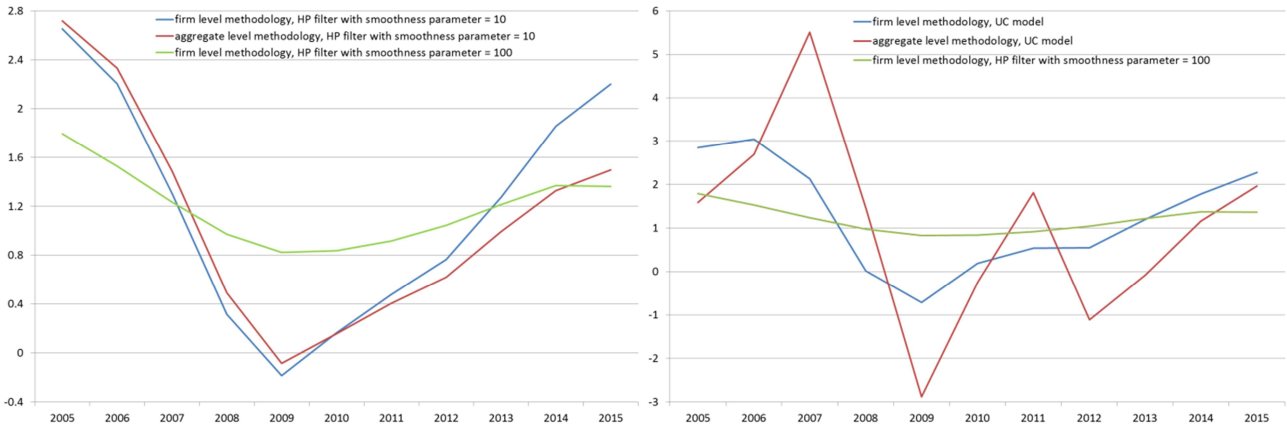
Figure 4: Potential output growth, selected sectors



5. Robustness checks

The results shown in the previous section are qualitatively confirmed when using either alternative filtering procedures or alternative definitions of capital and output. Baxter and King (1999) suggested an alternative value of 10 for the smoothness parameter of the HP filter to capture a definition of trend component coherent with the business cycle literature, where it includes the low frequencies with longer period than 8 years.

Figure 5: Potential output growth, alternative filters, HP and UC

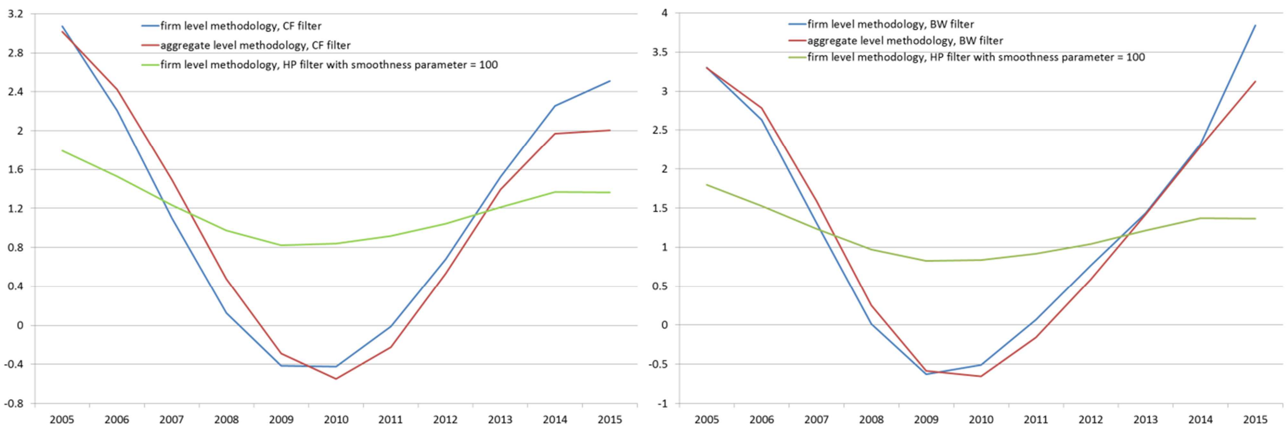


Applying the HP filter is equivalent to split the trend and cycle components using a unobserved component model with smooth trend, whose signal to noise ratio is calibrated according to the smoothness parameter of the HP filter; this unobserved component model is described by the following equations:

$$\begin{cases} x_{it} = \mu_{it} + \varepsilon_{it} \\ \mu_{it} = \mu_{it-1} + \beta_{it-1} \\ \beta_{it} = \beta_{it-1} + \xi_{it} \end{cases}$$

where x_{it} is the time series to be filtered, μ_{it} is the trend component, β_{it} is the parameter controlling the stochastic evolution of the trend, ε_{it} and ξ_{it} are uncorrelated error terms. Applying this framework, discussed in Harvey (1989; UC), the smoothness parameter can instead be endogenously chosen within the model to optimize the likelihood function.

Figure 6: Potential output growth, alternative filters, CF and BW



Christiano and Fitzgerald (2003; CF) proposed an alternative asymmetric band-pass filter, here calibrated to pass only frequencies with period greater than 8 years; the asymmetry of the CF filter should allow to increase the amount of information exploited and therefore the quality of the filter. Last, Butterworth (1930; BW) presented another popular filtering procedure, mainly used in engineering because of its regularity properties, but also in some economic applications (e.g. Pollock, 2000).

Figures 5 and 6 show the potential output growth estimates using all these different filters. The HP filter applied in the benchmark case selects a shorter range of frequencies and its dynamics is therefore flatter, but the qualitative evolution is very similar in all cases. In the UC model, the degree of smoothness implied by the data is even smaller than the one proposed by Baxter and King (1999), in particular when directly applying the model to aggregate data. The growth rate becomes negative around 2009 with all the alternative filters. Both the slowdown and the recovery are slightly stronger with the CF and the BW filters. In all cases, the estimates of potential output growth when the potential output growth rate is increasing and in particular in the last few years of the sample are almost always higher when using individual firm level data than with aggregate ones.

Figure 7: Potential output growth, alternative definitions of capital

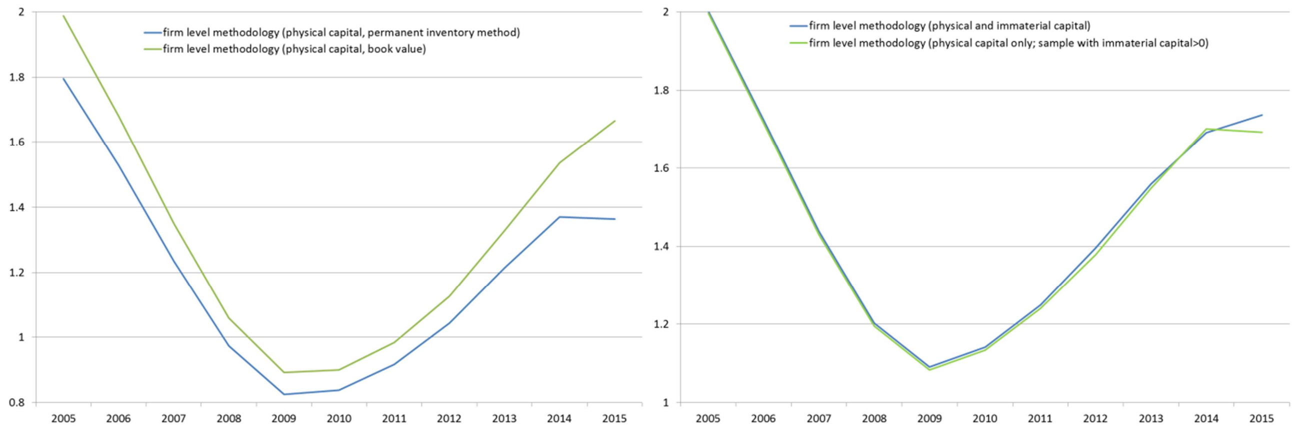
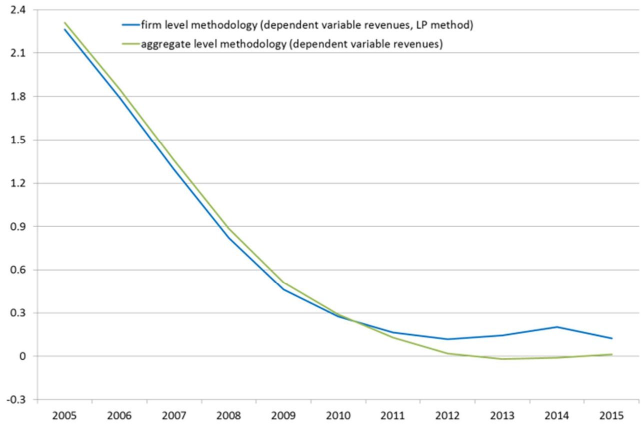


Figure 7 shows additional robustness checks using alternative definitions of capital. In the left box the book value of net physical capital is used instead of the one resulting from the permanent inventory method; in this case the estimates of potential growth are slightly higher in whole time window, but the overall dynamics are the same as in the benchmark case. Instead, estimates shown in the right box also include the amount of net immaterial assets of the firm as input, in addition to physical capital and labour; the sample used in this case is different from the previous one, as only the firms with strictly positive net immaterial assets are included; the estimates are essentially the same as with the main methodology.

Figure 8 shows the estimates when using revenues as output variable instead of value added. There are small methodological differences in the steps of the estimation, as described in LP, but the main procedure remains substantially the same as in the case of value added. The overall resulting dynamics are less favourable in this case, as potential output growth is still stagnating at the end of the time window, both when using the methodology based on individual firm level data and the one based on aggregate data. The results from the comparison between estimates using firm level and aggregate level methodology are essentially the same as before.

Figure 8: Potential output growth, alternative definition of output



6. The evolution of potential output growth: full sample

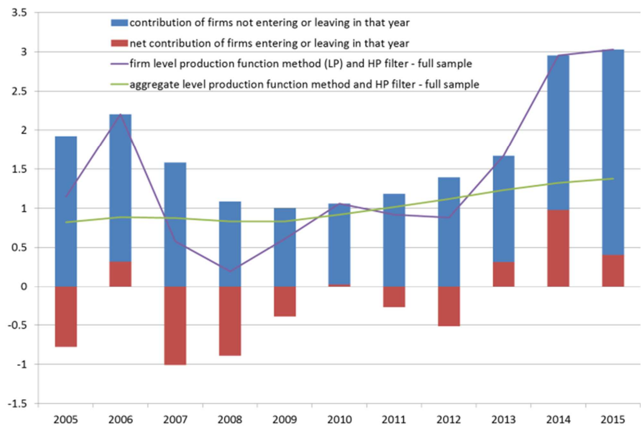
In this exercise I use the full sample of firms, thus allowing entry and exit over time. Firms' turnover is a cyclical phenomenon: more firms enter the market in the upturns, while exit is more prevalent in the downturns. Turnover of firms can be quite relevant in explaining the dynamics of potential output, as it amplifies and propagates the impact of aggregate shocks (Clementi and Palazzo, 2016), with a long term possible impact on the structural characteristics of the economy and the potential output. According to the analysis of Mistretta *et al.* (2016) based on a sample of large manufacturing firms, turnover explained about 5% of the loss of potential output of the sector during the recent crisis.

Cyclicality of turnover has been taken into account in the estimates of this section: I used the HP filter on the aggregate statistics regarding the share of firms respectively entering or leaving the market to capture their trend. A constant weight, different from 1, was then assigned to all the observations of the firms respectively entering or leaving the market in one given year, such that their weighted share in the overall economy was equal to the trend value[9,10].

[9] Alternatively, I used as a benchmark the unconditional average of the share of firms entering (exiting) the market instead of the HP filtered trend value; the results are very similar to those here presented.
[10] In the case a firm both entered and left the market in the time window and therefore there were two candidate weights, I choose the minimum weight between the two to minimize its impact on the overall dynamics.

Figure 9 shows potential output growth in the full sample, split in the contributions to growth respectively coming from the firms either entering or leaving the market in that year and from those stable within the market[11]. The dynamics of the estimates with firm level data methodology applied to the full sample were less smooth than those presented in Figure 2, as, because of entry and exit, the full panel includes firms with a shorter time series, more difficult to be filtered.

Figure 9: Potential output growth, full dataset



The conclusions when plotting together the results from the aggregate level and the individual firm level methodologies are broadly similar to those from the balanced sample: when using the methodology based on individual firm level data, potential output was more sluggish in the time window between 2007 and 2012 and grew faster afterwards; as before, this difference cannot be statistically evaluated. The contribution of the turnover of firms is negative in most years, in particular during both the crises, and became positive in the last years of the time window. The estimates of potential output growth rate of the firms not entering or leaving the market was damaged mainly in 2008-2009 and improved afterwards.

7. Conclusions

This work proposes estimating aggregate potential output growth through a production function approach applied to Italian individual firm level data (as opposed to aggregate data, as in the standard approach), with the purpose of uncovering possible biases related to the use of aggregate data and of extracting additional information on the drivers of potential output

[11] The potential output growth implied by contribution of the stable firms in the full sample, while conceptually similar to that one of the balanced sample, is different as in the former the contribution of all the firms not entering or leaving the market in that single year is included, while in the latter, more restrictive, the contribution of all the firms continuously existing for the whole length of the time window is included.

growth in the last ten years. The use of a production function approach on individual firm level data is found to suggest a more sluggish dynamics of potential output before the recent crisis and a stronger recovery afterwards, when plotted together with the estimates from the standard production function methodology based on aggregate data; the difference cannot be evaluated on a statistical basis because of the absence of standard errors, but it is relevant in the historical comparison.

The main reason behind this difference is related to the aggregation bias; the correction for endogeneity is relevant, but relatively less important, while the impact of sectorial heterogeneity appears overall small.

Estimates based on individual firm level data reveal that the contribution of labour and capital to the potential output growth declined over time, while most of the recovery after 2009 is explained by unobserved productivity of firms. The comparison of the aggregate and firm level estimates and this path for unobserved productivity are coherent with the results shown in the literature about misallocation of inputs for Italy, which increased in the years preceding the crisis and decreased afterwards.

All main sectors of activity were affected by a contraction of potential growth around 2009, but, while manufacturing firms recovered relatively soon, the services sector is recovering slowly and construction firms has not recovered yet.

Finally, when including in the sample firms entering and leaving the market, firms' turnover is found to have had a substantial negative impact on potential output growth during the crisis; however, its contribution became positive in more recent years.

Appendix: sectorial estimates of production function

Table A1: sectorial estimates of production function (LP method)

Sector	L coeff.	s.e.	K coeff.	s.e.	CRS test (1)	obs.
Crop & animal production, hunting, related service activities	0.39***	0.014	0.48***	0.015	58.42***	78385
Fishing & aquaculture	0.36***	0.033	0.29***	0.067	22.00***	12576
Mining & quarrying	0.67***	0.045	0.31***	0.046	0.30	23542
Manufacture of food products	0.61***	0.014	0.12***	0.016	207.91***	119942
Manufacture of beverages	0.57***	0.046	0.16**	0.065	10.41***	15558
Manufacture of textiles	0.71***	0.024	0.28***	0.029	0.06	78857
Manufacture of wearing apparel	0.72***	0.011	0.13***	0.02	39.34***	98427
Manufacture of leather & related products	0.70***	0.025	0.077***	0.024	38.31***	68610
Manufacture of wood & of products of wood & cork, except furniture; manufacture of articles of straw & plaiting materials; manufacture of paper & paper products	0.64***	0.04	0.12*	0.074	8.05***	86391
Printing & reproduction of recorded media	0.65***	0.032	0.15***	0.039	15.42***	63595
Manufacture of coke & refined petroleum products; manufacture of chemicals & chemical products; manufacture of basic pharmaceutical products & pharmaceutical preparations	0.56***	0.042	0.17**	0.081	7.42***	62480
Manufacture of rubber & plastic products	0.72***	0.026	0.33***	0.025	3.61*	83412
Manufacture of other non-metallic mineral products	0.60***	0.022	0.15***	0.045	25.43***	102458
Manufacture of basic metals	0.68***	0.029	0.22***	0.047	3.15*	31137
Manufacture of metal products, except machinery & equipment	0.68***	0.0062	0.19***	0.0074	250.32***	328635
Manufacture of computer, electronic & optical products	0.75***	0.023	0.16***	0.018	17.03***	61327
Manufacture of electrical equipment	0.72***	0.026	0.13***	0.034	17.01***	72154
Manufacture of machinery & equipment n.e.c.	0.70***	0.018	0.22***	0.028	5.49**	208016
Manufacture of motor vehicles, trailers & semi-trailers; manufacture of other transport equipment	0.68***	0.042	0.085*	0.053	22.21***	44936
Manufacture of furniture	0.70***	0.022	0.23***	0.034	2.36	81896
Other manufacturing	0.73***	0.022	0.29***	0.029	0.67	60004
Repair & installation of machinery and equipment	0.79***	0.025	0.14***	0.043	1.99	56581
Electricity, gas, steam & air conditioning supply; water collection, treatment and supply; sewerage	0.40***	0.028	0.18***	0.033	97.38***	26222
Waste collection, treatment, disposal; materials recovery; remediation activities, other waste management services	0.64***	0.023	0.38***	0.021	0.33	44238
Construction of buildings	0.53***	0.0051	0.14***	0.0057	1693.93***	455812
Civil engineering	0.51***	0.019	0.20***	0.031	66.62***	44926
Specialised construction activities	0.69***	0.011	0.14***	0.0096	145.87***	356234
Wholesale & retail trade & repair of motor vehicles & cycles	0.74***	0.0099	0.19***	0.011	20.77***	191050

Wholesale trade, except of motor vehicles & cycles	0.59***	0.0048	0.22***	0.0054	722.63***	848620
Retail trade, except of motor vehicles & cycles	0.50***	0.0051	0.20***	0.0052	1803.97***	554340
Land transport & transport via pipelines; water transport; postal & courier activities	0.66***	0.015	0.20***	0.014	54.99***	184320
Warehousing & support activities for transportation	0.82***	0.01	0.060***	0.018	34.48***	119256
Accommodation	0.14***	0.015	0.41***	0.077	32.64***	102697
Food & beverage service activities	0.38***	0.0094	0.22***	0.013	660.52***	244499
Publishing activities	0.55***	0.031	0.28***	0.026	23.99***	32450
Motion picture, video & television programme production, sound recording & music publishing activities; programming & broadcasting activities	0.32***	0.042	0.34***	0.035	111.61***	33946
Telecommunications	0.60***	0.034	0.13***	0.036	35.11***	9204
Computer programming, consultancy & related activities	0.76***	0.014	0.099***	0.009	93.88***	128851
Information service activities	0.80***	0.015	0.073***	0.016	34.10***	130921
Financial service activities, except insurance & pension funding	0.55***	0.051	0.21***	0.063	12.94***	9060
Activities auxiliary to financial services & insurance activities	0.65***	0.03	0.20***	0.018	17.33***	45118
Real estate activities	0.61***	0.0078	0.29***	0.0099	71.03***	167527
Legal & accounting activities	0.81***	0.021	0.20***	0.048	0.03	43391
Activities of head offices; management consultancy activities	0.67***	0.014	0.21***	0.017	32.59***	97727
Architectural, engineering activities; technical testing, analysis	0.69***	0.017	0.24***	0.017	9.94***	87611
Scientific research & development	0.58***	0.034	0.30***	0.048	7.27***	13752
Advertising & market research	0.62***	0.013	0.27***	0.02	23.98***	61557
Other professional, scientific & technical activities	0.71***	0.011	0.24***	0.025	3.80*	66150
Rental & leasing activities	0.45***	0.031	0.37***	0.03	28.32***	30692
Employment activities	0.59***	0.041	0.27***	0.084	2.07	4466
Travel agency, tour operator, reservation services & related	0.70***	0.028	0.29***	0.024	0.11	49460
Services to buildings & landscape activities	0.68***	0.019	0.088***	0.025	76.53***	90562
Office administrative & support, other business support	0.69***	0.0096	0.23***	0.017	21.80***	100305
Education	0.61***	0.012	0.25***	0.017	45.98***	48142
Human health activities	0.73***	0.023	0.35***	0.017	11.48***	92192
Residential care activities	0.73***	0.039	0.23***	0.086	0.19	24914
Social work activities without accommodation	0.94***	0.019	0.11***	0.022	3.00*	55610
Creative, arts & entertainment activities	0.50***	0.022	0.26***	0.028	65.49***	21742
Gambling & betting activities	0.37***	0.036	0.27***	0.061	29.17***	7531
Sports activities & amusement & recreation activities	0.36***	0.017	0.40***	0.028	67.40***	49892
Repair of computers & personal & household goods	0.77***	0.04	0.13***	0.041	3.52*	19075
Other personal service activities	0.65***	0.013	0.22***	0.042	8.74***	57120

(1) χ^2 test of Constant Returns to Scale (CRS).

References

Ackerberg, D. A., K. Caves and G. Frazer (2015), "Identification properties of recent production function estimators", *Econometrica*, 83(6), pp. 2411-2451

Adamopoulou, E., E. Bobbio, M. De Philippis and F. Giorgi (2016), *Allocative efficiency and aggregate wage dynamics in Italy*, Questioni di economia e finanza (Occasional papers) n. 340, Bank of Italy

Bartelsman, E. J., and Z. Wolf (2014), "Forecasting aggregate productivity using information from firm-level data", *The review of economics and statistics*, 96(4), pp. 745-755

Bassanetti, A., M. Caivano, A. Locarno (2010), *Modelling Italian potential output and the output gap*, Temi di discussione (Working papers) n. 771, Bank of Italy

Baxter, M., and R. G. King (1999), "Measuring business cycles: approximate band-pass filters for economic time series", *The review of economics and statistics*, 81(4), pp. 575-593

Busetti, F., and P. Cova (2013), *L'impatto macroeconomico della crisi del debito sovrano: un'analisi controfattuale per l'economia italiana*, Questioni di economia e finanza (Occasional papers) n. 201, Bank of Italy

Butterworth, S. (1930), "On the theory of filter amplifiers", *Experimental wireless and the wireless engineer*, 7, pp. 536-541

Caivano, M., M. L. Rodano and S. Siviero (2010), *La trasmissione della crisi finanziaria globale all'economia italiana. Un'indagine controfattuale, 2008-2010*, Questioni di economia e finanza (Occasional papers) n. 64, Bank of Italy

Calligaris, S., M. Del Gatto, F. Hassan, G. I. P. Ottaviano and F. Schivardi (2017), *Global productivity puzzles and misallocation, an Italian tale*, mimeo.

Christiano, L., and T. Fitzgerald (2003), "The band-pass filter", *International economic review*, 44(2), pp. 435-465.

Clementi, G. L., and B. Palazzo (2016), "Entry, exit, firm dynamics, and aggregate fluctuations", *American economic journal: Macroeconomics*, 8(3), pp.1-41

Collard-Wexler, A., and J. De Loecker (2016), *Production function estimation with measurement error in inputs*, NBER Working paper n. 22437, National bureau of economic research

De Loecker, J. (2011), “Product differentiation, multiproduct firms, and estimating the impact of trade liberalization on productivity”, *Econometrica*, 79(5), pp. 1407-1451

De Loecker, J., and P. K. Goldberg (2014), “Firm performance in a global market”, *Annual review of economics*, 6, pp. 201-227

Fernald, J. G. (2015), “Productivity and potential output before, during, and after the Great Recession”, in Parker, J. A., and M. Woodford (eds.; 2015), *NBER Macroeconomics annual 2014*, 29, pp. 1-51

Gamberoni, E., C. Giordano and P. Lopez-Garcia (2016), *Capital and labour (mis)allocation in the euro area: some stylized facts and determinants*, Questioni di economia e finanza (Occasional papers) n. 349, Bank of Italy

Harvey, A. C. (1989), *Forecasting, structural time series models and the Kalman filter*, Cambridge University Press

Hsieh, C.-T., and P. J. Klenow (2009), “Misallocation and manufacturing TFP in China and India”, *The quarterly journal of economics*, CXXIV(4), pp. 1403-1448

Hodrick, R. J., and E. C. Prescott (1997), “Postwar business U.S. cycles: an empirical investigation”, *Journal of money, credit and banking*, 29(1), pp. 1-16

Istat (2009), *Classificazione delle attività economiche Ateco 2007 derivata dalla Nace Rev. 2*, Metodi e norme n. 40, Istat

Kim, K. I., A. Petrin and S. Song (2016), “Estimating production functions with control functions when capital is measured with error”, *Journal of econometrics*, 190(2), pp. 267-279

Klette, T. J., and Z. Griliches (1996), “The inconsistency of common scale estimators when output prices are unobserved and endogenous”, *Journal of applied econometrics*, 11(4), pp. 343-361

Levinsohn, J., and A. Petrin (2003), “Estimating production functions using inputs to control for unobservables”, *Review of economic studies*, 70(2), pp. 317-341

Linarello, A., and A. Petrella (2016), *Productivity and reallocation: evidence from the universe of Italian firms*, Questioni di economia e finanza (Occasional papers) n. 353, Bank of Italy

Locatelli, A., L. Monteforte, and G. Zevi (2016), *Heterogeneous fall in productive capacity in Italian industry during the 2008-2013 double-dip recession*, Questioni di economia e finanza (Occasional papers) n. 303, Bank of Italy

Manjon, M., and J. Manez (2016), "Production function estimation in Stata using the Ackerberg-Caves-Frazer method", *The Stata journal*, 16(4), pp. 900-916

Monteforte, L., and G. Zevi (2016), "An inquiry into manufacturing capacity in Italy after the double dip recession", *Rivista bancaria Minerva bancaria*, 71(2-3), pp. 203-223

Mistretta, A., L. Monteforte and G. Zevi (2016), "La capacità produttiva dell'industria italiana durante la crisi e la demografia d'impresa", mimeo

OECD (2009), *Measuring capital. OECD manual*, OECD

Olley, G. S., and A. Pakes (1996), "The dynamics of productivity in the telecommunications equipment industry", *Econometrica*, 64(6), pp. 1263-1297

Petrin, A., B. P. Poi and J. Levinsohn (2004), "Production function estimation in Stata using inputs to control for unobservables", *The Stata journal*, 4(2), pp. 113-123

Pollock, D. S. G. (2000), "Trend estimation and de-trending via rational square-wave filters", *Journal of Econometrics*, 99(2), pp. 317-334

Woolridge, J. M. (2009), "On estimating firm-level production functions using proxy variables to control for unobservables", *Economics letters*, 104(3), pp. 112-114

Yasar, M., R. Raciborski and B. P. Poi (2008), "Production function estimation in Stata using the Olley and Pakes method", *The Stata journal*, 8(2), pp. 221-231

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DOTTORI D. and M. MANNA, *Strategy and tactics in public debt management,* Journal of Policy Modeling, v. 38, 1, pp. 1-25, **WP 1005 (March 2015).**

GERALI A., A. NOTARPIETRO and M. PISANI, *Macroeconomic effects of simultaneous implementation of reforms,* International Finance, Wiley Blackwell, v. 19, 1, pp. 42-65, **WP 997 (December 2014).**

LIBERATI D., M. MARINUCCI and G. M. TANZI, *Science and technology parks in Italy: main features and analysis of their effects on hosted firms*, Journal of Technology Transfer, v. 41, 4, pp. 694-729, **WP 983 (November 2014).**

MARCELLINO M., M. PORQUEDDU and F. VENDITTI, *Short-Term GDP forecasting with a mixed frequency dynamic factor model with stochastic volatility,* Journal of Business & Economic Statistics , v. 34, 1, pp. 118-127, **WP 896 (January 2013).**

RODANO G., N. SERRANO-VELARDE and E. TARANTINO, *Bankruptcy law and bank financing,* Journal of Financial Economics, v. 120, 2, pp. 363-382, **WP 1013 (June 2015).**

ZINNA G., *Price pressures on UK real rates: an empirical investigation,* Review of Finance,v. 20, 4, pp. 1587-1630, **WP 968 (July 2014).**

2017

AABERGE, R., F. BOURGUIGNON, A. BRANDOLINI, F. FERREIRA, J. GORNICK, J. HILLS, M. JÄNTTI, S. JENKINS, J. MICKLEWRIGHT, E. MARLIER, B. NOLAN, T. PIKETTY, W. RADERMACHER, T. SMEEDING, N. STERN, J. STIGLITZ, H. SUTHERLAND, *Tony Atkinson and his legacy,* Review of Income and Wealth, v. 63, 3, pp. 411-444, **WP 1138 (September 2017).**

ACCETTURO A., M. BUGAMELLI and A. LAMORGESE, *Law enforcement and political participation: Italy 1861-65,* Journal of Economic Behavior & Organization, v. 140, pp. 224-245, **WP 1124 (July 2017).**

ADAMOPOULOU A. and G.M. TANZI, *Academic dropout and the great recession,* Journal of Human Capital, V. 11, 1, pp. 35–71, **WP 970 (October 2014).**

ALBERTAZZI U., M. BOTTERO and G. SENE, *Information externalities in the credit market and the spell of credit rationing,* Journal of Financial Intermediation, v. 30, pp. 61–70, **WP 980 (November 2014).**

ALESSANDRI P. and H. MUMTAZ, *Financial indicators and density forecasts for US output and inflation,* Review of Economic Dynamics, v. 24, pp. 66-78, **WP 977 (November 2014).**

BARBIERI G., C. ROSSETTI and P. SESTITO, *Teacher motivation and student learning,* Politica economica/Journal of Economic Policy, v. 33, 1, pp.59-72, **WP 761 (June 2010).**

BENTIVOGLI C. and M. LITTERIO, *Foreign ownership and performance: evidence from a panel of Italian firms,* International Journal of the Economics of Business, v. 24, 3, pp. 251-273, **WP 1085 (October 2016).**

BRONZINI R. and A. D'IGNAZIO, *Bank internationalisation and firm exports: evidence from matched firm-bank data,* Review of International Economics, v. 25, 3, pp. 476-499 **WP 1055 (March 2016).**

BRUCHE M. and A. SEGURA, *Debt maturity and the liquidity of secondary debt markets,* Journal of Financial Economics, v. 124, 3, pp. 599-613, **WP 1049 (January 2016).**

BURLON L., *Public expenditure distribution, voting, and growth,* Journal of Public Economic Theory,, v. 19, 4, pp. 789–810, **WP 961 (April 2014).**

BURLON L., A. GERALI, A. NOTARPIETRO and M. PISANI, *Macroeconomic effectiveness of non-standard monetary policy and early exit. a model-based evaluation,* International Finance, v. 20, 2, pp.155-173, **WP 1074 (July 2016).**

BUSETTI F., *Quantile aggregation of density forecasts,* Oxford Bulletin of Economics and Statistics, v. 79, 4, pp. 495-512, **WP 979 (November 2014).**

CESARONI T. and S. IEZZI, *The predictive content of business survey indicators: evidence from SIGE,* Journal of Business Cycle Research, v.13, 1, pp 75–104, **WP 1031 (October 2015).**

CONTI P., D. MARELLA and A. NERI, *Statistical matching and uncertainty analysis in combining household income and expenditure data,* Statistical Methods & Applications, v. 26, 3, pp 485–505, **WP 1018 (July 2015).**

D'AMURI F., *Monitoring and disincentives in containing paid sick leave,* Labour Economics, v. 49, pp. 74-83, **WP 787 (January 2011).**

D'AMURI F. and J. MARCUCCI, *The predictive power of google searches in forecasting unemployment,* International Journal of Forecasting, v. 33, 4, pp. 801-816, **WP 891 (November 2012).**

DE BLASIO G. and S. POY, *The impact of local minimum wages on employment: evidence from Italy in the 1950s,* Journal of Regional Science, v. 57, 1, pp. 48-74, **WP 953 (March 2014).**

DEL GIOVANE P., A. NOBILI and F. M. SIGNORETTI, *Assessing the sources of credit supply tightening: was the sovereign debt crisis different from Lehman?,* International Journal of Central Banking, v. 13, 2, pp. 197-234, **WP 942 (November 2013).**

DEL PRETE S., M. PAGNINI, P. ROSSI and V. VACCA, *Lending organization and credit supply during the 2008–2009 crisis,* Economic Notes, v. 46, 2, pp. 207–236, **WP 1108 (April 2017).**

DELLE MONACHE D. and I. PETRELLA, *Adaptive models and heavy tails with an application to inflation forecasting,* International Journal of Forecasting, v. 33, 2, pp. 482-501, **WP 1052 (March 2016).**

FEDERICO S. and E. TOSTI, *Exporters and importers of services: firm-level evidence on Italy,* The World Economy, v. 40, 10, pp. 2078-2096, **WP 877 (September 2012).**

GIACOMELLI S. and C. MENON, *Does weak contract enforcement affect firm size? Evidence from the neighbour's court,* Journal of Economic Geography, v. 17, 6, pp. 1251-1282, **WP 898 (January 2013).**

LOBERTO M. and C. PERRICONE, *Does trend inflation make a difference?,* Economic Modelling, v. 61, pp. 351–375, **WP 1033 (October 2015).**

MANCINI A.L., C. MONFARDINI and S. PASQUA, *Is a good example the best sermon? Children's imitation of parental reading,* Review of Economics of the Household, v. 15, 3, pp 965–993, **D No. 958 (April 2014).**

MEEKS R., B. NELSON and P. ALESSANDRI, *Shadow banks and macroeconomic instability,* Journal of Money, Credit and Banking, v. 49, 7, pp. 1483–1516, **WP 939 (November 2013).**

MICUCCI G. and P. ROSSI, *Debt restructuring and the role of banks' organizational structure and lending technologies,* Journal of Financial Services Research, v. 51, 3, pp 339–361, **WP 763 (June 2010).**

MOCETTI S., M. PAGNINI and E. SETTE, *Information technology and banking organization,* Journal of Journal of Financial Services Research, v. 51, pp. 313-338, **WP 752 (March 2010).**

MOCETTI S. and E. VIVIANO, *Looking behind mortgage delinquencies,* Journal of Banking & Finance, v. 75, pp. 53-63, **WP 999 (January 2015).**

NOBILI A. and F. ZOLLINO, *A structural model for the housing and credit market in Italy,* Journal of Housing Economics, v. 36, pp. 73-87, **WP 887 (October 2012).**

PALAZZO F., *Search costs and the severity of adverse selection,* Research in Economics, v. 71, 1, pp. 171-197, **WP 1073 (July 2016).**

PATACCHINI E. and E. RAINONE, *Social ties and the demand for financial services,* Journal of Financial Services Research, v. 52, 1–2, pp 35–88, **WP 1115 (June 2017).**

PATACCHINI E., E. RAINONE and Y. ZENOU, *Heterogeneous peer effects in education,* Journal of Economic Behavior & Organization, v. 134, pp. 190–227, **WP 1048 (January 2016).**

SBRANA G., A. SILVESTRINI and F. VENDITTI, *Short-term inflation forecasting: the M.E.T.A. approach,* International Journal of Forecasting, v. 33, 4, pp. 1065-1081, **WP 1016 (June 2015).**

SEGURA A. and J. SUAREZ, *How excessive is banks' maturity transformation?,* Review of Financial Studies, v. 30, 10, pp. 3538–3580, **WP 1065 (April 2016).**

VACCA V., *An unexpected crisis? Looking at pricing effectiveness of heterogeneous banks,* Economic Notes, v. 46, 2, pp. 171–206, **WP 814 (July 2011).**

VERGARA CAFFARELI F., *One-way flow networks with decreasing returns to linking,* Dynamic Games and Applications, v. 7, 2, pp. 323-345, **WP 734 (November 2009).**

ZAGHINI A., *A Tale of fragmentation: corporate funding in the euro-area bond market,* International Review of Financial Analysis, v. 49, pp. 59-68, **WP 1104 (February 2017).**

2018

ADAMOPOULOU A. and E. KAYA, *Young Adults living with their parents and the influence of peers,* Oxford Bulletin of Economics and Statistics,v. 80, pp. 689-713, **WP 1038 (November 2015).**

BARONE G., G. DE BLASIO and S. MOCETTI, *The real effects of credit crunch in the great recession: evidence from Italian provinces,* Regional Science and Urban Economics, v. 70, pp. 352-59, **WP 1057 (March 2016).**

BELOTTI F. and G. ILARDI *Consistent inference in fixed-effects stochastic frontier models,* Journal of Econometrics, v. 202, 2, pp. 161-177, **WP 1147 (October 2017).**

BERTON F., S. MOCETTI, A. PRESBITERO and M. RICHIARDI, *Banks, firms, and jobs,* Review of Financial Studies, v.31, 6, pp. 2113-2156, **WP 1097 (February 2017).**

BOFONDI M., L. CARPINELLI and E. SETTE, *Credit supply during a sovereign debt crisis,* Journal of the European Economic Association, v.16, 3, pp. 696-729, **WP 909 (April 2013).**

BOKAN N., A. GERALI, S. GOMES, P. JACQUINOT and M. PISANI, *EAGLE-FLI: a macroeconomic model of banking and financial interdependence in the euro area,* Economic Modelling, v. 69, C, pp. 249-280, **WP 1064 (April 2016).**

BRILLI Y. and M. TONELLO, *Does increasing compulsory education reduce or displace adolescent crime? New evidence from administrative and victimization data,* CESifo Economic Studies, v. 64, 1, pp. 15–4, **WP 1008 (April 2015).**

BUONO I. and S. FORMAI *The heterogeneous response of domestic sales and exports to bank credit shocks,* Journal of International Economics, v. 113, pp. 55-73, **WP 1066 (March 2018).**

BURLON L., A. GERALI, A. NOTARPIETRO and M. PISANI, *Non-standard monetary policy, asset prices and macroprudential policy in a monetary union,* Journal of International Money and Finance, v. 88, pp. 25-53, **WP 1089 (October 2016).**

CARTA F. and M. DE PHLIPPIS, *You've Come a long way, baby. husbands' commuting time and family labour supply,* Regional Science and Urban Economics, v. 69, pp. 25-37, **WP 1003 (March 2015).**

CARTA F. and L. RIZZICA, *Early kindergarten, maternal labor supply and children's outcomes: evidence from Italy,* Journal of Public Economics, v. 158, pp. 79-102, **WP 1030 (October 2015).**

CASIRAGHI M., E. GAIOTTI, L. RODANO and A. SECCHI, *A "Reverse Robin Hood"? The distributional implications of non-standard monetary policy for Italian households,* Journal of International Money and Finance, v. 85, pp. 215-235, **WP 1077 (July 2016).**

CECCHETTI S., F. NATOLI and L. SIGALOTTI, *Tail co-movement in inflation expectations as an indicator of anchoring,* International Journal of Central Banking, v. 14, 1, pp. 35-71, **WP 1025 (July 2015).**

CIANI E. and C. DEIANA, *No Free lunch, buddy: housing transfers and informal care later in life,* Review of Economics of the Household, v.16, 4, pp. 971-1001, **WP 1117 (June 2017).**

CIPRIANI M., A. GUARINO, G. GUAZZAROTTI, F. TAGLIATI and S. FISHER, *Informational contagion in the laboratory,* Review of Finance, v. 22, 3, pp. 877-904, **WP 1063 (April 2016).**

DE BLASIO G, S. DE MITRI, S. D'IGNAZIO, P. FINALDI RUSSO and L. STOPPANI, *Public guarantees to SME borrowing. A RDD evaluation,* Journal of Banking & Finance, v. 96, pp. 73-86, **WP 1111 (April 2017).**

GERALI A., A. LOCARNO, A. NOTARPIETRO and M. PISANI, *The sovereign crisis and Italy's potential output,* Journal of Policy Modeling, v. 40, 2, pp. 418-433, **WP 1010 (June 2015).**

LINARELLO A., *Direct and indirect effects of trade liberalization: evidence from Chile,* Journal of Development Economics, v. 134, pp. 160-175, **WP 994 (December 2014).**

NUCCI F. and M. RIGGI, *Labor force participation, wage rigidities, and inflation,* Journal of Macroeconomics, v. 55, 3 pp. 274-292, **WP 1054 (March 2016).**

SEGURA A., *Why did sponsor banks rescue their SIVs?,* Review of Finance, v. 22, 2, pp. 661-697, **WP 1100 (February 2017).**

FORTHCOMING

ACCETTURO A., W. DI GIACINTO, G. MICUCCI and M. PAGNINI, *Geography, productivity and trade: does selection explain why some locations are more productive than others?,* Journal of Regional Science, **WP 910 (April 2013).**

ALBANESE G., G. DE BLASIO and P. SESTITO, *Trust, risk and time preferences: evidence from survey data,* International Review of Economics, **WP 911 (April 2013).**

APRIGLIANO V., G. ARDIZZI and L. MONTEFORTE, *Using the payment system data to forecast the economic activity,* International Journal of Central Banking, **WP 1098 (February 2017).**

BELOTTI F. and G. ILARDI, *Consistent inference in fixed-effects stochastic frontier models,* Journal of Econometrics, **WP 1147 (October 2017).**

CIANI E. and P. FISHER, *Dif-in-dif estimators of multiplicative treatment effects,* Journal of Econometric Methods, **WP 985 (November 2014).**

COVA P., P. PAGANO and M. PISANI, *Domestic and international macroeconomic effects of the Eurosystem Expanded Asset Purchase Programme,* IMF Economic Review, **WP 1036 (October 2015).**

D'AMURI F., *Monitoring and disincentives in containing paid sick leave,* Labour Economics, **WP 787 (January 2011).**

D'IGNAZIO and C. MENON, *The causal effect of credit Guarantees for SMEs: evidence from Italy,* Scandinavian Journal of Economics, **WP 900 (February 2013).**

ERCOLANI V. and J. VALLE E AZEVEDO, *How can the government spending multiplier be small at the zero lower bound?,* Macroeconomic Dynamics, **WP 1174 (April 2018).**

FEDERICO S. and E. TOSTI, *Exporters and importers of services: firm-level evidence on Italy,* The World Economy, **WP 877 (September 2012).**

GERALI A. and S. NERI, *Natural rates across the atlantic,* Journal of Macroeconomics, **WP 1140 (September 2017).**

GIACOMELLI S. and C. MENON, *Does weak contract enforcement affect firm size? Evidence from the neighbour's court,* Journal of Economic Geography, **WP 898 (January 2013).**

GIORDANO C., M. MARINUCCI and A. SILVESTRINI, *The macro determinants of firms' and households' investment: evidence from Italy,* Economic Modelling, **WP 1167 (March 2018).**

NATOLI F. and L. SIGALOTTI, *Tail co-movement in inflation expectations as an indicator of anchoring,* International Journal of Central Banking, **WP 1025 (July 2015).**

RIGGI M., *Capital destruction, jobless recoveries, and the discipline device role of unemployment,* Macroeconomic Dynamics, **WP 871 (July 2012).**

SEGURA A., *Why did sponsor banks rescue their SIVs?,* Review of Finance, **WP 1100 (February 2017).**