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# Italy's Total Factor Productivity in a Global Economy: Growth and Spillover Effects (c. 1400–2010)

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**Abstract**
Due to a lack of historical data, there is a gap in the literature with regard to total factor productivity (TFP) series in the long run for Italy. In this article, by combing information from the literature, original TFP estimates assessed with a "price dual" methodology (where changes in factor prices are used to capture physical output), and a Cobb–Douglas production equation, we first introduce a set of new TFP measures for Italy between 1360 and 1770 as well as for various global regions from c. 1400 to 2010. Second, the resulting new dataset allows us to decompose TFP in global spillover effects of technology and local effects for Italy in the long run. We find that spillover effects played a non-significant part in determining Italy's TFP decline between c. 1600 and 1800. However, the spillover component grew faster during the period 1890–2010 and reached peaks during phases of declining local (trend) TFP growth, such as between the two world wars and in the period starting with the second globalisation (1989–2010).

**Keywords** Total factor productivity · Technology · Italy · Spillover · Price dual · Trend-cycle

**JEL Classification** N13 · N14 · N15 · N30 · N33 · N34 · N35

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## 1 Introduction

After an initial stagnation/decline until c. 1000 CE, China and Western Europe slowly began to experience economic growth. Around 1400, Italy,[1] which at that time was the "leading European economy" (see Malanima 2018), also overtook China in terms of GDP per capita.[2] Subsequently, until the First Industrial Revolution that began in Great Britain in the mid-eighteenth century, Italian GDP per capita declined, although it did not fall behind that of other European countries (see e.g. Broadberry et al. 2018) or China.

There were various reasons for this convergence. Wages in Great Britain began to converge with those in Italy between the sixteenth and seventeenth centuries until they overtook them between 1670 and 1730 (Malanima 2013, 2018). In this period, a shift occurred from agriculture to industry. Urban wages in Great Britain from the period (see Allen 2001, 2009, 2011) increased more rapidly than rural ones, concurrently with a depression in rural wages due to a shifting of capital from agriculture and traditional industries towards industrial sectors employing new and high-productivity technologies. In this regard, Ventura and Voth (2015) argued for the importance of the diversion of nobility's capital from traditional sectors towards sovereign bonds (largely used by the state to finance military expenses). In this context, entrepreneurs progressively decreased their borrowing from the nobility and started instead to finance their investments through re-invested profits in those innovative industries which were riskier but with higher returns. At the same time, the reduction of capital flows from the nobility towards agriculture and traditional industries lowered wages in these sectors, and therefore created the conditions for rural–urban migration flows that increased the ranks of urban workers willing to accept lower wages in new-technology-oriented industries, eventually reducing the costs of entrepreneurs in these sectors.

This change in technology introduction patterns can be considered as one of the main determinants that initiated Great Britain's First Industrial Revolution and laid the foundations for a long-term favourable environment for productivity improvement. Indeed, as argued in growth theory (e.g. Solow 1956; Mankiw et al. 1992) and new growth theory (e.g. Romer 1986), long-run growth inevitably rests on technology introduction, which results in increasing productive efficiency. Figure 1 shows that, apart from the shock of World War I, the rate of growth of Great Britain's total factor productivity (TFP), which is an indicator of technological growth,[3] was constantly positive since the start of the First Industrial Revolution, even in the years of economic decline during the Great Depression (1929–1939).

[1] Italy here should be understood as the area that has been defined as the "cradle" of the Renaissance, namely between the southern borders of Tuscany, Umbria and Marche, reaching as far as the Alps (Malanima 2018, 5). Tuscany's economic indicators are taken as a proxy for central and northern Italy, given the similar trends in these areas (Malanima 2018). In the same way, for China, the Yangzi delta is taken as the reference region (Solar 2021).

[2] Contrary to what was previously suggested (Broadberry et al. 2018), more recent studies have placed this "Great Crossing" of Europe over China around this date (Solar 2021).

[3] TFP is intended as an overarching measure of a country's productivity level, including information such as technology level, general economic structure (industry or service-based), institutions, investments, hours worked, etc. On the definition of TFP see also Nadiri (1970), Hulten (2001), van Beveren (2012) and Sickles and Zelenyuk (2019).

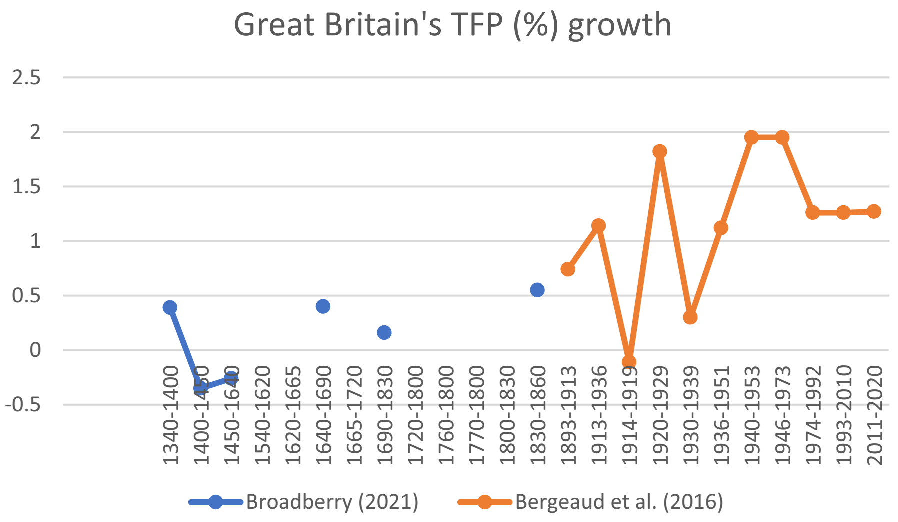


**Fig. 1** Great Britain's TFP (%) growth (c. 1340–2020). When necessary Great Britain is proxied by England

Over the centuries, technological growth was not just generated within national boundaries. As well as local (i.e. national) technological progress—which, as we mentioned above, was affected by manifold social and economic factors—, global circulation of technological knowledge among countries, also referred to as technology "spillover" effects, is another key determinant of economic convergence (see Clark and Feenstra 2003). Unsurprisingly, spillover effects are influenced by various factors as well, which we can roughly divide into three groups. First, models on technology dissemination argue that technology mainly spreads to (and is developed in) countries with high levels of physical capital-to-labour ratio, as countries with a low capital-to-labour ratio are unlikely to adopt capital intensive technology created by countries with a high capital-to-labour ratio (Acemoglu 2002; Allen 2012). Second, as described by Basu and Weil (1998), the different speed of diffusion of technological knowledge and consequent technological improvement are also linked to the degree of "appropriateness" to technological reception of the productivity environment of a country. The quality of the institutional background therefore plays a major role in the spread of technology—and consequently in convergence dynamics among countries (see e.g. North 1990; Acemoglu et al. 2005). Notably, government efficiency ensures the most appropriate environment for investment in unknown technologies, firstly by decreasing contracting hazards and secondly by acting as an incentive for industry competition in the promotion of new technology adoption (see e.g. Comin and Hobijn 2004; Zhu et al. 2006; Galang 2012). Third, knowledge spillovers increase with countries' geographical proximity (see Fischer et al. 2009).

The sum of the local (i.e. national, which we will refer to as "local" to avoid confusion) and global spread of technologies (i.e. spillover effects) together make up total TFP. This decomposition is empirically analysed by *inter alia* Calcagnini et al. (2021) for a group of seven high-income countries (including Italy). They find that, between 1954 and 2017, local TFP growth (economically referred to as trend) and spillover effects (to be identified with the presence of one single common "cycle", evidence of "business cycle synchronisation") were negatively correlated. Indeed, as a second point, Calcagnini et al. (2021) found that local (trend) innovations had a larger effect than spillover (cycle) ones. This suggests that developed countries were less likely to import technology and, consequently, more likely to develop new technologies themselves. Finally, for the group of seven countries analysed, more than one single common stochastic trend was witnessed for the period under examination, despite the fact that they shared a single common cycle, suggesting that differences in TFP growth were predominantly local rather than global for high-income countries.

In this paper, we aim to analyse TFP growth patterns for Italy for a period that ranges from the fifteenth century to the present. We do so by focusing on the size of the change of TFP measures for Italy and by empirically assessing the level of receptiveness to spillovers of technology developed elsewhere. We start in Sect. 2 by presenting Italy's original TFP growth estimations for the period between the outbreak of the plague in the fourteenth century and the nineteenth century. Besides the existing literature, we build our original estimates for the period 1360–1770 on a dual TFP methodology in which price changes cover physical output. In Sect. 3, by combining existing studies with our dual estimates for Italy and a novel set of estimates based on a Cobb–Douglas production equation, we introduce a new long-run TFP growth series for a group of nine countries that we use to proxy global regions between 1400 and 2010. In Sect. 4, we then use this newly built dataset to empirically assess the extent to which local TFP growth and global TFP spillover cycles of technology dissemination affected Italy in the long run. We find non-significant spillover effects for the period 1600–1800.[4] For the period 1890–2010, however, we find that technology spillovers (cycle component of TFP growth) have peaks for Italy, first in the period between the two world wars and then from the start of the second globalisation period in the late 1980s until the present day. In Sect. 5, we briefly conclude.

## 2 Italy's Total Factor Productivity (TFP) Between 1360 and 2010

Several studies calculate TFP in contexts ranging from East Asia (see Felipe 1999) to Europe (e.g. Gehringer et al. 2016; Beugelsdijk et al. 2018) and world level (Baier et al. 2006). Historically, for the period 1890–2010, Bergeaud et al. (2016) collected a panel dataset of yearly TFP growth for a group of 12 (mostly European) countries, also including Italy. For roughly the same time period, between 1860 and 2010, Malanima and Zamagni (2010), Broadberry et al. (2011) and Antonelli and Feder (2020) also provide data on TFP growth for Italy (see Table 1). All these studies—with the exception of Antonelli and Feder that detect instead a period of overall stagnation[5]—find a first general phase of TFP growth between the unification of Italy in 1861 and 1936.

[4] In our TFP estimates based on the Cobb–Douglas equation in Sect. 3, we used a 200-year lag, so with data starting in 1400, the first available TFP estimate using that method is for 1600.

[5] Antonelli and Feder (2020), while building on previous data of Broadberry et al. (2011), use nevertheless a different methodological approach based on the estimation of neutral technological change and biased technological change of TFP growth.

**Table 1** Italy's TFP growth (1861–2010), in percent

| | Malanima and Zamagni (2010) | Broadberry et al. (2011) | Antonelli and Feder (2020) | Bergeaud et al. (2016) |
|---|---|---|---|---|
| 1861–1913 | 1.11 | 0.13 | − 0.33 | – |
| 1913–1936 | 0.61 | 1.95 | 0.46 | 1.11 |
| 1936–1951 | 1.52 | 2.05 | – | 3.08 |
| 1951–1973 | 3.72 | 3.49 | 2.46 | 3.73 |
| 1973–2001 | 1.1 | 0.83 | 0.09 | 1.11 |
| 2001–2010 | – | – | – | − 0.52 |

Based on an adaptation of studies by Broadberry et al. (2011) and Antonelli and Feder (2020), with the year subdivision used by Malanima and Zamagni (2010)

A second phase of even higher TFP growth is found by all the studies between 1951 and 1973, the years of the so-called *miracolo italiano* (economic boom). A phase of still positive but much lower TFP growth is instead found between 1973 and 2010, even turning negative in the twenty-first century.

While there are several estimations of TFP for the nineteenth and twentieth centuries, because of a lack of historical data, few studies including pre-1850 TFP exist.[6] For Holland (as a proxy for the Netherlands), Van Zanden and Van Leeuwen (2012, 126) show periods of rising TFP from 1540 to 1620 and then once more from 1665 to 1800. For Great Britain, similar figures were calculated by Broadberry (2021), with peaks after the Black Death (1340–1400) and for the periods 1640–1690 and 1830–1860. These results are largely in line with the findings of other authors. According to Crafts and Harley (2000) and Antras and Voth (2003), TFP in England increased mainly in the nineteenth century. For China, Van Leeuwen et al. (2022) have presented long-run TFP estimations that show a picture of overall stagnant improvement, or minor decline, in productivity between the eighteenth century and the first half of the twentieth century.

In order to obtain an encompassing measure of TFP growth in Italy between 1400 and 1800, based on the "dual approach" of Antras and Voth (2003) to measure changes in productivity by using input and output prices instead of quantities, we calculate TFP using the following "price dual" TFP methodology. The Eq. (1) used can be written as:

$$\widehat{TFP} = \eta_K \widehat{r} + \eta_L \widehat{w} + \eta_T \widehat{q}, \tag{1}$$

where the hats indicate growth rates and $\widehat{r}$, $\widehat{w}$ and $\widehat{q}$ are the growth of factor payments of capital, labour and land respectively. $\eta_K$ is the factor share of capital, $\eta_L$ is the factor share of labour and $\eta_T$ is the factor share of land. The factor shares can be debated but generally vary little among existing studies. For Great Britain, Crafts (1985) initially used factor shares of 0.5 for labour, 0.35 for capital and 0.15 for land. Broadberry

[6] Also considering the strict underlying assumptions, e.g. perfect competition and constant returns to scale (see e.g. Antras and Voth 2003; Chaudhry 2009).

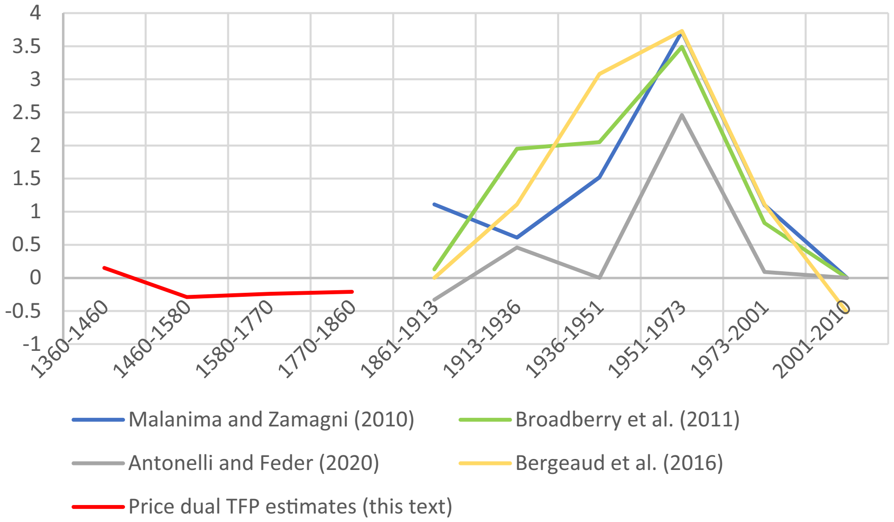


**Fig. 2** Italy's TFP (%) growth (1360–2010). Italy's TFP price dual estimates between 1360 and 1770 are based on Malanima (2003, 2004), Schmelzing (2019), Arroyo Abad (2006) and Malanima (2002)

(2021) used 0.4 for labour, 0.2 for human capital, 0.3 for capital and 0.1 for land. For the Netherlands Van Zanden and Van Leeuwen (2012) used labour 0.6, capital 0.3 and land 0.1. For the twentieth century these two authors used 0.55 for human capital, 0.45 for capital and 0 for land. For Italy, Malanima and Zamagni (2010) used 0.7 for labour and 0.3 for capital. It is important to stress that if we break factor shares down into just labour and capital, as is often done, labour is between 0.5 and 0.7 and capital between 0.5 and 0.3. In other words, the difference among countries is limited.

As well as factor shares, we need factor payments.[7] The factor payments for Italy were calculated as follows:

(a) Capital is the mean of real house price and real cattle price, corrected for depreciation and inflation.
(b) The factor price of labour is real wages.
(c) The factor price of land is real land rent.

Our results for Italy's TFP growth between 1360 and 1770 are plotted, together with the other mentioned series from the literature for the period 1861–2010, in Fig. 2.

Our results are by and large in line with those of Federico and Malanima (2004) on Italian agricultural productivity for the period between 1360 and 1860. After the productivity rise in the post-Black Death period—also due to a subsequent "accumulation of capital" for the surviving population after the high mortality of the first phases of the plague—, the sharpest drop in productivity can be placed between 1460 and

[7] The data on Italian housing, wages and essential baskets of agricultural and industrial products are from Malanima (2002, 2003, 2004) and on Italian interest rates are from Schmelzing (2019)—see also https://www.bankofengland.co.uk/working-paper/2020/eight-centuries-of-global-real-interest-rates-r-g-and-the-suprasecular-decline-1311-2018 Lira to silver conversions are based on Malanima (2002) and Arroyo Abad (2006, see https://gpih.ucdavis.edu/files/Italy_Florence_14thc.xls).

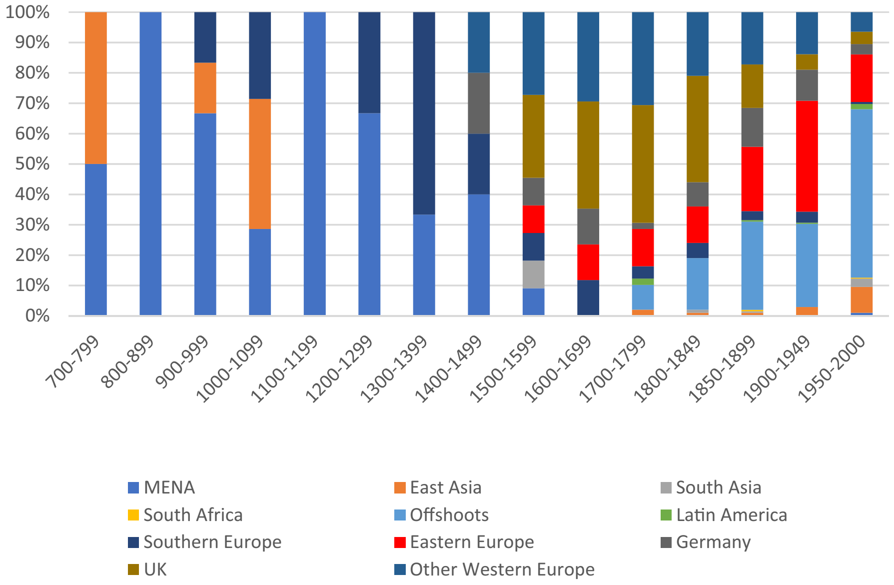


**Fig. 3** Share of inventors by period, 1000–2000. Source: Wikipedia

1600. Yet we also found a negative TFP growth value—albeit smaller in size than that of the previous time segment—between c. 1600 and 1770, in the same way as Allen (2000), while Federico and Malanima found positively signed growth. Like both Allen and Federico and Malanima, we also found negative TFP growth in the first half of the nineteenth century. Yet the size of the decline in our results is not as steep as the negative TFP growth values that we found for 1460–1580 and 1580–1770.

## 3 Italy's TFP in a Global Environment

Italy's TFP patterns are affected partly by local trends (e.g. the post-war economic boom) and partly by global cycles (e.g. waves of globalisation). To assess the size and proportion of the cycle component compared to trends, a comparison between global regions is necessary. So in this section we propose a long-run TFP dataset for various countries, which we use as a point of comparison to evaluate Italy's TFP trends and cycles in the long run. Creation of the dataset was a three-stage process. First, we built a metricised indicator of technology level per global region based on the number of inventors by year and by country in the long run (source: Wikipedia[8]). We report our results in Fig. 3.

Unsurprisingly, until 1000 CE both East Asia and the Middle East and North Africa (MENA) dominated in global technology advancement. From 1400 CE, we witness

[8] https://en.wikipedia.org/wiki/List_of_inventors. Accessed April 2022. In order to test the representativeness of this list, we crosschecked some of the main national trends on technology and human capital formation with available data from the literature (e.g., Wu et al. 2019; De Pleijt and van Zanden 2016).

**Table 2** Regression of ln(GDP/capita) on number of inventors, ca. 1000–2018 CE

| | Coefficient | t-value |
|---|---|---|
| Inventors | 0.005 | 3.68 |
| Inventors (200-year lag) | 0.027 | 2.57 |
| Global regions (minus country) | 0.004 | 1.76 |
| Constant | 8.445 | 42.87 |
| Year fixed effects | Yes | |
| Country fixed effects | Yes | |
| Obs | 65 | |
| Adj. $R^2$ | 0.875 | |

the rise of Western Europe until 1800. After 1800 there was a major rise in Western Offshoots as well as a small increase in East Asia.

Second, we regressed ln(GDP/capita)[9] in a traditional Cobb–Douglas equation, with ln(K/L) captured by country and year fixed effects, and TFP (proxied by the number of inventors per country and year). As well as these variables, we checked whether countries also profited from the technological development of nearby countries (variable “global regions (minus country)”[10]) and time lags (variable “inventors (lag 200 years)”). Other lags turned out to be insignificant.

In terms of data, we included China, India, Italy, France, Germany, Great Britain, Russia, Iraq and the United States for 1400–1800 as they covered various global regions (and represented large economies in these regions) and because historical data was readily available.[11] We report the results in Table 2.

Third and finally, we combined these new TFP data with our price dual method TFP estimates for Italy between 1400 and 1770 and with existing data from the literature. These include the estimates for the Netherlands between 1540 and 1800 of van Zanden and van Leeuwen (2012) and the estimates of Broadberry (2021) between 1340 and 1830 for Great Britain. We further calculated (again with a price dual methodology) TFP growth estimates for China between 1540 and 1890, which we then combined with the Van Leeuwen et al. (2022) estimates, and we eventually added them to the dataset. For the period between 1890 and 2010, we instead used the estimates of Bergeaud et al. (2016). Figure 4 depicts our resulting long-run series of TFP growth for a group of seven selected countries.

As seen in the previous section, Italy’s TFP growth, which was positive in the aftermath of the economic shock following the late 14th- to early 15th-century plague

[9] Data on GDP/capita are retrieved from Maddison Project Database, version 2020. Bolt and van Zanden (2020).

[10] “Global regions (minus country)” therefore has the purpose of estimating the potential spreading effect on individual countries of technology first introduced in neighbouring countries—e.g. Western Europe as a “global region” minus the country whose GDP per capita acts as the dependent variable. We find that it has a positive effect.

[11] The decision to start the data in 1400 instead of 1600, which we use in our analysis, was taken because we include a lagged variable of 200 years, so to obtain an estimate for 1600 the dataset needs to start in 1400.

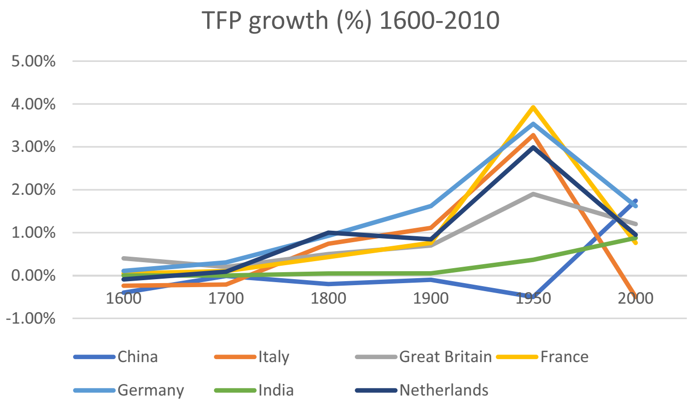


**Fig. 4** TFP (%) growth series between 1600 and 2010 for selected countries. Italy's TFP growth is based on price dual estimates (this text) for the period 1360–1770. 1800 is based on Cobb–Douglas estimates (this text). 1890–2010 is based on Bergeaud et al. (2016). India's series is based on Cobb–Douglas estimates (this text). France and Germany's series is based until 1890 on Cobb–Douglas estimates (this text). All countries except China are based on Bergeaud et al. (2016) for the period 1890–2010. The series of China, Netherlands and Great Britain (for the last two until 1890) are based on literature estimates (see Sect. 3 of this text)

outbreak, then steadily turned negative from 1460 until the late nineteenth century. It is important to bear in mind that the nineteenth century in Italy was characterised by the major historical event of the completion of the process of unification under a single central government of several regional micro-states in the north of Italy and the acquisition of the Bourbon kingdom in the south of the Italian peninsula in 1861. According to Malanima and Zamagni (2010), the level of measured productivity grew by a factor of 19 between 1861 and 2001 (it started from a low level) and contributed by around 50–58% to Italy's GDP growth rate—with labour contributing by 10–12% and capital by 30–40%. The related steady positive turn in Italy's TFP growth starting from the end of the nineteenth century (see Fig. 4) therefore firstly has a temporal correspondence, with a change in the underlying institutional environment at national level. Second, there was a parallel diffusion of innovations and modes of production from the First Industrial Revolution in the unified Italy, which, as for Great Britain one century earlier, could also have been fostered by a shifting of the resources of the aristocracy in the unified peninsula from traditional sectors to state sovereign bonds. From the period 1861 to 1934, Italian gross public debt was around or above 80% of GDP, with peaks of 120% around 1900 and 160% at the end of World War I (Bastasin et al. 2019), whereas Italy's labour market was characterised by much lower average wages for unskilled workers compared to coeval England (Rota and Weisdorf 2021).

Third, in the context of the first wave of globalisation between 1870 and 1913, global technology knowledge spillovers were also likely to have been a factor that played a role in determining the size of TFP growth in Italy. We analyse the contribution of spillovers—intended as a (common) cycle component of TFP growth—in the next section.

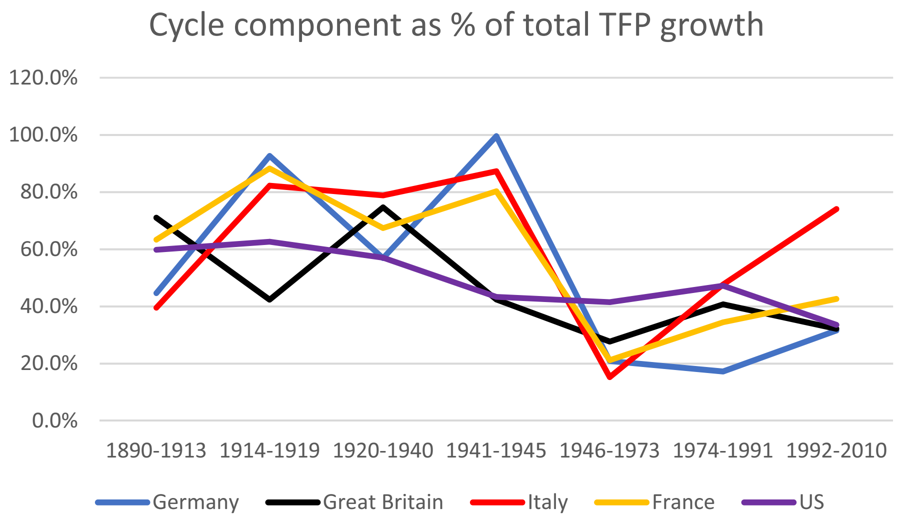


**Fig. 5** Spillover (cycle) component as % of total TFP growth for five selected countries (1890–2010). Source: This text

## 4 Local TFP Growth and Global Spillovers in Italy from 1890 to 2010

To assess the changing contribution of local TFP growth and global spillover effects to Italy's TFP growth in the long run, we first regressed the TFP growth values of seven countries (including Italy) in our newly built dataset on a vector of country fixed effect and time dummies. Time dummies can be interpreted as a proxy for the world component of a country's TFP growth, since they can capture the effect of synchronized global business cycles. By dividing the world TFP growth component by the country-level TFP growth component for Italy, we can see the contribution of technology spillovers for Italy. Our results for Italy from 1600 to 1800 are nevertheless non-significant.[12] We interpret this outcome as evidence of largely null spillover effects in Italy in these three centuries. Italy's TPF-level decline should be therefore interpreted for these centuries as a trend decline.

For the second period of interest—from the end of the nineteenth century to 2010—, adopting the second approach used by Calcagnini et al. (2021) to split TFP growth into trend and cycle components, we apply an HP filter (with smoother of 100) to the Bergeaud et al. dataset (2016). As mentioned in Calcagnini et al. (2021), this methodology has the great advantage of being able to encompass the long-run behaviour of diverse and differently generated data. However, it may potentially capture spurious dynamic relations, in particular for filtered values at the end of the sample. Therefore, we omit the data at the start and end of the sample. In Fig. 5, we report our results for the technological spillover component[13] between 1890 and 2010 for five selected countries, including Italy, Germany, Great Britain, France and the US.

12 Results are available on request.

13 We assumed the cycle component to have a minimum value of 0 and a maximum of 100.

Between 1890 and 2010, we find a significant presence of technological spillover effects for Italy, especially between 1914 and 1945 and between 1974 and 2010. We interpret the peak of the share of the cycle component in TFP growth in the 1914–1945 phase as mainly due to a sharp reduction in the yearly average trend (local) productivity, which in turn was determined by the outbreak of the two world wars and by the economic consequences stemming from the post-1929 Great Depression and the protectionist dynamics of the interwar years. In this context, while trend TFP growth declined and even turned negative, overall TFP growth slowed compared to the previous time segment 1890–1913 (see also for example Fig. 1 for Great Britain and Fig. 2 for Italy). Technological spillovers likely did not increase compared to the previous phase. It has been argued in the literature that there is strong evidence of the diffusion during the interwar years of technological innovation and modes of production introduced elsewhere and on the basis of the Second Industrial Revolution (see e.g. Roses and Wolf 2008; see also Chandler 1990 on the adaptation to American forms of mass production in other countries). Furthermore, Milanovic (2006) argues for the interwar years as a phase of income convergence at global level, and other studies, for example for England (see Philips et al. 2022), detect an occupational shift in working population from the primary and secondary sectors to the tertiary sector already by 1939. Yet the period 1914–1945 was characterised by the end of the first wave of globalisation (e.g. Jones 2004) and by a sharp reduction in trade at international level (see e.g. Chase 2004).

Our results in this regard offer a somewhat encompassing perspective. By splitting TFP growth into trend and cycle, we detect a sharp reduction in trend TFP growth due to the world wars and the economic crisis together with the end of the previous globalisation wave during the interwar years. In this context, technological spillover effects became predominant in supporting reduced TFP growth, even sometimes contributing to making negative TFP growth less negative—see also the case of Germany[14] with the two peaks of cycle growth corresponding to the war years. For Italy, while technological spillovers were the major contributors to (reduced) TFP growth during the wars and the interwar years—the latter largely overlapping with the twenty years of fascist regime at the institutional level—, their share fell sharply during the years of the Italian economic boom, between 1950 and 1973, because of the increase of the trend component in a rapidly growing TFP. As shown in Fig. 5, between 1946 and 2010, Italy's cycle growth depicts a U-shaped curve, with new growth in the cycle component running concurrently with both the second globalisation phase from 1989 and a new reduction in the trend component of TFP growth from the 1970s.

## 5 Conclusion

Total factor productivity (TFP) growth is one of the drivers of long-run growth, and for this reason it has attracted much scholarly attention over the years. In this paper, we began by addressing a lack of historical series on Italy's long-run TFP growth. By

[14] Germany was, moreover, a country traditionally characterized by decentralised modes of knowledge diffusion, for example through the conferences and meetings of the "economic societies" described by Cinnirella et al. (2022).

using a price dual methodology and estimations based on a Cobb–Douglas production equation, we calculated TFP both for Italy from 1360 to the nineteenth century and also for a group of other countries representing global regions. We found that Italy's TFP, after positive growth between the end of the fourteenth century and the beginning of the 15th—a change linked with the reduction in population size and lower pressure on available resources in the aftermath of the bubonic plague outbreak—, continuously declined in the following centuries, also owing to the absence of significant spillover effects from global regions to Italy.

Only in the second half of the nineteenth century did TFP once again begin to show consistent and positive growth in Italy. Indeed, after the political unification of the Italian peninsula in 1861, TFP growth was enhanced by two factors: the diffusion of innovation and modes of production from the First Industrial Revolution, and also an international climate characterised by the first wave of globalisation that fostered increasing circulation of technological knowledge. Indeed, we find that, in this phase, global technological spillover effects played a role in the growth of Italy's TFP, together with the growth of the local share of TFP.

In the subsequent phase, between the two world wars (1914–1945), while compound TFP growth—local and spillover together—slowed down, the share of the spillover component in total TFP growth reached higher values. We interpret these results mainly as a consequence of a sharp reduction in the share of the local component of TFP growth (and thus an increase in the share of spillover effects in TFP), in a context characterised by the economic shocks of the two wars and by a sustained phase of economic depression and protectionist policies. Moreover, during the interwar years, technological knowledge continued to spread among countries, with the introduction of innovations and the mass-production modes of the Second Industrial Revolution helping mitigate the decline in local TFP growth.

Spillover effects then became progressively less predominant when Italy faced a phase of significant productivity changes during the years of the *miracolo italiano*, a period of economic boom between the end of the Second World War and the first half of the 1970s. We find that during these years, Italy's TFP growth was mainly sustained by its local share, rather than the spillover share. Finally, with the start of the second wave of globalisation at the end of the 1980s, the spillover share increased again. This occurred in part because of the growth in international trade due to globalisation and also because of a parallel new phase of decline in the local share of TFP growth.

**Data availability** Data are available on request.

## Declarations

**Conflict of interest** The authors have no relevant financial or non-financial interests to disclose.

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