RESOURCE REALLOCATION AND TOTAL FACTOR PRODUCTIVITY IN TURKIYE: 2000-2022

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Resource reallocation and total factor productivity in Turkiye: 2000-2022

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Abstract:

This paper shows that the aggregate TFP growth is negative in 2000-2002 and 2008-2010 periods, but positive in 2003-2007 and 2011-2013 periods. Surprisingly, aggregate TFP growth is almost zero in the 2015-2022 period where there is no economic crisis. TFP growth is very volatile and low on average in construction sector. Services sector is characterized by negative TFP growth. Agriculture has the most smooth trends and highest TFP growth on average. This paper also decomposes the aggregate TFP into its within and reallocation components for the 2000-2022 period. While the reallocation effect is generally positive for labor (except for crisis years), there are two separate periods for capital. In the period 2000-2014, the reallocation effect for capital is positive, while in the period 2015-2022 it becomes consistently negative.

Keywords: Total Factor Productivity; Allocative Efficiency

JEL Classification: O47, D61

1 Introduction

Since the year 2000, the Turkish economy has undergone significant changes. At the risk of over-simplification, we can say that the lion's share of investment went to the construction sector, while the lion's share of employment went to the services sector. We can get an idea of these changes by looking at the changes in the two directly observable inputs of production, employment and investment. While there has been a 3.5-fold increase in aggregate real investment during this period, the sectoral distribution of this investment has changed dramatically over time. Investment in construction increased by 4.9 times, investment in services by 3.1 times (Table 1).[1] Between 2000 and 2011, the share of construction investments in total investments was approximately 30 percent. This percentage rose rapidly and reached 42 percent in 2014. From 2014 to 2020, it remained around 40 percent before slightly declining to approximately 36 percent in the last two years (See also Figure 6 in Appendix A). As a result of the rapid increase after 2014, the construction sector now has the highest investment at current prices. For a sector whose share in

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[1]In the same period investment in industry by 3.5 times, and investment in agriculture by 1.6 times.

national income lags far behind that of industry and services, this is not what one would expect. Similarly, total employment increased by a factor of 1.6. However, sectoral employment dynamics again show large differences (Table 2). While employment in the services sector increased by about 2.1 times, and construction employment by 1.4 times.[2]

Table 1: Change in real investment and employment: 2000-2022

sek	rat_I	rat_L
tot	3.5	1.6
agr	1.6	0.8
ind	3.5	1.8
ser	3.0	2.1
con	4.9	1.4

Note: rat_I and rat_L, are the multiples of the increase in investment and employment, respectively, between the years 2000 and 2022. agr, ind, ser, con refer to, agricultue, industry, services and construction, respectively. Source: TurkStat.

Naturally, one would have expected the share of construction and services in GDP to increase with such a large slice of the pie. As Table 2 shows this is not really the acse. Over a 22-year period, the share of construction in GDP at current prices fell from 5.9 percent to 5.5 percent, while the share of services fell from 58.9 percent to 57.8 percent. This contrasts with industry, which grew from 24 percent to 29.5 percent over the same period. So, why did the share of the two sectors that attract the largest share of inputs not increase as much as expected? And what is the implication of directing most of the resources to these sectors for GDP level and Total Factor Productivity (TFP)? To answer the first question we need to analyze *dynamics* of sectoral TFP. And to answer the second question we should study the effect of *resource reallocation* on productive capacity and TFP.

Table 2: Shares in GDP, investment and employment: 2000-2022

sek	y_00	y_22	i_00	i_22	e_00	e_22
agr	11.2	7.2	4.2	2.0	31.0	15.8
ind	24.0	29.5	26.4	29.1	19.4	21.7
ser	58.9	57.8	40.9	32.5	43.0	56.5
con	5.9	5.5	28.4	36.4	6.6	6.0

Note: y_20 and y_22 show the share of each sector in GDP in 2000 and 2022, respectively. Similarly, e_20 and e_22 show the share of each sector in employment while i_20 and i_22 show the share of each sector in investment in the same years. agr, ind, ser, con refer to, agricultue, industry, services and construction, respectively. Source: TurkStat

I find that TFP growth in construction and in services to be low on average (compared to industry and agriculture). Furthermore, TFP growth is very volatile and unsustainable in construction sector. Thus, the first reason of decreasing shares in GDP for construction and services sectors despite increasing shares of inputs is the low TFP growth rates in these two sectors. Since aggregate TFP is a function of sectoral TFPs, when low productivity sectors such as construction and services sectors use most of the resources this also has a direct negative effect on aggregate

[2]In the same period industrial employment by 1.8 times, and agricultural employment declined by 20 percent.

TFP. This component of aggregate TFP which is weighted average of sectoral TFPs is called the *within* component. But this is not end of the story. Directing most of the resources to these low productivity sectors has an additional negative effect on aggregate TFP through *reallocation* of resources. This second component is called the *between* component.[3]

This paper calculates both sectoral and aggregate TFP for Turkey for the 2000-2022 period. Unlike earlier studies (Bakis and Acar, 2019; Atiyas and Bakis, 2020; Atiyas and Bakis, 2023) this paper takes into account improvement in schooling over time while calculating sectoral TFP growth. Since schooling dynamics follow different patterns in each sector, depending on characteristics of workers in the sector, this avoids any bias in TFP calculations due to rising schooling levels. Unaccounted schooling improvements show up in the TFP growth which is likely to inflate TFP growth rates. For instance Bakis and Acar (2021) shows that the annual average bias is approximately 0.5 percentage points between 1990-2019. Aggregate TFP growth is negative in 2000-2002 and 2008-2010 periods, but positive in 2003-2007 and 2011-2014 periods. Surprisingly, aggregate TFP growth is zero in the 2015-2022 period where there is no economic crisis. TFP growth in the industry has the same pattern as aggregate TFP growth. TFP growth is very volatile and low on average in construction sector. Services sector is characterized by negative TFP growth. Agriculture has the most smooth trends and highest TFP growth on average.

This paper also decomposes the aggregate TFP into its within and reallocation components for the 2000-2022 period. Assuming that output is produced by capital and labor in each sector, I am able to calculate the input specific reallocation effect for the Turkish economy. While the reallocation effect is generally positive for labor (except for crisis years), there are two separate periods for capital. In the period 2000-2013, the reallocation effect for capital is positive, while in the period 2014-2022 it becomes consistently negative.

Empirical studies that estimate TFP relying on aggregate production function and aggregate data are unfortunately silent about the magnitude of the reallocation effect (Feenstra et al. 2015; Hall and Jones, 1999; Caselli, 2005; Hsieh and Klenow, 2010). To answer this important question one needs to use sectoral or firm-level data. There are many firm-level studies that study aggregation and reallocation issues (Basu and fernald, 2002; Baily, et al, 1992; Olley and Pakes, 1996; Aw et al. 1997; Foster et al., 2001; Petrin and Levinsohn, 2012; Fox, 2012; Bartelsman, et al 2013; Baqaee, and Farhi, 2020). These papers will not be discussed here because we want to focus on papers using sectoral data.

Jorgenson and his coauthors (Jorgenson et al.,2003; Cao et al., 2009; Jorgenson and Schreyer, 2013) use a gross-output based TFP measure while Diewert (2015, 2016) use a valued-added based

[3]To better understand how these two components complement each other, let us use the following example from Massel (1961). Consider a simple economy with 2 time periods, t_0 and t_1, and 2 firms (or sectors), A and B, and a constant level of inputs that can be used by firms (sectors). Going from t_0 to t_1, there will be changes both in the technology of each firm (sector) and in the allocation of resources. Even though both happen simultaneously, to decompose them, we can think of them as happening sequentially, in 2 steps. In the first step, for a given allocation of resources, there is a change in technology that causes a change in output. This is the *within* component. In the second step, resources are reallocated for a given technological capacity. As long as there are productivity differences between firms, this will cause a second change in the level of output. This is the *between* component.

TFP measure. Jorgenson approach has several benefits. The first one is that it relies on standard production functions where capital, labor and intermediate goods are used as inputs. Another benefit is that since it distinguishes between input specific reallocation effects we can analyze the effect of reallocations of capital and labor among different industries. However, the setup used by Jorgenson and his coauthors require detailed input-output tables which makes its application rather difficult for 2 reasons. First, since input-output tables are compiled every 5 or 10 years one cannot assess annual productivity dynamics. Second, industrial classifications are changing over time which makes intertemporal comparison difficult.

Diewert (2015, 2016) uses a more flexible setup which does not require input-output tables. Unfortunately, Diewert does not distinguish between factors of production. His analysis is based on industry input aggregates. This is unfortunate because reallocation of main factors of production such as capital and labor cannot be studied separately. Moreover, Diewert formulation is not clear enough regarding what constitutes reallocation effect. The reason is that the reallocation effect is generally linked to changes in relative sizes of each industry measured either using output or inputs. But, there are 3 terms that can be considered as part of the ***reallocation effect***: a term reflecting changes in real output prices, another term reflecting changes in real input prices, and finally a term reflecting changes in input cost shares. The presence of output and input prices is complicating the interpretation.

The outline of the paper is as follows. Section 2 discusses how aggregate TFP can be calculated as a function of sectoral TFPs and the reallocation effect, which captures improvements in TFP due to reallocation of factors of production across sectors. Section 3 presents the data compilation process and how this paper deals with the additivity problem inherent in chain volume indices. Section 4 presents the main results. Finally, Section 5 concludes the paper.

2 From sectoral TFP to aggregate TFP

Let us note current price sectoral aggregates by $P_{it}Y_{it}$ in industry i. Assuming that there exists an aggregate price level P_t and quantity level Y_t, as suggested by Jorgenson and Griliches (1967), we can write $P_tY_t = \sum P_{it}Y_{it}$. If we take the derivative of both sides with respect to time and divide it by the corresponding total value, we get the following equation

$$\frac{\dot{Y}_t}{Y_t} + \frac{\dot{P}_t}{P_t} = \sum_i s_{it}\frac{\dot{Y}_{it}}{Y_{it}} + \sum_i s_{it}\frac{\dot{P}_{it}}{P_{it}}$$

Then we can ***define*** real GDP growth and price growth as

$$\frac{\dot{Y}_t}{Y_t} = \sum_i s_{it}\frac{\dot{Y}_{it}}{Y_{it}}, \quad \frac{\dot{P}_t}{P_t} = \sum_i s_{it}\frac{\dot{P}_{it}}{P_{it}} \tag{1}$$

where s_i is the nominal shares of sector i: $s_i = \frac{P_i Y_i}{\sum_i P_i Y_i}$. Aggregate and sectoral production functions are given as

$$Y_t = A_t K_t^{\alpha} H_t^{1-\alpha}, \quad Y_{it} = A_{it} K_{it}^{\alpha_i} H_{it}^{1-\alpha_i}$$

where K is the (aggregate or sectoral) capital stock and H is the number of workers adjusted for "quality". The proxy of quality we use is the average human capital h that each worker has. Following Hall and Jones (1999) the human capital is constructed as

$$H = Lh = L\exp(\varphi(q))$$

where L refers to number of workers, q to average years of schooling. The function $\varphi(q)$ is a piecewise linear function so that the return to schooling is 13.4 percent for $q \leqslant 4$, 10.1 percent for $4 < q \leqslant 8$, and 6.8 percent for $q > 8$.

Taking the derivative of both sectoral and aggregate production functions with respect to time and rearranging for TFP growth we get

$$\begin{aligned}
\frac{\dot{A}}{A} &= \frac{\dot{Y}}{Y} - \alpha\frac{\dot{K}}{K} - (1-\alpha)\frac{\dot{H}}{H} \\
&= \sum_i s_{it}\frac{\dot{Y}_{it}}{Y_{it}} - \alpha\frac{\dot{K}}{K} - (1-\alpha)\frac{\dot{H}}{H} \\
&= \sum_i s_{it}\left(\frac{\dot{A}_{it}}{A_{it}} + \alpha_i\frac{\dot{K}_{it}}{K_{it}} + (1-\alpha_i)\frac{\dot{H}_{it}}{H_{it}}\right) - \alpha\frac{\dot{K}}{K} - (1-\alpha)\frac{\dot{H}}{H} \\
&= \underbrace{\sum_i s_{it}\frac{\dot{A}_i}{A_i}}_{WE} + \underbrace{\sum_i s_{it}\alpha_i\frac{\dot{K}_i}{K_i} - \alpha\frac{\dot{K}}{K}}_{RK} + \underbrace{\sum_i s_{it}(1-\alpha_i)\frac{\dot{H}_i}{H_i} - (1-\alpha)\frac{\dot{H}}{H}}_{RL}
\end{aligned} \tag{2}$$

WE is the contribution due to the changes in sectoral TFP growths, usually called the within effect. WE is a measure of intra-industry technological change which is nothing more than a weighted average of the rates of technological change within each industry. This component, by construction, excludes any improvements due to reallocation of resources among industries. This is why many see the within component as a proxy of "pure technological change". But this would be wrong because the value of all components depends on the number of industries used in the analysis. RK and RL show the contribution of reallocation of capital and labor. The reallocation effect is due to interindustry shift of factors of production.

Here, we should remind our readers that since we have only 4 sectors our decomposition, like any other decompositions, yields a within effect larger than what it is in reality. If we used a more detailed industry classification (such as 2 digit NACE industry classification) the TFP growth of each broad sector would be further decomposed into 3 components as in equation (2). With 4 broad sectors we can say that the reported WE should be interpreted as upper bound of the true effect while the reported RK and RL should be seen as lower bound of the true effect.

Following Massel (1961) we can show that RK and RL come from productivity differences across industries. For this, we need to rewrite (2) using marginal productivities. For this, let us show that (using $\alpha Y/K = F'_K$ and $\alpha_i Y_i/K_i = F'^i_K$)

$$
\begin{aligned}
\alpha_i s_{it}\frac{\dot{K}_i}{K_i} &= \alpha_i \frac{P_i Y_i}{PY}\frac{\dot{K}_i}{K_i} = \frac{\frac{\alpha_i Y_i}{K_i}}{\frac{\alpha Y}{K}}\frac{\alpha P_i}{PK}\dot{K}_i \\
&= \alpha \frac{P_i F'^i_K}{PF'_K}\frac{\dot{K}_i}{K} \\
\Rightarrow RK = & s_{it}\alpha_i\frac{\dot{K}_i}{K_i} - \alpha\frac{\dot{K}}{K} = \alpha\left(\frac{P_i F'^i_K}{PF'_K}\frac{\dot{K}_i}{K} - \frac{\dot{K}}{K}\right) = \alpha\left(\frac{P_i F'^i_K \dot{K}_i - PF'_K \dot{K}}{PF'_K K}\right)
\end{aligned}
$$

And similarly for labor (using $(1-\alpha)Y/H = F'_H$ and $(1-\alpha_i)Y_i/H_i = F'^i_H$)

$$
\begin{aligned}
(1-\alpha_i)s_{it}\frac{\dot{H}_i}{H_i} &= (1-\alpha_i)\frac{P_i Y_i}{PY}\frac{\dot{H}_i}{H_i} = \frac{\frac{(1-\alpha_i)Y_i}{H_i}}{\frac{(1-\alpha)Y}{H}}\frac{(1-\alpha)P_i}{PH}\dot{H}_i \\
&= (1-\alpha)\frac{P_i F'^i_H}{PF'_H}\frac{\dot{H}_i}{H} \\
\Rightarrow RL = & s_{it}(1-\alpha_i)\frac{\dot{H}_i}{H_i} - (1-\alpha)\frac{\dot{H}}{H} = (1-\alpha)\left(\frac{P_i F'^i_H}{PF'_H}\frac{\dot{H}_i}{H} - \frac{\dot{H}}{H}\right) = (1-\alpha)\left(\frac{P_i F'^i_H \dot{H}_i - PF'_H \dot{H}}{PF'_H H}\right)
\end{aligned}
$$

Reallocation effects exists only when marginal returns are not equal across sectors. So, in a sense, the above equation is a measure of the difference between marginal returns across sectors. If reallocation effects are negligible, then we can conclude that marginal returns are close to each other across sectors. A similar derivation can be found in Massel (1961) and in Jorgenson and coauthors's works (see Cao et al., 2009; Jorgenson and Schreyer, 2013). In the Jorgenson approach, TFP is based on gross output, while in this paper it is derived from value added. Using value added instead of gross output simplifies the derivation. In Massel (1961), TFP is based on value added but all aggregates are compiled using constant price national accounts methodology. In this paper, we use Divisia index numbers to derive aggregate productivity measures which is consistent with chain-linked volume measures used by TurkStat.

In the above derivation of agregate productivity there is no explicit role for changes in relative prices. And this makes complete sense because weights are continuously changing in Divisia approach. Continuously updated weights will already reflect changes in relative prices. However, in the literature we see both papers where relative prices have an explicit role (see, among others, Ohanian, 2001; Diewert, 2015,2016; Tang and Wang, 2004) and papers where there is no role for changes in relative prices (Jorgenson et al.,2003; Cao et al., 2009; Jorgenson and Schreyer, 2013). Diewert (2015) finds that while the effect of the change in relative prices can be fairly large for some industries, when when we sum across industries the overall effect of changes in relative prices is approximately zero in each year. The reason behind this puzzle is answered in Diewert (2016): the use of index numbers (Laspeyres, Paasche, Fisher, Törnqvist) to define aggregate outputs and inputs leads to a cancellation of changes in relative prices in the aggregate decompositions.

To see how changes in relative prices lead to a cancellation in the aggregate decompositions, we can start with accounting identity where aggregate VA (GDP) is equal to sum of sectoral VA (GDP) in current prices. Again, as in Jorgenson and Grilieches (1967), I assume that aggregate quantity and prices indexes exist. More specifically, Y_t denotes the real (chain indexed) GDP while P_t is the GDP deflator. I will use V_t to denote the nominal GDP. Then, by definition we have $V_t = Y_t P_t$ for the aggregate economy and $V_{it} = Y_{it} P_{it}$ for each sector, where P_{it} is the sectoral GDP deflator.

$$Y_t = \frac{V_t}{P_t} = \frac{\sum_i V_{it}}{P_{it}} = \frac{\sum_i P_{it} Y_{it}}{P_t} = \sum_i p_{it} Y_{it}$$

Taking the time derivative of both sides and dividing by real GDP we get

$$\frac{\dot{Y}_t}{Y_t} = \sum_i s_{it} \frac{\dot{Y}_{it}}{Y_{it}} + \sum_i s_{it} \frac{\dot{p}_{it}}{p_{it}} \tag{3}$$

Compared to GDP growth given in Divisia approach in (1) there is an extra term, $\sum_i s_{it} \dot{p}_{it}/p_{it}$ in (3). Actually, this extra term is approximately zero in discrete time and exactly zero in continuous time. To see this, let us rewrite the weighted average of relative price changes as

$$\sum_i s_{it} \frac{\dot{p}_{it}}{p_{it}} = \sum_i s_{it} \frac{\dot{P}_{it}}{P_{it}} - \sum_i s_{it} \frac{\dot{P}_t}{P_t} = \sum_i s_{it} \frac{\dot{P}_{it}}{P_{it}} - \frac{\dot{P}_t}{P_t}$$

where we used $p_{it} = P_{it}/P_t$ and $\sum_i s_{it} = 1$. When time is continuous the above expression is exactly equal to zero by the definition of the growth rate of the price component in Divisia approach given in (1). However, since real data is collected for discrete time periods the result is approximately zero: $\sum_i s_{it} \frac{\dot{p}_{it}}{p_{it}} \approx 0$. Please note that this approximation error is also present in volume component as well. This explains why Diewert (2015) finds a very small (close to zero) effect for the contribution of the real input and output price changes to the aggregate TFP growth.

3 Data

To estimate TFP growth we need GDP, capital and human capital series and values of parameters of production functions. All GDP and employment data is obtained from TurkStat. Sectoral GDP data is available since 1998. Sectoral employment data is available since 1988 from TurkStat website. Capital stock is derived from investment series. Sectoral investment data is obtained from the Presidency of Strategy and Budget[4]. Historical data on employment, GDP and einvestment is again available from the Presidency of Strategy and Budget[5].

Historical employment and GDP data is available for 9 sectors. But the classification used for investment is not consistent with the one used for employment and GDP. This makes impossible

[4] https://www.sbb.gov.tr/temel-ekonomik-gostergeler
[5] https://www.sbb.gov.tr/ekonomik-ve-sosyal-gostergeler

the construction of sectoral capital stocks for 9 sectors. However, the investment series contains ”housing” which is part of the ”construction” sector. Because of this problem earlier literature on TFP used to analyse only 3 sectors (agriculture, industry and services). This is unfortunate given the importance of the construction sector for Turkish economy. I follow Bakis and Acar (2020) to separate housing investment from other construction data. This yields an imperfect measure of capital stock for construction sector. Since it is not possible to construct capital stock for all 9 sectors I limit my analysis to 4 borad sectors: agriculture, industry (mining, manufacturing and public utilities), construction, and all remaining sectors regrouped as services.

Once we have an investment serie (sectoral or aggregate) we use the perpetual inventory method (PIM) to derive capital stock series. Given an estimate of initial capital stock, we derive capital stock as follows

$$K_t = (1-\delta)K_{t-1} + I_{t-1}$$

where δ is the depreciation rate. Since we rely on steady state assumption to compute initial capital stock using investment data, it is suggested to compute it as early as possible (in my case this is 1948) so that any error done in initial capital stock disappears in the long run.[6] For aggregate economy we set $\delta = 0.06$ as most of the literature. Since there are sectoral differences regarding the depreciation rate (Jorgenson, 1996; Hulten ve Wykoff, 1981) we set $\delta = 0.04$ for agriculture, $\delta = 0.08$ for construction and $\delta = 0.06$ for industry and services.

For sectoral capital stocks we use PIM method as well. The only difference is the way we estimate initial level of capital stock and the value of the depreciation rate. Following Caselli (2005), we use the non-arbitrage condition between sectors (marginal firm should earn the same rate of returns in each sector)

$$\frac{\alpha_a P_{a0} Y_{a0}}{K_{a0}} = \frac{\alpha_i P_{i0} Y_{i0}}{K_{i0}} = \frac{\alpha_s P_{s0} Y_{s0}}{K_{s0}} = \frac{\alpha_c P_{c0} Y_{c0}}{K_{c0}}$$

Combining the above equations with

$$K_0 = K_{a0} + K_{i0} + K_{s0} + K_{c0}$$

we can obtain initial capital levels for each of 4 sectors.

Another important parameter is the output elasticity of labor (human capital). Empirical studies use generally labor share to set this parameter. However, especially in developing countries such as Turkiye, there is a non-negligible amount of unpaid family workers and self-employed individuals (owners of unincorporated enterprises). In 2022 the share of unpaid workers is approximately 30 percent. As a result the reported share of labor is biased. To correct for this we need to impute a wage for those unpaid workers. To deal with the same problem, Feenstra et al. (2015) assume that the share of labor income in mixed income (income earned by self-employed workers where capital and labor incomes are not separated) is the same as the rest of the econ-

[6]The steady state assumption used to estimate initial level of capital stock is $K_0 = \frac{I_0}{\bar{g}+\delta}$ where $\bar{g}$ is the growth rate of capital and output in the steady state. As an approximation, we use the average growth rate of GDP over 1949-1959.

omy. Since mixed income is only available for 60 countries, they assume that all value added in agriculture is the labor income of the self-employed. Since the labor income of self-employed outside agriculture is ignored in this approach I prefer another solution. I assign average sectoral wage to unpaid workers in each sector. This process yields what we call "adjusted labour share" (ALS)

$$ALS_j = 1 - \alpha^j = \frac{w^j L_j}{P_j Y_j} \frac{N_j}{L_j}$$

where L_j refers to the number of employees (paid employment) and N_j to the total number of employees in the sector j. Using these adjusted labor shares I find the following values for sectoral capital shares

$$\alpha^a = 0.50, \quad \alpha^i = 0.63, \alpha^s = 0.48, \quad \alpha^c = 0.66$$

The capital share for aggregate economy, $\alpha = 0.53$, is simply found as a weighted average of sectoral capital shares where weights are GDP shares.

When constructing GDP and investment series going back to 1948 one needs to deal with changes in activity classification. I follow the steps described in Bakis and Acar (2020) to generate these series. Another problem that one has to deal with is the lack of additivity introduced with the adoption of chain indices in 2016. GDP or invesment in current prices is equal to the sum of its components. But this is not true for chain-linked volume series (real GDP or investment series) published by TurkStat. This is problematic because our analyses requires us to regroup either 21 sectors into 4 in the case of GDP series or 10 sectors into 4 in the case of investment series. In order to deal with this problem we follow the OECD practice, explained in Lequiller and Blades(2014)[7]. The idea is to express all volumes in prices of previous year instead of chain-linked volume levels because accounts in previous year prices preserve additivity because TurkStat uses chained Laspeyres indices to derive volume indices. For this, we apply the growth rate of each component to the lag of the values in current prices as $v'_t = v_{t-1}(1 + g_t)$. Here, v_t is value added in year t in current prices, while v'_t is the value added in year t in prices of previous year. Both v and v' refer to one of 20 industries defined by NACE Rev.2 economic activities. Then, we regroup both series in current and in previous year prices into 4 sectors. Finally, the growth rate for our broad sectors is calculated as $(x'_t / x_{t-1} - 1)$ where x_t is the value added in year t in current prices and x'_t is the value added in year t in previous year's prices for each of 4 broad sectors: industry, construction, services and agriculture. Iterating this process for all years we get the time series of the chained volume index for our 4 broad sectors.

Employment series are easier to construct compared to GDP and investment. The major hurdle is the jump introduced in 2004 when the Address Based Population Registration System (known as ADNKS in Turkish) was adopted. I follow the steps described in Bakis and Acar (2020) to generate consistent employment series.

[7]See Chapter 2 Exercice 6 for a concrete example.

4 Results

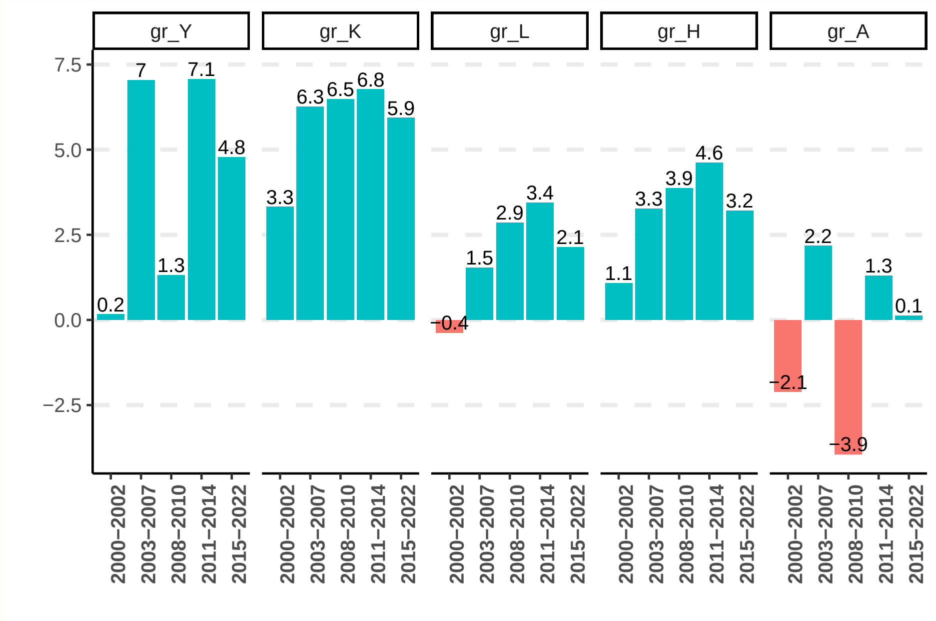
Before presenting the results, I should discuss the periodization that I prefer in this paper for 2000-2022. The first period, 2000-2002, covers the home-made crisis years. The second period, 2003-2007, corresponds to the reform years. The period 2008-2010 covers the global economic crisis years. For both crisis periods, I include the rebound year in the crisis period to avoid an artificially high performance for the following period because this year reflects a rebound from a low base. The fourth period, 2011-2014, is mainly a transition period in which we observe the first authoritarian signs. Finally, I regroup the years 2015-2022 as a period of stagnation / slowdown.

The periodization I use is very close to the one proposed by Atiyas and Bakis (2020, 2023). The only difference between this paper and Atiyas and Bakis papers is about the year 2014. While they regroup 2011-2013 as a period, in this paper I prefer 2011-2014. The reason for this slight change is as follows. Even if we agree that 2014 is a turning point, we can still see 2014 as the continuation of the period that started in 2011 because the presidential election was held on August 10, 2014 and there were only 4 months for the calendar year to be completed. I prefer to associate 2014 with the ”old regime” rather than the new one. This choice of periodization is, of course, arbitrary, but it reflects major changes that have occurred in the preferences of political authorities in Turkey. For example, Turan (2019) and Insel (2021) both argue that the 2014 presidential election was a turning point in the change of political regime in Turkey.[8]

Figure 1 shows the contribution of capital, human capital and TFP growth to overall GDP growth in Turkey between 2000 and 2022. TFP growth is especially high in the 2003-2007 and 2011-2013 periods where TFP growth can explain more than 25 percent of the overall GDP growth. TFP growth is, as expected, negative in crisis years, 2000-2002 ans 2008-2010 periods. The last period (2015-2022) where there is no TFP growth is more interesting. To better understand what is happening one should compare 2015-2022 period with 2003-2007 period. Even if capital and human capital growth are very similar in both periods, because of lack of any improvement in TFP, GDP growth is lower by 2.2 percentage points (only 4.8 percent instead of 7 percent). With almost the same inputs Turkey has produced far less output than expected.

[8]Another option would be to use the 2018 Turkish presidential elections as a turning point. Even if this is attractive at first glance, because the parliamentary system of government was replaced by a presidential system with the 2017 referendum, it would ignore the fact that the regime change began in 2014.

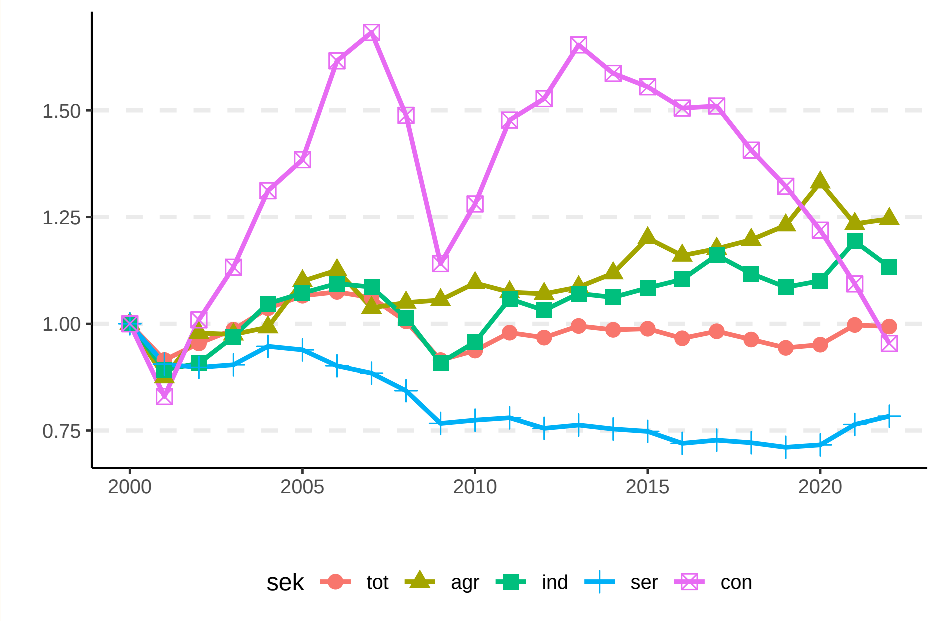
Figure 1: GDP growth and factor accumulation



Note: g_X is the average growth rate of X over the period where X is one of Y, K, L, H and A.

Figure 2 shows TFP index for aggregate economy and 4 broad sectors. Year 2000 value is normalized to 1 for all indexes. The most striking finding is huge volatility in construction sector. Between 2000 and 2009 we can say that TFP in construction is going in the same direction as other sectors but has far more volatility. Nevertheless, after 2010 construction productivity dynamics in construction sector are completely independent of other sector dynamics. First, while TFP index in other sectors is almost horizontal in the 2010-2014 period, for construction there is very strong and steady increase. Second, while other sectors keep their pace from earlier period in the 2015-2022 period , for construction we observe very large declines. Another important finding is that compared to the year 2000 agriculture is the best performing sector while industry is the second one. Services and construction has TFP levels in 2022 that are below their 2000 levels. If we analyze last 40 years (say post 1980 era) as in Atiyas and Bakis (2020) or Bakis and Acar (2020) then industry becomes the best performing sector. The reason being the good performance of industry in 1980s and 1990s compared to other sectors.

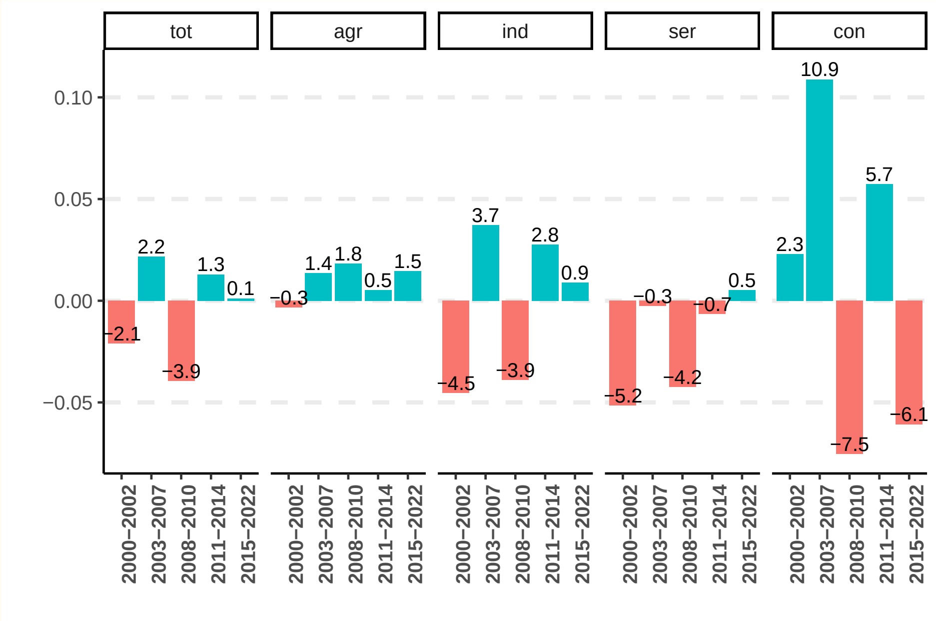
Figure 2: Aggregate and sectoral TFP indexes



Note: tot refers to aggregate economy; agr, ind, ser, con refer to, agricultue, industry, services and construction, respectively.

Figure 3 analyzes sectoral TFP growth by sector using our preferred periodization as well. There are several remarks that can be made. First, as expected in crisis years, 2000-2002 and 2008-2010, TFP growth is usually negative. The exception is positive TFP growth for construction in the 2000-2002 period. But in normal years without crisis TFP growth is not always positive. While TFP growth is generally positive in the 2003-2007 and 2011-2013 periods, TFP growth is either around zero or negative in the last period, 2015-2022. Second, TFP growth is generally positive in agriculture and negative in services. But it is volatile, with a zigzag shape, in industry and construction, with higher volatility in construction. Third, the decline in TFP is more pronounced in construction and services than in agriculture. Fourth, low (or even negative) TFP growth in services should be related to measurement problems in this sector. Another element supporting this idea is that low or even negative TFP growth in services is not specific to Turkey. Other studies find similar results for OECD countries and the US (see, among others, Kets and Lejour, 2003; Foerster et al., 2019).

Figure 3: Aggregate and sectoral TFP growth



Note: tot refers to aggregate economy; agr, ind, ser, con refer to, agricultue, industry, services and construction, respectively.

Now we will analyze the contribution of capital, human capital and TFP growth to sectoral GDP growth for each of broad sectors. We start with agriculture. Table 3 shows the growth rates for both GDP and for the factors of production in agriculture. GDP growth is positive in all periods except 2000-2002 period which corresponds to economic crisis. The highest growth rate is obtained in the 2008-2020 period which corresponds to global economic crisis. One of the reasons for this surprising finding is that TFP growth remains positive in agriculture even during the crisis unlike other sectors (see also Figure 3). Another one is the the increase in agricultural employment. Compared to 2007, the number of workers was 17 percent higher in agriculture in 2010 while the same figure was 16 percent in construction, 6 percent in services and 4 percent in industry. Nevertheless, the quality adjusted labor (human capital) growth is negative in 2000-2002, 2003-2007 and 2015-2022 periods. The main reason for these decreases is migration out of rural areas into urban areas. This migration process seems to be reversed during the 2009 crisis. Capital growth rate is always positive and between 1.5 percent and 3.2 percent. TFP growth is slightly negative during 2000-2002 period but positive and relatively high in other periods. One possible explanation for good performance of agriculture in terms of TFP is hidden unemployment in agriculture (see Atiyas and Bakis; 2014, 2020).

Table 3: Growth rates of TFP and factors of production: agriculture

	gr_Y	gr_K	gr_L	gr_H	gr_A
2000-2002	-0.4	1.5	-2.0	-1.7	-0.3
2003-2007	1.2	2.2	-3.4	-2.6	1.4
2008-2010	5.5	1.7	5.2	5.6	1.8
2011-2014	2.0	3.2	-1.0	-0.3	0.5
2015-2022	2.4	2.0	-1.5	-0.2	1.5

Note: g_X is the average growth rate of X over the period where X is one of Y, K, L, H and A.

Growth rates for both GDP and industrial production factors are shown in Table 4. Productivity dynamics in industry are very similar to aggregate economy. TFP growth is high during 2003-2007 and 2011-2013 periods but negative during 2000-2002 ans 2008-2010 periods which are crisis years. TFP growth is positive but relatively low in the 2015-2022 period. GDP growth is either negative are very low during crisis years but high in other periods. Capital growth is usually high (slightly above 6 percent between 2003 and 2013, and 4.1 percent after 2013). A surprising finding is the contrast between two crisis periods: While during the first crisis the average capital growth is only 1.9 percent, during the second one it is 6.2 percent which shows that the recovery was very fast after the global economic crisis. Human capital growth is positive and relatively high: above 3 percent in general, and 1.5 percent during the global crisis.

Table 4: Growth rates of TFP and factors of production: industry

	gr_Y	gr_K	gr_L	gr_H	gr_A
2000-2002	-2.2	1.9	1.9	3.2	-4.5
2003-2007	8.9	6.5	2.1	2.9	3.7
2008-2010	0.5	6.2	1.4	1.5	-3.9
2011-2014	8.3	5.9	4.2	4.9	2.8
2015-2022	4.8	4.0	2.8	3.7	0.9

Note: g_X is the average growth rate of X over the period where X is one of Y, K, L, H and A.

Table 5 shows the growth rates of GDP and of the factors of production for the services sector. Although TFP growth is negative in almost every period, it takes its lowest values in crisis years: -5.2 percent in 2000-2002 and -4.2 percent in 2008-2010. Capital growth is well above the economy average. Average capital growth is close to 10 percent between 2000-2014, and 6.2 percent after 2014. Similarly, human capital growth has been well above the economic average, except in the period 2008-2010. The main driver of this continuous increase in human capital is migration from rural to urban areas. Average labor growth (g_L) is higher in the services sector compared to total labor growth with the exception of the 2008-2010 period. Since $H = Lh$, an increase in L is directly translated into an increase in H. A typical example of this phenomenon would be a person who works in agriculture in the village, moves to a suburb in the city and starts working in the service sector.

Table 5: Growth rates of TFP and factors of production: services

	gr_Y	gr_K	gr_L	gr_H	gr_A
2000-2002	1.5	10.8	2.0	2.8	-5.2
2003-2007	6.4	9.5	3.5	4.1	-0.3
2008-2010	1.4	8.8	2.1	2.8	-4.2
2011-2014	6.7	9.7	4.7	5.3	-0.7
2015-2022	5.6	6.2	3.4	4.1	0.5

Note: g_X is the average growth rate of X over the period where X is one of Y, K, L, H and A.

Table 6 shows the growth rates for both GDP and for the factors of production in construction. TFP growth is phenomenal during 2003-2007 and 2011-2014, respectively 10.9 percent and 5.7 percent. These exceptionally high TFP growth rates translate into even higher GDP growth above 10 percent (15.9 and 11.9 percent, respectively). In fact, capital growth is similar to industry sector between 2003 and 2014, while human capital growth is higher in the same period. The last period, 2015-2022, is very interesting: we have unusually high capital accumulation (7.7 percent), low human capital growth (0.5 percent) and negative TFP growth (-6.1 percent), resulting in declining GDP growth on average. The period from 2015 to 2022 is similar to the global crisis (2008-2010) for the construction sector.

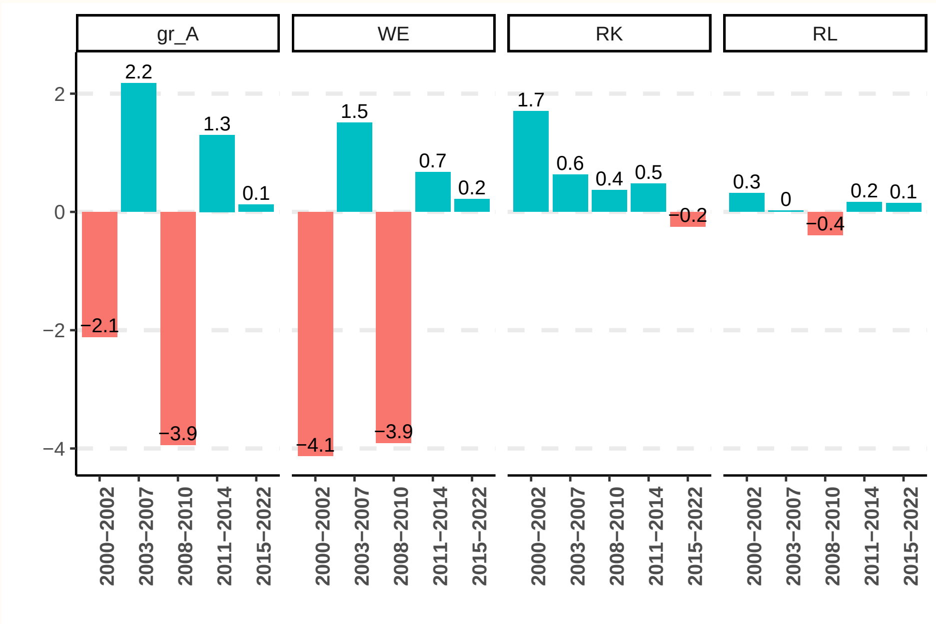
Table 6: Growth rates of TFP and factors of production: construction

	gr_Y	gr_K	gr_L	gr_H	gr_A
2000-2002	-2.9	-0.6	-17.7	-14.1	2.3
2003-2007	15.9	4.3	6.3	6.5	10.9
2008-2010	-2.0	5.4	5.0	5.8	-7.5
2011-2014	11.9	5.3	7.2	8.0	5.7
2015-2022	-0.9	7.7	-0.4	0.5	-6.1

Note: g_X is the average growth rate of X over the period where X is one of Y, K, L, H and A.

Figure 4 shows the results of TFP decomposition found in equaion (2). Among the 5 periods analyzed aggregate TFP growth (gr_A) is higher than the within component (WE) in 3 periods: 2000-2002, 2003-2007, 2011-2013. They are almost equal in the 2008-2010 and 2014-2022 periods. This implies that the reallocation effect is approximately zero during 2008-2010 and 2014-2022 periods. While the reallocation effect of labor (RL) is usually positive and low, the reallocation effect of capital (RK) contributed to TFP growth significantly in the past. The magnitude of RK is between 0.4-1.7 percentage points between 2000-2014. To gauge the significance of this figure, it should be remembered that average TFP growth between 2003 and 2007, the best period in terms of TFP performance, was only 2.2 per cent. However, after 2014 average value of RK is small and negative (0.2 percentage points).

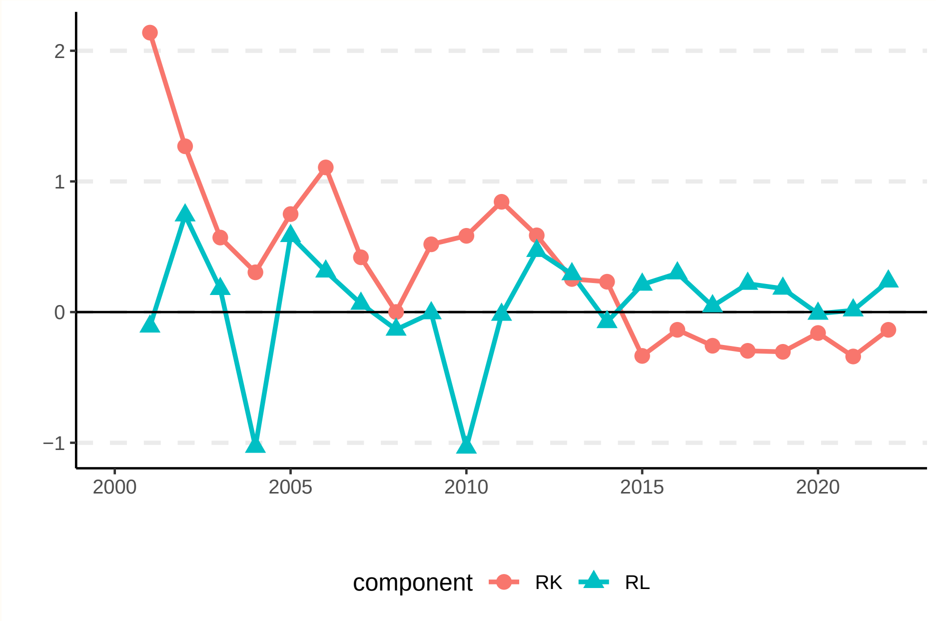
Figure 4: Decomposing aggregate TFP growth



Note: Average TFP growth (gr_A) is decomposed into within component *WE*, the reallocation of capital RK, the reallocation of human capital (labor) RL.

To make sure that this average is not driven by any outliers, I prepared Figure 5. There is a clear declining trend for RK while there is no clear trend for RL. As a result, we can say that during the period 2000-2022, the reallocation of capital not only worsened over time, but also became consistently negative after 2013. This is in line with previous studies which find that resources were directed to unproductive sectors, especially construction. It is important to note that since only 4 sectors were used for the decomposition, the calculated RK effect represents a lower bound.

Figure 5: Reallocation effect of Capital and Labor



Note: RK nad RL refer to the reallocation effect due to capital and human capital over time.

5 Conclusion

This paper has two objective: First, making a growth accounting exercise both of the aggregate economy and in agriculture, industry, construction and services taking into account amelioration in schooling. Second, decomposing aggregate TFP growth so that we can separate the effect due to reallocation of factors of production across sectors from the within component which reflects technological changes occurring within each sector.

I find that TFP growth is high between 2003-2007 and 2011-2014, negative during crisis years (2000-2002 and 2008-2010) and almost zero during the 2015-2022 period. TFP growth is relatively low in construction and in services sectors. Construction sector is also characterized by a very volatile and unsustainable TFP growth. An important contribution of the paper is to show that the reallocation effect is generally positive for labor (except crisis years), however for capital there are two separate periods. In the 2000-2014 period the reallocation effect is positive for capital, whereas it becomes consistently negative in the 2015-2022 period. My analysis shows that expansionary economic policies following 2016 led to some growth in the short run, but their long-term benefits to society are questionable due to efficiency problems they cause.

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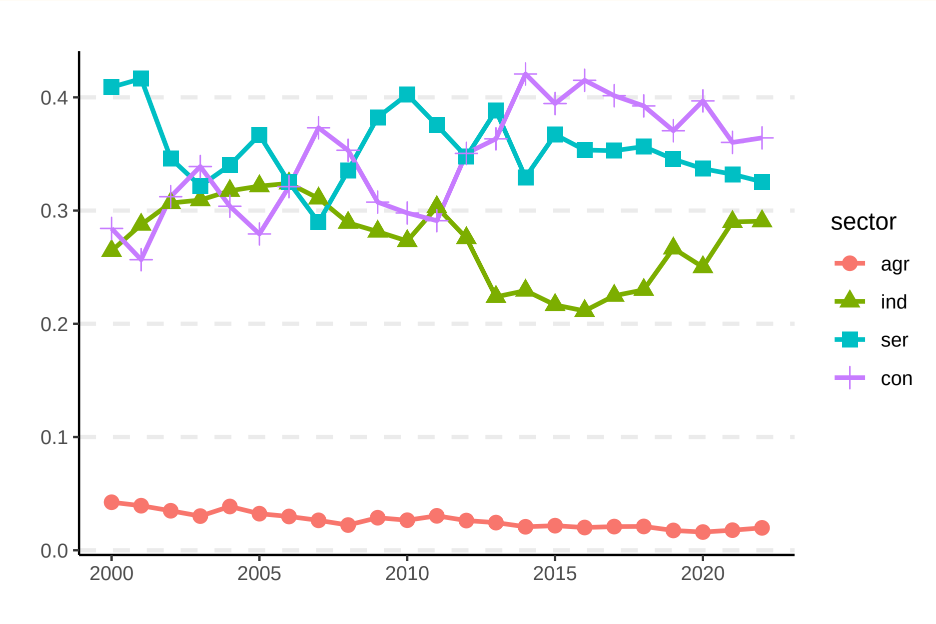
A Additional figures

Figure 6: Sectoral shares in investment at current prices: 2000-2022



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