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Relative underperformance *Alla Turca* ☆

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A B S T R A C T

From 1960 to 2003, Turkey has underperformed relative to several Western economies, in terms of hours worked and output per hour. Our sectoral analysis illustrates two points. First, Turkey's large drop in hours is due to the fact that the substantial decline in agricultural hours has not been accompanied by a corresponding increase in nonagricultural market hours. Second, the sectoral composition of output is important for understanding Turkey's relatively weak rise in output per hour. We develop a simple model of structural transformation and home production to provide an account of Turkey's performance relative to the U.S. and Southern Europe. We find that the evolution of exogenous differences in sectoral productivity and taxes, between Turkey and the U.S., as well as Southern Europe, can account quantitatively for most of Turkey's relative underperformance to these regions.

1. Introduction

A number of recent studies point out the poor economic performance of several Western European countries relative to the United States, in terms of both income and hours of work (Prescott, 2002, 2004; Rogerson, 2008; Conesa and Kehoe, 2005). Rogerson (2008) shows that productivity growth (starting from a low base) and tax changes are both quantitatively important in understanding changes in market hours, between Europe and the U.S., in the post WWII period. Does the importance of productivity and taxes, for market hours, extend more generally, beyond the European core studied in Rogerson (2008)? We show that compared to Continental (France, Germany, Italy) and Southern (Greece, Portugal, Spain) Europe, Turkey started from a lower level of productivity, and exhibited a starker deterioration in market hours. In addition, it displayed a much weaker productivity growth, and experienced an even steeper increase in taxes. We argue that these circumstances make Turkey a striking case for studying the importance of the forces emphasized in Rogerson (2008).

In this paper, we document the evolution of Turkey's performance relative to the U.S. and Southern Europe over 1960–2003, and offer a quantitative account of this evolution. We begin our analysis by showing that any explanation about

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Turkey's relative underperformance should account for two facts: (1) the dramatic decline in aggregate hours per working age person; (2) the relatively weak rise in output per hour.

To gain further insight into the underlying sources of these aggregate observations, we examine disaggregate data by decomposing economic activity into agriculture and nonagriculture. Over the period 1960–2003, Turkey, Southern Europe and the U.S. went through a process of structural transformation, reducing the share of agriculture in the economy.[1] However, Turkey's experience of structural change reveals several striking observations when compared to the U.S. and Southern Europe. First, Turkey has been relatively slow in re-allocating hours from agriculture to nonagriculture. Second, only a small fraction of the hours reduced in agriculture have been channeled to nonagricultural market activities, eventually pushing down aggregate hours. Third, measured agricultural output per hour in Turkey deteriorated relative to those in both the U.S. and Southern Europe.

The process of the structural transformation over the past 40 years in Turkey has been accompanied by a seemingly unrelated increase in the size of government. The marginal effective tax rate on labor has increased more than *three-fold* from 1965 to 2003. While taxes in Southern Europe more than doubled over the same period, a considerable increase when compared to the relatively constant U.S. taxes, this increase is overshadowed by the growth in Turkish taxes.

We argue that the evolution of the structural transformation, and the substantial increase in taxes can explain why Turkey has experienced a dramatic deterioration in aggregate hours. Many of the hours given up in agriculture ended up being a net loss to total market hours, as the increasing taxes discouraged market work. Although labor productivity in agriculture was relatively low and declining, a large fraction of the economy's hours still remained in agriculture, increasing the weight on the low productivity sector, and resulting in slow growth of aggregate output per hour. Thus, while we do not explain aggregate productivity per se, we show that the sectoral composition of output per hour is important for understanding its evolution.

Following Rogerson (2008), we develop a simple general equilibrium model of structural transformation and home production. Here, we abstract from an explicit service sector, and focus on agriculture vs. nonagriculture.[2] Our analysis is based on a hybrid model of structural change, in which the re-allocation of economic activity between agriculture and nonagriculture is driven by: (i) non-homothetic preferences (as in Kongsamut et al., 2001) (ii) differences in sectoral productivity growth rates (as in Baumol, 1967; Ngai and Pissarides, 2007). The allocation of labor input between market production and home production, and between agriculture and nonagriculture (within market production), is determined by the returns to these activities. In our model, differences in returns across countries derive from sectoral productivity differences and aggregate tax differences on market activities. The motivation for our quantitative theory is that, both these factors have exhibited strong and persistent trends for Turkey, relative to the U.S. and Southern Europe, over the period of interest.

In our quantitative experiments we find that, taking as exogenous the observed sectoral labor productivity growth differences and differences in the evolution of aggregate taxes, over 1960–2003, our model can reproduce the main patterns of Turkey's relative underperformance. In particular, our theory accounts for all of the deterioration in relative aggregate labor input relative to the U.S. over 1960–2003, and 58% of the deterioration relative to Southern Europe. Furthermore, our model explains most of the distribution of (market) hours between agriculture and nonagriculture in all regions.

Our paper is related to several strands of literature. Along the neoclassical tradition of Prescott (2002), Kehoe and Prescott (2002), Cole et al. (2004), we study economic performance as being a relative phenomenon. Similar to Prescott (2004), Rogerson (2008), and Conesa and Kehoe (2005), we find that taxes are quantitatively important in accounting for poor labor input outcomes.

The view that the process of the structural transformation can convey information about the deterioration in labor input in market activities, is studied in Rogerson (2008), Ngai and Pissarides (2008), and Akbulut (2005). Several other papers study the effect of the structural transformation in accounting for the composition of aggregate labor productivity differences across countries, without studying labor input size: for example Gollin et al. (2002, 2004), Restuccia et al. (2008), Duarte and Restuccia (2006, 2007). In our application to Turkey, we study both labor input and the composition of labor productivity, through the lens of the structural transformation.

The rest of the paper is organized as follows. In Section 2 we document Turkey's relative economic performance, and in Section 3 we present sectoral observations. Section 4 contains our model and Section 5 our quantitative work. In Section 6 we discuss the gender decomposition of labor input in Turkey, and in Section 7 we conclude.

2. Turkey's relative economic position

In this section we show that Turkey stands out as a case of poor relative performance over the period 1960–2003, when compared to the U.S., Continental and Southern Europe. By Continental Europe we refer to France, Germany, and Italy. By

[1] The process of structural transformation, whereby the share of agriculture in economic activity declines and rises in industry and then services, has been well documented for several developed economies (Kuznets, 1966; Chenery and Syrquin, 1975; Maddison, 1980; Kongsamut et al., 2001).

[2] For two-sector versions of the model without home production, see for example Laitner (2000), Caselli and Coleman (2001), and Gollin et al. (2002). For three sector versions (that include services) without home production, see for example Kongsamut et al. (2001) and Echevarria (1997).

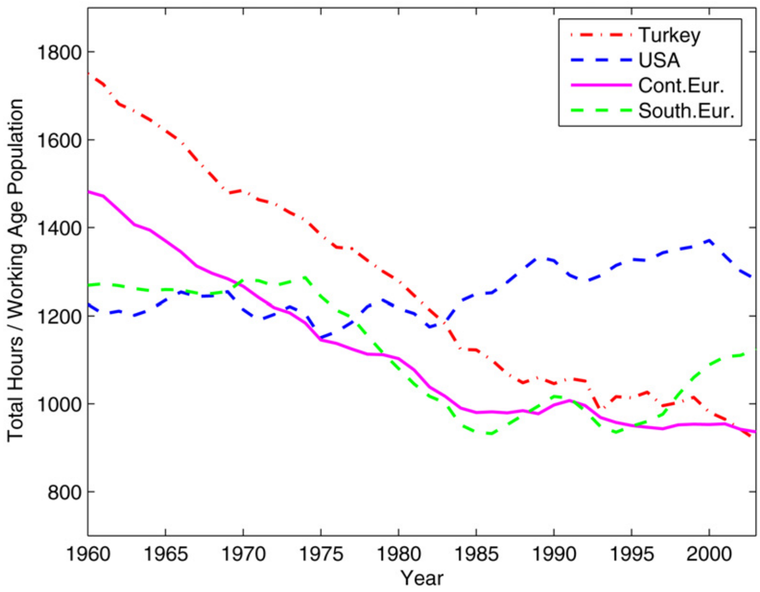

Fig. 1. Hours.

Southern Europe we define Greece, Portugal, and Spain. We use data from various sources, described in detail in Appendix A. We start our analysis in 1960 as this is the earliest year for which data are available from all sources.[3]

2.1. Hours of market work

In Fig. 1, we compare Turkey to the United States, Continental Europe and Southern Europe in terms of labor input. Our measure of labor input is hours per working age person, H/N, defined as the total annual number of hours worked in the market sector, H, normalized by the population that is of working age, i.e., between the ages of 15–64, N. We construct total annual hours as the product of the total number of persons employed and the number of hours worked per person employed. The number of persons employed and the working age population data are available from the OECD, while the hours per worker come from the Conference Board and the Groningen Growth and Development Centre (GGDC).

According to Fig. 1, all countries, with the exception of the U.S. (until 2000), experienced some strong downward trend in their hours of market work. Over the period 1960–2003, hours in Continental Europe declined steadily, by a total of 36.8%. While in Southern Europe hours declined by an overall 11.4%, this number confounds a decline of 24.8% between 1975 and 1985, and a subsequent partial recovery in the late 1990s and early 2000s. Both Continental Europe and Southern Europe have been shown previously to have performed poorly in terms of hours relative to the U.S. (Prescott, 2002, 2004; Rogerson, 2008; Conesa and Kehoe, 2005). The most striking feature of Fig. 1, however, is the dramatic and monotonic decline in Turkish hours per working age person – *an overall decline of 47.5%*. While in 1960 Turkish hours are by far the highest at 1750 per working age person, by 2003 they are cut almost to half, and are even lower than the Continental European ones (the lowest in the rest of the sample in 2003).

2.2. Output per hour

In Fig. 2, we compare Turkey to the U.S., Continental and Southern Europe, in terms of labor productivity. Our measure of labor productivity is output per hour, Y/H, calculated as real GDP, Y, from the PWTv6.2, over the total number of annual hours, H. In 1960, Turkish output per hour was only 13% of the U.S. level, but by 2003 it had reached 23% of the U.S. level. In other words, Turkey appears to have exhibited considerable catch-up relative to the industrial leader. However, this catch-up falls short of that exhibited by Continental and Southern Europe (up to 1980) – even though these countries started from a higher initial level. This is most obvious if one looks at output per hour in Turkey relative to these regions in Fig. 2. Turkish output per hour dropped from 31% of the Continental European level in 1960 to 24% in 2003. Relative to Southern Europe, Turkish labor productivity went from 46% in 1960 to 34% in 1980, and recovered partially back to 42% by 2003.

Out of the countries examined, we take Southern Europe to be Turkey's closest peer group, not only because of geographical proximity but also because they were closest in economic conditions in the early 1960s. Henceforth, we focus on comparing Turkey to Southern Europe, in addition to the industrial leader, the U.S.

[3] We calculate all regional variables as weighted averages of the comprising countries. Germany in our sample refers to West Germany until 1990, and unified Germany after that.

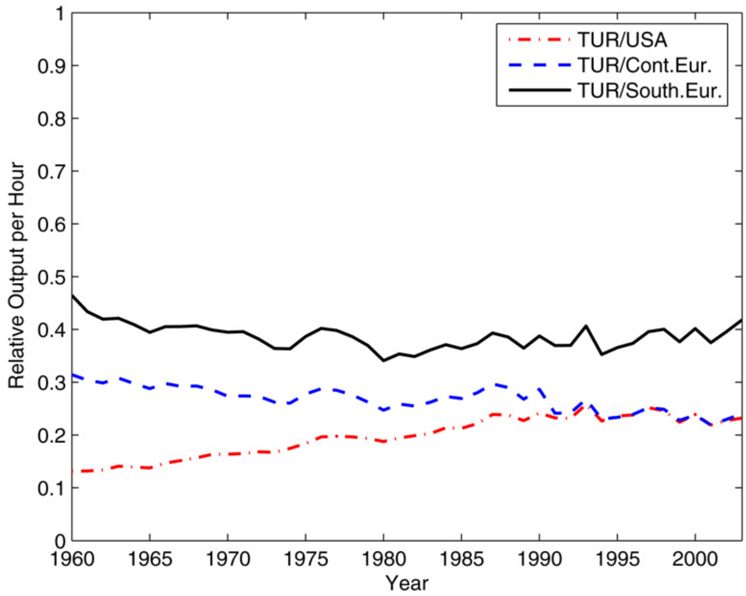

Fig. 2. Relative output per hour.

In Appendix B, we conduct growth accounting to investigate the proximate sources of Turkey's performance in output per hour relative to the U.S. and Southern Europe. We find that capital accumulation has not been the source of Turkey's underperformance in output per hour. Instead, Turkish relative output per hour has moved closely with relative TFP.

We conclude from the analysis that understanding Turkey's relative underperformance problem requires understanding primarily why its labor input declined so dramatically, and secondly why its GDP per hour did not exhibit any major catch-up relative to the U.S. and Southern Europe.[4] The importance of labor input in Turkey's relative underperformance is what makes Turkey's case different from those of several other underperforming countries, where TFP is the prime suspect and labor input is roughly stable (see for example Cole et al., 2004 on Latin America).

3. A sectoral perspective

To gain additional insight into the sources of the above aggregate observations we decompose aggregate hours per working age person and aggregate output per hour into their agricultural (a) and nonagricultural (na) components.[5] This sectoral division of hours and output is pertinent to our case study, as Turkey was at a relatively early stage of its development process in 1960.

3.1. Sectoral hours

Aggregate hours can be re-written as the sum of the hours in agriculture and nonagriculture,

$$\frac{H}{N} = \frac{H_a}{N} + \frac{H_{na}}{N}$$

where H_j are the total annual hours of work in sector $j \in \{a, na\}$, and N is the total working age population in the economy. We construct total sectoral hours as the product of employment and hours per worker in sector j. We use sectoral employment data for all countries from the OECD. We use the longest consistent time series of sectoral hours per worker – starting in 1970, for the U.S. and Southern Europe, available from EU-KLEMS. For the earlier period, 1960–1969, we complement this data for the U.S. with sectoral hours per worker calculated from the GGDC. Due to lack of data for Southern Europe over 1960–1969, we assume that relative hours per worker in nonagriculture to agriculture are equal to the average of this ratio over 1970–1980. For Turkey hours per worker by sector are not available. Thus, for Turkey, we calculate total sectoral hours of work (H_a, H_{na}) by multiplying total hours H with the respective shares of employment in each sector; this method essentially assumes that hours per worker are the same across sectors. Our procedure allows us to calculate sectoral hours

[4] The fact that Turkey had an immigration wave, mainly to Germany, particularly until 1973, may suggest that GDP and the market hours are not the ideal measures of living standards and labor input over this period. When we compare GDP to GNP (which includes migrant's remittances), we find that the two series have evolved remarkably similarly. In addition, both the number of persons employed and the working age population statistics, used in our calculation of market hours, do not include migrants. Thus any potential bias, even up to 1973, is likely to be very small.

[5] The definition of each sector is provided in Appendix A.

Table 1
Sectoral hours per working age person.

	USA		Turkey		Southern Europe	
	Agr.	Nonagr.	Agr.	Nonagr.	Agr.	Nonagr.
1960	118.4	1107.7	1282.9	467.2	549.3	719.6
1970	59.9	1154.2	904.5	580.6	379.1	902.3
1980	47.6	1169.2	660.1	618.9	231.2	849.1
1990	40.8	1284.1	477.5	568.5	149.1	867.9
2000	35.1	1335.9	345.2	635.9	107.0	982.1
2003	22.2	1260.0	303.9	614.2	98.7	1025.9

Source: Author calculations. See Appendix A for data sources.

series, for all countries, continuously from 1960 to 2003. A detailed description of the data sources and our methodology is provided in Appendix A.

In Table 1, we present sectoral hours per working age person for the U.S., Turkey, and Southern Europe, by decade – starting in 1960. Three key observations emerge. First, in the U.S., up to 2000, there has been a strong rise in the hours for nonagriculture, with a weaker decline in hours for agriculture, implying that the U.S. is experiencing a net increase in overall hours.[6] Second, since 1960 Turkey has experienced a dramatic decline in its agricultural hours, but the vast majority of these hours have not been replaced with hours in the nonagricultural market sector. Third, while Southern Europe lost more hours from agriculture than it gained in nonagriculture, the intensity of these sectoral hour movements was not as stark as in the case of Turkey.

3.2. Sectoral decomposition of output per hour

Aggregate output per hour can be re-written as a weighted average of the labor productivities of the two sectors, weighted by the respective sectoral shares of hours in total hours,

$$\frac{Y}{H} = \frac{H_a}{H} \cdot \frac{VA_a}{H_a} + \frac{H_{na}}{H} \cdot \frac{VA_{na}}{H_{na}}$$

where VA_j is value added in sector $j \in \{a, na\}$. Thus, from a quantitative point of view, movements in relative aggregate output per hour are accounted for by relative movements in sectoral hours shares and relative movements of sectoral productivities. We examine these two sets of variables in turn.

We calculate the sectoral hours shares for the U.S., Turkey, and Southern Europe by combining hours per working age person with the sectoral hours per working age person for each country. These data reveal that Turkey has a dramatically different economic structure from the U.S., in terms of sectoral labor allocations. In 1960, Turkey had 73% of its hours in agriculture, whereas the U.S. had only 9.7%. Even though this share dropped considerably over the next 40 years, by 2003, Turkey still had 33% of its total hours of work in agriculture, while in the U.S. this share dropped to 1.7%. Southern Europe also had a large agricultural sector in 1960, and managed to reduce the share of hours in agriculture from 43% to 8.8% by 2003.

The movements of sectoral hours shares experienced by the U.S., Turkey, and Southern Europe, are consistent with the well documented process of structural transformation, which accompanies the process of development. Then one could argue that there is nothing fundamentally different between these economies in sectoral terms, except for the fact that they are at different stages of their development process. However, such a conclusion could be misleading. While the absolute decline in the agricultural hours share experienced by Turkey and Southern Europe was similar (40% vs. 35%), Southern Europe was re-locating labor from agriculture at a much faster rate. The annualized percentage change in the agricultural hours share in Turkey was only −1.83% compared to −3.64% of Southern Europe. If Turkey had shed hours from agriculture at the same annual rate as Southern Europe had, Turkey would have had only 15% of its total hours in agriculture in 2003, as opposed to 33%.[7] The implication of the above analysis is that not only has the process of re-structuring in Turkey started considerably later than in both Southern Europe and the U.S., but even after it was underway it progressed at a relatively slow pace.

Table 2 displays measured value added per hour in Turkey relative to the U.S. and Southern Europe in turn.[8] We report values by decade here, but we calculate continuous series from 1960 to 2003, which we use in our quantitative experiments. Relative Turkish productivity in agriculture was lower than in nonagriculture to begin with, and has declined considerably over 1960–2003: from 15% to 6% relative to the U.S., and from 66% to 36% relative to Southern Europe. Relative to the U.S., Turkish productivity in nonagriculture was fairly constant until 1980, and in fact increased after that time. Relative to

[6] Even though U.S. nonagricultural hours start falling after 2000, on the net, nonagricultural hours increased from 1960 to 2003.

[7] If Turkey had shed hours from agriculture at the rate that the U.S. had (−3.9%) it would have had an agricultural hours share of 13% in 2003. However, the comparison of Turkey to Southern Europe is more appropriate given that in 1960 they had a more similar economic structure.

[8] See Appendix A for a detailed description of how sectoral value added per hour is calculated.

Table 2
Relative sectoral output per hour.

	Turkey/USA		Turkey/Southern Europe	
	Agr.	Nonagr.	Agr.	Nonagr.
1960	0.155	0.290	0.660	0.731
1970	0.141	0.284	0.632	0.543
1980	0.144	0.290	0.427	0.457
1990	0.092	0.371	0.315	0.544
2000	0.099	0.320	0.358	0.507
2003	0.063	0.306	0.360	0.519

Source: Author calculations. See Appendix A for data sources.

Southern Europe there was a considerable decline in Turkish nonagricultural productivity until 1980, which slightly recovered over 1980–2003. Given the size of agriculture in Turkey, its effect on aggregate output per hour has been dominant. In other words, Turkey's output per hour has underperformed because it has had a very high weight on a sector in which it has been particularly unproductive and in which it has become relatively more unproductive over time.

Given that agriculture vs. the rest of the economy is at the center of the sectoral patterns for the country pairs Turkey–U.S. and Turkey–Southern Europe, we develop a theory in the next section based on the agriculture–nonagriculture division of output and hours.

4. A simple model of structural transformation

Following Rogerson (2008) we develop a simple model of structural transformation and home production.[9] Unlike Rogerson (2008), who emphasizes the goods–services division of output, we focus on the agriculture–nonagriculture split of output.[10]

4.1. Environment

Consider an economy with two consumption goods, agricultural and nonagricultural, and a single factor of production, labor. The nonagricultural good can be produced either in the market sector or the home production sector. Output produced in the home sector is directly consumed by households, and is not subject to government policies.

To keep the model simple we abstract from capital since our analysis has indicated that the rate of capital accumulation has not been a factor in Turkey's underperformance relative to the U.S. and Southern Europe. Furthermore, consistent sectoral capital stock data do not exist for the economies we study. Thus the model consists essentially of a sequence of static problems.

4.1.1. Preferences

The economy is populated by a large number of identical, infinitely-lived households with log-linear preferences over vectors of agricultural consumption, nonagricultural consumption and leisure,

$$U(c_{a,t}, c_t, l_t) = \{\sigma \log(c_{a,t} - \bar{a}) + (1-\sigma)\log c_t + \phi \log l_t\} N_t \tag{1}$$

where $c_{a,t}$ is per capita consumption of the agricultural good, c_t is an index of per capita consumption of the nonagricultural good, l_t is per capita leisure, and N_t is the size of the working age population, all at time t. The share of the agricultural good in the household's consumption basket is determined by the parameter $\sigma \in (0,1)$. The parameter $\phi > 0$ specifies the value of leisure for the household.

These preferences accomodate Engel's law, as the presence of the subsistence term $\bar{a} \geqslant 0$, implies that the income elasticity with respect to food is less than one. The low income elasticity for agricultural goods, along with exogenous technological progress (even when common across sectors) is capable of producing a structural transformation.

Nonagricultural consumption is an aggregate of market $c_{na,t}$, and nonmarket consumption $c_{z,t}$, described by the CES aggregator,

$$c_t = \left[\mu c_{na,t}^{\varepsilon} + (1-\mu)c_{z,t}^{\varepsilon}\right]^{\frac{1}{\varepsilon}}. \tag{2}$$

[9] For household production models applied to business cycles and development, see for example Greenwood et al. (1995), Parente et al. (2000). Aguiar and Hurst (2007) find that, over 1965–2003, there has been a 17% decline in nonmarket work in the U.S. There is no evidence on changes in hours of home production for Turkey. However, the time use survey conducted in 2006 by the Turkish Statistical Institute (available at http://www.turkstat.gov.tr/PreHaberBultenleri.do), found that nonemployed individuals spent more than 3 times the amount of hours spent by employed individuals on household production. If this difference has not changed much, it would suggest that a decline in the number of people employed would lead to an increase in the overall amount of hours spent at home production per working person.

[10] Rogerson (2008) studies a set of developed economies, namely the U.S. and several Western European countries, for which the transition from goods sectors to services is important. Given that Turkey is at an earlier stage of development the important transition that we study is from agriculture to the rest of the economy.

In the CES aggregator, μ captures the relative importance of market and home goods in the nonagricultural consumption basket, and ε determines the elasticity of substitution, $1/(1-\varepsilon)$, between goods produced in the market and home sectors.

Each household member is endowed with one unit of time. The time constraint faced by every household member of working age is

$$h_{a,t} + h_{na,t} + h_{z,t} + l_t = 1 \tag{3}$$

where $h_{a,t}$ is time devoted to agricultural production, $h_{na,t}$ is time devoted to nonagricultural market production, $h_{z,t}$ is time devoted to home production of nonagricultural goods, and l_t is leisure. The total supply of labor to market activities is $h_t = h_{a,t} + h_{na,t}$. Work time devoted to the market sector, unlike work time devoted to the household sector, is subjected to government policies.

We emphasize policies that distort the allocation of labor input between the market and the nonmarket sectors. In particular we assume that time devoted to market activities is taxed at a rate of $\tau_{e,t} < 1$. This tax rate is a catchall for all the tax burden that ends up falling on labor: personal income taxes, social security taxes, and indirect taxes. We assume that the government rebates tax receipts in a lump-sum fashion to households and balances its budget each period,

$$TR_t = \tau_{e,t} w_t h_t N_t. \tag{4}$$

Given that, in principle, the assumption of lump-sum transfers is not innocuous, in Section 5.4, we also consider quantitatively the case in which part of the tax receipts are used for wasteful government expenditures.

4.1.2. Production technologies

The agricultural good is produced solely in the market sector. The nonagricultural good can be produced either in the market sector or in the household sector. The nonagricultural household production technology is

$$c_{z,t} N_t = A_{z,t} H_{z,t} \tag{5}$$

where $c_{z,t}$ is per person consumption of the home nonagricultural good, $A_{z,t}$ is the productivity of the home technology, and $H_{z,t}$ is the total amount of hours spent by the household in home work. Market goods are also produced according to production functions that are linear in labor input,

$$Y_{i,t} = A_{i,t} H_{i,t}$$

for $i \in \{a, na\}$. $Y_{i,t}$ is the total amount of output produced by sector $i \in \{a, na\}$ using total hours $H_{i,t}$. The productivity terms $A_{i,t}$, for $i \in \{a, na, z\}$ grow at exogenous and possibly time varying rates $\gamma_{i,t} - 1$.

4.1.3. Market clearing

The agricultural and the market nonagricultural goods are only used for consumption purposes,

$$c_{a,t} N_t = Y_{a,t}, \tag{6}$$

$$c_{na,t} N_t = Y_{na,t}. \tag{7}$$

The total amount of hours available to the household can be used for market work, home work or leisure,

$$H_t + H_{z,t} + l_t N_t = N_t. \tag{8}$$

4.2. Equilibrium

We let the market nonagricultural good be the numeraire, and denote the relative price of the agricultural good by $p_{a,t}$. An equilibrium for this economy is a sequence of output and factor prices $\{p_{a,t}, w_t\}$, a sequence of policies $\{\tau_{e,t}, TR_t\}$, a sequence of allocations for the firms $\{Y_{a,t}, Y_{na,t}, H_{a,t}, H_{na,t}\}$, a sequence of allocations for the household $\{c_{a,t}, c_{na,t}, c_{z,t}, h_{a,t}, h_{na,t}, h_{z,t}, l_t\}$, such that (1) given prices and policies, $\{c_{a,t}, c_{na,t}, c_{z,t}, h_{a,t}, h_{na,t}, h_{z,t}, l_t\}$ solves the household problem, (2) wages are competitive, (3) markets clear, (4) the government satisfies its budget constraint every period.

The household faces a time allocation problem: it has to allocate its time between work vs. leisure; between working in agriculture vs. nonagriculture; and between working in the market vs. the home sector. The household's date t budget constraint is

$$[p_{a,t} c_{a,t} + c_{na,t}] N_t = w_t (1 - \tau_{e,t}) h_t N_t + TR_t \tag{9}$$

where w_t is the real wage rate paid for hours devoted to the market sector, and TR_t are lump-sum transfers to the stand-in household. The household maximizes (1), subject to (2), (3), (5), and (9). The first-order conditions to the household's problem imply the following optimality conditions,

$$\frac{\sigma}{1-\sigma}\frac{c_t^{\varepsilon}c_{na,t}^{1-\varepsilon}}{c_{a,t}-\bar{a}}=\mu p_{a,t},$$
$$\frac{\phi}{l_t}=w_t(1-\tau_{e,t})\mu(1-\sigma)c_t^{-\varepsilon}c_{na,t}^{\varepsilon-1},$$
$$\frac{\mu}{1-\mu}\left(\frac{c_{na,t}}{c_{z,t}}\right)^{\varepsilon-1}=\frac{A_{z,t}}{w_t(1-\tau_{e,t})}.$$

The representative firm in each sector solves a sequence of static problems at each date: the firm chooses the labor input to maximize profits, taking prices and government policy as given. Labor is perfectly mobile across the two market sectors. The problems of the representative firms in the agricultural and market nonagricultural sectors are

$$\max_{H_{at}}\{p_{a,t}A_{a,t}H_{a,t}-w_tH_{a,t}\},$$
$$\max_{H_{na,t}}\{A_{na,t}H_{na,t}-w_tH_{na,t}\}.$$

4.2.1. Characterization

In equilibrium, the relative price of agriculture is, $p_{a,t}=A_{na,t}/A_{a,t}$. The ratio of market to home nonagricultural consumption is

$$\frac{c_{na,t}}{c_{z,t}}=\left(\frac{1-\mu}{\mu}\frac{A_{z,t}}{A_{na,t}(1-\tau_{e,t})}\right)^{\frac{1}{\varepsilon-1}}. \tag{10}$$

The ratio of market nonagricultural hours to leisure hours is given by

$$\frac{h_{na,t}}{l_t}=(1-\tau_{e,t})\frac{\mu(1-\sigma)}{\phi}\left[\mu+(1-\mu)\left(\frac{c_{na,t}}{c_{z,t}}\right)^{-\varepsilon}\right]^{-1}. \tag{11}$$

The fraction of time devoted to market nonagricultural production is given by

$$h_{na,t}=\frac{1-\bar{a}/A_{na,t}}{1+\frac{\sigma}{1-\sigma}[1+\frac{(1-\mu)}{\mu}(\frac{c_{na,t}}{c_{z,t}})^{-\varepsilon}]+(\frac{c_{na,t}}{c_{z,t}})^{-1}\frac{A_{na,t}}{A_{z,t}}+(\frac{h_{na,t}}{l_t})^{-1}}. \tag{12}$$

Then the time devoted to each of the other activities can be calculated,

$$h_{a,t}=\frac{\bar{a}}{A_{a,t}}+\frac{\sigma}{1-\sigma}\left[1+\frac{(1-\mu)}{\mu}\left(\frac{c_{na,t}}{c_{z,t}}\right)^{-\varepsilon}\right]h_{na,t}, \tag{13}$$
$$h_{z,t}=\left(\frac{c_{na,t}}{c_{z,t}}\right)^{-1}\frac{A_{na,t}}{A_{z,t}}h_{na,t}. \tag{14}$$

As is clear from (10)–(14) the allocation of time across activities each period depends on the returns to these activities, which in turn are determined by productivities (A_a, A_{na}, A_z) and taxes (τ_e). Aggregate market GDP in this model is given by $Y_t=p_{a,t}Y_{a,t}+Y_{na,t}$. For cross-country comparisons we require real GDP, which is calculated using a common relative price of agriculture across countries p_a^*. Then real GDP per hour is

$$\frac{Y_t^*}{H_t}=p_a^*A_{a,t}\frac{H_{a,t}}{H_t}+A_{na,t}\frac{H_{na,t}}{H_t}.$$

In the context of this model, with exogenous sectoral productivity processes, accounting for output per hour requires accounting for its composition, i.e., the sectoral hours shares.

5. Quantitative analysis

We use the model developed in Section 4 to provide an account of Turkey's relative economic performance over the period 1960–2003. We calibrate the model to the U.S. structural transformation and aggregate taxes. In our application to Turkey and Southern Europe, we take as exogenous the sequences of measured productivity growth rates for market activities and aggregate tax rates for each case. Then, we ask how the model does in replicating Turkey's relative underperformance to the U.S. and Southern Europe.

5.1. Calibration

Given that the model is about sectoral hours of market work, when comparing the model to the data, we use the series of agricultural and nonagricultural hours per working age person described in Section 3 and Appendix A.

Table 3
Marginal tax rates (τ_e).

	United States	Southern Europe	Turkey
1965	0.34	0.22	0.12
1970	0.40	0.23	0.15
1975	0.40	0.24	0.20
1980	0.39	0.34	0.23
1985	0.40	0.39	0.17
1990	0.41	0.43	0.26
1995	0.40	0.45	0.34
2000	0.41	0.48	0.38
2003	0.35	0.46	0.41
Factor increase (2003/1965)	1.0	2.1	3.4

Source: Author calculations using Prescott's (2004) methodology. See Appendix A.

The parameters that need to be calibrated are: (1) the preference parameters, σ, ε, $\bar{a}$, μ, ϕ, (2) the initial productivity levels $\{A_{i,1960}\}$ for $i \in \{a, na, z\}$, (3) the productivity growth rate vector $\{\gamma_{i,t}\}_{1960}^{2003}$ for $i \in \{a, na, z\}$, and (4) the effective marginal tax rate vectors $\{\tau_{e,t}\}_{1960}^{2003}$. Our calibration strategy is to parameterize the model so that it matches data for the U.S. economy and key features of its structural transformation over the period 1960–2003.

We normalize the initial productivity levels in all sectors to one for the U.S. economy in 1960, $A_{a,1960} = A_{na,1960} = A_{z,1960} = 1$. These normalizations correspond to a choice of units. We take the sectoral market productivity growth rate vectors, $\{\gamma_{a,t}, \gamma_{na,t}\}$, directly from the data, to match the annual growth rates of measured sectoral labor productivity (value added per hour) for the U.S. economy over the period 1960–2003. The average annual growth rates implied by these productivity series, are 4.59% for agriculture and 1.72% for nonagriculture.

The appropriate interpretation of the tax rate τ_e in the model is the effective marginal tax rate, i.e., it includes all the tax burden that falls on labor: income taxes, social security taxes, and indirect taxes. We calculate marginal tax rates for the U.S., Southern Europe, and Turkey, over 1965–2003, at five year intervals. For the U.S. and Southern Europe (average of Greece, Portugal, and Spain) we calculate tax rates from the UN National Accounts Statistics. For Turkey, due to lack of tax data in the UN National Accounts, we combine National Account Statistics with OECD Revenue Statistics to obtain estimates of marginal tax rates. The methodology and formulas for estimating the effective tax rates are identical to the ones outlined in Prescott (2004). More details on our data sources and calculation procedure is provided in Appendix A.

In Table 3, we present the marginal tax rates for the U.S., Turkey, and Southern Europe over 1965–2003, that we have calculated using Prescott's methodology. The U.S. marginal effective tax rate has been about 35% at the end points of the period 1965–2003, and has remained virtually constant at about 40% over 1970–2000. The simple average of the tax rates of Greece, Portugal, and Spain, started from 22% in 1965, increasing by a factor of 2.1, to 46% by 2003. However, the largest increase in taxes was experienced by Turkey. Even though the Turkish marginal effective tax rate started from the much lower level of 12%, by 2003 it had risen by a factor of 3.4, to 41%. A large part of this increase occurred after the mid-1980s.

We choose the weight of farm goods in the household's consumption basket, σ, to match the market share of hours in agriculture in 2003 for the U.S. economy. We set the parameter ε, that determines the elasticity of substitution between nonagricultural goods and services produced in the market and at home, based on *a priori* information. Micro and macro studies find this parameter to be between 0.4 and 0.45 for the whole economy (see for example, Rupert et al., 1995; McGrattan et al., 1997). As discussed in Rogerson (2008) some more recent studies report estimates of this parameter as high as 0.6. Following Rogerson (2008), we choose the conservative value of 0.45, and conduct sensitivity analysis in Section 5.4.

Given taxes and the productivity growth profiles in sectoral market activities, we choose the home production productivity profile $\{\gamma_{z,t}\}_{1960}^{2003}$ to match the evolution of the aggregate hours per working age person in the U.S. This implies an average annual growth rate of home production productivity of 0.88% over 1960–2003.

We then choose the parameters $\bar{a}$, μ, and ϕ to match the time allocation for the U.S. economy in 1960. Time use studies for the U.S. find that households devote 25% of their total time to home production activities and 33% of their time to market activities (Juster and Stafford, 1991). These two numbers determine targets for home and total market work, $h_{z,1960} = 0.25$ and $h_{1960} = 0.33$. The third target is the share of the market hours in agriculture, $\frac{h_{a,1960}}{h_{1960}} = 0.097$. These targets imply values for $\bar{a}$, μ, and ϕ of 0.028, 0.63, and 0.59 respectively. The values of the calibrated parameters and their targets are provided in Table 4. This calibrated model reproduces the pattern of structural transformation and the movement in the aggregate hours per working age person observed in the U.S. economy, over the period 1960–2003.[11]

[11] We note that a two-sector model without home production cannot reproduce the changes observed in U.S. hours. The pattern of home sector productivity is necessary to reproduce the U.S. hours movements.

Table 4
Calibration to U.S. data.

Parameter	Value	Target
σ	0.008	2003 agricultural hours
ε	0.450	McGrattan et al. (1997)
ϕ	0.594	1960 aggregate hours
$\bar{a}$	0.028	1960 agricultural hours
μ	0.625	1960 home hours
$\{\tau_e\}$	–	Authors' calculation
$\{\gamma_a\}$	–	Agricultural labor prod. growth
$\{\gamma_{na}\}$	–	Nonagric. labor prod. growth
$\{\gamma_z\}$	–	Evolution of aggregate hours

5.2. Experiments for Turkey relative to the U.S.

In the application to Turkey, we take the preference parameters of the model to be the same as those in the U.S. In the benchmark experiment, we take as given both market sectoral (agricultural and nonagricultural) productivity processes and tax vectors for Turkey from the data, and ask how the model does in predicting the time paths of relative aggregate output per hour, and relative aggregate hours per working age person, between Turkey and the U.S. Then, to disentangle the contribution of each of the above two factors, we ask the same questions by shutting down aggregate tax movements.

5.2.1. Experiment 1: Sectoral productivities and taxes

In this experiment we assume that Turkey is identical to the U.S. except for the productivity processes in market activities and the tax vector. The taxes we feed into the model are the marginal aggregate taxes for the Turkish economy in Table 3. The growth rates of the productivity processes in agriculture and nonagriculture, $\{\gamma_{a,t}, \gamma_{na,t}\}$, are chosen to match the annual growth rates of measured value added per hour in these sectors from the Turkish data, over 1960–2003. We assume that the home production productivity in Turkey evolves at the same rate as in the U.S. This assumption allows us to assess the ability of market productivity differences and taxes alone to account for the data.[12] Given that this assumption is potentially not an innocuous one, we conduct sensitivity analysis along this dimension.

To obtain sectoral productivity series for agriculture, market and home nonagriculture, it remains to determine the initial, 1960 levels of these productivity series. Our calibration strategy involves choosing the initial levels of productivity for Turkey, $A_{a,1960}$, $A_{na,1960}$, $A_{z,1960}$ to match three targets in 1960: the Turkish share of hours in agriculture; the ratio of Turkish to U.S. aggregate hours per working age person; and the ratio of Turkish to U.S. aggregate output per hour. The implied values for the initial levels of productivity are, 0.082 in agriculture, 0.267 in market nonagriculture, and 1.65 in home nonagriculture.

Given the productivity series and tax vectors we ask how the model does in replicating Turkey's aggregate performance relative to the U.S. As Fig. 3 indicates, the model accounts for most of the movement of relative aggregate output per hour. Given that sectoral productivity series are taken as exogenous, this is a direct consequence of the model's success in accounting for Turkey's structural transformation, i.e., movements in the share of hours in agriculture, particularly until the early 1990s. Thus, while the model does not explain productivity per se, this result shows that the sectoral composition is important in accounting for aggregate output per hour over time.

Fig. 4 displays the series for the aggregate hours per working age person, in Turkey relative to the U.S., produced by the model against the respective series from the data. The two factors we focus on, market productivities and taxes, do a very good job in reproducing the decline in relative hours. Comparing the end point change, from 1960 to 2003, the model accounts for the entire overall drop (in fact overpredicting by 2%) in relative aggregate hours per working person. While the model closely matches the time pattern of relative Turkish–U.S. hours throughout the period, there is a remaining gap between the model and data series that emerges over 1980–2000, suggesting other factors could have contributed to Turkey's deterioration in labor input over this period.

5.2.2. Experiment 2: Sectoral productivities

In this experiment we take as given only the sectoral market productivity growth rates from the data for Turkey. We assume that the marginal aggregate Turkish taxes, for the entire period, are equal to their 1960 level. Hence, the initial productivity parameters, $A_{a,1960}$, $A_{na,1960}$, $A_{z,1960}$, are identical to those in the previous experiment. The purpose of this experiment is to isolate the contribution of the market productivity processes alone.

In Table 5 we summarize the results from this exercise, for relative hours per working age person, and relative output per hour. We report the end-points of the period 1960–2003, which we examine. We also provide the data, and the results from the first experiment with productivities and taxes jointly, for comparison. The model with productivities alone continues

[12] Ideally one would want to have a direct measure of home productivity. It is well known that such measures are difficult to come about, even more so for Turkey. An alternative experiment would be to choose the productivity process for home production in Turkey to match the relative market hours between Turkey and the U.S. Since this variable is one dimension along which we want to assess the performance of our model we choose not to follow this route.

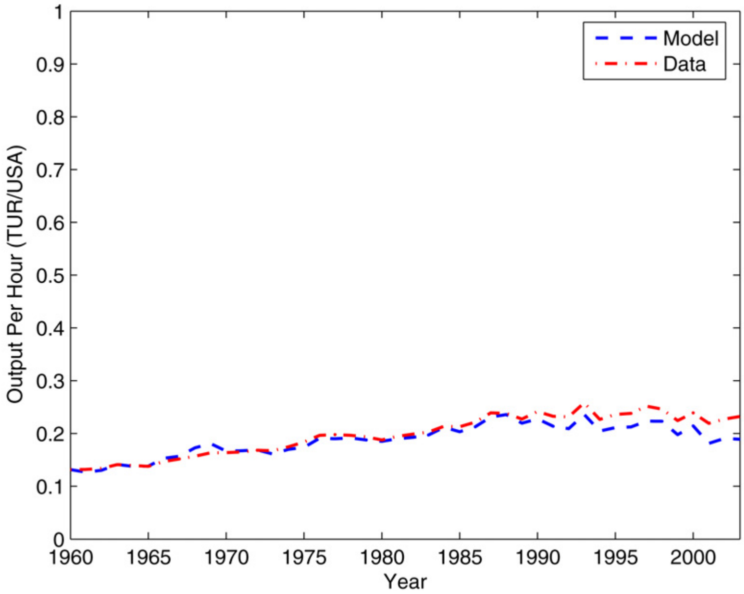

Fig. 3. Relative output per hour (Turkey to USA).

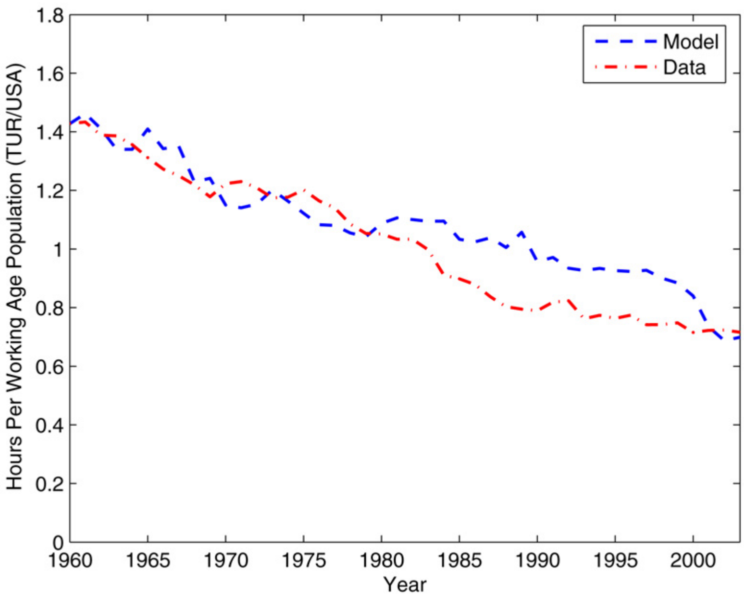

Fig. 4. Relative hours (Turkey to USA).

Table 5
Contribution of sectoral productivities and taxes (Turkey relative to U.S.).

	Relative output per hour			Relative hours		
	Data	Prod. and taxes	Prod.	Data	Prod. and taxes	Prod.
1960	0.13	0.13	0.13	1.43	1.43	1.43
2003	0.23	0.19	0.21	0.72	0.70	0.96

to do very well in accounting for the changes in Turkey's agricultural share of hours, and as a result for output per hour relative to the U.S. In fact, relative output per hour is 0.21 by 2003 here vs. 0.19 in the experiment with productivities and taxes jointly. However, differences in market productivities alone, can account only for 66% of the overall drop in aggregate market hours, instead of the 102% in the experiment with productivities and taxes. Considering the entire time series, the model with productivities does quite well in matching the decline in the relative aggregate hours until about 1980, but then this decline levels off in the model up to 2000, while continues in the data.

These results indicate that while market productivity alone can account for the behavior of relative output per hour, tax differences are pivotal in accounting for the dramatic decline in relative Turkish hours. The contribution of taxes is particularly pronounced after the early 1980s, precisely when the model with only productivity differences underperformed.

How does the mechanism of the model, sectoral productivities and taxes, help to account quantitatively for Turkey's performance relative to the U.S.? Consider first the effect of sectoral productivities alone. Turkey's relative output per hour did not exhibit a major catch-up relative to the U.S., because Turkey continued to devote many hours to agriculture, which was becoming relatively more unproductive. Consider now the effect of sectoral productivities on relative aggregate hours per working age person. The increase in Turkish agricultural productivity (even though slower than the U.S.) led to a much larger decline in agricultural hours relative to the U.S., simply because Turkey started from a much higher level of agricultural hours. Given that the reduced agricultural hours were proportionately allocated between the market and nonmarket activities, more hours were withdrawn from the market in Turkey. The above results indicate that this mechanism can explain only part of the decline in relative labor input. A large chunk of the decline in relative hours after 1980 can be explained by the rising aggregate taxes observed for the Turkish economy. Intuitively, as hours in agriculture were falling, the growing taxes deterred individuals from raising hours proportionally in the market nonagricultural sector. This in turn encouraged a flow of hours into the home sector.

5.3. Experiments for Turkey relative to Southern Europe

As in the experiment for Turkey relative to the U.S., we assume that Southern Europe differs from the U.S. only with respect to sectoral market labor productivities and aggregate taxes. Then we ask how the model does in accounting for the observed evolution of relative aggregate output per hour, and the relative aggregate hours per working age person, between Turkey and Southern Europe.

The growth rates of the productivity processes in agriculture and market nonagriculture, $\{\gamma_{a,t}, \gamma_{na,t}\}$, are chosen to match the growth rates of measured value added per hour in these sectors for Southern Europe, over 1960–2003. As in the previous experiments the growth rates for home production productivity are the same as in the benchmark calibration. To complete the construction of the sectoral productivity profiles for agriculture $\{A_{a,t}\}$, market and home nonagriculture $\{A_{na,t}, A_{z,t}\}$, we determine the 1960 levels of the series, using the same calibration strategy as the one used for Turkey relative to the U.S. above. The implied values for the initial levels of productivity are, 0.195 in agriculture, 0.35 in market nonagriculture, and 1.158 in home nonagriculture. Aggregate taxes for Southern Europe are taken from Table 3.

Figs. 5–6 display Turkish to Southern European aggregate output per hour, and aggregate hours per working age person, from the model against the same statistics in the data. Taking as exogenous sectoral labor productivities and taxes, the model is able to reproduce the key patterns for the relative statistics of interest. In particular, the model can account for: (a) the relatively stagnant aggregate output per hour, with both the decline up to 1980 and the subsequent rise; (b) the downward trend and the pattern in the relative hours (and also accounts for 58% of the overall decline).

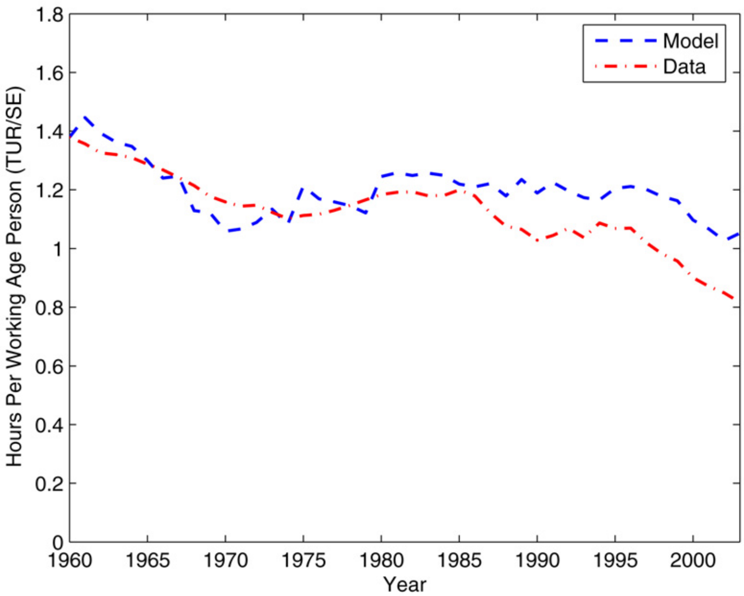

Fig. 5. Relative hours (Turkey to Southern Europe).

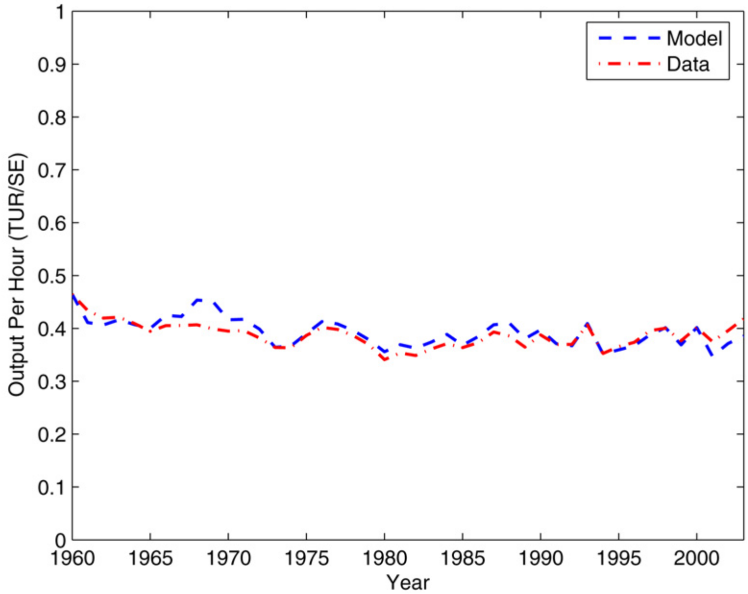

Fig. 6. Relative output per hour (Turkey to Southern Europe).

We find that including aggregate tax differences, in addition to market productivity differences, the model does better in accounting for relative output per hour and hours per working age person between Turkey and Southern Europe, relative to the case where only productivity differences are fed into the model. However, the contribution of tax differences is not as pronounced as in the experiments of Turkey vs. the U.S.

We conclude that, the factors that are important for understanding Turkey's relative underperformance to the U.S., taxes and sectoral productivities, are also important for understanding Turkey's relative falling behind to Southern Europe. We do not downplay other possible factors, but rather argue that taxes must be part of the story for Turkey's experience after 1980. Clearly, there are other distortions besides taxes that are not explored quantitatively here, but have the potential to account for the remaining "unexplained" part of the data, over 1980–2000. An important first step for disentangling these additional factors is the timing: it has to be a factor that exhibited a strong persistent trend after 1980. We discuss some potential factors in the Conclusions.

5.4. Sensitivity analysis

We examine the sensitivity of our results with respect to: (a) the growth rate of home sector productivity in Turkey; (b) the nature of the government's expenditure programs; (c) the elasticity of substitution between market and home activities, and (d) the assumption of a two-sector rather than a one-sector model.

5.4.1. Home sector productivity

In the benchmark experiments we assumed that the evolution of home sector productivity in Turkey was identical to that of the U.S. To examine the sensitivity of the results to this assumption we now consider the case where Turkish home sector productivity evolves at the same rate as Turkish nonagricultural market productivity. In Fig. 7 we compare Turkish–U.S. relative hours under this alternative assumption, to the benchmark case (identical Turkish–U.S. home sector growth rates). Under the alternative assumption the model produces a larger drop in relative hours than the benchmark model – overpredicting the total decline in relative hours by 14%. The reason is that under the alternative assumption the growth rate of Turkish home sector productivity is positive for the entire period (rather than negative for several periods as required to match movements in the U.S. aggregate hours),[13] thus encouraging a further decline in Turkish market work than that implied by taxes and market productivities alone. We obtain similar results if instead we assume that home sector productivity in Turkey evolves according to agricultural Turkish productivity.

5.4.2. Government expenditure programs

In the benchmark experiment, we assumed that in each country all tax revenue was used to fund lump-sum transfers to households. The implication of this assumption is that government and private spending on goods/services are perfect

[13] See Rogerson (2007a) for an explanation of the negative technological progress in the home sector, when home sector productivity is of the labor augmenting type as it is here.

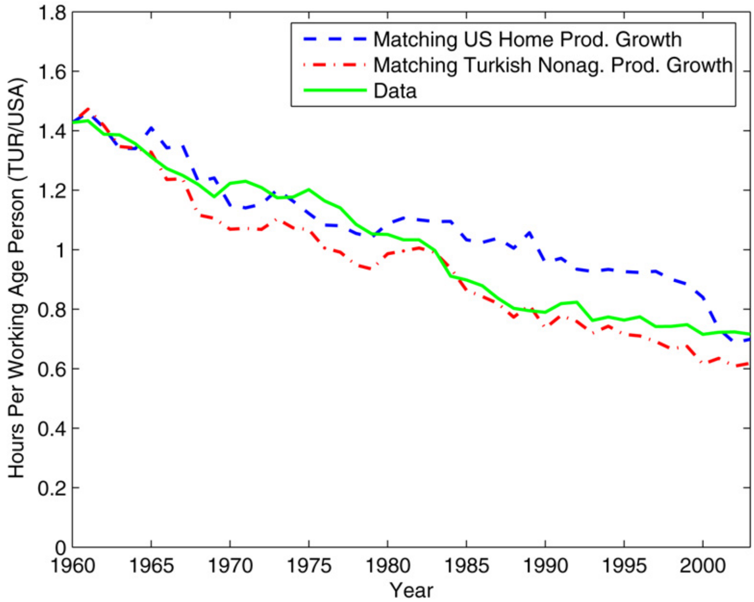

Fig. 7. Sensitivity: Home sector productivity,

substitutes. The abstraction of lump-sum transfers is a useful benchmark if the largest part of public spending is either direct transfers to consumers (e.g. unemployment insurance, social security) or is used to fund goods and services that can alternatively be provided by the private sector (e.g. health care, education). In reality however, some government spending, such as military expenditures, do not fall into this category. Rogerson (2007b) shows that the response of hours of work to a given tax increase depends on how the government spends the resulting tax revenue. We examine the sensitivity of our results to the assumption of lump-sum transfers, by considering expenditure programs that involve wasteful government spending that is not valued by consumers. This kind of expenditure does not affect the marginal utility of private consumption on the margin (alternatively we could have assumed that the government purchases public goods/services valued by consumers, but which enter the consumer's utility function separably).

We continue to assume that all public spending in the U.S. is in the form of lump-sum transfers as in the benchmark exercise, calibrating the model's parameters accordingly. In our application to Turkey we consider two alternative expenditure programs: (a) a pure wasteful expenditure program; (b) a mixed expenditure program, whereby a fraction θ of the total tax revenues is used for wasteful government expenditures, and the rest of the tax revenues are used for lump-sum transfers. Currently, in Turkey, 60% of total central government expenditures (net of interest on government debt) consist of transfers and services such as health care and education.[14] Therefore, we set $\theta = 0.4$ in the mixed program. In running the experiments for Turkey we take both sectoral productivity growth vectors and tax vectors as given. In Fig. 8 we compare the Turkish–U.S. relative hours, from the model with the pure lump-sum transfer program to the models with the pure wasteful program and the mixed expenditure program. We find that in every period, the larger the share of wasteful spending in the government's expenditure program, the smaller the effect on relative hours. In other words, Turkish aggregate hours fall by more relative to the U.S. under the pure transfer assumption, and do so even more after the mid-1980s when the steep increases in Turkish taxes took place. The labor input effects of increasing taxes are stronger under the transfers assumption than under the wasteful or mixed expenditures assumptions, because the tax-pure transfer scheme has additional income effects relative to the other cases, when employed with the preferences described by (1).

5.4.3. Value of ε

This is a key parameter of the model, because it determines the elasticity of substitution between market and home nonagricultural goods/services. In the benchmark calibration we set this parameter equal to 0.45, consistent with micro and macro evidence for the aggregate economy. In Fig. 9 we present how our results change if instead we assume $\varepsilon = 0.55$, keeping the rest of our parameters as in the benchmark calibration. A higher value of ε implies that home and market goods and services are more substitutable. This in turn implies that for a given differential in the returns between home and market nonagricultural production, the re-allocation of activity between these sectors will proceed at a faster rate. In particular, we find that the model now overpredicts the overall decline in the observed relative aggregate hours between Turkey and the U.S. by 16% (vs. 2% of the benchmark model) and misses especially in the 1970s and 2000s.

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[14] See the Central Bank of Turkey: http://tcmbf40.tcmb.gov.tr/cbt-uk.html.

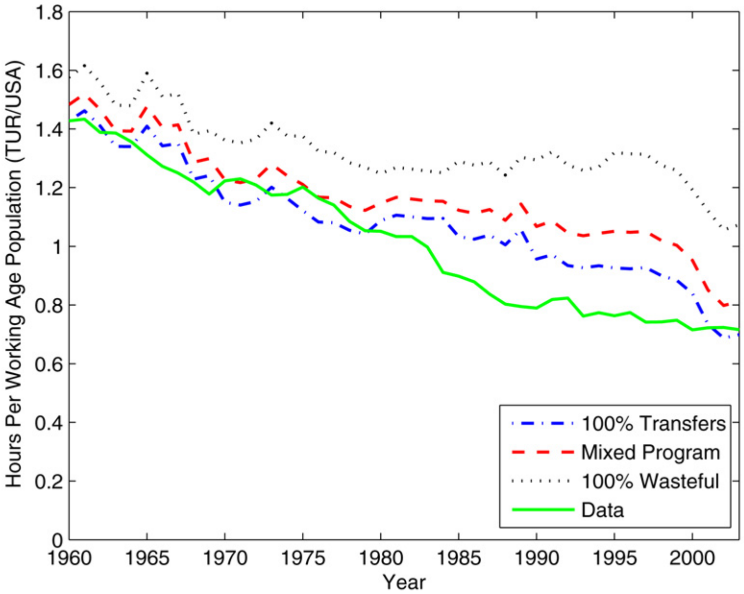

Fig. 8. Sensitivity: Alternative expenditure programs for Turkey.

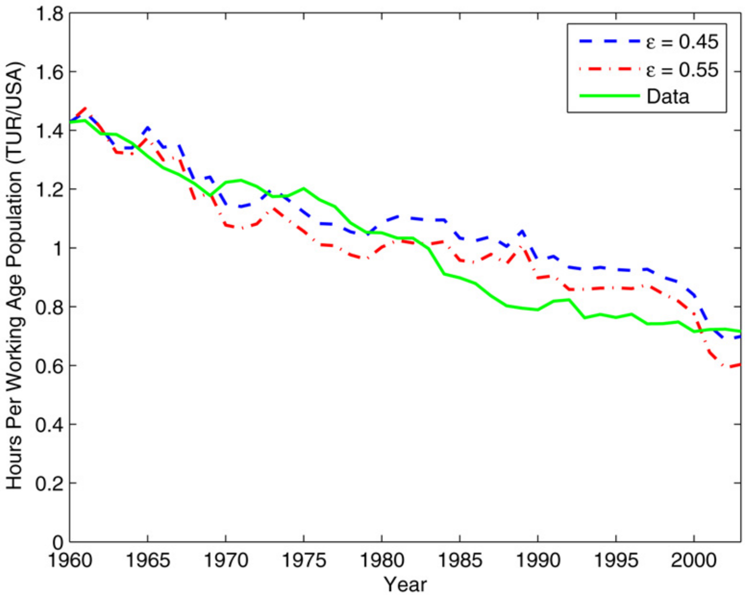

Fig. 9. Sensitivity: Elasticity of substitution.

5.4.4. One- vs. two-sector model

In Fig. 10 we compare aggregate Turkish–U.S. relative hours per working age person of the benchmark two-sector model to that of a one-sector model. The one-sector model does not incorporate a separate agricultural sector, but it still includes a home production sector and a subsistence constraint for aggregate consumption. In the experiment for the one-sector model we take as given differences in aggregate output per hour and differences in aggregate taxes between Turkey and the U.S. Fig. 10 reveals that the one-sector model, unlike the two-sector model, cannot reproduce the dramatic decline in relative hours: it accounts for 52% of the overall decline instead of 102% accounted for by the two-sector model, but more importantly completely misses in between.

In the one-sector model, the subsistence constraint does not affect the allocation of hours between market and nonmarket production, as it is applied to aggregate consumption (a bundle of market and nonmarket consumption). The presence of the subsistence constraint on consumption does imply though that total work hours fall in favor of leisure hours as productivity rises. Quantitatively this effect would be somewhat stronger for Turkey compared to the U.S. since aggregate output per hour in Turkey relative to the U.S. increased slightly. As a practical matter however this channel is not that large

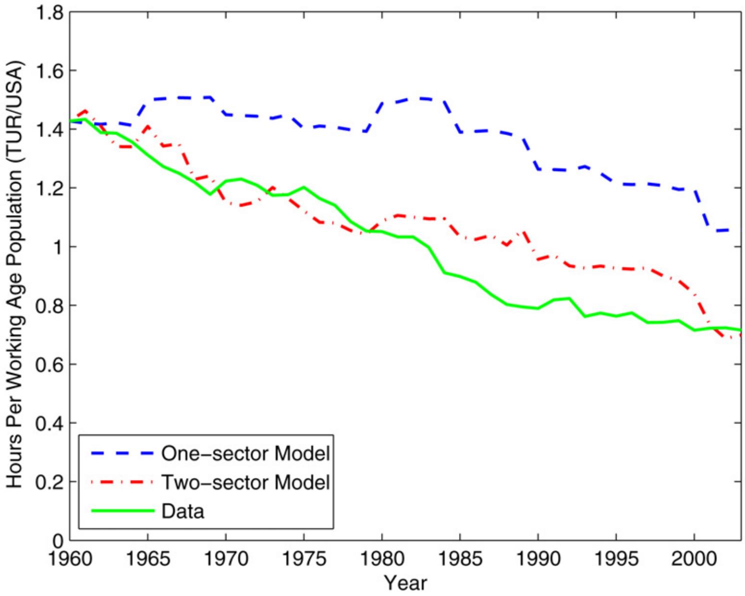

Fig. 10. Sensitivity: One- vs. two-sector model.

as consumption carries a much larger weight in utility than leisure. Thus the remaining mechanism in the one-sector model driving down relative aggregate hours, are movements in taxes in Turkey vs. the U.S.

6. Labor input by gender

In order to account for the decline in aggregate hours in Turkey, in this paper, we have emphasized the decomposition of hours by economic activity (agriculture vs. nonagriculture). There are two related questions we have not studied here: (1) Among which groups of individuals is the drop in Turkish market hours more pronounced? (2) Are the movements in the sectoral allocation of Turkish hours uniform across individuals? If the bulk of the drop in aggregate and agricultural labor input is concentrated among a particular demographic group, this could prove useful in enhancing our understanding of Turkey's deterioration in hours of market work.

We look at the first question along the gender dimension. In particular, we decompose aggregate hours per working age person by gender,

$$\frac{H}{N} = \frac{H_f}{N} + \frac{H_m}{N}$$

where H_f are total hours worked by females (f) and H_m are total hours worked by males (m). Combining this gender decomposition with the sectoral decomposition we can dissect sectoral hours by gender to get at the second question,

$$\frac{H_a}{N} = \frac{H_{a,f}}{N} + \frac{H_{a,m}}{N},$$
$$\frac{H_{na}}{N} = \frac{H_{na,f}}{N} + \frac{H_{na,m}}{N}$$

where $H_{j,i}$ are hours worked in sector $j \in \{a, na\}$ by individuals of gender $i \in \{f, m\}$. To construct total hours by gender and sectoral hours by gender we need employment and hours per worker for each category. Hours per worker are not available for Turkey for any category. From the OECD Labor Market Database we have Turkish data on employment by gender and sector only for very limited years. To construct total hours per working age person by gender we multiply aggregate hours per working age person by the gender employment shares in each year. By doing so we are essentially assuming that hours of work per worker are constant across males and females. We follow a similar procedure to obtain sectoral hours per working age person by gender. A detailed description of our data sources and methodology is provided in Appendix A.

Table 6 provides our decompositions of aggregate and sectoral hours by gender for the two end points of the period we study, 1960–2003. We observe the following. (1) Total hours per working age person declined for both males and females over the period 1960–2003. However, the bulk of the decline in aggregate hours, is accounted for by the decline in female hours. (2) While hours in agriculture have declined considerably for both males and females, they have declined more so for females. (3) For males, nearly 1/5 of the decline in agricultural hours, over 1960–2003, has been offset by an increase in nonagricultural hours. For females, approximately 90% of the hours given up in agriculture have not been recovered in market nonagriculture.

Table 6
Hours per working age person by gender and sector.

	Females			Males			All		
	Total	Agr.	Nonagr.	Total	Agr.	Nonagr.	Total	Agr.	Nonagr.
1960	783.3	718.6	43.4	966.8	564.3	423.8	1750.1	1282.9	467.2
2003	255.8	146.2	107.4	662.3	157.6	506.9	918.1	303.9	614.2
Change	−527.5	−572.4	64.0	−304.5	−406.7	83.1	−832.0	−979.0	147.0

Source: Author calculations. Based on OECD employment and labor market statistics.

A similar picture is painted with data from Tansel (2001). While the labor force participation rate in Turkey has decreased for both men and women, the decline for women has proceeded at a much faster pace: the female labor force participation rate declined from 72% in 1955 to 26% by 2000, while the male participation rate dropped from 95% to 73% over the same period. Further, in 2000, while for males there is no substantial difference in the labor force participation rates between rural and urban areas (77% in rural vs. 71% in urban), for females the rural labor force participation rate more than doubles the urban one (39% vs. 17%). In 1955, 96% of female employment worked in agriculture (71% of male employment), and as of 2000, 60% of female employment is still in agriculture (26% of male employment).

The observations from the OECD data and from Tansel (2001) imply that in rural areas women work in agriculture and are counted in employment, whereas when moving to urban areas women do not work as much. Our tax story is consistent with these additional employment and hours observations by gender. In particular, if taxes discourage market work in favor of home production, then it is possible that this will manifest itself mainly as lower female labor input.[15] An alternative explanation is that cultural forces in Turkey may impede female labor market participation in urban areas relative to rural areas. Disentangling the effects of culture and tax policy on labor market outcomes is beyond the scope of this paper, but is certainly an interesting area for future research.

7. Conclusions

The proximate explanation for Turkey's underperformance to the U.S. and Southern Europe, over the past 40 years, lies in the relative deterioration of aggregate labor input and the less than stellar rise in relative labor productivity. We have shown that movements in relative sectoral productivity differences in Turkey relative to the U.S. and Southern Europe, and the evolution of aggregate taxes in Turkey relative to these regions can account quantitatively for most of Turkey's underperformance.

Our analysis suggests that Turkey has faced two main problems. First, the very low productivity growth in agriculture, which still results in a very large portion of the population's hours to be worked in agriculture. Second, the low return to market vs. home production in nonagriculture, which has deterred people who have been giving up agricultural hours to channel their hours to other market activities. The implication of our analysis is that, policy changes that, (a) can allow productivity in agriculture to grow faster, and (b) encourage individuals to (re-) channel hours to the market sector, could prove useful for Turkey's catch-up.

Given that taxes and productivity do not explain all of Turkey's decline in hours after 1980, it would be of interest to study quantitatively other factors that could have contributed to Turkey's declining labor supply. For example, policies that encourage early retirement[16] can be promising, primarily because their introduction coincided with the timing of the decrease in labor supply. Unless more structure is added to the model, these policies cannot be explored quantitatively in the environment we have here. Several demand side distortions may also be promising in explaining Turkey's low employment problem, such as minimum wages (Öztürk, 2005), policies that impede temporary and part-time employment, and high employment protection policies. Again we believe that a different model, perhaps with search frictions, is more appropriate for studying the quantitative importance of such issues.

A key question is, why relative agricultural productivity growth has been so low in Turkey. Our model is silent with respect to the sources of measured labor productivity differences. Understanding why sectoral labor productivities have evolved the way they have is certainly an important question (see for example Restuccia et al., 2008 on the importance of intermediate inputs).

[15] To see this, consider a household consisting of a male and female. If we assume that males and females value leisure similarly, but females have a comparative advantage in home production (due to the nature of work), then the elasticity of labor supply for females will be higher than for males. In such an environment, females will experience a larger drop in their labor supply in response to higher taxes.

[16] According to early retirement policies introduced in the early 1980s, a woman after 20 years of service or at age 50, and a man after 25 years of service or at age 55 could retire (Tansel, 2001).

Appendix A. Data description

Classification of broad sectors

The definitions of sectors is based on the International Standard Industrial Classification (ISIC) Revision 3. The broad sector "agriculture" includes ISIC divisions 1–5 (Agriculture, Hunting and Forestry, Fishing). The broad sector "nonagriculture" includes ISIC divisions 10–99, i.e., the rest of the economy.

Penn World Table v6.2

The following variables have been obtained from the PWTv6.2 for all countries. *POP*: Population. *RGDPCH*: Real GDP per capita (Constant price: Chain series). *KI*: Constant price share of investment in real GDP. We calculate real GDP as $RGDPCH \cdot POP$.

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From the OECD LFS tables (available through http://www.sourceoecd.org) we have obtained the following variables, for all countries. *Population between 15 and 64*: working age population. *Employment*: total number of employed persons based on ILO definition. *Employment – Agriculture*: civilians employed in agriculture, based on ISIC Rev.3. We calculate nonagricultural employment residually, as the difference between total and agricultural employment.

Aggregate hours of work

We have obtained annual hours worked per person employed, for the U.S., France, Germany, Italy, Greece, Portugal, Spain, Turkey, over 1960–2003, from the *Total Economy Database* of the **Conference Board and the Groningen Growth and Development Centre**, Jan. 2008 (available at http://www.conference-board.org/economics/database.cfm#4). We construct total hours of work H_t, as the product of hours worked per person employed η_t, and the number of persons employed E_t: $H_t = \eta_t \cdot E_t$.

Calculation of aggregate capital stock series

We calculate the capital stock series as follows. Using the data in Easterly and Levine (2001), we compute the average capital-output ratio over the period 1951–1960: 1.08 for Turkey; 2.07 for the U.S.; 1.54 for Southern Europe. We multiply these numbers with real GDP in 1950 for each region, from the PWTv6.2. The resulting numbers constitute our initial conditions for the capital stock series, K_0. The capital stock series are calculated using a law of motion with geometric depreciation, $K_{t+1} = (1-\delta)K_t + X_t$, where X_t is the real investment series from the PWTv6.2. Assuming $\delta = 0.06$ and the perpetual inventory method we calculate capital stock series over the period 1950–2003, and discard the first 10 years of the series (since our growth accounting is conducted over the period 1960–2003). This procedure reduces the sensitivity of the capital stock series to the choice of initial condition for capital.

Sectoral value added output shares

From the *10-Sector Database* of the **Groningen Growth and Development Centre**, we have calculated sectoral value added GDP shares for the U.S. until 1997 (Table 1.9) and Spain until 1994 (Table 1.6). For Portugal the value added GDP shares are calculated for the period 1960–1995 based on data from the **Bank of Portugal** (available through http://www.bancodeportugal.pt). For Greece, over the period 1960–1975 the value added GDP shares are calculated from the *National Accounts of OECD Countries, Detailed Tables – Vol. 2* of the **OECD**. For all these countries, sectoral output shares for the remaining years to 2003, are calculated from the *STAN Database for Industrial Analysis* of the **OECD** (available through http://www.sourceoecd.org). Sectoral value added GNP shares for Turkey, over the entire period 1960–2003, are obtained from the publication "*İstatistik Göstergeler: 1923–2004*" (Table 21.8) of the **Turkish Statistical Institute**.

Sectoral hours per worker

For the United States and the countries of Southern Europe (Greece, Portugal, Spain), hours per employee by sector $\{\eta_{a,t}, \eta_{na,t}\}$, over the period 1970–2003, are calculated from the **EU-KLEMS Database** – March 2008 (for details on this database, linked from the GGDC, see Marcel Timmer, Mary O'Mahony & Bart van Ark, *The EU KLEMS Growth and Productivity Accounts: An Overview*, University of Groningen & University of Birmingham; downloadable at http://www.euklems.net/index.html). We use this database because $\{\eta_{a,t}, \eta_{na,t}\}$, are consistently available for the longest period for all four countries (U.S., Southern European countries), relative to other databases.

Construction of total sectoral hours

We outline the procedure we follow to construct total sectoral hours $\{H_{a,t}, H_{na,t}\}$, consistent with aggregate hours H_t. First note that, total hours can be decomposed into agricultural and nonagricultural hours, $H_t = H_{a,t} + H_{na,t}$, or alternatively, $H_t = \eta_{a,t} \cdot E_{a,t} + \eta_{na,t} \cdot E_{na,t}$. Using directly the sectoral hours per employee from EU-KLEMS, $\{\eta_{a,t}, \eta_{na,t}\}$, there is no guarantee that the above equation will hold. To ensure that the equation does hold we calculate relative hours per employee $\frac{h_{na,t}}{h_{a,t}}$ and then re-arrange the above equation to obtain the implied levels for sectoral hours per employee that are consistent with it. In particular we have that,

$$\eta_{a,t} = \frac{H_t}{E_{a,t} + (\frac{\eta_{na,t}}{\eta_{a,t}})E_{na,t}}$$

and $\eta_{na,t} = (\frac{\eta_{na,t}}{\eta_{a,t}})\eta_{a,t}$. Then, total sectoral hours by sector are simply calculated as $H_{j,t} = \eta_{j,t} \cdot E_{jt}$, ensuring that $H_t = H_{a,t} + H_{na,t}$. We follow this procedure for the U.S. and Southern Europe for 1970–2003. For the period 1960–1969, for the U.S., we use the same procedure to construct sectoral hours but calculate $\frac{\eta_{na}}{\eta_a}$, from the **GGDC 10-Sector Database** (available at http://www.ggdc.net). For the period for which the GGDC 10-Sector Database and the EU-KLEMS Database overlap (1970–1996), the ratio of $\frac{\eta_{na}}{\eta_a}$ is very similar between them. For the Southern European countries we do not have relative sectoral hours per employee before 1970 from any source. For Southern European countries over 1960–1969, we allocate total hours across sectors using the same procedure but assume that for each country $\frac{\eta_{na}}{\eta_a}$ is constant and equal to its average over the period 1970–1980.

For Turkey, sectoral hours per employee are not available from any of the above sources for any year. For Turkey, we allocate economy-wide hours across sectors using the sectoral employment shares, $\frac{H_a}{N} = \frac{H}{N} \cdot \frac{E_a}{E}$, and $\frac{H_{na}}{N} = \frac{H}{N} \cdot \frac{E_{na}}{E}$. Note, that this procedure essentially amounts to assuming that sectoral hours per employee are the same across sectors and equal to the economy-wide hours per employee.

Calculation of sectoral output per hour

Value added for each sector, at international prices, is calculated by multiplying the sectoral value added shares, described above, with real GDP in international dollars from the PWTv6.2. *Measured* labor productivity for a particular sector is calculated as value added for that sector divided by the total number of hours in the sector. Note that, these labor productivities do not take into account differences in relative sectoral prices across countries, as the sectoral output shares used in this calculation are based on domestic relative sectoral prices. Thus, the measured sectoral productivity growth rates can confound movements in the relative price of agriculture and movements in actual productivity.

As a first pass at this issue, we get estimates for the relative prices of agriculture in Turkey, Greece, Portugal, and Spain relative to the U.S., by dividing agricultural PPPs from Rao (1993, FAO), by the aggregate PPPs from the PWTv6.1 (to proxy for the price of nonagriculture). Table 7 indicates that there is no systematic trend in the relative price of agriculture in any of these countries relative to the U.S. for the period 1970–1990, for which the Rao (1993) data are available. This might suggest that the systematic decline in measured relative agricultural productivity of Turkey to the U.S. and Southern Europe, is not likely to be coming from systematic movements in relative prices but more likely from movements in actual relative labor productivity.

Table 7
Relative price of agriculture (relative to the U.S.).

	1970	1975	1980	1985	1990
Greece	2.4	1.8	2.1	2.7	1.9
Portugal	2.4	2.1	2.8	3.5	2.3
Spain	2.5	1.9	1.4	2.1	1.5
Turkey	2.6	2.3	2.2	3.0	1.5

Source: Rao (1993), PWTv6.1.

Calculation of marginal taxes

We estimate marginal tax rates (τ_e) for the United States, Southern Europe (the average of Greece, Portugal, and Spain), and Turkey at 5-year intervals over the period 1965–2003. In estimating marginal tax rates we follow Prescott's methodology as outlined in Prescott (2004, pp. 5–7). The construction of these tax rates makes use of National Accounts Statistics. For all countries, except for Turkey, we use National Accounts Statistics for the entire period, 1965–2003, from the United Nations (*National Accounts Statistics: Main Aggregates and Detailed Tables, Parts I and II, United Nations*, various years).[17] For Turkey, there

[17] For the period 1965–1995, we use the System of National Accounts UN SNA68. Since SNA68 is discontinued after 1995, for the 2000 and 2003 values we use UN SNA93.

are missing data for most years from the UN National Accounts. For the period 1980–2003 we use the National Accounts for Turkey reported by the **Turkish Statistical Institute** (obtained from the publication *İstatistik Göstergeler: 1923–2004* – Table 21.3). These data also report GDP by cost which allows us to obtain estimates for indirect taxes. For the period 1965–1975 we use the GDP expenditures from the UN National Accounts. We obtain direct taxes on personal income and social security contributions over 1965–2003, and net indirect taxes over 1965–1975 (all as fractions of GDP) from the **OECD** publication, *Revenue Statistics OECD, 1965–2005*.[18] Combining these numbers we are able to obtain estimates for Turkey's marginal tax rates over the period 1965–2003.

Gender hours of work

We obtain aggregate and sectoral employment data by gender from the *Employment by Activities and Status Vol 2008 release 01* of the **OECD Employment and Labor Market Statistics** database. These data are available for the years 1960, 1965, and after 1988 continuously. Hours per worker are not available for any category. To construct gender hours of work per working person (ensuring that gender hours sum up to the aggregate ones) we multiply aggregate hours per working person, H/N, by the male and female share of employment, E_f/E and E_m/E respectively: $\frac{H_f}{N} = \frac{H}{N} \cdot \frac{E_f}{E}$ and $\frac{H_m}{N} = \frac{H}{N} \cdot \frac{E_m}{E}$. This procedure implicitly assumes that hours per worker are the same across genders. Similarly, to ensure gender hours by sector sum up to the total sectoral ones, we multiply hours per working age person in each sector by the sectoral gender employment shares. Again, the implicit assumption for this procedure is that hours per worker are the same across genders and sectors.

Appendix B. Growth accounting

We posit an aggregate Cobb–Douglas production function, in which output in country i at time t depends on the total capital stock (K_{it}), aggregate hours of work (H_{it}), and total factor productivity (A_{it}), $Y_{it} = A_{it} K_{it}^{\alpha} H_{it}^{1-\alpha}$. Following Parente and Prescott (2005) and Cole et al. (2004), we assume that TFP is the product of two terms: $A_{it} = \pi_{it} A_t$. We interpret A_t as the world technological frontier, which is common across all nations. The country-specific component $0 < \pi_{it} \leqslant 1$ indicates how close a country is to the frontier. We re-arrange the above production function to write output per hour, in terms of a TFP factor, and a capital intensity factor,

$$\frac{Y_{it}}{H_{it}} = \pi_{it}^{\frac{1}{1-\alpha}} \cdot A_t^{\frac{1}{1-\alpha}} \cdot \left(\frac{K_{it}}{Y_{it}}\right)^{\frac{1}{1-\alpha}} \tag{15}$$

and use it to conduct growth accounting. We assume a standard value of $\alpha = 0.33$. Details on the construction of the capital stock series are provided in Appendix A. Table 8 displays the annualized growth rate of relative output per hour and each factor in (15) for Turkey relative to the U.S. and Southern Europe, by decade and for the entire period (note that the common TFP term drops out when calculating relative output per hour). From Table 8 it is evident that capital accumulation is not the source of Turkey's underperformance. Overall, the capital intensity factor increased (although nonmonotonically) relative to those in both the U.S. and Southern Europe, from 1960 to 2003. Thus, Turkey's relative underperformance in output per hour has been accounted for mostly by Turkey's underperformance in its idiosyncratic TFP factor – slightly increasing relative to the U.S. and decreasing relative to Southern Europe.

Table 8
Growth accounting of relative output per hour (% growth rate).

	Turkey/U.S.			Turkey/Southern Europe		
	$\frac{(Y/H)_{TUR}}{(Y/H)_{USA}}$	$\left(\frac{\pi_{TUR}}{\pi_{USA}}\right)^{\frac{1}{1-\alpha}}$	$\left(\frac{(K/Y)_{TUR}}{(K/Y)_{USA}}\right)^{\frac{\alpha}{1-\alpha}}$	$\frac{(Y/H)_{TUR}}{(Y/H)_{SE}}$	$\left(\frac{\pi_{TUR}}{\pi_{SE}}\right)^{\frac{1}{1-\alpha}}$	$\left(\frac{(K/Y)_{TUR}}{(K/Y)_{SE}}\right)^{\frac{\alpha}{1-\alpha}}$
1960–1970	2.22	2.01	0.20	−1.62	−0.94	−0.69
1970–1980	1.38	0.05	1.33	−1.45	−1.85	0.41
1980–1990	2.55	2.97	−0.41	1.29	1.57	−0.28
1990–2003	−0.30	−1.44	1.16	0.59	−0.59	1.19
1960–2003	1.33	0.72	0.61	−0.25	−0.47	0.23

Source: Authors' calculations.

Is the evolution of Turkish relative TFP driven by the evolution of relative human capital? Table 9 reports average years of schooling, obtained from the Barro and Lee (2000) data set, for Turkey, Greece, Portugal, and Spain relative to the U.S. Even though Turkey started with the lowest level among these four countries, and still has the lowest today, it exhibited the largest catch-up relative to the U.S. If years of schooling proxy to some extent for human capital levels, then human capital accumulation does not seem to be the source of Turkey's underperformance in aggregate TFP.[19]

[18] All tax revenue shares are reported from 1965 to 2000 at five year intervals.

[19] There is a large debate in the development accounting literature about the role of human capital and how much it can "chip off" from the TFP term. See for example, Klenow and Rodriguez-Clare (1997), Caselli (2005), Manuelli and Seshadri (2005), Erosa et al. (2005).

Table 9
Average years of schooling (relative to the U.S.).

	Greece	Portugal	Spain	Turkey
1950	0.47			0.13
1960	0.54	0.22	0.42	0.23
1965	0.54	0.24	0.41	0.22
1970	0.53	0.25	0.48	0.22
1975	0.57	0.28	0.45	0.23
1980	0.55	0.27	0.43	0.24
1985	0.59	0.30	0.45	0.29
1990	0.64	0.36	0.51	0.33
1995	0.66	0.37	0.54	0.38
2000	0.69	0.40	0.59	0.39

Source: Barro and Lee (2000).

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