Economic Development in Turkey and South Korea: A Comparative Analysis

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Abstract

An interesting question in comparative economic development is why Turkey fell behind South Korea even though she had better development prospects in 1960. The existing literature offers illuminating narratives of most plausible reasons, but only a few papers have identified the microeconomic foundations of relative underperformance of the Turkish economy. This paper constructs and analyzes two-sector catching up models to find contrasts between Turkey and South Korea. Results following from data-based calibrations indicate the following: With respect to initial conditions and values of structural parameters, both economies have advantages and disadvantages. The most significant contrast, however, is the huge difference in how efficiently the two countries adopt frontier technologies. While South Korean economy operates with an efficiency level very close to its upper bound of 100%, Turkey is located at the other end of the spectrum with efficiency less than 1%. Counterfactual experiments confirm the dominant role of this efficiency parameter against initial conditions and other structural parameters. An extended analysis indicates that human capital differences can only partially explain the large difference in efficiency levels.

Keywords: productivity growth, catching up, efficiency, absorptive capacity, human capital, calibration.
JEL Classification Codes: O33, O41, O57.

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South Korean economy has recorded miraculous successes in the postwar period, and it has forged ahead of many initially similar economies in only a couple of decades. Turkey in 1960 has been positioned with better economic development prospects than South Korea, but South Korea has forged ahead of Turkey as well (Krueger, 1987).

In 1960, real GDP per capita in Turkey has been about 2 times larger than Korean in purchasing power parity corrected US dollars. The gross saving rate in Turkey has been about 13% points higher than the Korean rate. Perhaps most significantly, the total volume of exports in Turkey has been about 8.5 times larger than Korean in 1961. In 1980, these statistics have been reversed remarkably. Turkish real GDP per capita has been about 6% lower. The gross saving rate in South Korea has been about 6.5% points higher than the Turkish rate. The total volume of exports in South Korea has been 4.5 times larger than the corresponding volume for the Turkish economy. The relative underperformance of Turkey has continued after 1980s with an increasing difference in real GDP per capita levels. South Korea has kept converging to the rich economies while Turkey has failed to do so.[1]

Figure 1 pictures the evolution of real GDP per capita from 1870 to 2010 for selected economies and in purchasing power parity corrected terms.[2] The imperial Turkey in 1870, while richer than Japan, Korea, and China, is a poor economy in modern standards. After the fall due to World War I (WWI) and the National Liberation War, the young republic returns to its pre-WWI level of real GDP per capita in the early 1930s. The growth rate, however, does not permanently exceed 2.95% per annum for the rest of the history. While all three East Asian economies considered here experience economic growth at quantitatively comparable rates that are significantly larger than those of England and the United States, the long-run growth rate in Turkey remains much lower.

< Insert Figure 1 about here >

Looking more closely to the case of 'South Korea versus Turkey' reveals the persistent difference of growth rates in these economies after early 1960s. The inevitable end result of this difference is the Turkish fall behind South Korea, occurring at around 1980. The history then records the absence of an upward trend break in Turkish real GDP per capita until today and a growth slowdown in South Korea after 1990s.

The main question here is why this reversal did happen, and this has motivated a literature searching for the contrasts between South Korea and Turkey. Some studies emphasize the timing of transition from import substitution to export orientation and other trade-related issues (Krueger, 1987; Yılmaz, 2002; Onaran and Stockhammer, 2005). Some other studies focus on the structure of and the strategies pursued by the private sector firms and the role of state in directing the process of industrialization (Öniş, 1992; Buğra, 1994; Aydın, 1997; Erdoğdu, 1999; Oh and Varcin, 2002; Öniş and Şenses, 2007; Taymaz and Voyvoda, 2012). The quality of labor force and the innovative/imitative performance of the economy are also underlined in the existing literature (Pak and Türkcan, 2000; Taymaz, 2001; Şenses and Taymaz, 2003). In a comparative study focusing on the post-2001 experience of the Turkish economy, Öniş and Bayram (2008) ask whether Turkey will emerge as a new tiger or remain as a temporary star.[3] They emphasize that Turkey can have tiger-like

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[1] South Korean miracle is the main subject matter of a sizable literature. A selective list of references includes Dornbusch and Park (1987), Amsden (1989), Haggard et al. (1991), and Cha et al. (1997). Also highly relevant is the World Bank's (1993) 400-page report *The East Asian Miracle* that tends to undermine the governments' roles as developmental states. For an excellent critique of this report, see Rodrik (1994).

[2] This figure captures some of the main lessons of world economic history. These include the fall of England relative to the United States in the 20th century, the persistence of the level difference between these two economies, the collapses associated with the Great Depression and World War II, and the successive rises of Japan, South Korea, and China in the second half of the 20th century.

[3] Other than the Japan-centered and American hegemony explanations, Öniş and Bayram (2008) list three perspectives explaining the East Asian miracle; the *neoclassical* perspective focuses on the critique of the import substitution policies, the *statist* perspective focuses on the enabling role of state, and the *culturalist* perspective focuses on Confucian values.

performance as in East Asia only if she sustains growth via higher domestic savings and exports and lower external financing.

This paper presents some quantitative evidence on how technology may have affected the divergent development experiences of South Korea and Turkey. The purpose is to infer technological structures of Turkey and South Korea using a simple model with microeconomic foundations and a collection of relevant data that is informative for the model economy. Since the analysis builds upon microeconomic foundations, it allows for rigorous inferences on the contrasts between the two economies. The comparison, at the end, returns some concrete messages.

The starting point of the analysis is the simple catching up model proposed by Lucas (2009).[4] This model has two production sectors, one representing traditional agriculture, i.e., the farm sector, and the other representing modern industry, i.e., the city sector. The productivity in the city sector grows as domestic firms catch up with the world technology frontier. This frontier expands in the leader country at a fixed and an exogenous rate. The growth of productivity in the city sector also spills over to the farm sector. In time, the dependence to land in the farm sector and free labor mobility across sectors cause the labor share of the farm sector to decline. The city sector keeps catching up with the frontier at a decelerating pace throughout the transition. Lucas (2009) calibrates the model parameters using several targets and taking the United States as the world technology frontier. His end result is that the model successfully explains the evolution of GDP per capita and the decline of agriculture in a set of open economies.

This paper first shows that the model does not perform remarkably well in replicating South Korean and Turkish data at the benchmark parameter values Lucas (2009) uses. The data is at annual frequency covering the years from 1960 to 2014, and the source of the data is World Development Indicators (World Bank, 2016). The Lucas (2009) benchmark values predict a worse performance for South Korea and a better one for Turkey in catching up with the world technology frontier. Compared with the benchmark economy in Lucas (2009), South Korea is unsurprisingly an over-performer and Turkey is unsurprisingly an under-performer.

Given the lack of a very successful match at the benchmark values, this paper extends the simple model with a new structural parameter. This additional parameter represents a barrier to the catching up process as in Parente and Prescott (1994). It reflects, admittedly in an agnostic way, the time-invariant cultural and institutional characteristics affecting the success of the economy in exploiting the full potential of technology adoption. Denoted by η, it basically governs how efficiently an economy adopts the more advanced technology. The parameter takes values from the $[0,1]$ interval as in Cohen and Levinthal's (1989: 571) absorptive capacity γ_i. Specifically, the minimum at $\eta = 0$ represents the complete shutdown of the catching up process because of blocking inefficiencies, and the maximum at $\eta = 1$ represents the Lucas (2009) benchmark. This benchmark is the case of no structural barriers, i.e., the case of full efficiency.

The extended model returns a very successful match of both South Korean and Turkish data. The paper carefully calibrates the structural parameters of the extended model including η using Turkish and South Korean data on real GDP per capita and the share of rural population.[5] Results indicate the following: With respect to initial conditions and values of structural parameters, both economies have advantages and disadvantages. Turkey, for example, has a higher level of exogenous productivity in

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It is worth noting that Landes (1998: 517) cites 'South Korea versus Turkey' as an example of how culture makes a difference in comparative economic development.

[4] The idea of catching up in the sense of poorer economies growing faster to catch up with richer ones dates back to Veblen's (1915) descriptions of technological diffusion and to Gerschenkron's (1962) historical analysis based on the 19th century European experience. Nelson and Phelps (1966) provide an early mathematical formalization of the idea where productivity growth in a follower economy is explained by its distance to frontier and its absorptive capacity. See Baumol (1986) for an empirical analysis. See Benhabib and Spiegel (2005) for a review of catching up models.

[5] This calibration strategy resembles the Simulated Method of Moments as it uses scaled and squared deviations of time paths of the target variables.

the farm sector, but South Korea enjoys a larger level of spillover elasticity. The most significant contrast, however, is the huge difference in the efficiency parameter η. While South Korean economy operates with an efficiency level very close to its upper bound of unity, Turkey is located at the other end of the efficiency spectrum with efficiency less than 0.01. Counterfactual experiments confirm the dominant role of this efficiency parameter against initial conditions and other structural parameters.

The paper also analyzes a version of the extended model where efficiency in technology adoption is an increasing function of average human capital of the labor force as formulated by Nelson and Phelps (1966) and others. Using human capital measurements from Feenstra et al. (2015), the analysis recalibrates all structural parameters of the model where efficiency has now a time-variant component changing with human capital. The results indicate that, even though the inclusion of human capital leads to a sizable reduction in the South Korean-to-Turkish efficiency difference, a large difference in efficiency in technology adoption remains as a country fixed effect determined by cultural and institutional factors.

This paper is most directly related with three important papers investigating the sources of relative underperformance of Turkey in the second half of the 20th century through models building upon microeconomic foundations.[6] Adamopoulos and Akyol (2009) construct a two-sector model with distortionary taxes and home production and find that Turkey's underperformance relative to the United States and Southern Europe after 1960s can be attributed to high tax rates discouraging market hours and to low productivity growth rates. Çiçek and Elgin (2011), presenting an analysis for the 1968–2004 period, emphasize the dominant role of total factor productivity (TFP) as a driver of economic growth and the relevance of capital adjustment costs and time-variant distortionary taxes for the evolution of the real economy. İmrohoroğlu et al. (2014) conclude that, in comparison to countries with similar macroeconomic policies, lower TFP growth rates in both agricultural and non-agricultural sectors play a role in the relative underperformance of the Turkish economy from 1968 to 2005. The main contribution of this paper to this literature is the identification of mechanisms explaining the endogenous co-evolution of sectoral productivity levels. Thus, it simply complements these papers by making productivity growth endogenous within a dual economy catching up model.

Three other papers that develop, calibrate, and simulate endogenous technology models for the Turkish economy are also related. Yeldan (2012) constructs a small open economy model with human capital and R & D and calibrates the model parameters for an analysis of alternative research policy mixes. The main conclusion is that human capital promoting programs in the short- to medium-run should be complemented with R & D promoting ones in the medium- to long-run. Attar (2013) studies the semi-reduced form of a second-generation Schumpeterian model with product and process innovations for an analysis of fertility changes. His results indicate that TFP growth will have an increasingly dominant role in the near future to sustain economic growth in Turkey but technological progress in the absence of path-changing reforms is not fast enough to alleviate the adverse effects of population aging. Yılmaz and Saracoglu (2016) extend a first-generation Schumpeterian model with a catching up process to analyze how Turkey could avoid being trapped in a state of stagnation. Their results show that Turkish economy should increase the quality and the quantity of schooling and the share of capital goods in imports to boost its absorptive and innovative capabilities.

The outline of the paper is as follows: The next section studies the simple model, first introducing theory and then presenting the simulation results. The section following that extends the model with efficiency parameter η, calibrates the structural parameters separately for Turkey and South Korea,

[6] Several studies published in 2000s and 2010s use growth-accounting exercises, decomposition methodologies, and econometric estimations to decipher the sources of economic growth and relative stagnation in Turkey. These include Saygılı et al. (2005), Altuğ and Filiztekin (2006), Altuğ et al. (2008), Saygılı and Cihan (2008), Ismihan and Metin-Ozcan (2009), Atiyas and Bakis (2014), Üngör and Kalafatcılar (2014), and Üngör (2014). While results obtained in this literature are diverse due to differing data sources and methods, two of the emerging messages are less controversial: First, both physical capital accumulation and total factor productivity (TFP) growth are important in explaining economic growth in per capita terms. Second, the role of TFP growth is increasingly more important in the post-1980 period.

and presents counterfactual experiments building upon this extended model. Another section introduces human capital as a determinant of efficiency, recalibrates the model parameters, and implements some counterfactual analyses. A discussion section collects the main messages originating from the analyses and provides a discussion on whether institutional differences between South Korea and Turkey can account for large, time-invariant differences in efficiency levels from a statist perspective. A brief, closing section presents some final remarks.

The Simple Dual Economy

Theory

This subsection introduces the dual economy model constructed by Lucas (2009). The only difference with the original paper is that the model time in the present paper is discrete. There is a traditional farm sector where land is an essential input. There also exists a modern city sector catching up with the world technology frontier. Both sectors, for simplicity, produce exactly the same commodity, e.g., "GDP," and both are occupied by perfectly competitive firms. The demographic structure does not complicate the analysis since the model operates with *per worker* variables.

Let $t \in \{0,1,\dots\}$ denote the model time. The key control-like variable of this model, denoted by $x_t \in [0,1]$, is the share of population (and labor force) employed in the farm sector. The key endogenous state variable, on the other hand, is the level of labor productivity in the city sector, denoted by $h_t \in (0,+\infty)$. For a pair (x_t, h_t), the levels of production per worker in the city and the farm sectors respectively satisfy

$$y_{ct} = h_t(1 - x_t) \tag{1}$$

and

$$y_{ft} = A h_t^{\xi} x_t^{\alpha} \tag{2}$$

where $A \in (0,+\infty)$ is a fixed parameter that positively affects labor productivity in the farm sector. The latter also increases as a result of productivity growth in the city sector given the spillover parameter $\xi \in (0,1)$. That the labor elasticity α in the farm sector is between $(0,1)$ implies the dependence on the land input. For simplicity, land per worker is fixed and incorporated in A.

Under the assumption that the labor is free to move across sectors, the equilibrium allocation of labor across sectors is simply the one that solves the problem of

$$\max_{x_t} \left[h_t(1 - x_t) + A h_t^{\xi} x_t^{\alpha} \right]. \tag{3}$$

The unique (interior) solution given h_t satisfies

$$x_t = x(h_t) \stackrel{\text{def}}{=} \left(\frac{\alpha A}{h_t^{1-\xi}} \right)^{\frac{1}{1-\alpha}}, \tag{4}$$

and real GDP per capita, denoted by y_t, clearly satisfies

$$y_t = y(h_t) \stackrel{\text{def}}{=} y_{ct} + y_{ft} = h_t[1 - x(h_t)] + A h_t^{\xi} [x(h_t)]^{\alpha}. \tag{5}$$

What governs the process of economic development in this static resource allocation framework is simply the growth of h_t. Provided that h_t keeps growing for large t, an increasing fraction of labor would be employed in the city sector. The farm sector then disappears asymptotically, i.e.,

$$h_t \to +\infty \Rightarrow x(h_t) \to 0. \tag{6}$$

The labor productivity h_t in the city sector grows because the firms in this sector catch up with foreign firms operating with the frontier technology. $H_t \in (0,+\infty)$ denotes the level of labor productivity corresponding to the world technology frontier. The $\{H_t\}_t$ sequence is exogenous to the dual economy model, and H_t exhibits perpetual growth at the fixed (percentage) rate μ, i.e.,

$$\frac{H_{t+1}}{H_t} = 1 + \mu. \tag{7}$$

Given H_t and $x(h_t)$ at the end of period t, h_{t+1} satisfies a law of motion postulated as

$$\frac{h_{t+1}}{h_t} = 1 + \mu[1 - x(h_t)]^{\zeta} \left(\frac{H_t}{h_t}\right)^{\theta} \tag{8}$$

where $\zeta \in (0, +\infty)$ and $\theta \in (0,1)$ are fixed parameters.

This catching up technology works as follows: First, being a laggard country in technology is an opportunity in technology adoption; the relative backwardness term $(H_t/h_t)^{\theta}$ positively affects the growth of h_t where θ indicates the strength of frontier technology spillovers. As usually taken for granted in the literature of catching up models, a larger potential for technology adoption implies, ceteris paribus, a larger level of actual "exploitation" of this potential.

The second notion here is that, in "exploiting" the given potential of technology adoption, the dual economy enjoys an agglomeration effect in cities. When a larger fraction $1 - x(h_t)$ of population is in the city sector depending on (α, A, h_t), the growth rate of h_t is larger. This, as Lucas (2009: 15) emphasizes, is due to "*the role of cities as centers of intellectual interchange and as the recipients of technological inflows*." Put differently, the dual economy faces a drag imposed by the gradual decline of the farm sector; technically, we have $[1 - x(h_t)]^{\zeta} < 1$ for any h_t.

Notice that, for any given pair (h_0, H_0) of initial values of the state variables naturally satisfying $h_0 < H_0$, we can easily solve for the unique dynamic equilibrium of the model. The end result is that the growth rate of h_t in the dual economy converges to the same perpetual (percentage) rate μ of the world technology frontier as t diverges to $+\infty$. Asymptotically, this transition also witnesses the convergence of $x(h_t)$ to 0 and of h_t to H_t. In other words, the follower country catches up in the long run.

Data and Simulations

This subsection evaluates the empirical performance of the simple dual economy model for South Korea and Turkey. As in Lucas (2009), the country representing the world technology frontier is the United States, with H_t simply denoting real GDP per capita in this country. South Korea and Turkey, on the other hand, are two follower countries, with initial levels of h_t satisfying $h_0^{\text{TUR}} < H_0$ and $h_0^{\text{KOR}} < H_0$.

The task of this section is to see how closely the simulated sequences for the observed variables keep track of their empirical counterparts at the benchmark parameter values Lucas (2009) uses. For a meaningful match, one needs to correctly initialize South Korean and Turkish economies using the model equations and the relevant data points.

< Insert Table 1 about here >

The quantitative analysis of the model uses observed values of x_t and y_t at annual frequency for the period of 1960–2014 from the World Development Indicators (World Bank, 2016).[7] Thus, it is natural to match $t = 0$ with the year 1960 in the sample. Then, given the benchmark parameter values collected in Table 1, two model equations defining x_t and y_t as functions of h_t simultaneously identify the pair $(A^{\text{i}}, h_0^{\text{i}})$ for all i $\in$ {TUR, KOR}. Specifically, for all i $\in$ {TUR, KOR}, we have

[7] For both countries, y_t is simply GDP per capita in constant 2005 U.S. dollars, and x_t is derived by taking $1 - x_t$ as the share of urban population from the original data source.

$$A^{\mathrm{i}} = \left\{ \frac{y_0^{\mathrm{i}}}{\left[\alpha\left(x_0^{\mathrm{i}}\right)^{-(1-\alpha)}\right]^{\frac{1}{1-\xi}}\left(1-x_0^{\mathrm{i}}\right)+\left[\alpha\left(x_0^{\mathrm{i}}\right)^{-(1-\alpha)}\right]^{\frac{\xi}{1-\xi}}\left(x_0^{\mathrm{i}}\right)^{\alpha}} \right\}^{1-\xi} \tag{9}$$

and

$$h_0^{\mathrm{i}} = \left(\frac{\alpha A^{\mathrm{i}}}{\left(x_0^{\mathrm{i}}\right)^{1-\alpha}}\right)^{\frac{1}{1-\xi}} \tag{10}$$

< Insert Table 2 about here >

Table 2 shows the resulting values for h_0^{i} and A^{i} as well as the input values of x_0^{i} and y_0^{i}. These indicate that, if South Korea and Turkey did have the same microeconomic structure characterized by the parameter values reported in Table 1, Turkey in 1960 must have had a larger city sector productivity and a larger exogenous productivity in the farm sector. The reversal story of South Korea and Turkey is indeed an interesting case of comparative economic development.

Figures 2 and 3 picture the main results of this section. Figure 2's bottom panel shows that the Lucas (2009) benchmark initialized for South Korea exhibits a poorer economic growth performance than actual South Korea. The mismatch is increasingly more pronounced after 1970s, and the share of rural population is not very successfully matched for the entire sample except 1990s.

< Insert Figure 2 about here >

< Insert Figure 3 about here >

Figure 3 shows the analogous images for Turkey. The Lucas (2009) benchmark is not very successful in explaining the pace of economic growth and urbanization in Turkey, with discrepancies becoming more visible after 1980s. The actual Turkey grows consistently slower than the benchmark economy, and the level difference keeps increasing to the present day.

Inefficiency in Technology Adoption

An Extension

The simple dual economy model studied above teaches us a lot about technology adoption and catching up. A relatively backward economy has a potential advantage in quickly diminishing its distance to frontier $H_t - h_t$. The existence of a dual economy within such a framework plays a central role for the model economy to match the data satisfactorily well: The knowledge spillovers from the city to the farm sector slow down the rural-urban migration, and this drag on technology adoption implies more realistic initial growth rates for the follower countries; see Lucas (2009).

But the simple model's prediction that there are underperformers such as Turkey relative to the Lucas (2009) benchmark suggests another plausible drag. What if a follower economy does face deep, structural barriers to technology adoption as emphasized by Parente and Prescott (1994)? What if cultural and institutional features of a society do affect the level of efficiency at which its economy is catching up with the leader? What if inefficiency in technology adoption, due to structural features not quite easily change in time, act as a blocking barrier on the process of catching up?

This section of the paper shows that a significant contrast between South Korea and Turkey may indeed be the difference in the associated efficiency levels. This result follows from a secondary evaluation of the dual economy model extended in a straightforward way.

First, a time-invariant parameter $\eta \in [0,1]$, representing the level of efficiency in technology adoption, extends the technology of catching up as in

$$\frac{h_{t+1}}{h_t} = 1 + \eta\mu[1 - x(h_t)]^{\zeta} \left(\frac{H_t}{h_t}\right)^{\theta}. \tag{11}$$

Here, then, $\eta = 0$ represents the complete shutdown of technology adoption, and $\eta = 1$ represents full efficiency. The interior values with an increasing level of η simply indicate increasing levels of efficiency.

The second task achieved in this section is to recalibrate all the parameters of the model including η, for both South Korea and Turkey, to find the best possible match between the extended model and the corresponding data on observed variables. It is this calibration exercise that allows us to infer the microeconomic structures of Turkey and South Korea in a simple but rigorous way; the exercise returns country-dependent values not only for A and h_0 but also for ξ, ζ, θ, and η.

The quantitative algorithm works as follows: Let $\boldsymbol{\phi}^{\mathbf{i}} \stackrel{\text{def}}{=} \left(\xi^{\mathrm{i}}, \zeta^{\mathrm{i}}, \theta^{\mathrm{i}}, \eta^{\mathrm{i}}\right)$ denote the vector of structural parameters for each of the follower countries where $\mathrm{i} \in \{\mathrm{TUR}, \mathrm{KOR}\}$. Set $\alpha^{\mathrm{TUR}} = \alpha^{\mathrm{KOR}} = \alpha = 0.6$ as in Lucas (2009) since the observed variables turn out to be not informative for this technology parameter. Also, set $\mu = 0.0207$ as before since extending the simple model does not affect how the world technology frontier evolves in time. Then, for any given pair $(\alpha, \boldsymbol{\phi}^{\mathbf{i}})$ of structural parameters, $\left(A^{\mathrm{i}}, h_0^{\mathrm{i}}\right)$ pair for country $\mathrm{i} \in \{\mathrm{TUR}, \mathrm{KOR}\}$ follows from the data points x_0^{i} and y_0^{i} exactly as in the previous section. Moreover, the simulations of the observed variables can simply be calculated using the forward recursion of the model economy. Let these sequences be conveniently denoted by

$$\left\{y_t^{\mathrm{i}}(\boldsymbol{\phi}^{\mathbf{i}}), x_t^{\mathrm{i}}(\boldsymbol{\phi}^{\mathbf{i}})\right\}_t,$$

and notice that the algorithm returns a unique collection of these sequences for any given $\boldsymbol{\phi}^{\mathbf{i}}$. Thus, a numerical optimization problem in the form of

$$\min_{\boldsymbol{\phi}^{i} \in \boldsymbol{\Phi}} Q^{\mathrm{i}} = Q(\boldsymbol{\phi}^{i}) \stackrel{\text{def}}{=} \sum_{r=1}^{R} \left[\frac{y_r^{\mathrm{i}} - y_r^{\mathrm{i}}(\boldsymbol{\phi}^{\mathrm{i}})}{(0.5)\left(y_r^{\mathrm{i}} + y_r^{\mathrm{i}}(\boldsymbol{\phi}^{\mathrm{i}})\right)}\right]^2 + \sum_{r=1}^{R} \left[\frac{x_r^{\mathrm{i}} - x_r^{\mathrm{i}}(\boldsymbol{\phi}^{\mathrm{i}})}{(0.5)\left(x_r^{\mathrm{i}} + x_r^{\mathrm{i}}(\boldsymbol{\phi}^{\mathrm{i}})\right)}\right]^2 \tag{12}$$

would return an optimal point $\boldsymbol{\phi}^{\mathbf{i}}$ if it exists and is numerically identified.

< Insert Table 3 about here >

Here, $\left\{y_r^{\mathrm{i}}, x_r^{\mathrm{i}}\right\}_r$ is the collection of observed data sequences where $r = 1$ corresponds to $t = 1961$ and $r = R$ to $t = 2014$ in the sample. $\boldsymbol{\Phi}$, a subset of $\mathbb{R}^4$, is a compact set enlarged after a couple of evaluations of the algorithm in order to ensure convergence to an interior point; this choice set must ideally be large enough to avoid the convergence to boundary points that are usually implausible from an economic point of view. The initial point $\boldsymbol{\phi}_{(\mathbf{0})}^{\mathbf{i}}$ of the numerical optimization problem sets the values of $\left(\xi^{\mathrm{i}}, \zeta^{\mathrm{i}}, \theta^{\mathrm{i}}\right)$ to the values of the Lucas (2009) benchmark and of η^{i} to simply 0.5.[8]

[8] Ensuring that the global minimum of $Q(\cdot)$ exists and is unique is in general not a very straightforward task for such algorithms. However, mainly because control-like variables are not piecewise functions of the endogenous state variable h_t, the algorithm converges quickly in all of the runs with successful matches in both Turkish and South Korean cases.

Figures 4 and 5 and Table 3 summarize the main results of this section. Starting from the first row of Table 3, South Korea seems to have been enjoying a slightly larger productivity spillover parameter ξ in the farm sector. Also slightly larger in South Korea is the drag parameter ζ but this implies a city sector productivity growth advantage on the side of Turkey since $[1 - x(h_t)]^{\zeta} < 1$ for any h_t.

< Insert Figure 4 about here >

< Insert Figure 5 about here >

While the calibrated values of these two parameters seem to be close to each other in South Korea and Turkey, the next two parameters exhibit large differences. The catching up parameter θ governing the effect of the distance to frontier term is considerably larger for Turkey. This indicates an advantage for Turkey since the distance to frontier term satisfies $H_t/h_t > 1$. That Turkey has a larger productivity growth elasticity with respect to H_t/h_t is perhaps surprising at first glance but such a finding actually demonstrates why our inferences should follow from rigorous calibrations of models with microeconomic foundations.

Most importantly, the largest difference in favor of South Korea is obtained for the efficiency parameter η whose higher values directly imply higher growth rates of the city sector productivity. In fact, results indicate that South Korea attains a level of efficiency in technology adoption which is extremely close to its upper bound of unity. In stark contrast, the level of efficiency for Turkey is around 0.12%. This roughly means that, while South Korea adopts almost all of its technological opportunity at any given year, Turkey performs very poorly and is located at the other extreme of the efficiency spectrum closing a miniscule fraction of its distance to frontier.

Finally, the table also reports the resulting recalibrated values of A that respond to the values of other parameters. Turkey here is the advantageous country as it is simply reflected in its initially superior position in terms of lower rural population share and higher real GDP per capita level.

< Insert Figure 6 about here >

Whether the extended model is a good enough representation of reality, at least whether it is better than the Lucas (2009) benchmark, is visible from Figures 4 and 5. Careful examinations of these figures and comparisons with the corresponding figures of the simple model reveal that extending the model with η and formally calibrating the structural parameters in a country-wise manner allow the theory to get the *shape* of transitions remarkably well. For both countries, the calibrated trajectories of real GDP per capita are quite close to their data counterparts especially after 1980s. This also reflects the extended model's success in correctly identifying the growth slowdowns for both countries even though the slowdown is much more pronounced in South Korea and for the period after 1990.

Figure 6, the last piece of this section, pictures the implied city productivity levels for both countries and the United States in logarithmic terms. Here, the logic of the growth slowdowns becomes fully transparent as it is simply implied by the logic of the catching up process: South Korean growth slowdown is more pronounced simply because South Korean miracle after 1960s quickly diminishes the productivity gap between the United States and South Korea, and the percentage growth rate of city sector productivity starts converging to its minimum of $\eta^{\mathrm{KOR}}\mu$.

Besides, calibration targets are informative for the parameters since the optimal point is coordinate-wise different than the initial point $\boldsymbol{\phi}^{\mathbf{i}}_{(\mathbf{0})}$.

Counterfactual Experiments: The Extended Model

We have now an understanding of the most crucial difference between Turkey and South Korea if the extended dual economy catching up model is a sufficiently good approximation of reality: The main problem Turkey has faced appears to be the very low level of efficiency in technology adoption. But can we learn more about the mechanisms in play? Specifically, can we isolate the role of inefficiency from other aspects of the microeconomic structure and the effect of initial conditions?

To provide some answers, this section reports the results of three counterfactual experiments obtained through the simulations of the extended model. A brief description of these experiments is now in order.

The first experiment supposes that structural parameters ξ, ζ, θ, and η in South Korea are exactly equal to those of Turkey, i.e., $\boldsymbol{\phi}^{\text{KOR}} = \boldsymbol{\phi}^{\text{TUR}}$, but it allows for the initial conditions to differ. Therefore, this experiment distinguishes the role of structural parameters affecting the shape and pace of transition from the role of historical starting points.

The second experiment changes only the value of the efficiency parameter η by imposing $\eta^{\text{KOR}} = \eta^{\text{TUR}}$. Hence this experiment isolates the sole effect of the inefficiencies in technology adoption.

Finally, the third experiment imagines a South Korean economy where η^{KOR} is equal to some cutoff value such that the two economies attain exactly the same level of real GDP per capita in 2014. It turns out that, this cutoff value is approximately equal to 33% of South Korea's benchmark efficiency. Since the latter is very close to unity, the experimented value of η^{KOR} is about 1/3.

< Insert Figure 7 about here >

Figure 7 summarizes the main results of the counterfactual analysis; it pictures Turkey's benchmark along with three counterfactual results for South Korea. First notice that structural parameters dominate initial values in determining the long-run evolution of real GDP per capita as South Korea in the first experiment quickly forges ahead of Turkey and converges to the same growth path. Here, initial values explain why South Korea transits at a very fast pace as it is usual in such catching up models. The second experiment isolating the role of inefficiency clearly indicates that inefficiency is perhaps all that matters for the divergence of South Korea and Turkey within the limitations of the present framework. Put differently, the South Korean economy would not possibly take off if its technology adoption practices are limited at a very low level of efficiency as in Turkey. Finally, we also learn that a counterfactual efficiency level of 1/3 for an economy such as South Korea significantly alters the miraculous growth and urbanization performance. South Korea in this third experiment does not forge ahead of Turkey before 2014.

Inefficiency in Technology Adoption and Human Capital

The analysis above builds upon a framework where inefficiency in technology adoption, while allowed to vary from one country to another, is fixed for any country in time. This section investigates whether the poorer catching up performance of Turkey relative to South Korea can partially be attributed to human capital differences.

The Human Capital Model

Efficiency in technology adoption is assumed here to be an increasing function of human capital per worker. An extensive theoretical and empirical literature after Nelson and Phelps (1966) suggests that efficiency in technology adoption (or the absorptive capacity) is positively associated, among other things, with average human capital of the labor force.[9]

Imagine, then, an extended framework where the efficiency parameter η is no longer exogenous and constant but instead an increasing function of human capital per worker, e.g., $\eta_t \equiv \eta \times f(\text{Human Capital}_t)$ with $\eta, f' > 0$. More specifically, let $q_t^i > 0$ denote the average quality (or human capital) of the labor force in country i $\in \{\text{TUR}, \text{KOR}\}$ at time t, and suppose that we have

$$\eta_t^i = \eta^i \left(q_t^i\right)^{\omega^i} \tag{13}$$

where the time-variant efficiency term η_t^i of country i $\in \{\text{TUR}, \text{KOR}\}$ has both a fixed, country-dependent component $\eta^i > 0$ that reflects the role of broadly-defined institutional factors and a time-variant component that increases with q_t^i endogenously. In this specification, it is assumed that $\omega^i > 0$ that partially determines the effect of q_t^i on η_t^i is also country-dependent.[10]

< Insert Figure 8 about here >

Estimates of average human capital per worker for both South Korea and Turkey are readily available from the Penn World Table data of Feenstra et al. (2015). These rigorous estimates build upon various sources on average years of schooling and returns to education. Figure 8 pictures the evolution of average human capital per worker constructions for Turkey and South Korea. Clearly, South Korean average is about two times larger than that of Turkey in 1960s, and the difference slightly grows in time. There thus exists a persistent level difference as well as an increasingly more discernible difference in growth rates of average human capital levels.

The task now is to implement the calibration exercise for each country while the model is fed directly with q_t^i data of country i $\in \{\text{TUR}, \text{KOR}\}$. Note that $\boldsymbol{\phi}^{\mathbf{i}}$ is now being extended to include ω^i. The initial value for this parameter is set to unity, and the support is capaciously bounded between 0 and 2.

< Insert Figure 9 about here >

< Insert Table 4 about here >

< Insert Figure 10 about here >

The main results for the human capital model are summarized in Table 4 and Figures 9 and 10.[11] The table collects the newly calibrated parameter values for both South Korea and Turkey. The results are mostly in line with those originating from the extended model without human capital differences. For instance, the spillover parameter ξ is still larger for South Korea, and the elasticity of the distance to frontier term (H/h) is still higher for Turkey. However, nontrivial differences across countries exist

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[9] Benhabib and Spiegel's (2005) *Handbook of Economic Growth* chapter is the classic reference for the literature on human capital and technology adoption. The authors cite several empirical papers supporting the Nelson-Phelps view, and they also analyze the theoretical properties of different technology adoption models. See Stokey (2015) for an illuminating theoretical analysis.

[10] Also note the following: First, the curvature parameter ω^i is not restricted to be smaller than unity. Thus, in principle, any type of "efficiency" returns from human capital is allowed. Second, the specification in (13) implies that a country is not fully inefficient in technology adoption (i.e., $\eta_t^i \neq 0$) if q_t^i, however small, is positive; q_t^i should not be equal to zero due to innate abilities and/or raw skills in theory and is not equal to zero in the Penn World Table data of Feenstra et al. (2015).

[11] The calibration algorithm performs well for both countries as in the previous section. Omitted figures that compare and contrast model versus data counterparts of real GDP per capita and the share of rural population are quite similar to the ones pictured in Figures 4 and 5.

regarding the parameter pair (η, ω) that determines efficiency in technology adoption. First, while a remarkably large difference between South Korea and Turkey in terms of fixed component of efficiency that is represented by η is still present, this difference is being reduced from about 833-fold to about 80-fold in the human capital model. Put differently, the model ignoring human capital differences between South Korea and Turkey vastly overpredicts the time-invariant differences in efficiency levels. Second, the elasticity of efficiency with respect to human capital that is represented by ω is about 6 times higher in Turkey. This results in a much flatter efficiency as a function of human capital in Turkey as pictured in Figure 9 with the South Korean function being much more curved.

Note that the efficiency term η_t^{TUR} for Turkey remains remarkably lower than the corresponding term for South Korea at all years even though extending the model with human capital considerably decreases the ratio $\eta^{\mathrm{KOR}}/\eta^{\mathrm{TUR}}$ of exogenous efficiency components. In 1960, the efficiency term in South Korea is about 75 times larger while this number decreases only to 55.8 in 2014. Figure 10 pictures the evolution of relative efficiency for Turkey, i.e., $\eta_t^{\mathrm{TUR}}/\eta_t^{\mathrm{KOR}}$. In time, Turkey keeps decreasing its efficiency gap with South Korea, but the pace of this convergence is visibly lower for 1960–1975 and 1985–1995 episodes.

Counterfactual Experiments: The Human Capital Model

To get a better understanding of the effects of human capital, this subsection reports the results of two counterfactual experiments. The design of these experiments, i.e., Experiments 4 and 5, are similar in spirit to those implemented in the previous section.

Here, in Experiment 4, we simulate the human capital model for Turkey where counterfactual Turkey has a (micro)economic structure characterized by Turkey's parameter values but is endowed with South Korean human capital at all years. Then, in Experiment 5, the reversed case is simulated where counterfactual Turkey is endowed with her own human capital but characterized with South Korean structural parameters.

Figure 11 shows the simulated sequences of real GDP per capita and the share of rural population for Experiments 4 and 5 and for the benchmark of Turkey. Comparing counterfactual Turkey cases of Experiment 4 and 5 (circles and triangles respectively) with the benchmark of Turkey (solid line) allows us to see the isolated effects of human capital and of structural parameters for technology adoption. Notice that, since human capital q_t enters the model by partially determining the efficiency of technology adoption only, observed effects are of second-order nature; counterfactually higher values of human capital do not have direct output effects. Considering large human capital differences between South Korea and Turkey, we can conclude that efficiency gains for Turkey due to higher levels of human capital are minor. The counterfactual Turkey of Experiment 5, having her own human capital endowment but otherwise being identical to South Korea, is slightly poorer until mid-1990s but grows significantly faster in the long run.

< Insert Figure 11 about here >

The overall conclusion here is that, while making the efficiency in technology adoption endogenous via human capital affects the predicted levels of $\eta^i > 0$, the level of human capital *per se* does not significantly alter the growth path of the economy in the long run. What matters most for the growth path is still the fixed, country-dependent component $\eta^i > 0$.

Discussion

The analysis presented above returns a few messages about economic development experiences of South Korea and Turkey. First, the dual economy catching up model of Lucas (2009) is not extremely successful in explaining South Korean and Turkish paths at the common benchmark values. Second, when this simple model is parsimoniously extended with a country-dependent efficiency term, the extended model performs remarkably well for both countries. Crucially, this extended model shows that the two countries differ most significantly with respect to the level of efficiency in technology adoption. The South Korean efficiency is 833 times higher than Turkey's, with country-dependent "fixed effects" being decisive. Third, one further extension making efficiency a function of human capital shows that the fixed component of efficiency, albeit modified considerably, is about 80 times higher in South Korea. Finally, counterfactual experiments in the human capital model show that it is this fixed, country-dependent component of efficiency, not the human capital level, that significantly alters the long-run growth rate of the economy. The key task is thus to understand which particular deep causes are at the root of such efficiency differences.

Particular mechanisms by which South Korea rises as a miracle may illuminate us in understanding why Turkey has a remarkably low level of efficiency in technology adoption. In one of the most comprehensive accounts of technological capability building in South Korea, Kim (1993) includes (i) strategic import substitution and export promotion policies and (ii) the government's involvement in the establishment of big companies among the main areas at which South Korea differed mostly from other newly industrialized countries. From the statist perspective, the Korean state played the enabling role in these two areas as a developmental state that coordinates and regulates economic activity (Amsden, 1989, 2001; Wade, 1990; Rodrik, 1994, 1995; Evans, 1995; Kang, 2002; Chang, 2007). Following is a brief, comparative account of how the Korean state successfully directed a strong technological capability building after 1960s but the Turkish state failed to do so.[12]

The Korean state's success in strategic import substitution and export promotion policies is one of the foremost defining characteristics of the country's economic miracle. In Amsden's (1989: v) words, state interventions deliberately got the relative prices "wrong" as these prices, determined through subsidies and protection decisions, basically governed what, when, and how much to produce (Amsden, 1989: 144). Rodrik (1995) thus describes how South Korea and Taiwan grew rich via the phrase "getting interventions *right*." In South Korea, different industries were under protection and promotion schemes in different times; Kim (1993: 362) underlines that, in 1960s, the strategy was to protect and promote plywood, textiles, consumer electronics, and automobile industries, but the strategic sectors were steel, shipbuilding, construction, and machinery in 1970s. Interestingly, some sectors were selected for import substitution even after the Korean development strategy was transitioned to export orientation (Şenses, 1996: 103). Perhaps most importantly, governments in South Korea were successful in sustaining exporting as a performance standard and in implementing tax penalties on businesses when export targets were not met (Rodrik, 1994: 41). The Turkish path differs from the Korean in a number of ways. First, strategic trade policy in Turkey transitioned from import substitution to export orientation in 1980. This is about a decade later than the time South Korea initiated strategic export promotions, and being late may have adversely affected technological capability building in Turkey relative to South Korea (Öniş and Şenses, 2007). Second, the expansion of export volume in Turkey in 1980s was largely due to increased capacity utilization and the Iran-Iraq war (Celasun and Rodrik, 1989), and production and investment flows in manufacturing remained below the expansion in the volume of exports (Kepenek and Yentürk, 2008). While structural transformation and investment increase were key aspects of South Korean development as discussed by Rodrik (1995), Turkey's development witnessed a slower pace of industrialization since

[12] Two other areas of relevance, according to Kim (1993), are education and foreign technology imports. In education, the most important qualitative difference between South Korea and Turkey seems to be that a high fraction of business and government personnel in South Korea had access to overseas training since as early as 1950s (Kim, 1993). In Turkey, this was limited mostly with the mobility of academic personnel. Regarding foreign technology imports, flows of foreign direct investment and foreign licensing were limited in both countries during 1960s and 1970s. The Turkish disadvantage stems mainly from the fact that the share of capital goods imports in total declined from over 40% levels to the levels slightly higher than 20% in Turkey after 1980s (Conway, 1987). As noted in the Introduction, Yılmaz and Saracoğlu's (2016) analysis for Turkey indicates that there exist large absorptive capacity gains from increasing educational quality and increasing capital goods imports.

then. A third, noteworthy difference between South Korean and Turkish trade policy experiences is the degree of effectiveness in implementing strategic export promotion. Rodrik (1994: 41) explains the Turkish disadvantage in this respect by citing Krueger and Aktan (1992) on how exporting firms in Turkey faced no tax or exclusion penalties when they failed to meet the export targets in a given year.

The establishment of big companies called chaebols in South Korea was a key complement of strategic trade policy. Similar to the Japanese Zaibatsu, chaebols owned by elite Korean families became defining actors of South Korean development after 1960s. Receiving generous financial support from commercial banks nationalized after 1961 and benefiting from strategic trade policy actions, chaebols exhibited fast growth with respect to the volume of exports. In 1982, the total export share of the 10 biggest chaebols was around 58% (Koo, 1984). Accompanying this growth was a high degree of capital concentration, and the market structures were far from being competitive. This corporatist stance contaminated with corrupt practices contradicted with the Korean tradition of an egalitarian society, but the state-business relationships reduced transaction costs considerably (Kang, 2002). The crucial thing here is that these big chaebols increased their technological learning and absorptive capacities in time as they were operating in foreign markets since as early as 1970s. Exactly as in the imitation-to-innovation strategy of Acemoglu et al. (2006), big chaebols such as Samsung and Hyundai eventually became world leaders in technology. In Turkey, holding companies owned by elite families were the closest things to Korean chaebols. According to Buğra (1994: 222), the major difference lies in the fact that South Korean state was a mechanism of stability but, in contrast, the Turkish state was a major risk factor in business life. One reason of weaker state autonomy in Turkey is the Turkish state's much more limited control over the financial system and, hence, over the holding companies, and Buğra (1994: 223) underlines the Turkish state's failure in implementing necessary policy mixes in a timely manner. Oh and Varcin (2002) characterize both South Korea and Turkey as similar top-down mafioso states and argue that Korean chaebols and Turkish holding companies were organizational forms of private business corporations created under similar mafioso states. An important difference in big business performance, however, exists mainly because military coups were much more frequent and militarist regimes had much shorter durations in Turkey after 1960s. The last but not the least, Öniş and Şenses (2007) describe the Turkish developmental state as a fragmented one as it did not possess a strong autonomy as in East Asia; eventually the Turkish state was not able to coordinate the actions of holding companies.

Concluding Remarks

This paper studies a challenging problem of comparative development. This is the problem of finding the causes of divergent development experiences of Turkey and South Korea in the second half of the 20th century. Even though Turkey has had clear advantages and a more promising development prospect at the beginning of 1960s, world economic history has recorded a growth miracle for South Korea and missed opportunities for Turkey. South Korea has transformed itself into an innovating economy converging to the world technology frontier only in a couple of decades. Turkey, however, has attained a limited success and lagged behind the growth miracles and some other emerging market economies that have achieved high growth rates.

Identifying the proximate causes of this reversal story is very straightforward: R & D inputs and outputs, the volume and share of high technology exports, the estimated levels of human capital, and productivity statistics clearly indicate the South Korean success and the Turkish failure. But these are the so-called proximate causes of economic growth; what we really need to do is to take steps further and identify the fundamental causes at work.

The literature that investigates the contrasts between South Korea and Turkey provides us with a truly illuminating narrative of significant differences between the two economies. These differences run all the way from (international) political economy considerations to cultural endowments. This paper fills a gap in this literature by identifying some microeconomic foundations. The analysis constructs a dual economy catching up model and uses the relevant data that is informative for this model's structural parameters. The purpose of all this is to see exactly where South Korea and Turkey may have been and are differing. This is a route that has not been traveled before.

While both economies have advantages and disadvantages, Turkey's relative underperformance against South Korea is primarily associated with Turkey's remarkably low level of efficiency in technology adoption. Importantly, this result is not sensitive to the inclusion of human capital as a determinant of efficiency, and a sizable difference in favor of South Korea remains. A plausible explanation for this remaining difference in efficiency is the differential performances of South Korean and Turkish states in directing late industrialization through strategic industrial and trade policies. The comparative analysis shows that Turkey was unsuccessful in transforming her big businesses into global innovation machines. This is largely consistent with Arpacı's (2011) survey-based finding that the three most significant obstacles to innovation in Turkey are bureaucracy, the authority of approval, and legislation.

The main consequence of low-efficiency in technology adoption is the slow growth of TFP in the city sector, and this in turn explains why the sectoral transformation of the Turkish economy has been very slow and has left a significant portion of the workforce in agriculture. The present analysis thus resolves two of the three puzzles emphasized by Altug et al. (2008) for the Turkish economy.

The models studied in this paper assume away fertility and population growth. This simplification is clearly not trivial, and much insight can be generated with a richer model where fertility is endogenous. This would not merely add some realism to the analysis; the real contribution would be the opportunity of understanding the deep causes of differences in human capital levels and growth rates through the quality-quantity tradeoff in the fashion of, e.g., Becker (1960), Becker and Lewis (1973), Becker et al. (1990), and Galor and Weil (2000). Since fertility and education decisions are taken jointly in such frameworks, the partial roles of preference and technology parameters would be made entirely transparent.[13] A further extension of the model with endogenous fertility dynamics is left for future research.

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[13] Galor et al. (2009) develop a model with endogenous fertility and endogenous human capital accumulation and argue that land ownership inequality has an adverse effect on development as human capital is not complementary with land input and landowners would not benefit from educational reforms. One of the historical cases that provides strong support to this hypothesis is the South Korean development path where the fast expansion in education and the decline of fertility followed the land reforms of 1948–1950.

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Tables

Table 1

Common Values for the Simple Model

	Symbol	Support	Value	Source / Comment / Target
frontier growth rate, $\boldsymbol{H}$	μ	$(0, +\infty)$	0.02	Estimated via OLS
farm technology, $\boldsymbol{x}$	α	$(0,1)$	0.60	Lucas (2009, Sec. IV)
farm technology, $\boldsymbol{h}$	ξ	$(0,1)$	0.75	Lucas (2009, Sec. IV)
catching up, $\boldsymbol{1-x}$	ζ	$(0, +\infty)$	1.00	Lucas (2009, Sec. IV)
catching up, $\boldsymbol{H/h}$	θ	$(0, +\infty)$	0.65	Lucas (2009, Sec. IV)

Notes: This table collects the values Lucas (2009) uses to match both cross-section and time-series data. The value for the frontier growth rate follows from the OLS regression in the form of $\log(H_t) = \log(H_0) + \log(1+\mu) \times t + u_t$ where H_t simply denotes real GDP per capita in the United States at 2005 constant US dollars and u_t is an i.i.d. normal variable with zero mean and constant variance. The estimated value, $\mu = 0.0207$, is only slightly larger than the value of 0.02 used by Lucas (2009).

Table 2

Country-Dependent Values for the Simple Model

	Symbol	South Korea	Turkey	Source / Comment / Target
initial rural population share	x_0	0.72	0.68	Data
initial GDP per capita	y_0	1,106.75	2,345.64	Data
initial productivity, city	h_0	746.83	1,610.39	Initial values (x_0, y_0)
exogenous productivity, farm	A	7.65	9.07	Initial values (x_0, y_0)

Notes: This table collects the initial values (x_0, y_0) and the calibrated values (A, h_0) for each country for the simple model.

Table 3

Country-Dependent Values for the Extended Model

	Symbol	South Korea	Turkey
farm technology, $\boldsymbol{h}$	ξ	0.8281	0.7712
catching up, $\boldsymbol{1-x}$	ζ	4.6168	4.0308
catching up, $\boldsymbol{H/h}$	θ	1.9053	4.5301
efficiency	η	0.9999	0.0012
exogenous productivity, farm	A	4.5651	7.7581

Notes: This table collects the (re)calibrated structural parameters for each country for the extended model.

Table 4

Country-Dependent Values for the Human Capital Model

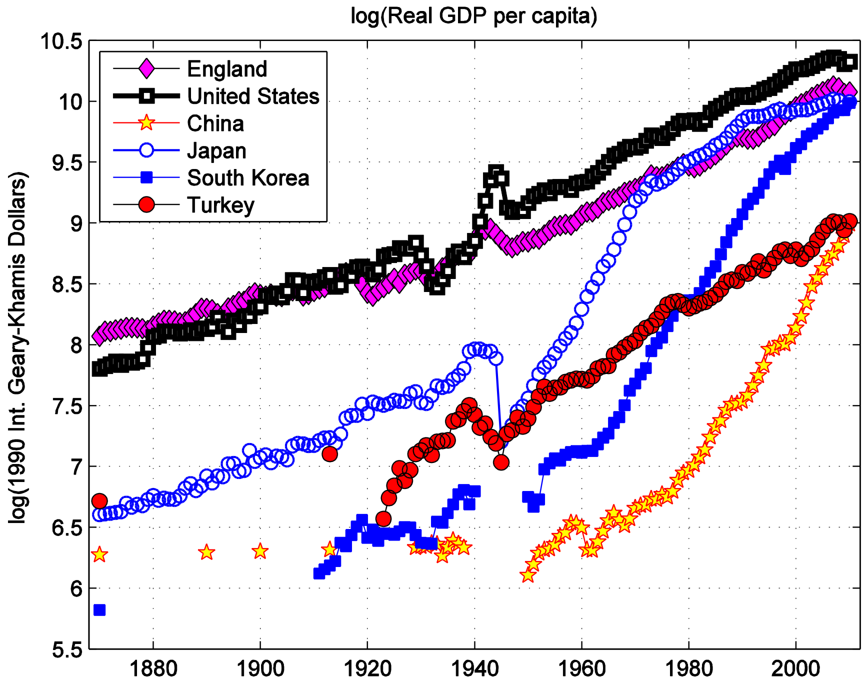
	Symbol	South Korea	Turkey
farm technology, $\boldsymbol{h}$	ξ	0.8301	0.7811
catching up, $\boldsymbol{1-x}$	ζ	4.5329	2.7259
catching up, $\boldsymbol{H/h}$	θ	1.8632	2.9723
efficiency, fixed	η	0.9999	0.0125
efficiency, human capital $(\boldsymbol{q})$	ω	0.0935	0.5571
exogenous productivity, farm	A	4.5038	7.2127

Notes: This table collects the (re)calibrated structural parameters for each country for the human capital model.

Figures

Figure 1

Long-Run Economic Growth in Selected Economies: 1870–2010



Data Source: The Maddison Project (2013)

Figure 2

South Korea and the Lucas (2009) Benchmark

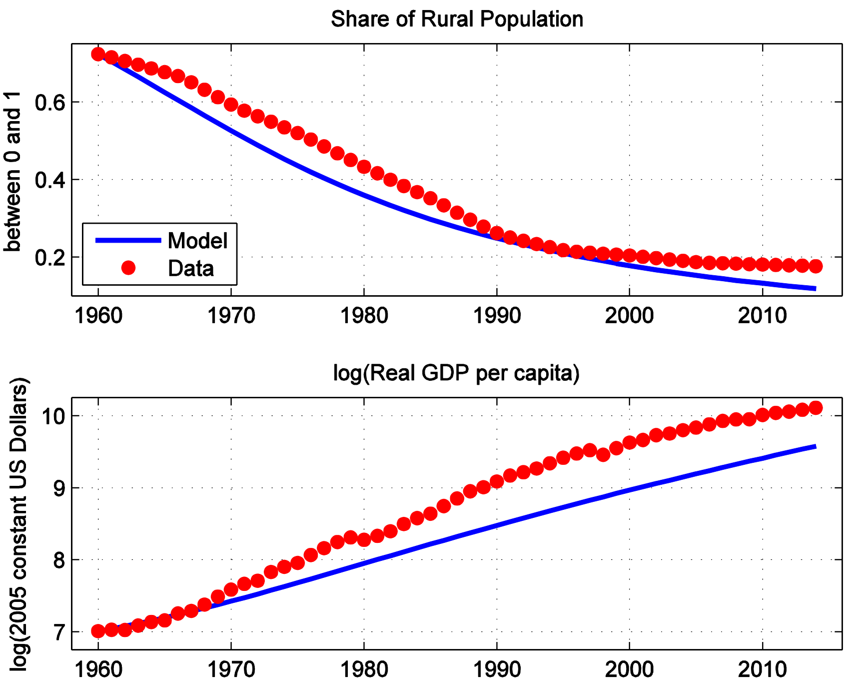


Figure 3

Turkey and the Lucas (2009) Benchmark

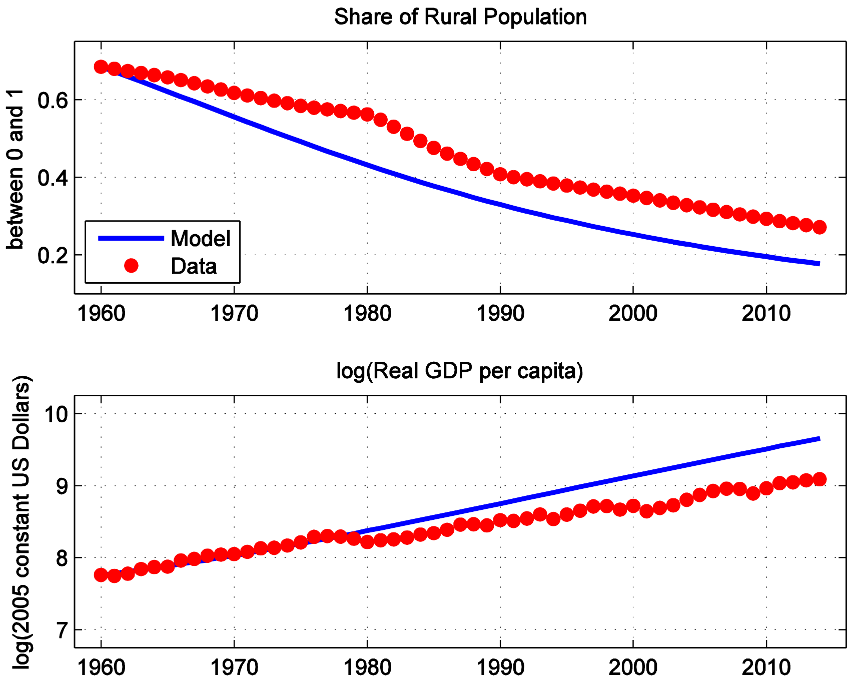


Figure 4

Real GDP per capita in the Extended Model

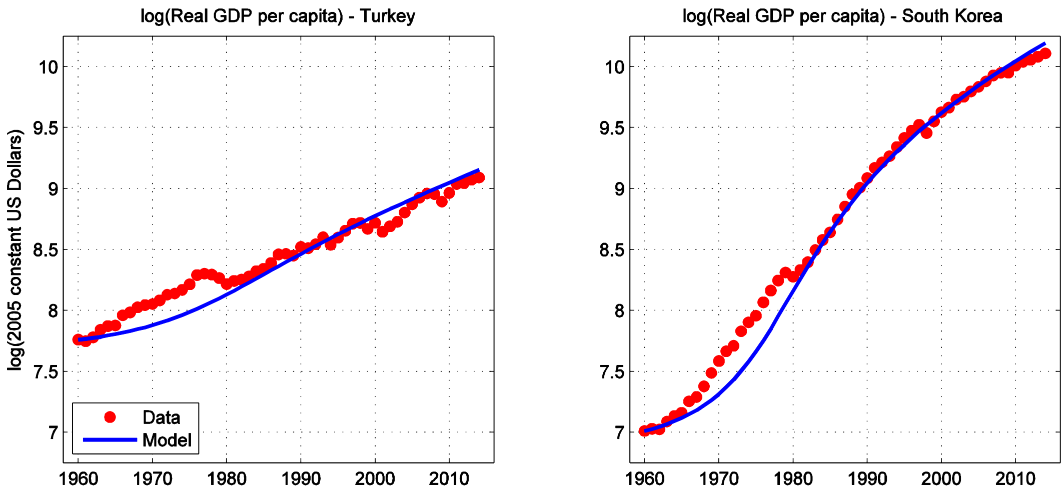


Figure 5

The Share of Rural Population in the Extended Model

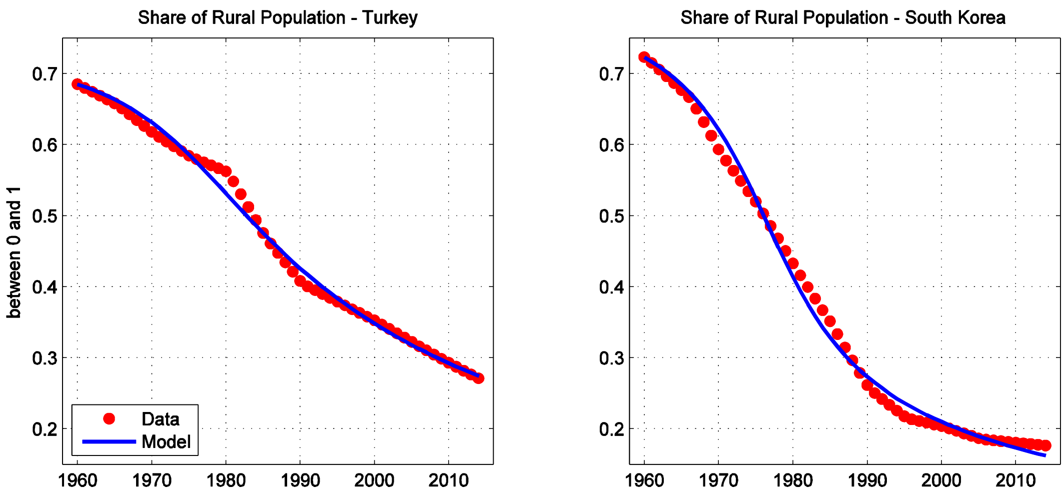


Figure 6

City Sector Productivity in the Extended Model

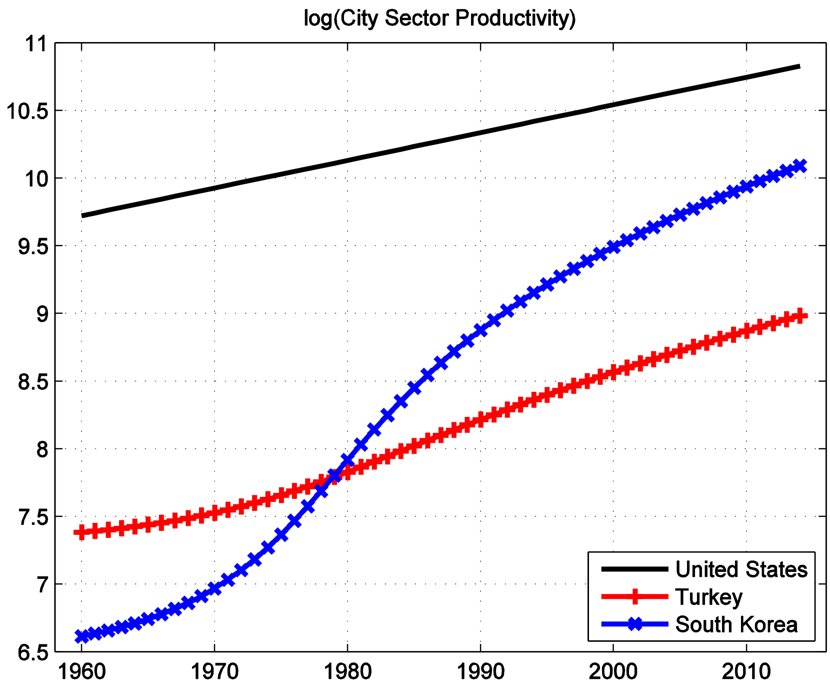


Figure 7

Counterfactual Experiments in the Extended Model

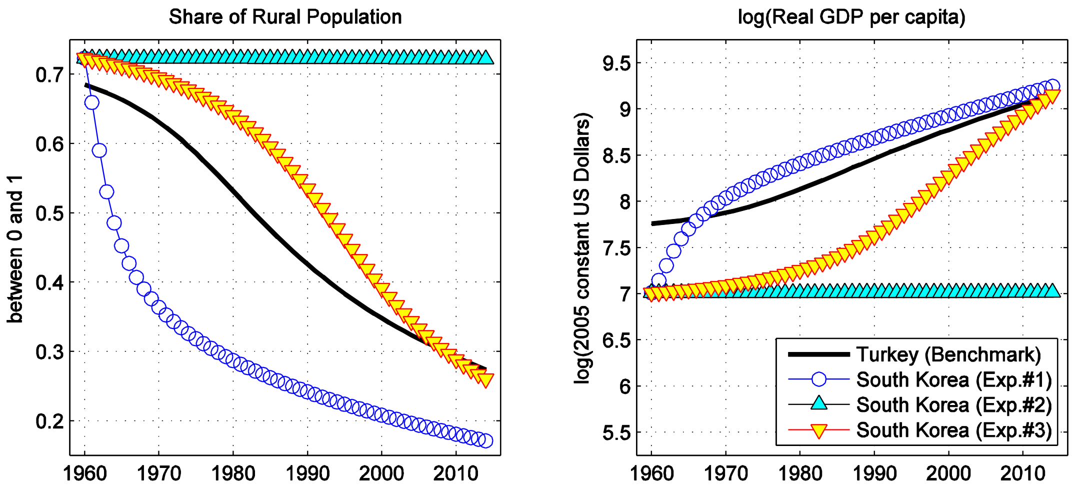
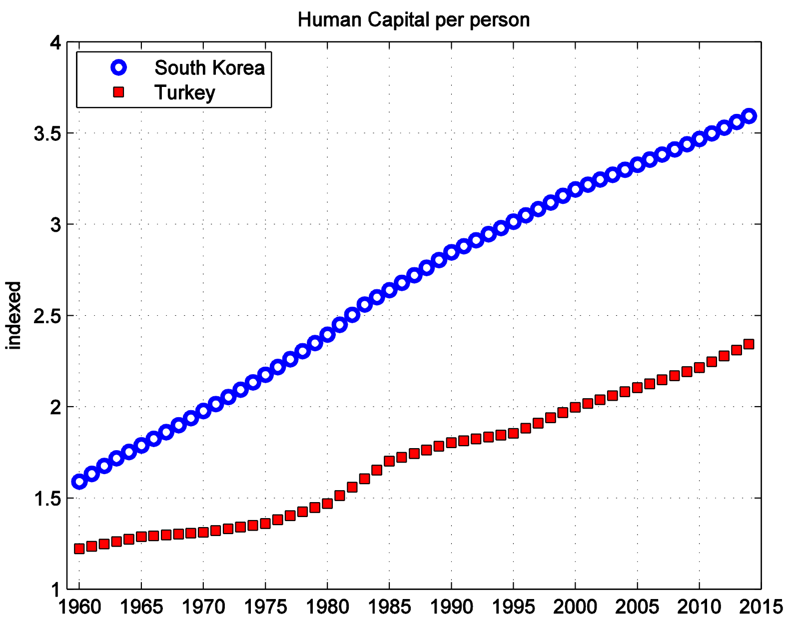


Figure 8

Human Capital in South Korea and Turkey



Data Source: Feenstra et al. (2015)

Figure 9

Efficiency in Technology Adoption vs. Human Capital

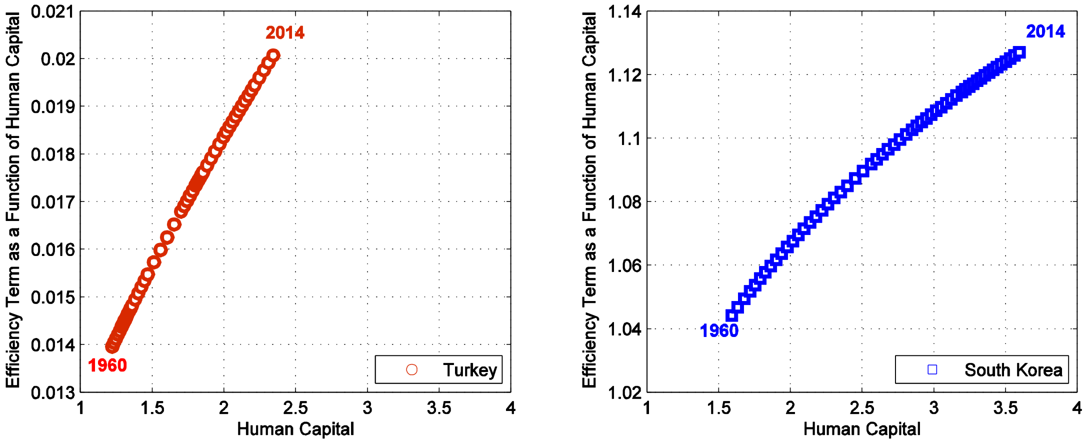


Figure 10

Efficiency Dynamics: Turkey relative to South Korea

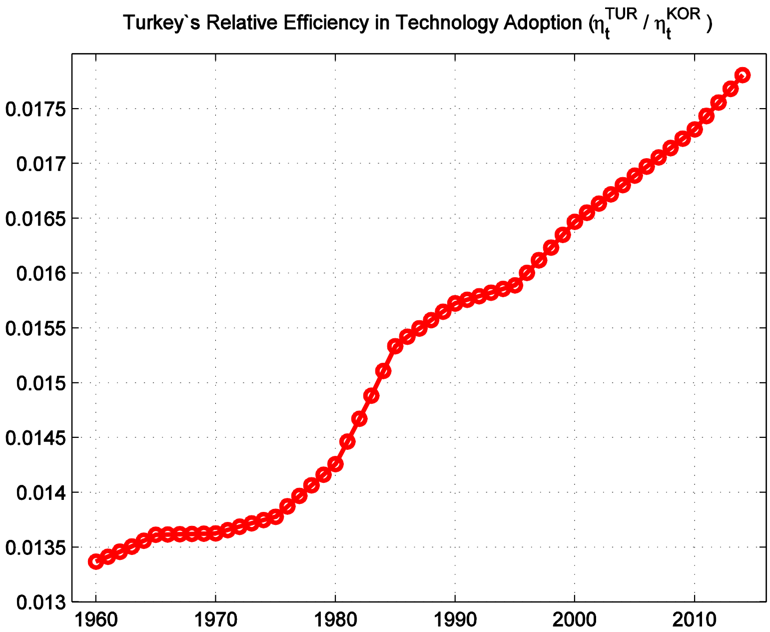


Figure 11

Counterfactual Experiments in the Human Capital Model