TFP Growth in Turkey Revisited: The Effect of Informal Sector

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Abstract. In this paper, we aim to contribute to the growth literature by presenting evidence that the presence of an informal sector might significantly affect both the level as well as the course of the total factor productivity (TFP). To this end, we develop a framework where we can compare the TFP in Turkey generated by a one-sector benchmark model to the one originating from an extended model with the presence of formal and informal labor. Our results indicate that, over the course of 1950 to 2014, the TFP generated by the benchmark model generally underestimates the productivity of the formal sector and this underestimation is mainly observed and is widened after 1980. Moreover, we also find that the substitution between formal and informal labor significantly affects this underestimation.

Keywords: TFP Growth; Informal Sector; CES Production Functions.

1. Introduction

A general empirical result arising from the growth literature is that the total factor productivity (TFP) is the main source of economic growth for a large set of countries and a significant time horizon. (See Prescott, 1998 or Senhadji, 2000 among many others in the literature). Independent of the production function or the dataset used in the analysis, growth in TFP generally dominates the contributions of other inputs on growth. A similar and related fact from the business cycle accounting literature also postulates that the efficiency wedge, which is nothing but the detrended TFP, is also the main source behind the business cycles for a large set of economies, including Turkey. (Cicek and Elgin, 2011a)

Turkey is also not an exception with respect to the growth accounting. Even though in some sub-episodes of the Turkish economy, inputs other than the TFP might play some significant roles, TFP is also the main general source of growth in Turkish economy over the past 60 years. (See Ismihan and Metin-Ozcan, 2006; Imrohoroglu and Ungor, 2009, Cicek and Elgin, 2011b and more recently Ungor, 2014.) Therefore, it is very important for economists as well as policy-makers in Turkey to understand the evolution of the TFP as well as its components.

In this paper, we aim to contribute to the growth and productivity literature by presenting evidence that the presence of an informal sector might significantly affect both the level as well as the course of TFP. Specifically, we develop a framework where we can compare the TFP in Turkey generated by a one-sector benchmark model to the one originating from an extended model with the presence of formal and informal labor. Our results indicate that, over the course of 1950 to 2014, the TFP generated by the benchmark model generally underestimates the productivity of the formal sector and this underestimation is mainly observed and is widened after 1980. Moreover, the underestimation is more pronounced when the elasticity of substitution between formal and informal labor increases. Therefore, these results imply that the omission of the informal labor input and neglecting the potential substitution between the two types of labor may result in significantly understated levels of formal productivity. We also argue that these results are also in line with the evolution of some key and relevant variables during the recent history of Turkish economy.

Turkey with an informal sector size at about 25-30 % of official GDP has the largest informal sector size (relative to GDP) among OECD members along with Mexico. Even though the informal sector size has declined significantly after 1980's, it still constitutes a large fraction within the economy and acts as a barrier for growth, technological advancement and the efficiency of public finance. Even though the analysis we present here is only applied to the Turkish economy, it can also be generalized to include any other economy.

The rest of the paper is organized as follows: In the next section, we present the benchmark model as well as the two modified models we use in our simulations. Then, in the third section, we discuss the data and the calibration methodology. In section four, we present the quantitative analysis. Finally, in the last section we provide some concluding remarks.

2. Model

First, we will summarize the standard neoclassical production technology with only one type of labor (formal labor). Second, we will summarize two alternative production technologies that extend the standard neoclassical production technology to incorporate a second type of labor - the informal labor.

2.1. Model with Formal Sector Labor (Benchmark). There is a standard well-known approach to calculate TFP levels in the neoclassical development literature. Following this line of work, our proposed production technology overlaps one-to-one with the standard one used in the neoclassical framework. More in details, we assume that the GDP at time t - is denoted by Y_t - is a function of factor endowments and productivity, and this function follows a constant returns to scale Cobb-Douglass technology as follows:

$$Y_t = (K_t)^{\alpha}(A_t L_t)^{1-\alpha}, \tag{1}$$

where A_t, K_t and L_t denotes, respectively, the productivity, the stock of capital and the input of labor. Notice that the production technology assumes the productivity is labor augmenting. This assumption, which is a standard approach in the literature, is important for the analysis we want to pursue because it will make the productivity measures proposed in this section and the next one comparable. We will elaborate on this point later on.

Based on the production technology given in (1), the productivity measure A_t can be calculated by using the following equation:

$$A_t = \left[\frac{Y_t}{(K_t)^{\alpha}(L_t)^{1-\alpha}}\right]^{(\frac{1}{1-\alpha})} \tag{2}$$

2.2. Models with Formal and Informal Sector Labor. In this section, we will introduce informal sector labor into the neoclassical production technology. Following Caselli and Coleman (2002, 2006), we will use two alternative CES production technologies. Next section provides a summary of these two alternative setups.

One Level CES Production Technology (Model 1). We assume that the output Y_t

is produced according to the following CES production technology

$$Y_t = (K_t)^{\alpha} \left[(A_t^F L_t^F)^{\sigma} + (A_t^I L_t^I)^{\sigma} \right]^{\frac{1-\alpha}{\sigma}}, \tag{3}$$

where L_t^F is formal labor, L_t^I is informal labor, A_t^F is productivity level of formal labor, A_t^I is productivity level of informal labor and $\sigma < 1$. The elasticity of substitution between formal and informal labor is equal to $1/(1-\sigma)$. Observe that in case $\sigma = 1$, this production technology implies that only the more productive labor input (the one with higher A_t) will be employed. Logically, assuming that the more productive labor input is the "formal labor", the informal labor will not show up in the production function in the case of $\sigma = 1$ and, therefore, the production function will be reduced to the standard Cobb-Douglass.

Notice that, in this modelling approach, Y_t corresponds to the sum of formal and informal sector outputs. Therefore, in our productivity calculations, the output measures used will incorporate this fact.

When we solve for the optimal allocation problem by assuming that all factors of productions are paid their marginal productivity, we can obtain closed form solutions for A_t^F and A_t^I. Let w_t^F, w_t^I and r_t denote, repectively, the formal wage, informal wage and marginal productivity of capital stock. Then, we obtain closed form solutions for A_t^F and A_t^I as follows:

$$A_t^F = \left[\frac{(Y_t)^{\frac{1}{1-\alpha}} (K_t)^{\frac{-\alpha}{1-\alpha}}}{L_t^F} \right] \left(\frac{w_t^F L_t^F}{w_t^F L_t^F + w_t^I L_t^I} \right) \tag{4}$$

$$A_t^I = \left[\frac{(Y_t)^{\frac{1}{1-\alpha}} (K_t)^{\frac{-\alpha}{1-\alpha}}}{L_t^I} \right] \left(\frac{w_t^I L_t^I}{w_t^F L_t^F + w_t^I L_t^I} \right) \tag{5}$$

The productivity A_t^F in (4) will be the measure that will be used (in our comparisons) to identify *"the effect of the existence of informal labor on* ***formal productivity"*****.**

Two Level CES Production Technology (Model 2). In this section, we assume that the output Y_t is produced according to the following two level CES production technology

$$Y_t = \{ (A_t^I L_t^I)^{\sigma} + \left[(A_t^F L_t^F)^{\rho} + (A_t^K K_t)^{\rho} \right]^{\frac{\sigma}{\rho}} \}^{\frac{1}{\sigma}}, \tag{6}$$

where L_t^F is formal labor, L_t^I is informal labor, A_t^F is productivity level of formal labor, A_t^I is productivity level of informal labor, A_t^K is productivity level of capital, $\sigma < 1$ and $\rho < 1$. The elasticity of substitution between formal labor and capital is equal to $1/(1-\rho)$. Similarly, the elasticity of substitution between formal and informal labor, and between capital and informal labor, is equal to $1/(1-\sigma)$. This production structure allows us to capture the fact that *the interaction between capital and formal labor can be quite different*

compared to the interaction between capital and informal labor.

As in Model 1 summarized above, we can obtain closed form solutions for productivity levels by assuming that all factors of productions are paid their marginal productivity. Let w_t^F, w_t^I and r_t denote, repectively, the formal wage, informal wage and the marginal productivity of capital stock. Then, we obtain closed form solutions for A_t^F, A_t^I and A_t^K as follows:

$$A_t^F = \frac{Y_t}{L_t^F}\left(1 - \frac{r_t(\frac{K_t}{Y_t})}{S_t}\right)^{1/\rho} S^{1/\sigma} \tag{7}$$

$$A_t^I = \frac{Y_t}{L_t^I}(1-S)^{1/\sigma} \tag{8}$$

$$A_t^K = \left(\frac{r_t(\frac{K_t}{Y_t})^{1-\rho}}{S_t}\right)^{1/\rho} S^{1/\sigma} \tag{9}$$

where

$$S_t = \frac{\frac{w_t^F L_t^F}{w_t^I L_t^I} + r_t(\frac{K_t}{Y_t})}{\frac{w_t^F L_t^F}{w_t^I L_t^I} + 1} \tag{10}$$

The productivity A_t^F in (7) will be the measure that will be used (in our comparisons) to identify *"the effect of the existence of informal labor on* ***formal productivity****"*.

3. Data and Calibration

The data for macro aggregates are from 1952 to 2014. The time series for capital stock K_t, formal labor L_t^F, and formal output Y_t^F (which is equao to total output Y_t in the *Benchmark Model*)are from Penn World Tables. The time series for informal labor L_t^I and informal output Y_t^I for Turkey over the period of interest are from Elgin and Oztunali (2012). Observe that, in Model 1 and Model 2, the total output is the sum of informal and formal outputs ($Y_t = Y_t^F + Y_t^I$). For formal wage w_t^H, we use time-series of real average wages observed in the industrial sector from 1952 to 2014 (see Elgin and Kuzubas (2013) for details). Baskaya and Hulagu (2011) estimate the wage difference between formal and informal workers in Turkey as 20 percent on average. Following their findings, we generate informal wage time-series by assuming that informal wages are equal to 80% of formal wages over the period of interest.The marginal productivity of capital stock, r_t, is equal to the real interest rate plus the rate of depreciation on physical capital. We found that the average real interest rate and the average capital depreciation rate for Turkey are equal to, respectively, 7.5% and 5.5% over the period of 1952-2014. Accordingly, the average marginal productivity of capital over the period of interest turns out to be 13%.

We set the capital share parameter to $\alpha = 0.34$, which is the value used by Penn World Tables in calculating TFP series for Turkey. Now, we will discuss the calibration of elasticity parameters σ and ρ used in Model 1 and Model 2. In the literature, the only study that provides an estimate for the easticity of substitution between formal and informal labor is Schramm (2014), which estimates $\sigma = 0.41$ and, therefore, an elasticity of $1/1-\sigma = 1.7$. This will be the benchmark value for σ that we will use in our calculations. In addition, we provide a sensitivity analysis that shows how results change in case σ takes a lower value $\sigma = 0.30$ or a higher value $\sigma = 0.50$. Karabarbounis and Neiman (2014) provide several estimates for the elasticity of substitution between capital and formal labor. Following their findings, we set $\rho = 0.33$ as our benchmark value and, in addition, we provide a sensitivity analysis that shows how results change in case ρ takes a lower value $\rho = 0.22$ or a higher value $\rho = 0.41$.

4. Quantitative Analysis

First, we want to compare the productivity series obtained in our Benchmark Model to the ones reported in the literature. Second, we want to compare the productivity measures obtained in Model 1 and Model 2 to the ones obtained in the Benchmark Model.

Benchmark Model vs. Penn World Tables. In tis section, we want to compare the productivity series obtained in our Benchmark Model to the ones reported in Penn World Tables (PWT). In our Benchmark Model, recall that the production function that we use is $Y_t = (K_t)^{\alpha}(A_t L_t)^{1-\alpha}$, which implies the productivity measure A_t is labor augmenting. Accordingly, by using equation (2), we generate time series for labor augmenting productivity in Turkey between 1952-2014. On the other hand, the production function that PWT use to generate its productivity measure takes the form $Y_t = A_t(K_t)^{\alpha}(h_t L_t)^{1-\alpha}$, where (i) h_t denotes the human capital stock per worker, and (ii) the productivity measure A_t is factor augmenting and net of human capital productivity. In order to make the productivity measures reported by us and PWT comparable, we adjust the productivity series reported by PWT as $(A_t)^{\frac{1}{1-\alpha}} h_t$. This way, the productivity measure reported by PWT becomes labor augmenting and also include human capital stock.

Figure 1 compare the productivity time series obtained from our Benchmark Model and the adjusted productivity series (as explained above) from PWT over the period of interest. The figure shows that these two series are closely following each other. This verifies the validity of the series generated by our Benchmark Model. Therefore, with confidence, we can compare our findings from the Benchmark Model with the ones obtained in Model 1 and Model 2, in order to analyze the effect of the existence of informal labor on formal productivity.

Model 1 vs. Bencmark Model. Figure 2 displays the formal labor productivity calculated with the Benchmark Model and Model 1 with one-level CES production technology. According to this figure, the two formal labor productivity series nearly completely coincide with each other until 1980. However, beginning with 1980 the Benchmark Model starts to understate the productivity of the formal labor sector. Furthermore, the rate of this understatement increases over time as the gap between the two series widens. Specifically, while the two formal labor productivity measures are nearly identical and equal to 30 in 1980 (measures are adjusted with respect to their values in 1952 which are normalized to 10), the formal productivity calculated with Model 1 reaches to nearly 65 and the formal labor productivity measure obtained with the Benchmark Model manages to only become 50 in 2014. Therefore, these results imply that the omission of the informal labor input and neglecting the potential substitution between the two types of labor may result in significantly understated levels of formal productivity.

These results are also in accordance with the evolution of some key and relevant variables through the recent history of Turkish economy. The degree of unionization, which can be regarded as one of the main determinants of labor productivity - through its negative effect on profitability[1] and which potentially deters investment into activities that enhance labor productivity, has steadily increased till the 1970s (trade union density increased up to 42.7% in 1975) and then started to decline continuously beginning from 1980s - from 39.5% in 1980 to 6.3% in 2013 - according to the trade union density data from OECD's Employment and Labour Market Statistics Database[2]. Therefore, the high degree of unionization (which only applies to formal labor as by definition informal sector does not abide by any rules and regulations) untili the late 1970s may have prevented investment that enhance formal labor's productivity, and therefore the omission of informal labor during the calculation of formal labor productivity may not result in an underestimation of productivity in this period. However, due to the dramatic fall in the trade union density that started in the beginning of 1980s, investment in productivity enhancing activities in the formal labor sector most probably started to increase and formal labor productivity starts to accelerate at a higher rate compared to the prediction of the Benchmark Model. In addition to the fall in the degree of unionization in the formal sector, the adoption of neoliberal policies (especially the capital account liberalization) and education policy (establishment of private universities and the increase in the number of public universities) aimed at increasing overall educational attainment in 1980s and early 1990s can also be regarded as factors that contributed to the productivity of formal labor at a relatively higher degree compared to informal labor.

[1] See Menezes-Filho (1997) which finds a negative association between profitability and unionization in the UK.

[2] See Yılmaz (2010) for a detailed summary of the evolution of the degree of unionization in Turkey.

After calculating formal labor productivity under Model 1 where the elasticity between formal and informal labor is assumed to be $\sigma = 0.41$, we conduct sensitivity analysis with respect to this parameter. First, we simulate the case in which the degree of elasticity of substitution between the two types of labor is lower by setting $\sigma = 0.3$. Secondly, we simulate the opposite case where the degree of substitutability between the two types of labor is higher via setting $\sigma = 0.5$. Figure 3 displays the results of our experimental simulations. According to that, increasing the degree of substitutability between formal and informal labor narrows the gap between the formal labor productivity prediction of the two sector model and the prediction of the one sector Benchmark Model. These results are due to the fact that increasing the degree of substitution between the two labor types translates into the disappearance of the informal labor - in the limiting case of Model 1 where $\sigma = 1$, the two labor types become perfect substitutes and all labor input is employed in the sector with higher productivity, i.e. the formal sector. Therefore increasing σ corresponds to transforming the production technology to a one-sector model without informal labor via reducing the role of relatively less productive informal labor in overall production.

Model 2 vs. Benchmark Model. In this section, we first calculate formal labor productivity with Model 2 which involves constant elasticity of substitution along two dimensions: (i) between formal labor and informal labor and (ii) between formal labor and capital. Next, we compare our findings with the predictions of the one-sector Benchmark Model. Finally, we conduct sensitivity analysis.

Figure 4 displays the comparison of the formal labor productivity predictions obtained with Model 2 and the Benchmark Model. The parameter governing the degree of substitution between formal and informal labor is assumed to be $\sigma = 0.41$, while the parameter governing the degree of substitution between formal labor and capital is chosen as $\rho = 0.33$. According to figure 4, the formal labor productivity predictions of the two models coincide with each other completely again in the period before 1980s. Furthermore, similar to our results from Model 1, the formal labor productivity predicted by Model 2 exceeds the prediction of the one-sector Benchmark Model throughout the period between 1980-2014. However the gap between the predictions of the two models is now less pronounced compared to what we observe in the case of Model 1 - now the formal labor productivity reaches to 60 in 2014 (which is lower than Model 1's prediction of 65 for this year).

In Figure 5, we display the results of the sensitivity analysis conducted by experimenting with the value of the parameter that governs the degree of substitution between formal and informal labor via first setting $\sigma = 0.30$ and then alternatively choosing $\sigma = 0.50$. Similar to the previous section, results indicate that increasing the subsitutability be-

tween these two types of labor results in a lower gap between the productivity times series generated by Model 2 and ones gnerated by the Benchmark Model.

Figure 6 displays the results of simulations where we experiment with the parameter that corresponds to the degree of substitution between capital and formal labor via alternating between the parameter values of $\rho = 0.41$ and $\rho = 0.22$. Our simulation results indicate that in the case of low substitution between capital and formal labor (i.e. when $\rho = 0.22$), Model 2's predictions nearly completely coincide with the predictions of the Benchmark Model. On the other hand, decreasing the degree of complementarity between the two factors of production by setting $\rho = 0.41$ results in a considerably higher predicted levels of formal labor productivity compared to the Benchmark Model. Overall, the results of the sensitivity analysis lend credence to the robustness of our results under sensible parameter values.

5. Conclusion

In this paper, we show that the presence of an informal sector might significantly affect the course of TFP over time. To this end, we show model based evidence from the time-series evolution of the Turkish economy. Even though Turkey is a good choice for such an analysis, as it is a country with the largest informal sector size as percentage of GDP among OECD economies, one can extend the analysis of the current paper to include a wider cross-section of economies. This we leave to future research.

REFERENCES

Baskaya, Y. S. and Hulagu, T., (2011). "Informal-Formal Worker Wage Gap in Turkey: Evidence From A Semi-Parametric Approach", Working Papers 1115, Research and Monetary Policy Department, Central Bank of the Republic of Turkey.

Caselli, F and Coleman, W. J. II, (2002). "The U.S. Technology Frontier", American Economic Review P&P, 92 (2), pp. 148-152.

Caselli, F and Coleman, W. J. II, (2006). "The World Technology Frontier", American Economic Review, 96 (3), pp. 499-522.

Cicek, D. and Elgin, C. (2011a). "Accounting for Turkish Business Cycles."Iktisat Isletme ve Finans, 26 (309), 09-32.

Cicek, D. and Elgin, C. (2011b). "Not-quite-great depressions of Turkey: A quantitative analysis of economic growth over 1968 - 2004, "Economic Modelling, 28 (6), 2691-2700.

Elgin, C. and Kuzubas, T.U., (2013) "Wage-productivity gap in OECD economies", Economics E-Journal, 2013-7, pg. 1-21.

Elgin, C. and Oztunali, O., (2012) "Shadow Economies around the World: Model Based Estimates", Working Paper, Bogazici University.

Ismihan, M. Metin-Ozcan,K. (2006). "Sources of Growth in the Turkish Economy, 1960-2004. Iktisat Isletme ve Finans, 241. 74-86.

Imrohoroglu, A., Ungor, M. (2009). "Growth Facts in Turkey," 2009 Meeting Papers 1275, Society for Economic Dynamics.

Karabarbounis, L and Neiman, B., (2014). "The Global Decline of the Labor Share", Quarterly Journal of Economics,129 (1), pp. 61-103.

Prescott, E. C, (1998). "Needed: A Theory of Total Factor Productivity,"International Economic Review,39 (3), 525-551.

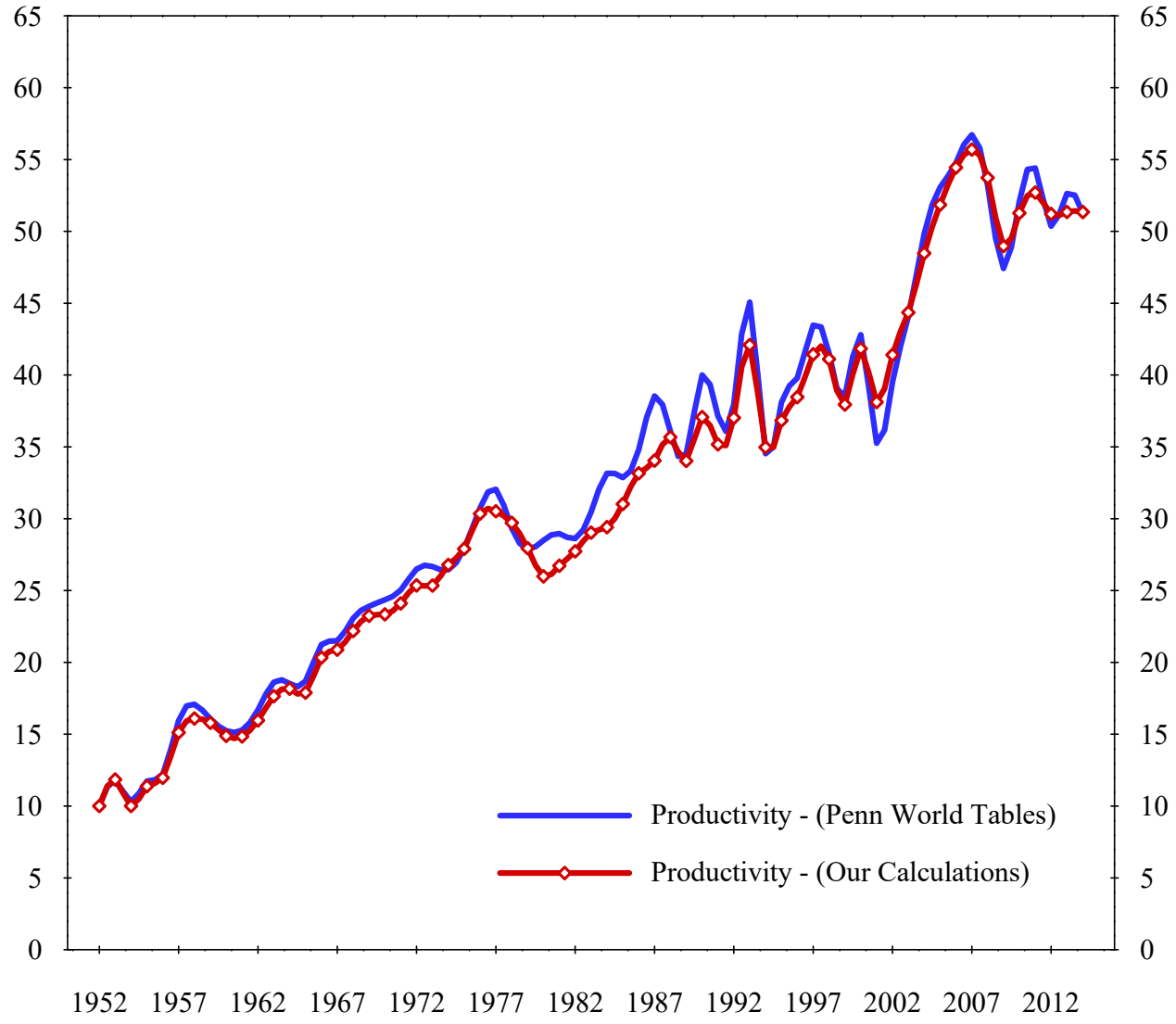
Schramm, H. R., (2014). "The Equilibrium Effects of Income Taxation on Formal and Informal Labor Markets", Working Paper, University of Virginia.

Senhadji, A. (2000). "Sources of Economic Growth: An Extensive Growth Accounting Exercise", IMF Econonic Review. 47, 129-157.

Ungor, M. (2014). "Some Observations on the Convergence Experience of Turkey", Comparative Economic Studies, 56 (4), 696-719.

Figure 1: Formal Productivity Time Series for Turkey

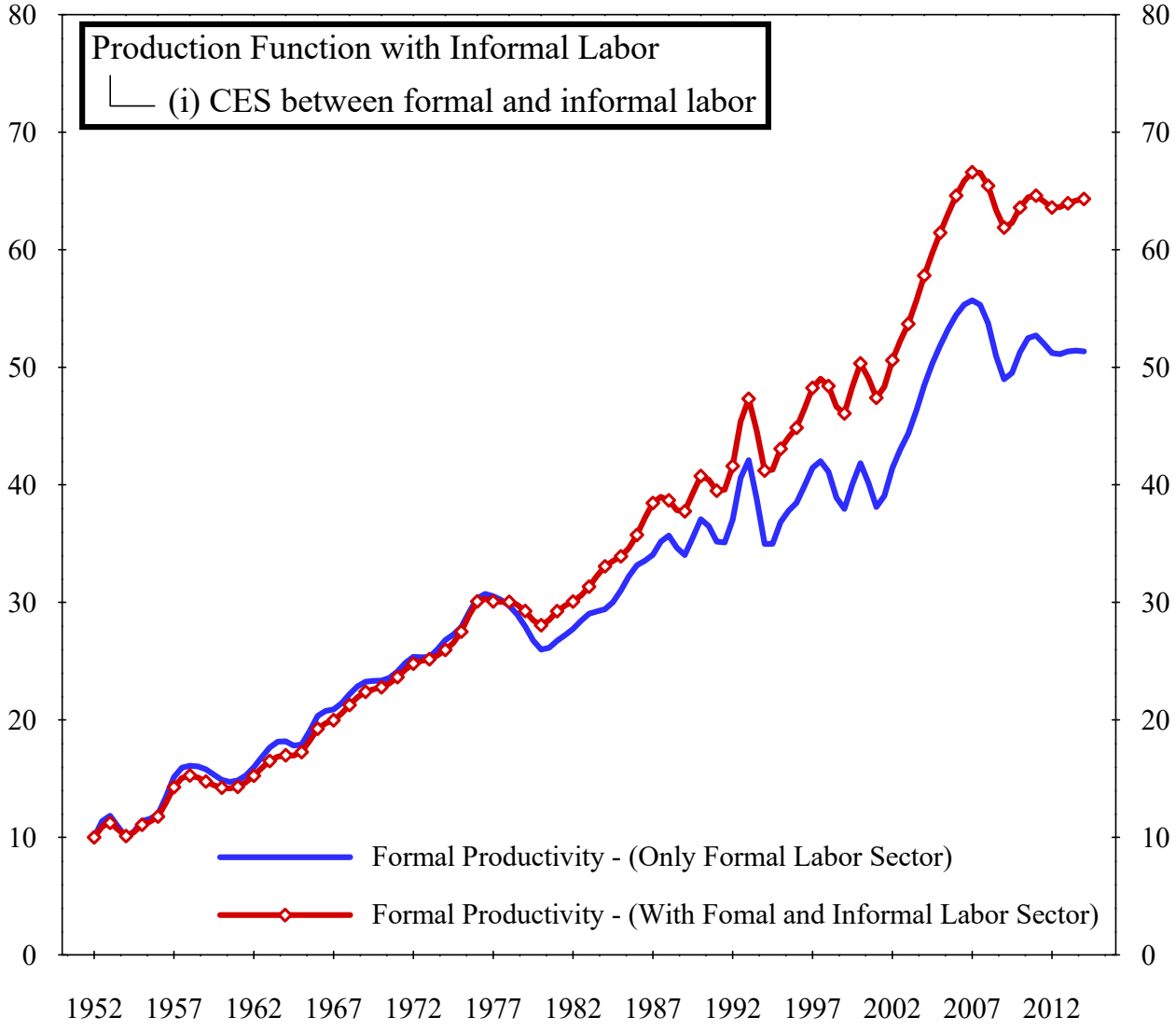
(Penn World Tables vs. Our Calculations)



* 1952 levels are normalized to 10

Figure 2: Formal Productivity Time Series for Turkey

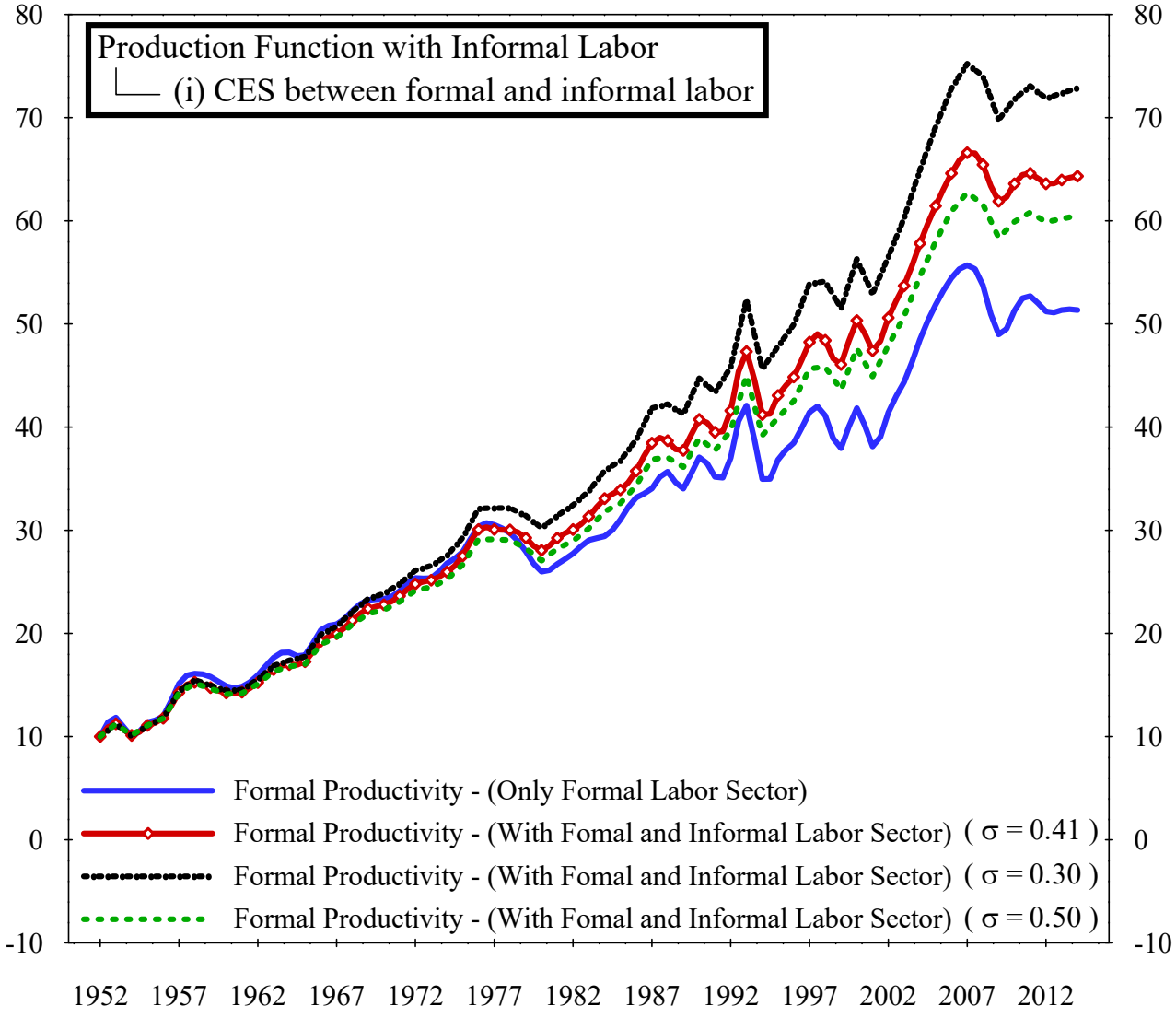
(With vs. Without Informal Labor Sector)



* 1952 levels are normalized to 10

Figure 3: Formal Productivity Time Series for Turkey

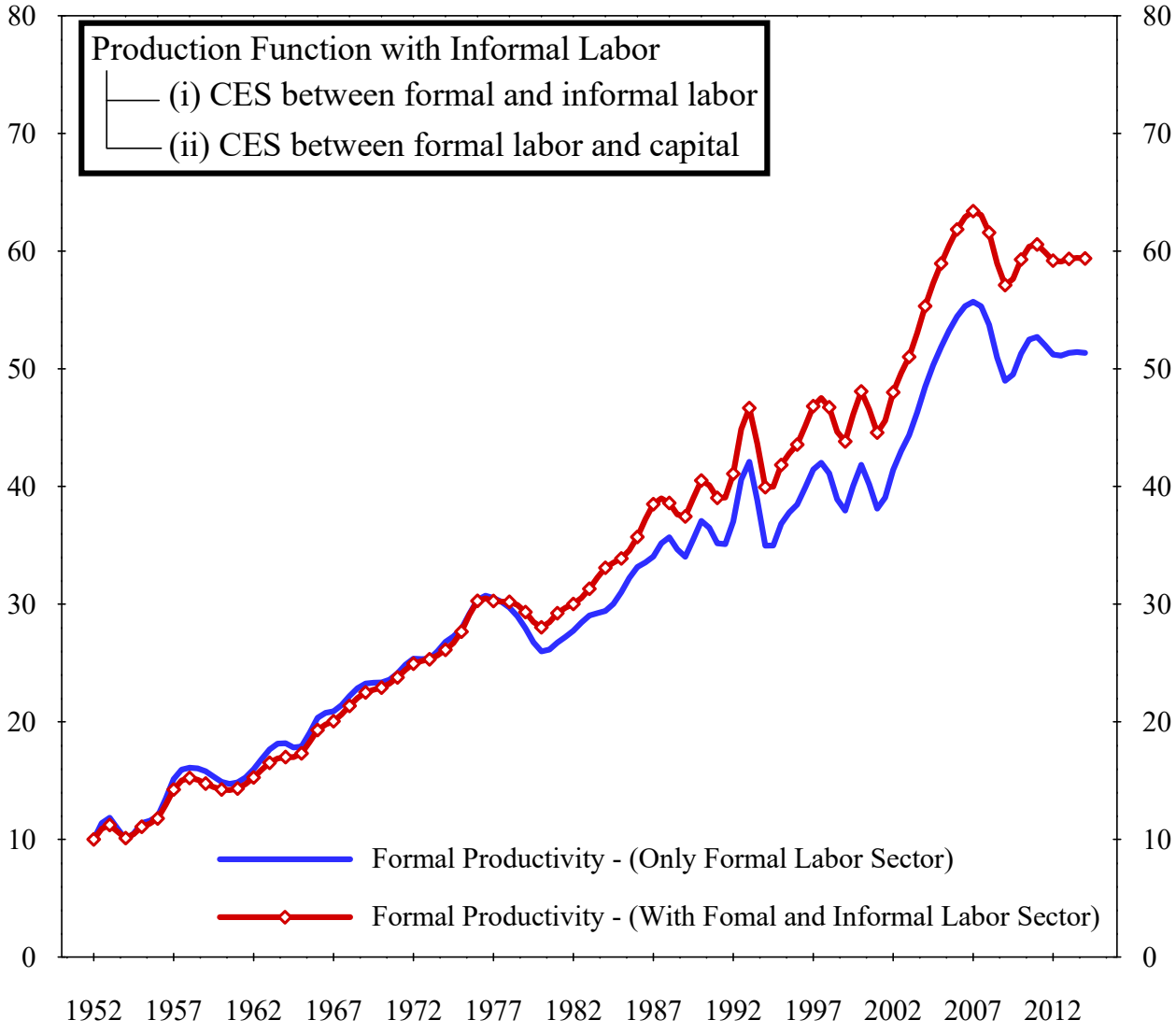
Sensitivity Analysis - (w.r.t. parameter σ)



* 1952 levels are normalized to 10

Figure 4: Formal Productivity Time Series for Turkey

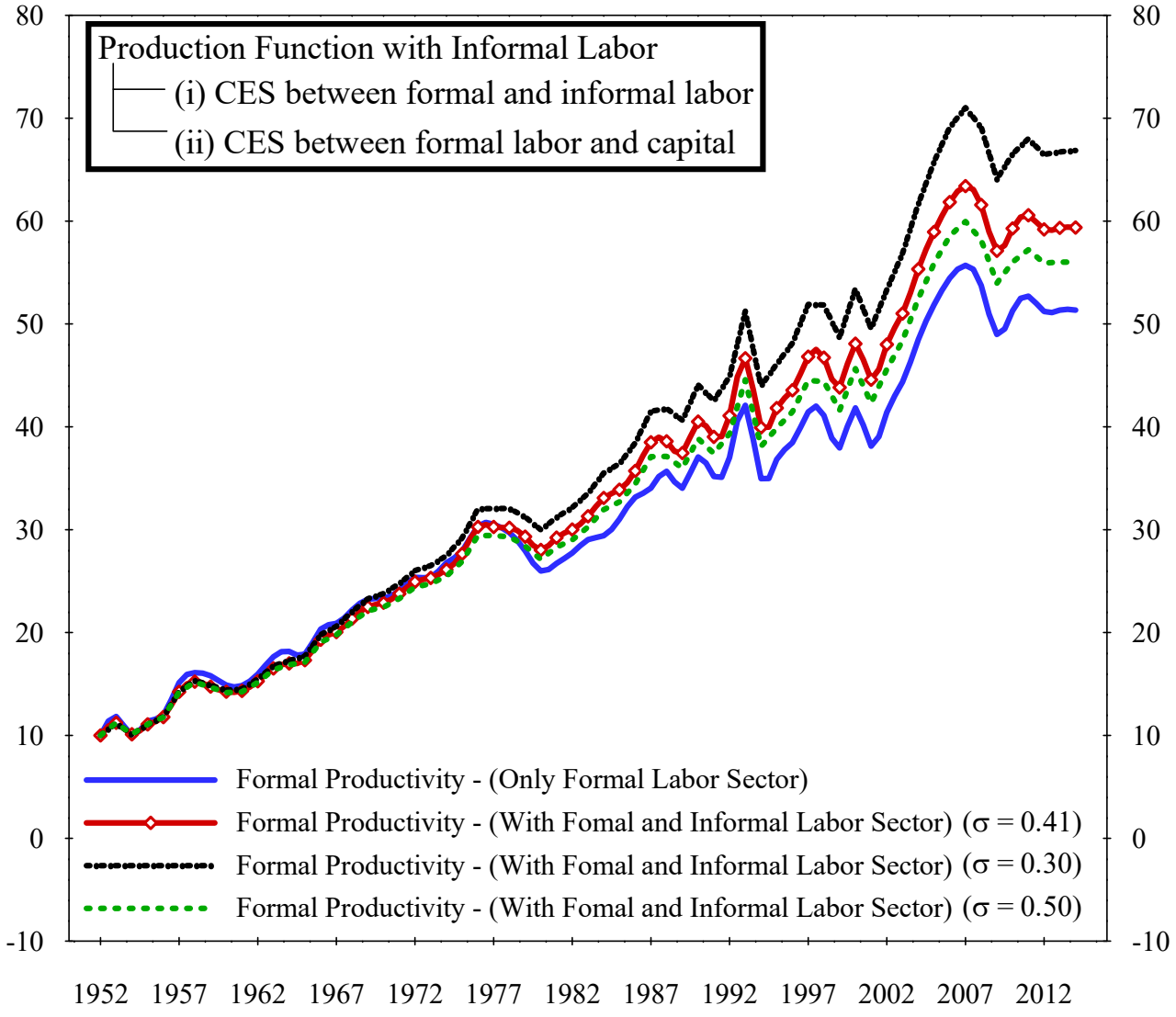
(With vs. Without Informal Labor Sector)



* 1952 levels are normalized to 10

Figure 5: Formal Productivity Time Series for Turkey

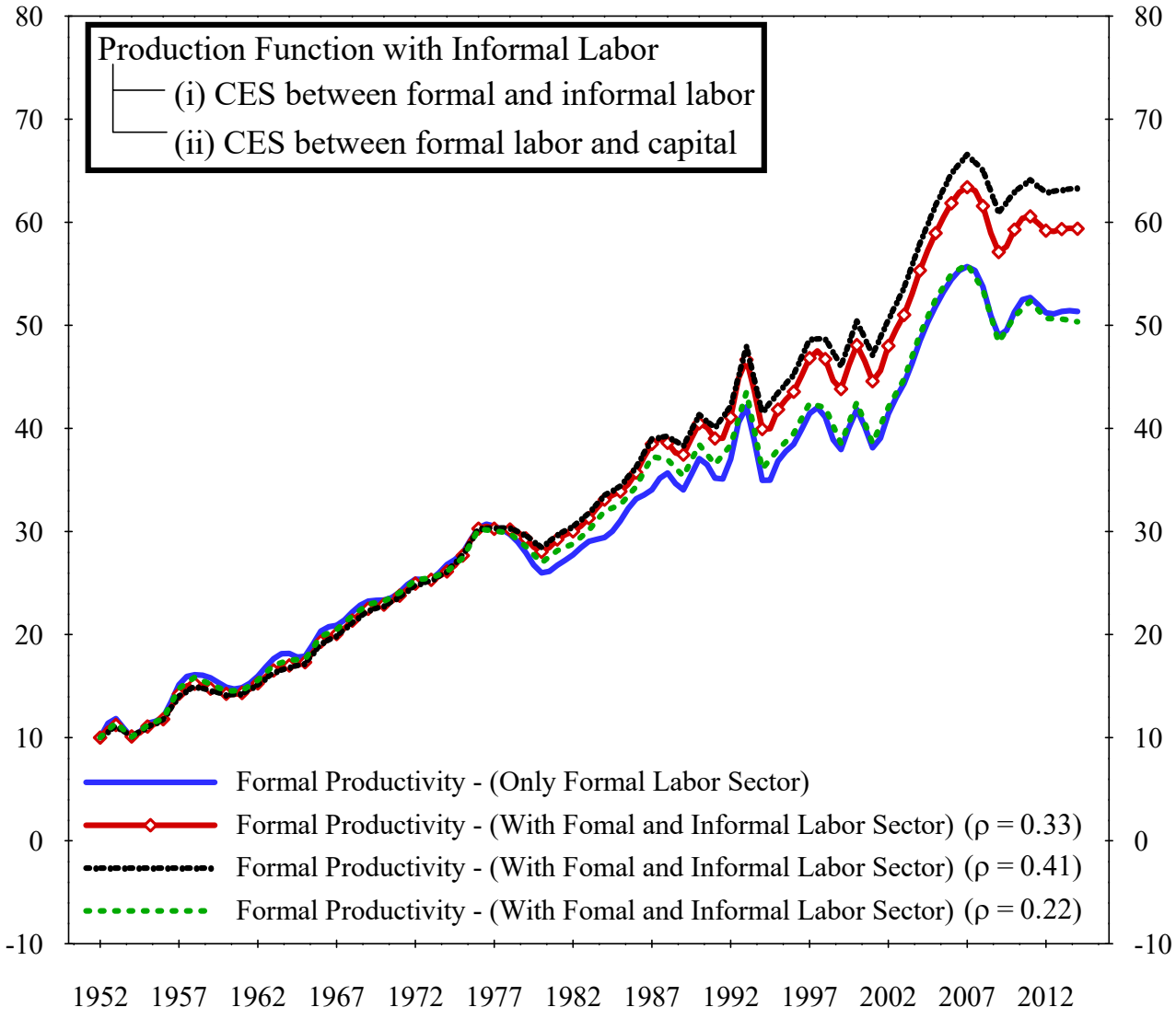
Sensitivity Analysis - (w.r.t. parameter σ)



* 1952 levels are normalized to 10

Figure 6: Formal Productivity Time Series for Turkey

Sensitivity Analysis - (w.r.t. parameter ρ)



* 1952 levels are normalized to 10