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Testing the Validity of the Galor-Weil Model for Turkiye

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Abstract

The purpose of this study is to test the validity of the Galor-Weil (2000) model for Turkiye. In our study, there are two issues that are thought to contribute to the literature. The first one is to extend the Galor-Weil model by categorizing the education factor as secondary and tertiary education. The second is to econometrically analyze the process of escape from the Malthusian trap with the Galor-Weil (2000) model for Turkiye for the first time. In this study, the Galor-Weil (2000) model is analyzed for the period 1974-2021 in Turkiye using Vector Autoregression (VAR), Granger causality and variance decomposition method. According to the findings of the analysis, secondary education does not affect fertility and tertiary education does not accelerate technological development in Turkiye. Moreover, the level of technological development decreases despite increasing tertiary education. As a result, Galor-Weil (2000) model is not valid for Turkiye. The main reason why the Galor-Weil (2000) model is not valid for Turkiye is the inability of the education system to transform from quantity to quality. The conclusion reached in the light of the findings of this study is that the education system in Turkiye is successful in quantitative terms but unsuccessful in qualitative terms.

Keywords: Malthusian Trap, Quantity-quality tradeoff, Economic Growth
Jel codes: J13, I25, F63

1. Introduction

According to Malthus (1872), the increase in production is not sufficient for population growth. Therefore, as long as output growth is not higher than population growth, breakthrough towards development can not be realized and countries cannot escape from this vicious circle. According to Galor and Weil (2000), escape from the Maltusian trap can be achieved through quantity-quality transfer. According to them, the realization of quantity-quality transfer will positively accelerate technological development. This acceleration in technology would have a positive impact on output. But if the increase in welfare leads to an increase in fertility, this cycle will continue. According to them, to avoid this trap, parents should shift their choice of children from quantity to quality. Moreover, continuous improvement in the educational level of human capital will increase the efficiency of technology. Therefore, technological development and human capital will proceed in harmony. As a result, if the quantity-quality transfer is realized and technological progress continues, economic growth increases not only quantitatively but also qualitatively. This process may not be valid for all countries, nor may it be realized with the same steps and processes in those that are. This is also the case for Turkiye.

Turkiye was founded in 1923 following the collapse of the Ottoman Empire in the late 1910s and the winning of the War of Independence. During this period, Turkiye faced significant economic burdens due to its defeat in the war, inherited debts, and capitulations from the Ottoman era. In order to overcome the existing problems, to remain strong in the world arena and to escape from this trap, structural reforms were first prepared and put into practice. One of the important steps in this direction was the education policies introduced in 1924. From 1924 to the present, both the number of educated population and their education level have increased. However, the main concerns and motivations of this study are whether the transformation of the population from quantity to quality has realized in Turkiye and whether Turkiye has escaped the Malthusian trap. Based on these motivations, the purpose of this study is to examine the transformation of population from quantity to quality in Turkiye and its relationship with technology and growth using the Galor-Weil (2000) model.

This study contributes to the Malthusian trap literature in two ways. The first is to extend the Galor-Weil model by categorizing the education factor as secondary and tertiary education. Second, it is the first econometric analysis of Turkiye's recovery from the Malthusian trap. According to Galor-Weil (2000), education accelerates technology positively by enabling the transition from quantity to quality in society. However, in order for this acceleration to continue and for the existing human capital to operate in harmony with the developing technology in the production process, the level of education should also be increased. Therefore, categorizing the level of education into secondary and tertiary education provides a clearer picture of the effects of education on demographic transformation and technological development.

This study consists of five chapters following the introduction. The second section presents the Galor and Weil (2000) model and reviews the literature on empirical studies of this model. The third section presents the research methodology and data. Section four presents the empirical results and discussions. The fifth section contains conclusions and policy implications.

2. Theoretical Background And Empirical Literature

Galor and Weil (2000) extend the Malthusian model by adding education to express how countries can escape the Malthusian trap. The main assumption of the Galor and Weil (2000) model is that families choose between the number of children and the level of education of children. Accordingly, the production function of Galor and Weil (2000):

$$Y = H_t^{\alpha}(A_t X)^{1-\alpha} \qquad 0 < \alpha < 1 \tag{1}$$

In this equation, Y is total output, H_t is the productivity level of labor employed at time t, X is the total amount of land. $A_t > 0$ represents the endogenously determined technological level at time t.

The main assumption of the Galor and Weil (2000) model is that families make a choice between the number of children and their education level. The time spent on a child is divided into two parts: time spent on basic childcare (τ) and time spent on the child's education (τ^e). Assuming that the time allocated to a child's education in the next period is e_{t+1}, nt denotes the total number of children of the family in period t, while the normalized total time that families will allocate for their children is 1. Based on this information, the family's time constraint assumption is as follows:

$$n_t(\tau + \tau^e e_{t+1}) = 1 \tag{2}$$

Equation (2) shows the choice between the number of children and the education level of existing children.

The source of escape from the Malthusian trap depends on this choice. In other words, society's preference for quantity over quality.

In the Galor and Weil model, the optimal level of e_{t+1} is a function of technological progress ($e_t = (g_t)$). The underlying logic is that the higher level of education in a society, the greater the rate of technological progress. The growth rate of technological knowledge is shown in equation (5):

$$\frac{A_{t+1}-A_t}{A_t} = g_{t+1} = g(e_t L_t) \tag{3}$$

As the level of education increases in this economy, the rate of technological progress will increase. In this case, as the economy reaches equilibrium at a higher level of education and technology, the Malthusian trap would be escaped.[1]

1 For the derivation equation, see Galor and Weil, 2000.

Table 1 summarizes the applied literature that examines escape from the Malthusian trap with the Galor-Weil (2000) model.

Table 1. Literature Table

Author(s)	Data Set	Method	Empirical Findings
Mejía, D., Ramírez, M. T. & Tamayo, J. (2008)	Colombia (1905-2005)	VAR Analysis	Galor-Weil (2000) model is valid.
Elgin, C. (2010)	England (1750-2000)	Simulation	Galor-Weil (2000) model is valid.
Ashraf, Q., & Galor, O. (2011)	21 OECD Countries (1-1500)	OLS	Galor-Weil (2000) model is not valid.
Si-Tou, W. K. (2011)	China (1960-2008)	Simulation	Galor-Weil (2000) model is not valid.
Xue, J., & Yip, C. K. (2017)	China (1979-2016)	Simulation	Galor-Weil (2000) model is not valid.
Madsen J., & Strulik H. (2023)	21 OECD Countries (1750-2000)	2SLS Regression Analysis	Galor-Weil (2000) model is valid.

The analysis methods preferred in the few studies in this field are: vector autoregressive (VAR) model, Simulation method, ordinary least squares (OLS) method and 2SLS Regression Analysis. The studies are shaped over the long run. The studies examined whether societies were able to escape from the Malthusian trap as a result of technological progress triggered by demographic transformation. The validity of the model contains controversial results.

3. Data & Methodology

In this section, the data set of the study is presented in a table and descriptive information about the variables is provided.

Table 2. Data and Methodology Table

Symbol	Variable	Definition	Year	Source
pc_1	GDP per capita growth	Annual growth rate of real income per capita	1974-2021	World Bank
g	Technology	Rate of growth in total factor productivity	1974-2021	Our World in Data (2019-2021 data derived from ARIMA method)
fr	Fertility rate	Birth rate per woman	1974-2021	World Bank
mr	Mortality rate	Newborn mortality rate per 100 births	1974-2021	World Bank

e(2)	School enrollment, secondary	Gross enrollment ratio for secondary school is calculated by dividing the number of students enrolled in secondary education regardless of age by the population of the age group which officially corresponds to secondary education, and multiplying by 100.	1974-2021	World Bank
e(3)	School enrollment, tertiary	Gross enrollment ratio for tertiary school is calculated by dividing the number of students enrolled in tertiary education regardless of age by the population of the age group which officially corresponds to tertiary education, and multiplying by 100.	1974-2021	World Bank
pg	Population growth	Percentage change in population according to the population of the previous year	1974-2021	World Bank

The analysis period is 1974-2021. The reason for choosing 1974 as the starting year is that it is the year when the "Basic Law on National Education", which is considered as the first major change in education policies in Turkiye and defines the profile of the citizens to be raised, was enacted (Yıldız and Yıldız, 2016; Çakıroğlu and Çakıroğlu, 2003).

VAR analysis approach was chosen to analyze the research hypothesis. The reason for choosing this method is that the Galor-Weil (2000) model shows the causality relationship and the explanation power of the variables with the variance decomposition test.

4. Analysis Results

In time series analyses, the stationarity of the data is first checked by unit root tests. Extended Dickey-Fuller (ADF) and Phillips-Peron (PP) tests are used for stationarity checks. The results of the unit root tests are shown in Table 1. According to the unit root test results shown in Table 1, all variables are stationary at I(0) level.

Table 3. Unit Root Tests

Level				
	Constant		Constant and Trend	
	ADF	PP	ADF	PP
pcı	-6,22***	-6,62***	-4,98***	-6,69***
g	-5,56***	-8,24***	-5,67***	-8,34***
fr	-6,51***	-5,04***	-3,70**	-3,50**
mr	-3,17**	-8,66***	-3,34*	-5,49***
e(2)	-4,58***	-6,43***	-4,57***	-4,41***
e(3)	-4,13***	-4,02***	-4,09**	-3,98**
pg	-6,21***	-7,80***	-6,16***	-7,72***

Note: *, ** and *** denote stationary data at 10%, 5% and 1% statistical significance levels, respectively.

In the second stage of the analysis, the VAR model was constructed. In the third stage, the three conditions that must be provided for the VAR model to be accurate were tested. According to the test results; firstly, the modulus values of the characteristic equation are within the unit root circle and are stationary. Secondly, the model does not contain changing variance and has constant variance at 5% significance level. Finally, the model is not autocorrelated at 5% significance level. According to these results, all three conditions of VAR analysis are provided. In the fourth stage, Block Exogeneity Wald Test is applied for Granger causality analysis.

Table 4. Granger Causality Test (Block Exogeneity Wald Test) Results

sc3	→	pc1	6.421403**	There is one-way Granger causality	Increasing tertiary education increases per capita income. In terms of causality, it is consistent with the Galor-Weil (2000) model.
pg	→	sc2	5.271770*	There is mutual Granger causality	Population growth increases secondary education. The increase in the schooling rate of the child population is consistent with the escape from the Malthusian trap.

Note: *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

In the last stage of the analysis, Variance decomposition test is performed. With this test, the explanation powers of the variables on each other in the short and long run are obtained. Thus, the changes in the explanation power of variables in Turkiye's demographic transformation process are detailed. In this way, Turkiye's consistency with the Galor-Weil (2000) model is examined more clearly.

Table 5. Variance Decomposition Test Results

	Yıl	PCI	PG	FR	MR	SC2	SC3	G
Growth in Per Capita Income	1	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	2	83.92017	1.746161	0.052535	0.612872	0.065411	12.90158	0.701274
	3	77.17986	4.174037	0.340193	1.509308	2.224699	11.89502	2.676884
	4	72.42220	5.818406	2.563448	1.990479	2.127312	12.57314	2.505016
	5	71.32958	6.477764	3.033500	2.003459	2.282064	12.32194	2.551697
	6	69.92516	8.247733	3.052569	1.962713	2.246278	12.06606	2.499492
	7	69.85991	8.241432	3.056717	1.962214	2.242519	12.04629	2.590919
	8	69.71018	8.291271	3.072719	1.954784	2.235368	12.06304	2.672637
	9	69.62276	8.384966	3.071481	1.955634	2.234124	12.05900	2.672037
	10	69.56235	8.437486	3.071405	1.959054	2.232182	12.05535	2.682173
Growth Population Rate	Yıl	PCI	PG	FR	MR	SC2	SC3	G
	1	0.001237	99.99876	0.000000	0.000000	0.000000	0.000000	0.000000
	2	0.424283	96.09975	2.395401	0.182066	0.896489	0.000889	0.001126
	3	0.922817	90.05338	2.934709	0.166248	0.843593	0.633608	4.445643

4	1.500341	88.81557	3.382814	0.170162	1.058944	0.622592	4.449575
5	1.533959	88.09919	3.405824	0.191309	1.106187	0.816845	4.846686
6	1.606902	87.37815	3.956989	0.250131	1.097068	0.825001	4.885755
7	1.599367	87.32242	4.013693	0.260595	1.112890	0.820045	4.870992
8	1.607744	87.31291	4.019264	0.260811	1.122568	0.818091	4.858611
9	1.619581	87.26531	4.030782	0.261947	1.121616	0.822986	4.877780
10	1.626760	87.24624	4.032054	0.261900	1.121756	0.822678	4.888613

Fertility Rate

Yıl	PCI	PG	FR	MR	SC2	SC3	G
1	0.865274	0.657383	98.47734	0.000000	0.000000	0.000000	0.000000
2	4.328903	2.724952	89.86181	0.379785	1.566329	1.012625	0.125599
3	3.442669	4.029963	88.04310	1.827666	1.732258	0.677875	0.246472
4	3.083148	4.292347	84.88802	4.440387	2.442382	0.647099	0.206614
5	2.987088	4.446787	80.65385	8.233292	2.834702	0.644208	0.200070
6	2.816258	4.791004	75.80511	12.67899	3.013746	0.711011	0.183874
7	2.652995	4.639558	71.30079	17.29337	3.135284	0.798914	0.179091
8	2.502677	4.453530	67.09055	21.73120	3.185385	0.860960	0.175699
9	2.375996	4.321978	63.32166	25.67216	3.182868	0.929525	0.195816
10	2.266940	4.149406	60.10932	29.08301	3.159342	1.001864	0.230115

Mortality Rate

Yıl	PCI	PG	FR	MR	SC2	SC3	G
1	0.187498	0.124866	2.979193	96.70844	0.000000	0.000000	0.000000
2	0.065837	0.260802	0.894553	98.52071	0.055441	0.036334	0.166322
3	0.030316	0.342601	0.361251	97.82560	0.516314	0.301824	0.622095
4	0.068792	0.187357	0.225232	97.06965	0.926506	0.621113	0.901347
5	0.131884	0.193199	0.275016	96.28478	1.164183	0.913612	1.037329
6	0.174291	0.253167	0.484770	95.56466	1.331307	1.122234	1.069566
7	0.201936	0.321446	0.788767	94.92595	1.489424	1.238672	1.033809
8	0.229914	0.410105	1.114015	94.28500	1.643399	1.316064	1.001499
9	0.254848	0.491321	1.400220	93.70569	1.782685	1.385327	0.979913

	10	0.274647	0.571861	1.630166	93.21683	1.900273	1.447942	0.958285
	Yıl	PCI	PG	FR	MR	SC2	SC3	G
Secondary Education	1	1.221247	5.216616	4.727158	1.454106	87.38087	0.000000	0.000000
	2	3.200508	6.385396	6.017782	2.087826	78.97200	3.309541	0.026947
	3	3.772640	10.59166	6.074947	2.132661	73.89994	3.348166	0.179985
	4	4.311556	15.58328	5.795744	1.992491	68.75794	3.218204	0.340783
	5	4.283512	15.48480	6.046408	1.985043	68.24704	3.367933	0.585266
	6	4.447961	16.00311	5.974505	1.964884	67.42391	3.410348	0.775292
	7	4.421382	16.44924	5.940335	1.953992	66.98743	3.465968	0.781655
	8	4.416584	16.47465	5.941278	1.952473	66.88792	3.466431	0.860658
	9	4.418860	16.55135	6.000340	1.948226	66.74217	3.461522	0.877526
	10	4.419116	16.61281	6.011312	1.946536	66.67531	3.458264	0.876649
	Yıl	PCI	PG	FR	MR	SC2	SC3	G
Tertiary Education	1	1.923142	0.056485	8.862931	0.328396	5.955412	82.87363	0.000000
	2	12.52119	0.282525	8.571229	1.578982	3.992482	72.93550	0.118094
	3	12.05058	1.081225	8.590483	3.601833	4.307398	69.09928	1.269204
	4	12.84239	1.449964	8.564108	4.983141	4.142050	66.77692	1.241421
	5	13.16752	3.155099	9.960070	5.435724	3.916423	63.12985	1.235319
	6	12.87980	3.060637	12.35361	5.543846	3.788702	61.09161	1.281791
	7	12.65977	3.011024	13.48054	5.499743	3.767973	60.15263	1.428314
	8	12.58389	3.088416	13.78736	5.477838	3.784626	59.85886	1.419004
	9	12.58364	3.092412	13.79859	5.478975	3.792242	59.83472	1.419419
	10	12.58076	3.097010	13.80262	5.477902	3.791440	59.82336	1.426914
	Yıl	PCI	PG	FR	MR	SC2	SC3	G
Technology	1	84.48781	0.130274	0.000240	0.357878	0.143173	0.329655	14.55097
	2	73.96732	3.186723	1.557225	0.299140	0.671302	7.523536	12.79475
	3	72.98664	3.195673	1.535549	0.297836	1.309521	7.445704	13.22908
	4	71.26751	4.220408	1.500595	0.306328	1.456434	8.335545	12.91318

5	71.04171	4.235614	1.699226	0.374583	1.518669	8.291225	12.83897
6	70.31580	4.844623	1.961806	0.424894	1.528994	8.210656	12.71323
7	70.19977	4.895511	2.047353	0.435362	1.534509	8.186606	12.70089
8	70.05330	4.977950	2.110882	0.438076	1.532565	8.198229	12.68900
9	70.02397	5.000008	2.124586	0.437970	1.532696	8.196515	12.68426
10	69.98870	5.023347	2.128929	0.438052	1.531918	8.198598	12.69045

According to the variance decomposition test results, the entire change in the growth in per capita income in the short run is explained by itself. However, the explanatory power of tertiary education and population growth rate on the growth in per capita income increases from the second period onwards. In the long run, tertiary education and population growth rate are also among the determinants of growth in per capita income.

The entire change in the population growth rate in the short run is explained by itself. Although this rate decreases to 87% in the long run, other variables do not have a significant explanation power on population growth rate in the long run.

In the short run, the entire change in fertility is explained by itself. In the long run, the explanation power of newborn mortality rates on fertility is about 30%. The effect of the change in newborn mortality rates on fertility in the long run is consistent with the Malthusian trap theory. However, secondary education has no explanation power on fertility. According to this result, the quantity-quality transfer, which is the first step to escape from the Malthusian trap, is not realized in Turkiye.

The entire newborn mortality rate is explained by itself both in the short run and in the long run. No other variable has explanation power over the mortality rate in the short and long run. According to the Galor-Weil (2000) model, an increase in the conscious population along with education will reduce newborn mortality rates. Therefore, according to the model, secondary education is expected to have a significant explanation power on newborn mortality rate. However, according to the analysis findings, this is not the case for Turkiye.

While 87% of the change in secondary education in the short run is explained by itself, this rate drops to 66% in the long run. The explanation power of population growth, on the other hand, rises from 5% in the short run to 16% in the long run. Therefore, population growth slightly increases the participation rate in secondary education.

While 82% of the change in tertiary education in the short run is explained by itself, this rate drops to 59% in the long run. The explanation power of fertility for tertiary education increases from 8% to 13% in the long run. Moreover, the explanation power of the growth in per capita income is almost nonexistent in the short run but increases to 12% in the long run. Accordingly, the growth in per capita income affects the level of tertiary education in Turkiye.

While 84% of the short-run change in technology is explained by the growth in per capita income, only 14% is explained by itself. In the long run, the power of technology to explain itself drops to 12%, while the power of growth in per capita income to explain technology drops to 70%. The explanation power of tertiary education for technology starts in the second period and does not exceed 7-8%. According to the results of the analysis, tertiary education has no effect on technology in Turkiye. According to this result, the argument that the increase in the quality of human capital, which is necessary to escape from the Malthusian trap, supports technological development is not valid in Turkiye.

5. Conclusion

Galor-Weil (2000) argues that the Malthusian trap can be escaped through technological development as a result of quantity-quality transfer. In this study, the Galor-Weil (2000) model is tested on Turkiye, an economically depressed country that struggled for independence in the early 20th century. The Turkish government enacted its first national education policy in 1924, one year after the foundation of the Republic. These policies were aimed at demographic transformation and the acquisition of qualified human capital. In 1934, the first five-year industrial development plan entered into force. The aim of this plan was similarly to realize a technological breakthrough by achieving a quantity-quality transformation.

According to the results of Granger causality and variance decomposition test for the period 1974-2021 in Turkiye, none of the variables indicating that a country has escaped the Malthusian trap within the framework of the Galor-Weil (2000) model is statistically significant. Although fertility and mortality rates have decreased and the level of secondary and tertiary education has increased, the population has not been transformed from quantity to quality. As it is known, the first stage of escape from the Malthusian trap is quantity-quality transformation. For this transformation, parents are expected to shift their preferences in family planning from quantity to quality. Therefore, the explanation power of secondary education on fertility is expected to increase significantly over time. Then, the explanation power on technological development is expected to shift from growth in per capita income to tertiary education. When this process is completed, the second stage required to escape the trap is successfully completed. However, according to the results of the analysis, this process does not work in Turkiye. At this point, there is a situation that is not mentioned in the Galor-Weil (2000) model, but which causes the process to fail if it is not realized. This is the quality of education. The level of technology in Turkiye is declining despite the increase in the level of tertiary education. The decline in fertility cannot be explained by the level of secondary education. This is because, despite the increase in the level of secondary and tertiary education in Turkiye for the analyzed period, there is no transition from quantity to quality in education.

Education in Turkiye has increased significantly in quantitative terms over the years, both in secondary and tertiary education. However, the increasing educated population is not transformed into human capital and does not produce high value-added output. Moreover, education policies in Turkiye are subject to frequent changes in both ideological and structural terms. Although governments resort to structural changes to improve education and set a standard during their terms, they are not successful in coordinating them. In this situation, even though each new government makes well-intentioned changes, this situation negatively affects the quality of education. As a result of the decline in the quality of education, although the educated labor force increases, human capital accumulation cannot be achieved. Therefore, Turkiye fails to produce human capital. As a result, it cannot be concluded that Turkiye has escaped the Malthusian trap. Galor-Weil model is not valid for Turkiye.

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