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# An alternative test of Kuznets' hypothesis

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**Abstract** This paper uses a novel approach for testing Kuznets' hypothesis. Following Kuznets' original insights, we test for an inverted U relationship between employment outside agriculture and income inequality, instead of the traditional focus on GDP per capita and income inequality. Our results, obtained using panel and country by country regressions, do not support Kuznets' hypothesis.

**Keywords** Kuznets' hypothesis · Kuznets' curve · Economic development and inequality · Rural–urban migration · Employment in agriculture

## 1 Introduction

This short paper offers an alternative test of the well-known and much discussed Kuznets' "inverted U" hypothesis. To the best of our knowledge, this test has not been performed previously in the literature. Our results reject Kuznets' hypothesis as an empirical regularity that can be observed in most countries.

Kuznets' hypothesis, that income inequality first increases and then decreases as countries experience economic development, has surely been one of the most discussed propositions in economics.[1] The number of papers testing Kuznets' intuitively appealing "inverted U" relationship is very large. Early papers, performed using essentially cross-country datasets, found support for the hypothesis; but this has

[1] An excellent review of the literature is provided by Fields [8, chapter 3].

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since been disproved by papers using larger datasets allowing for panel estimation or country by country regressions.[2]

From a methodological point of view, panel estimation and country by country regressions are superior to cross-country regressions when testing Kuznets' hypothesis. The process described by Kuznets is inherently dynamic and ought to be tested by analyzing how countries change over time. Using cross-section data for this purpose implicitly assumes that all countries follow the same development path regardless of their particular history, institutions, culture and geography.

What all papers in this literature have invariably done, however, is to interpret Kuznets' hypothesis as a relationship between GDP per capita and income inequality. This paper takes a different route, and interprets Kuznets' hypothesis as a relationship between the share of the population employed in agriculture and income inequality.

In his seminal 1955 article, Simon Kuznets did not just state that economic development should cause an inverted U pattern on income inequality; he discussed the mechanisms that would lead to this pattern. Kuznets' view of the process of economic development, like most thinking on the subject at the time, was focused on the progressive shift from a "traditional" and low productivity sector to a "modern" and high productivity sector. Kuznets, like many others with him, interpreted this traditional sector as agriculture.

It is easy to understand why such shifts in the employment of the labor force would create an inverted U pattern in income inequality. The initial and final stages of the process would be characterized by a low level of inequality: everybody is a poor rural laborer before development begins while everybody is an urban worker when the process finishes. The intermediate stages would be characterized by higher inequality due to the difference between urban workers and farm labourers.

That these shifts in the employment of the labor force were at the core of Kuznets' thinking is evident when we look at Kuznets' argumentation. Most of it was not based on data, of which he had very little, but on a simulation exercise of the process of development. This simulation consisted precisely of an economy with two sectors, "agriculture" and "all others", where employment in agriculture would shift progressively from 80% to 20% of the labor force [11, pages 12–17].[3]

While GDP per capita and employment in agriculture are no doubt related, the latter measure corresponds better to the mechanism stressed by Kuznets. Moreover, GDP per capita presents some problems of its own since it will be affected by many factors besides the shifts in population outside agriculture and we do not have a widely accepted theory as to the effects of such factors on inequality.

This paper contributes to the literature on Kuznets' hypothesis by testing for an inverted U relationship between the share of the population employed in agriculture and income inequality.[4] We also use the share of the population living in urban

[2]Examples of this more recent literature are Deininger and Squire [6], Barro [4], Frazer [9], Higgins and Williamson [10], Li et al. [12] and Matyas et al. [13]. Deininger and Squire [6] and Fields [7] investigate the validity of Kuznets' hypothesis in a country by country framework.

[3]More rigorous modellings of the process and of its effects on inequality were provided by Robinson [14] and Anand and Kanbur [1].

[4]The ideal measure for our study would be the share of the population employed in "traditional" agriculture since modern, mechanized agricultural production was certainly not in Kuznets' mind.

areas as a reasonably close alternative measure that allows us to expand the country coverage.

## 2 Data and methodology

Most of the literature tests for the presence of a Kuznets' curve by regressing income inequality on GDP per capita and its square. If the coefficients on these two regressors have, respectively, a positive and a negative sign an inverted U relationship is in place. We follow this same procedure but replace GDP per capita with the variables discussed below.

Our first choice of regressor is the percentage of the population employed *outside* agriculture (since Kuznets' mechanism is that inequality first increases and then decreases as people shift from agriculture into the rest of the economy). The variable is calculated as one minus the percentage of the labor force employed in agriculture, taken from the World Bank's World Development Indicators (Edition 2006). The number of observations and country coverage for this variable is quite restricted and it only covers the period 1980–2005. For this reason we will also use the share of the population living in urban areas as a reasonably close alternative that allows us to expand the country and time coverage. For this second variable the data covers the period 1960–2005 for a total of 226 countries and regions. The source for this second variable is also the World Bank.

Our source for income inequality data is the World Income Inequality Database version 2.0, published by the World Institute for Development Economics Research at the United Nations University (UNU-WIDER). This is the largest secondary database on income inequality available and contains, among many other sources, the work of Deininger and Squire [5], diverse estimates made by the World Bank and the data from numerous national statistical agencies. The full database contains over four thousand observations of Gini coefficients for most countries in the world, mainly over the last five decades.

We test for the effects of agricultural employment on inequality using two alternative econometric methodologies. First, we pool all countries together and consider a panel regression. The implicit assumption is then that a given shift of population outside agriculture produces the same effect on inequality in all countries. We also use this methodology when we group countries by region.

The second methodology is to estimate separate regressions for each country, using the longest possible time series for each one of them. This approach allows for a given shift of population outside agriculture to produce different effects on inequality in different countries.

In both methodologies we deal with the problem of comparability between inequality measures from different sources by including a fixed effect for each source (and not just for each country). This means that if the time series for a certain country includes some observations that have been calculated by the World Bank and others that have been calculated by the local statistical institute we assign a fixed effect

To the best of our knowledge, there is no data on employment in "traditional" agriculture; and in any case such a measure would be highly correlated with the measure we use (total employment in agriculture).

to each set of observations. This is of importance since a difference between two inequality measures from different sources may well be due to differences in factors such as the equivalence scale, the definition of income, the population coverage, the weighting of observations and so on.[5]

## 3 Empirical results

### 3.1 Panel regressions

The result from our panel regressions are reported in Table 1 (using the percentage of the labor force employed outside agriculture) and in Table 2 (using the percentage of the population living in urban areas). The first column of these two tables presents our baseline regression, when all countries are taken together. With the population employed outside agriculture as the regressor the signs of the coefficients correspond to a U-shaped relationship, and they are both statistically significant. When we use the urban population as regressor the signs of the two coefficients still denote a U-shaped relationship but this time they are not statistically significant. Thus, when all countries are taken together the results do not support Kuznets' hypothesis.

A look at the $R^2$ coefficient of this regression reveals that most of the variation of the endogenous variable is being explained (95% in Table 1, 94% in Table 2). This high explanatory power is common for panel regressions of inequality and is due to the presence of the fixed effects. If the fixed effects are not included and we estimate a single intercept for all countries the explanatory power of the regression falls to 8.8% when using the population employed outside agriculture and to 4% when using urban population (not shown in the tables). This is additional evidence against Kuznets' hypothesis: agricultural employment and its square are only marginally relevant in explaining the variation in the data.[6]

All remaining columns in Tables 1 and 2 repeat the panel estimation from the first column in diverse sub-groups of countries. Column 2 investigates the possibility that Kuznets' hypothesis characterizes only developing countries by excluding high income countries from the sample. We use the World Bank's definition of high income countries, which includes not just Western Europe, North America and Japan but also countries such as Korea, Hong Kong, Singapore and many small states. When using employment outside agriculture as regressor we find no evidence of a Kuznets curve among developing countries (column 2 of Table 1). The same regression using the urban population (column 2 of Table 2) results in an inverted U relationship but only one of the two parameters is statistically significant. The evidence is therefore still not supportive of Kuznets' hypothesis.

Columns 3 to 7 in Table 1 and columns 3 to 8 in Table 2 group countries by geographical location (Table 1 does not include sub-Saharan Africa due to insufficient data). When using employment outside agriculture, we find an inverted

[5] See Atkinson and Brandolini [3] on the importance of this issue. More details on this procedure can be found in Angeles [2].

[6] Deininger and Squire [6]) and Matyas et al. [13] present similar results: very high $R^2$ coefficients in the presence of fixed effects and much lower values when these are removed. Matyas et al. [13] also interpret this as evidence against Kuznets' hypothesis.

**Table 1** Panel regressions using employment outside agriculture as explanatory factor

| | (1) All countries | (2) Developing countries | (3) East Asia and the Pacific | (4) Europe and Central Asia | (5) Latin America and the Caribbean | (6) Middle East and North Africa | (7) South Asia |
|---|---|---|---|---|---|---|---|
| Employment outside agriculture | −0.5304 | −0.1295 | 0.4189 | −2.9272 | −0.6931 | −61.0133 | 3.3428 |
| (p-value) | (0.0) | (0.43) | (0.02) | (0.0) | (0.05) | (0.27) | (0.32) |
| Employment outside agriculture, squared | 0.0040 | 0.0005 | −0.0029 | 0.0189 | 0.0050 | 0.3220 | −0.029 |
| (p-value) | (0.0) | (0.67) | (0.10) | (0.0) | (0.03) | (0.26) | (0.39) |
| Turning point[a] | 66.3 | 129.5 | 72.2 | 77.4 | 69.3 | 94.7 | 57.6 |
| $R^2$ | 0.9586 | 0.9575 | 0.9396 | 0.8883 | 0.9412 | 0.9916 | 0.8389 |
| Number of observations | 1583 | 784 | 200 | 963 | 270 | 11 | 24 |

[a] value of the share of employment outside agriculture, in percent, at which the U or inverted U shape turns. A value larger than 100 implies that the relationship is monotonically increasing or decreasing over the admissible range (0,100)

**Table 2** Panel regressions using urban population as explanatory factor

| | (1) All countries | (2) Developing countries | (3) East Asia and the Pacific | (4) Europe and Central Asia | (5) Latin America and the Caribbean | (6) Middle East and North Africa | (7) South Asia | (8) Sub-Saharan Africa |
|---|---|---|---|---|---|---|---|---|
| Urban population | −0.0487 | 0.2759 | 0.8766 | −0.8556 | −0.5364 | −0.9016 | 0.1200 | 0.4830 |
| (p-value) | (0.57) | (0.03) | (0.0) | (0.0) | (0.08) | (0.20) | (0.79) | (0.62) |
| Urban population, squared | 0.0011 | −0.0018 | −0.0093 | 0.0070 | 0.0044 | 0.0044 | 0.0015 | −0.0055 |
| (p-value) | (0.14) | (0.13) | (0.0) | (0.0) | (0.06) | (0.13) | (0.90) | (0.69) |
| Turning point[a] | 22.1 | 76.6 | 47.1 | 61.1 | 60.9 | 56.3 | 40.0 | 43.9 |
| R2 | 0.9420 | 0.9429 | 0.9185 | 0.8634 | 0.9144 | 0.7521 | 0.7932 | 0.8355 |
| Number of observations | 2602 | 1442 | 336 | 1417 | 402 | 48 | 112 | 132 |

[a] value of the urban ratio, in percent, at which the U or inverted U shape turns. A value larger than 100 implies that the relationship is monotonically increasing or decreasing over the admissible range (0,100)

U relationship in two regions (though none is statistically significant) and a U-shaped relationship in three regions (two of which are statistically significant). When using urban population our findings are two inverted U relationships (one of them significant), three U-shaped relationships (one significant) and one monotonically increasing relationship (not significant). Support for Kuznets' hypothesis remains thus elusive: we are at least as likely to find U-shaped relationships as inverted U relationships in different country groupings.

### 3.2 Country by country regressions

Here we follow Deininger and Squire [6] and test for the presence of a Kuznets curve by considering each country individually. We select for this purpose the countries having experienced considerable rural–urban migration, defined as an increase of the urban ratio of at least 12%. There are 32 countries in our dataset for which the percentage of urban population has increased by at least 12% between our earliest and latest observation of inequality.[7] Individual regressions are estimated for each of these 32 countries when we use urban population as our regressor (Table 4). When we use employment outside agriculture, however, the number of countries available is reduced to 20 due to the data limitations on this variable (Table 3).

In Table 3, each of the 20 countries fall into one of four groups according to the results of its individual regression: countries with an inverted U relationship and statistically significant coefficients, countries with a U-shaped relationship and statistically significant coefficients, and the two corresponding cases where the coefficients are not statistically significant. The first result that comes from this table is that it is roughly as likely to find an inverted U or a U-shape when we examine countries individually (ten countries on each case). This is what we would expect if employment outside agriculture is not systematically related to inequality in any particular way.

Moreover, in 17 out of the 20 cases of Table 3 the relationship is not statistically significant, reinforcing the case against any empirical regularity linking these two variables. Only one out of the 20 countries considered presents a statistically significant inverted U relationship, roughly what we would expect from pure randomness with a 5% threshold on statistical significance.[8]

Similar results are reported in Table 4 using urban population. This time 13 countries present an inverted U relationship, 18 a U-shaped relationship and 1 presents a monotonic relationship. As before, the majority of the estimated coefficients are not statistically significant. Of the 32 countries considered only 4 present a statistically significant inverted U relationship. Moreover, none of these last four countries is from the developing world; a fact that, given the time coverage of the present study, further contradicts Kuznets' hypothesis.

Overall, when we examine countries individually we do not find a systematic pattern linking employment outside agriculture or urban population with inequality. The occurrence of statistically significant inverted U curves is rare enough to be due to pure randomness (one case out of 20 with employment outside agriculture, four

[7]The conclusions of this exercise would not change if the threshold for "considerable change" is set at a level higher than 12%. Angeles [2] has more details on this selection process.

[8]It should be noted, however, that in some regressions the lack of statistical significance may be caused by the reduced number of observations.

**Table 3** Country by country regressions using employment outside agriculture as explanatory factor

| Country | Employment outside agriculture | p-value | Employment outside agriculture, squared | p-value | Turning point[a] | $R^2$ | Number of observations |
|---|---|---|---|---|---|---|---|
| Inverted U relationships, statistically significant | | | | | | | |
| Netherlands | 178.561 | 0.005 | −0.931 | 0.005 | 95.9 | 0.909 | 43 |
| Inverted U relationships, not statistically significant | | | | | | | |
| Korea | 0.363 | 0.889 | −0.005 | 0.777 | 36.3 | 0.717 | 15 |
| Brazil | 3.164 | 0.565 | −0.018 | 0.622 | 87.9 | 0.694 | 30 |
| Bulgaria | 22.540 | 0.101 | −0.149 | 0.092 | 75.6 | 0.893 | 36 |
| Philippines | 3.583 | 0.418 | −0.029 | 0.459 | 61.8 | 0.773 | 23 |
| Mexico | 55.416 | 0.126 | −0.344 | 0.127 | 80.5 | 0.821 | 14 |
| Japan | 34.287 | 0.321 | −0.181 | 0.330 | 94.7 | 0.935 | 10 |
| Greece | 3.011 | 0.416 | −0.022 | 0.366 | 68.4 | 0.749 | 11 |
| Spain | 0.247 | 0.915 | −0.002 | 0.869 | 61.8 | 0.915 | 47 |
| Poland | 2.039 | 0.632 | −0.009 | 0.744 | 113.3 | 0.898 | 66 |
| U-shaped relationships, not statistically significant | | | | | | | |
| Turkey | −0.358 | 0.950 | 0.001 | 0.988 | 179.0 | 0.988 | 6 |
| Malaysia | −7.149 | 0.105 | 0.047 | 0.104 | 76.1 | 0.894 | 12 |
| Costa Rica | −7.080 | 0.309 | 0.047 | 0.306 | 75.3 | 0.914 | 23 |
| China | −0.249 | 0.874 | 0.009 | 0.644 | 13.8 | 0.697 | 15 |
| Venezuela | −24.625 | 0.162 | 0.140 | 0.166 | 87.9 | 0.935 | 46 |
| Israel | −61.013 | 0.268 | 0.322 | 0.260 | 94.7 | 0.992 | 10 |
| Dominican Republic | −59.685 | 0.124 | 0.363 | 0.124 | 82.2 | 0.850 | 7 |
| Panama | −3.939 | 0.354 | 0.026 | 0.346 | 75.8 | 0.661 | 15 |
| U-shaped relationships, statistically significant | | | | | | | |
| Finland | −23.376 | 0.000 | 0.134 | 0.000 | 87.2 | 0.976 | 85 |
| Chile | −50.802 | 0.002 | 0.310 | 0.001 | 81.9 | 0.745 | 37 |

[a]value of the share of employment outside agriculture, in percent, at which the U or inverted U shape turns. A value larger than 100 implies that the relationship is monotonically increasing or decreasing over the admissible range (0,100)

**Table 4** Country by country regressions using urban population as explanatory factor

| Country | Urban population | p-value | Urban population, squared | p-value | Turning point[a] | $R^2$ | Number of observations |
|---|---|---|---|---|---|---|---|
| Inverted U relationships, statistically significant | | | | | | | |
| Greece | 4.867 | 0.009 | −0.048 | 0.011 | 50.7 | 0.947 | 25 |
| Spain | 10.086 | 0.000 | −0.073 | 0.000 | 69.1 | 0.922 | 55 |
| Netherlands | 5.778 | 0.001 | −0.040 | 0.001 | 72.2 | 0.908 | 45 |
| France | 8.933 | 0.006 | −0.071 | 0.003 | 62.9 | 0.986 | 27 |
| Inverted U relationships, not statistically significant | | | | | | | |
| Korea | 0.786 | 0.096 | −0.009 | 0.066 | 43.7 | 0.474 | 31 |
| Puerto Rico | 0.069 | 0.985 | −0.002 | 0.939 | 17.3 | 0.787 | 10 |
| Japan | 1.639 | 0.278 | −0.016 | 0.262 | 51.2 | 0.698 | 31 |
| Morocco | 3.406 | 0.390 | −0.042 | 0.433 | 40.5 | 0.945 | 6 |
| Nigeria | 2.448 | 0.621 | −0.035 | 0.634 | 35.0 | 0.875 | 16 |
| Bahamas | 29.271 | 0.052 | −0.179 | 0.057 | 81.8 | 0.744 | 10 |
| Ukraine | 1.476 | 0.910 | −0.013 | 0.902 | 56.8 | 0.586 | 36 |
| Dominican Republic | 1.940 | 0.529 | −0.021 | 0.462 | 46.2 | 0.856 | 11 |
| Belarus | 4.768 | 0.099 | −0.038 | 0.086 | 62.7 | 0.944 | 35 |
| U-shaped relationships, not statistically significant | | | | | | | |
| Brazil | −0.808 | 0.720 | 0.006 | 0.676 | 67.3 | 0.234 | 37 |
| Bulgaria | −0.543 | 0.698 | 0.006 | 0.646 | 45.3 | 0.840 | 63 |
| Turkey | −1.425 | 0.346 | 0.010 | 0.441 | 71.3 | 0.949 | 11 |
| Malaysia | −0.279 | 0.717 | 0.002 | 0.797 | 69.8 | 0.740 | 18 |
| China | −0.028 | 0.982 | 0.020 | 0.346 | 0.7 | 0.808 | 32 |
| Indonesia | −1.089 | 0.184 | 0.017 | 0.214 | 32.0 | 0.809 | 19 |

**Table 4** (continued)

| Country | Urban population | p-value | Urban population, squared | p-value | Turning point[a] | $R^2$ | Number of observations |
|---|---|---|---|---|---|---|---|
| Bangladesh | −1.418 | 0.133 | 0.067 | 0.048 | 10.6 | 0.655 | 29 |
| Finland | −4.906 | 0.061 | 0.044 | 0.070 | 55.8 | 0.876 | 96 |
| Venezuela | −9.878 | 0.075 | 0.060 | 0.072 | 82.3 | 0.933 | 51 |
| Poland | −12.208 | 0.058 | 0.107 | 0.059 | 57.0 | 0.828 | 74 |
| Israel | −12.585 | 0.237 | 0.080 | 0.207 | 78.7 | 0.795 | 14 |
| Tunisia | −1.077 | 0.638 | 0.007 | 0.731 | 76.9 | 0.860 | 7 |
| Hong Kong | −52.184 | 0.207 | 0.283 | 0.219 | 92.2 | 0.680 | 10 |
| Panama | −0.906 | 0.743 | 0.008 | 0.722 | 56.6 | 0.631 | 15 |
| Chile | −12.164 | 0.294 | 0.077 | 0.269 | 79.0 | 0.779 | 39 |
| U-shaped relationships, statistically significant | | | | | | | |
| Philippines | −1.820 | 0.001 | 0.021 | 0.001 | 43.3 | 0.811 | 33 |
| Costa Rica | −2.168 | 0.007 | 0.021 | 0.009 | 51.6 | 0.614 | 28 |
| Mexico | −3.258 | 0.012 | 0.028 | 0.007 | 58.2 | 0.673 | 55 |
| Monotonic relationship, not statistically significant | | | | | | | |
| Colombia | −0.061 | 0.996 | −0.004 | 0.970 | n/a | 0.826 | 25 |

[a]value of the urban ratio, in percent, at which the U or inverted U shape turns. A value larger than 100 implies that the relationship is monotonically increasing or decreasing over the admissible range (0,100)

cases out of 32 with urban population). These tests of Kuznets' hypothesis confirm the recent results in the literature.

## 4 Conclusion

This paper provides a test of Kuznets hypothesis that has not been previously implemented in the literature. We start from the observation that Kuznets' justification for his hypothesis was based on the progressive shift of labor from agriculture towards "modern" sectors of the economy. This lead us to interpret Kuznets' hypothesis as a relationship between employment in agriculture and inequality instead of the traditional focus on GDP per capita and inequality.

Our results are quite conclusive and rejoin the more recent literature on the subject. We do not find support for Kuznets' hypothesis in panels of countries or in country by country regressions. The largest panels we consider, with all countries or with all developing countries, reject Kuznets' hypothesis. If we consider countries individually the results are not significant most of the time and we are as likely to find a U-shaped relationship as an inverted U relationship. The number of countries where a statistically significant inverted U is detected is small relative to the number of countries considered. We conclude that neither employment outside agriculture, nor the related measure of urban population, are related to inequality in any systematic way, contradicting the existence of a Kuznets' curve as an empirical regularity.

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