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Can smallholders double their productivity and incomes by 2030?

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Can smallholders double their productivity and incomes by 2030?

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Abstract

Through the sustainable development goals (SDGs), the international community has committed to double smallholder productivity and incomes by 2030, as part of efforts to end hunger and achieve food security. This paper assesses past trends in agricultural land and labour productivity, as a test whether it is feasible to meet the given target within a 15-year time span if history were to serve as a guide. The target implies agricultural productivity would need to increase by 4.6 percent per year on average during 2015-2030. Available country-level data on land productivity (1961-2012) and labour productivity (1980-2012) for 140 countries shows that past trends fall well short of the desired pace of productivity growth. No consistent long-term time series are available to assess productivity growth by size of land holding. As a proxy, we group the countries by the ratio of total agricultural land and number of workers in agriculture. We find that average productivity growth has been higher in countries where smallholder farming dominates agricultural production, taking average farm size of less than 2 hectares per worker as the threshold. Yet, at less than 3 percent per year for both land and labour productivity, continuation of past trends in these contexts would also fall well short of the target. During the observed period, there were 41 countries in the case of land productivity and 41 countries in the case of labour productivity that managed to double productivity at least once within a 15-year time span. Looking more closely at some of the success cases, it appears that pro-active government policies played a key role in pushing up productivity.

Keywords: smallholders, land productivity, labour productivity, productivity growth

JEL codes: O13, O47, Q10, Q18

1. Introduction

This study presents an empirical assessment of aggregate agricultural land and labour productivity growth across 140 countries between 1961 and 2012. During this period, global agricultural production has tripled, while the world population doubled (grew by 126 percent) and land under cultivation expanded by 8 percent (FAO, 2014 p.29). Given continued population growth, rising average incomes and urbanization, global food production is projected to increase by at least 60percent by 2050 from its 2005/07 base assuming the growing global level demand for food equals supply, according to FAO projections (Alexandratos and Bruinsma, 2012). Growth in food demand is expected to be particularly strong in the least developed countries, where population is projected to double to 1.8 billion people between 2013 and 2050 (FAO, 2014 p.28). The scope for enhancing food production by putting more land under cultivations varies starkly across regions, but generally is considered to be limited for a variety of reasons.[1] Consequently, meeting the growing demand for food will mainly need to come from yield increase (Alexandratos and Bruinsma, 2012).

Small farms account for a large proportion of agricultural holdings worldwide. Using data from the World Agricultural Census 1990 and 2000 round, FAO estimates that 72 percent of the roughly 570 million farms worldwide operate on less than 1 hectare and an additional 12 percent on less than 2 hectares (Lowder *et al.*, 2014 cited in FAO, 2014 p.10). Yet, these farms cover only 12 percent of total farmland. By far most smallholder farms are in Asia (75 percent), while 9 percent of the world total are in Sub-Saharan Africa, 7 percent in Europe and Central Asia, 4 percent in Latin America and the Caribbean 4 percent, and 3 percent in the Middle East and North Africa.

Family farms (including most smallholders) produce over 80 percent of the food consumed by the developing world (FAO, 2014 p.9), and the majority of people living under the $1.92 poverty line (in 2011 purchasing power parity US dollars) depends on agriculture to make a living. Improving smallholder farm productivity thus seems to hold the key for simultaneously achieving food security and eliminating extreme poverty (UN, 2012). The 2030 Agenda for Sustainable Development, adopted by the international community in September 2015, recognizes this notion. Target 2.3 related to the goal for ending hunger, achieving food security and making agriculture sustainable states explicitly: “By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment” (UN, 2015). Doubling productivity and incomes over a 15-year period implies, for any initial value, an average growth rate of 4.6 percent per year. A key question raised in this paper is whether, given past trends, such a pace is feasible.

Before presenting and interpreting the findings it is important to point at some caveats related to SDG target 2.3. First, as defined, it does not take into account initial conditions. Absolute gains from a doubling of productivity levels are of course much less in low-productivity contexts than those where productivity is already high. Push and pull factors for productivity growth also differ from one context to another. For instance, the dynamically growing Asian economies provide strong pull factors for agricultural growth. In Sub-Saharan Africa, in contrast, many smallholders are trapped in subsistence farming and low-paying off-farm activities (Hazell,

[1] These reasons are, for example other usage of land (forest cover, protected areas, human settlements, economic infrastructure), uneven distribution of land among regions and countries, lack of infrastructure, ecological fragility and low fertility.

2007). Country and region-specific characteristics such as the climate, the legal framework, and infrastructure make doubling productivity a very different task across countries. By just emphasizing agricultural productivity growth, other elements required to achieve more dynamic rural income growth are omitted. Such conditions relate to diversification of rural economies and income sources and capacity of smallholders to manage risks and shocks such as those associated with variable weather conditions, market volatility, and vulnerability to climate change and natural disasters (Burchi and Holzapfel, 2015).

Renewed interest in patterns of structural transformation has given added impetus to study agricultural growth paths (see, e.g. Timmer, 2015). Agricultural productivity growth traditionally has been central to classic development thinking. Countries climbing the ladder towards greater economic prosperity all tend to go through processes of structural economic transformation. Four main characteristics typify structural change: a declining share of agriculture in economic output and employment; migration of rural workers to urban areas; an increasing share of economic activity in industry and modern services in urban areas; and high population growth before a new equilibrium is reached.[2] Historical pathways of structural transformation teach us three key lessons. First, structural transformation has shown to be an important way for people to climb out of poverty, especially when productivity rises in both agricultural and non-agricultural sectors through strong inter-sectoral linkages. Without broad-based productivity growth, labour more likely will be 'pushed' into low-paying informal service jobs, rather than 'pulled' out by highly productive manufacturing and services. Second, even with broad-based productivity growth, structural transformation tends to widen the income gap between agricultural and non-agricultural sectors and between rural and urban areas, putting most of the pressure on rural societies to adjust. Third, in order to catalyze productivity growth and structural change, substantial investments in the agricultural sector are needed despite its declining relative importance (Timmer, 2015).

Obtaining a better understanding of patterns of structural change is part of a broader FAO research agenda. In this paper, we focus on the speed and nature of agricultural productivity growth. We compare country level patterns of agricultural productivity growth over the past decades in order to explore the potential for accelerating farm productivity, especially among small-scale food producers. We describe trends in land and labour productivity growth during 1961-2012.

We explore historical trends in agricultural productivity growth in 140 countries at all levels of development and across all continents (36 European, 35 Asian, 34 African, 26 from Latin America and the Caribbean, 7 from Oceania and 2 from North America). Data are from FAOSTAT covering the five decades between 1961 and 2012 for land productivity and, owing to data constraints, three decades for labour productivity (1980-2012). We measure land productivity as the value of agricultural production (measured in constant 2004-2006 international dollars) per hectare of agricultural land. Several studies have observed the so-called "inverse productivity relationship", according to which land productivity decreases with land size.[3] The conventional explanation for this phenomenon is that smaller farms use labour more intensively due to market imperfections, while differences in soil quality are considered unobservable. Barrett *et al.* (2010) investigate these conventional explanations and find that market imperfections seem to account for only about one third of the inverse relation, whereas they find no support for the explanation of soil quality. In this paper we seek to test this hypothesis further in the light of the ambitions of the sustainable development goals.

[2] This notion of structural change goes back to the founding fathers of development economics, such as Kurt Mandelbaum, W. Arthur Lewis, and Paul Rosenstein-Rodan (see, e.g., Meier and Seers, 1984 for a seminal overview), and eloquently reassessed from the perspective of agricultural development, by Peter Timmer (2015).

[3] See Barrett *et al.,* 2010 and Larson *et al.,* 2013.

The literature further contends that agricultural labour productivity, in contrast, tends to increase with land size. Small-scale farming tends to be more labour intensive, in part because these farmers lack scale and resources to invest in labour-saving technologies. Labour productivity growth should reflect growth in physical output per worker but it may well mask a shift towards higher value crops. We find that both the level and the pace of growth in labour productivity has been much lower in low-income countries than in high-income countries over the past three decades. The widening gap in labour productivity between these countries tends to be influenced further by the lack of opportunities for employment outside agriculture in low-income countries. On average, labour inputs per unit of land have continued to increase in these countries, resulting in higher land productivity growth (FAO, 2014, p.32).

The lack of sufficient micro data makes studying productivity by size of landholding a daunting task. Household surveys with agricultural questionnaires are available for a limited number of countries. At the same time, where they exist, those surveys cannot give conclusive results about aggregate agricultural productivity as they only provide information about household-based farms, omitting larger non-family commercial farms (FAO 2014, p.16). In addition, infrequent collection of those survey data hamper the construction of time series to study trends over time.

In this study, we use country-level data from FAOSTAT for the value of agricultural production, agricultural area (including arable land, permanent crops, permanent meadows and pasture), and agricultural labour.[4] This source does not disaggregate the time series by farm size. As a proxy, we compare country level performance based on the predominant form of agricultural production by size of land holding. In doing so we define the ratio of available agricultural land and the economically active population in agriculture. We detail this approach further in Section 3.

The proxy has obvious limitations and should be taken with some caution. Yet, our key finding tells us that the average pace of agricultural productivity growth over the past 50 years has been well short of that demanded by the ambitions of the 2030 Agenda. The target of doubling smallholder productivity in the 15-year timespan (2015-2030) seems equally ambitious considering historical trends.

The remainder of this paper is organized as follows. Section 2 summarizes the key findings on average productivity growth across the 140 countries in the dataset. Section 3 explains the grouping of these countries by average land size per worker, and shows the findings for productivity trends for this type of country grouping. Section 4 compares changes in land and labour productivity. Section 5 presents a number of success cases of countries that managed to double agricultural productivity within 15 years. Section 6 concludes with a summary of the key findings and needs for further research.

[4] These time series data contain missing entries that have been replaced with linear projection estimates. Please refer to the technical notes in the Annex (Section A.5) for further information.

2. Average productivity growth

In this section, we present an overview of the change in productivity for 140 countries. Land productivity is defined as the value of agricultural output per hectare of land under cultivation, land temporarily left fallow and permanent meadows, while labour productivity is defined as the value of agricultural output per worker.[5] The value of agricultural output is measured in constant 2004-2006 international dollars.

In general, both land and labour productivity have increased substantially through the observed period, though there are great differences between countries both in levels and in pace of growth. Table 1 shows that in 2015, land productivity averaged $552 per hectare for the whole sample of countries, while labour productivity was $1,973 per worker. The data show that, on average, land productivity increased by 1.96percent per year between 1961 and 2012, while labour productivity increased at an annual rate of 1.32percent. Both these rates fall short from the target rate of 4.62percent. These average trends are similar to those found in previous studies.[6]

Table 1 Level and growth of agricultural land and labour productivity, global averages

Variable, average of 140 observed countries	Land	Labour
Productivity 2015 (constant 2004-2006 Int.$ per hectare and per worker)[a]	552	1,973
Productivity growth (annual, average)[b]	1.96%	1.32%
Required growth rate to double productivity within 15 years	4.62%	4.62%
Gap	2.66%	3.30%

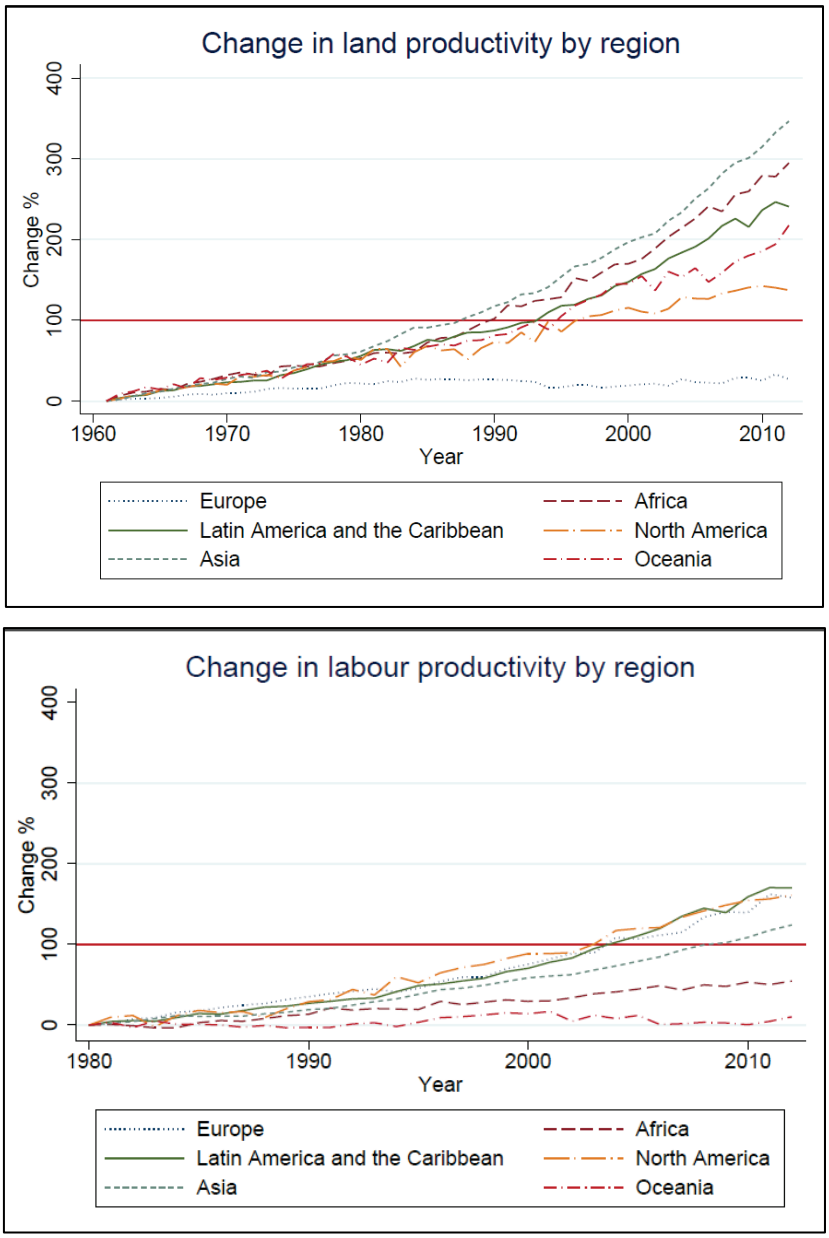
Source: Calculations based on FAOSTAT data.
[a] Estimate, linear projection from 2012
[b] Historical average of the period 1961-2012 for land productivity and 1980-2012 for labour productivity

Figure 1 depicts the cumulative growth of agricultural land and labour productivity, grouping the countries by geographical region. The reference line shows where the cumulative growth reaches 100 percent, i.e. where productivity doubles. The top panel of Figure 1 shows that with the exception of Europe, all regions managed to double land productivity during the observed period, but they needed roughly 25 to 35 years to do so. The bottom panel of Figure 1 shows that there are greater differences between the geographical regions regarding the pace of growth of labour productivity. Countries in Africa and Oceania show very slow growth and have not managed to double productivity during the observed period (1980 and 2012). Asia reached the doubling threshold in roughly 28 years, Latin America and Europe in 24 years and North America in 23 years.

[5] "Workers" are defined here as the economically active population in agriculture, as the available series for the number of employed in agriculture are not continuous for the observed time period.

[6] For instance, Fuglie (2010) and Fuglie and Wang (2012) estimate the average land productivity growth for a similar set of countries at 2.01 percent and 2.00 percent per annum for, respectively, the periods 1961-2007 and 1961-2009. For labour productivity, these studies estimate a yearly average rate of 1.25 percent and 1.19 percent, respectively, for the same periods.

Figure 1 Cumulative land (top, 1961-2012) and labour (bottom, 1980-2012) productivity growth by geographical region



Source: Calculations based on FAOSTAT data.

3. Productivity growth by proxied size of landholding

Since the aim of this study is to prepare the ground for analyzing smallholder productivity, we want to capture the average size of the agricultural holdings. As there is no reliable information on the distribution of farm size for a sufficient number of countries, the most suitable measure available is the ratio of total area of agricultural land measured in hectares and the economically active population in agriculture (average hectare per worker). Using this ratio does not allow us to account for the levels of number of workers and size. Hence, one might argue that it is a proxy for labour intensity, rather than for farm size. However, since smaller farms generally tend to use labour and natural resources more intensively (FAO, 2014 p. xi), the hectare/worker ratio can be seen as an indirect measure of farm size. Table A.3 in the Appendix compares the average farm size based on data from the World Census of Agriculture to the average hectare per worker ratio in our dataset for the Americas, Europe, Africa, and Asia.

Studying the composition of country groups thus created, we find that our proxy appears to be a good fit for average farm size when comparing the ratio with observed estimates of average size of land holding for countries for which such information is available.

Using this ratio, the 140 countries were grouped into five categories: 0-2 ha/worker, 2-5 ha/worker, 5-20 ha/worker, 20-50 ha/worker and more than 50 ha/worker. Tables 2 and 3 show agricultural productivity growth trends for these country groupings. We find that countries with a lower average farm size have experienced both faster land and labour productivity growth. At almost three per cent per annum, land productivity growth in countries dominated by smallholder farming (0-2 ha/worker) was well above the all-country average (1.97 percent per year) and above the average for any of the other country groupings with larger average size landholdings.

An explanation for the high growth rate can be that we observe land productivity from 1961, including the period of the Green Revolution, which had a great impact in Asian countries, in particular sixteen out of the 31 countries in the “0-2 ha/worker” group are Asian. If we accept this grouping as a representative measure of farm size, the figures in Table 2 are also in line with the literature on the inverse relationship between productivity and farm size (FAO, 2014 p.16).
Higher agricultural labour productivity growth rates are observed in countries with average landholdings of less than 2 hectares per worker and in countries with more than 20 hectares per worker (Table 3). Most countries in the latter group are in Europe (17 out of 36). As mentioned above, the majority of countries in the 0-2 ha/worker group are in Asia. The value of output per worker, however, declines with land size. The scatter plots in Figure A.1 and Figure A.2 of the Appendix show the dispersion of productivity within the country groups. In each group, there is great variance, but the broader trend holds: the smaller the average land size per worker, the higher land productivity and the lower labour productivity.

Table 2 Agricultural land productivity level and growth by average size of landholding (proxy), 1961-2012

Average area per worker	Land Productivity 2015[a]	Average annual growth (1961-2012, %)	Target growth rate (%)	Gap (%)
0-2 ha/worker	1,314	2.79	4.62	1.83
2-5 ha/worker	638	1.68	4.62	2.94
5-20 ha/worker	386	1.21	4.62	3.41
20-50 ha/worker	510	0.82	4.62	3.80
50- ha/worker	248	1.49	4.62	3.13

Source: Calculations based on FAOSTAT data.
[a] Estimate, linear projection from 2012. In constant 2004-2006 international dollars per hectare.

Table 3 Agricultural labour productivity level and growth by average size of landholding (proxy), 1980-2012

Average area per worker	Labour Productivity 2015[a]	Average annual growth (1980-2012, %)	Target growth rate (%)	Gap
0-2 ha/worker	1,168	2.69	4.62	1.93
2-5 ha/worker	1,849	0.61	4.62	4.01
5-20 ha/worker	3,743	1.11	4.62	3.51
20-50 ha/worker	16,345	3.08	4.62	1.54
50- ha/worker	49,865	2.72	4.62	1.90

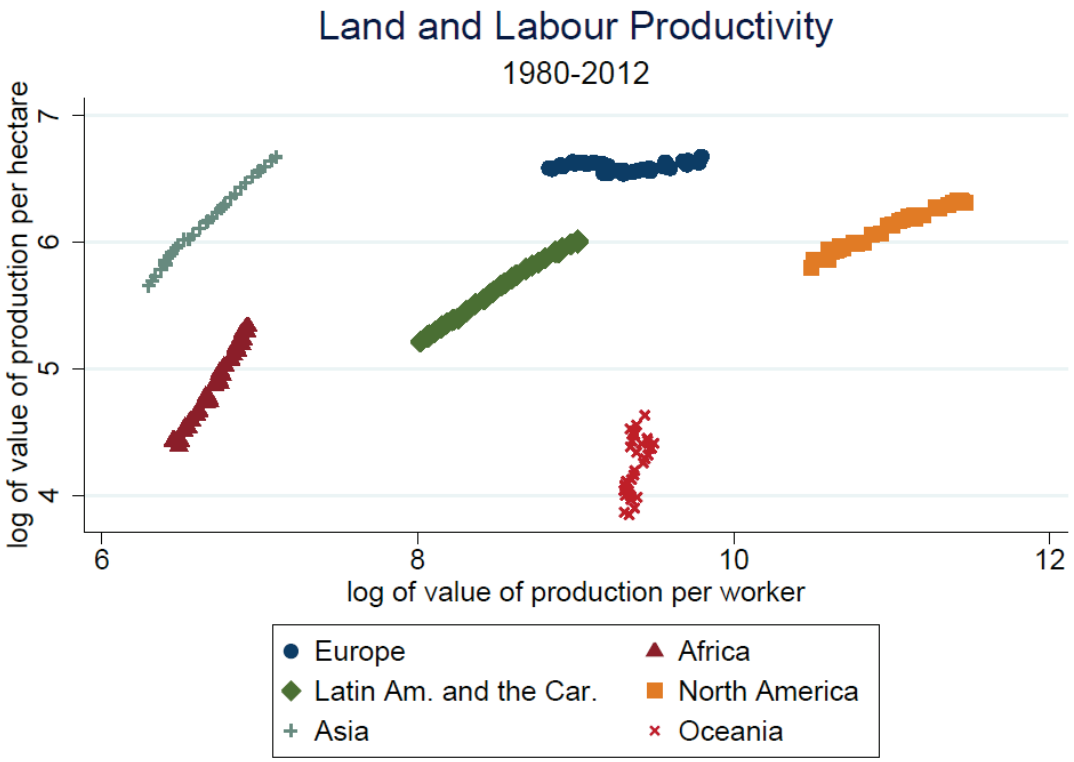
Source: Calculations based on FAOSTAT data.
[a] Estimate; linear projection from 2012. Values are in constant 2004-2006 international dollars per worker

4. Land versus labour productivity

Figure 2 plots trends in land productivity against those in labour productivity. The vertical axis shows the level of land productivity and the horizontal axis shows that for labour productivity. Values on both axes are in natural logs and cover the 1980-2012 period. Each point represents a one-year observation per geographical region. For each region, the series of points represent the change in productivity levels over time. In general, all regions show improvement in productivity: the points move from the lower left to the upper right. However, there are great differences in the slopes of the curves.

Labour productivity is generally significantly lower in low and middle-income regions. Africa, Asia and Latin America are all on the left side of the scatter diagram. The labour productivity gaps with higher income regions increase, as the slopes for low-income regions are steeper, reflecting an increase in labour intensity relative to land use intensity. One of the main reasons for this difference is that the rural labour force grows faster than opportunities for employment outside of agriculture become available in low and middle-income countries, as argued in FAO (2014). North America and Europe show much higher land and labour productivity levels throughout the period. The flat productivity lines suggest that agriculture has become less labour-intensive in these regions, as also found by Alston and Pardy (2014).

Figure 2 Land and agricultural labour productivity by geographical region, 1980-2012

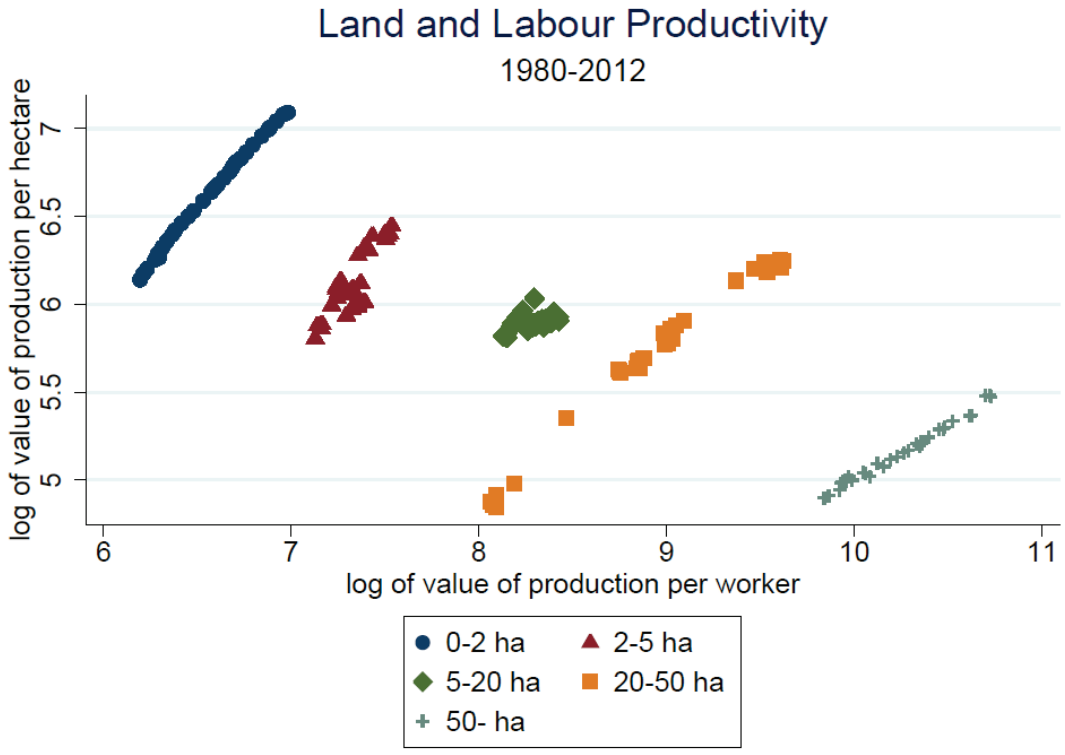


Source: Calculations based on FAOSTAT data.

Figure 3 depicts the same comparison, but grouped by average size of holding. Countries with low average land size (0-2 ha per worker) are found in the left upper corner of the plot,

showing that land productivity is high and labour productivity is low relative to the other country groups. Land productivity decreases and labour productivity increases with the size of the landholding (as proxied by hectares of agricultural land per worker). These findings are in line with those presented in Tables 2 and 3 in the previous section.[7]

Figure 3 Land and agricultural labour productivity by average size of landholding (proxy), 1980-2012



Source: Calculations based on FAOSTAT data.

Upon further examination of these findings, two things are striking. The first is the rapid pace of gain in most regions. Japan, Vietnam and China, for instance, have seen major gains in both labour and land productivity, especially since about 1980, although average farm size only started to increase in Japan since then. Most of Europe has seen gains in labour productivity via larger farm size. Eastern Europe and the countries of the former Soviet Union suffered severe reversals after the fall of communism. The most striking feature of Figures 2 and 3, however, is the stagnation of growth of labour productivity in Sub-Saharan Africa and (South) Asia and among smallholders, which already started from very low levels. Although yields per hectare have been increasing, there has been virtually no gain in agricultural labour productivity.

The second striking feature is that land consolidation had barely begun at a global level. Indeed, according to Timmer (2015), farm size continues to get smaller on average, driven by the gradually shrinking farms in Asia and the more quickly falling farm size in many parts of Africa. Farm size has been virtually constant in Latin America. Uncertain land ownership and tenancy laws in Asia and Sub-Saharan Africa may account for some of this

[7] Note that Table 2 shows productivity figures for the period of 1961-2012, while Figure 3 presents figures on the period of 1980-2012.

fragmentation in the reported size of farm holdings. Underestimation of actual agricultural labour productivity may also account for some of this, since workers counted as part of the agricultural labour force may in fact derive most of their income from off-farm sources.

5. Can agricultural productivity be doubled by 2030?

Globally, there was no 15-year period between 1961 and 2012 when overall land or labour productivity doubled on average worldwide. We use this benchmark period given the timeframe of the SDGs (2015-2030). The largest increase in land productivity was between 1993 and 2008, when land productivity grew by 46 percent. Labour productivity also increased the most between 1993 and 2008, at 34 percent. Neither any of the geographically defined regions, nor any of the groupings by land size witnessed a 100 percent increase in the given timeframe.

Beyond country group averages, there were 41 countries that managed to double land productivity and another set of 41 countries that doubled labour productivity in at least one 15-year period during 1961 and 2012, respectively between 1980 and 2012. The composition of the countries is very different in the two cases: land productivity doubled mostly in African (15) and Asian (16) countries, while labour productivity doubled mostly in European (19) countries. Table A.1 and Table A.2 of the Appendix present the complete list of countries that managed to double their land or labour productivity by geographical region and average land size. Tables 4 and 5 below summarize which Asian and African countries in the size group "0-2 ha/worker" managed to double productivity at least once within 15 years. The third column shows the starting year of the 15-year period. In Ethiopia, for instance, land productivity doubled in four sub-periods spanning between 1981 and 2005. Malawi achieved the same in two sub-periods between 1992 and 2009.

Table 4 African and Asian countries with small average farm size (0-2 ha/worker) that doubled land productivity within a 15-year period

	Country	Beginning of 15 year period
Africa	Cabo Verde	1972-1978, 1983-1985
	Ethiopia	1981, 1982, 1987, 1990
	Malawi	1992, 1994
	Rwanda	1994-1997
Asia[8]	Cambodia	1992-1994, 1996, 1997
	Republic of Korea	1962-1964, 1967, 1968
	Viet Nam	1978

Source: Calculations based on FAOSTAT data.

Table 5 African and Asian countries with small average farm size (0-2 ha/worker) that doubled labour productivity within a 15-year period

	Country	Beginning of 15 year period
Africa	Cabo Verde	1981-1986, 1994
	Egypt	1981-1989
	Malawi	1992, 1994
Asia[8]	Japan	1990-1997
	Republic of Korea	1980-1997

Source: Calculations based on FAOSTAT data.

Looking at some of these success stories of countries with fast land and/or labour productivity growth, it seems pro-active government policies played a key role. In **Ethiopia**, the government adopted and new development strategy in 1992. The strategy, called Agricultural Development-led Industrialization (ADLI), aims to stimulate farm output and rural incomes. The focus of the strategy is on increasing smallholder production and productivity through complementary interventions such as promotion of improved agricultural technologies, provision of credit services and improvement of health care services, primary education and infrastructure. In 2005, the government introduced the Productivity Safety Net Program (PSNP) to support poor households in drought prone areas. The country has experienced solid economic growth in since the early 2000s, registering a yearly average real GDP per capita growth of 6.9 percetn between 2000/2001 and 2012/2013. The poverty incidence decreased by 9.1 percentage points (from 38.7 percent to 29.6 percent) between 2004 and 2011. The prevalence of undernutrition decreased by 15 percentage points (from 55 percent to 40 percent) between 1999 and 2011 (FAOSTAT, 2015).

The Agricultural Input Subsidy Program in **Malawi** was first implemented in 2005. The large-scale program disbursed heavily subsidized fertilizers and seed to a large number of recipients. During the period after the program started, there were several improvements in production and productivity, food availability, wage increase and poverty reduction (poverty incidence has fallen by 12 percentage points in 3 years), however, positive effects have been mitigated by the price increase following the implementation of the subsidy. Some of these positive effects are also due to improvements in other circumstances (macroeconomic stabilization with low interest rates and inflation, good weather) (Dorward and Chirwa, 2011).

Rwanda also managed to double agricultural productivity levels within a fifteen-year timespan after 1994. It should be noted, however, that the doubling was achieved from very low levels when the country emerged from a devastating civil war (UHRC, 2016). Activist policies helped in the recovery. The government of **Rwanda** initiated several policy interventions lately to promote agricultural productivity growth, including the Crop Intensification Programme (initiated in 2007), the introduction of a voucher system, and a programme for land-use consolidation. Bizoza and Byishimo (2013) investigate the effects of these policies using secondary data to describe productivity trends and a household survey of 100 households. They find that the voucher system had significant positive marginal effects on crop yields. About 70 percent of the survey respondents sustained improvements in food security during the 2000s (Bizoza and Byishimo, 2013).

Cabo Verde has experienced sound economic growth in the past four decades. In 2004, the United Nations General Assembly adopted the resolution on the country's graduation from the category of least developed countries. The country also proved to be a 'fast achiever' of the Millennium Development Goals. Natural resource endowments do not favour agriculture, as only 10 percent of the land is suitable for production and farmers have to cope with severe shortage of rainfall. Sustained government policies helped reduce the high dependence on food imports. Early reforms aimed to improve access to land for agricultural production, which brought land under cultivation to full potential. Furthermore, the government recycled revenues from food aid to finance investments in the construction of dykes, planting of trees and other public works thereby shoring up basic economic infrastructure in support of agricultural productivity on the main islands. In addition, governmental policies included extension programmes, microcredit schemes for farmers, and technical support promoting drip irrigation. These policies were successful in boosting local food production and reducing rural poverty. Between 2001 and 2007 the national poverty headcount decreased by 10 percentage points (from 37 percent to 27 percent), and biggest improvements were achieved in the rural areas (African Development Bank, 2012).

Cambodia managed one of the best agricultural growth performance worldwide during the 2000s. The lives of many Cambodian farmers have changed, and farm wages doubled over the last decade. The poverty headcount dropped from 50 percent in 2007 to 18 percent in 2012, meaning 4 million people have been lifted out of poverty. Most lifted out of poverty remain in vulnerable livelihoods, however. If income per capita of those who recently exited poverty would drop by 70 dollar cents, Cambodia's poverty rate would more than double again to 40 percent. Rice remains the main staple crop, though some diversification towards vegetables, cassava and maize took place during the 2000s. Agricultural growth of the past decade relied heavily on land expansion. This is now reaching its limits and growth has decelerated significantly in recent years. Rising global food prices were another driver of the growth of Cambodia's agricultural sector. Recent declines in food prices also explain the more recent slowdown. The changing conditions call for a different approach to achieve more efficient use of resources by shifting to modern agricultural technologies, increased use of quality seeds, fertilizers and irrigation (Joosu-Palu, 2015).

In 1981, the government of **Vietnam** introduced major agrarian policy reforms. The new policy framework allowed cooperatives (who were in total control of production before) to distribute land plots to households based on an annual production contract. Further reforms followed in 1988, when farmers were allowed to sell their own products (after paying taxes) and become independent economic agents. From 1989, Vietnam became a net food exporter and agricultural production grew on average by 5.3 percent per year on average to 2008 (Din Hoe, 2012). Agricultural production and productivity growth facilitated industrial development and was a major factor in downing rural poverty, which fell from 49.2 percent in 1992 to 4.8 percent in 2010 (World Bank, 2015). The share of agriculture in the GDP has dropped from roughly 40 percent to 20 percent during the same period. Din Hoe (2012) points out that the slowdown caused by the transfer of resources from agriculture to other sectors needs to be offset with new technologies increasing total factor productivity to allow the sector to continue to contribute to industrialization and the country's economic development.

6. Conclusions

Given future limits to area expansion for agricultural production, land productivity is expected to increase to meet growing global food demand in 2030. Labour productivity should increase in smallholder households if goals for poverty reduction and elimination of hunger are to be met.

The new international development agenda has set the ambitious target of doubling smallholder productivity and incomes over the next 15 years. Increases in labour productivity may be achieved through higher on-farm yields, but may also need to come through increases in farm size. Such a combination would imply that some smallholder farmers leave the agricultural sector for better income opportunities off the farm, whether in rural non-farm activities or in urban employment.

The empirical findings of this paper suggest that it will be challenging, though not impossible for the world to achieve the target set. Four findings stand out:

- Over the past half century, both land and agricultural labour productivity growth was well short from the proposed target rate of 4.62 percent.
- On average, countries with a lower average farm size have experienced faster productivity growth, but still well below the desired pace.
- Land productivity increased faster compared to labour productivity in low-income, while middle and high-income countries saw bigger absolute gains in labour productivity.
- There was no 15-year period between 1961 and 2012 when global or regional level productivity doubled. A fair number of individual countries did manage to double land and/or labour productivity within a 15-year time span. Case studies suggest that pro-active governmental policies played an important role.

The target of doubling productivity is set for smallholders in particular. In this study, we focused on national averages and using a proxy for land size, due to the lack of data. These findings will need to be validated and complemented through further research using micro data from farm and household surveys and by looking at conditioning factors in order to arrive at more robust conclusions about the potential for raising smallholder productivity and incomes and what this implies for the transformation of agriculture and rural economies more broadly. Such a broader assessment would include a more systematic assessment of the factors that defined the historical pathways of structural transformation discussed in the introductory session. This would include looking at how agricultural transformations can help accelerate poverty reduction, what role of inter-sectoral (farm and non-farm) linkages should play to generate sufficient employment and incomes for both farmers and workers shifting out of agriculture. At likely difference from historical pathways, transformative change of agricultural sectors will need to address ever more pressing environmental constraints (from climate change, in particular), and what this means for the nature of agricultural investments moving forward. This broader research approach would be befitting of the sustainable development agenda, which seeks integral solutions to these challenges.

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Appendix

Table A.1 Countries doubling land productivity within a 15 year period

Region	Country	Beginning of 15 year period	Size Group
Europe (4 countries)	Albania	1961, 1963	0-2ha
	Croatia	1985-1994	5-20ha
	Cyprus	1961-1974	2-5ha
	Malta	1981-1985	0-2ha
Africa (15 countries)	Algeria	1977-1978 1997	20-50ha
	Burkina Faso	1976, 1977, 1980, 1981 1983,	2-5ha
	Cabo Verde	1972-1978, 1983-1986	0-2ha
	Cameroon	1997	2-5ha
	Ethiopia	1981, 1982, 1987, 1990	0-2ha
	Ghana	1981, 1982, 1983, 1990	2-5ha
	Malawi	1992, 1994	0-2ha
	Morocco	1995	5-20ha
	Mozambique	1992-1995	5-20ha
	Niger	1987, 1993, 1995	5-20ha
	Nigeria	1987	
	Rwanda	1994-1997	0-2ha
	Sudan (former)	1989-1990	20-50ha
	Tunisia	1969, 1980, 1981	5-20ha
	Zambia	1995-1997	5-20ha
Latin America and the Caribbean (6 countries)	Antigua and Barbuda	1968	0-2ha
	Belize	1962-1963, 1965	5-20ha
	Chile	1980, 1983-1986	20-50ha
	Costa Rica	1979-1991	5-20ha
	Nicaragua	1961	5-20ha
	Peru	1992-1993	5-20ha
Asia (16 countries)	Azerbaijan	1997	2-5ha
	Brunei Darussalam	1965-1972, 1978-1979, 1984-1997	2-5ha 5-20ha (1989-1994, 1995-1996)
	Cambodia	1992- 1995, 1997	0-2ha
	China, Hong Kong SAR	1963-1967	0-2ha
	Iran	1967, 1971, 1975, 1977-1980, 1990-1995	5-20ha
	Israel	1961-1963	5-20ha
	Jordan Jordan (cont.)	1970, 1973, 1975-1983, 1987-1989, 1996	5-20ha 5-20ha
	Lebanon	1975-1979, 1981	5-20ha
	Qatar	1963 -1977, 1980-1985, 1987	5-20ha
	Republic of Korea	1962-1964, 1967, 1968	0-2ha
	Saudi Arabia	1962-1977	50ha-

	Singapore	1961-1970, 1974-1997	0-2ha
	Tajikistan	1996, 1997	5-20ha
	Turkmenistan	1992, 1996-1997	50ha-
	Viet Nam	1978	0-2ha
	Yemen	1991, 1994-1997	5-20ha

Source: Calculations based on FAOSTAT data.

Explanation: Albania for example doubled productivity in two subperiods between 1961-1978 (1961-1971, 1963-1978).

Table A.2 Countries doubling labour productivity within a 15 year period

Region	Country	Beginning of 15 year period	Size group
Europe (19 countries)	Albania	1988-1991	0-2ha
	Belarus	1993-1997	5-20ha
	Bosnia and Herzegovina	1992-1997	2-5ha
	Bulgaria	1985, 1993-1997	5-20ha
	Croatia	1980-1997	2-5ha (1980-1982) 5-20ha (1983-)
	Cyprus	1980-1985	2-5ha
	Denmark	1988-1989, 1992	5-20ha
	France	1981, 1983, 1987, 1989	5-20ha (-1985) 20-50ha (1987-)
	Germany	1992-1997	5-20ha
	Italy	1984-1986, 1989-1990	5-20ha
	Lithuania	1993-1997	5-20ha
	Malta	1980-1990	0-2ha
	Portugal	1981, 1983, 1984	2-5ha
	Republic of Moldova	1994, 1996	2-5ha
	Romania	1989-1997	5-20ha
	Slovenia	1980-1997	2-5ha
	Spain	1981-1989, 1994, 1995	5-20ha
	FYR Macedonia	1983-1989, 1993-1997	2-5ha
	Ukraine	1996, 1997	5-20ha
Africa (7 countries)	Cabo Verde	1981-1986, 1994	0-2ha
	Cameroon	1994, 1995, 1997	2-5ha
	Egypt	1981- 1989	0-2ha
	Malawi	1992, 1994	0-2ha
	Morocco	1995	5-20ha
	Nigeria	1980-1990	2-5ha
	South Africa	1995	50ha-
Latin America and the Caribbean (4 countries)	Brazil	1986-1997	5-20ha
	Dominican Republic	1995, 1997	2-5ha
	Nicaragua	1988-1997	5-20ha
	Puerto Rico	1994-1997	5-20ha
North America (1 country)	Canada	1980-1986, 1988-1989	50ha-

Asia (10 countries)	Armenia	1980-1981, 1983, 1989-1994, 1997	2-5ha
	Brunei Darussalam	1980 -1997	2-5ha
	China, Hong Kong SAR	1992	0-2ha
	Japan	1990-1997	0-2ha
	Jordan	1996	5-20ha
	Kazakhstan	1996	50ha-
	Lebanon	1980-1989	5-20ha
	Malaysia	1996-1997	2-5ha
	Qatar	1980, 1982--1990	5-20ha
	Republic of Korea	1980-1997	0-2ha

Source: Calculations based on FAOSTAT data.

Explanation: Albania for example doubled productivity in four consecutive subperiods between 1988 and 2006 (1988-2003, 1989-2004, 1990-2005, 1991-2006).

Table A.3 Comparing WCA average farm size to average hectare per worker ratio based on data from FAOSTAT

Region	Average farm size (WCA)	Average ha/worker
North and Central America	117.8	32.2*
South America	74.4	17.8
Europe	12.4	15.4
Africa	11.5	6.4
Asia	1.0	1.7

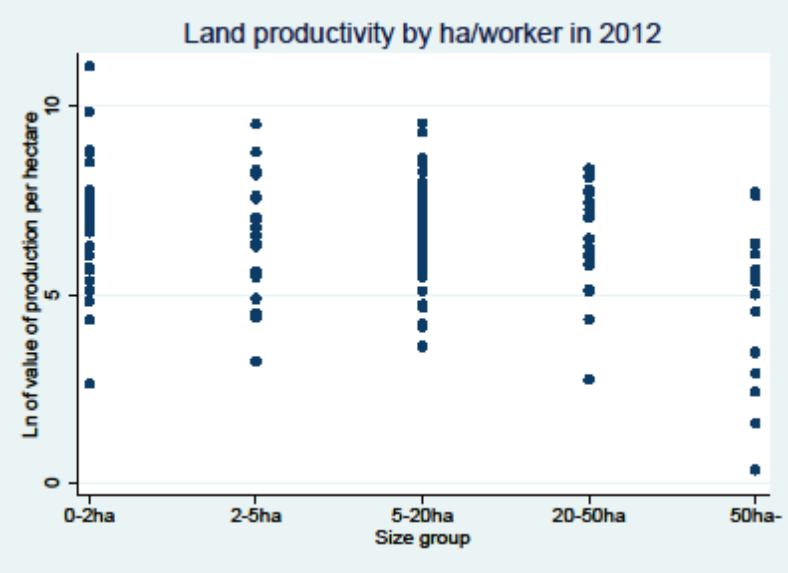
*For only North America it is 132.9

Source: World Census of Agriculture data from FAO ESS website[9] and calculations based on FAOSTAT data

[9] http://www.fao.org/economic/ess/ess-wca/wca-2000/ess-wca2000-tables/en/

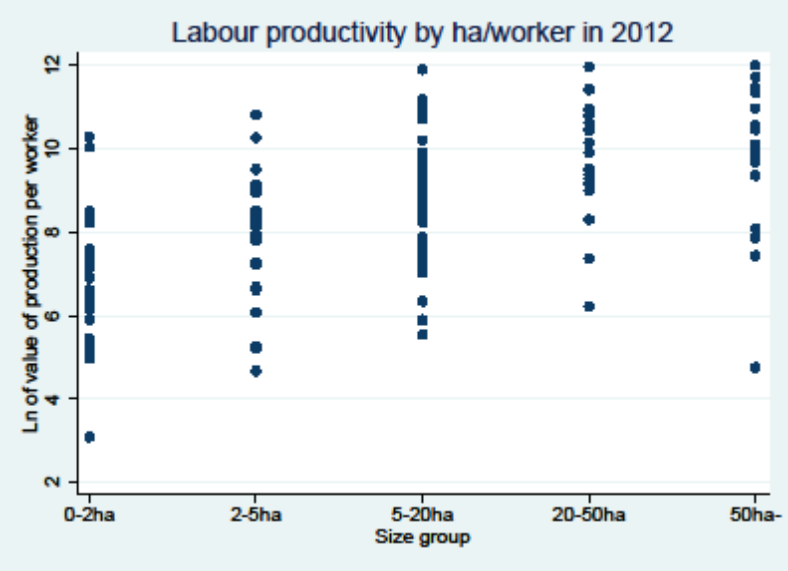
Retrieved last in May 2016

Figure A. 1 Dispersion of land productivity within size groups



Source: Calculations based on FAOSTAT data.

Figure A. 2 Dispersion of labour productivity within size groups



Source: Calculations based on FAOSTAT data.

A.5 Technical Notes

A.5.1 Growth accounting

We define land productivity by the value of agricultural production in international 2004-2006 USD per hectares of agricultural land, and labor productivity by the value of agricultural production per the economically active population in agriculture.[10] For production and land, data is available from 1961 for 140 countries. Economically active population in agriculture is only available from 1980. The average growth rate was determined by using the following formula:

$$gr_Y = 1/t^* (\log Y_t - \log Y_0) \qquad (1)$$

Where gr_Y is the annual growth rate, Y_0 is the level of productivity for the first observed year, Y_t is the level of productivity in the last observed year, and t is number of years between the first and last observed year.

A.5.2 Missing values treatment

In the case of 29 countries, we had missing values for some years. For the majority of post-soviet states, data is only available from 1992. In order to not lose these countries, we replaced missing values assuming linear growth rate. That is, for countries where data is available between 1992 and 2012, we take the average growth rate of this period, and we assume the same growth rate for the period between 1961 and 1991. This was important to include these countries when calculating regional averages across regions, as a lot of the missing values are regionally concentrated. For instance, 17 of the 36 countries in Europe have missing values. Table A.4 below lists the countries with missing values, with the number of missing years in parenthesis. In some cases, we dropped all data on the country, where a significant amount of data was missing (above 33 observations).

[10] Value of production: http://faostat3.fao.org/download/Q/QV/E,
Agricultural area: http://faostat3.fao.org/download/R/RL/E,
Total economically active population in agriculture: http://faostat3.fao.org/download/O/OA/E.
For details see *Data* section in References

Table A. 4 Countries with missing values

Country (number of missing values)
Armenia (31)
Azerbaijan (31)
Belarus (31)
Belgium (39) dropped
Bosnia and Herzegovina (31)
Brunei Darussalam (1)
Croatia (31)
Czech Republic (32)
Eritrea (32)
Estonia (31)
Ethiopia (32)
Georgia (31)
Kazakhstan (31)
Kyrgyzstan (31)
Latvia (31)
Lithuania (31)
Luxembourg (39) dropped
Occupied Palestinian Territory (33) dropped
Republic of Moldova (31)
Russian Federation (31)
Serbia (45) dropped
Serbia and Montenegro (38) dropped
Slovakia (32)
Slovenia (31)
Sudan (former) (2)
Tajikistan (31)
The former Yugoslav Republic of Macedonia (31)
Turkmenistan (31)
Ukraine (31)

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