

Recent Developments in Economic Growth

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A fundamental question in the field of economic growth and development is why some countries are rich and others poor. Both the longer term historical experience of individual countries and the more recent data for a large number of countries show periods of marked increases in income inequality across countries, as well as episodes where individual countries catch up with the leading country. What determines when countries start the process of modern economic growth? Why do some countries sustain positive economic growth for long periods of time while others countries seem to fail to catch up with the leading country and even fall behind other countries that are able to catch up? Understanding the factors driving income inequality has potentially enormous welfare consequences and the design of effective economic policy hinges on answers to these and related questions.

I start this survey article by first describing a broad set of facts from international data on gross domestic product (GDP) per capita as a measure of welfare across countries. These facts motivate most of the inquiry in the field of growth economics. The main facts can be summarized as follows. First, not only are there remarkable differences in per capita income across countries, but also inequality has increased over the last 30 years. To be more concrete, while average GDP per capita of the richest countries was about 25 times that of the poorest countries in 1960, it was about 65 times that of the poorest countries in 2005. Second, the international evidence presents numerous episodes of countries catching up, stagnating, or falling behind in relative income over time.

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Next, I review the recent literature in growth economics. I take a narrow view of the field with a focus on quantitative explorations.¹ I discuss the literature that directly or indirectly addresses the facts on income differences across countries and over time. Essentially, this literature emphasizes that cross-country differences for aggregate outcomes arise from cross-country differences in the allocation of factors of production and productivity across heterogeneous production units where those units can generically refer to sectors/industries or establishments within sectors. I begin my survey with the literature that focuses on the structural transformation of the economy—broadly described as systematic changes in the allocation of factors of production across sectors in the economy. I emphasize the role of agriculture for the early stages of development and for the current income differences between rich and poor countries. I also emphasize the reallocation of factors to the service sector in determining recent patterns of aggregate productivity growth across countries. I then discuss models that focus on understanding differences in measured aggregate total factor productivity (TFP) arising from the allocation of factors of production across establishments with heterogeneous productivity levels. Substantial work remains to be done on identifying the fundamental determinants of productivity and resource allocation across productive units.

The article is organized as follows. In the next section, I lay out the main facts in economic growth and development that organize the ultimate objectives of the recent quantitative literature in growth economics. Section 2 surveys models emphasizing the role of the structural transformation in the economy—changes in the allocation of factors of production across sectors. In Section 3, I discuss the literature that relates measured TFP differences across countries to distortions that misallocate factors of production across heterogeneous establishments. I conclude in Section 4.

1. FACTS

In this article, I focus on documenting a narrow set of facts using the recent data on GDP per capita from Heston, Summers, and Aten (2009). The data is often referred to as the Penn World Table (PWT). To provide a broader perspective, I complement the description of the facts from this data with references to the literature where refinements of the basic facts have been made. Let me first describe the data. I use GDP per capita as a measure of welfare in each country.² A critical element of the data is that the measure of GDP

¹ Even with a narrow focus, the survey is bound to leave out the discussion of many important contributions for which I preemptively apologize.

² Clearly, GDP per capita is a limited measure of welfare in an economy as cross-country differences in life expectancy, education, work hours, and inequality, among others, are also relevant

reported in the PWT is adjusted for price differences across countries (purchasing power parity adjusted) and, hence, represents a measure of income in units that are comparable across countries.³ The data spans from 1950–2007 for 189 countries in the world. Since I am interested in assessing the evolution of cross-country incomes over time, I restrict attention to a sample of 101 countries that have data for each year from 1960–2007 and that have a population of more than 1 million people in 2007. I emphasize two sets of facts from this data. First, income differences across rich and poor countries are not only large at any point in time between 1960–2007, but also have increased quite substantially in the last two decades. Second, while the dispersion in income per capita has either stayed constant or increased in the last two decades, the data reveal remarkable episodes of individual countries catching up, stagnating, and declining in per capita income relative to that of the United States. I now elaborate on the description of these basic facts.

Income Differences

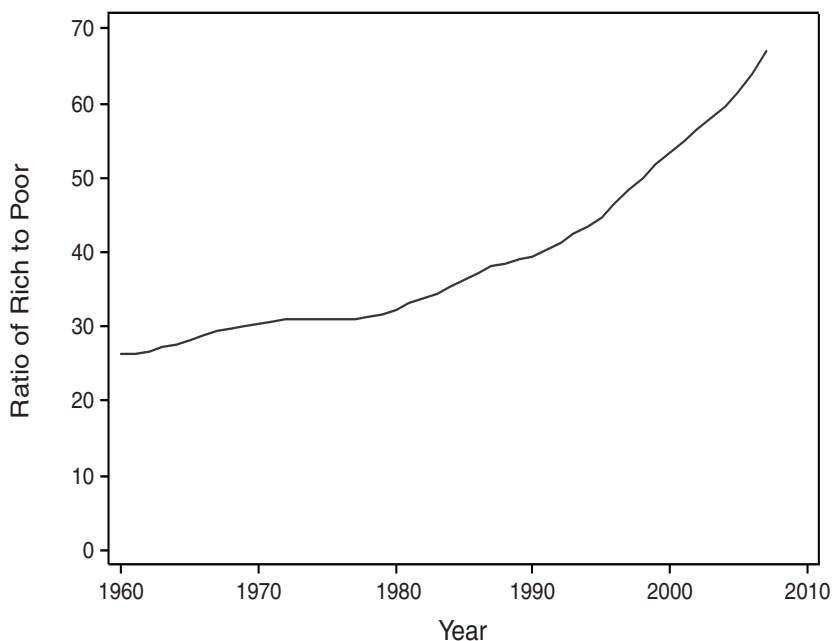
To start, for each year between 1960–2007, I rank countries by their GDP per capita relative to that of the United States. I use the United States as a benchmark country for comparison since it is a large, stable, and diverse country that has been at the frontier of the world's production technology during the sample period. As a result, changes in income in the United States roughly approximate changes in the world state of knowledge that, in principle, should be available for adoption elsewhere. I then calculate the average GDP per capita for the richest 5 percent of the countries and the poorest 5 percent of the countries (i.e., I calculate the average of the richest and poorest 5 countries in the sample). The ratio of the average GDP per capita of the richest and poorest 5 percent of countries is reported in Figure 1.⁴ Income per capita differences across countries are large. GDP per capita in the richest countries is, on average, 40 times that of the poorest countries. Moreover, income differences, while relatively stable between 1960 to about 1985, have been increasing since then such that in 2007 GDP per capita in the richest countries was, on average, 66 times that of the poorest countries.⁵ The increase in income

measures in a country's welfare. I follow the standard practice in the literature of focusing on GDP per capita as the main determinant of welfare in a country. See Jones and Klenow (2011) for an analysis of welfare across countries and time that includes measures of consumption, leisure, inequality, and mortality.

³ In the version of the PWT I use, international prices refer to world prices of 2005.

⁴ Parente and Prescott (1993) emphasize the ratio of the richest and poorest 5 percent of countries in GDP per capita as a measure of dispersion in income across countries at a point in time and across time. Duarte and Restuccia (2006) emphasize similar statistics but for measures of labor productivity such as GDP per worker.

⁵ Note that while there is substantial persistence in cross-country income differences over time, the set of poor and rich countries may be changing over time.

Figure 1 GDP per Capita Ratio of Rich to Poor

Notes: GDP per capita from Heston, Summers, and Aten (2009). The ratio refers to the average of the richest 5 percent of countries to the poorest 5 percent of countries in each year. Since the sample contains 101 countries, these are averages of 5 countries.

inequality between the rich and poor countries is mainly driven by a fall in relative income in the poorest countries, which is not necessarily a decline in absolute incomes of poor countries, but a failure of poor countries to grow as fast as the United States. This fact is not a curiosity of the poorest countries alone in this sample, which happen to be mostly in Africa, but continues to hold even when focusing on larger groups of poor countries or on different subgroups of the poorest countries. To illustrate this fact, Table 1 summarizes the evolution of GDP per capita across countries relative to that of the United States for deciles of the income distribution in selected years. The richest 10 percent of countries (Decile 10) gained on average, increasing relative GDP per capita from 0.87 in 1960 to 0.91 in 2007. The poorest 10 percent of countries (Decile 1) failed to keep up with the United States, losing half of the relative income position, from a relative income of 0.04 in 1960 to less than 0.02 in 2007. But relative income also declined for most of the other groups

Table 1 GDP per Capita Relative to the United States (Percent)

Decile	Year					
	1960	1970	1980	1990	2000	2007
1	4.3	3.9	3.5	2.8	2.2	1.9
2	6.3	6.1	5.2	3.9	3.3	3.6
3	8.7	7.5	7.0	5.9	5.1	5.0
4	11.4	9.9	10.3	9.1	8.3	7.8
5	15.0	15.0	15.4	14.2	12.4	12.7
6	20.4	18.9	21.3	17.9	17.1	17.9
7	27.3	28.9	28.4	26.8	25.0	24.9
8	39.3	43.3	45.3	42.4	47.3	52.7
9	57.6	64.5	67.8	68.1	70.4	72.0
10	86.8	86.2	87.7	87.0	87.0	91.4

Notes: GDP per capita from Heston, Summers, and Aten (2009). Countries are ranked according to GDP per capita in each year and divided into groups, with Decile 1 being the poorest countries and Decile 10 being the richest countries. As a result, countries in each decile may vary from year to year.

of poor countries, such as Deciles 2–7, even though their relative decline is not as dramatic as in the poorest countries.

One explanation for the large differences in income per capita observed across countries today attributes them to the countries' timing of the start of industrialization: Poor countries are slowly catching up to rich countries that started the process of modern growth much earlier. In particular, Lucas (2000, 2002) describes the cross-country differences in the timing of takeoff in growth in income per capita by looking at the historical time series of GDP per capita from 1500 to today.⁶ Lucas shows that prior to 1800, differences in income per capita were moderate (about a factor of 2 between rich and poor countries), but that the differences quickly expanded when, starting with the process of industrialization, GDP per capita no longer remained stagnant for a group of initially western countries and started to increase at positive rates. Lucas conjectures that if today's income differences across countries result from differences in the timing when modern growth takes off in a country, then the distribution of per capita income may shrink again to pre-industrial levels once all countries have made the transition. This interpretation of the historical relevance of today's income differences seems difficult to reconcile with the expanding income differences observed in most deciles of the income distribution in the cross-country data reported in Table 1. I will return to this issue in Section 2, where I review the related literature.

⁶ In related work, Buera, Monge-Naranjo, and Primiceri (2011) study the evolution of state-intervention and market-oriented policies across countries and time in the context of a learning model where past experiences (including those of countries' neighbors) determine policy choices.

In addition to documenting the large income differences across countries, the development accounting literature has established that differences in income per capita are mostly driven by differences in labor productivity (often measured as either GDP per worker or GDP per labor hour) since differences in labor supply (measured as either employment to population ratio or total hours of work per capita) are not large enough to explain a substantial portion of the differences in per capita income across countries. In turn, differences in labor productivity are mostly accounted for by differences in TFP. That is, differences in income per capita are not explained by measurable factors such as employment, physical capital, or human capital.⁷

Country Experiences over Time

The reported evolution of the income distribution across countries hides tremendous variation in country experiences over time. In the data, there are numerous episodes of catch up, catch up followed by a slowdown, stagnation, and even decline. While reporting time series for 101 countries is impractical, Table 2 attempts to summarize country experiences by reporting the evolution of average GDP per capita relative to that of the United States for 20 groups, each comprising 5 percent of countries in the sample. Unlike in Table 1 and Figure 1, the countries in each group in Table 2 remain the same over time and represent the ranking of countries according to relative GDP per capita in 1960.

Focusing on the richest and poorest 5 percent of countries in 1960, I find that inequality in GDP per capita actually declined from a factor of 26 in 1960 to 16 in 2007, as a result of the richest countries in 1960 declining relative to the leading country (from .95 in 1960 to .81 in 2007) and the poorest countries in 1960 catching up relative to the leading country (from .037 in 1960 to .049 in 2007). Table 2 also shows that episodes of catch up and decline occur throughout the income distribution in 1960, with countries in Group 7 almost tripling their relative income (from .11 in 1960 to .30 in 2007). Table 2 does not identify individual countries featuring catch up or decline in relative income. To complement the summary in Table 2, Figure 2 documents the time series of GDP per capita for selected countries with remarkable growth experiences in the sample period. I emphasize the episodes of remarkable catch up in per capita income by highlighting Singapore, Botswana, and more recently China and India. I also note the growing gap in per capita income between the United

⁷ See, for instance, Klenow and Rodríguez-Clare (1997), Hall and Jones (1999), Caselli (2005), and Hsieh and Klenow (2010). A critical element in establishing the relative importance of TFP and factors of production in explaining income differences across countries is the treatment of human capital. There is a recent literature addressing the importance of human capital in amplifying differences in TFP across countries; for instance, Manuelli and Seshadri (2006) and Erosa, Koreshkova, and Restuccia (2010).

Table 2 GDP per Capita Relative to the United States (Percent)

GR5pc	Year					
	1960	1970	1980	1990	2000	2007
1	3.7	3.7	3.6	3.5	3.9	4.9
2	5.1	5.0	4.7	3.9	3.6	3.8
3	5.8	6.2	6.8	7.3	7.1	7.4
4	6.8	6.0	6.3	6.4	6.3	6.3
5	7.9	7.7	8.5	8.8	8.5	8.7
6	9.4	7.4	6.8	6.6	6.4	6.7
7	10.7	12.5	18.0	21.9	26.0	29.5
8	12.1	10.7	9.2	7.6	5.9	5.7
9	14.1	12.2	12.7	11.5	11.6	12.6
10	15.9	14.6	15.3	14.0	13.6	14.5
11	18.8	17.5	17.8	13.2	10.8	10.3
12	22.1	24.9	25.9	21.2	17.5	14.7
13	25.9	26.8	33.7	39.1	41.9	45.7
14	28.7	32.3	31.2	28.8	30.2	31.3
15	36.6	37.9	37.9	35.6	34.3	34.7
16	41.9	47.7	47.3	45.0	46.6	49.1
17	51.8	55.1	56.2	50.0	54.9	62.3
18	63.4	68.6	72.2	67.6	64.3	65.5
19	78.7	79.9	81.3	80.8	83.3	85.2
20	94.9	91.8	88.4	83.2	79.0	80.6

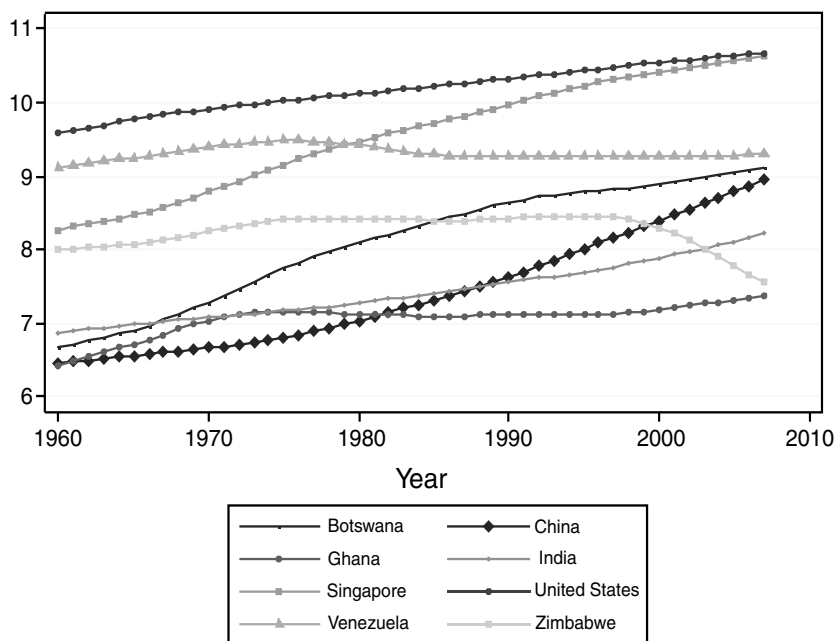
Notes: GDP per capita from Heston, Summers, and Aten (2009). Countries are ranked according to GDP per capita in 1960 and divided into groups. The country groups remain constant across years. For instance, Group 1 refers to the poorest countries in 1960 whose GDP per capita relative to the United States was 3.7 percent in 1960 and 4.9 percent in 2007.

States and Venezuela, Ghana, and Zimbabwe. Explaining these remarkable growth and collapse episodes is a challenging and exciting task for the field of quantitative growth economics.

2. STRUCTURAL TRANSFORMATION

In this section I discuss the recent quantitative literature that emphasizes the role of factor reallocation across sectors in explaining income and growth differences across countries.⁸ The process of economic development is associated with a systematic reallocation of factors of production across sectors—

⁸ The literature on structural transformation is too large to be fairly recognized in this article; please see the recent survey in Herrendorf, Rogerson, and Valentinyi (2011) for references. I note, however, that the literature considers several approaches in driving reallocation across sectors. For example, some models emphasize non-homothetic preferences, such as Echevarria (1997) and Kongsamut, Rebelo, and Xie (2001), while other models emphasize non-unitary elasticity of substitution across goods and differential productivity growth across sectors such as Baumol (1967) and Ngai and Pissarides (2007).

Figure 2 GDP per Capita, Selected Countries (in logs)

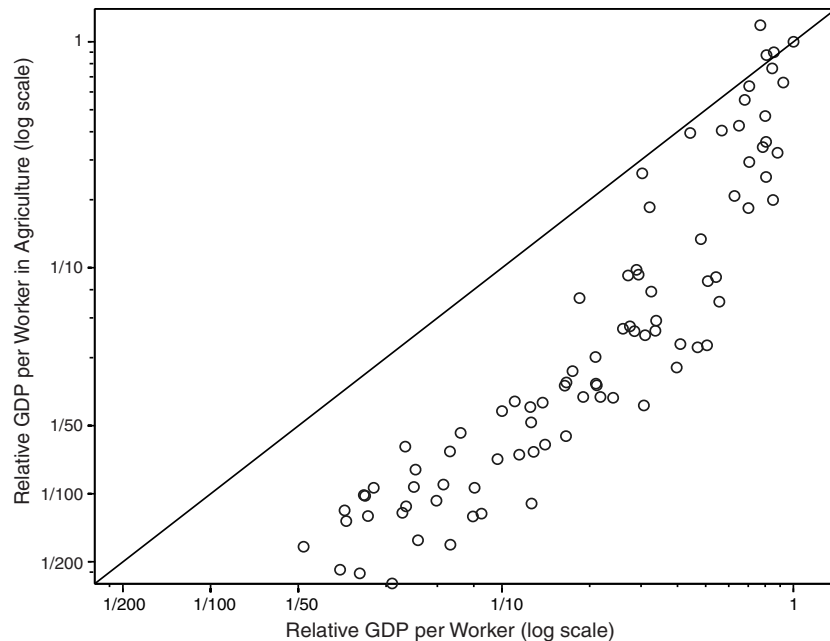
Notes: GDP per capita data is from Heston, Summers, and Aten (2009).

the structural transformation—whereby factors are reallocated initially from agriculture to industry and services and later from agriculture and industry to services. There is a growing literature, following Kuznets (1966), emphasizing the importance of sectoral reallocation for aggregate outcomes.

The Role of Agriculture

An important development in the understanding of income differences across countries has been the recognition that agriculture plays a crucial role. Progress in this area has been enhanced by the availability of comparable data on agricultural output across countries, allowing a quantitative characterization of the magnitude of agricultural productivity differences, and by quantitative assessments of plausible hypotheses using sectoral models.⁹ To start, let me motivate why agriculture is important. From a historical perspective, the reallocation

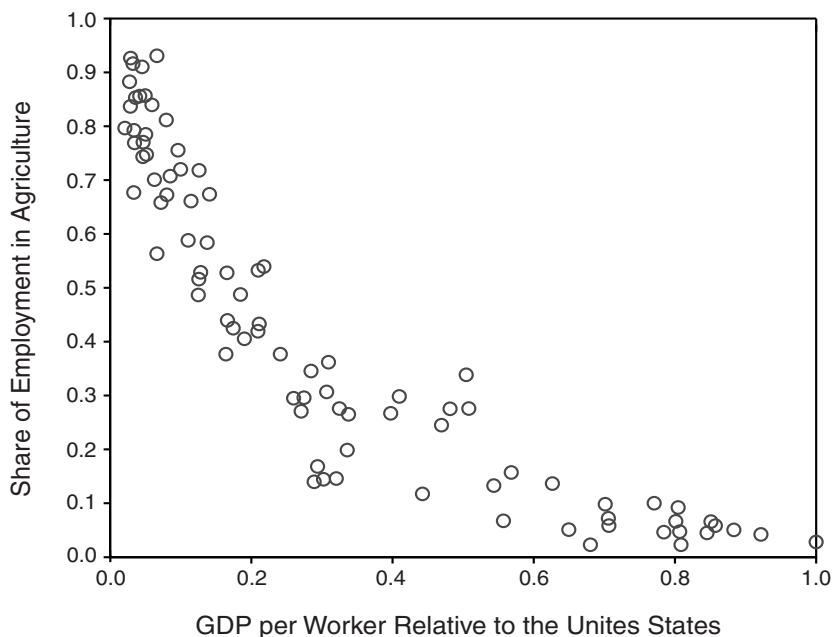
⁹ See, for instance, Rao (1993) and Restuccia, Yang, and Zhu (2008).

Figure 3 Labor Productivity in Agriculture across Countries

Notes: Data from Restuccia, Yang, and Zhu (2008). Data for 1985.

process away from agriculture—hence, the process of industrialization—has been associated with improvements in agricultural productivity (see, for instance, Kuznets [1966]). In addition, in the more recent cross-country data, we observe that agriculture plays a critical role since, relative to rich countries, labor productivity in agriculture in poor countries is much lower than in the rest of the economy (see Figure 3) and most of their labor is allocated to agriculture. Whereas poor countries allocate more than 85 percent of the labor force to agriculture, rich countries only allocate 4 percent (see Figure 4). Noting that aggregate labor productivity is the sum of labor productivity across sectors weighted by the share of employment in each sector, and using labor productivity and employment data for rich and poor countries, I find that agriculture accounts for 85 percent of the difference in aggregate labor productivity across rich and poor countries.¹⁰ Recalling that the bulk of the

¹⁰The data reported in Restuccia, Yang, and Zhu (2008) suggests that if poor countries were to have the same share of employment and labor productivity in agriculture as the rich countries, then the aggregate labor productivity factor between rich and poor countries would be

Figure 4 Share of Employment in Agriculture

Notes: This is Figure 1 in Restuccia, Yang, and Zhu (2008). Data for 1985.

differences in income per capita across countries are explained by differences in labor productivity, the literature concludes that understanding productivity and labor allocation in agriculture may be at the core of income differences among rich and poor countries. The recognition that agriculture is central in understanding low productivity in poor countries is important in seeking the factors that account for this outcome, whether these factors are policy driven or institutional.

There are two broad branches of this literature. The first branch can be roughly summarized as emphasizing the timing of industrialization in explaining current differences in income. The focus is on the delay in the process of structural transformation—broadly described as the process of resource reallocation from agriculture to other sectors in the economy. The second branch focuses on explaining the factors behind the low productivity in

approximately 5-fold instead of the actual 34-fold difference. Hence, agriculture accounts for 85 percent ($100 - 5/34 \times 100$) of the difference in aggregate labor productivity between rich and poor countries in the data.

agriculture in poor countries observed in the cross-country data at a point in time. The two branches are closely connected as they seek to assess the relevance of the sectoral structure (agriculture versus non-agriculture in particular) in cross-country income differences. The two branches differ in terms of the relevance of the information that can be extracted from time-series variations in the sectoral structure across countries. I expand on this issue below.

While there is an old and extensive literature in development on the role of agriculture and structural transformation, only recently has the literature provided a quantitative assessment. Gollin, Parente, and Rogerson (2002) provide a model that rationalizes delays in the process of structural transformation and rising income inequality over long periods of time.¹¹ The model formalizes many ideas in the traditional development literature and provides a quantitative assessment of the importance of the timing of the adoption of modern agricultural technology in explaining current international income differences. The model in Gollin, Parente, and Rogerson (2002) is quite simple. The economy is populated by homogeneous individuals that derive utility from consuming agricultural and non-agricultural goods and there is a subsistence need for agricultural goods. Thus, at low levels of income, individuals spend a bigger fraction of their income on agricultural goods than at high levels of income. There is strong empirical evidence in support of these types of preferences. Agricultural goods can be produced with two alternative technologies: a traditional production function that is linear in labor and features no labor productivity growth, and a modern technology, also linear in labor, that features positive labor productivity growth. The technology for producing non-agricultural goods is standard, featuring capital and labor inputs and positive labor productivity growth. The economy is characterized as follows. When the productivity of the modern agricultural technology is low—below that of the traditional technology—all labor is allocated to agriculture and income per capita is low and stagnant—essentially people are consuming close to their subsistence needs. This characterization resembles economies prior to 1800, where income per capita was roughly constant over time. Because of positive productivity growth in the modern agricultural technology, at some point in time the modern technology becomes more productive than the traditional technology and the adoption of the modern technology in agriculture starts the process of industrialization and modern growth. With productivity growth in modern agriculture, labor is systematically reallocated from agriculture to non-agriculture over time. In the long run, the economy features properties that are consistent with the characterization of modern growth—a positive and stable per capita income growth.

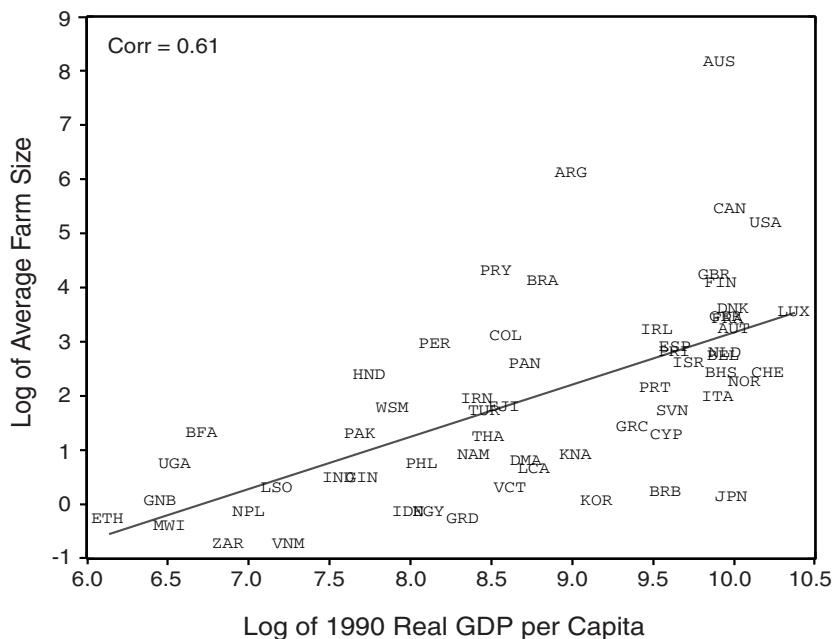
¹¹ Closely related is the work of Lucas (2000) and Hansen and Prescott (2002), although these articles do not explicitly consider the agricultural sector.

Gollin, Parente, and Rogerson (2002) calibrate a benchmark economy to U.K. data for about 250 years and show that the model reproduces very well the reallocation of labor out of agriculture over time, as well as the growth in output per capita. Then, the authors use the model to conduct experiments where the productivity of modern agriculture is lowered relative to the level in the United Kingdom. Different productivity levels imply different dates at which the modern technology in agriculture becomes more productive than the traditional technology and, hence, the date at which industrialization and modern growth starts. Interestingly, reasonable differences in the timing of adoption of the modern agricultural technology imply large current differences in output per capita across economies. Moreover, the differences in income per capita persist for long periods of time. One conclusion from this study is that, as argued by Lucas (2002), a large portion of today's income differences across countries result from differences in the timing of the adoption of modern technologies.¹² There are two issues with this interpretation of the results. First, the persistence of income gaps over time in the model is related to the assumption that the process of reallocation of employment out of agriculture is common across countries. Cross-country data indicate, however, that countries that started the process of industrialization later than the United States or United Kingdom have accomplished a comparable transformation in a much shorter time (see Duarte and Restuccia [2007] for the case of Portugal). Second, the model implies that income gaps should diminish over time, which is not observed in the recent cross-country data in Section 1. I conclude that this branch of the literature is useful in understanding cross-country differences in the timing of industrialization and the related transition, but it is unlikely to explain the current differences in agricultural productivity observed between rich and poor countries.

The second branch of the literature focuses on the factors behind low productivity in agriculture in poor countries. The focus is on understanding cross-country differences in the agricultural sector at a point in time as opposed to cross-country differences over time. Restuccia, Yang, and Zhu (2008) develop a two-sector model of agriculture and non-agriculture emphasizing economy-wide differences in productivity and barriers to intermediate input use and labor mobility in agriculture. Empirical evidence suggests there is a strong systematic relationship between the level of development of a country and two forms of barriers in agriculture: a wedge between wages in agriculture and non-agriculture (barriers due to limited labor mobility), and a high relative price of non-agricultural intermediate inputs such as fertilizers and pesticides (interpreted broadly as a barrier to intermediate input use). These empirical regularities suggest that inefficiencies in agriculture may contribute to low

¹² See Ngai (2004) for a related study of the importance of barriers to investment in physical capital in the delay of the adoption of modern technologies.

agricultural productivity in poor countries and, as a consequence, a large share of employment in agriculture. Restuccia, Yang, and Zhu (2008) embed these features in a model where preferences for consumption goods feature a subsistence level requirement for food. Furthermore, producing non-agricultural goods requires only labor while producing agricultural goods requires land, labor, and non-agricultural intermediate inputs. The spirit of the exercise conducted in Restuccia, Yang, and Zhu (2008) is as follows. Since the technology for producing non-agricultural goods is linear in the labor input, data on labor productivity in non-agriculture pins down the level of economy-wide productivity in each country. This level of productivity is assumed to be exogenous in the analysis but standard explanations of technology adoption and capital accumulation can be applied for this factor. Importantly, these explanations are not specific to the agricultural sector. Restuccia, Yang, and Zhu (2008) also take as given the differences across countries in the land-to-population ratio, the barriers to intermediate input use in agriculture, and the barriers to labor mobility. These objects are directly pinned down by country observations. Then the question becomes: How important are all these factors (and each in isolation) in explaining low productivity in agriculture and high agricultural employment in poor countries? There are several results worth emphasizing. First, if the model could reproduce the low productivity in agriculture observed in poor countries (by, for example, lowering an agriculture-specific productivity parameter in poor countries), then the model can rationalize the observed large share of employment in agriculture in these countries. Hence, understanding low productivity in agriculture in poor countries is key, with the ensuing reallocation of labor acting as a transmission mechanism to aggregate productivity differences. Second, exogenous differences in economy-wide productivity (measured as differences in non-agricultural productivity) and barriers are important in explaining low productivity in agriculture in poor countries, whereas differences in land endowments are of second-order importance. In particular, the model with exogenous differences in economy-wide productivity, barriers, and land endowments, can explain two-thirds of the differences in labor productivity in agriculture between rich and poor countries, still leaving an important factor unexplained (about one-third). Third, inefficiencies in agriculture are not the only determinant of low productivity in agriculture in poor countries. If productivity in non-agriculture in poor countries were to be equalized to that of rich countries—even keeping productivity and barriers in agriculture the same—the model would imply levels of productivity and employment in poor countries much closer to that of rich countries compared to the baseline model, for instance, a share of employment in agriculture of 30 percent versus 68 percent in the baseline model, a factor difference in labor productivity in agriculture of 10-fold versus 23-fold in the baseline model, and an aggregate productivity difference of 1.4-fold versus 10.8-fold in the baseline model. This result suggests that not all problems

Figure 5 Average Farm Size across Countries

Source: Adamopoulos and Restuccia (2011).

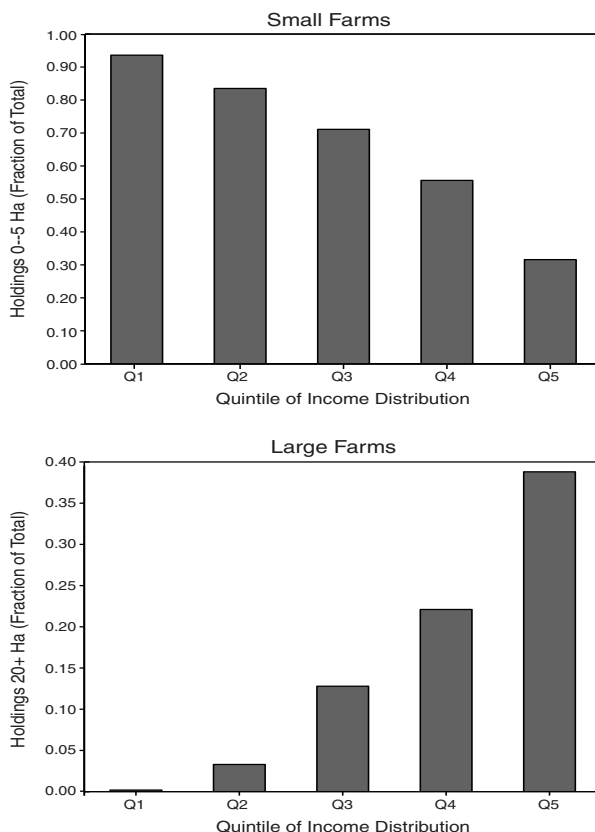
lie in agriculture; instead, solving the problems that prevent non-agricultural productivity in poor countries to rise to the level of developed countries can help in eliminating a substantial portion of the large differences in income among rich and poor countries.

Since there is still a large unexplained gap in labor productivity in agriculture, understanding low productivity in agriculture in poor countries has remained an active area of research. Four recent contributions have emphasized the role of transportation infrastructure (Adamopoulos 2011), the role of ability selection into agriculture (Lagakos and Waugh 2011), the role of farm size (Adamopoulos and Restuccia 2011), and the role of trade restrictions for importing food (Tombe 2011).¹³ In this article, I only summarize the findings on the importance of farm-size differences across countries. Adamopoulos and

¹³ See also the recent accounting exercises of the productivity gap between agriculture and non-agriculture in Herrendorf and Schoellman (2011), who emphasize the differences across U.S. states, and in Gollin, Lagakos, and Waugh (2011), who emphasize the differences across developing countries.

Restuccia (2011) develop a model of farm size to investigate its importance in understanding the low productivity problem in agriculture. The motivation for why farm size may matter is twofold. First, there are striking differences in average farm sizes and farm-size distributions across countries. Whereas average farm size is 54 Hectares (Ha) in the richest 20 percent of countries, average farm size is only 1.6 Ha in the poorest 20 percent of countries, a 34-fold difference. Figure 5 documents the positive relationship between the level of development and average farm size across countries. Cross-country differences in farm-size distributions are systematic. Whereas in poor countries, more than 90 percent of the farms are small (less than 5 Ha), only around 30 percent of the farms in rich countries are small. In poor countries, none of the farms are large (more than 20 Ha), while almost 40 percent of the farms in rich countries are large. (See Figure 6 for a documentation of the share of small and large farms across quintiles of the income distribution.) Second, labor productivity is much higher in large than in small farms. For instance, in the data from the U.S. Census of Agriculture, average labor productivity in farms greater than 800 Ha relative to farms less than 4 Ha is a factor between 14- and 34-fold depending on how operators and hired labor are treated in the measure of labor in farms. The question addressed by Adamopoulos and Restuccia (2011) is what explains farm-size differences across countries and whether or not these differences help explain the productivity problem in agriculture in poor countries.

Adamopoulos and Restuccia (2011) consider a model of farm size that is based on the span-of-control model of Lucas (1978) embedded into a standard sectoral model of agriculture and non-agriculture. The production unit in agriculture is a farm that requires the input of a farmer (labor), capital, and land. Farmers differ in their productivity of managing a farm and the farming technology is such that for each type of farmer there is an optimal farm size where more productive farmers demand more capital and land and, hence, manage larger farms. While reallocation between agriculture and non-agriculture in the model depends on the same fundamental channels described in the previous literature (e.g., Gollin, Parente, and Rogerson [2002] and Restuccia, Yang, and Zhu [2008]), productivity in agriculture is also determined by the allocation of factors (capital and land) across farmers. There are three main findings. First, farm-size distortions, such as land reforms that cap the size of farms and progressive land taxes, are the most likely explanation for differences in farm-size distributions. There is overwhelming evidence for these distortions in cross-country data and measured distortions can account quantitatively for most of the differences in farm-size distributions across countries. Other potential explanations such as cross-country differences in aggregate factor endowments (land, capital, and economy-wide productivity) can account for, at most, one-fourth of the cross-country farm-size differences. Second, calibrating farm-size distortions to account for the observed farm-size differences helps explain

Figure 6 Farm Size Distribution across Countries

Source: Adamopoulos and Restuccia (2011).

three-fourths of the differences in agricultural and aggregate labor productivity across countries, with the remaining one-fourth being explained by differences in

aggregate factors. Third, specific distortionary policies in individual countries such as a land reform in the Philippines and progressive land taxation reform in Pakistan are found to generate substantial drops in size and productivity in these countries. Moreover, other factors occurring at the same time or over time in these countries are found to potentially mask the negative effects of distortionary policies on size and productivity in the agricultural sector, making empirical characterizations of these distortionary policies difficult.

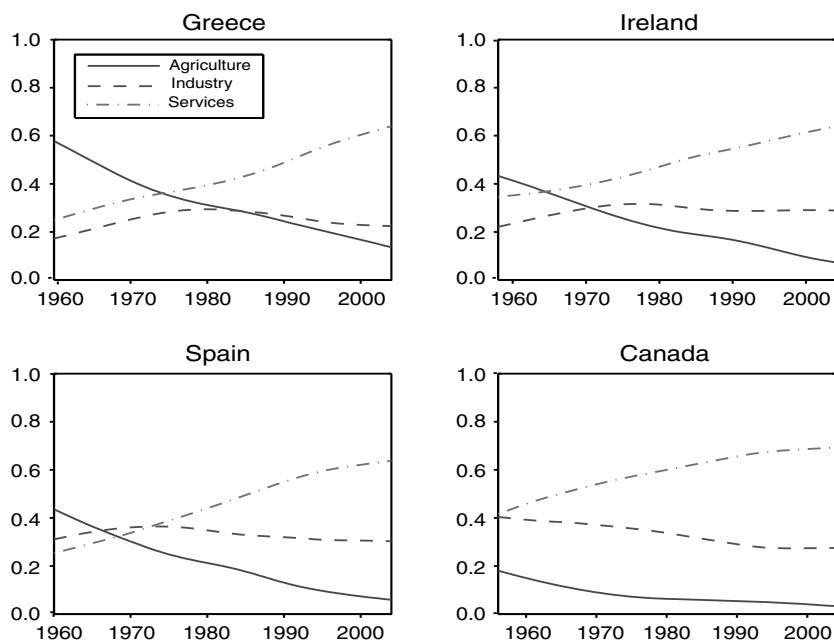
Reallocation to Services

As emphasized earlier, models of structural transformation, that is the reallocation of labor across sectors in an economy over time, have featured prominently in historical perspectives of growth and the timing of industrialization such as in Lucas (2000, 2002) and Gollin, Parente, and Rogerson (2002).¹⁴ Duarte and Restuccia (2010) argue that structural transformation is also closely connected with the set of facts emphasized in Section 1 about the diversity of growth patterns in the time series for individual countries, the patterns of catch up, slowdown, stagnation, and decline in labor productivity that are observed even for more developed countries. For these countries, agriculture is less important in the economy and the more relevant transformation involves a substantial shift to services rather than a shift out of agriculture.¹⁵

Duarte and Restuccia (2010) develop a tractable model of the structural transformation to quantitatively assess the contribution of sectoral labor productivity growth in understanding the evolution of aggregate productivity across countries. The model consists of three sectors: agriculture, industry, and services, with linear technologies in labor in each sector. Structural transformation is driven in the model by two factors: non-homothetic preferences for agriculture and services goods (with income elasticity less than one for agriculture and more than one for services) and an elasticity of substitution less than one for industry and services so that differential productivity growth in industry and services also generates reallocation across these sectors. Hence, a poor country in the model featuring low productivity in all sectors allocates a large share of labor to agriculture, a low share of labor to services, and the remaining labor to industry. With positive productivity growth in all sectors, labor is reallocated away from agriculture toward industry and services. With faster productivity growth in manufacturing than in services—as documented in the cross-country data by Duarte and Restuccia (2010)—there is further reallocation of labor from industry to services. Further, faster productivity growth in agriculture produces a speedier transformation out of agriculture. The framework is used with two purposes. The first purpose is to infer from the model comparable measures of labor productivity across sectors and countries. These sectoral measures of labor productivity are not generally available for a large cross-section of countries. The second purpose is to assess quantitatively the relevance of sectoral labor productivity growth in driving labor reallocation across sectors and aggregate productivity over time across countries.

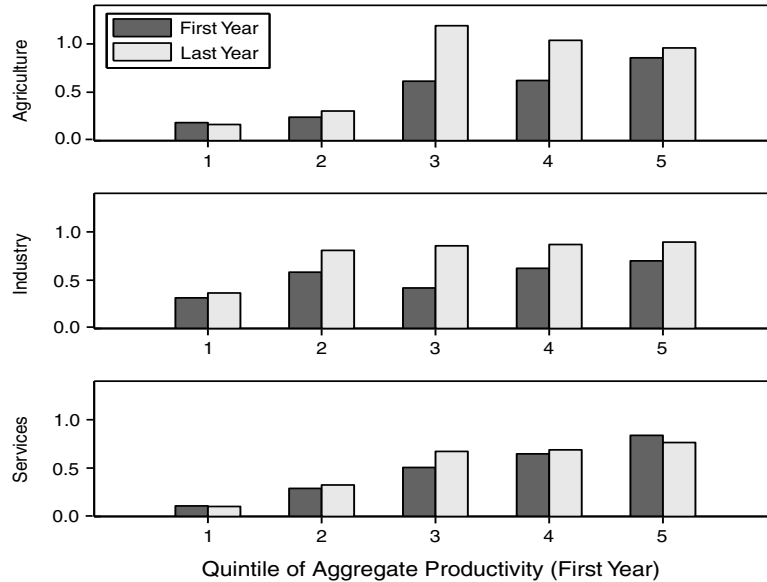
¹⁴ See also the recent survey article by Herrendorf, Rogerson, and Valentinyi (2011) on models of structural transformation.

¹⁵ For example, notice in Figure 7 how, in the earlier stages of structural transformation in Greece, Ireland, and Spain, labor reallocated from agriculture to both industry and services, but in a later stage (and throughout Canada) reallocation also occurs from industry to services, with the agricultural sector representing in a small fraction of total hours.

Figure 7 Share of Hours across Sectors, Selected Countries

Notes: This is Figure 2 in Duarte and Restuccia (2010).

Two key findings emerge from this framework. The first finding is that labor productivity differences across countries at a point in time are largest in agriculture and services and smaller in industry. These findings have the following mechanical and intuitive implication. Suppose for the moment that labor productivity differences across sectors and countries remain constant over time, that is, assume that growth in labor productivity in each sector is equal across countries. Then, with positive productivity growth in all sectors, the process of structural transformation implies that countries are reallocating labor from agriculture to manufacturing and to services. Since labor productivity is lower in agriculture relative to industry in poor countries compared to rich countries, the reallocation of labor from agriculture to manufacturing can explain an increase (catch up) in relative productivity for the poor countries. As the process of structural transformation continues with reallocation from manufacturing (and to a lesser extent agriculture) to services, a lower ratio of labor productivity in services relative to industry in poor countries compared to rich ones may imply episodes of slowdown, stagnation, and decline in relative aggregate productivity. The cross-country growth pattern across sectors gets a

Figure 8 Relative Labor Productivity across Sectors and Countries

Notes: This is Figure 6 in Duarte and Restuccia (2010).

bit more complicated when, in addition, labor productivity gaps are changing over time. In fact, the evidence suggests that there has been substantial cross-country catch up in labor productivity in agriculture and manufacturing over time but not in services, and that this process is important in understanding the evolution of aggregate productivity across countries. Figure 8 shows the implications of the model in Duarte and Restuccia (2010) for the first year in the sample (1956 for most countries) and the last year in the sample (2005 for most countries). Countries in the second, third, and fourth quintiles of the income distribution managed to achieve substantial catch up in relative sectoral productivity for agriculture and industry, but in general there is a lack of catch up in productivity in services.

The second finding is that the patterns of sectoral productivity across sectors and countries just emphasized account for most of the labor reallocation observed across countries.¹⁶ Moreover, the catch up in manufacturing

¹⁶ Duarte and Restuccia (2010) emphasize that, for some countries, sectoral productivity growth generates labor reallocation that is different from the data, suggesting that distortions/frictions may be important for some individual-country experiences.

productivity accounts for 50 percent of the catch up in aggregate productivity across countries and the lack of catch up in services explains all the experiences of slowdown, stagnation, and decline in aggregate productivity across countries. These findings point to the importance of the service sector in current growth experiences and present a challenge for economic policy in disentangling the relevant policies/regulations that affect the evolution of service-sector and aggregate productivity across countries.

3. REALLOCATION ACROSS ESTABLISHMENTS

A recurrent finding of the development accounting literature such as in Klenow and Rodríguez-Clare (1997) and Prescott (1998) is that TFP is the most important factor in explaining income differences across countries. Most of the analysis in explaining productivity differences across countries was done in the context of frameworks with a stand-in or representative firm featuring constant returns to scale of production. The result was then an emphasis on aggregate factors that explain the lack of technology adoption in poor countries. For instance, Parente and Prescott (1994, 2000) develop a framework emphasizing barriers to technology adoption in poor countries.

Complementing this work, the evidence from microeconomic studies, such as Baily, Hulten, and Campbell (1992) and Foster, Haltiwanger, and Syverson (2008), suggests that the reallocation of factors of production—from failing to entering firms, and especially from less to more productive firms—accounts for a substantial portion of aggregate productivity growth in the data. For this reason, Restuccia and Rogerson (2008) consider a model of heterogeneous production units where reallocation across these units is at the core of measured productivity in the economy.¹⁷

Misallocation and Productivity

The model in Restuccia and Rogerson (2008) embeds an industry equilibrium model of Hopenhayn (1992) into a standard one-sector growth model.¹⁸ Production takes place in establishments. The technology at the establishment level differs in TFP and features decreasing returns to scale in capital and labor inputs. The implication of these two features is that there is an optimal size of establishments, i.e., an optimal amount of capital, labor, and output for each productivity type and the size of an establishment is positively related to productivity. In other words, the efficient allocation of factors given

¹⁷ See also Banerjee and Duflo (2005) for a survey of closely related literature in microeconomic development.

¹⁸ An early analysis of the importance of reallocation is in Hopenhayn and Rogerson (1993), who focus on the effect of firing taxes on employment differences across countries.

these assumptions is such that capital and labor are allocated according to productivity, and the amount of aggregate resources determines the number of establishments. The aggregate production function then features constant returns to scale in the sense that if capital and labor were to double in the economy, then the number of establishments and output would double too. A critical feature of the model is that policies or institutions that affect the prices paid or received by establishments (what Restuccia and Rogerson [2008] call idiosyncratic distortions) generate a reallocation across establishments that lowers productivity. The list of institutions and policies that create such reallocation is large and is a prevalent feature of poor countries. For example, non-competitive banking systems offering below-market interest rate loans to selected producers based on non-economic factors, governments exempting certain producers of regulations or taxes, public enterprises often associated with low productivity receiving large subsidies from the government for their operation (financed through taxes on other producers), are the type of distortions that affect the size of certain establishments inducing a misallocation of factors of production. Labor market regulation and trade restrictions may also lead to idiosyncratic distortions. The approach in Restuccia and Rogerson (2008) is to represent all these potential sources of distortions through a generic form of tax/subsidy schemes and to assess their potential impact on aggregate productivity.

Restuccia and Rogerson (2008) study policy configurations whereby a fraction of establishments is taxed at a specified rate and the remaining fraction of establishments is subsidized. The subsidy rate is such that the aggregate capital stock remains the same. The reason for this approach is that the elements that affect capital accumulation are well understood and research has shown that capital accumulation is not a crucial factor in accounting for income differences (see, for instance, Klenow and Rodríguez-Clare [1997]).¹⁹ To make a quantitative assessment, Restuccia and Rogerson (2008) calibrate a benchmark economy with no distortions to data for the United States. The key components in calibrating the model are the elements that allow the model to reproduce the distribution of establishments and their size in the data. Experiments are conducted assuming that all countries are identical to the benchmark economy except on a configuration of idiosyncratic distortions. Even though the experiments are such that aggregate resources and the distribution of production efficiencies are the same as in the benchmark economy, idiosyncratic distortions are shown to have substantial negative effects on measured TFP and output. In particular, a policy configuration where 50 percent of the

¹⁹ More generally though, idiosyncratic distortions to establishments can also lead to substantial effects on aggregate capital accumulation, which may be of importance for individual-country experiences. See, for instance, Bello, Blyde, and Restuccia (2011) for an assessment of idiosyncratic distortions on capital accumulation in Venezuela.

most productive establishments are taxed at 40 percent implies a drop in TFP and output of 30 percent. Drops in TFP and output can be larger if more establishments are taxed, for instance if 90 percent of establishments were taxed and only 10 percent subsidized, measured TFP and output would drop by 50 percent.²⁰

While the policy experiments that Restuccia and Rogerson (2008) implement are hypothetical, there is substantial evidence on the types of policies that create idiosyncratic distortions. In related work, Hsieh and Klenow (2009) use microeconomic data of plants in the manufacturing sector for China, India, and the United States to measure the size of policy distortions and evaluate their aggregate impact. They find that eliminating misallocation in China and India (relative to that of the United States) can increase measured TFP between 30 percent and 60 percent. Roughly speaking, the intuition for how the microeconomic data can uncover the size of policy distortions is that in an economy without distortions, establishments with access to the same technology (except for TFP) and facing the same prices for output and factor inputs would equalize the marginal product of factors to the aggregate prices. With underlying differences in productivity across establishments, the more productive establishments are larger than less productive establishments. Idiosyncratic policy distortions affect the prices faced by individual establishments and, hence, prevent establishments from equalizing their marginal products. Data on establishment-level output, factor inputs, and input payments permit an evaluation of the price distortions that must be in place for the data to be an equilibrium of the distorted economy. Therefore, given the distortions, an evaluation can be made of the productivity gains from eliminating them.²¹

Interestingly, Hsieh and Klenow's (2009) empirical work also uncovers important differences between China, India, and the United States in the distribution of establishment-level productivity. The distribution of productivity across establishments is assumed to be the same across countries in Restuccia and Rogerson's (2008) experiments as the focus is on reallocation across these units. Differences in the distribution of productivity are also abstracted from in the gains from reallocation in Hsieh and Klenow's (2009) calculations.²² The differences in the distribution of productivity across establishments can

²⁰ I note that Restuccia and Rogerson (2008) also look at other potential policy configurations whereby distortionary policies are either random (some establishments are subsidized and others taxed but which establishment is taxed/subsidized is not related to productivity) or the more productive establishments are subsidized. While less damaging, these alternative policy configurations also have a negative impact on aggregate productivity as the size of establishments is distorted.

²¹ Much work has followed Hsieh and Klenow's (2009) approach using microeconomic data on firms to uncover distortions and productivity gains from reallocation in many countries. See, for instance, Pagés (2010) for applications in Latin American countries.

²² Hsieh and Klenow (2009) calculate the gains from reallocation as the ratio of efficient output to actual output for each country, where efficient output is produced by assuming factors of production are assigned efficiently to the establishments in the country.

potentially be the result of distortionary policies and can be studied jointly, for example, by allowing the policy distortions to have an impact on the selection of establishments through entry/exit and on productivity investment by establishments. Recent work has started to allow for an interaction between policy distortions and the distribution of establishments. In these frameworks, the shift in the distribution of establishment-level productivity is a consequence of changes in the amount of investment by establishments on their level of productivity in the face of idiosyncratic distortions that may discourage higher efficiency and barriers to entry and doing business, which are quite prevalent in poor countries.²³ In this regard, Restuccia (2011) and Bello, Blyde, and Restuccia (2011) study variants of the Restuccia and Rogerson (2008) model, where policy distortions shift the distribution of productivity across establishments in the economy toward the lower productivity units.²⁴

Specific Policies and Institutions

A limitation of the empirical measures of idiosyncratic distortions in Hsieh and Klenow (2009) is that they don't directly connect with specific policies and institutions. Such connection is critical in the determination of policy prescriptions for poor countries. Recent studies have tried to provide a quantitative assessment of specific policies or institutions in accounting for misallocation and low productivity in poor countries. This literature cannot be described in much detail in this article.²⁵ Broadly speaking, the applications span issues that include: the importance of financial development such as in Buera, Kaboski, and Shin (2011), Greenwood, Sanchez, and Wang (2010, 2011), and Midrigan and Xu (2010); the relevance of size-dependent policies that discourage large-scale operation through heavier regulation and taxes such as in Guner, Ventura, and Xu (2008); the importance of restrictions to foreign direct investment such as in Burstein and Monge-Naranjo (2009); the relevance of specific policies such as land reforms and progressive land taxes that discourage large-scale operation in farming in Adamopoulos and Restuccia (2011), among many others.²⁶ Focusing on the role of specific factors reduces the

²³ See, for instance, the empirical measures of cost of entry in *Doing Business* 2011 from the World Bank (2011).

²⁴ See also the interesting work in Ranasinghe (2011a, 2011b) and a related literature in trade that emphasize a shift in the distribution of productivities, e.g., Atkeson and Burstein (2010), and Rubini (2010).

²⁵ The growing literature on misallocation and productivity will be the subject of a special issue of the *Review of Economic Dynamics* to be published in January 2013.

²⁶ There is also a growing empirical literature assessing the importance of policies on specific experiences, but often the empirical studies are limited by the availability of good-quality microeconomic data and by the difficulty of accessing the data. Two interesting examples of cases where good microeconomic data is available are the study of trade reform in Colombia in Eslava et al. (2011), where the data includes quantity and price information for each producer, allowing for a real measure of productivity at the establishment level as opposed to the typical revenue

scope of potential impact on aggregate productivity and often still involves difficult issues of measurement. As a result, much work remains to be done in identifying and measuring specific policies and institutions and assessing their quantitative significance on the allocation of resources across productive units and, hence, on understanding aggregate productivity differences across countries.

4. CONCLUSIONS

Differences in income across nations are large. Moreover, the data shows remarkable episodes of growth catch up and collapse. In this article, I reviewed the recent literature in quantitative growth economics, broadly addressing these facts. In a nutshell, substantial progress has been made by studying the determinants of resource allocation across heterogeneous productive units, whether across sectors or across establishments within sectors. Much more work remains to be done in determining the fundamental factors in resource allocation across productive units.

To be more concrete, while agriculture has been shown to be important in explaining the income differences between rich and poor countries, further advances are needed in accounting for the low productivity problem in agriculture in poor countries. For instance, what specific policies and institutions explain the small-scale operations in agriculture in poor countries? Is the lack of well-defined property rights important? Are price distortions or other specific policies that discriminate against large operational scales important? What sort of barriers prevent trade in agricultural goods in low productivity countries? Similarly, while differences in labor productivity across sectors and countries are found to be important in accounting for the patterns of aggregate labor productivity growth across countries, it remains to be analyzed in detail what factors/policies/institutions explain the observed differences in labor productivity levels and growth rates across sectors and countries. For example, what determines the large gap in labor productivity in the service sector even among relatively developed countries? How do regulations and market structure affect productivity in services across countries? Closely related, misallocation of resources across heterogeneous production units are also found to generate substantial negative effects on measured aggregate TFP. But empirical measures of misallocation have so far been addressed in a relatively small number of countries, and these measures need to be linked with specific policies and institutions. Better measurement of individual policies and institutions affecting productivity at the establishment level, as well as better measurement of productivity at the microeconomic level, are likely to yield

measure of productivity, and the study of the increase in dispersion in tariffs associated with the Smoot-Hawley Tariff in the United States during the Great Depression in Bond et al. (2011).

important returns in terms of our understanding of productivity differences across countries. These advances are likely to allow for the design of effective policies addressing frictions and market imperfections that prevent an optimal allocation of resources, as well as the removal of barriers that prevent poor countries from operating closer to the technological frontier.

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