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Can population pressure cause sustainability problems to world economic growth? An analysis of the recent past

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CAN POPULATION PRESSURE CAUSE SUSTAINABILITY PROBLEMS TO WORLD ECONOMIC GROWTH? AN ANALYSIS OF THE RECENT PAST [(1)]

ABSTRACT:

In this paper we present further quantitative evidence for the impact of population growth on the world economy (prices, per capita GDP) during the second demographic transition. We use population growth as a proxy for the evolution of aggregate demand at the world level as well as the United Nations population-growth projections to the end of the twenty-first century. Since population can be considered as an endogenous variable of the economy, an Instrumental Variable analysis has been developed in order to obtain different and more reliable results on the causality effect of population growth on the world economy. We compare worldwide results with the Instrumental Variables results of the continents that currently represent the greater population pressure on supply: Sub-Saharan Africa and Asia. From this analysis we conclude that inflation rates are mostly explained by the purchasing power of populations – that is, the aggregate demand – rather than by population pressure. On the other hand, population ageing in the richest countries (such as OECD and China) have a life-cycle effect that impacts world measures on economic growth: a marginal increase of population causes a marginal decrease of GDP per capita.

Keywords: world population pressure, sustainability, human capital, output per capita, inflation.

JEL CODES: A11, A12, I15, J11, N3

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1. MOTIVATION OF THE PAPER

The world's population has been growing at a fast rate, and by 2010 the most important world economic agencies (the United Nations (UN) and the World Bank) regarded population growth, vis à vis the availability of calories, as an important problem in the medium term. This kind of concern about population growth, diminishing returns of land, and the surge of prices dates back at least to Malthus. In our case we are mainly interested in tracing to causality effects of population pressure on economic growth and inflation. As we will suggest in part 3 of the paper most of population growth in OECD countries is caused by the ageing of population. We identified that the rise of the share of consumers at the expenses of producers in the economy causes the decrease of per capita output. Therefore, we are also interested in this sort of life-cycle events as well as on the impact of economic endowments and productivity evolution in the poorest countries of the planet. We also account for the surge of prices caused by population pressure. Although we use a randomized and exogenous IV variable for population evolution, we conclude, from the regional case studies from Sub Saharan Africa and Asia, that population growth per se is not the main reason behind inflation rates. Our regional case studies analysis suggests instead that the crucial variable to explain inflation is the population purchasing power and therefore the evolution of aggregate demand.

2. INTRODUCTION: WORLD POPULATION GROWTH

According to the aforementioned international agencies in part 1, future world population growth is going to threaten the sustainability of the planet. The World Bank's and the UN's current world population data and projections are as follows:

TABLE 1. WORLD POPULATION (IN MILIONS)

1960	3,032
1970	3,682
1980	4,433
1990	5,280
2000	6,114
2010	6,922
2020	7,900
2030	8,548
2040	9,198
2050	9,735
2100	10,900

Source: World Bank datasets and UN projections.

Between 1960 and 2040 the world's population is going to increase threefold, surpassing the threshold of the 9 billion inhabitants that, according the world's economic authorities – such as the UN and the World Bank – should never be exceeded. This is a Malthusian hypothesis that does not take into consideration the

role of technological changes in the economy. On the other hand, Oded Galor (2020, 2022) regards population growth (rather than growth of per capita GDP) as one of the main reasons behind the warming of the planet. Therefore, technological changes to allow for the economic growth of this population spurt must be ecological and green. In order to achieve this goal, further investment is needed in education to promote innovation (Deschenes, O., C. Malloy, G.G. MacDonald, 2023).

We see in Table 1, and in Figure 26 of the appendix, that the rate of growth of the world's population has nonetheless been decreasing since 1968. In Figure 26, we can observe that from the start of the twentieth century until 1968 the annual rate of population growth increased, reaching a maximum in 1968 when it was 2.1%. After that the rate of growth has been decreasing, reaching 1.08% in 2019. The projected rate in 2100 is 0.1% – close to zero.

These changes in the annual rate of population growth show the impact of the demographic transition of population increase. During the twentieth century, life expectancies doubled in OECD countries pushing population growth upwards. Later, during the second half of the century, mortality conditions also improved in developing countries (World Bank, 2020). The Covid pandemic caused a drawback of this pattern, but the world's population growth is recovering, and in the medium term the effects of Covid on the trends of population growth are being overcome. Fertility rates adjust to low levels of mortality with a delay of several decades, leading to the temporary population explosion known as 'demographic transition'.

TABLE 2. REGIONAL FERTILITY RATES IN 2010

Region	**Fertility rate***
OECD countries	1.74
Latin America	2.63
East Asia and the Pacific	2.76
Non-OECD Europe	2.82
South Asia	2.97
North Africa	2.98
Central Asia and the Middle East	3.98
Sub-Saharan Africa	4.63

* Births per woman at reproductive age
Source: World Bank, 2010

Nowadays, 70% of the world's countries have fertility levels below replacement, that is, below two births per woman at reproductive age. Fertility is higher in countries where infant mortality is also higher. When deciding on having children, couples are and were making the calculation on how many children would survive (Williamson, 2001). But the reasons behind the highest fertility rates in Sub-Saharan Africa (4.63) are the different role of children in the family economy, polygamy, and higher levels of infant mortality. But on the other continents, the more accelerated downward trend of fertility after 1960 explains why the rates of the

world's population growth are decreasing (see Figure 26). On the other hand, life expectancy has diminishing returns with respect to income, and while doubling during the twentieth century, it is very plausible that life expectancy is going to increase at a much slower rate during the twenty-first century (Camps, Engerman, 2014). These trends of fertility and mortality explain the expected very low rates of population growth by 2100 (0.1%).

On the other hand, and although we have pointed out that the world's population is going to surpass the maximum threshold of 9 billion inhabitants by 2040, before the Russia–Ukraine war there were no signs that the scarcity of food calories led to high inflation rates. The bottlenecks caused by the wars, by climate change, and by changes to the global map caused by the armed conflicts, are causing the increase in the price of food. The recovery from two years of the lack of economic activity during the Covid pandemic, the sudden demand increase, and expansive monetary and fiscal policies in most of the Western world led to a surge in prices soon after the pandemic years (World Economic Forum, 2022). But higher inflation rates and the scarcity of fuel (oil and gas) and food are also related to wars. Even if these variables are not influenced by population growth, they affect the overall level of consumer prices, which is also a dependent variable of our analysis, as we shall see.

According to the information supplied by the International Monetary Fund, the world's inflation rate in 1981 was 12.5% and has never surpassed this level in the recent past. The 1970s and 1980s saw high inflation rates because of the Yom Kippur and Iran–Iraq wars and the policies adopted by the Organization of the Petroleum Exporting Countries (OPEC). These have been the highest inflation rates in recent history. Unfortunately, at the moment we cannot forecast the medium-term effects of the Russia–Ukraine war and all current wars. But the trends of the five richest countries of the world (Canada, USA, Germany, UK, and Japan) up to 2020 are shown in Figure 25 of the appendix. Notice that the high peaks of around 20% annual inflation of 1973/74 and 1979/80 have not been repeated in the history of developed countries, while after 1994 rates of around 2% to 4% were usual. It is well known that oil inflation in the 1970s led to an inflation of costs and to a process of stagflation throughout the Western world (Camps-Cura, 2013). As we have pointed out, we do not yet know the final effects of the current Russia–Ukraine war on the economic performance of Europe and the Western world. But, as in the 1970s, inflation is mainly growing or stabilizing because of the relative shortage of oil and gas resulting from the war and the bottlenecks in the provision of cereals that Russia and Ukraine were exporting in the past. Famine is starting to spread in those countries of Africa that were extremely dependent on the grain exports from Russia and Ukraine. Hopefully, most of the world's countries may move towards green technologies in order to reach greater independence from oil and gas (Deschenes, O., C. Malloy, G.G. MacDonald, 2023). Climate change also has a role in the rise of the prices of foodstuffs.

2. WORLD POPULATION, OUTPUT AND PRICES: AN IV ANALYSIS (1960–2020)

By 2050 the most populated countries of the world are going to be India (1,639 million), China (1,402 million), Nigeria (401 million) and the USA (379 million) (UN projections). Notice that India and China are the most populated countries in the world with a huge difference with respect to other nations. Concern about this population size led to a one-child-per-couple policy and to family planning in China in the recent past. Nonetheless, this policy had a negative effect on the survival of girls. By the year 2000, this led to a much higher infant mortality of girls (World Bank datasets 2000; Camps-Cura, 2019), where the official policy mandated one child per couple. Those couples who wanted a son may well have been inclined to offer their daughters for adoption, or, as in the case of Taiwan and other parts of Asia and Africa, to arrange a child marriage for them. The end result of such adoptions and marriage patterns was an increase in the infant mortality of girls (Sen, 1992, 2003; Boserup, 2007; Camps, Engerman, 2014).

In order to better frame the causality effects of population growth on the world's output and price levels, we performed an IV analysis of the period 1960–2020. The world regression analysis is based on the data of the six richest countries in every continent according to levels of GDP per capita by 2020 (see the countries in Figures 1 to 24 of the appendix) with the exception of North America (two countries), Australia (one country), and Russia (belonging to two continents). Since, at the continental level, these countries are very close to each other, and in order to allow for international comparative results, as a first step we performed a baseline OLS regression with country and time fixed effects and with observations on an annual basis. The number of annual observations of the regressions is large enough and supply statistically significant results even though for some countries there are many missing values. The data source for per capita GDP, population and prices (Consumer Price Index (CPI)) is the World Bank datasets. Unfortunately, this data source only offers information up to 2022, and our regression results only show the economic reality of the period 1960–2020: i.e., the recent past and before the major impact of the Covid pandemic in the twenty-first century. Therefore, at the moment, we cannot capture the regression effects of population growth on output and price projections in the post-Covid era. The control variables (CO_2 per capita, income inequality, gender equality and religious freedom) come from the Gap Minder dataset which is easily available online.

We use the following equation to evaluate the causality effect of population growth on the world's outputs and prices:

$$y_{i,t} = \alpha_0 + \alpha_1 \cdot population_{i,t} + \alpha_2 \cdot z_{i,t} + \mu_i + \nu_t + \varepsilon_{i,t}$$

Where:

$y_{i,t}$ is either GDP per capita or CPI price level for country *i* in year *t*.
$population_{i,t}$ is the variable we are interested in; it indicates different population levels in country *i* and year *t*. Population, price, and GDP per capita are in log form.
$z_{i,t}$ is the control variable, including CO_2 per capita, Gini Coefficient, Gender Equality Index and Religious Freedom Index.
μ_i and ν_t are the individual country fixed effect and time fixed effect.

The baseline OLS results can be seen in Table 3. The effect of population growth on output and price is heterogeneous. An increase in population of 1% can lead to a near-equivalent reduction in GDP per capita but more than a threefold increase in price level. This is consistent with the Malthusian thinking that excessive population growth will result in a decline in living standards. Also, since a greater population means a greater demand, this makes sense for a positive coefficient of the price level.

Table 3. WORLDWIDE SAMPLE (1960–2022) OLS REGRESSION

	Log(GDP per capita)	Log(Price)
Log(Population)	-1.198^{***}	3.1454
	(0.3440)	(2.588)
CO_2 per capita	0.1267^{***}	-0.1770
	(0.0239)	(0.1131)
Gini Coefficient	0.0126	0.0370
	(0.0122)	(0.0570)
Gender Equality Index	-0.0084	0.0253
	(0.0059)	(0.0607)
Religious Freedom Index	0.0038	0.0673
	(0.0035)	(0.0609)
Constant	16.2794^{***}	-30.6072
	(3.1016)	(23.5925)
Country FE	Y	Y
Time FE	Y	Y
Observations	1213	1155
# countries	28	27

*p<0.1, **p<0.05, ***p <0.01

We stated that population can be considered as an endogenous variable of the economy and have proceeded to the IV analysis. In order to obtain a strong IV, we have selected ‘gross tertiary education enrolment rates%’ as a percentage of population in that age group (World Bank/UNESCO datasets) as an IV of population. This variable consists of the population of all ages enrolled in tertiary education as a percentage of population of the age group in which tertiary education is planned for successful students in every country. Notice that the variable is ‘gross enrolment rate’ and includes students repeating courses with ages above what is normative for

successful students. This is an important matter to stress since it is well known that education may also be an endogenous variable, and this could be a potential threat to the accuracy our IV analysis. But from our analysis, we conclude that the real endogenous variable is 'educational attainment' not 'gross enrolment' (see the country data on educational attainment at the world level at Barro, Lee (2013)). As for the gross tertiary education enrolment rate, UNESCO's worldwide rankings show that Greece is first, Turkey second, and Australia is third.

Educational attainment results in very different outcomes for the economy. From the literature (Beker, 1990, 2005; Baizan, Camps, 2007) we know that higher education attainment leads to fewer, but higher quality, educated children. A mother's education has a very significant effect on the reduction in the number of children in her family. One more year of schooling of mothers leads to 0.33 fewer children per couple in average terms at the world level (Camps, Engerman, 2014). Higher education attainment can also lead to economic development and therefore to an improvement of life expectancy. Countries that rank first in educational attainment worldwide include USA, UK and China – these are the countries where the trade-off between quantity and quality of children is more apparent. By using the 'gross tertiary education enrolment rate' we avoid this sort of endogeneity. This IV includes some extra economic inefficiencies of the education system caused by different features of family life, historical background, the institutional educational framework, religious beliefs, etc. Each of these can produce shortcomings of educational success: gross tertiary education enrolment includes a reverse causation effect on the economic growth variables and cancels the positive forward role of educational attainment on economic development. All of these aspects transform our IV variable into a randomized and exogenous variable for our equation.

More importantly, and econometrically speaking, a potential risk of using this IV could be that it is correlated with the dependent variables: Log GDP per capita and Log Prices. But we have calculated the correlation coefficients: correlation of the IV with respect to Log GDP per capita is 0.0372; and with respect to Log Prices 0.0512. These correlation coefficients are very low and prove that the standard errors are not correlated. Therefore, our IV variable accounts for a more sensitive causality estimation of population growth than the other economic variables. Our IV results are presented in Table 4

TABLE 4: IV WORLDWIDE SAMPLE (1960–2020)

	Log(GDP per capita) (IV)	Log(Price) (IV)
Log(Population)	-1.4533^{***}	5.4367^{***}
	(0.2025)	(0.909)
CO_2 per capita	0.1315^{***}	-0.1365^{***}
	(0.008)	(0.032)
Gini Coefficient	0.0070	0.046^{***}
	(0.0035)	(0.017)
Gender Equality Index	-0.0129^{***}	0.0525^{***}
	(0.002)	(0.015)
Religious Freedom Index	0.0051^{***}	-0.0109^{*}
	(0.001)	(0.006)
First Stage: Log(Population)		
Tertiary enrolment rate (%)	-0.0043^{***}	-0.0045^{***}
	(0.0004)	(0.0004)
Country FE	Y	Y
Time FE	Y	Y
Kleibergen-Paap rk Wald F statistic	134.406	126.189
Observations	1160	1107
# countries	28	27

*p<0.1, **p<0.05, ***p<0.01

Indeed, as the first stage regression in Table 4 shows, gross enrolment rate in tertiary education does not have a significant negative effect on population: one additional enrolment rate leads to around 0.0043% decrease in population.
F- statistics are 134.406 and 126.189 respectively, suggesting that a weak IV should not be the primary concern here. In respect of the ultimate effect of population on output and price, our IV suggests that a 1% of population growth can result in 1.4533% decrease in GDP per capita and 5.4367% increase in price level. Both coefficients are larger than the baseline results, providing more valid evidence of population growth on the demand side. But again, the results are Malthusian, since population growth leads to a decrease of output per capita and a surge in prices.

Regarding the first result – the negative coefficient of GDP per capita relative to population growth – we must remember that the sample includes the richest countries of each continent. Particularly in OECD countries – or in countries like China with very low fertility rates – population increase is explained by a decrease in mortality and an improvement of life expectancy, and to a lesser extent by

immigration, rather than by decreasing fertility rates. As long as this process is sustained, and the stage of the demographic dividend is surpassed, population growth is mainly explained by the increasing proportion of the elderly in the population. Therefore, there is a shift in the balance of producers–consumers. Population growth just implies an increase in consumers and an erosion of the producer–consumer balance. Therefore, a marginal increase of population significantly leads to the diminution of GDP per capita since the denominator of this magnitude is increasingly based on consumers who are not producing. As a result, GDP levels do not increase or negatively increase with population growth (Allen, Kelley, 1988; Bloom, Canning et al., 2003; Jones, 2022; Mason, Lee, 2022; Kotschy, Bloom, 2023).

On the other hand, these results raise the hypothesis that the high population growth we observe in this period is not associated with increases of the same magnitude in labor productivity in the poorest or the developing countries of Africa, Latin America, or parts of Asia. As pointed up by Galor (2020, 2022), demographic transition fosters a population explosion that leads to a post-Malthusian period in which fertility rates no longer converge at low levels. Population growth reduces the value of output per capita. If the supply of goods and commodities is relatively scarce because of the lack of investment that fosters productivity growth, the pressure of demand caused by the increase in population leads to an increase in prices.

Beginning in the 1960s, with the contributions of Becker (1964), Barro (2011), Lucas (2002), and Barro and Sala-Martin (2004), among others, theoretical economics began to grow more sophisticated, incorporating human capital as an endogenous factor of economic growth following the model developed by Robert Solow. Human capital's defining feature is its multiplier effect on the productivity of the labour. Moreover, when added to physical capital, it removes the restriction of diminishing returns in the absence of technological change and paves the way for sustained long-term growth even when no exogenous technological change has taken place, thereby altering the characteristics of the production function. Therefore, in keeping with recent work by theoretical economists, human capital has emerged as an important factor for explaining labour productivity and economic growth.

In most poor countries as we shell mention in part 3 of this paper, levels of human capital are very low and do not converge with levels in rich countries. Despite population growth fosters a cheap labor supply, if labor productivity and human capital formation are low, and other inputs or imported manufactured goods are relatively more expensive, the lack of competitiveness may, hypothetically, cause higher prices, as for instance in Africa, Latin America, or parts of Asia. All of this depends on endowments, income inequality, and the development of productivity. The main exceptions are China and India, which, after the 1980s, started a process of economic growth and productivity increase based on an abundant and cheap labor supply. Or to put this in other words: in less-developed countries, when the rate of population growth is greater than the rate of productivity growth, problems of

scarcity are going to appear, resulting in price rises and reductions of output per capita.

Finally, the increase of the world's population – and therefore of aggregate demand – has had a strong impact on price levels. This suggests that the weight of products with inelastic demand in the purchasing basket was high. As we have already stated, the period under consideration in this paper includes the years of the oil shocks, during which we saw that annual inflation rate could reach a level of 20% in some of the richest economies (see Figure 25 in the appendix).

3.THE CONTINENTS FOSTERING HIGHER DEMOGRAPHIC PRESSURE: SUB-SAHARAN AFRICA AND ASIA.

In order to further explore the differences of the impact of population growth on per capita GDP and consumer prices, we have developed the same IV exercise for countries of Sub-Saharan Africa (the continent with higher rates of population growth) and Asia (the most populated continent in the world) in order to provide further causal evidence of the impact of population pressure on per capita GDP and prices. As Table 5 shows, the population of Africa is growing at an annual rate of 2.49% – the highest rate worldwide – while Asia represents 59.5% of the world's population: the greatest share.

TABLE 5. RATES OF GROWTH AND POPULATION SHARE OF THE WORLD'S REGIONS, 2023

	RATE OF GROWTH	POPULATION SHARE
Asia	0.86%	59.5%
Africa	2.49%	17.2%
Europe	0.06%	9.6%
Latin America and the Caribbean	0.90%	8.4%
North America	0.62%	4.7%
Oceania	1.31%	0.5%

Source: United Nations, 2023

In IV regressions on Sub-Saharan Africa and Asia, we include annual data of all countries and not just the six richest countries of each continent, as in the world sample. As shown in Table 6 (Sub-Saharan Africa) and Table 7 (Asia), in both case studies, the value of the F statistic rejects the hypothesis of a weak IV. And we reported that Sub-Saharan countries represent the sample of world countries with higher demographic growth and higher fertility rates. Together, the Asian countries represent the most populated continent in the world but with a low rate of demographic growth.

Table 6: **Sub-Saharan Africa 1960–2020**

	Log(GDP per capita) (IV)	Log(Price) (IV)
Log(Population)	-0.566**	3.932***
	(0.254)	(0.868)
CO_2 per capita	0.278***	−0.002
	(0.023)	(0.043)
Gini Coefficient	-0.004**	0.039***
	(0.002)	(0.008)
Gender Equality Index	−0.009***	0.021**
|	(0.002)	(0.010)
Religious Freedom Index	0.001	0.009
	(0.001)	(0.007)
First Stage: Log(Population)		
Tertiary enrolment rate (%)	−0.011***	−0.012***
	(0.001)	(0.001)
Country FE	Y	Y
Time FE	Y	Y
Kleibergen-Paap rk Wald F	149.42	178.19
statistic	1635	1407
Observations	42	41
# countries		

*p<0.1, **p<0.05, ***p <0.01

As presented in Table 6 for Sub-Saharan countries, a 1% increase in population leads to a rate of increase of 3.932% in prices and 0.566% decrease in output per capita. The inflationary effect of population growth – and therefore of the increase in aggregate demand – is lower than in the worldwide sample. Indeed, the aggregate demand is composed not only of population size but also of levels of consumption and investment. As a result, poverty has been, and remains, a problem in the countries of Sub-Saharan Africa. Even if, according to Galor (2022), Africa was the origin of human civilization, subsequent slave trading, colonization, ethnic fractionalization – all of which have led to wars, military conflicts and decolonization – have subjected African countries to a tragic stage of economic development, violence, and low levels of human capital formation (Artadi, Sala-i-Martin, 2003; Moscona, Nun, Robinson, 2020). This can explain why, even if the rate of growth of population reaches a maximum, the purchasing power of the population is lower. This last fact implies that the population pressure on economic variables such as price and per capita GDP is also lower, as reported by the coefficients obtained in our IV regression analysis.

In the case of Asian countries (see Table 7), we obtain the result of higher levels of inflation as a consequence of population growth. A 1% increase in population leads to a 5.596% increase in prices and a 0.378% decrease in GDP per capita. Inflation levels obtained for Asian countries are nearly the same as for the worldwide sample. This suggests that average living standards are also similar at the aggregate level. We must bear in mind that our worldwide sample includes data from the poor countries of Latin America and Africa, and that living standards in Sub-Saharan Africa are the lowest in the world. Therefore, consumer power and real wages are important variables which, for the moment, we do not include in our analysis, but which we want to include in future research. On the other hand, Asian countries include the emerging economies of China and India that started a process of sustained growth by the 1980s (for the effect of the growth of China on global inequality levels see Sala-i-Martin (2006)). Therefore, Asian countries include high disparities in the level of wellbeing and economic development. But considering that China is the second largest economic power of the world – and, according to the World Bank, it is the first in purchasing power parity (PPP) terms – and its economic influence spreads in part of the continent, it is not causal that we obtain similar levels in inflation rates with respect to the worldwide sample. As for the lower levels of decrease of GDP per capita as a result of population pressure, we must bear in mind that the process of population ageing is less developed in Asian countries (Galor, 2022) with respect to some of the world's richest economies in the West.

Table 7: **Asia 1960–2020**

	Log(GDP per capita) (IV)	Log(Price) (IV)
Log(Population)	-0.378	5.596^{**}
	(0.571)	(2.418)
CO_2 per capita	0.015^{**}	0.059^{*}
	(0.007)	(0.036)
Gini Coefficient	-0.006	-0.032
	(0.005)	(0.020)
Gender Equality Index	0.009^{*}	-0.111^{***}
|	(0.005)	(0.018)
Religious Freedom Index	-0.005	0.057***
	(0.003)	(0.014)
First Stage: Log(Population)		
Tertiary enrolment rate (%)	-0.003^{***}	-0.003^{***}
	(0.001)	(0.001)
Country FE	Y	Y
Time FE	Y	Y
Kleibergen-Paap rk Wald F	23.508	16.07
statistic	1419	1273
Observations	38	37
# countries		

*p<0.1, **p<0.05, ***p<0.01

As a final remark on these IV results, we must stress that the lower rates of price growth in Sub-Saharan Africa – the continent with a higher population growth rate with respect to the world sample – reinforce the conclusion that population growth per se has not been the main engine of inflation or of the increase of the CPI. Living standards and the purchasing power of demand also play an important role. Results on inflation are higher for the worldwide sample and for Asia, while the effect of the higher population growth on economic variables is much lower for Sub-Saharan Africa, where levels of education and real wages are the lowest of the world.

Even if we cannot forecast the future from the information we have available, the world's regional distribution of population as projected by UN (see Figure 28 of the appendix) is going to change the territorial balance of the world's population, and Asia and Africa are going to represent its major share. Of course, this poses other questions, such as the direction of migratory movements from the aforementioned more populated continents, and how core countries are going to receive migrants. But this is a different topic of research that we do not cover in this paper, but which we plan to explore in the future.

Finally, in the appendix of figures, you can also find the graphs of Log per capita GDP, population and prices of the countries used in the worldwide regression. For greater clarity, we present the time series from 2000 to 2020. But in the appendix, you can also find figures for the long-term evolution of annual inflation rates (Figure 25); population growth, including a projection up to 2100 (Figure 26); population densities at the country level (Figure 27); projected world population by region up to the year 2100 (Figure 28), and the rates of population growth at the country level (Figure 29).

4. CONCLUSIONS

In this paper we have attempted to present results on population growth and its impact on output per capita and prices at the world level and at the regional level of Sub-Saharan Africa and Asia. Our IV regression analyses have shown the causality impact of population growth on the economic variables output per capita and price. Our IV analyses show that a 1% increase in population led to a decrease of 1.4533% in output per capita in the worldwide sample, and decreases of 0.566% in Sub-Saharan Africa and 0.378% in Asia. The higher rate of decrease of output per capita in the worldwide sample has suggested the effects of ageing in countries that experienced a demographic transition in the nineteenth century, mainly in the OECD countries. The ageing of populations changes the producer–consumer balance at the expenses of the producers. This life cycle result may explain why population growth results in lower levels of output per capita.

The effect of population growth on prices is also impressive: a 1% increase in population led to a 5.4367% increase in the level of prices in the worldwide sample, and increases of 3.932% in Sub-Saharan Africa and 5.596% in Asia. These results suggest that some of the products in the purchasing basket had inelastic demand, particularly in the most developed countries of the world, which were more dependent on the price of oil and gas; prices which increased during the oil shocks in the period under consideration. The similar levels of inflation in Asia with respect to the worldwide sample have provided evidence that in average terms living standards are similar on this continent with respect to the worldwide sample, a sample that includes rich countries as well as the poorest countries of Africa and Latin America. The case of Sub-Saharan Africa has provided insights into the role of education and living standards in the supply variables of the economy (output per capita and price). Since Sub-Saharan Africa is the continent with a higher population growth of all the regions studied, its lower levels of inflation have shown that population growth per se is not the main reason behind the surge in prices. Aggregate demand – composed of consumption and investment – depends on the purchasing power of the population, and this last variable is weaker in the continents with higher population growth and with lower levels of real wages and human capital formation. On the other hand, population growth provides a more abundant and therefore cheaper labor supply. Lower living standards in Sub-Saharan Africa explain its lower levels of inflation. Therefore, caution expressed by international economic agencies regarding the effect of population growth on inflation may be partly dismissed.

Apart from population growth, other variables affect the level of consumer prices reported in our results. Climate change and wars stand out as two of the reasons that cause uncertainty in the future evolution of the supply variables presented in this analysis. But step by step, and since population growth will reach its sustainable maximum by 2040, we hope that countries are going to move towards green and renewable energy technologies to deal with the effects of current population growth. Still further investments in human capital are needed in order to promote the necessary innovation processes to spread these new technologies worldwide at efficient prices.

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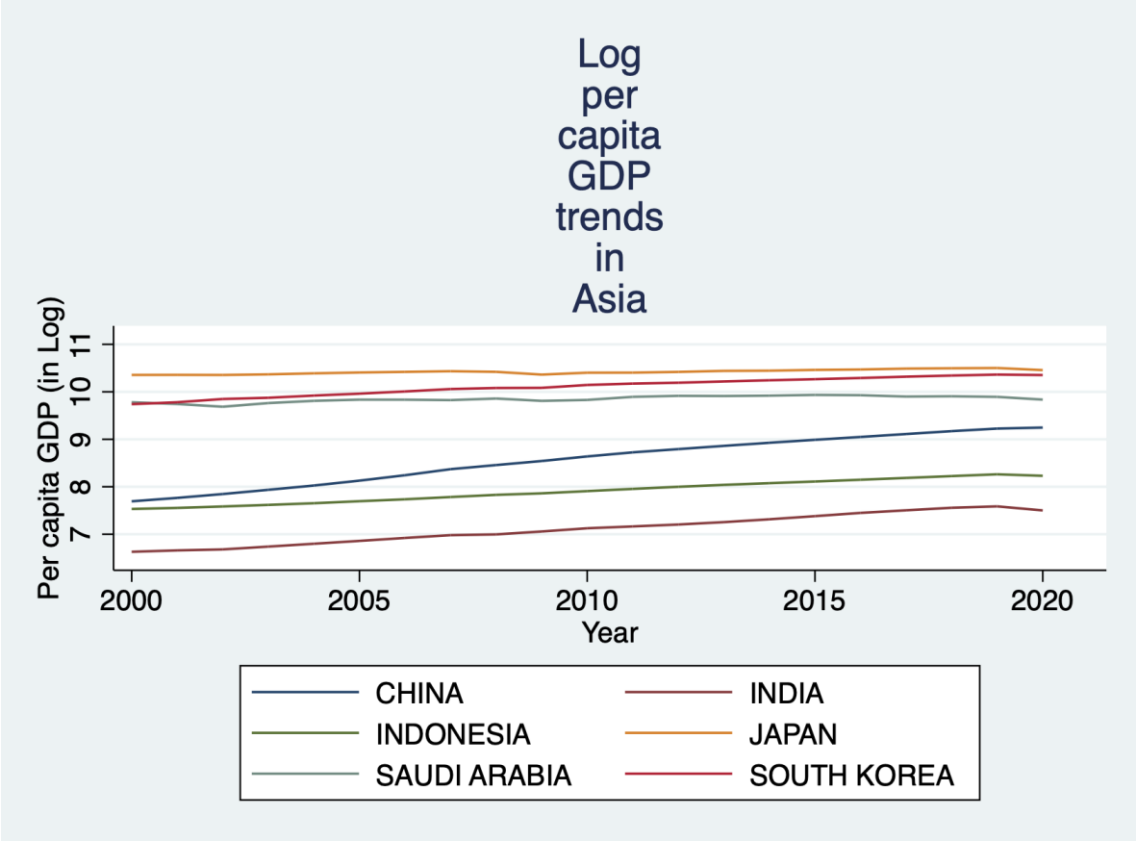
APPENDIX OF FIGURES

GDP graphs by country (1–7)
Population trends by region (8–14)
Price level graphs (15–21)
Specific country trends (22–24)
Annual inflation rates (25)
Population graphs (26–29)

GDP graphs by country

Figure 1



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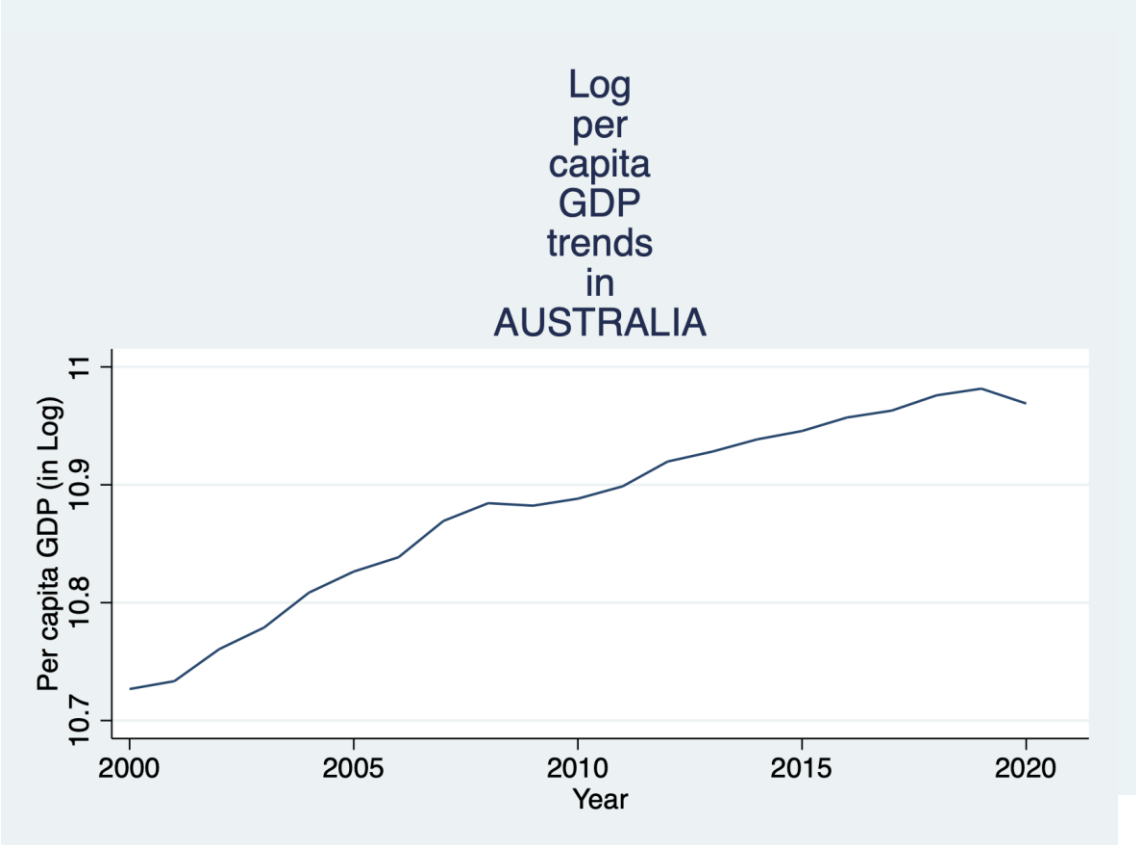

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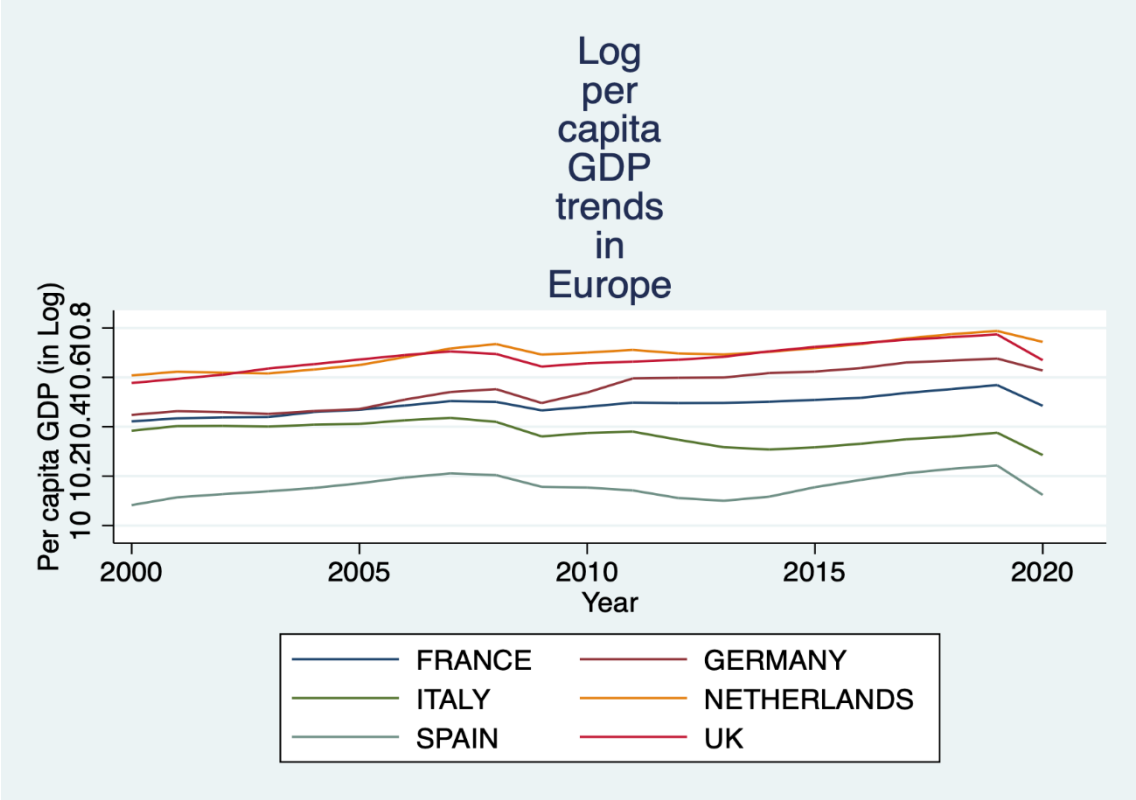

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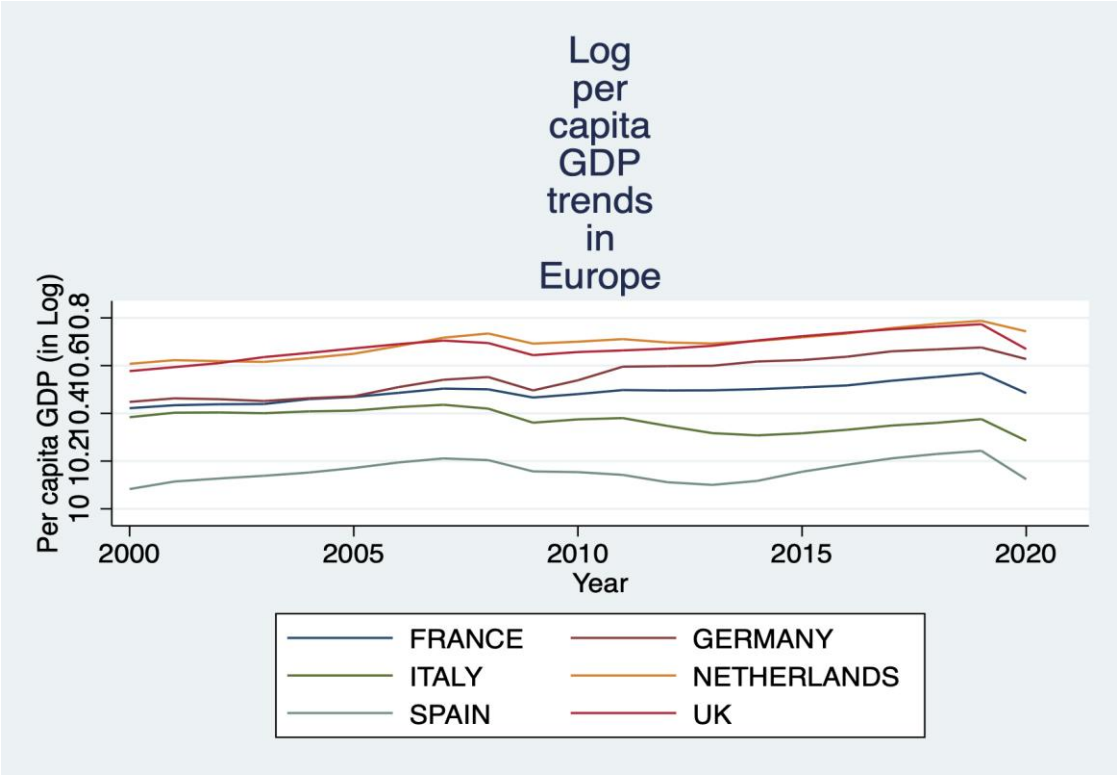

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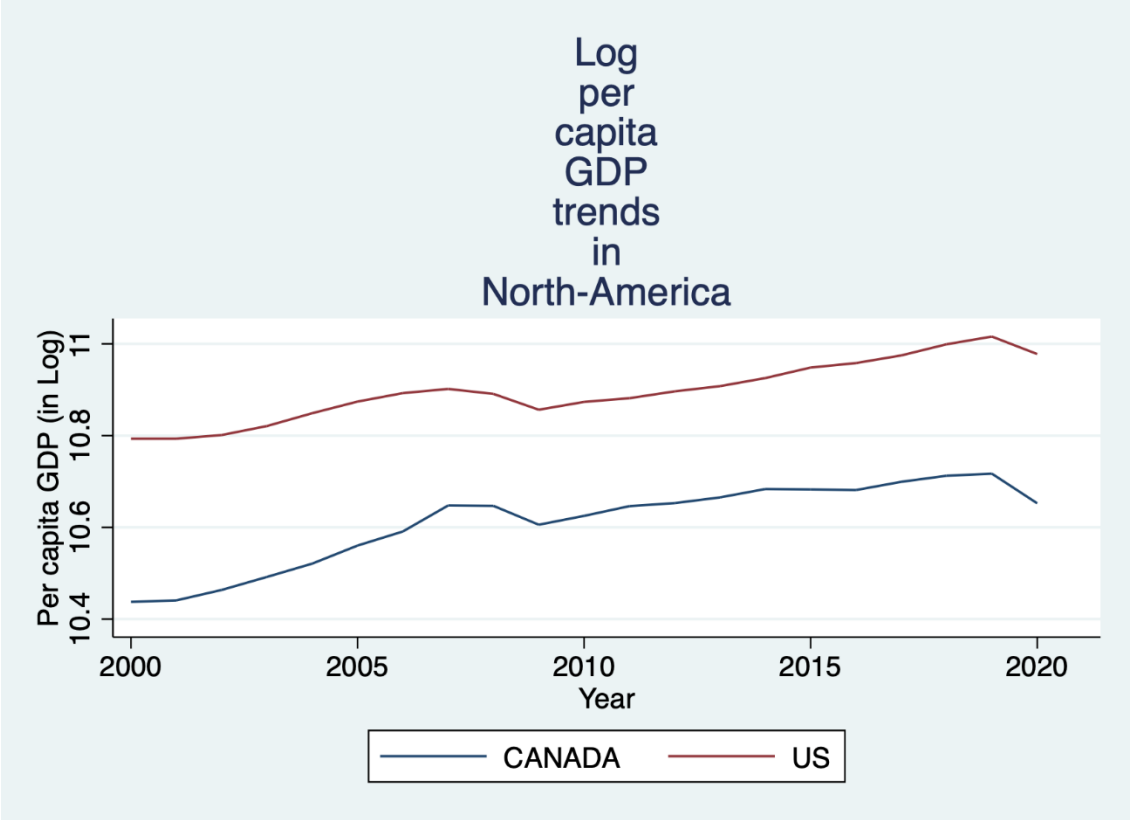

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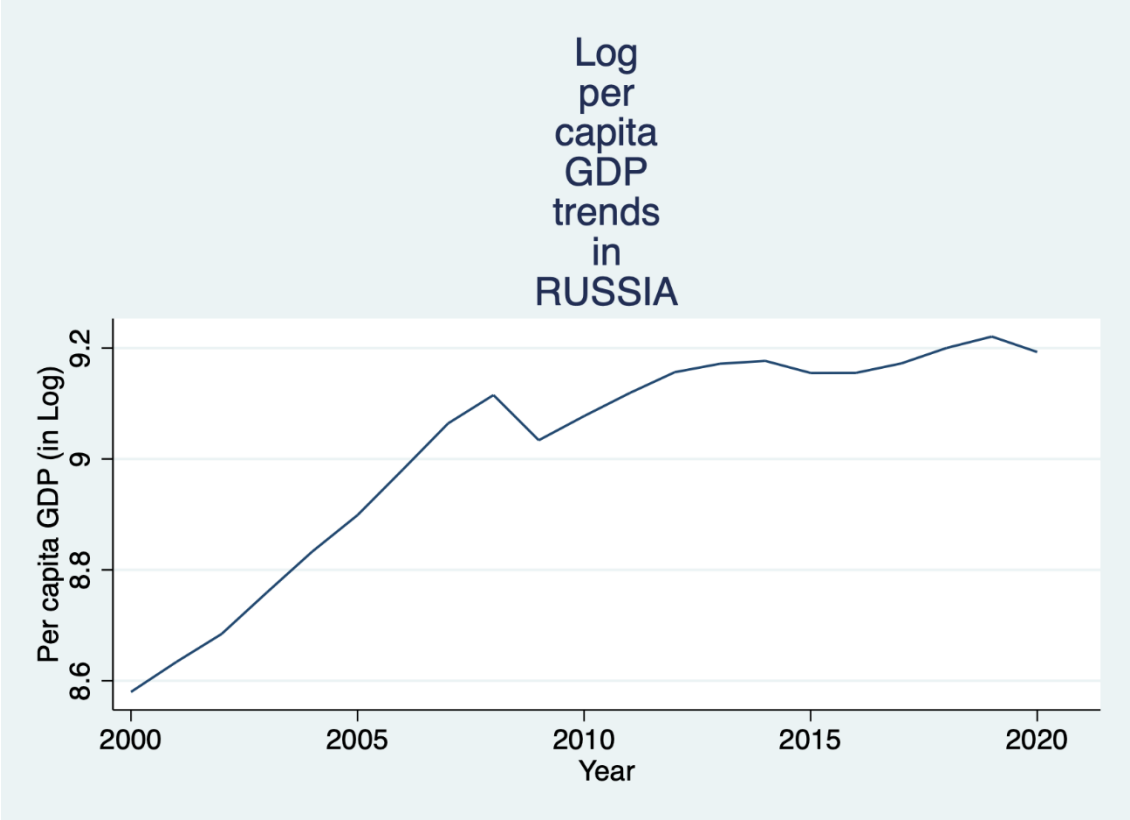

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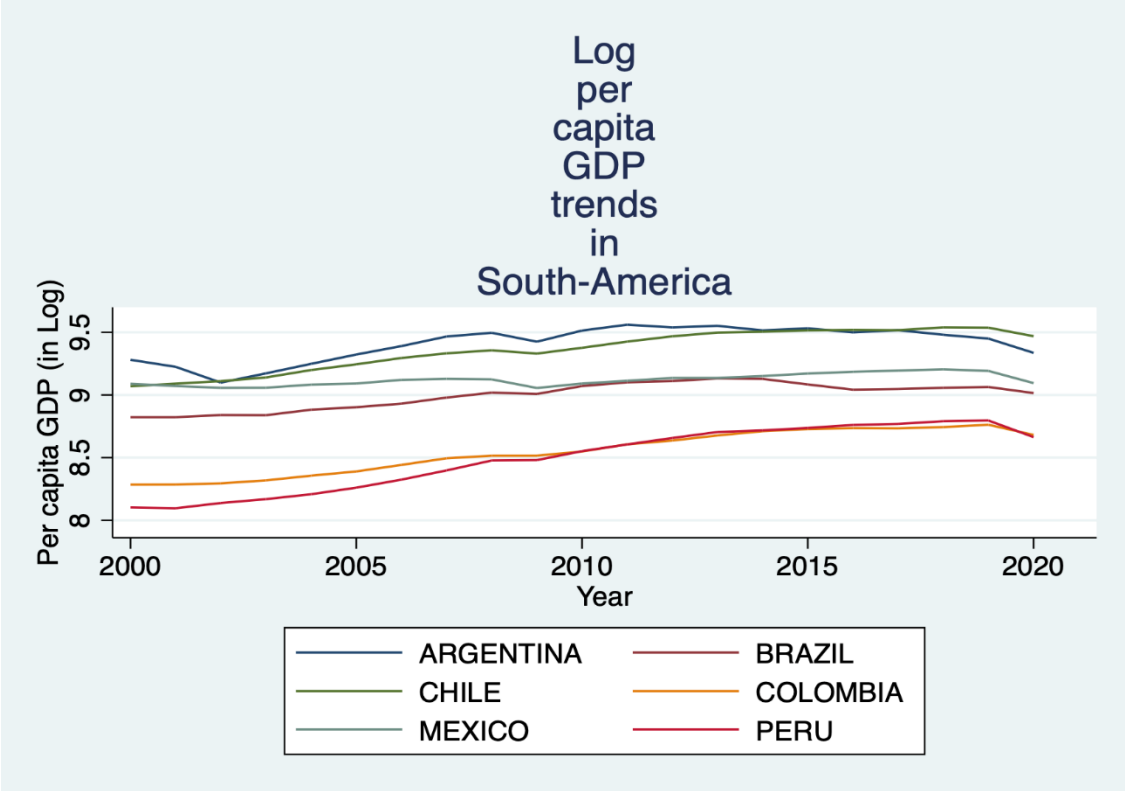
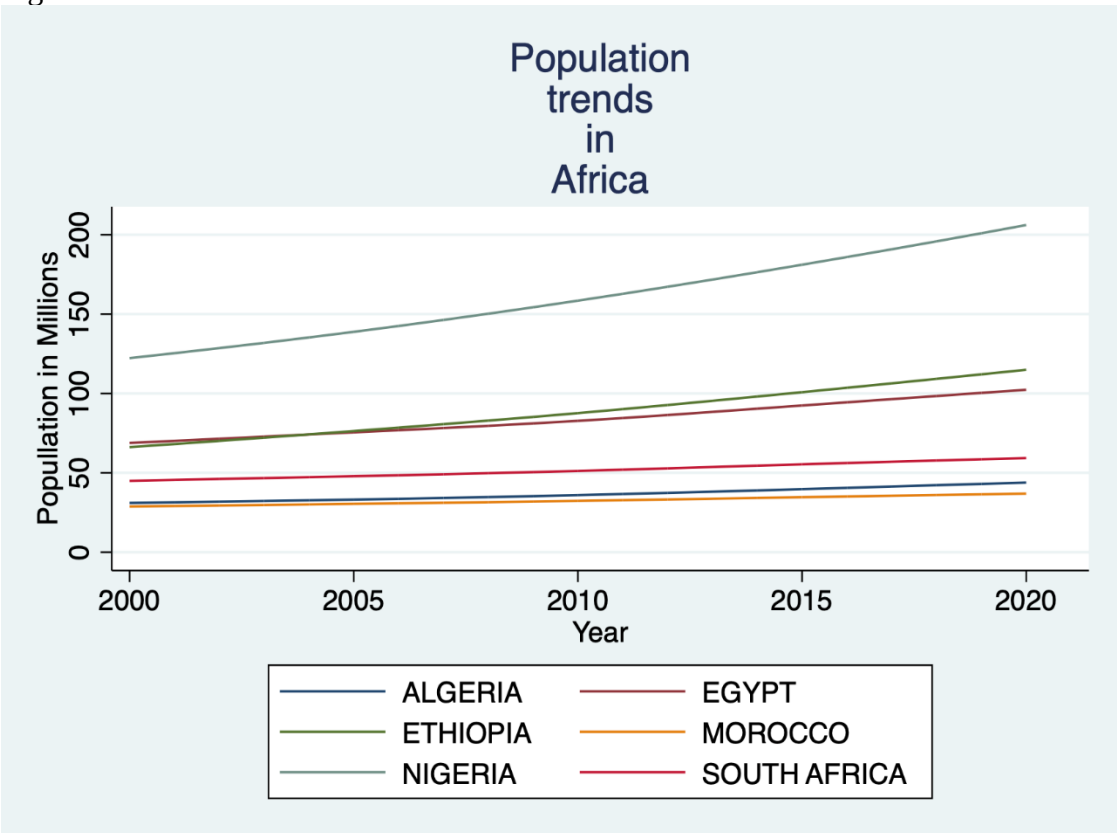


Population trends by region

Figure 8



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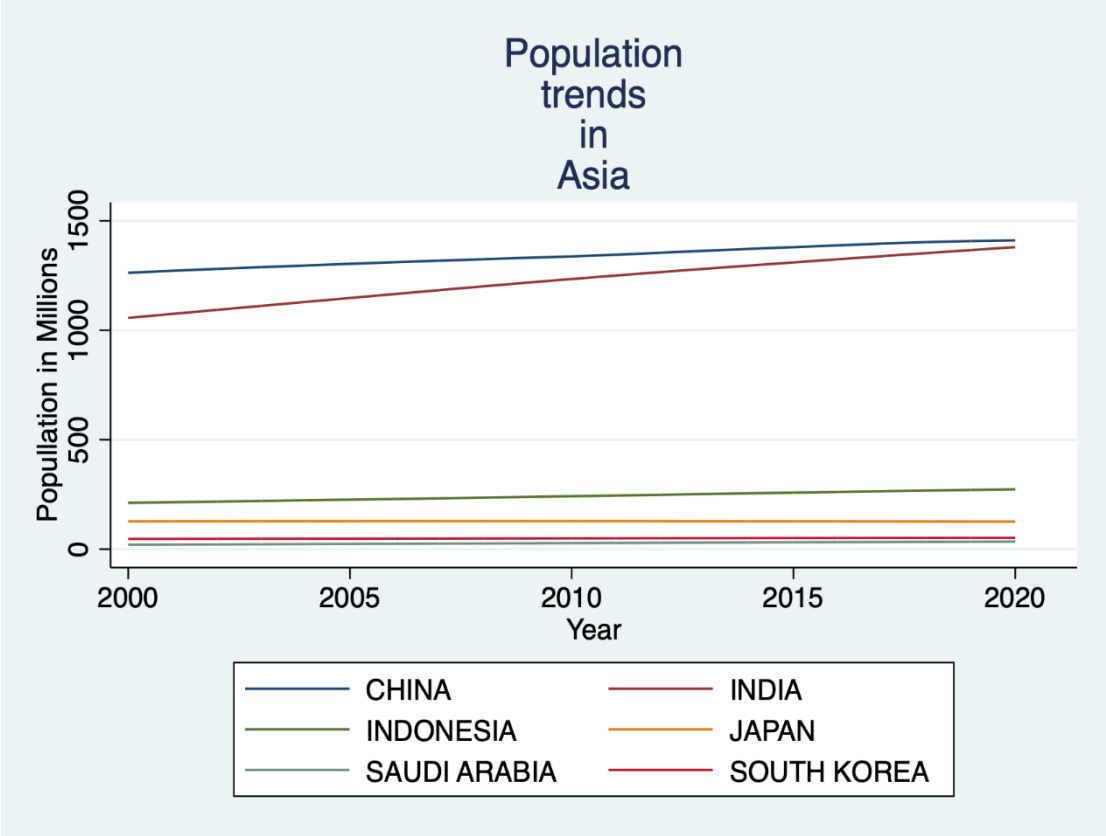

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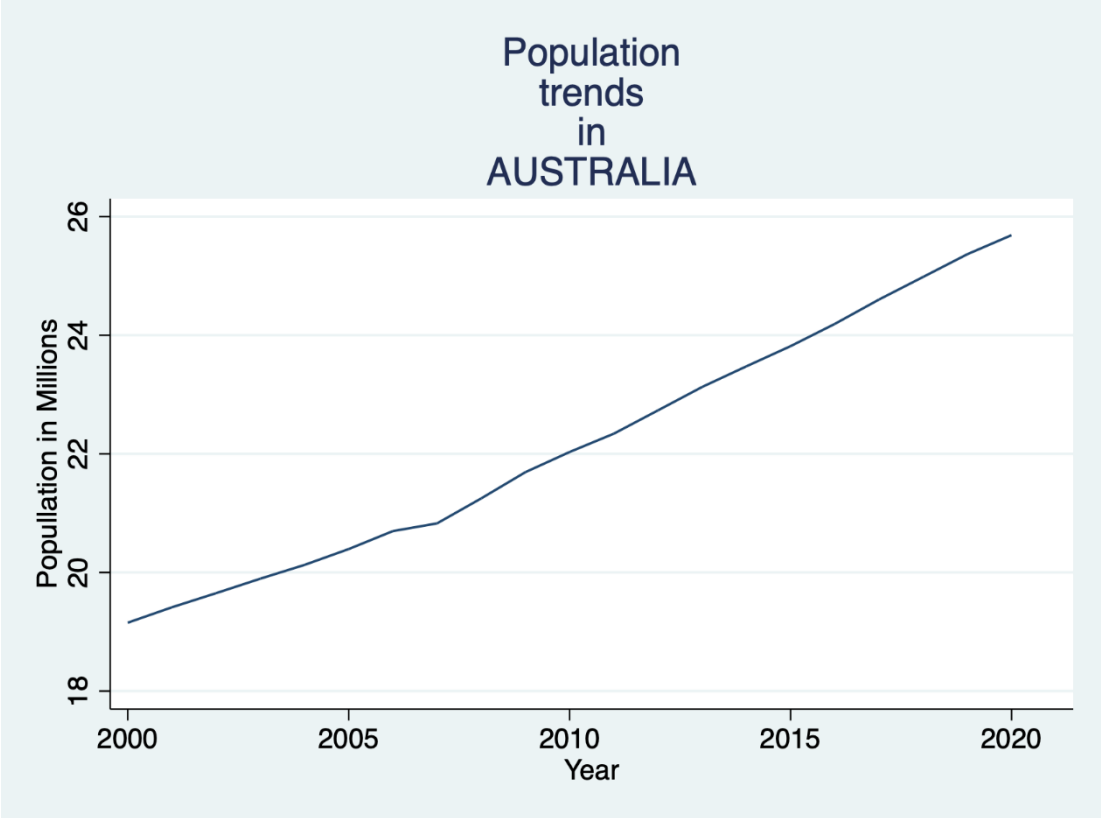

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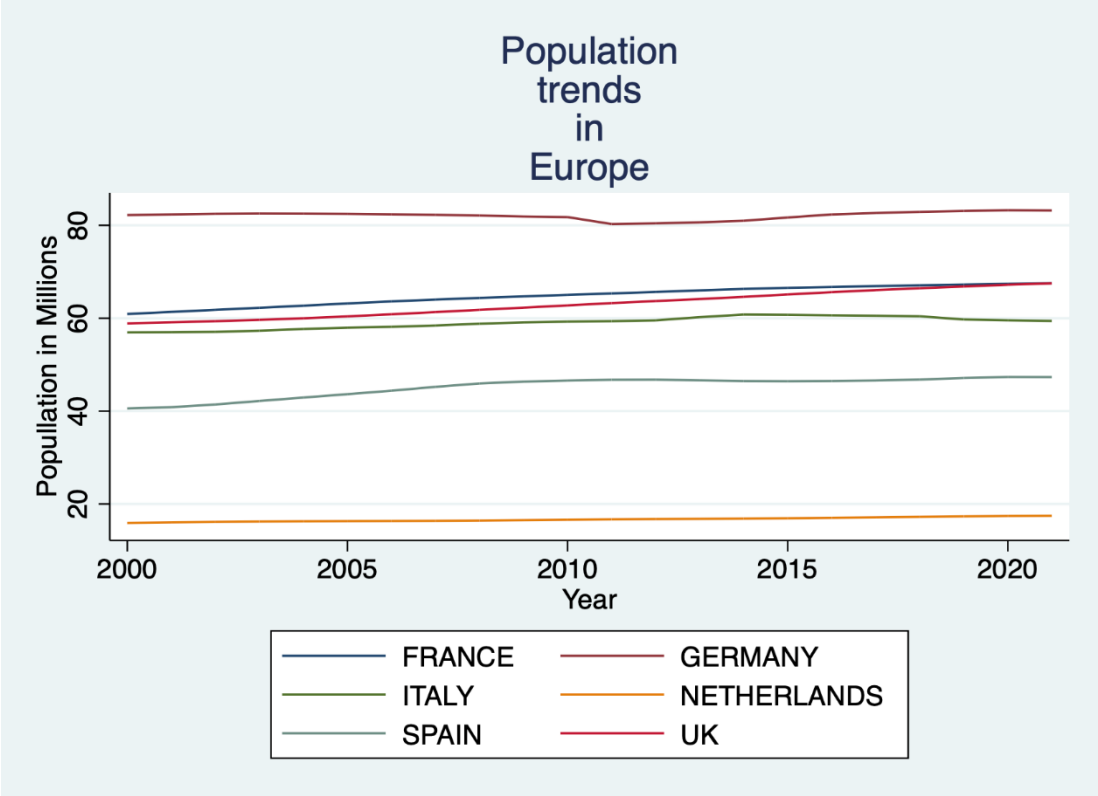

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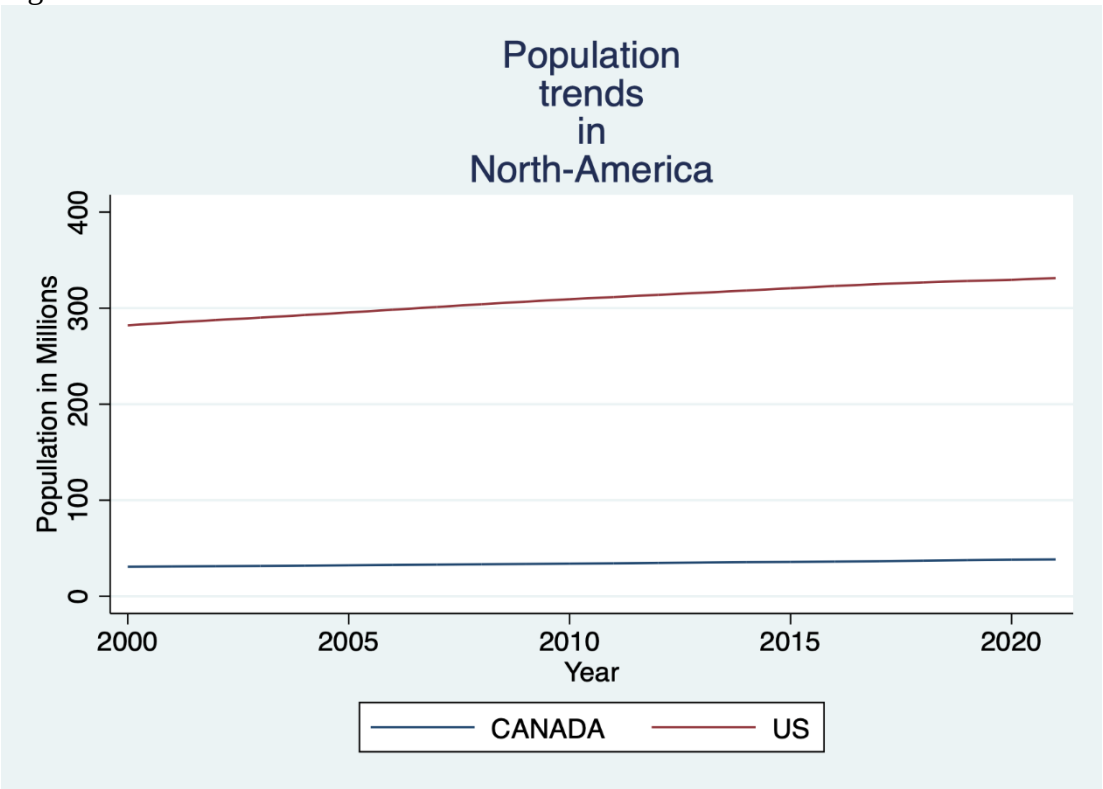

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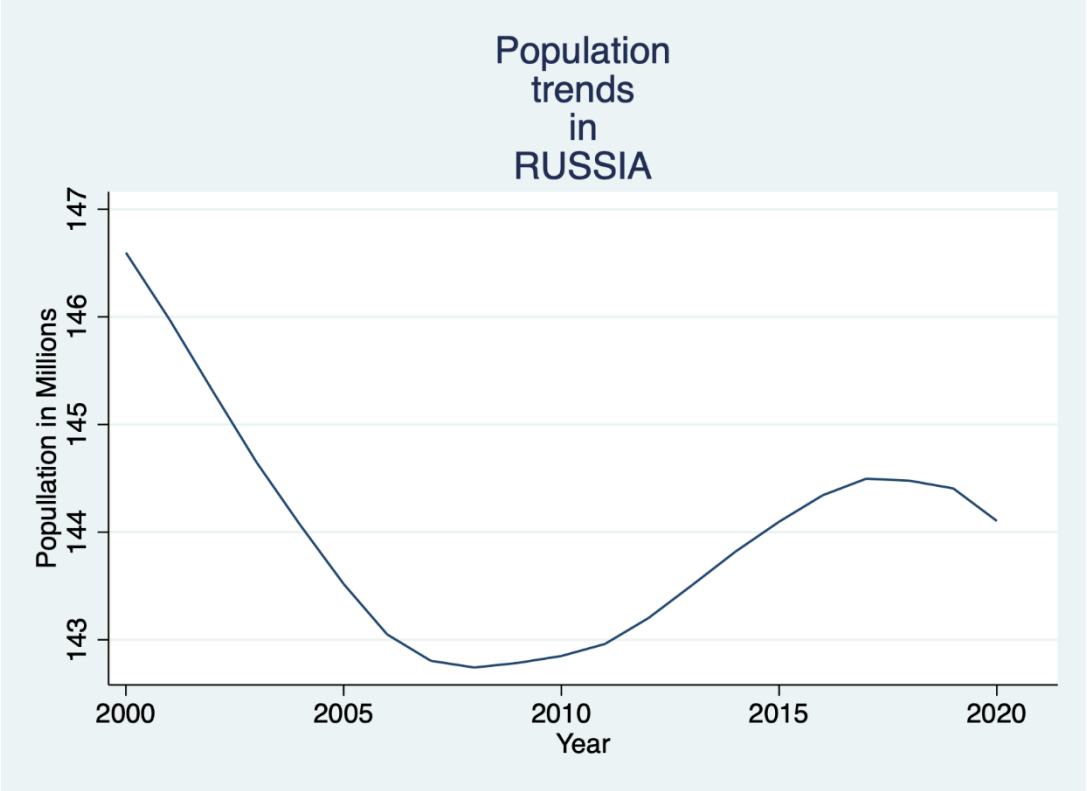

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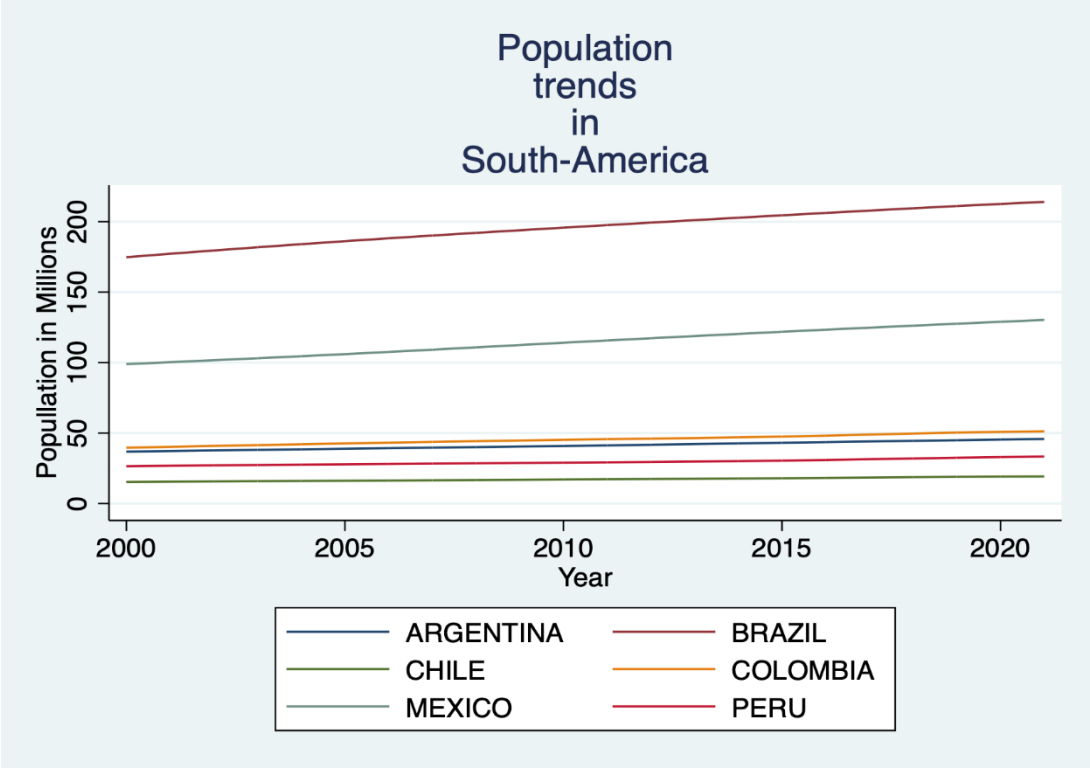
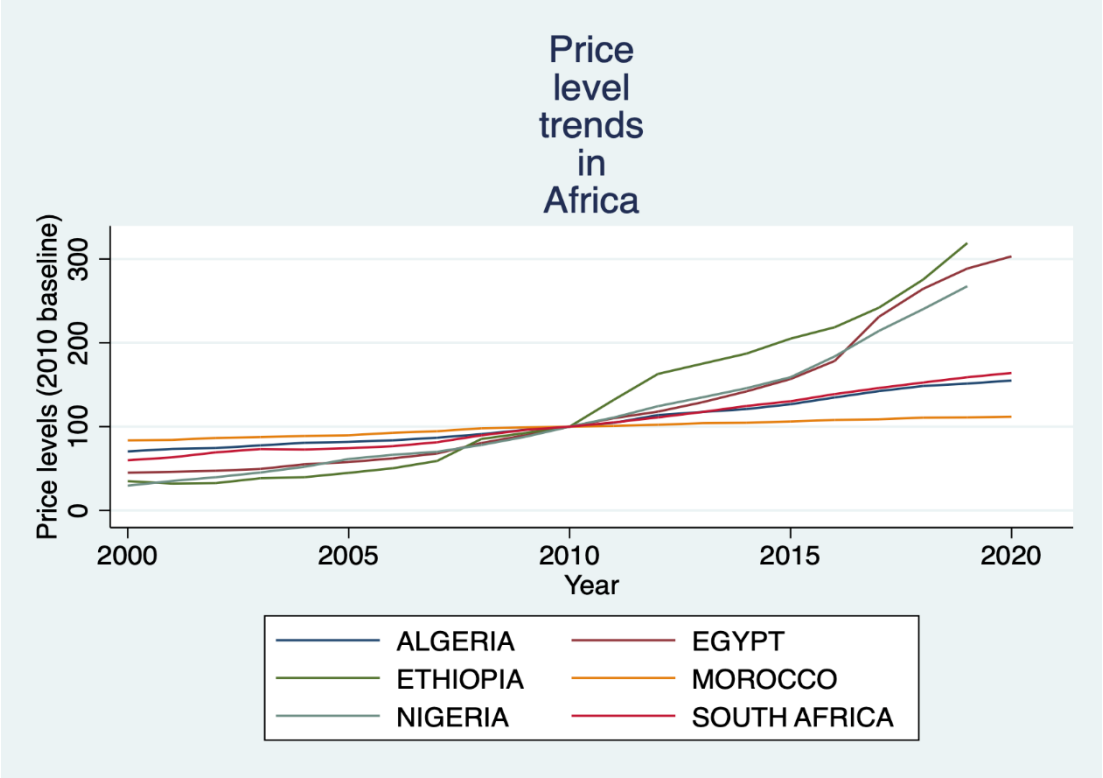


Price level graphs

Figure 15



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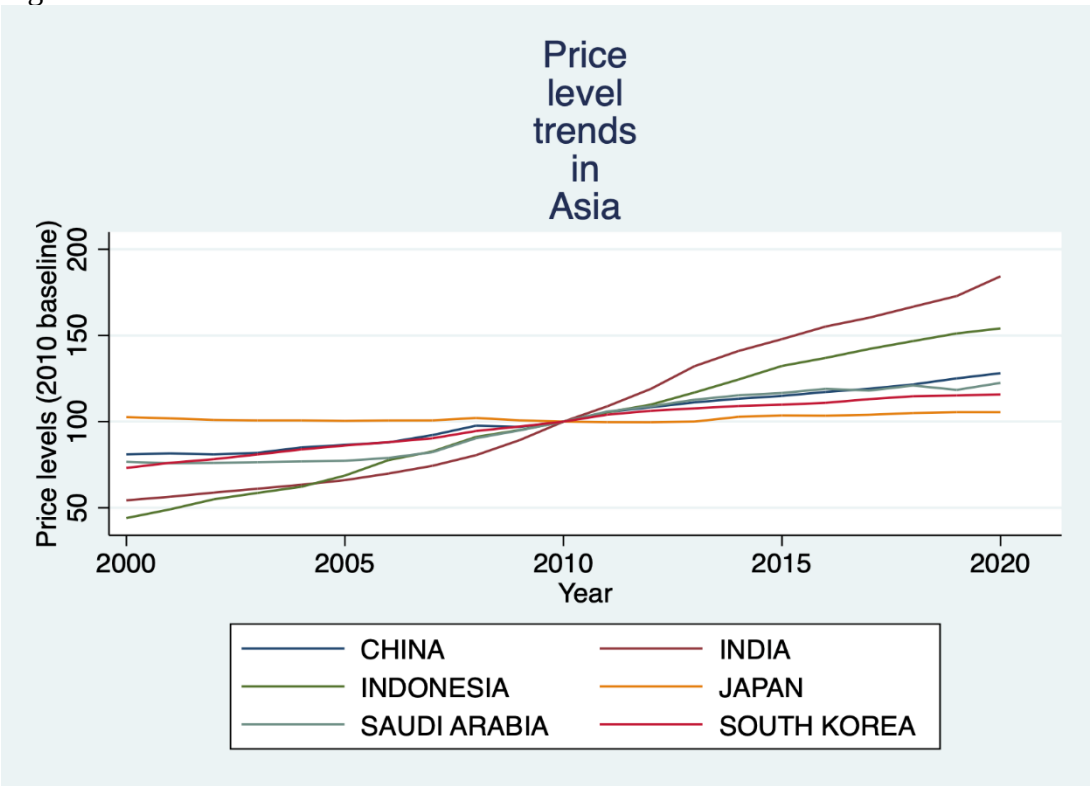

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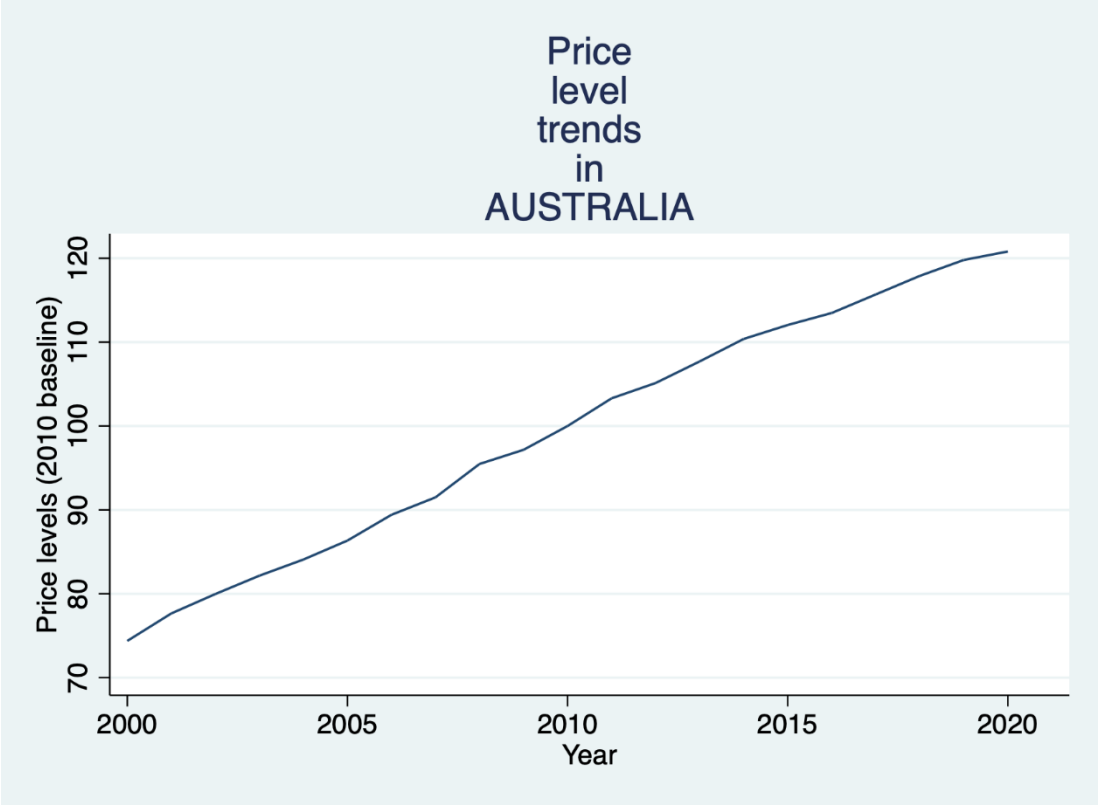

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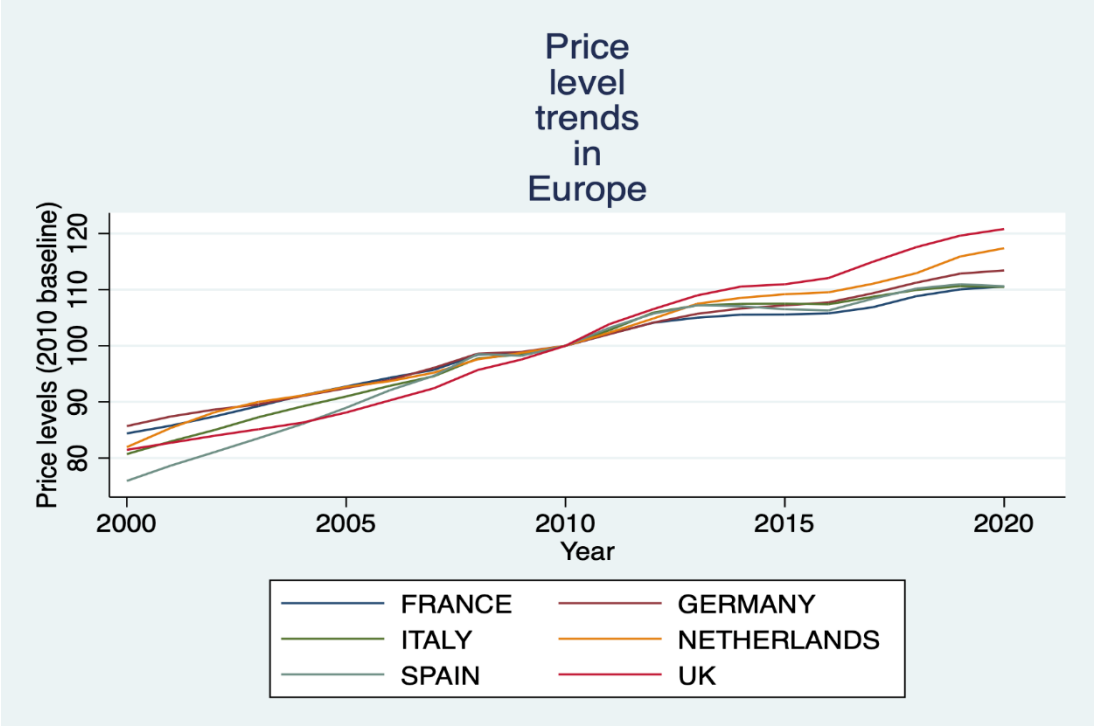

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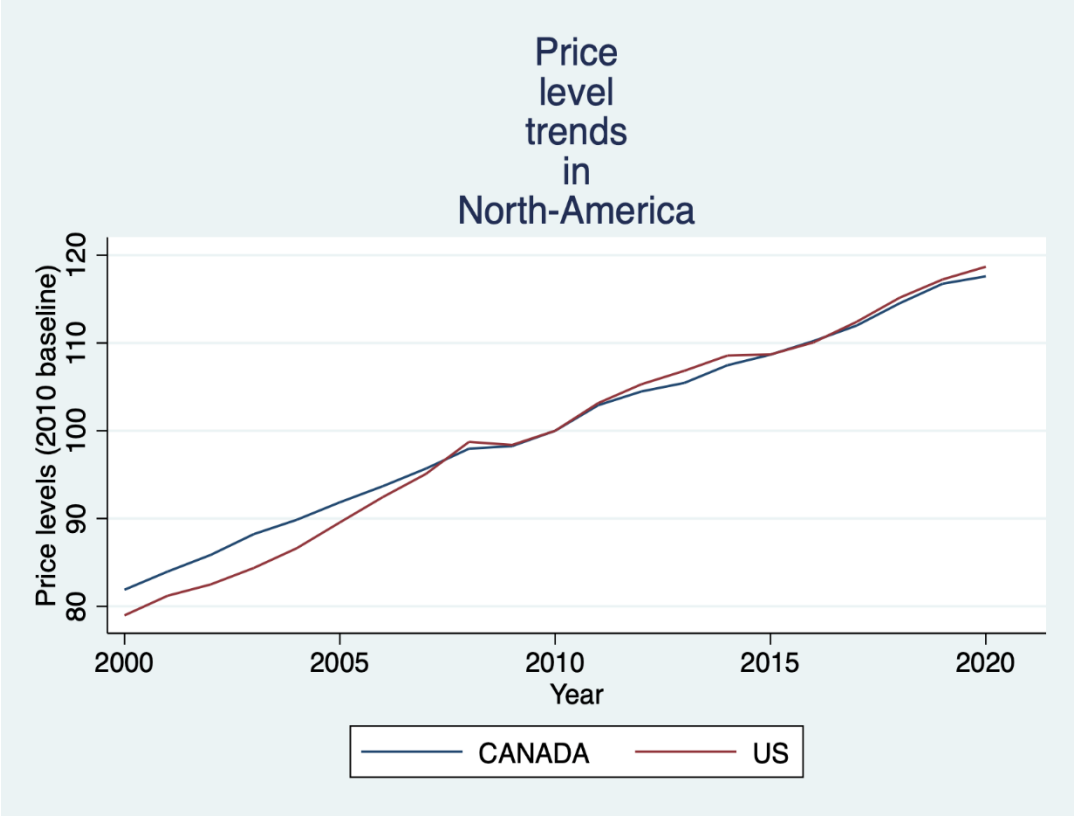

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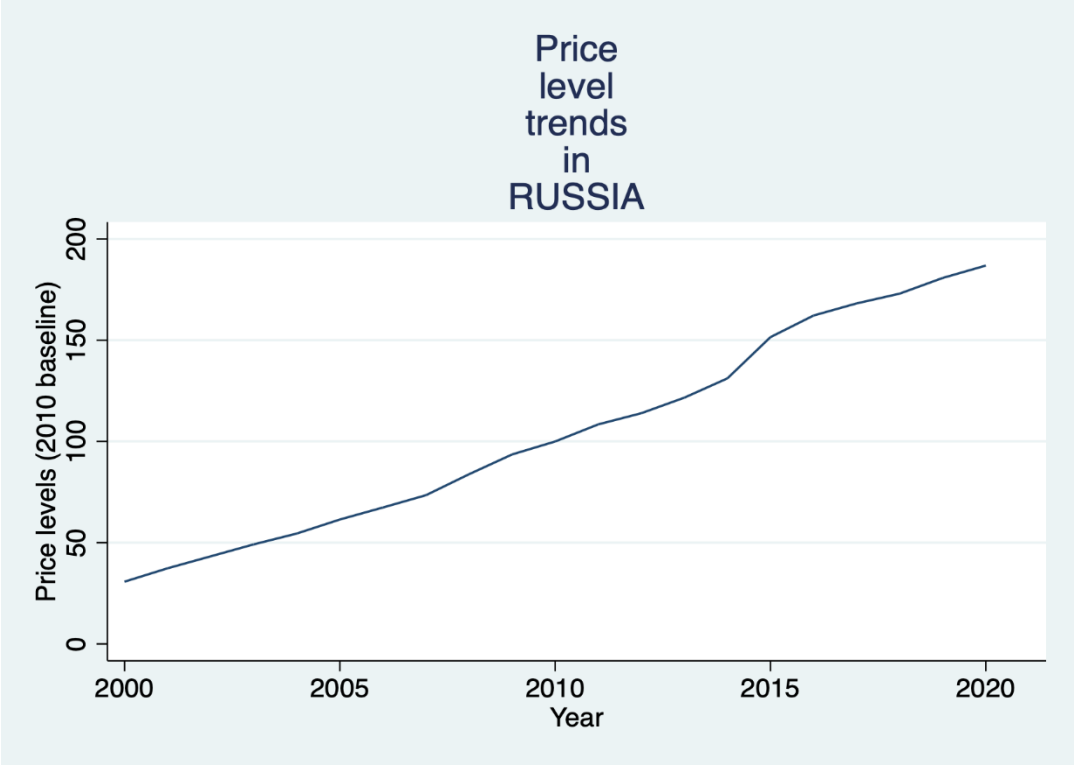
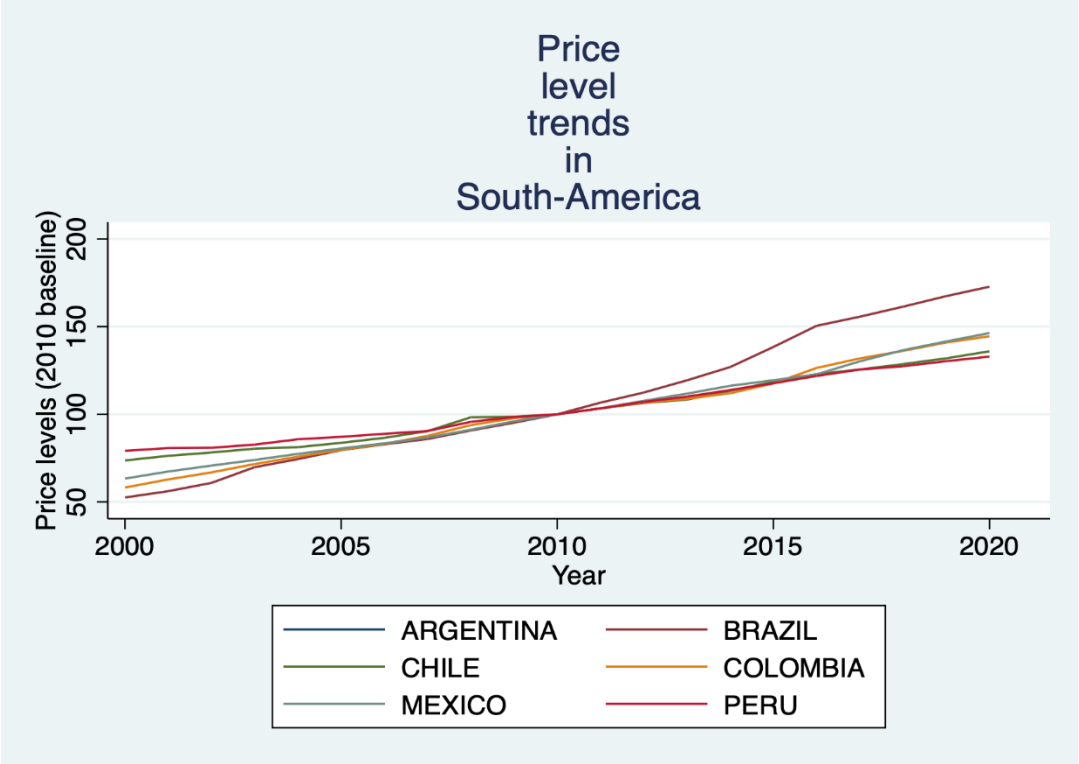


Figure 21



Specific country trends

Figure 22

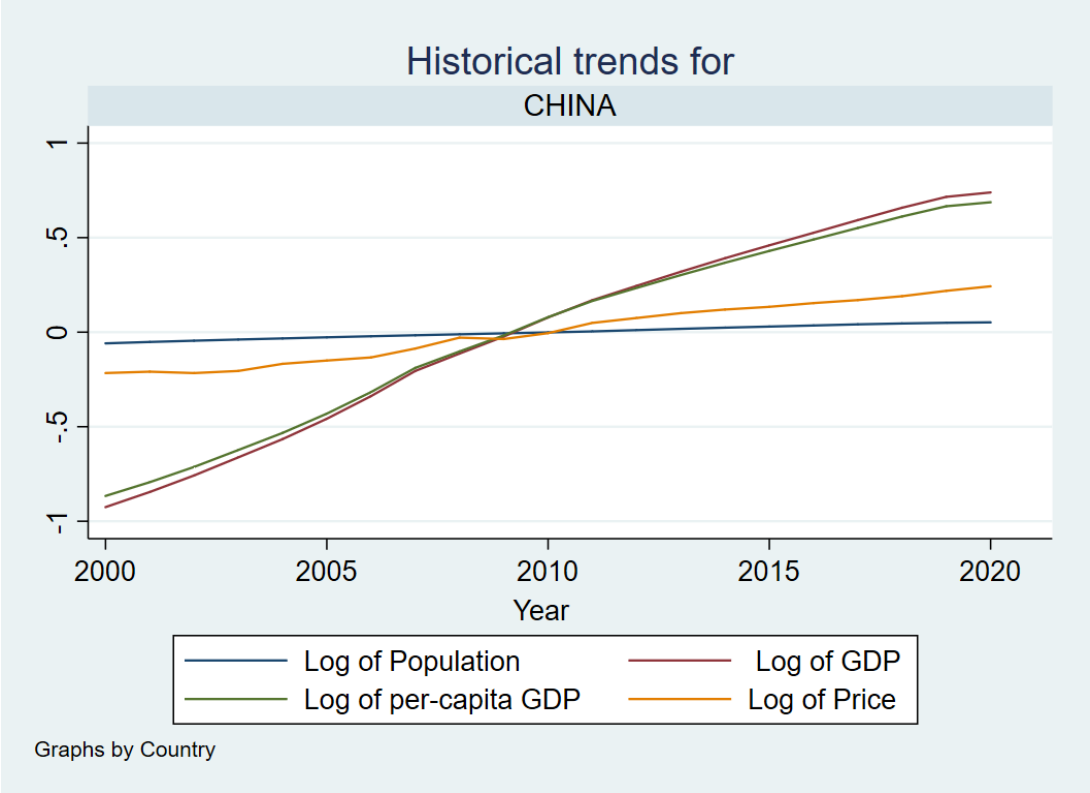
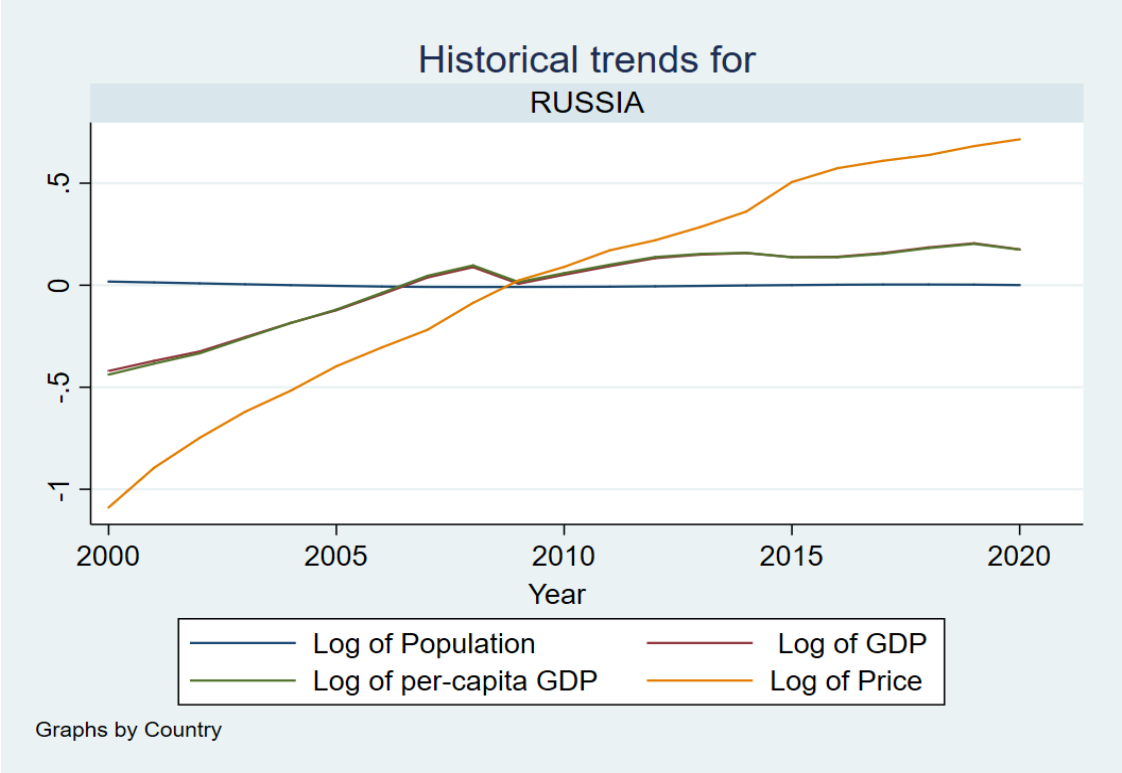


Figure 23



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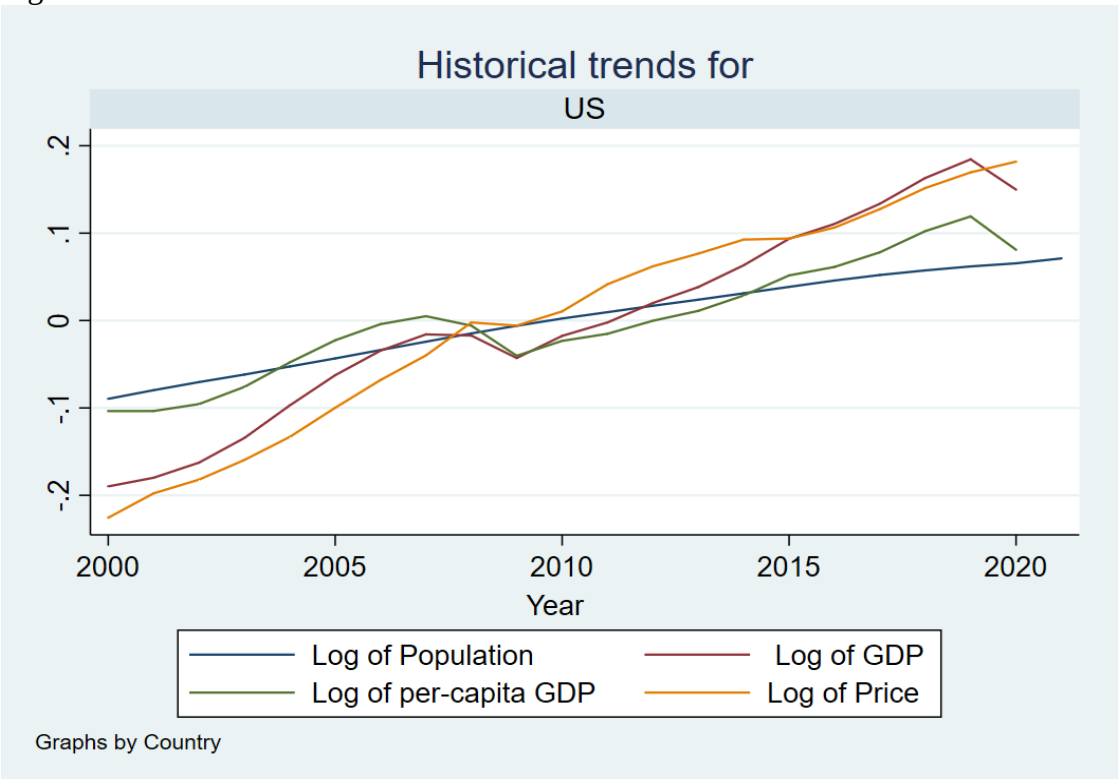
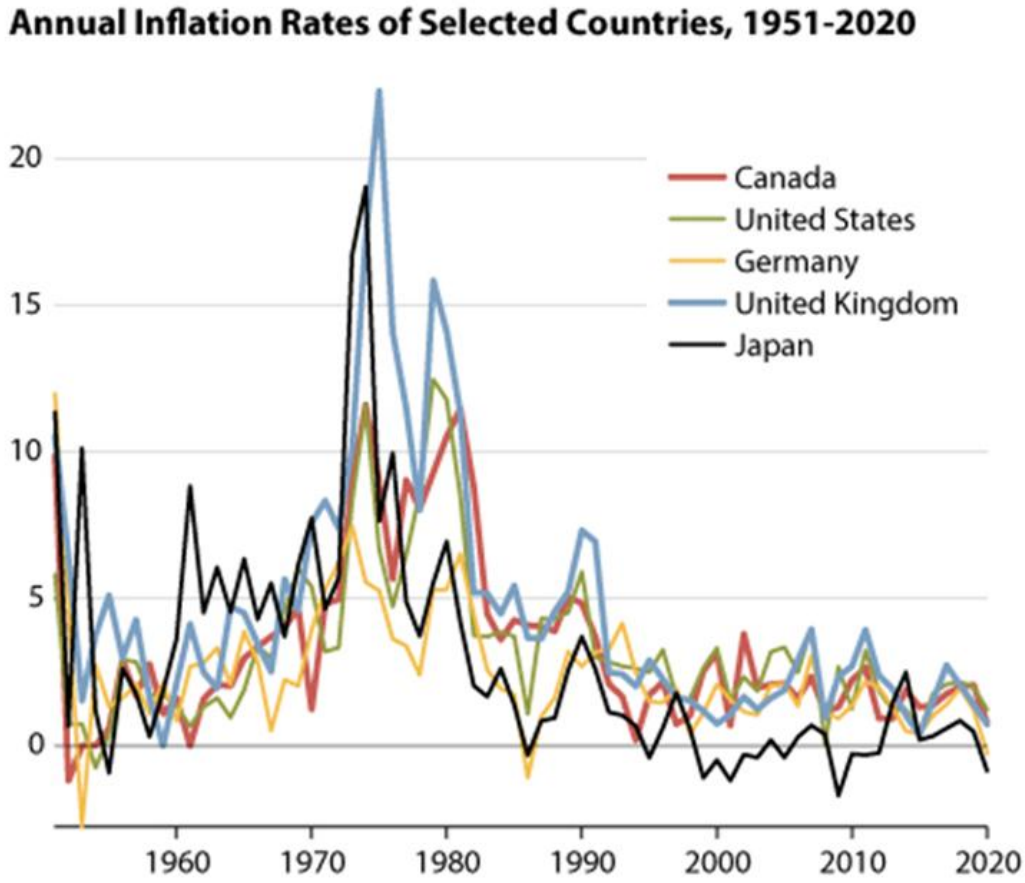


Figure 25 – Annual inflation rates

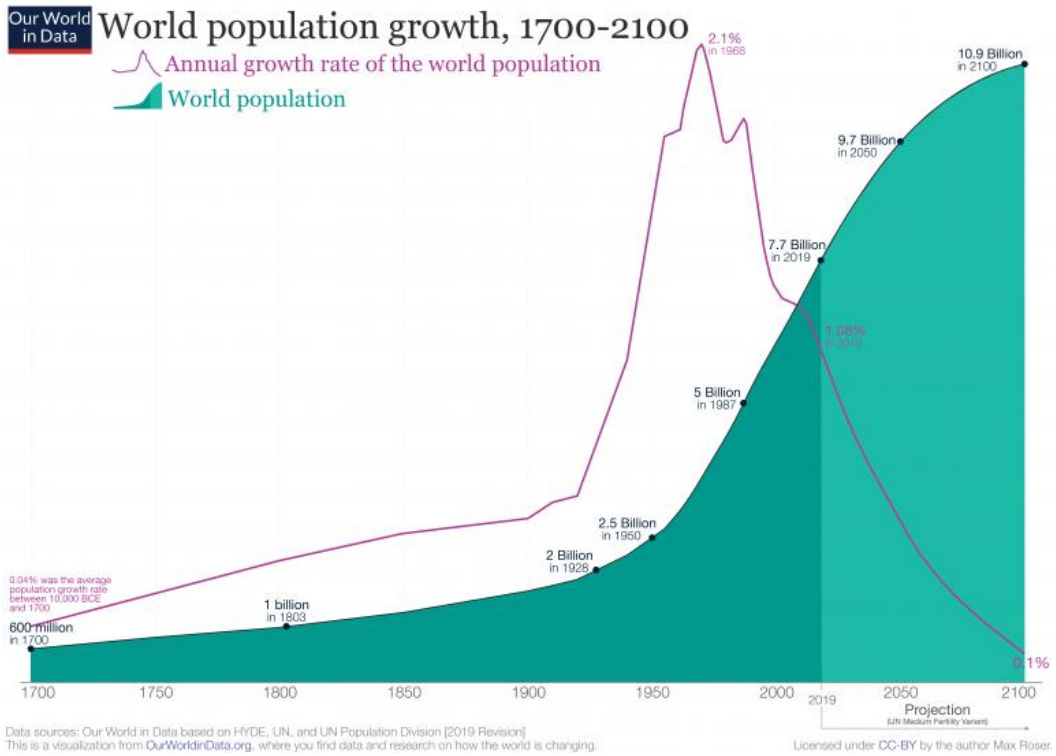


NOTE: The figure shows annual (Q4-to-Q4) CPI inflation rates for Canada, the United States, Germany, the United Kingdom, and Japan from 1951 through 2020.

SOURCE: Global Financial Database; International Monetary Fund, International Financial Statistics (IMF IFS); and Haver Analytics.

Population graphs

Figure 26



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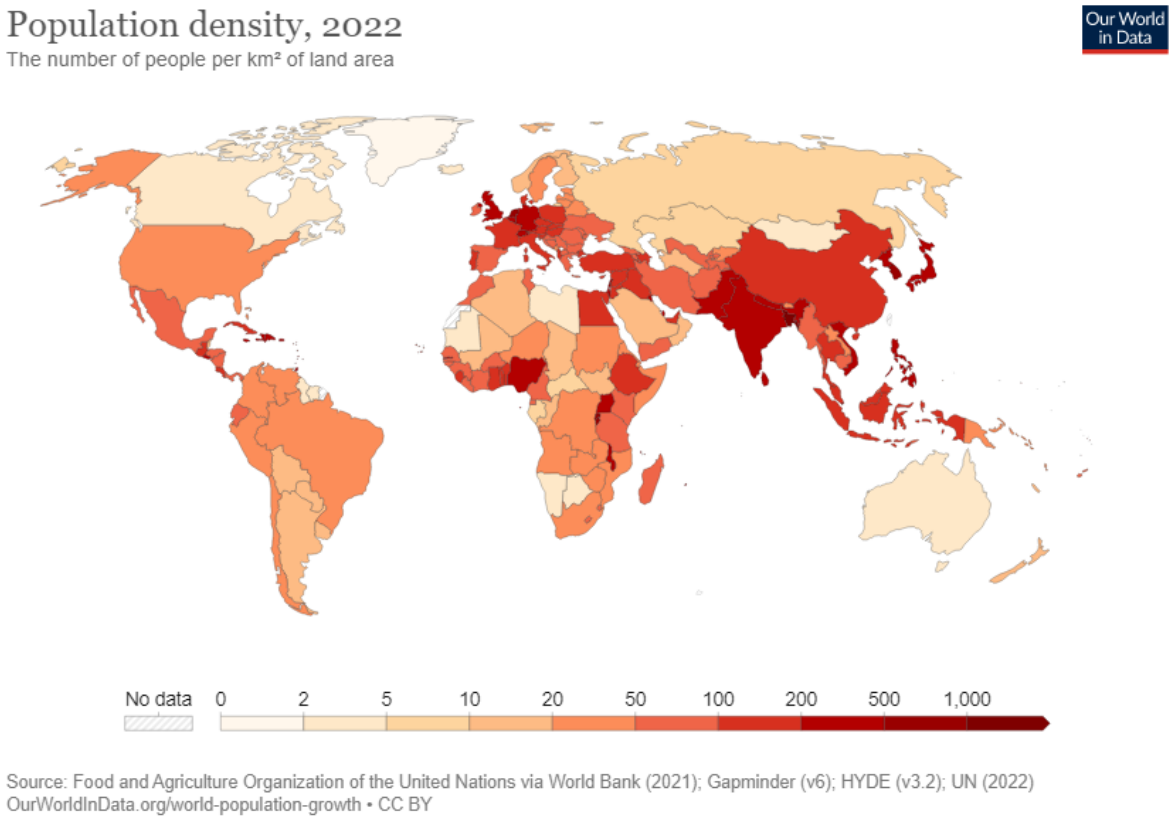

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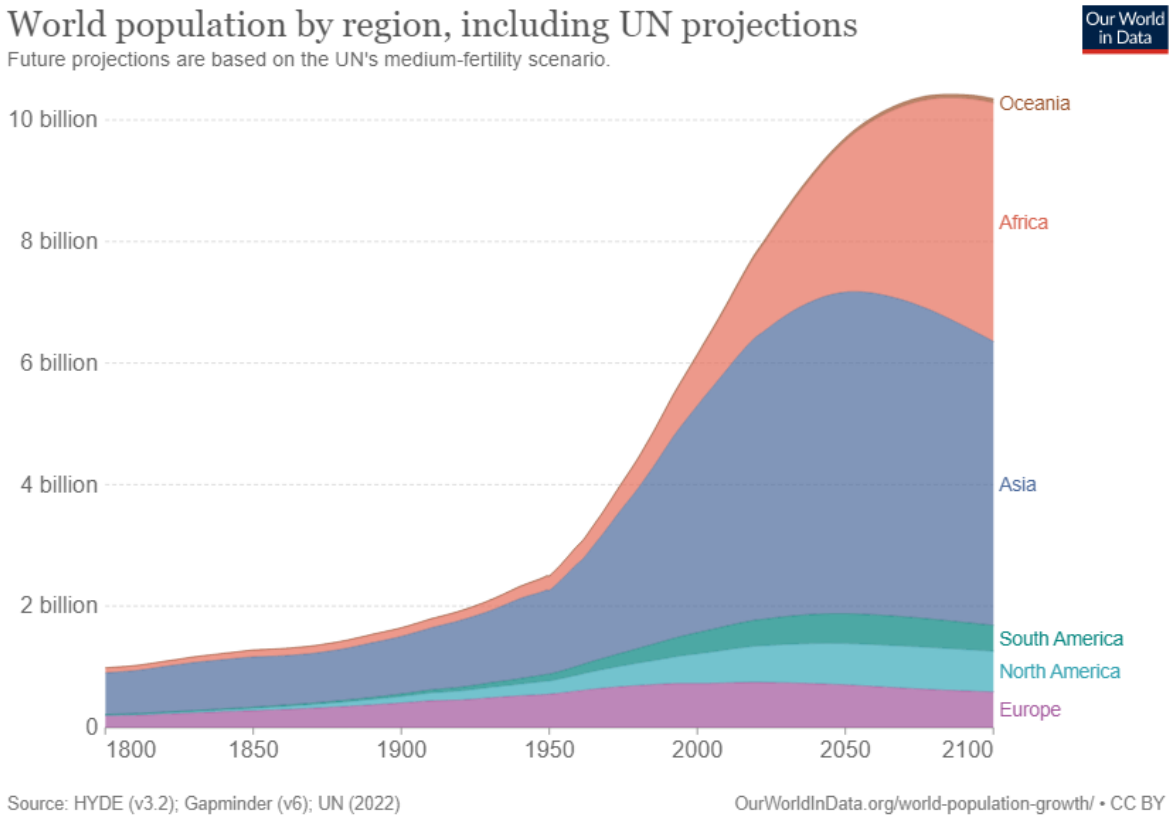
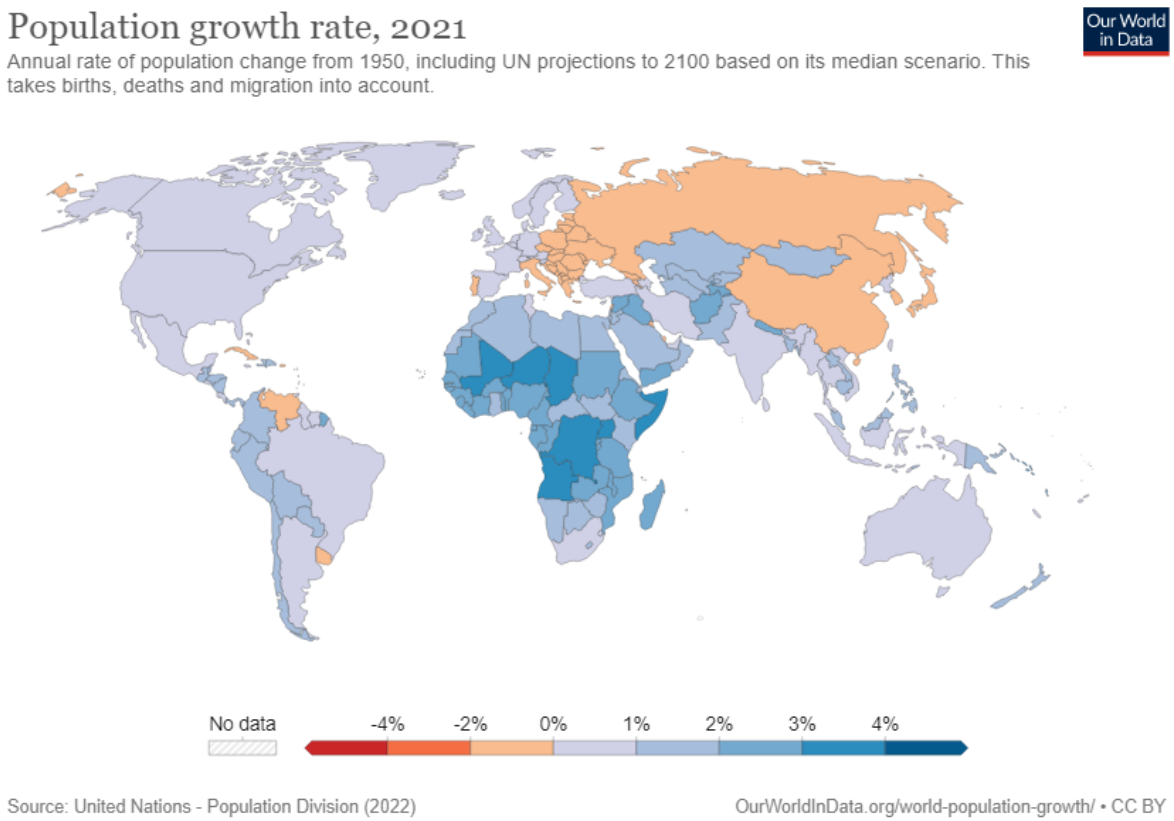
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