Can Africa Help Europe Avoid Its Looming Aging Crisis?

Charles Kenny and George Yang

Abstract

There will be 95 million fewer working-age people in Europe in 2050 than in 2015, under business as usual. This will cause significant fiscal stress as well as slower economic growth. Potential responses include: (a) raising labor force participation by women and older workers; (b) automation; and (c) outsourcing. But none will be sufficient. This leaves immigration: while migrants create demand for jobs as well as fill them, they can help rebalance the ratio of working to non-working populations. The paper compares business as usual estimates of inflows to 2050 with the size of the labor gap in Europe. Under plausible estimates, business as usual will fill one-third of the labor gap. This suggests a need for an urgent shift if Europe is to avoid an aging crisis. Africa is the obvious source of immigrants, to mutual benefit.

Keywords: migration, population dynamics, future of work

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Charles Kenny
Center for Global Development
ckenny@cgdev.org

George Yang
Center for Global Development
gyang@cgdev.org

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Center for Global Development
2055 L Street NW
Washington, DC 20036

202.416.4000
(f) 202.416.4050

www.cgdev.org

1 Introduction

Europe is rapidly aging. The region's population is living longer and having fewer children. As a result, the proportion of the population that is working is going down. The United Nations' (UN) central projection is that there will be 95 million fewer people aged 20-64 in Europe in 2050 than there are in 2020. Those UN forecasts have been broadly accurate in the past, and they suggest that all else equal, the ratio of the 20-64 working-age demographic to the total population will fall from 60 percent to 52 percent in the next thirty years. That points to considerable economic challenges–in particular, the risk of age-induced stagnation. There are potential responses: raising birth rates or replacing workers with robots, for example. But the evidence suggests that neither of those solutions will play a significant role.

Europe will have to look outside: exporting jobs or encouraging immigration, with Africa the obvious partner. But without a dramatic shift in European policies –perhaps even with a dramatic shift in policies—Africa will not be able to save its Northern neighbor from the demographic quicksands.

This paper compares existing estimates of population growth (UN, Wittgenstein) with their implications for migration demand and supply. This paper also constructs independent estimates of migration demand and supply and provides a brief analysis on whether African migrants will have the skills needed to meet Europe's labor demand. We find that should current trends continue, under every estimate, migration demand will outstrip the supply of migrants.

2 Japan's Shock of the Old

If people in Europe want some sense of what the next thirty years could look like, they might want to study Japan's recent past. Older readers may remember when, based on decades of phenomenal growth, the country was viewed in the US as the next cold war adversary after the Soviet Union: poised to become the world's largest economy, buying up Rockefeller Center and other iconic American brands and starring as the sinister unstoppable force in a Michael Crichton thriller. But things didn't go according to plan: as the country aged, miracle growth rates waned.

While GDP per worker in Japan has grown at almost the same rate as the US over the past two decades, GDP per capita growth has been markedly slower. It averaged 3.7 percent in the 1980s, 1.2 percent in the 1990s and 0.4 percent in the first decade of the new millennium.[1] In large part that is because a quarter of the population is already over the age of 65 (the figure will be one third in 2030). The trend to an aging population is driven not just by hugely improved health over the past sixty years, but crashing birth rates, down to around 1.3 children born per woman.

Government attempts to encourage families to have more children, including childcare services, parental leave and child allowances, have had limited effect.[2] Other sources of increased market labor are being tapped: female labor force participation in the country has climbed ten percentage points since 2000 and is already considerably higher than the OECD average; and the retirement age is being raised. But these will only temporarily slow the decline in the workforce.[3]

As it largely failed in efforts to replace older workers with their children, Japan tried replacing them with machines instead. The country has the fourth most industrial robots per capita in the

[1] data.worldbank.org/indicator/NY.GDP.PCAP.KD.ZG?locations=JP

[2] ("Government Response to Low Fertility in Japan" 2015)

[3] www.upi.com/Top_News/World-News/2020/02/04/Japan-approves-laws-to-raise-retirement-age-to-70/2741580840804/?ur3=1. Also see Shambaugh, Nunn, and Portman (2017)

world,[4] but they remain concentrated in a few manufacturing sectors. Getting them to do a wider range of tasks is proving immensely complex.[5]

This left the country one option to fill the gap. Although Japan has traditionally spurned migrants, the foreign share of the Japanese population has tripled since 1985, from 0.6 to 1.8 percent. And, recently, the government has started active recruitment drives. A new visa policy enacted in early 2019 will allow Japanese companies to hire a third of a million skilled workers from overseas over five years. But ambition has fallen far short of need: a third of a million is equal to less than one percent of the predicted population decline the country will experience in the next 45 years.[6] Worse, the response has been tepid: the scheme attracted less than three percent of the hoped for migrant inflow of 47,000 in 2019.[7] And Covid-19 shuttered the country in 2020, leading to a growing number of headlines about worker shortages.[8]

Even after the threat of the virus is controlled, Japan's government will need a radically more ambitious approach to fill the country's rapidly expanding labor gap. Without that approach, Japan's population overall is expected to fall from 126 million to 88 million by 2065, and the working age share will continue to decline. The country is facing a migrant crisis: there may not be enough immigrants to do the jobs that the country needs done. It will soon be joined by a lot of other countries, as news stories in late 2019 and 2020 have made clear:

- "Tonnes of crops left to rot [in the UK] as farms struggle to recruit EU workers... Brexit fears and fall in sterling causing pickers to stay away, says National Farmers' Union."[9]
- "UK employers are facing continued skills shortages among workers amid concerns that the UK's future immigration system could cause further problems in finding the right talent."[10]
- "Germany Tries To Mend Skilled Labour Shortage, Wants To Attract Workers Outside EU."[11]
- "In Germany there is a labor shortage in the field of train drivers. That's why some German states have launched training programs to attract migrants and refugees to fill the gap."[12]
- "Around a quarter of Italian food products are gathered by 370,000 foreign seasonal workers... The country needs at least 50,000 workers through spring. But [only] around 2,000 people have applied to substitute for the seasonal workers."[13]
- "Such is the skills shortage [in Ireland] that construction companies have been forced to cast their employment net overseas in search of quantity surveyors, civil engineers, and project managers, with talent from as far afield as Brazil and South Africa responding."[14]

[4] www.weforum.org/agenda/2019/05/infographic-the-countries-with-the-highest-density-of-robot-workers

[5] www2.staffingindustry.com/row/Editorial/Daily-News/Japan-Robots-fall-short-of-human-standards-in-some-work-assignments-The-New-York-Times-52402

[6] www.ibtimes.com/japans-rapidly-aging-population-raises-questions-its-future-2894698

[7] www.japantimes.co.jp/opinion/2019/12/15/editorials/slow-start-new-work-visa-scheme/#.XtlVjmhKjIU

[8] www.japantimes.co.jp/news/2019/11/22/national/hokkaido-scholarship-program-foreign-care-workers-alleviate-labor-shortage-draws-nationwide-attention/

[9] www.theguardian.com/business/2019/oct/11/tonnes-of-crops-left-to-rot-as-farms-struggle-to-recruit-eu-workers

[10] news.yahoo.com/uk-firms-struggling-to-recruit-skilled-workers-amid-immigration-concerns-000127668.html

[11] www.republicworld.com/world-news/rest-of-the-world-news/germany-tries-to-mend-skilled-labour-shortage.html

[12] www.infomigrants.net/en/post/21929/german-states-are-seeking-to-attract-refugees-as-train-drivers

[13] economictimes.indiatimes.com/news/international/world-news/europe-struggles-to-find-farm-workers-for-harvest/labour-shortage/slideshow/75530930.cms

[14] www.irishexaminer.com/breakingnews/business/columnists/john-daly/john-daly-construction-industry-calls-out-for-more-workers-979376.html

- "Early Childhood Ireland reports that providers are facing into a staffing crisis. Over a third of providers are unable to recruit employees with half unable to retain staff. A growing number are advertising for staff from overseas."[15]

It is no surprise that labor shortages are most acute in some of the least attractive (poorly paid, unreliable and uncomfortable) jobs including agriculture. But as these examples make clear, the problem is spreading beyond those jobs, and is destined to get worse.

3 Smaller Workforce, Older Population

The world as a whole is rapidly aging, with richer countries in the lead. Lant Pritchett notes that the ratio of 'prime age' (25-64) to retirement age (65+) populations will fall across advanced economies worldwide so fast that 383 million prime-age workers would need to emigrate between now and 2050 to keep the ratio with retirees the same.[16]

The potential implications of a rising ratio of older people for health care and safety net systems are obvious. Under a business as usual scenario, for example, Spain will have to raise spending on health care, elder care, and pensions by ten percent of GDP between 2004 and 2050.

More broadly, the relationship between population aging and growth is disputed, and certainly depends on how much workers and governments react.[17] But looking at growth rates amongst G-7 countries since the 1960s, where retirees have made up less than ten percent of the population, annual per capita GDP growth rates averaged four percent.[18] When retirees were between ten and 20 percent of the population, the average per capita growth rate was two percent. Where more than 20 percent of the population was above the age of 65, per capita GDP has grown at an average of just 0.4 percent. Again, according to an estimate by economists at the RAND Institute, population aging will cut 1.2 percentage points from annual U.S. GDP growth in this decade and an additional 0.6 percentage points in the next. There are similar grim forecasts for Europe.[19]

Other advanced economies have the same broad set of options to respond as Japan has already tried: increase labor force participation, birth more workers, replace workers with robots, or encourage immigration. Indeed, many have already embarked on some combination of these approaches, with the same mixed success as Japan.

Some economies are taking steps to gradually increase retirement ages, but it is politically immensely complex to considerably speed this process. Across a sample of 31 OECD countries average retirement ages climbed from 64 to 64.7 between 2002 and 2016, at that rate they will have reached 66.4 by 2050.[20] Actual labor force participation amongst older workers is also climbing– 17.6 of people in OECD countries aged 65-69 in 1990 were working, by 2016 that had reached 25.5 percent. On current trends the proportion might reach 36 percent by 2050. But older ages still work very infrequently, so that these increased participation rates will only play a small role in retarding the decline in workers.[21] Again, while female labor force participation rates still lag male

[15] www.irishtimes.com/opinion/the-irish-childcare-model-is-broken-1.4128802
[16] lantpritchett.org/the-future-is-older/
[17] Nagarajan, Teixeira, and Silva (2016)
[18] www.foreignaffairs.com/articles/2019-11-11/real-immigration-crisis
[19] Cooley, Henriksen, and Nusbaum (2020)
[20] Axelrad and Mahoney (2017)
[21] Martin (2018)

labor force participation in the OECD, it appears the impact of further plausible increases will do little to slow overall decline in the worker to dependent ratio caused by aging labor force.[22]

As to fertility rates, these continue to decline despite a growing range of government interventions designed to increase them. Average OECD fertility fell from about two children born per woman in 1985 to a new low of 1.68 in 2018 (they fell lower during the Covid-19 pandemic). In the European Union that number is 1.54, a half child off replacement rates. And even in a more gender-equitable world there will be a tradeoff between total adult labor force participation and fertility rates – someone needs to look after young children. While the tradeoff can be significantly mitigated with high quality affordable childcare, that takes additional workers to provide it.

Of course, fears of too *few* workers fit ill with forecasts of a jobs robopocalypse that point to mass unemployment. But the idea that automation will replace jobs without creating new ones flies in the face of the last two hundred years of history.

Automation has sometimes made up for labor shortages in particular sectors and job types in the past. The end of the US-Mexico Bracero migration program in 1964 locked out 500,000 seasonal workers from US farms. Some farmers switched crop mixes; others introduced machines: rotary hoes and mechanical picking for cotton, mechanized thinning and weeding in sugar beet production.[23] A similar phenomenon may occur in Europe today as a result of the exclusion of seasonal farm workers due to Covid-19.[24] But in the US case, automation was already ongoing with sugar and cotton crops –the machines worked and were available to buy. And while both (tradeable) agriculture and manufacturing may be seeing rapid enough productivity growth that both advanced economy and even global employment in both sectors may be at or beyond their peak, the same is not true of services.

More broadly, automation has been accelerating since the start of the industrial revolution and yet jobs have not disappeared. Industrialization created whole new products, which created entirely new sectors for the economy. Economists at the time wondered how people would be employed; the answer was that many would be employed in jobs that simply didn't exist before the technological advances of the Nineteenth Century.[25]

A (clichéd) example of technology both creating new jobs and destroying old ones is the elevator. Early elevators created the need for elevator operators while safety advances and electronics meant, eventually, operators were no longer required. Again, the technology of home video systems created the demand for 60,000 Blockbuster video employees in the mid 1990s while the innovations of Netflix and RedBox flattened that demand.[26] Seventy years ago, Schumpeter discussed how railroads created new employment in the Mid-West while destroying the agriculture of the old West, and he was simply building on Marx's similar ideas about the nature of capitalism from a century before. Automation changes what jobs are available, often with considerable costs for those working in older industries, but that is very different from suggesting that it reduces the overall demand for employees.

And, at least until today, there has been absolutely no relationship between automation (as reflected in higher labor or total factor productivity) and overall employment in OECD countries.[27] With regard to robots in particular, robot density worldwide is highest in Germany, Korea, and

[22] Bloom, Canning, and Fink (2011)

[23] Clemens, Lewis, and Postel (2018)

[24] techhq.com/2020/06/uk-farmers-turn-to-robots-in-face-of-seasonal-worker-shortage/

[25] Mokyr, Vickers, and Ziebarth (2015)

[26] www.businessinsider.com/rise-and-fall-of-blockbuster#in-the-following-years-blockbusters-market-value-dwindled-hinting-at-its-bleak-future-12

[27] Autor and Salomons (2018)

Singapore, and all have high employment rates.

If automation becomes more rapid (and, again, there is no evidence of that yet), it could lead to significant displacement. In the US, one estimate is that perhaps 9 percent of jobs are at risk of being automated in the next two decades.[28] The OECD suggests something similar: 9 percent of jobs across the 21 OECD countries are automatable. Worldwide, McKinsey suggest "less than 5 percent [of current jobs] are candidates for full automation today... [but] about half of all the activities people are paid to do in the world's workforce could potentially be automated." If this occurred, demand for and wages of the low-skilled might be particularly affected.[29] That said, higher productivity would create increased demand which (as it always has) will create new employment.[30]

It is also worth examining the scale of productivity gains from automation that would be necessary simply to offset the impact a declining workforce on GDP growth. A recent estimate is that labor productivity growth would have to be double current levels in the European Union, implying an increase in the growth rate of robotization by a factor of between 8 and 23.[31]

In short: there is no evidence yet that automation will reduce the overall demand for workers even if it may considerably change what those workers do. Europe's economies may benefit from a slower productivity slowdown if automation picks up speed. More of its existing workers may need support transitioning to new employment. But more rapid automation will not be nearly enough to counteract the effects of aging.

4 Exporting Jobs Rather Than Encouraging Immigration?

One potential hope for Europe is the increased tradability of services. Richard Baldwin suggests we face a "globotics upheaval," in which US and European service sector and professional jobs are opened to direct competition from abroad. That will be supported by instant machine translation, improved remote communication, and easier cross-border collaboration. Covid-19 has surely demonstrated the potential (if also limits) of remote working.

The ability to work from home might be a fair proxy for the ease of working from abroad. Recent World Bank research has suggested "the amenability of jobs to working from home increases with the level of economic development of the country." The authors suggest that managers, professionals, technicians and clerical support workers find it considerably easier to work from home than people in sales, agriculture, crafts, manufacturing, and service providers[32]–again, something that matches the evidence of which sectors saw the most rapid employment collapse during Covid-19. It appears likely, then, that the growing tradeability of services will have its greatest impact on professional and clerical roles.

But it is also worth comparing sectors where tradeability will have its greatest impact to sectors that face long term worker shortages: child-care, agriculture, nursing, old age care, tourism, entertainment. These jobs are hard to outsource.[33] The US Bureau of Labor Statistics suggests

[28] Arntz, Gregory, and Zierahn (2017); Kenny (2019)

[29] Manyika, Chui, et al. (2017)

[30] www.newscientist.com/article/mg23931873-700-robots-and-ai-will-actually-create-more-jobs-than-they-take/#ixzz6PqSu7oSe

[31] Leitner and Stehrer (2019)

[32] Hatayama, Viollaz, and Winkler (2020)

[33] Gelatt, Batalova, and Capps (2020) are more bullish on the impact of automation. They look at 3 data sources: US Bureau of Labor Statistics projections, the Frey and Osborne 2017 automation index, and the Blinder 2007 offshoring index. They suggest that future jobs not susceptible to automation and offshoring skew high or middle

the number of jobs in the categories of healthcare practitioners, educators, police officers, care work construction work, building cleaning and maintenance, food preparation and services, and maintenance and repair will rise by 4.7 million over the next decade in the US alone.[34]

Furthermore, just as automation has not been associated with lower overall employment in the past, nor has trade. As with automation, it may have shifted the kinds of jobs that people do in individual countries, but there is no compelling link between higher trade to GDP ratios and higher unemployment or lower labor force participation and no particular reason to think that greater tradeability of some services will suddenly create that link. While they may help at the margins, neither automation nor telecommunication is going to save Europe from the challenge of an aging population.

5 Storied Pomp With a Side of Huddled Masses?

This leaves the option of encouraging immigration. Since Emma Lazarus wrote *The New Colossus* in 1883, featuring huddled masses of European migrants coming to the US, the old continent has actually been a net recipient of immigrants. Indeed, migration is already an important part of keeping European labor force numbers up. Between 2000 and 2018 international migrants accounted for more than 75 percent of the total population increase in European countries.[35] (Similiarly, in the US, 83 percent of workforce growth from 2010-2018 came from immigration).[36] One in four UK hospital staff were born abroad[37], and a quarter of the 3.2m people that work in the UK hospitality industry are non-British.[38] But the scale of immigration that would be needed to fill the hole left by an aging population would be considerably larger than in the past.[39] That leads to the question: are there the migrants to be had?

Despite cheaper travel, growing education levels, an expanding population in source countries, and a relaxation of global immigration rules over the period, between 1950 and 2017, the proportion of international migrants in the world population has remained stable, between 2.7 and 3.3 percent of the population.[40] Migrant stocks as a proportion of the global population may have been higher in 1900 than recently.

Border controls are obviously one (reversible) factor behind the broad stagnation of migrant stocks. But they appear to have played little role in determining migration between Mexico and the United States or Turkey and the EU, for example. One reason: restrictions reduce both inflows *and* outflows of migrants–if it is going to be hard to get back in, people will stay.[41] Czaika & Haas estimate that visa requirements decrease inflows 67 percent and outflows 88 percent on average for the same migrant groups. And restrictions can encourage migrants to go elsewhere without necessary increasing the total stock of potential emigrants (Guyanese migration largely shifted from Britain to North America as British restrictiveness increased, for example).[42]

skilled. They often require greater communication skills, and require domestic certification (e.g. nurses, teachers, social services).

[34] Manyika, Lund, et al. (2017)

[35] Benček and Schneiderheinze (2019)

[36] Gelatt, Batalova, and Capps (2020)

[37] www.theguardian.com/society/2019/dec/04/both-labour-and-tory-migration-plans-would-worsen-nhs-staffing

[38] www.ft.com/content/900f66ac-3acc-11ea-b232-000f4477fbca

[39] lantpritchett.org/the-future-is-older/

[40] Haas et al. (2019)

[41] Czaika and Haas (2017)

[42] Haas et al. (2019)

Again, the pattern from Europe to the United States from the late Nineteenth and early Twentieth Century and within the EU today –periods and routes of fairly unrestricted emigration – similarly suggests that emigration decisions are not driven primarily by restrictions.[43] There has been almost thirty years of free movement in the EU, and yet populations have proven remarkably sticky in the face of considerable income differences. Workers in poor areas of Bulgaria make about twenty times less than workers in London, and had the freedom to move from one place to the other until 2020, for example. But despite these vast potential gains, in 2015, just 4.5 percent of EU citizens lived in another EU country, up from three percent in 1960. Less than four percent of Greece's population has emigrated elsewhere and less than two percent of Spain's. Across the Atlantic, average wages in the United States are more than three times as high as those in Mexico, but more Mexican citizens are currently leaving the United States than entering it: the undocumented population in particular fell from 12.2 million in 2007 to 10.7 million in 2019.

Broadly, at least at higher levels of income, greater wealth is associated with a declining emigrant pool. Looking across countries, Michael Clemens suggests an inverted u-shaped relationship between emigrant stocks peaking at a per capita GDP of about 10,000 dollars. Below about 5,000 dollars per capita GDP, a 100 percent increase in income has been associated with a 35 percent rise in emigration from developing countries to all destination countries, and a 74 percent rise in emigration to high-income destination countries. That relationship slackens after 5,000 dollars and reverses at about 10,000 dollars (Figure 1, while Figure 2 shows the relationship between immigrant stock and income).[44]

While Clemens' work suggests a slight increase in the expected number of emigrants at a given income over time at low incomes, that most countries are over the hump of the inverted U suggests that the stock of emigrants may at best stagnate going forward.[45] Figure 3 presents naïve estimates for the percent of countries (historically and in the future) which will be above these per capita GDP thresholds based on simple growth forecasts (annual GDP growth for each country will equal the average historical GDP growth within the country's income group). It suggests that in 2050, more than 70 percent of the global population will live in a country with a GDP per capita that is greater than $10K PPP.

Global demographic trends suggest the most positive picture is still probably darker than that: young people are more likely to migrate, but the whole world is aging. A weak European economy will further deter immigration, suggesting the possibility for a vicious circle: a low working age to total population ratio slows growth, deterring migrants, further depressing the working age to population ratio.[46]

Europe also faces the problem of increased competition for immigrants.[47] By 2030, there will be a shortage of 42,600-121,300 doctors in the US.[48] Canadian firms have been begging for more

[43] Controls may have had greater efficacy in other parts of Europe.(Haas et al. 2019)

[44] M. A. Clemens (2020). Looking at the variation of flows over short-term periods suggests an even more worrying picture: a straightforward and consistent negative association between income and emigration to OECD countries: increasing GDP growth rates by 1 percent reduces emigration by about 0.5 percent. This is probably largely driven by negative income shocks (Benček and Schneiderheinze 2019).

[45] One potentially positive trend is expanding education in developing countries Dao et al 2016 suggest that levels of migration are partly determined by education levels in sending countries –college graduates have the highest propensity to emigrate (Dao et al. 2018). Note M. Clemens and Mendola (2020) suggests the same but also that this does not overcome the hump.

[46] Haas et al. (2019)

[47] Haas et al. (2019)

[48] www.niskanencenter.org/trumps-travel-ban-is-worsening-health-care-shortages-in-rural-america/

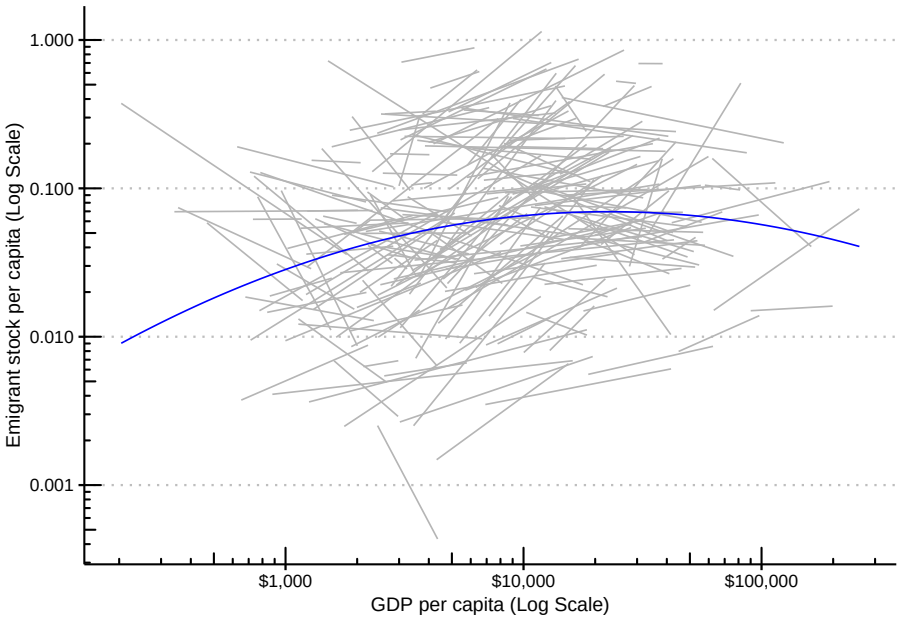

Figure 1: Emigrant Stocks per Capita vs. GDP per Capita

Note: Each light grey line is a linear fit through a country's emigrant stocks per capita from 1960 to 2019.

workers in agriculture, manufacturing, and restaurants.[49] But it is not just other OECD countries and the oil-rich economies of the Middle East. The global population of those older than 65 will increase from 665 million in 2020 to more than 1.9 billion in 2090.[50] China, in particular, is rapidly aging—while the problem of crashing birth rates in the East of the country was ameliorated by migration from the West, that process is winding down.[51] And the late 2019-early 2020 period has seen the growth of headlines about labor shortages and growing demand for migrants to do both less attractive and skilled jobs across East Asia:

- "In an attempt to ease labor shortages in fisheries, Thailand is issuing issue permits for immigrant workers wanting to work in the fisheries sector."[52]
- "Exodus of 1,500 migrant workers daily sparks worry of Thai labor shortage."[53]
- "The natural solution to the problem [of Malaysia's migration ban during Covid-19] is hiring local workers, but... local Malaysians do not want to do 3D (dirty, dangerous, and difficult)

[49] www.vancourier.com/restaurant-industry-needs-to-find-answers-to-labour-shortage-1.24050435; www.cimmigrationnews.com/simply-not-enough-skilled-workers-20000-vacancies-in-quebec-manufacturing/

[50] www.foreignaffairs.com/articles/2019-11-11/real-immigration-crisis

[51] Peng (2011)

[52] www.pattayamail.com/thailandnews/cabinet-to-consider-implementing-article-83-to-solve-fisheries-labor-shortage-283052

[53] newsinfo.inquirer.net/1288692/exodus-of-1500-migrant-workers-daily-sparks-worry-of-thai-labor-shortageixzz6OsVD6OKF

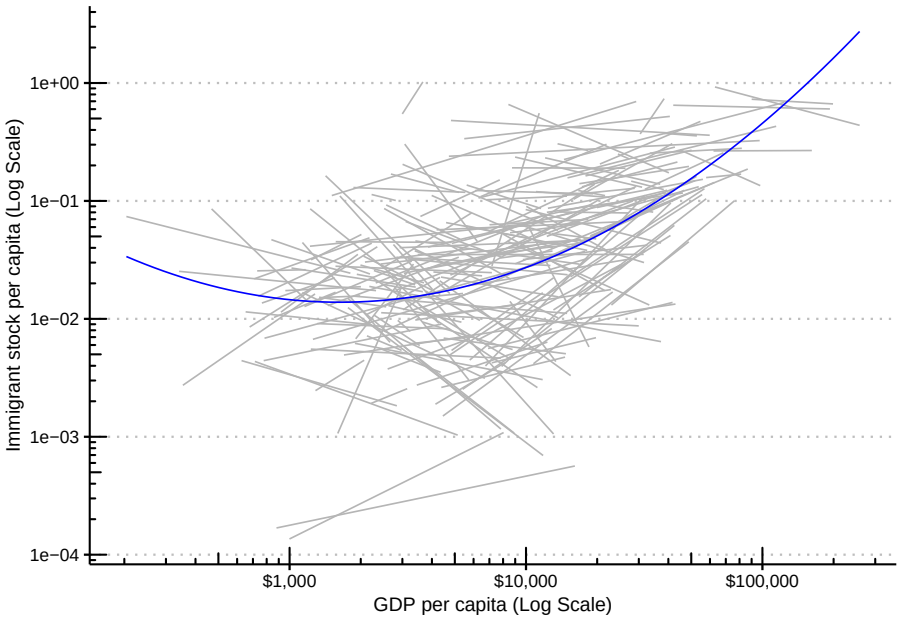

Figure 2: Immigrant Stocks per Capita vs. GDP per Capita

Note: Each light grey line is a linear fit through a country's immigrant stocks per capita from 1960 to 2019.

jobs for such low pay."[54]

- "Malaysia's economy relies on palm oil, its most important agricultural commodity, but palm oil needs migrant workers from Indonesia, Bangladesh and India to do jobs locals won't."[55]
- "An Indonesian government plan to allow start-ups to hire foreign staff more easily could help plug a shortage of skills in the country..."[56]

Europe has one significant advantage: proximity to the global region that is home to the youngest population (one that is still growing), and where incomes are largely on the left hand side of Clemens' inverted U. This is a region where there is significant fear of the working age population expanding faster than the rate at which employment opportunities –and in particular good employment opportunities– will grow. Sixty percent of Africa's population in 2019 is under the age of 25, but only 19.1 percent of those aged 15-24 received wages in 2019. Moreover, employed youth are often in informal jobs.[57] Additional determinants of the direction and scale of migration point to the op-

[54] www.therakyatpost.com/2020/06/29/malaysian-trades-union-asks-for-increased-wages-to-prevent-labour-shortage/

[55] www.japantimes.co.jp/news/2020/06/05/asia-pacific/malaysia-palm-oil-worker-shortage/.XtpSF2hKjIU

[56] kfgo.com/news/articles/2020/feb/14/indonesia-aims-to-plug-skills-shortage-in-booming-tech-sector/985131/?refer-section=business

[57] mo.ibrahim.foundation/news/2019/africas-first-challenge-youth-bulge-stuck-waithood, Hanson and McIntosh (2016)

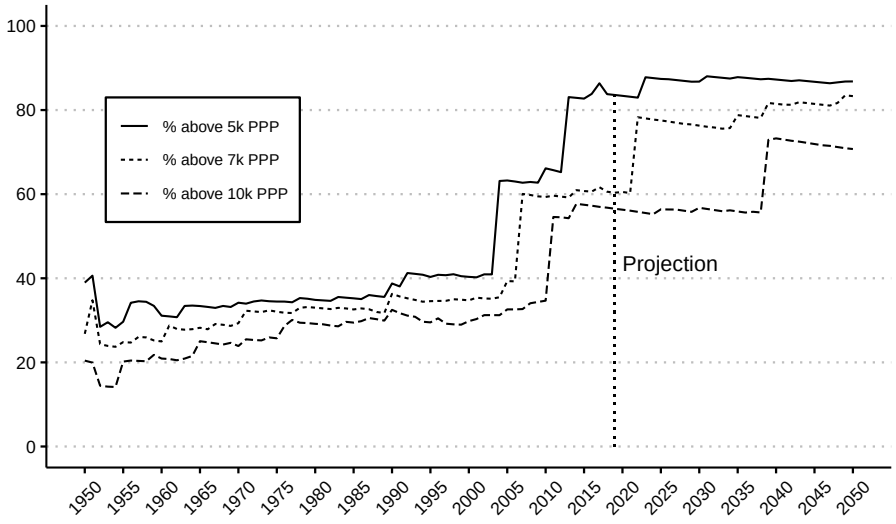

Figure 3: Percent of people living in countries above inverted U

Note: Projections are naive estimates based on assumption that real GDP growth will equal the arithmetic mean of historical real GDP growth within the country's current World Bank defined income classification.

portunity for France and the UK in particular from Africa's future immigrants: common language and colonial heritage.[58]

6 Will African Migrants Have the Skills Europe Needs?

Whether African immigrants can fill the European jobs gap depends in part on whether they have the skills necessary for employment. Andreas Backhaus has inspected the data of the OECD Programme for the International Assessment of Adult Competencies (PIAAC)[59] of certain EU countries and compared it to the World Bank's STEP Skills Measurement Program (STEP) available for developing countries.[60] Backhaus suggests the average employment rate for those under the age of 40 in Germany, France, and the UK falls from almost 90 percent to nearer 70 percent when the

[58] Llull (2016)

[59] ("Survey of Adult Skills (PIAAC) - PIAAC, the OECD's Programme of Assessment and Analysis of Adult Skills. OECD" 2017)

[60] ("STEP Skills Measurement Program. World Bank" 2013). OECD provides a detailed discussion of the comparability of PIAAC and STEP surveys ("Assessing Adults' Skills on a Global Scale: A Joint Analysis of Results from PIAAC and STEP" 2020). In particular, PIAAC was administered to many participants via a computer; STEP is completely paper-based. STEP was administered only to urban adults; PIAAC is nationally representative. Finally, PIAAC is inaccurate at the lower end of the skill distribution, as it relies on a model to impute scores for participants that fail a core assessment. Nevertheless, as STEP was an instrument created to imitate PIAAC, "literacy proficiency... results are directly comparable."

average literacy score (as measured by PIAAC) falls from 250 to 200 points.[61]

Backhaus's estimates can help us construct a lower bound for expected employability. We can use the World Bank STEP data to estimate the percent of urban residents in Ghana and Kenya who would have around a 90 percent chance of employment in Germany, France, and the UK by seeing what percent of urban residents lie above the 250 literacy score cutoff. In Kenya, the percent of urban residents ages 20-34 achieving a 250 score is 20.8 percent, or 0.626 million people (see Table 1 and Figure 4). In Ghana, the percent of urban residents ages 20-34 achieving this score is 15.5 percent, or 0.562 million people.[62] For the two countries today, this sums to about 1.188 million young people with sufficient literacy to have a high probability of employment in Europe. Kenya and Ghana between them account for only 6.3 percent of the population on the African continent, suggesting a considerable stock of potential African emigrants with the basic skills required for employability in Europe.[63]

While it should also be noted that African migrants are also likely to face language challenges outside of France and the UK, we are (even) more optimistic about the relationship between literacy and employability for African migrants than these lower bound estimates suggest. Given a considerably weaker education system in most African countries than most European countries, to the extent PIAAC scores reflect in part underlying drive, talent and intelligence, the same score will be associated with a higher level of these qualities amongst Africans than amongst Europeans. Furthermore, we repeat Backhaus's analysis on all PIAAC countries (most of which are in Europe) and find that those scoring 200 have approximately 87 percent employability[64]. This relationship held even when restricting our sample to only those that identified in the survey as immigrants.

Table 1: Education of Ghana and Kenya 20-34 year olds

Country	Year	Percent above 90% employment cutoff	Percent above 70% employment cutoff	Population above 90% employment cutoff (M)	Population above 70% employment cutoff (M)
Ghana	2013/2015	15.5	36.7	0.562	1.33
	2050	30.0	71.0	1.930	4.56
Kenya	2013/2015	20.8	54.4	0.626	1.64
	2050	40.5	100.0	2.260	5.59

Note: Author's calculations from PIAAC, STEP, and Wittgenstein data, using methods from Backhaus. Employment cutoffs represent the chance of employment should someone from Ghana or Kenya migrate to Germany, France, or the UK, according to Backhaus. PIAAC and STEP data are in 2013, while Wittgenstein data is from 2015. Urban population was calculated from multiplying the Wittgenstein total population estimate with the WDI 2014 country-wide urban percentage. Since urbanization is trending upwards, we also use the WDI 2014 country-wide urban percentage estimate for 2050 population values as a conservative estimate.

Given the slow change and variability in education quality, the difficulty in comparing stan-

[61] Backhaus (2020)

[62] author's calculations based on Backhaus (2020)

[63] author's calculations based on Backhaus (2020) and Lutz et al. (2018)

[64] Here, the figure we replicated was Figure 8, Skills and employability in OECD countries. We dropped those that were over the age of 55 and those that were not seeking employment. As Backhaus does, we use a kernel-weighted local polynomial smoothing of the relationship between the literacy skills and the average employment rate in the U.S.

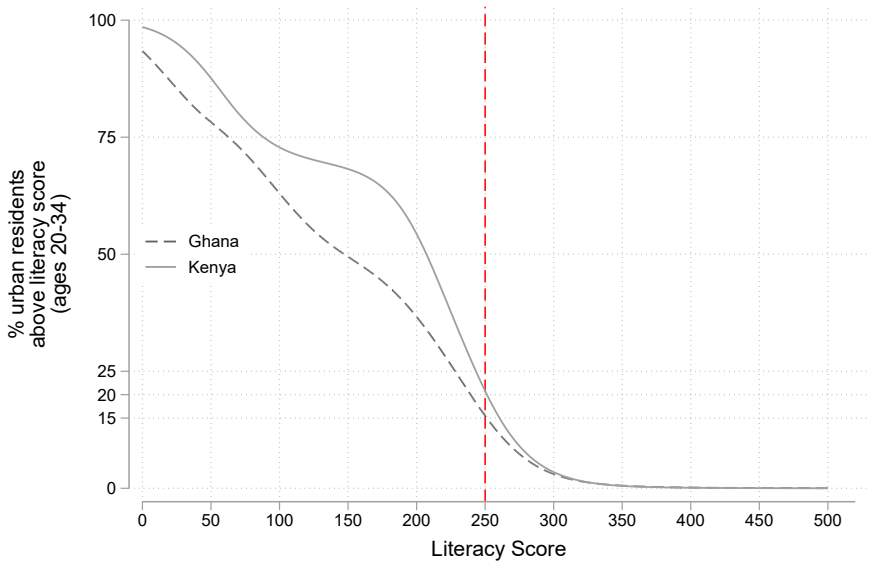

Figure 4: STEP literacy score of young urban people in Ghana and Kenya

Note: 250 is the literacy score, noted by Backhaus, where someone has a 90 percent probability of employment in France, Germany, and the UK. STEP data provides ten plausible values of literacy score. We first use adaptive kernel density estimates to obtain a cumulative distribution function of each of the ten literacy score estimates. Then, we take the arithmetic mean of the cumulative distribution function at each step and plot its complement.

dardized test scores across countries, and limited data, it is difficult to calculate future literacy or employability scores for the African continent as a whole.[65] However, we can use a simple ratio between projections of upper secondary education from the Wittgenstein dataset (described at greater length in the next section) and Backhaus' percentile cutoffs to find a rough estimate of percent cutoffs in 2050. Suppose that the ratio between the percent of urban residents receiving upper secondary education and the percent of urban residents above a certain literacy score is constant. Then, since Wittgenstein provides projections of future percent of people receiving upper secondary education, assuming education quality remains the same, in 2050, 30 percent (1.93 million) of Ghanaians age 20-34 would fall above the 90 percent employment threshold. For Kenya, it is 40.5 percent (2.26 million) for those aged 20-34. For perspective, in 2050, our model (explained

[65]There have been a few recent attempts at quantifying education levels of low income countries that do not have access to comprehensive international standardized testing. Among them is LAYS, by the World Bank; this uses conversion rates between different tests taken in different years, locations, and by different age groups to create a holistic perspective on human capital within a country.("TCdata360: Learning-Adjusted Years of School. World Bank" n.d.) The benefit of using a dataset like LAYS is that it is comprehensive; the downside, that LAYS in its current nascent form is not incredibly accurate. For a test of LAYS' accuracy on a validation set of Latin American countries, see www.cgdev.org/blog/does-education-need-qaly-and-lays-it. Other attempts by the global education community include more targeted conversion methods between different standardized tests (Patel and Sandefur 2020), but the difficulty here is their limited coverage of relevant countries and adult age ranges. Relying on these measures to accurately portray adult education and transferrable skills would require us to perform our own LAYS-like extrapolation of youth education levels to adult ones.

later) estimates that Ghana and Kenya will make up 1.06% (2.4 million) and 0.893% (2.8 million) of high income countries' total (all-age) migrants, respectively. And note, again, this is a lower-end estimate.

Despite the fact that there appear likely to be amply sufficient young African workers with the basic skills to be employable in Europe, the disparity in educational quality speaks to the importance of education interventions, such as global skills partnerships, which help match training in lower income countries to skills gaps in higher income countries. And the question remains, what is the likely size of emigration from Africa to Europe over the next thirty years and how does it compare to need?

7 Filling the Gap: Some Numbers

7.1 Data

In order to construct a forecast of likely migration flows over the next few decades, we use data from the following sources:

- International Institute for Applied Systems Analysis (IIASA), Wittgenstein population projections, which estimate future country populations by education and age from 2015-2100.[66]
- The UN Population Division Trends in International Migrant Stock: The 2017 Revision (1990–2017 data), and UN forecasts of population including forecasts including future migration flows and their impacts and a zero-migration forecast. The UN provides estimates for migrant stocks by age, sex, and origin country from 1990-2019 in 5-year increments.[67]
- The World Bank, which provides data on bilateral migrant stocks for 1960-2000 in decade increments. We use a mean of the World Bank and UN data on the years of overlap: 1990 and 2000. This does, however, mean that there are artificial jumps in these years.[68]
- Per capita GDP estimates are obtained from the World Development Indicators (WDI)[69] and Penn World Tables (PWT) (series rgdpna).[70] A mean of the two series is used.[71]

[66] Lutz et al. (2018)

[67] www.un.org/en/development/desa/population/migration/data/estimates2/estimates19.asp

[68] While the UN includes refugees within their data for some countries, the World Bank makes every effort to remove them from their data: "The number of refugees is subtracted from the totals, with the intention of removing refugees in camps from the total, since the focus is on economic migration." Additionally, both datasets can suffer from over-reporting of migrants to *jus sanguinis* countries, where citizenship is determined by parents' citizenship, and not solely by birth location. The World Bank data is affected to a lesser degree, since it, where possible, attempts to define migrants by country of birth, not just citizenship. We use a mean of both datasets; nevertheless, since the World Bank data is only provided each decade, this can cause notches in the time series of select countries where the UN data and World Bank data differ.

[69] data.worldbank.org/indicator/NY.GDP.PCAP.PP.KD

[70] www.rug.nl/ggdc/productivity/pwt/pwt-releases/pwt9.1

[71] Penn World Tables has the benefit of going as far back as 1970, while the World Development Indicators have the benefit of there being more recent data available (2018 and 2019 for some countries). There are 804 missing country-years (across 189 countries) from PWT that are present in WDI. For an explanation on why we use a mean, see Pinkovskiy & Martin: "A strict reading of our paper would suggest that one use a linear combination of PWT 9.0 RGDPNA and WDI 2011 PPP (perhaps with equal weights on each measure)." (2016)

7.2 Predicting the Supply of Emigrants Under Business as Usual

We regress the emigrant stock of a country o in a given destination economy d on year (T), log UN zero migration population at origin (L_o), log GDP per capita at origin (PPP) (Y_o), the squared log of GDP per capita at origin (PPP), and country fixed effects (μ_o) from the years 1950 to 2019 in an unbalanced panel:

$$\text{emigration}_{o,d} \;=\; \beta_1 \;+\; \beta_2 T + \beta_3 \ln(L_o) \;+\; \beta_4 \ln(Y_o) \;+\; \beta_4 (\ln(Y_o))^2 \;+\; \beta_5 \mu_o$$

We perform this regression on every country's emigrant stocks within the US, UK, China, France, Germany, the EU+UK, and High Income countries (i.e. we have seven individual outcome variables and seven regressions).

To obtain 2050 predictions, we make a naïve assumption that annual GDP growth for each country will equal the arithmetic mean of historical GDP growth within the country's income group, as currently defined by the World Bank, and use coefficients from the regression to forecast 2050 values.

We sum all the predicted migrant stocks and subtract them from 2015 migrant stocks to obtain a total estimate of the *increase* in migrant stocks. We also sum the predicted increase in migrants from African countries. When performing the predictions for groups of countries, such as the EU+UK or High Income countries, our estimates do not consider within-group migration. That is, we do not consider a French person migrating to the U.S. as a "migrant to a High Income" country (similarly for the EU+UK, we do not consider a Spaniard migrating to Germany in this total).

The results are presented in Table 3 & 4 (see Appendix).

7.3 Comparisons with Existing Estimates and Estimating Additional Demand for Workers

For comparison and robustness, we take 2050 population forecasts from the UN and Wittgenstein, including their 'medium variant' and 'zero migration' estimates.[72] The zero migration population estimates start to differ from the medium variant estimates in 2015. So, taking the 2050 medium variant population estimate minus the 2050 zero migration population estimate produces UN and Wittgenstein estimates for the change in population due to migrantion from 2015 to 2050. We also report estimates for the working age (20-64) population due to migration for 2050 from the UN and Wittgenstein using a similar method.

To calculate the demand for additional workers, we take the UN and Wittgenstein zero-migration population predictions and calculate the gap in working age population over total population compared to 2015:

$$\frac{w_{15}}{t_{15}} t_{50} - w_{50}$$

Where w_{15} is the initial population in the region that are of working age (20-64) in 2015, and t_{15} is the total population of any age in 2015. w_{50} and t_{50} represent the working-age population and total population in 2050 under the zero-migration forecast. Another way of interpreting this

[72] Wittgenstein relies on expert opinion on demographic and economic trends. The UN differentiates countries that have more recent fluctuations in migration from those that do not, and they keep constant net migration for the latter countries until 2050. See Cekota and Trentini (2012), Wilmoth (2019), and Lutz, Butz, and KC (2014b) (pg. 117).

equation is, "How many more working-age people would be needed to keep the ratio of workers to the total population the same as that of 2015?" We perform this exercise for high income countries, the EU+UK, U.S., France, Germany, the UK, and China.

Note that our estimates are not directly equivalent to those of Wittgenstein and the UN. Our forecasts take as outcome variable past migrant stocks; we then subtract our 2050 projection from total 2015 migrant stocks. UN and Wittgenstein estimates come from subtracting total population estimates (2050 medium variant minus 2050 zero migration). Thus, our estimates exclude the impact on total population of migrants' children born between 2015 and 2050 (some of whom will be in the workforce by 2050). The estimation of UN and Wittgenstein's 'migrant stocks' for 2050 includes these migrant children.

Note also to call these forecasts 'business as usual' is somewhat misleading. The UN and Wittgenstein estimates implicitly consider policy changes. The UN, for example, says that they modify their migration estimates based on the "policy stance of each country with regard to future international migration flows."[73] Wittgenstein asks 550 population experts on where they see future migration trends, and these experts may take into account where they see country policy headed.[74]

8 Results

The results from predicting migrants stocks are summarized in Table 4 (see Appendix). The column, "total new migrants" indicates the expected change in new migrant stock from 2015 to 2050. The "new worker migrants" column indicates the expected change in new migrants aged 20-60 from 2015 to 2050. The Kenny and Yang estimates of the "new worker migrants" column takes the average of the UN and Wittgenstein's proportion of working age migrants (over total migrants) in a destination country or country group and multiplies it by our estimate of total new migrants. The total worker gap is the value calculated from the aforementioned equation, $\frac{w_{15}}{t_{15}} t_{50} - w_{50}$. The last three columns are per capita values of the previous three estimates.[75]

For the EU+UK, we expect a total of 24.5 million new migrants by 2050, of which 6.72 million are from Africa. The UN and Wittgenstein expect total new migrants of 25.8 and 32.5 million. UN and Wittgenstein also expect a total worker gap of 60.8 and 72.7 million, but only 17.1 and 22.1 million new worker migrants. This suggests immigrant workers will fill only between 23 and 30 percent of Europe's total worker gap in 2050 under business as usual, with African immigrants accounting for only about a quarter of that.

For comparison, looking at the US, we expect a total of 22.1 million new migrants by 2050, of which 12.5 million are from Africa. The UN and Wittgenstein expect total new migrants of 40.8 and 44.5 million. UN and Wittgenstein also expect a total worker gap of 42.4 and 50 million, but only 26.8 and 29.7 million new worker migrants.

Our estimates are broadly consistent with those of UN and Wittgenstein –though to repeat, UN and Wittgenstein project population totals; our estimate projects migrants. The estimates suggest that Europe will not be saved by migration under business as usual, in part because African migrants appear more likely to end up going to the US than to Europe, despite the latter region's proximity.

A common pitfall in thinking about migration is the 'lump of labor fallacy': that there are a set number of jobs to be done and if migrants take them there will be fewer for natives. The

[73] Cekota and Trentini (2012)

[74] Lutz, Butz, and KC (2014a)

[75] for the Kenny and Yang per capita estimates, we do not calculate a new population value. Rather, we use an average of the expected UN and Wittgenstein population medium variant projections.

(repeatedly empirically demonstrated) rejoinder to that is that migrants create jobs: they found new businesses that hire people and consume goods and services that generate demand and (so) more employment. But if migration creates demand for employment, it cannot be a simple cure for a shortage of workers. Again, some migrants arrive as children or retirees, and thereby contribute to the dependency ratio. This is a reason for considerable caution in directly comparing the emgiration forecasts we present to the 'total worker gap' numbers. It is the case, however, that migrants are more likely to be young adults than the population as a whole, so that they are likely to improve dependency ratios. That the forecast under business as usual suggests the worker gap is much larger than potential migration flows and that this underestimates the size of the problem points to the need for a rapid course correction.

9 Conclusion

There is a growing global problem of too few migrants. In Figure 5, we plot predicted global emigrant and immigrant stocks based on the regressions underlying Figures 1 and 2 as well as (post-2019) our forecasts of economic growth. In reality, both stocks will be the same, because all emigrants from one country are immigrants into another country. But the forecasts suggest global immigrant stocks will exceed predicted global emigrant stocks, suggesting that, in 2050, the supply of migrants will fall 31.5 million below the demand for migrants under business as usual.

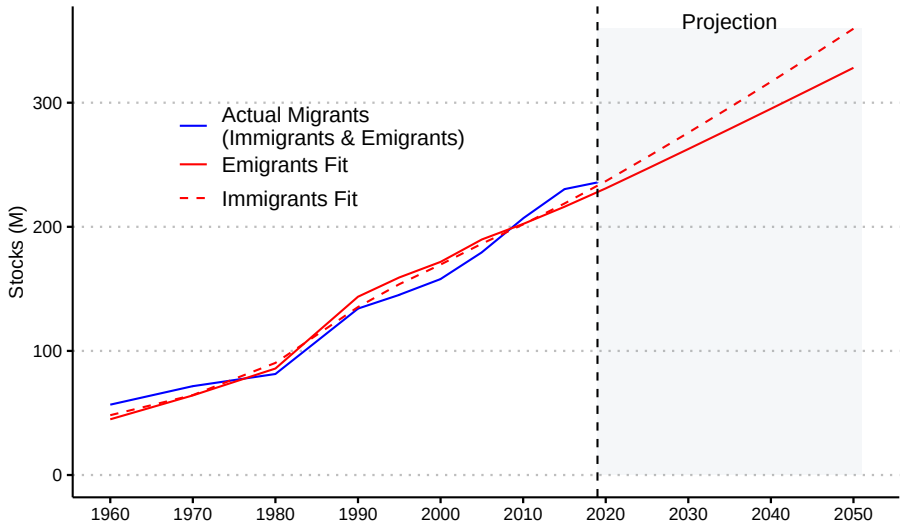

Figure 5: Global Immigrant stock vs. Emigrant stocks

Note: We project expected immigrants and emigrants based on the regressions underlying Figures 1 and 2 and the assumption that real GDP growth will equal the arithmetic mean of historical real GDP growth within the country's current World Bank defined income classification.

Our calculations using UN estimates show the EU+UK needs 44 million more workers by 2050 on top of those that will be supplied by migrant flows under business as usual (see Table 4, Appendix).[76] Even if the demand for these jobs were halved due to automation, Europe would still require 22 million jobs to be filled. Ensuring a high quality of life, especially for Europe's aging population, requires more immigration. Escarce and Rocco find that greater immigration in Europe is already associated with reduced depressive symptoms and lower probability of clinically significant depression among older natives.[77] As migrants become increasingly responsible for the care and welfare of retirees, that association will surely strengthen.

The continent needs to work far harder to attract people: opening up universities to more foreign students with larger scholarship and loan programs; developing skills partnerships that provide training in developing countries for potential emigrants so that they arrive ready to do the jobs that need to be done; accepting larger numbers of refugees to build networks to attract more immigrants later; ensuring housing and transition services so new arrivals can be assimilated. For reasons of both equity and political plausibility, it also needs to work on upskilling its own population to ensure no worker is left behind and that increased immigration benefits all European workers as well as the immigrants themselves.

Africa faces its own challenges: a rising young, educated population with far too few jobs to go around. Migration will directly provide some of those jobs. By strengthening trade ties, investment, and technology transfer, greater migration will also create more jobs in the continent itself. There have been two great migrations out of Africa in the past: the first peopled the planet. The second, involuntary and evil, re-peopled the Americas in the aftermath of Columbus. The third, voluntary and mutually beneficial, has hopefully only just begun. It will help Europe and Africa both.

[76] In Table 4, Appendix, subtracting UN EU+UK total worker gap with EU+UK new worker migrants.
[77] Escarce and Rocco (2019)

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11 Appendix

Table 2: Model Summary Statistics

Destination	Measure	migrants	year - 2000	log(GDP per capita)	(log(GDP per capita))^2	log(total zero migration total population)
EU	mean	141000	-3.29	8.77	78.3	15.50
	stdev	327000	17.30	1.20	21.4	2.01
China	mean	2520	-3.26	8.98	82.1	15.50
	stdev	17400	17.30	1.23	22.1	1.91
Germany	mean	46000	-3.26	8.96	81.8	15.50
	stdev	182000	17.30	1.23	22.1	1.94
UK	mean	29600	-3.26	8.96	81.9	15.50
	stdev	81100	17.30	1.23	22.1	1.94
US	mean	165000	-3.26	8.96	81.8	15.50
	stdev	694000	17.30	1.23	22.0	1.93
High Income	mean	513000	-3.13	8.44	72.1	15.60
	stdev	1310000	17.30	0.94	15.7	1.97
France	mean	36300	-3.26	8.96	81.9	15.50
	stdev	133000	17.30	1.23	22.1	1.94

Table 3: Regressions

	EU	China	Germany	UK	US	High Income	France
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Year	5,761***	14	830***	1,140***	3,355**	20,055***	528***
	(625)	(49)	(307)	(161)	(1,557)	(4,334)	(187)
log(GDP per capita)	164,567**	−12,128*	−20,912	47,397**	428,997**	457,752	30,758
	(74,768)	(6,373)	(39,316)	(20,634)	(201,140)	(572,867)	(24,023)
$(\log(\text{GDP per capita}))^2$	−8,587**	850**	1,646	−2,360**	−21,259*	−5,415	−1,600
	(4,307)	(364)	(2,249)	(1,180)	(11,506)	(34,815)	(1,374)
log(Zero Migr Total Pop)	−110,779***	640	−19,703*	−24,412***	21,581	−369,383**	−3,152
	(23,152)	(1,840)	(11,530)	(6,041)	(58,579)	(164,013)	(7,027)
Constant	485,573	27,424	265,240	41,986	−2,389,750**	3,800,074	−109,895
	(375,851)	(29,843)	(185,747)	(97,344)	(946,038)	(3,085,730)	(113,237)
Country dummy?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,432	1,678	1,678	1,678	1,678	1,211	1,678
R^2	0.85	0.57	0.85	0.79	0.73	0.72	0.89
Adjusted R^2	0.83	0.52	0.83	0.76	0.69	0.69	0.88
Residual Std. Error	134,110.80	12,038.71	75,137.30	39,433.71	383,597.70	732,716.20	45,904.66
F Statistic	45.20***	10.71***	44.70***	29.97***	21.39***	20.22***	67.34***

Notes:
***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.
Recent data from China are likely inaccurate. Prior to and including 2000, China received immigrants from almost every country. Data after 2000 only have immigrants from 20, mostly Asian, countries.

Table 4: Estimates for Supply and Demand of Migrants in 2050 (vs. 2015)

destination	origin	organization	total new migrants	new worker migrants	total worker gap	total new migrants per 1000 people	new worker migrants per 1000 people	total worker gap per 1000 people
US	Africa	Kenny and Yang	12.5	8.3		32.3	21.4	
	Global	Kenny and Yang	22.1	14.6		57.2	37.9	
		UN	40.8	26.8	42.4	108.0	70.8	112.0
		Wittgenstein	44.5	29.7	50.0	113.0	75.7	127.0
UK	Africa	Kenny and Yang	1.4	0.9		18.4	12.2	
	Global	Kenny and Yang	5.5	3.6		73.9	48.9	
		UN	6.4	4.2	7.8	86.5	57.3	106.0
		Wittgenstein	5.2	3.4	8.5	69.3	45.7	115.0
China	Africa	Kenny and Yang	0.2			0.1		
	Global	Kenny and Yang	0.7			0.5		
		UN			152.0			
		Wittgenstein			135.0			
France	Africa	Kenny and Yang	0.3	0.2		4.5	2.9	
	Global	Kenny and Yang	3.1	2.0		43.8	28.0	
		UN	2.5	1.5	5.4	36.5	22.0	79.5
		Wittgenstein	5.6	3.8	8.3	75.2	50.9	112.0
Germany	Africa	Kenny and Yang	1.4	0.9		16.8	11.5	
	Global	Kenny and Yang	6.8	4.6		84.6	57.7	
		UN	6.0	4.0	11.0	74.3	50.0	137.0
		Wittgenstein	9.5	6.6	14.4	119.0	82.2	180.0
EU	Africa	Kenny and Yang	6.7	4.5		13.3	9.0	
	Global	Kenny and Yang	24.5	16.5		48.7	32.7	
		UN	25.8	17.1	60.8	51.9	34.5	122.0
		Wittgenstein	32.5	22.1	72.7	63.6	43.2	142.0

Table 4: Estimates for Supply and Demand of Migrants in 2050 (vs. 2015) *(continued)*

destination	origin	organization	total new migrants	new worker migrants	total worker gap	total new migrants per 1000 people	new worker migrants per 1000 people	total worker gap per 1000 people
High Income	Africa	Kenny and Yang	42.5	29.3		34.4	23.7	
	Global	Kenny and Yang	108.0	74.5		87.3	60.2	
		UN	96.2	66.5	155.0	79.0	54.7	127.0
		Wittgenstein	118.0	81.2	186.0	94.0	64.6	148.0

Note: "Total new migrants" is the predicted change (in millions) in migrant stock from 2015 to 2050. "New worker migrants" is the expected change (m) in migrants aged 20-60 from 2015 to 2050. For the UN and Wittgenstein, these come from subtracting medium-variant and zero-migration population projections. The author's estimates of "new worker migrants" takes the mean UN and Wittgenstein's proportion of working-age migrants (over total migrants) and multiplies it by the author's estimate of total new migrants. "Total worker gap" is the number of workers (m) needed to keep the ratio of workers to the total population the same as that of 2015. The authors make no population forecasts, and so this column is blank for some rows. The last three columns are per capita values of the previous three estimates. Some values for migration to China cannot be computed, since the UN and Wittgenstein population projections in medium variant scenarios are smaller than population projections in zero-migration scenarios.