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NOTE FROM THE EDITOR-IN-CHIEF



Expert lexicographers behind the Oxford Languages' Word of the Year campaign came to the conclusion that 2020 was not a year that could neatly be expressed in one single word.

Rather, 2020 deserved a report aptly named [Words of an Unprecedented Year](#). Economists have also adopted words new to their field, adding the [Great Lockdown](#) to the list of the Great Depression and the Great Recession. As the world emerges from the traumas of COVID-19, concerns have grown that a two-track pandemic is leading to a [two-track recovery](#) and that many countries will come out of the pandemic with higher sovereign debt and potential scars, making policy choices more difficult.

The articles featured in this issue of the IMF Research Perspectives offer insights on how we can navigate these uncertain and unprecedented times and solve the puzzle of [building back better](#) by looking at some questions that have occupied economists long before the pandemic but have since then gained urgency. They focus on understanding the risk of fiscal dominance, getting the most bang for the buck in fiscal policies when interest rates are low, improving sovereign debt instrument design, incorporating mortality dynamics into economic models, and supporting innovative solutions to new challenges through public involvement. After all, sometimes going back to basics is the simplest way to move forward. ~Deniz Igan

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GLOBAL ECONOMIC & **OUTLOOK** **POLICY**

Interview with **Oya Celasun**

Oya currently heads the Multilateral Surveillance Division in the IMF's Research Department. Prior to that, she was the chief of the World Economic Studies Division, which produces the World Economic Outlook (WEO), between 2015 and 2019. She will soon be moving to the IMF's European Department to take on a new role as the mission chief to Germany. In this interview with Deniz Igan, Oya tells us about her journey as an economist and the process through which original research feeds into the Fund's assessment of the global economic outlook and policy recommendations.

ABOUT YOU

What attracted you to economics?

My father was a professor of macroeconomics; he was actually self-educated. He had gradually shifted from mining engineering, which he studied as an undergraduate and PhD student at Columbia University in the late 1950s, towards operations research and then macroeconomics. I used to overhear him speaking to his students or visitors from abroad—sometimes from the IMF and World Bank, staffers who would be asking him for his insights on the state and outlook of the Turkish economy. I thought the issues were fascinating—closely connected to our daily lives yet requiring sophisticated

frameworks to understand and form a view on. I therefore studied engineering first (in my time, you did so if you could) and then moved on to graduate studies in economics.

Was working at the IMF always in your plans?

Not necessarily the IMF, but I was very much interested in policy institutions. As I mentioned, I was curious about how economies end up at a given juncture, what the policies that can put them at a better place are, what the political economy constraints are to that. I also grew up through repeated economic and balance of payments crises in my own country and observed firsthand how these crises affected people's lives, as did a lack of development (comparing my father's country, Turkey, with my mother's country, Denmark). I also liked the idea of working on different countries and understanding the differences better. So the IMF was very attractive.

Tell us a bit about your research interests. You have published on various topics, ranging from public debt sustainability, sovereign risk, and corporate debt and inflation in emerging market economies to the costs of unpredictable aid flows in low-income countries. What inspired you to look into these questions?

My background. At graduate school I was drawn to working with Guillermo Calvo, who had done conceptual work on crises and open economy macro problems. My thesis topic was inflation and disinflation policies—having lived through chronically high inflation for years in Turkey. The sovereign risk and corporate debt topic was inspired by work I did for Chile as a RES [IMF Research Department] economist participating in an Article IV mission.

My most original empirical work was probably on [aid predictability](#)—a topic [my husband](#), also an economist, had to organize a conference on. He had a great idea about how to document the cost of unpredictable aid flows—a buzzword at

the time with very little analysis to it. He collected the data on projected versus actual macroeconomic variables, sifting through more than a hundred IMF staff reports, and I did the analysis, which showed that aid shortfalls induced cuts in investment that were never made up by aid excesses. [The Economist](#) dedicated an article to it shortly after we put it out.

While the Research Department has been your home base, you have also had considerable field experience—in particular, as the mission chief to Uruguay in 2013–14 and as an economist for the US and Canada desks. How has your research influenced your approach to identifying the critical issues facing these countries and developing policy recommendations?

Uruguay was one of the last few high-performing emerging markets that had relatively high inflation (at 8–9 percent: above target), so that was a natural fit for me. I did some background work on

A quiet moment with family



inflation on the US desk for projection purposes as well; I remember that I had found out that the Fed's most trusted Phillips curve had very similar coefficients to mine! And some work I did on the Islamic Republic of Iran on inflation as a young economist in the [Economist Program](#) (applying some techniques I learned in a course provided by the IMF's Institute for Capacity Development) was apparently on the reading list of an econometrics course at Oxford University—a research assistant I had worked with who then moved to do graduate studies there, Roxana Mihet, told me. So I guess I found a way of working on what I knew more about and was interested in the countries I worked on here.

YOUR CURRENT WORK

Tell us about what the Multilateral Surveillance Division does, especially how it plays an important role in an environment where global cooperation is most needed.

One of the Division's tasks is to support the Finance Track of the G20—which brings together finance ministers and central bank governors. You write reports that set out the issues that IMF staff think they should be working on jointly. In other words, you contribute to their agenda. Such cooperation is always needed, but it is especially vital during crises.

Another item is the analysis and coordination of Fund work on cross-border spillovers. This is right at the heart of the Fund's core mandate, and something that the institution is uniquely placed to do. In fact, at the G20 Framework Working Group meetings (which is a group of Finance Ministry and central bank staffers), we are always asked what the spillover effects of individual members' policies are.

Finally, we have started an [agenda on climate change](#), which is the international coordination problem par excellence. Our work shows how different

countries would be affected by adopting policies to reduce emissions to net zero, for instance, which we hope will provide input into discussions on how countries can cooperate and support each other in stopping catastrophic climate change.

What are the most challenging aspects? What are the most rewarding?

It's a truly busy division, and its agenda is constantly expanding in the crisis environment. But it is rewarding to be so close to the main topics of the day and have some influence on our messages. The most rewarding part is that it's a very collaborative and easygoing team, despite the very busy work environment. And there is a sense of collective learning.

How, overall, has the Fund contributed to the recovery from COVID-19? Can you give specific examples where you noticed that results from your (and colleagues') research convinced your

counterparts on a particular issue or influenced the agenda or approach to a problem?

In our field—especially multilateral surveillance—decisions are so complex and decision makers so diffuse that it is hard to see the immediate impacts. But the strong policy response of many countries to ease the burden of the COVID crisis on people did benefit from all the work the Fund did to support the idea. Desks and our economists did valuable work on tracking policy responses, which has been a very useful tool for the authorities in learning about what other countries are doing to address the crisis. Another example—the work my colleagues in RESMS [Multilateral Surveillance Division] did on [financial spillovers from major central bank actions](#) was cited often in the IMFC [International Monetary and Financial Committee] plenary and G7-G20 meetings at the [2021 Spring Meetings](#)—suggesting that we were able to provide a thought framework for the policy discussion.



Multilateral Surveillance Division get together after 15 months of working from home.



THE FUTURE

Needless to say, 2020 was an extraordinary year: not only did it upend lives around the world but it also posed a new challenge for many in the economics profession. Terminology like “nonpharmaceutical interventions” and SIR (susceptible-infectious-recovered) models embedded in macroeconomic models quickly became common in economics publications. How has your work adapted? Any lessons for remaining agile if we’re faced with another nontraditional shock?

It’s all about being curious, putting in the hours, and talking to people who know about the topic much more than you do. And being clear about your assumptions. Being very connected to the most pressing immediate policy issues, we do early work that we know is not the final word on the issue, but work that moves the discussion forward. That means that you have to be very clear about your assumptions.

The economists I worked with were indeed very agile and were not afraid to do early-stage work. Three of them produced some very nice work in the initial several weeks on the size of the most affected contact-intensive sectors in the G20 and looked at scenarios of how much national income would be lost—and the importance of tourism across the membership. One economist worked with an interdepartmental team to use SIR models to study macro policy questions during the pandemic. Another economist is now looking at how many lives can be saved globally with more equitable vaccine distribution.

Looking ahead, what are the key economic issues we need to do more work on? Are the existing tools enough to tackle them? Are there areas where going back to basics could still provide valuable insights?

I think inequality had already become the most pressing issue before the pandemic, and the problem has only deepened and become more visible. The crisis has revealed how people’s resilience to shocks varies greatly—many people have no financial buffers to deal with setbacks, and what could seem temporary losses get handed down across generations in the form of lost opportunities. I think distributional consequences, and in particular how lower-income groups are affected by policies and shocks, have to be an inseparable part of all macroeconomic and financial analysis. The basic representative agent tools and thinking are not adequate; it is good to see that macro analysis has shifted towards models that incorporate heterogeneity across agents. Also becoming more mainstream is micro data analysis to better understand the macro picture.

What are the key takeaways from your time working on the WEO and supporting the G20 for your new role as the mission chief to Germany?

As you know, a lot of attention gets devoted in the WEO process to make sure that the country forecasts are mutually consistent. The German economy is large and tightly connected through trade with many other economies, so forecasts for Germany’s GDP and external sector matter for the regional and global growth forecasts.

I have a good sense of how much interaction and communication between teams and departments it takes to achieve internal consistency, and the value that has for the quality of the global and individual country forecasts.

Working with the G20 Framework Working Group made me realize how interested country authorities are in learning from each other’s approaches to addressing economic problems, and how uniquely placed the Fund is to compile experiences and distill policy lessons for the benefit of all its members. A great example is the [COVID-19 Policy Tracker](#), initially developed in the Strategy and Policy Review Department by a team led by Vladimir Klyuev, and later extended by a team in RESMS. But the biggest contributors to these efforts are the country desk economists. Knowing the value such information has for our members will be a useful perspective to have when I join an area department team, I think.

Any advice for aspiring economists?

There are no set rules, and you have to chart your own course. Working on what you are most interested in and with people you can learn from is a great career strategy. Also, try to maintain a longer-term vision of who you want to be and what you want to contribute to. What exactly you do in a given year during your first several years and how quickly you reach a given milestone is not as important as it may seem.

Finally, be open to trying new things in the early years. The job you seem the least equipped for may have the most to offer in terms of what you can learn.

WHERE ARE ALL THE GDP-LINKED BONDS?



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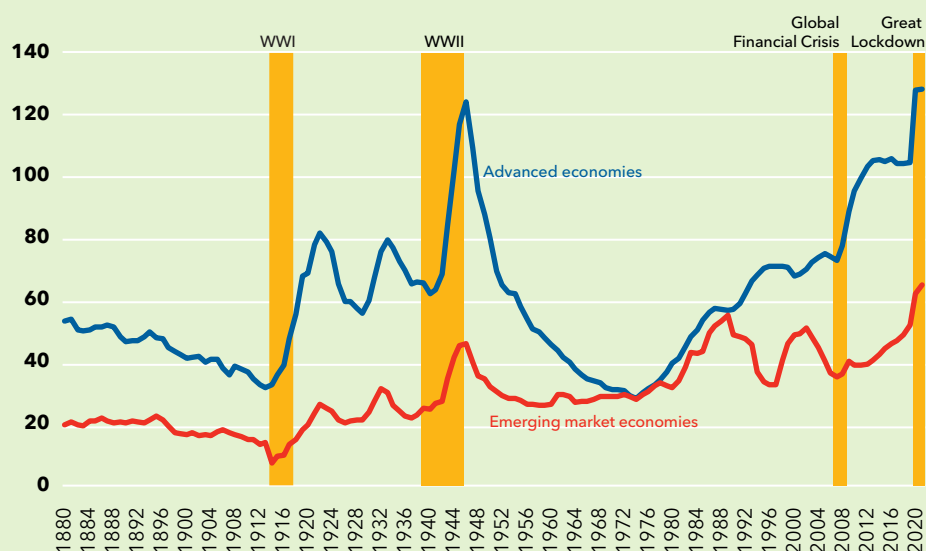
In response to the COVID-19 pandemic, most economies have implemented large fiscal stimulus programs that pushed public debt to historic highs (Figure 1). This development has revived interest in proposals for [state-contingent debt instruments](#) as a strategy to reduce the likelihood of future costly debt crises. The idea has been around for a while and is quite neat in theory: state-contingent debt instruments allow a sovereign issuer to reduce payments when times are bad and, hence, offer many benefits. These instruments [decrease default risk, reduce the cyclical impact of fiscal policy, and improve risk sharing](#).

Despite these well-understood advantages, state-contingent debt instruments are rare in practice, and countries have not been able to issue them at a reasonable premium. For instance, the premium on the GDP warrants that Argentina issued as part of its 2005 debt restructuring, after taking out default and liquidity risk, was estimated to be [as wide as 1,200 basis points](#) at issuance and to have declined to a still-high 600 basis points. Similar premiums are estimated for the GDP-linked bonds issued by Greece in 2012 and by Ukraine in 2015 (Kim and others 2021). This is often interpreted as a premium for “novelty”—investors demand a premium because they are not familiar with the instruments. But, if so, why would this premium remain high even a decade and a half after issuance, giving investors plenty of time to get familiar with the instruments in question? Surprisingly, there is little theoretical analysis of the reasons behind these premiums, and the lack of indexation in sovereign debt markets remains puzzling.

WHY ARE STATE-CONTINGENT BONDS PRICED SO UNFAVORABLY?

In [a recent IMF working paper](#), we propose a framework to rationalize the observed unfavorable prices of state-contingent debt instruments. The framework is based on a resolution of the equity premium puzzle—which

Figure 1. Update of World Economic Outlook June 2020



Sources: IMF, Historical Public Debt Database; IMF, World Economic Outlook; Maddison Project Database; and IMF staff calculations.

refers to many standard economic models’ inability to explain the high premium on a diversified portfolio of equities over that of “risk-free” government securities—and helps explain why these instruments have had limited success so far. The hindrance may well reflect not what investors know they don’t know but rather what investors do not know that they do not know. Under rational expectations, lenders know that the realization of future GDP is uncertain, but they fully understand the single probability distribution governing the possible outcomes. This notion of risk, or uncertainty, within the model is the typical uncertainty considered in macroeconomics. Alternatively, we consider investors who mistrust their forecasting model and consider the possibility that their forecasts may be biased in some unknown direction. They entertain different models that are statistically close to their baseline model and could also fit the data reasonably well. This type of uncertainty applies for instance when data are limited or when investors fear that some of the model ingredients are not correct but are only approximations. We analyze how lenders’ concern about model misspecification—that models may

miss some unknown unknowns—could affect the desirability of issuing state-contingent debt instruments.

We evaluate prices and welfare effects of state-contingent debt using a standard quantitative model of sovereign debt and strategic default, augmented with international lenders with [a preference for robustness to model misspecification](#). These lenders have in mind a statistical model to evaluate future outcomes, but do not trust it fully. Therefore, they consider alternative possible models and seek actions that would perform well under all of these alternative models.

For the commonly used threshold state-contingent bond structure (for example, the GDP-linked warrants issued by Argentina in 2005, Greece in 2012, and Ukraine in 2015 pay only when GDP growth meets a certain threshold), there is an “ambiguity” premium in bond spreads that can explain most of the residual labeled as novelty premium. As investors seek robust decision rules that perform well under all known and unknown unknowns, they act as if the probability of bad states is higher and demand compensation for holding bonds that do not pay when times are bad. This additional premium source leads to welfare losses for the issuing sovereign.

ROBUST INVESTORS HAVE A DISTORTED VIEW OF THE WORLD

When investors have concerns about model misspecification, they may consider alternative probability models that are difficult to distinguish from their main forecasting model with limited data. How large a distortion they consider measures the lack of trust in the main model. Now, depending on which actions they plan to take (for example, purchasing the state-contingent bond of a certain country), some of this unease will lead to worse expected payoffs. To address the lack of trust in the model, they may then want to use the worst-case forecast to price bonds. This would support an investment strategy that is robust to specification errors.

For example, if robust investors are considering the purchase of a bond that pays only if the country's GDP surpasses a particular threshold, they will look very closely at how they forecast GDP. When they price the bond using the worst-case model, robust investors overestimate the probability of low-repayment scenarios. Under the worst-case distribution, GDP will fall short of the threshold more often than under the baseline. In this sense, the investors are endogenously pessimistic.

A key insight from our research is that the design of state-contingent bonds influences how robust lenders distort their forecasts. Our results suggest that events that are very unlikely will probably remain unlikely after disturbances that are statistically difficult to detect. By contrast, likely events offer much more scope for the distortion of their probability of occurrence. The types of bonds countries have issued in the past stipulate non-repayment with high probability (that is, the government would pay only in relatively good times) and thus are particularly sensitive to probability distortions. As a result, these instruments are ultimately priced by models in which non-repayment is much more likely, inducing the large spreads we see in the data.

DESIGN MATTERS

With rational expectations, modifying a bond structure in a way that keeps expected repayments the same does not affect its price. With robustness, however, variation in expected repayment enables different probability distortions. These then feed into ambiguity premiums and contribute to higher spreads.

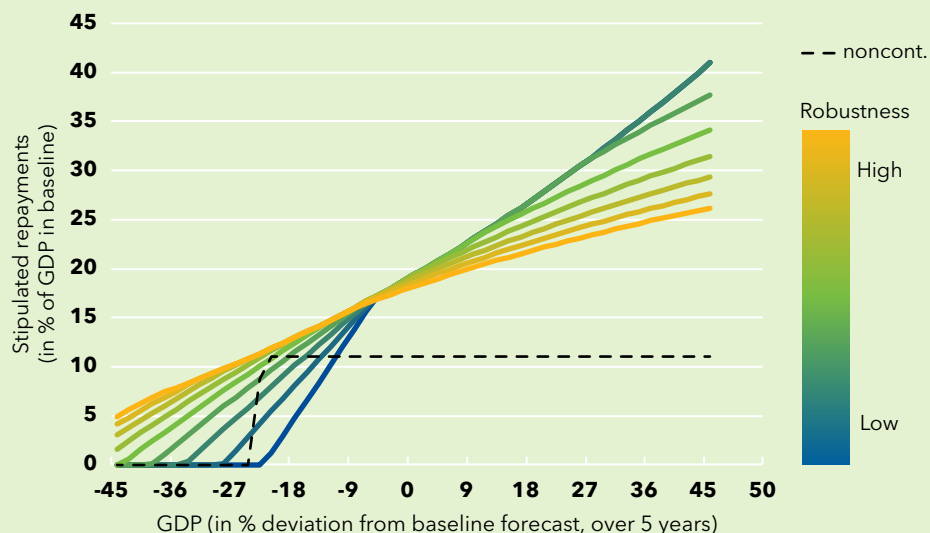
The optimal design of state-contingent debt depends on the investors' degree of robustness. Figure 2 shows at each

level of GDP the stipulated repayments optimally designed for each type of lender. Regardless of the degree of robustness, optimally designed debt always promises higher payments when GDP is high, effectively sharing the country's risk with its lenders. This feature is dampened as lenders become more robust. When lenders fully trust their model (and are no longer concerned with robustness), they are willing to provide insurance to the country by allowing zero payments in a large range of (low) GDP values, compensated by high payments when the country does well. But when they do not trust their model and want to guard against misspecification, lenders prefer bond structures that offer more security. They value not having to stand by their forecast when they have little faith in it. Moreover, when robustness is extreme, the government would like to minimize the contingency in stipulated repayments. But ex post default risk also gives rise to contingency. Therefore, for bad states, the government promises as much as it can credibly commit to repay. In contrast to the commonly used threshold bond, the optimal design generates substantial welfare gains, although these gains are decreasing with the level of robustness.

CONCLUSION

Robustness helps explain the prices of state-contingent debt. We link the typical design of these instruments to their prices: thresholds in good times, with no payments whatsoever for a large share of possible contingencies, are particularly susceptible to the probability distortions (or endogenous pessimism) of robust lenders. Our model calibrated to data with noncontingent debt can account only for the prices of state-contingent bonds issued by Argentina in its 2005 debt restructuring. Our findings account for the scant use of these instruments in practice and shed light on their optimal design. This provides valuable lessons as interest in these instruments peaks again with governments around the world facing higher debt and an uncertain economic outlook due to COVID-19.

Figure 2. Optimal Debt Design



Sources: Authors' calculations.

Note: noncont. = noncontingent.

FISCAL DOMINANCE

in Sub-Saharan Africa
Revisited



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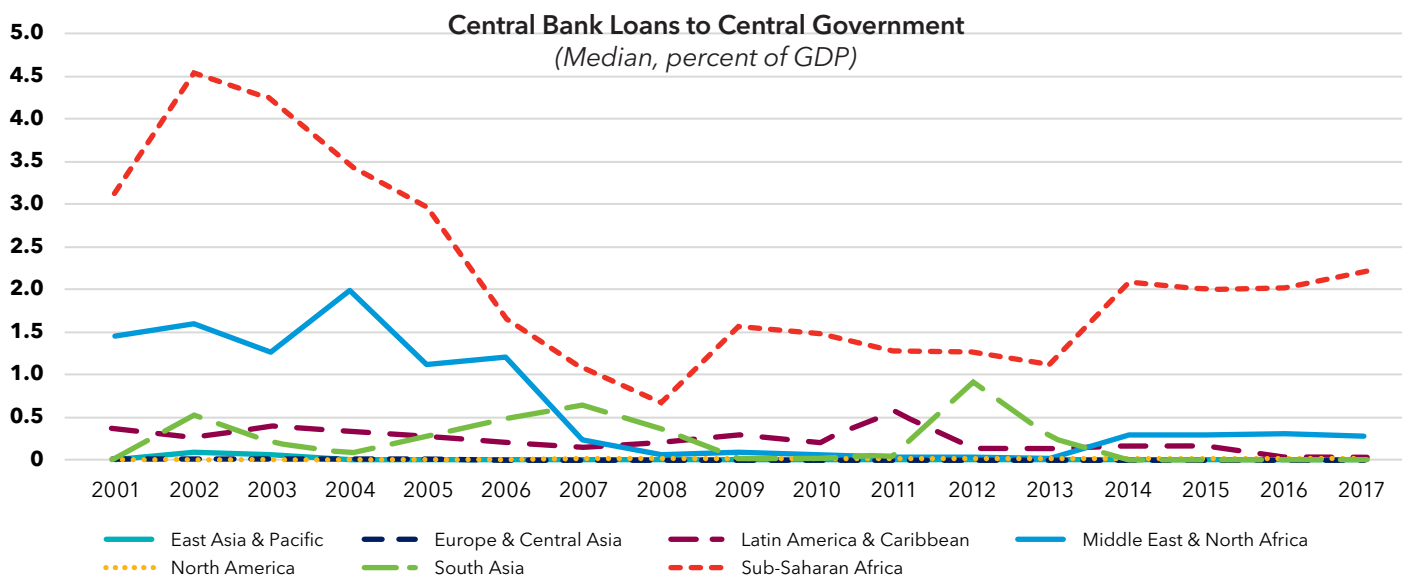
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Economists and policymakers often warn of the dangers of direct central bank financing of governments, and history provides no shortage of cautionary tales. Many hyperinflation episodes have been associated with central bank financing of government debt: Weimar Germany (1922-23), Hungary (1945-46), Greece (1941-45), and Latin America during the 1980s debt crisis, to name a few. In recognition of the economic risks, many countries impose legal limits on central bank lending to government, specified in their central bank legislation.

In the wake of the COVID-19 pandemic, government borrowing from their central banks to finance deficits or debt has returned to the forefront of the policy debate as many countries face the challenge of additional budgetary pressure in an environment of high debt. Yet there has been limited empirical research on the incidence, magnitude, and impact of central bank financing of government deficits beyond the most extreme episodes of hyperinflation. Instead [studies](#) of central bank government relations have tended to focus on the much broader question of central bank independence.

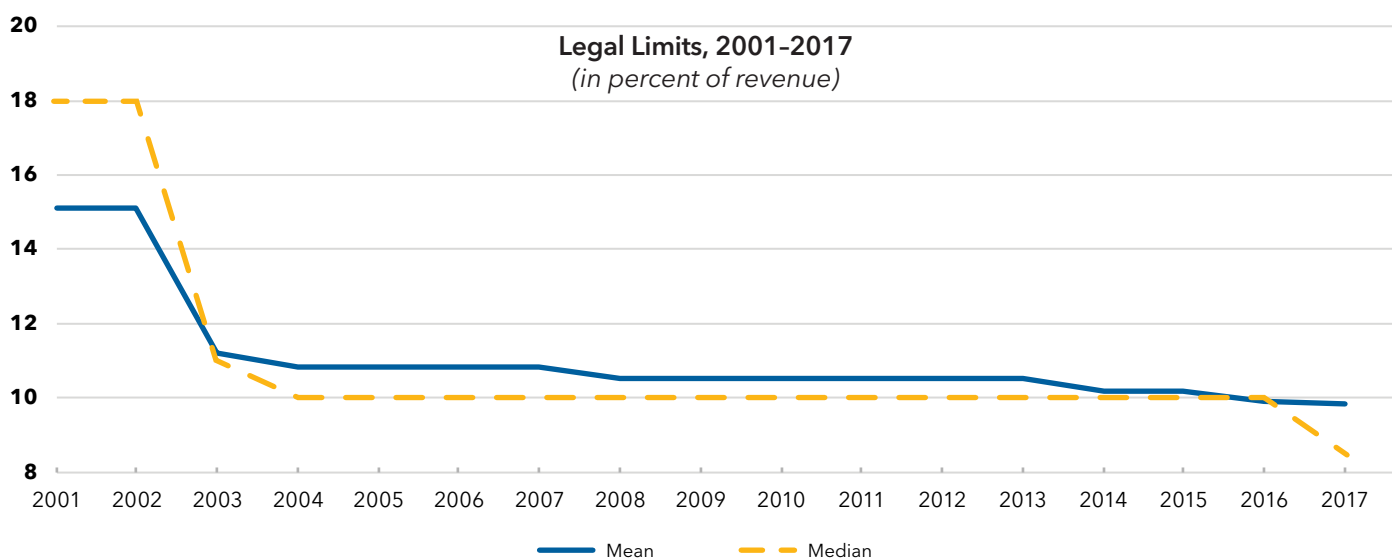
In sub-Saharan Africa unsustainable fiscal deficit financing by central banks has been a particularly pressing problem and led to stark episodes of hyperinflation in Angola, the Democratic Republic of the Congo, and Zimbabwe. The incidence of central bank lending to government has also been much higher in the region than elsewhere (Figure 1), amounting to 2 percent of GDP on average during 2001-17, compared with less than ½ percent in other regions. Strikingly, in four sub-Saharan African countries, this ratio exceeded 10 percent of GDP. And after declining in the first part of the past decade, it has started to pick up again since 2014, coinciding with a rise in deficits and debt.

Figure 1. Central Bank Financing (Central Bank Financing is highest in sub-Saharan African countries.)



Sources: IMF, *International Financial Statistics*; IMF, *World Economic Outlook*; and IMF staff calculations.

Figure 2: Legal Limits in Sub-Saharan Africa (Legal limits have become stricter over time.)



Sources: IMF, Central Bank Legislation Database; IMF, *World Economic Outlook*; national authorities; and IMF staff calculations.

Because of the prevalence of central bank lending to government in sub-Saharan Africa, the question of whether (or how much) to restrict it has been a prominent feature of debates on central bank reform. Moreover, COVID-19 has [renewed pressure](#) on some central banks to permit direct financing of government as financing constraints have started to bite. To take a step toward filling the gap in the literature on these questions, [recent IMF research](#) revisits the evidence for central bank lending to government for fiscal purposes and its macroeconomic impact in the two decades prior to the onset of the current crisis. The study seeks to answer three main questions:

What is the evidence for central bank lending to government in practice, and how does it relate to legal limits?

We augment the IMF's [Central Bank Legislation Database](#) for our sample of African central banks to include quantitative information on legal limits on central bank lending to government, updated to 2017. This shows that many sub-Saharan African countries have introduced (and in some cases tightened) such limits over the past three decades (Figure 2). The limits are typically applied to loans, overdrafts, and advances extended in any given year, defined as a percentage of fiscal revenue. Most limits allow for some limited budgetary financing from the central bank, usually with the aim of providing a lender-of-last-resort facility to cover intra-year

fluctuations in revenue in economies where alternative market financing options may be sparse and shocks relatively frequent. The limits are set somewhat higher in sub-Saharan African countries than in other regions, but still permit only modest and temporary central bank lending to government.

In practice, however, lending by central banks to government in the region has not been modest and temporary, as intended in the law. We define "fiscal dominance" as central bank lending above the legal limit (although the term is used widely, there no established definition), which appears to be a systemic phenomenon—about 16 percent of revenue on average. Nevertheless, the amount by which central bank lending exceeds legal limits (or the magnitude of fiscal dominance) has fallen over time, despite tighter limits.

Why do governments choose to finance deficits through central bank borrowing?

The patterns of noncompliance suggest that legal limits have teeth—a result confirmed in the empirical analysis. Even though the limits were frequently breached, the recourse to the central bank when deficits rose was indeed lower when legal limits were in place. The effect of legal limits is therefore analogous to a speed limit for car drivers: the limit is often exceeded, but rarely hugely so, and drivers go more slowly than when there is a (more stringent) limit.

Further, less central bank financing is used when more financing options are available. On average, about 9 percent of a fiscal deficit is financed by the central bank. But if the government is able to borrow from financial markets and issue bonds, then only about 3 percent of the fiscal deficit is covered by central bank financing.

Finally, IMF programs that restrict lending are effective. If the government has an IMF-supported program with a condition on domestic borrowing or central bank borrowing, then almost none of the deficit is covered by central bank financing.

Should we care?

In short, YES, because central bank deficit financing matters for inflation. Empirical investigation of the impact of central bank lending on monetary aggregates, the exchange rate, and inflation finds a statistically significant contemporaneous impact on the exchange rate and a lagged impact on inflation. An increase in central bank credit to the government by 1 percentage point of GDP—or about 5 percentage points of revenue—is associated with a decline in the exchange rate of 1 percentage point contemporaneously and an increase in inflation by ½ percentage point a year later. Moreover, the impact on inflation seems to be mostly through the exchange rate channel; there does not seem to be evidence of credit growth (the aggregate demand channel).

These findings suggest that fiscal dominance is a relevant macroeconomic issue that policymakers should take seriously—even if the impact does not reach hyperinflation proportions, it can still generate significant inflation pressure. Although the central bank may sometimes need to provide additional financing in exceptional circumstances, including during the COVID-19 pandemic, it should be on a temporary basis to avoid the risk of runaway inflation and keep expectations anchored. Moreover, additional financing should be allowed through clearly defined escape clauses rather than by eliminating or relaxing legal limits. Although legal limits are no panacea, they do provide a useful defense against fiscal dominance: countries borrow less from central banks when they have stricter legal limits. Finally, policies that foster development of financial markets can also reduce the propensity of the government to turn to the central bank.

The **POWER** of **GOVERNMENT SPENDING** when **INTEREST RATES** are **LOW**



Giovanni Melina

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The interest-rate-growth differential ($r - g$) has been under close scrutiny in the past few years. This differential is essential to understanding long-term fiscal sustainability. Higher interest rates generate higher interest payments to service government debt and lead to greater debt accumulation. In contrast, higher GDP growth tends to lower the debt-to-GDP ratio because it increases its denominator.

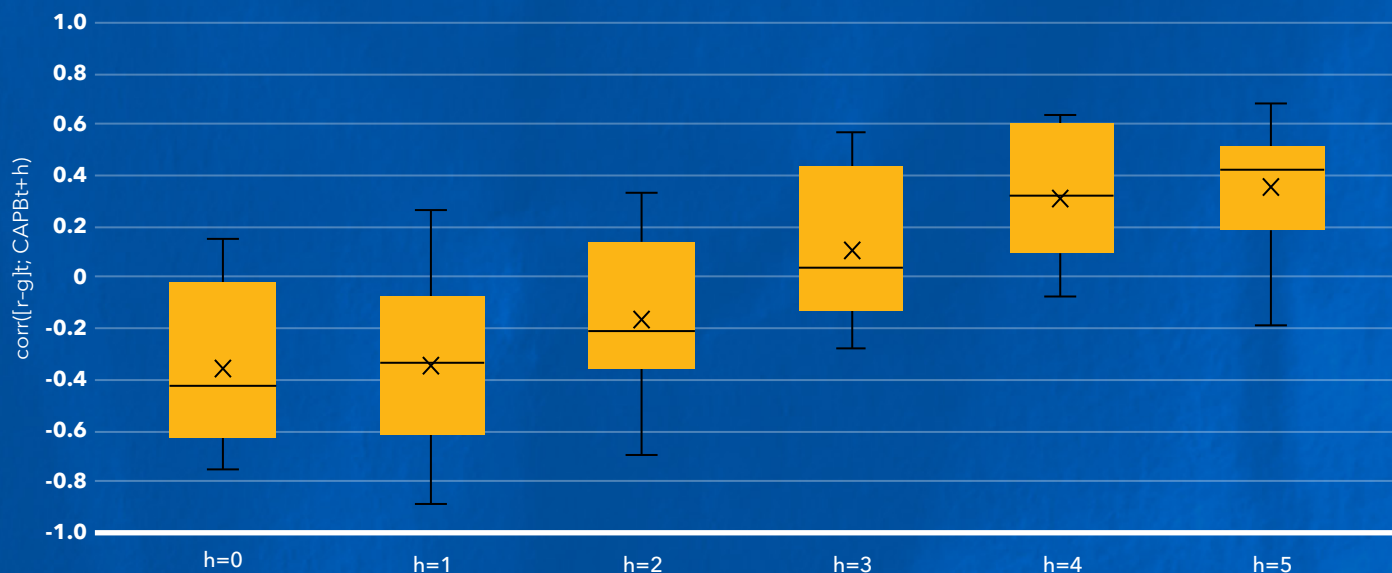
With interest rates persistently low, $r - g$ has turned negative in many countries in the aftermath of the global financial crisis, bolstering arguments for [fiscal stimulus to boost economic activity](#). The evidence for advanced economies hints that [a negative \$r - g\$ may persist over the long term](#). However, [there is no guarantee](#), given that this differential could quickly turn positive as a result of large adverse shocks, [especially if government debt is high](#).

This debate could not be more timely, in the context of the economic fallout of the COVID-19 pandemic: countries have increased, and will likely continue to increase, government expenditures to deal with the health emergency, mitigate the economic collapse, and accelerate the recovery. Whether fiscal expansions will

deliver the intended objectives boils down to the extent to which they are able to boost GDP, the relationship captured by the concept of fiscal multiplier. This multiplier represents a measure of the effect of increases in fiscal spending on a country's economic output and is defined as the ratio between the change in GDP and the change in government spending.

A [recent IMF study](#) using data from 10 euro area countries finds that the level of $r - g$ affects the size of the government spending multiplier. According to textbook macroeconomics, at every point in time, the debt stock will grow by the existing debt stock multiplied by $r - g$, net of the primary budget balance (with debt and the primary balance expressed as fractions of GDP). Although [a negative \$r - g\$ does not guarantee debt sustainability](#), government debt will tend to fall when $r - g$ is negative and will tend to grow when $r - g$ is positive. In addition, the higher $r - g$, the higher the future primary budget balance a government will need to stabilize its debt, a theoretical prediction confirmed by euro area data (Figure 1). Forward-looking private agents will incorporate this mechanism into their expectations and increase their savings.

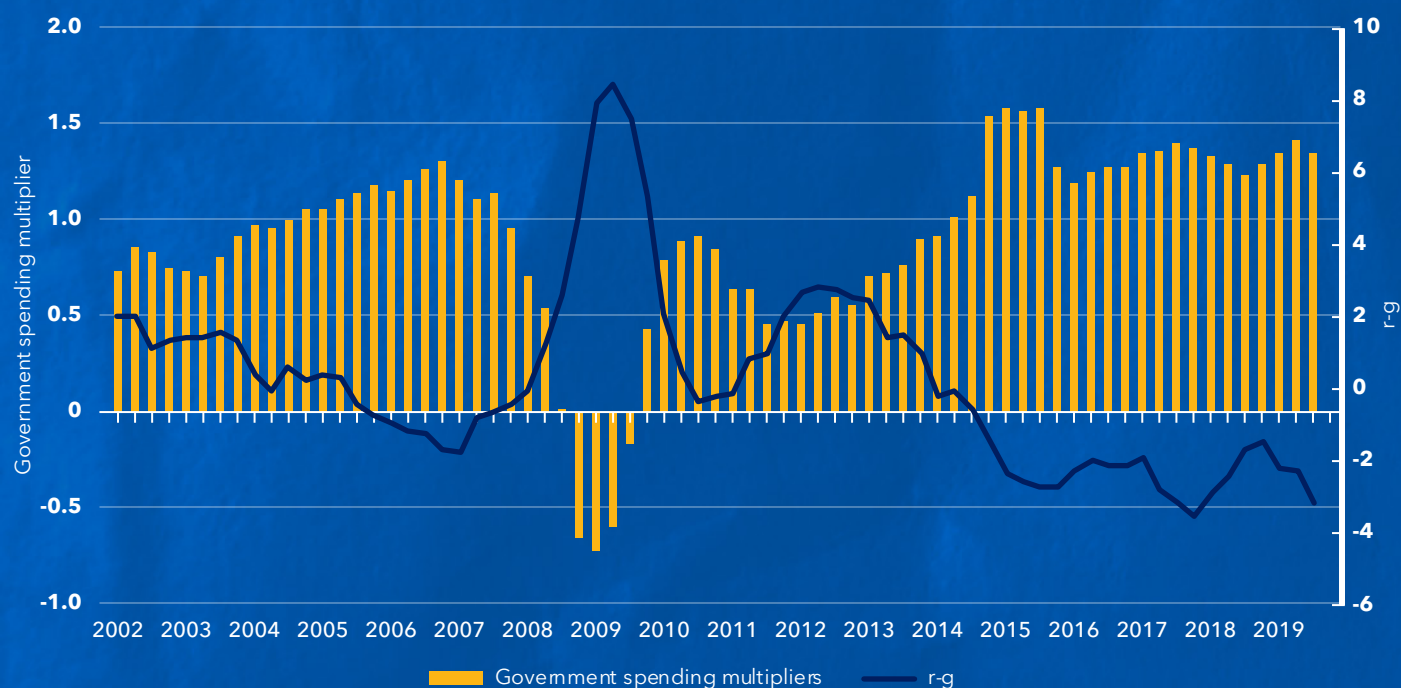
Figure 1. Dynamic Correlations between $r - g$ and Cyclically Adjusted Primary Balances in the Euro Area



Sources: IMF, Fiscal Monitor database; [Di Serio, Fragetta, and Melina \(2021\)](#); and Refinitiv Datastream.

Note: The figure reports dynamic correlations between $r - g$ at time t and the IMF's cyclically adjusted primary balance (fraction to potential GDP) at time $t + h$, with $h = 0, 1, \dots, 5$. In each box, the horizontal line (x) represents the median (average) correlation across 10 euro area countries (Austria, Belgium, Finland, France, Germany, Ireland, Italy, The Netherlands, Portugal, Spain); the upper and lower edges of each box represent the top and bottom quartiles of the correlations, respectively; and the top and bottom whiskers denote the maximum and minimum correlation, respectively. CAPB = cyclically adjusted primary balance; corr = correlation.

Figure 2. Historical Evolution of Cumulated Five-Year Government Spending Multipliers in the Euro Area



Source: [Di Serio, Fragetta, and Melina \(2021\)](#).

Note: Multipliers are computed conditional on the economy being in a given quarter at the time of the government spending shock. $r - g$ is computed as a weighted average of national values of 10 euro area countries (Austria, Belgium, Finland, France, Germany, Ireland, Italy, The Netherlands, Portugal, Spain), using national GDP as weights.

This behavior affects the size of the government spending multiplier, which is inversely correlated with the level of $r - g$ (Figure 2). Statistical tests reveal that in the negative $r - g$ regime, the multiplier is larger than in the positive $r - g$ regime with high probability. The difference in the multipliers across the two regimes increases at time horizons beyond the first year. Over the medium term (five years), median cumulated multipliers range between 1.22 and 1.77 when $r - g$ is negative and between 0.51 and 1.26 when $r - g$ is positive. To put this in perspective, if euro area governments had spent €100 in the early 2000s, when $r - g$ was positive, this would have generated an average increase in GDP of €86. Spending the same €100 in the late 2010s would have generated an average increase in GDP of €150—almost twice as much.

These findings carry important policy implications, especially in the context of the [EU Recovery Plan](#), which is leading to ambitious government spending programs in member countries. With GDP growth expected to resume, insofar as interest rates remain low, the resulting $r - g$ should promote relatively high government spending multipliers. However, this scenario may be reversed, and multipliers may become significantly more modest, if adverse shocks keep $r - g$ significantly above zero in large member countries. For example, during the global financial crisis, $r - g$ spiked in the euro area and then remained positive for several years. In such circumstances, it is even more important that fiscal spending prioritize what is most productive. This policy has a high chance of maximizing the growth impact directly, but also indirectly by curbing $r - g$ and the expectations of necessary future fiscal adjustments.



What drives
**INNO-
VATION** ?

Lessons from
COVID-19
Research and
Development

RPSP2021



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The **COVID-19** pandemic is one of the greatest challenges ever faced by modern medicine. When China publicly shared the genetic sequence of the novel coronavirus on January 12, 2020, scientists quickly began working on vaccines and treatments to fight SARS-CoV-2. The odds for quick success looked dim. On the vaccine front, the fastest any vaccine had previously been developed was in four years—for mumps in the 1960s—and thus even predictions of success by summer 2021 seemed highly optimistic. On the treatment front, limited progress had been made on the other known coronaviruses that cause disease in humans despite decades of research.

The scientific community responded with a massive research and development (R&D) effort. By December 2020, several vaccine candidates had excellent results in large trials, with two (developed by Pfizer/BionTech and Moderna) receiving emergency use authorization in several countries. Researchers had also identified various treatments that could modestly reduce mortality. While major challenges [remain](#) in scaling up the production and distribution of vaccines and tackling the new virus strains, the pharmaceutical innovation response to COVID-19 has already turned out to be an unprecedented success in terms of product discovery and development.

The COVID-19 experience demonstrates that drug development can potentially proceed rapidly—without compromising safety—when there is a global emergency and there are sufficient resources available for R&D. This raises the question, What lessons can we draw from the response to COVID-19 about the drivers of innovation, and how can it inform the global effort to scale up the fight against other deadly diseases and other challenges, such as climate change?

Recent IMF [research](#) sheds light on this question by examining how the entire landscape of clinical trials changed

in response to the large discrete shift in global medical needs—and thus the market size for pharmaceutical products—brought about by COVID-19. Four key takeaways emerge.

First, R&D efforts typically do not increase one to one as a disease becomes “bigger.” The cross-sectional relationship between the market size of a disease (measured as the disease-level mortality risk at the national level weighted by national income levels) and R&D effort (measured as new clinical trials) is established by matching data on worldwide clinical trials to 75 broad disease categories with a non-negligible death burden. The estimated elasticity—how much R&D effort increases when market size increases—is strictly less than 1 (about 0.5) across all disease categories and also within subcategories (such as cancer or infectious diseases). Put simply, R&D effort put into fighting a disease increases less than the market size of that disease. We call this relationship the “law of diminishing effort.”

Second, the R&D response to COVID-19 is a major exception to this law: the number of COVID-19 trials is 7 to 20 times greater than what is implied by the historical relationship between market size and R&D effort.

Third, the R&D response to COVID-19 suggests that global innovation can be scaled up rapidly and sizably. That is, even in the short term, the aggregate supply elasticity of science and innovation can be very large. In the initial months of the pandemic, up to 50 percent of new trials were directed toward COVID-19. And, despite the large increase in COVID-19 R&D, overall new clinical trials rose by 38 percent in 2020, with little crowding out of R&D effort for other diseases.

Fourth, public research institutions were a key driver of the COVID-19 R&D effort—accounting for 70 percent of all COVID-19 clinical trials globally. These public institutions were 10 percentage points more likely to conduct a COVID-19 trial than private firms. In addition, US and Chinese vaccine candidates were on average developed two months faster than candidates from other countries. This crucial boost in speed may have resulted from more early-stage incentives from the policy response in these countries, including through programs such as Operation Warp Speed in the United States that funded clinical trials and manufacturing capacity for various vaccine candidates. Last but not least, several important COVID-19 pharmaceutical innovations were driven by public research institutions with no explicit monetary incentives—suggesting the role of intrinsic motivation and altruism among researchers. For instance, several key treatment findings came from university labs during publicly funded clinical trials—with no obvious monetary benefits (for example, the National Institute of Health Research funded a clinical trial on dexamethasone).

This research hopes to inform ongoing work in innovation economics. Even after six decades of active research since a seminal 1960 National Bureau of Economic Research [conference](#), The Rate and Direction of Inventive Activity, many notable questions in innovation economics remain open. In this context, there are three broad implications for the future of innovation economics.

Market size alone may not suffice

Simply boosting the market size of pharmaceutical products (for example, through commitments to pay more for successful innovations) may not effectively scale up innovation to fight major diseases—given the law of diminishing effort. The diminishing effort effect blunts the effectiveness of the classic market size incentives favored in economics. The law of diminishing effort could arise because of various mechanisms, such as (1) decreasing returns to scale as a result of a scarcity of ideas or talent, (2) risk aversion among firms’ management, and (3) disease-specific ex post taxation (what we call the “paradox of market size”). Future research should investigate the relative importance of these mechanisms and examine whether these factors lead to market inefficiencies.

Public sector helps the invisible hand

Public research institutions, government-led incentives, and nonmonetary incentives drive innovation. Current thinking in the economics profession is still dominated by a perspective that innovation is driven by private sector market-size factors. Consistent with a widespread belief in the economics profession and among policymakers, enhancing market size has been seen as key to accelerated COVID-19 innovation. For instance, in a [survey](#) of prominent economists conducted by the University of Chicago Initiative on Global Markets on June 23, 2020, the questions were focused on how much acceleration in COVID-19 innovation could be achieved by enhancing the market size; meanwhile early-stage incentives and the role of the public sector were not even considered.

The COVID-19 experience invites us to rethink the role of public research institutions and the catalyzing role of governments in promoting innovation for the greater good. Various factors played a role in the innovation success—including an intrinsic pursuit of the

greater good by many in the global scientific community, past experience with related virus pathogens, and better manufacturing technology—but government-led incentives and funding played an important role in the success story.

Scope to significantly scale up global innovation

The rapid and large R&D response to COVID-19 raises the distinct possibility of scaling up global innovation to fight future challenges—including other deadly diseases and climate change. However, scaling up global innovation may require a more active role by governments in providing early-stage R&D incentives. Policymakers may also need to gain better understanding and eliminate barriers that currently prevent researchers from harnessing their intrinsic motivation to scale up research during normal times. Such measures are likely to be complementary to other efforts to advance the global knowledge frontier, such as policy [measures](#) to increase the quality of human capital.

Economists are naturally in favor of market size as a driving force for innovation. (“If the market size of the product is sufficiently large, then innovation will happen.”) This research suggests, however, that enhancing market size alone may not be an effective pull when it comes to driving innovation in the face of large challenges. Policymakers may want to complement the market size effect with early-stage incentives and by harnessing the power of public research institutions and nonmonetary incentives.



UNDERSTANDING Lifelong Mortality



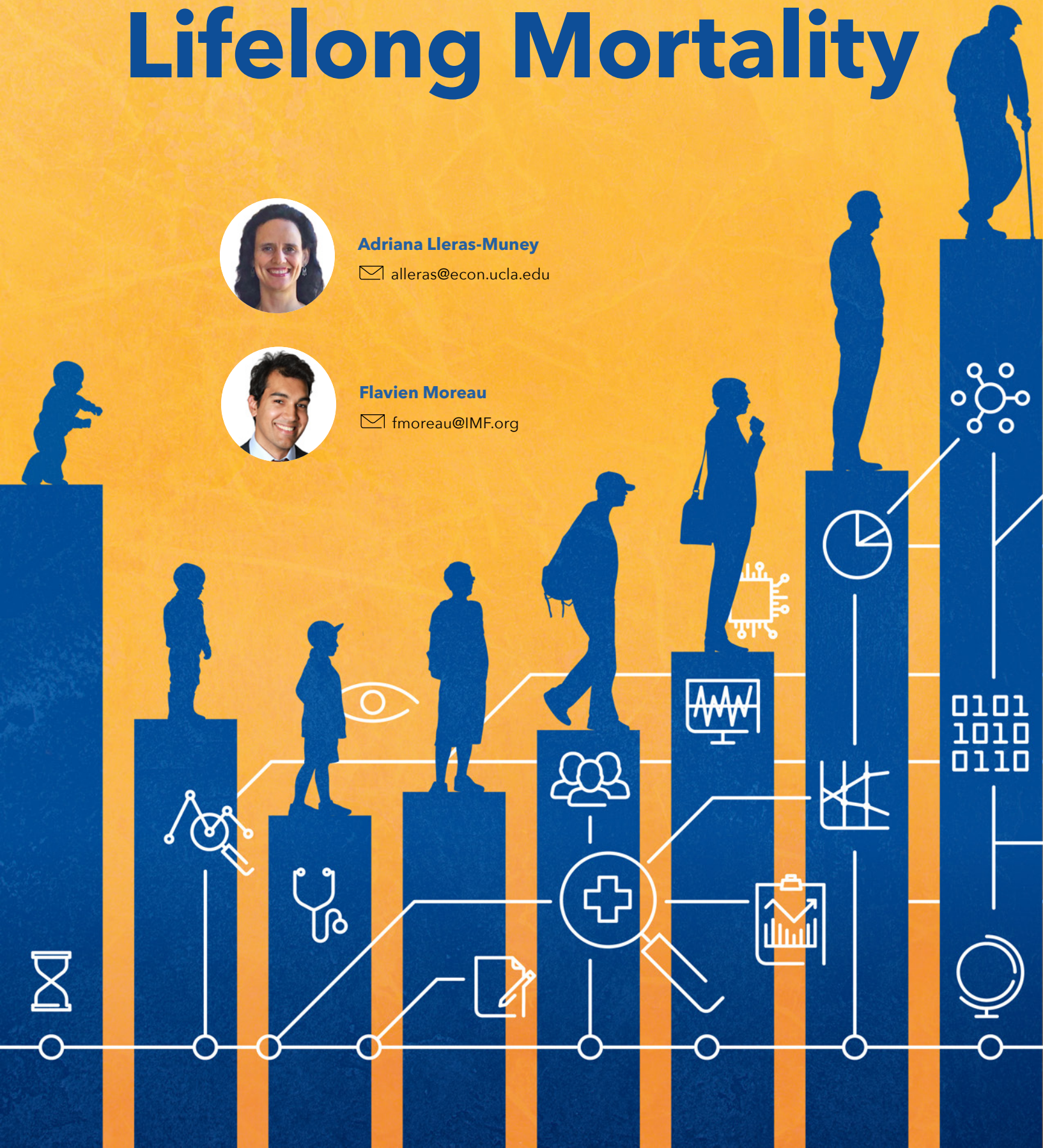
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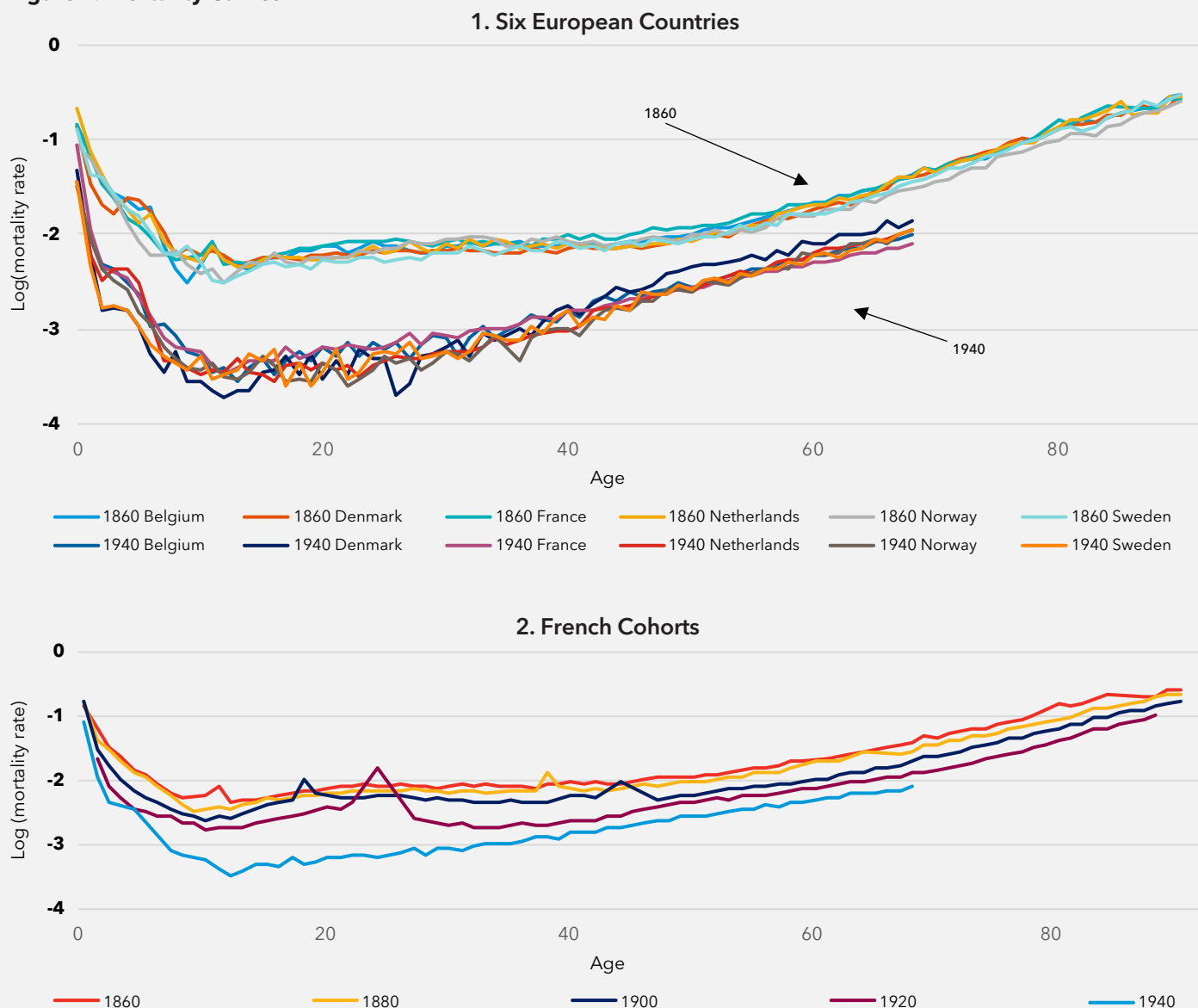


The COVID-19 crisis has demonstrated the importance of health policies for our economies. In fact, as declared by the IMF’s managing director during the 2021 Spring Meetings, “[vaccine policy is economic policy.](#)” Economists have responded by integrating epidemiological insights to shed light on macroeconomic dynamics. Yet little is known about the deeper and long-lasting impact of COVID-19 on populations: what will be the long-term effects on mortality and on socioeconomic inequality? There are no easy answers to these questions, which are nonetheless crucial inputs to many economic

models. In order to make progress, [a recent IMF working paper](#) proposes a simple health model that tracks lifetime cohort mortality rates. This model allows exploration of a variety of phenomena studied in the empirical literature and shows how shocks affect population health at various ages. We start with a simple observation: mortality has a strikingly regular shape like a check mark—high at birth, low during youth, and high and rising almost linearly with age in late adulthood. Figure 1 shows this pattern for selected cohorts of women born between 1860 and 1940 for various European

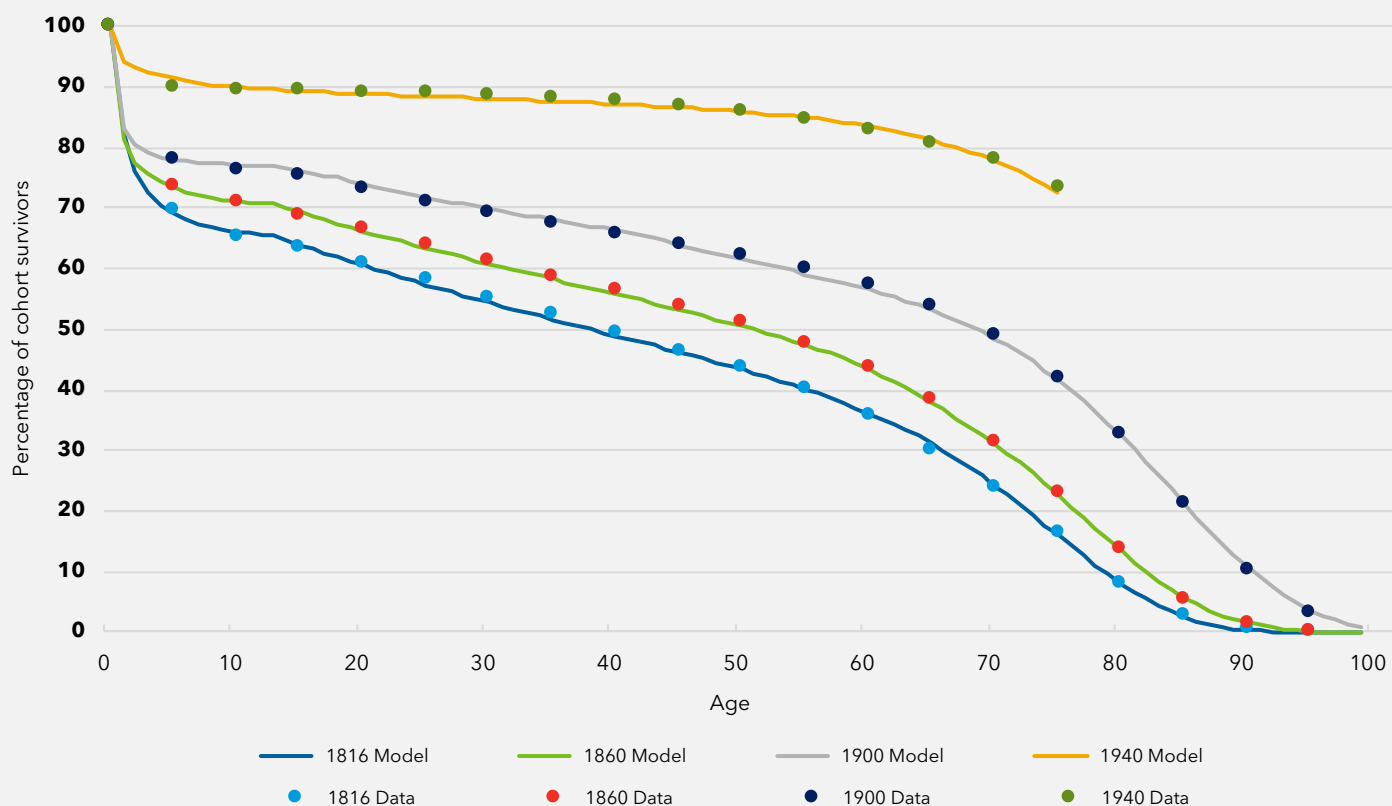
countries—Belgium, Denmark, France, The Netherlands, Norway, and Sweden—(panel 1) and for France alone (panel 2). Although the level of mortality has changed substantially over time, the evolution of mortality rates by age is very similar across many countries and over time (these patterns are similar though not identical for men). Mortality curves also display an “adolescent hump,” especially [visible in cohorts born in the 19th century](#). Maternal mortality, as well as hormonal and other changes associated with the transition to adulthood are thought to explain this [adolescent hump](#).

Figure 1. Mortality Curves



Sources: [Human Mortality Database](#); authors’ calculations.

Figure 2. Observed and Estimated Cohort Survival Rates



Sources: [Human Mortality Database](#); authors' calculations.

A simple model of the health distribution of a population accounts for these stylized facts on mortality. In the model, people are born with an initial health level that evolves not only as a result of natural aging but also in response to environmental shocks and investments. People die when their health level falls below a certain threshold.

Rising life expectancy

The model is able to track the evolution of the mortality profiles for all the individual cohorts since 1816. Survival curves over that period have become more rectangular, which mirrors mortality curves and denotes the fraction of a cohort that survives a given age. This pattern has accelerated over the decades (Figure 2). Survival to age 1 has increased dramatically. The section of the survival curve from age 1 to age 60 has flattened considerably. In addition, a steep downward slope has emerged among the oldest.

What are the sources of these increases in longevity? Starting in the 1830s, there was a constant and rather dramatic decline in external causes of death, consistent with the elimination of maternal mortality—a [major cause of death among women](#) of childbearing age in the past—and a steep decline in violent deaths. Health at birth starts to [increase steadily at the end of the 19th century](#), consistent with the timing of [improvements in access to water and sanitation](#) and a sharp decline in epidemic and infectious disease mortality, which greatly reduced the number of infant deaths.

Disruption by major events

Of course, not all deaths have direct biological causes. Many deaths, like accidents and homicides, strike individuals regardless of their health status. And sometimes these events are correlated as a result of large

environmental shocks, such as wars, that affect entire cohorts. Wars not only lead to spikes in mortality (see, for instance, the sharp rise in mortality around age 25 for the 1920 cohort in Figure 1, panel 2) but also have [long-lasting detrimental health effects among survivors](#). Such “scarring” effects have been [documented in at least 13 European countries](#) after World War II. Compared with less exposed survivors, those who were more exposed to the war [experienced worse economic and health outcomes several decades later](#). The model can rationalize such scarring effects and estimates that World War I lowered life expectancy by approximately 16 years for the male 1896 cohort, and World War II lowered it by another 2 years. Alarmingly, [detrimental events in utero](#) (from war, famine, stress, and so forth) can result in large and persistent declines in health visible in infancy and old age and in elevated

mortality among survivors. Perhaps surprisingly, the [empirical literature](#) finds that the effects of various shocks appear to fade initially only to reappear later in life. Our model predicts this exact U-shaped pattern.

By comparison, extreme weather or pollution events can lead to a sudden increase in the number of deaths, followed by abnormally low mortality. Simulated effects of a temporary increase in the health threshold at age 60 results in very high mortality the year of the shock. But mortality starts to drop before the shock ends because the frailest already died in the first phase of the shock. Once the threshold is restored to its original (lower) level, mortality falls substantially because there are very few individuals left close to this level. This holds true for a long time until the aging process naturally brings a portion of the population closer to the threshold. Known in demography as “harvesting,” this phenomenon was, for instance, [documented in France during the 2003 heat wave](#).

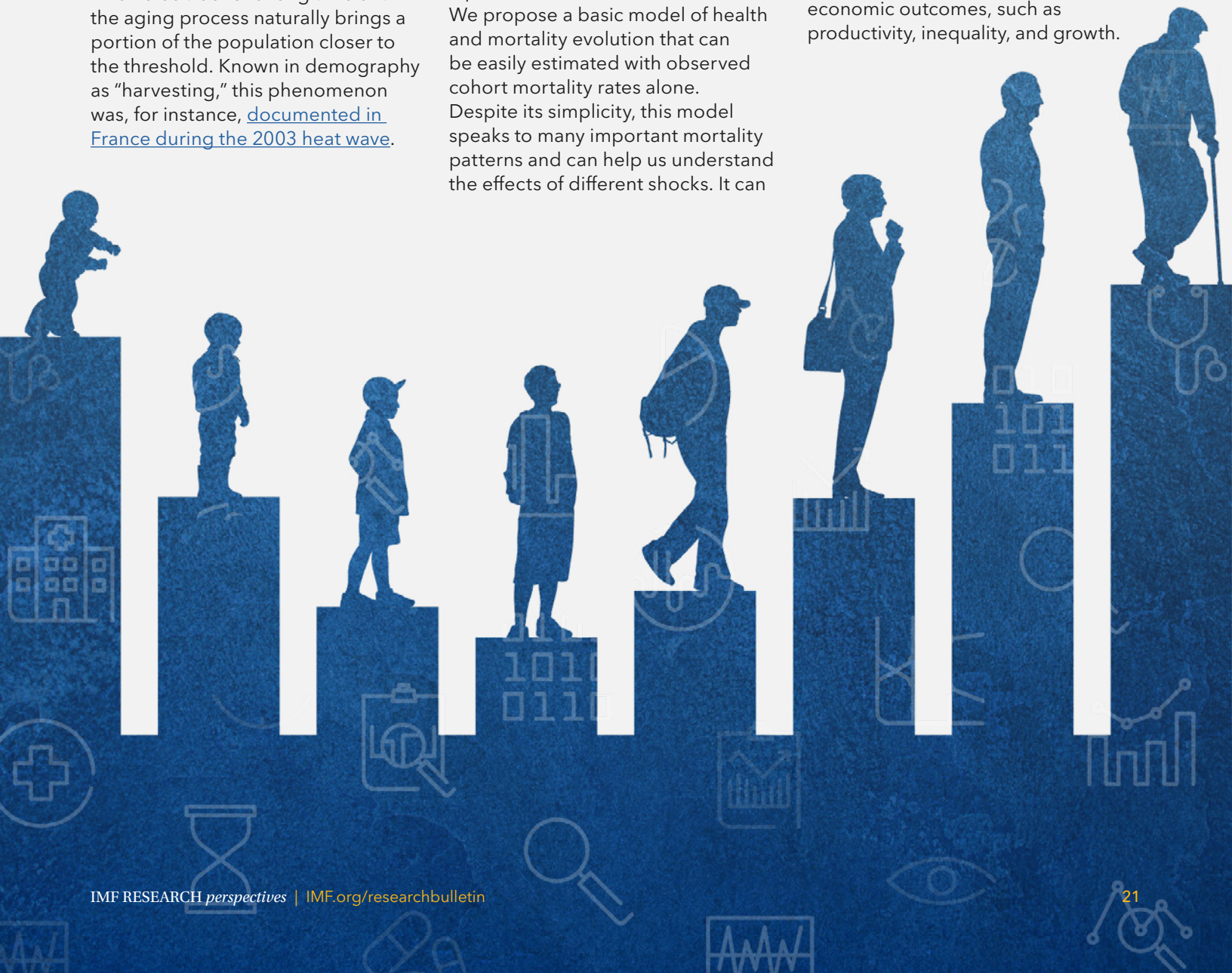
Socioeconomic factors

Large and persistent gaps in mortality and health across individuals open up during adulthood. These gaps result in large life expectancy differences [associated with different socioeconomic status](#), such as education, income, occupation, and race. We study such differences in our model by simulating what happens when a population is subject to persistent smaller investments in health and find that they give rise to gaps in mortality [similar to the empirical pattern documented in US data](#).

Concluding remarks

Health and mortality are important inputs for economic models. We propose a basic model of health and mortality evolution that can be easily estimated with observed cohort mortality rates alone. Despite its simplicity, this model speaks to many important mortality patterns and can help us understand the effects of different shocks. It can

also be expanded to consider the role of behavior and policy. For instance, in the absence of financial frictions, optimal health expenditures are U-shaped over a person’s lifetime. With systematic data on health inputs and shocks, as well as prices and budgets over the course of a life, these implications could be fruitfully further explored. The model can be used to investigate other questions, such as socioeconomic and gender differences as well as the long-term impact of COVID-19. For example, it may not be possible to identify the effects of in utero shocks with health data for adolescents or young adults alone, and it may take decades before the true toll of the pandemic surfaces in mortality data. In the meantime, model-based forecasts could shed light on potential economic outcomes, such as productivity, inequality, and growth.





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