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Emmanuel Farhi
In Memoriam

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Emmanuel Farhi, Economist Par Excellence

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Abstract

Undoubtedly one of the best economists of his generation, Emmanuel Farhi transformed the theories of taxation, macroeconomics, and international finance. This essay describes his itinerary and his research style and attempts to pay tribute to his immense contribution to economics.

1. THE SCHOLAR

Undoubtedly one of the best economists of his generation and on the Nobel track, Emmanuel Farhi was born on September 8, 1978, in Paris. Ranked first at the age of 16 in the French high school competition in physics, he could have become a physicist. The assistant of Cédric Villani, 2010 Fields medalist, he could have become a top mathematician himself. I could have equally envisioned him a startupper or a top civil servant; indeed, he long hesitated to continue his career within the Corps des mines, the elite French civil-service corps. But reading Paul Samuelson's text convinced him that economic ideas are an alternative route to making this world a better place, and so he opted to study for an economics PhD at MIT after his studies at Lycée Louis-le-Grand and École Normale Supérieure. He wrote his thesis under the supervision of Ivan Werning and Ricardo Caballero. He was a faculty in the Department of Economics at Harvard University from 2006 through 2020, receiving tenure only five years after his PhD.

His scientific approach is characterized by five traits. First, Emmanuel was unabashed about being a theorist. While he welcomed the data revolution, he believed in the power of ideas. And the realm of ideas was his kingdom. He felt that, while facts are important, they need a framework to become compelling. Theory further supplies the normative structure, which enables the move to policy recommendations, which were central to his career choice. In this respect, as in many others, Emmanuel was the worthy heir of the founders of the Econometric Society: When in 1930 the likes of Irving Fisher, Ragnar Frisch, Joseph Schumpeter, François Divisia, René Roy, Harold Hotelling, and John Maynard Keynes founded the society, they aimed at unifying theoretical and empirical approaches and at "creating a society for the advancement of economic theory in its relation to statistics and mathematics."[1]

Second, although Emmanuel Farhi loved mathematics and was as proficient at it as any in the profession, he was not blinded by the tool. The elegance of his models was at the service of making ideas accessible, not of demonstrating technical prowess.

The third permanent trait was doubt, the DNA behind his research. He was distrustful of fads, certainties, and preachers. He wanted to avoid the mistakes of the true believers. He was agnostic and let his science take him wherever it would lead, perhaps in unexpected directions. As a macroeconomist, his work can probably be best described as Keynesian, although he did not really care about labels. Again, he was wary of falling into the trap of thought-hindering prior beliefs, and he wanted to unveil the conditions of validity of Keynesian economics as well as its limits. His pathbreaking work made explicit the microeconomic imperfections at the root of macroeconomic failure, so as to build a normative analysis and thus formulate economic policy recommendations.

Fourth, Emmanuel Farhi was enthusiastic about engaging with historical debates on important and enduring questions. Discussions with him were filled with fascinating remarks about Quesnay's tableau économique, Keynes's paradox of thrift, the 1960s' Cambridge (UK)–Cambridge (US) controversy, Mundell's trilemma, or the Triffin dilemma. These historical insights, many of which had not found a proper formalization or whose implications were underexplored, resurfaced in his research work.

The fifth trait capturing Emmanuel Farhi's research is patience. In an interview given in April 2020, and taking his recent work on value chains with David Baqaee as an illustration, he emphasized that good research requires a sustained effort (he invited the French journalist to a rendezvous in a few years), and that communicating this research calls for being transparent on empirical uncertainty and candid about the limits of our theoretical understanding.

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[1] The original memo, written by Irving Fisher, Ragnar Frisch, and Charles Roos, can be found at **http://dev.econometricsociety.org/sites/default/files/historical/OriginalAnnouncement29%2011%2030.pdf**.

Emmanuel Farhi felt that he had chosen a wonderful occupation; he loved his work, his colleagues, and his students. Yet, he thought we could do better collectively: take better care of students and junior faculty, be less competitive, listen more to others, show more respect and interest for those who work in different fields and with different approaches, and restrain from using the media and blogs to arouse interest in one's work prior to peer validation. It is true that our desire for recognition, which is human and a key motivator for accomplishment, sometimes grows into narcissism and distracts us from what we are meant to serve—science. We are all aware of our individual and collective shortcomings, but Emmanuel Farhi was more mindful than most of us about the need to strike the right balance between self-interest and other-regarding behavior. With his meritocratic upbringing, he valued hard work and expressed outrage at the little arrangements and self-promotions that plague any profession, including ours.

Those reflections about our scientific duties, which he shared amicably with his friends over dinner, were not meant to take the high moral ground; that was definitely not his style. Most importantly, he implemented his standards as a colleague and a transmitter of knowledge. He could talk enthusiastically about his own work without ever overselling it, and only after listening to the research of colleagues, especially students and junior faculty. Nicolas Werquin, a young researcher at the Toulouse School of Economics (TSE), accurately summed him up: "Emmanuel was a real role model for me. I of course admired his extraordinary intelligence and his depth of mind whenever we talked about research, but also the attention he paid to young researchers, his humility, generosity and kindness" (N. Werquin, personal communication). Emmanuel could have been more than full of himself; instead, he always remained modestly attentive to others.

Emmanuel Farhi never stayed in his ivory tower. A member of the French Government's Conseil d'Analyse Économique from 2010, he was involved in French intellectual life. A few hours before his death, he took part in a meeting of the French president's expert commission on major economic challenges, which Olivier Blanchard and I have the honor of chairing. His intellectual qualities and his always well-argued dialogue made him a much sought-after advisor to public decision makers, central banks, and other institutions in France and beyond. He actively advised the Banque de France, which awarded him a prize in 2013.

Emmanuel remained very close to France, where he returned as often as he could. He appreciated his home country's culture and art of living. A lover of French poetry and literature, he was sociable and full of humor. A pure product of the French meritocratic republican school, he was also committed to the scientific life of his country. He came to Toulouse and to Paris several times a year, sharing his passion for economics with young researchers and students. He sat for a long time on TSE's scientific council and was a member of its board of directors. He organized numerous conferences in France and in Europe.

2. CONTRIBUTIONS

Emmanuel Farhi transformed the theory of taxation, macroeconomics, and international finance. His range of interests also included behavioral economics, and even industrial organization. I cannot do justice to the breadth of his contributions (for one thing he was incredibly prolific), and this selection will unavoidably miss important material; but I can highlight a few elements. Being more knowledgeable about it, I will also put definitely much more emphasis on our joint work than is warranted (see Section 3).

2.1. Global Imbalances

An important article with Ricardo Caballero and Pierre-Olivier Gourinchas, originating in a chapter of Emmanuel Farhi's 2006 PhD thesis and subsequently published in 2008 as "An Equilibrium

Model of 'Global Imbalances' and Low Interest Rates," conceptualized the consequences of global financial imbalances generated by a shortage of stores of value (Caballero et al. 2008). Farhi and coauthors developed a simple framework with two countries that differ along two dimensions: their rate of economic growth and the level of financial development, measured by the degree to which capital income can be pledged (itself determined by legal framework, taxation, corporate governance, or overall trust in management). Countries with low levels of financial development and high growth rates—the "South"—have a high demand for stores of value but a low supply. Under autarky, asset prices in the South would be high, and, equivalently, the interest rate would be low. Countries with high levels of financial development and low growth rates—the "North"—have a low demand for stores of value but a high supply. Under autarky, asset prices in the North would be low, and, equivalently, the interest rate would be high. Under financial integration, comparative advantage implies that capital flows from the low-financial-development/high-growth countries to the high-financial-development/low-growth ones to equate global returns. This mechanism results in global imbalances: current account deficits in the North and surpluses in the South. The model provided an insightful and timely analysis of the joint pattern of current account balances, interest rates, and external debt between the United States and the rest of the world.

More recently, the three authors revisited the global imbalance question in an article titled "Global Imbalances and Policy Wars at the Zero Lower Bound" (Caballero et al. 2021). As the desired demand for stores of value increases, the global interest rate reaches a zero lower bound (ZLB)—or, more generally, the effective lower bound (ELB), since the rate at which monetary policy loses effectiveness need not be 0—due to constraints on nominal interest rates and price rigidities. The authors describe how the ZLB constitutes a tipping point for the global economy. Above the ZLB, capital flows are benign. They reallocate the excess demand for stores of value but do not affect economic activity. At the ZLB, the excess demand for stores of value creates a global recession, a version of Keynes's paradox of thrift. Moreover, by running a current account surplus, a country can export its recession onto its trading partners. The model offers sharp and provocative insights: Once at the ZLB, countries have a strong incentive to either depreciate their currency relative to their partners (currency wars) or enact unilateral tariffs (trade wars). Both policies do little to address the underlying problem—the scarcity of stores of value—but redirect a deficient global demand toward domestic producers. Unlike these zero-sum policies, fiscal policy and public debt issuance in any country are globally helpful as they help offset the underlying global shortage of assets.

These papers focus mostly on a general shortage of stores of value, regardless of their risk characteristics. Farhi and coauthors argued that the scarcity is particularly acute for safe assets whose defining characteristic is their resilience to adverse systemic events.

In "The Safety Trap," Emmanuel Farhi and Ricardo Caballero, in a framework including in particular very risk-averse agents, argue that a shortage of safe assets has very different implications once the economy hits the ZLB (Caballero & Farhi 2017). The shortage first leads to a benign reduction in the riskless interest rate until the latter can no longer fall, at which point the equilibrating mechanism becomes a reduction in output and a recession. As in the work on global imbalances discussed above, the sudden stop of the interest rate adjustment triggers a quantity adjustment and has an adverse impact on economic activity.

Safe assets constitute the cornerstone of the global financial system. Few advanced countries, such as the United States, or private actors, such as some of the highest-rated financial institutions, are able to issue safe assets. In the last decades, the supply of these safe assets (mostly from the United States) has not kept up with the high demand originating from emerging economies (in particular China) and their central banks. This resulted in a dramatic increase in the last

20 years in the price of these safe assets (a decline in their yields) relative to more risky assets (an increase in risk premia), and it generated strong incentives for the private sector to manufacture "private-label" safe assets. This safe asset imbalance was a harbinger of the 2008 crisis, as the increase in securitization—creating supposedly safe assets through tranching—contributed to the real estate boom in the United States. Farhi and coauthors argued that the crisis and its aftermath exacerbated these trends: Fiscal fragility in the Eurozone reduced the global supply of public safe assets, while most private-label safe assets were recategorized as risky. Moreover, prudential regulation reforms further increased the demand for safe assets from financial institutions subject to new liquidity requirements.

This global imbalance in safe assets makes the global financial and monetary system particularly vulnerable. A widely influential report, written for the French Council of Economic Advisers with Pierre-Olivier Gourinchas and Hélène Rey in 2011, revisits Robert Triffin's classic dilemma (Farhi et al. 2011).[2] Triffin noted a tension between the rapidly growing global demand for dollar holdings and the constant US stock of gold (recall that the gold standard was in effect until 1971, with the dollar pegged in terms of gold at the official exchange rate of $35 per ounce). The US monetary authorities could either tighten dollar supplies—so as to keep the dollar-gold parity stable, as envisioned by the 1944 Bretton Woods agreement—at the risk of a domestic and global recession or would soon be forced to let go of the gold peg. Farhi and coauthors observed that the United States may be facing a modern version of the Triffin dilemma, with a growing demand for US-issued safe assets (mostly US Treasuries) but a limited fiscal capacity. Their report discussed ways to increase the global supply of safe assets by pooling resources, using swap lines more systematically, or encouraging the emergence of alternative safe assets from large and fiscally sound economies.

Emmanuel Farhi's insatiable curiosity led him to explore the foundations of international finance more systematically. His article with Matteo Maggiori, "A Model of the International Monetary System," focused on a world in which risk-free assets, as we have seen one of Farhi's favorite themes, are provided by one or more reserve countries (Farhi & Maggiori 2018). Imagine that a country—say, the United States, whose debt has long served as a reserve asset—caters to an investment demand from investors across the rest of the world. Being the sole provider of that reserve asset, the United States can charge a markup and run a trade deficit. However, if the debt held by the rest of the world is too large, there is a risk of sovereign default.[3] This, in turn, undermines confidence in its currency: a "Triffin" moment. But if the dominant currency does not provide that liquidity, it may be overtaken by another country that will compete away the reserve currency rent. Farhi & Maggiori analyzed the possibility that a multipolar world—one with multiple reserve currencies—could be more unstable than a world with a single reserve currency, reconciling the Keynesian stance with that of financial stability.

Some of the ingredients of Farhi & Maggiori's framework are taken off the shelf, in particular the Calvo/Cole–Kehoe model of self-fulfilling sovereign crises (Calvo 1988, Cole & Kehoe 2000). A reserve country issues a safe bond, for which there is a demand by risk-averse investors in the rest of the world. As posited by Calvo (1988), the country may later on default at a cost, possibly destroying the reserve value of the bond. As discussed earlier, a higher level of borrowing triggers a higher risk of (endogenous) default: This is the Triffin dilemma. A monopoly issuer may produce too much of the reserve asset: It tends to produce too little because of the standard monopoly distortion, but it may also produce too much of the reserve asset in the absence of commitment

[2] Robert Triffin exposed this fundamental problem in the international monetary system while testifying before the US Congress in 1960.

[3] Actually, default does not take the form of a formal repudiation or restructuring in the article, but rather the debt is inflated away; but the outcome is the same.

(as default implies a welfare loss for the inframarginal investors).[4] Farhi & Maggiori (2018) also present an interesting extension to the case of a ZLB.

Finally, let us point at Emmanuel Farhi's work on rare disasters and exchange rates with Xavier Gabaix, which is one of the most interesting applications of Rietz's (1988) and Barro's (2006) idea that the possibility of rare but extreme disasters is an important determinant of risk premia in asset markets. Farhi & Gabaix (2016) built a clean model delivering many insights into exchange rate dynamics.

2.2. Public Finance and Inequality

Together with Ivan Werning, Emmanuel Farhi investigated a number of dynamic public finance issues, such as the inheritance tax and the wealth tax,[5] that later became topical in the political arena.

Farhi & Werning (2010) laid down the foundations for a progressive taxation of wealth and capital with the aim of building a reasoned debate on a very sensitive subject. The first sentence of the article says it all: "One of the biggest risks in life is the family you are born into" (Farhi & Werning 2010, p. 635). The article improved our understanding of the dual role of taxation as a redistributive tool (from the richer to the poorer) and as social insurance (from the active to the unemployed, for example) that is made necessary by the heterogeneity of individual trajectories.

Consider the following simple economy: Parents live during the first period. In the second period, they are replaced by their children. Parents are altruistic toward their children; they work, consume, and bequeath. To analyze welfare in such an economy, one must consider not a single fictitious dynastic agent, but rather a convex combination of the utilities of parents and children. Farhi & Werning take a veil-of-ignorance approach, combine Mirrleesian income tax with a bequest tax, and derive the Pareto frontier. The intuition is that the planner should promote some equal opportunity; as Farhi & Werning (2010, p. 636) say, "luck is only imperfectly inherited" at the optimum. They show that the estate tax should be progressive. In that world, bequests should be subsidized—as a subsidy encourages the provision of an externality, bequests, which improves the welfare of newborns—but if this is infeasible, the estate tax should be equal to zero up to a threshold and progressive thereafter. Regardless, progressivity will promote equal opportunity. This analysis (as well as a couple of extensions) is extremely illuminating.

Farhi & Werning's (2012) article titled "Capital Taxation: Quantitative Explorations of the Inverse Euler Equation" evaluated the benefit of a tax on capital. In the standard Mirrlees (1971) model of labor taxation, taxing capital is suboptimal—this is Atkinson & Stiglitz's (1976) idea that capital taxation distorts the savings decision and encourages current consumption over investment. By contrast, in a dynamic economy with unforeseen future individual productivity (disability, illness, stranded skills), a positive capital tax is optimal [as was shown in a two-period framework by Diamond & Mirrlees (1977) and Rogerson (1985)]. As shown elegantly in the article, this results from the no-capital-tax allocation satisfying the Euler equation, while the social optimum (subject to Mirrleesian nonobservability of individual productivity) satisfies the inverse Euler equation. The two coincide when there is no uncertainty (and so capital should not be taxed), but not under uncertainty. Jensen's inequality delivers the positive capital tax rate. The key contribution of the

[4]Industrial organization–oriented readers will here draw an interesting analogy with Spence's (1975) choice of quality by a monopolist.

[5]Farhi's (2010) job market paper titled "Capital Taxation and Ownership when Markets Are Incomplete" was the starting point of his work on capital taxation. That paper looked at a representative-agent economy with linear taxes on labor and capital. Financial markets are incomplete, and the government can avail itself of few instruments, so the complete-markets Ramsey outcome is not attainable. Farhi used calibration to show that optimal capital taxes are highly volatile in such circumstances.

article is to develop the analysis in a multi-period context and to compute the welfare gain from introducing an optimal capital tax (relative to no tax at all). Their calibration found that general equilibrium effects (when the accumulation technology is concave) make the gains from capital taxation much smaller than suggested by partial equilibrium calculations (in which the pretax rate of interest is exogenous, i.e., the technology is linear).

In the same year, Emmanuel Farhi and Ivan Werning, together with Christopher Sleet and Sevin Yeltekin, published "Nonlinear Capital Taxation Without Commitment" (Farhi et al. 2012). Policies are chosen sequentially over time, without commitment. Again, Atkinson & Stiglitz's (1976) optimality of absence of wealth taxation is violated (as it is in practice in most developed countries), but for a different reason. In the absence of commitment, past savings, being inelastic, are an obvious target for a benevolent, redistribution-minded government. To escape this ex-post nondistortive expropriation of existing wealth and its deleterious effect on capital accumulation, there must be a cost of expropriating agents' wealth. With two periods, this cost is assumed to be exogenous; with long horizons, by contrast, it could be just the loss of reputation of the government, modeled as the outcome of a repeated game with constituents (or, I should say, overlapping generations of constituents). Like Farhi & Werning (2010) in the progressive estate tax article discussed above, Farhi et al. (2012) show the optimality of marginal taxes on wealth that are positive at the top, unlike the optimal income tax in Mirrlees's (1971) classic article (which has labor income taxes only). And it does so in a very robust form. The difference with the previous literature—the focus on wealth taxation and the state's difficulty to commit—is key.

In "Inequality and Social Discounting," Farhi & Werning (2007) revisit the classic Atkeson & Lucas's (1992) long-run immiseration result under repeated taste shocks. As in Farhi & Werning's (2010) article, in this study it is desirable to insure the unborn against the risk associated with the draw of their ancestors. The welfare of future generations is embodied both indirectly through the altruism of earlier ones (as in Atkeson & Lucas 1992) and directly. This importantly leads to a social discount factor higher than the private one. In turn, with ongoing taste shocks, this increased patience leads to more insurance for future generations and mean reversion (which goes with higher social mobility). Moreover, inequality remains bounded in the long run (unlike in Atkeson & Lucas 1992).

To conclude this discussion of Emmanuel Farhi's contributions to public finance, we note that, in collaboration with Xavier Gabaix, he bridged behavioral and public economics. In "Optimal Taxation with Behavioral Agents," Farhi & Gabaix (2020) derive optimal Ramsey, Pigou, and Mirrlees taxation with behavioral agents. Their key concept is the behavioral wedge, equal to the difference between the price and the marginal utility of the good, computed for the agent's true or experienced utility. Although the modeling is not fully general, it is much more so than standard modeling is in the behavioral economics literature. Farhi & Gabaix show, for instance, that three classic models are special cases: decision versus experienced utility (say, the hyperbolic discounting model, in which the current generation puts too much weight on present consumption); misperceptions (in which the consumer misperceives the price vector); and mental accounts (which they formalize as mental accounting functions that map prices and income into how much money is devoted to each subset of goods' account). Behavioral economics had recently become a favorite topic of Emmanuel Farhi, who also revisited with Ivan Werning the New Keynesian model when agents are imperfectly rational (i.e., they employ level-k thinking) (see Farhi & Werning 2019).

2.3. New Keynesian Economics

Emmanuel Farhi published a series of articles that transformed Keynesian macroeconomics. We already discussed a couple of these. More generally, Farhi and coauthors allowed for a wide range

of economic frictions: slow price adjustments, the ZLB (the difficulty for the central bank to bring nominal interest rates below zero when cash guarantees a steady nominal value), the solvency constraints of banks and companies, the liquidity available in the economy, and economic agents' behavioral anomalies. This work will continue to be relevant in the post-COVID-19 economy.

Along the slow-price-adjustment line, Emmanuel Farhi, together with Isabel Correia, Juan Pablo Nicolini, and Pedro Teles (Farhi et al. 2013a), built on the idea of using fiscal policy to lower real interest rates when the central bank can no longer adjust nominal rates downward due to ZLB constraint on nominal interest rates: They propose an increase in VAT recreating some inflation, accompanied by a decreasing trajectory of labor taxes, to neutralize the impact of this consumer price adjustment on firms' pricing response. The overall idea of using fiscal policy to undo the deleterious effects of nominal rigidities had been developed by his coauthors (who showed that setting the nominal interest rate to zero does not constrain policy if the state has enough instruments), and more informally by earlier writers such as Keynes (1931) and, for Japan, Feldstein (2000). In their article, Farhi et al. (2013a) combined microfoundations, dynamics, and expectations formation, which enabled them to perform a full welfare analysis and to establish public policy on firmer ground. Prices are sticky in the sense that they adjust when an opportunity arises [à la Calvo (1983)]. With lump-sum taxes, the allocation is even first best and therefore time consistent (this is not so in the absence of lump-sum taxes); in any case, the ZLB constraint is never binding. The authors did not build in a vacuum, of course [important work had been done by Krugman (1998) and Eggertsson & Woodford (2004), for instance]. Yet, its use of microfoundations, which enable a full-fledged welfare and therefore policy analysis, makes the article particularly appealing.

In a similar spirit, "Fiscal Devaluations" (Farhi et al. 2014), written jointly by Emmanuel Farhi, Gita Gopinath, and Oleg Itskhoki, shows that nominal exchange rate devaluations can be mimicked—in terms of their real outcomes—while keeping the nominal exchange rate fixed, through a small set of fiscal instruments, and this regardless of the form and location of the price stickiness (wage stickiness, sticky producer currency pricing, or sticky local currency pricing). The article provides the first formal analysis of fiscal devaluations in a dynamic stochastic New Keynesian environment. The fiscal devaluation can be achieved through either (*a*) import tariffs and export subsidies or (*b*) an increase in the VAT and a reduction in production taxes (in general complemented with an increase in income taxes and a reduction in consumption taxes).

In "Dilemma not Trilemma? Capital Controls and Exchange Rates with Volatile Capital Flows," Farhi & Werning (2014) started another major aspect of their collaboration, associated with price rigidities. Mundell (1961) famously argued that the case for restricting capital flows is much stronger for a country that is a member of a currency union or in a peg: While a country with a flexible exchange rate enjoys an independent monetary policy and can use it to counter shocks, a country with a fixed exchange rate cannot avail itself of this instrument and must therefore interfere with capital flows. Farhi & Werning's first foray into the New Keynesian tradition argues that, with nominal rigidities, the capital account must be managed even if the exchange rate is flexible. They show that optimal controls lean against the wind, for example, by matching a capital inflow with a temporary tax on inflows and a subsidy on outflows.

Then came a particularly important contribution of the Farhi & Werning team: their article titled "Fiscal Unions" (Farhi & Werning 2017). This article revisits the old argument made by Kenen (1969) that there must be interregional transfers within a country of regions or a union of countries, so as to accommodate regional or country idiosyncratic shocks. The argument is more complex than it first appears, though, since economic agents can themselves buy insurance, at least if financial markets are well developed and therefore economic agents can design their privately optimal smoothing strategy (and to some extent they do, as the pension of a resident of Texas is

not much invested in Texan undertakings; but in practice the tax and welfare system adds further redistribution across US states). If financial markets are incomplete—in the sense that cross-state or international portfolio diversification is not available to consumers—the federal government must of course substitute for the missing markets and provide the insurance itself (beyond the level consumers would choose if portfolio diversification were available, as we next see); but the article finds a role for transfers even with complete financial markets. Farhi & Werning (2017) introduce aggregate demand externalities by putting a New Keynesian model in an optimal insurance framework. In such an environment, fiscal transfers should go beyond what economic agents will arrange for themselves. Interestingly, there is a formal analogy between the two frameworks (incomplete financial markets and sticky prices): Both call for cross-region or cross-country transfers. The article studies the constrained efficient allocations under the twin constraints of price rigidity (i.e., the price of the nontraded goods is not state contingent) and currency union (i.e., the price of traded goods is the same across countries). Taken together, the two constraints prevent a proper adjustment of the relative prices to the realization of the state of nature.

A transfer to a country increases consumption of traded and nontraded goods. Due to price rigidity, the impact on nontraded goods is particularly powerful in a bad state of the world for the country (i.e., if the country is in a bust), and thus it stabilizes output and income across countries. In a sense, Farhi & Werning's (2017) article provides a coherent framework for the conventional wisdom that currency unions must be completed by fiscal ones, a point that has been made repeatedly in the Eurozone context. Optimal transfers should address only asymmetric shocks and should be increasing in the persistence of these shocks, as one would expect. In contrast with earlier wisdom, transfers are more effective in a more closed economy (as countries outside the currency union achieve their stabilization through the flexibility of their exchange rates).

By limiting necessary price adjustments, monetary unions pose a host of other problems under decentralized fiscal policy. In "Coordination and Crisis in Monetary Unions" (Aguiar et al. 2015), Mark Aguiar, Manuel Amador, Emmanuel Farhi, and Gita Gopinath study issues related to member countries' lack of commitment with respect to the repayment of their sovereign debts, while the common central bank selects inflation (also without commitment). Countries, if left on their own, tend to overborrow, constrained only by the threat of a permanent lack of access to capital markets and of an output cost if they ever choose to default (by contrast, there is no punishment when the central bank inflates away sovereign debt). The central bank can erase some of the countries' debts by creating inflation; as usual, the expectation of inflation is embodied in the interest rate. Inflation is distortionary, but time inconsistency means that the central bank, which internalizes the total welfare in the monetary union (in contrast with fiscal authorities, which only internalize domestic welfare), cannot help but create inflation. How much inflation it creates depends on the total stock of debt to alleviate (I will reason with a representative member state for simplicity, even though an important component of the analysis focuses on high- and low-debt countries and their incentives to join the monetary union). To the standard inefficiency due to the lack of commitment is added another, fiscal, inefficiency. Each country ignores (if small, it more generally insufficiently accounts for) the impact of its borrowing on total debt and therefore on inflation. Therefore, the monetary union (in the absence of fiscal union) generates higher debt, higher inflation, and lower welfare. This externality differs from other, non-inflation-based borrowing externalities, such as the bailout externalities discussed in my article on country solidarity (Tirole 2015), or the more traditional expropriation externalities of default on sovereign bondholders. Aguiar et al.'s (2015) article is very rich beyond the features I just highlighted: It explores asymmetric indebtedness, fundamental debt crises versus self-fulfilling crises à la Cole & Kehoe (2000), and more. . .

Finally, their work on fiscal unions led Farhi & Werning to realize that a more general economic force of aggregate demand externality is at play. In a 2016 article, they looked at macroprudential interventions when price or wage rigidities combined with a ZLB or fixed exchange rates constrain monetary policy (Farhi & Werning 2016). The article, which represents the culmination of this line of work, shows that aggregate demand externalities matter for the design of policy (or financial taxes) much more generally. It offers a general theory of externalities that nests aggregate demand externalities (nominal rigidities and constraints on monetary policy, which had been the early focus of Farhi & Werning) and pecuniary externalities associated with imperfect financial markets [i.e., the incomplete markets or asymmetric information in contracting that Caballero & Krishnamurthy (2001), Lorenzoni (2008), and others had focused on]. The two forms of externalities differ, as pecuniary externalities operate through price movements, whereas price rigidities by essence prevent such movements. Yet, the main result is a simple and robust formula for how much one should distort financial transactions. Intuitively, it shows how the inherent distortions in spot markets can be optimally improved by engineering distortions (taxes or restrictions) in financial markets. The results are expressed in terms of wedges from the first best, capturing under- or overprovision of goods.

2.4. Input-Output Linkages

With his former student, David Baqaee, Emmanuel Farhi had been working in the last few years on exciting new methods for growth accounting. This line of research, starting with the article titled "The Macroeconomic Impact of Microeconomic Shocks: Beyond Hulten's Theorem" (Baqaee & Farhi 2019b), aims at analyzing macroeconomics as a network of interacting industries and at seeing how economic shocks have cascading effects, with implications such as the tripling of the oil shock impact in the 1970s or the current devastating economic effects of the Coronavirus pandemic. In this field of research launched by Hulten (1978), and then pursued by Gabaix (2011) and Acemoglu et al. (2012), Baqaee & Farhi show how linear approximations can be misleading, and they extend Hulten's theorem.

Hulten (1978), himself building on Solow's (1957) earlier work, showed that aggregate productivity growth, defined as output growth minus share-weighted input growth, is equal to a weighted sum of microeconomic changes in technology. This characterization relies on perfect competition and, more generally, on the absence of frictions (such as financial frictions, etc.). In what is likely to become extremely influential work, Baqaee & Farhi (2019b) extend Hulten's aggregation result in economies with arbitrary input-output network linkages to the more relevant case of inefficient economies. The frictions considerably change the order of magnitude of the estimated macroeconomic impacts of shocks or policies. A total factor productivity (TFP) shock in some industry reallocates outputs elsewhere, and associated changes in allocative efficiency are no longer equal to zero as posited by Hulten. As mentioned above, this nonlinear characterization of production shocks delivers, for example, a threefold increase in the impact of the oil shock in the 1970s.

Baqaee & Farhi applied their approach to a variety of questions. For instance, in "Productivity and Misallocation in General Equilibrium" (Baqaee & Farhi 2020a), they estimate that the improvement in allocative efficiency, due to the reallocation over time of market share to high-markup firms, accounts for about half of aggregate TFP growth over the period 1997–2015. This is due to a composition effect between firms, whereby firms with high markups, which were too small in the first place, gained market share. Similarly, they estimate that reductions in markups have effects of several orders of magnitude higher than those envisioned by Harberger (1954). Similarly, in "Networks, Barriers, and Trade" (Baqaee & Farhi 2019a), they show that gains from trade are larger than initially thought whenever production networks exhibit complementarities in production. They reemphasize this theme in a recent working paper titled "The Darwinian

Returns to Scale" (Baqaee & Farhi 2020b), where they argue that an increase in the size of a market generates more competition: Big firms expand, small firms shrink and exit, and new firms enter. In particular, resources are reallocated from low-markup to high-markup firms.

Beyond the input-output and growth accounting themes emphasized in their early work, Baqaee & Farhi's overarching goal is to unpack the aggregate representation of production in macroeconomics starting from a fully disaggregated microeconomic level. As they say, they are after unbundling reduced forms that are familiar in macroeconomic models—the aggregate production function and the representative agent—under various distortions, consumer heterogeneity, and general demand and supply functions. For example, inspired by Quesnay's tableau économique, they study a broad class of models with heterogeneous agents and input-output networks and investigate the propagation of shocks, looking not only at aggregate implications but also at the impact on an industry of a shock arising in another industry (Baqaee & Farhi 2018); in contrast with a partial equilibrium approach, this paper considers the impact of the shock not only on the industry in which it originates but also on the many other industries that the shock will affect.

Relatedly, in his *Journal of the European Economic Association* lecture (delivered at the 2018 EEA Congress),[6] Emmanuel Farhi once again revisited an important debate in the history of economic thought: the Cambridge (UK)–Cambridge (US) controversy. The Cambridge (UK) side argued that one cannot in general subsume the capital stock into a single aggregated index number, as is done for instance to derive the decreasing-returns property, to determine the distribution of income (based on the implication that the distribution of income is determined by relative factor scarcity), or to compute the rate of interest (technologically driven and equal to the marginal productivity of capital). This side of the controversy used "reswitching" examples in which diminishing returns obtain for every capital good, but not overall: The capital-labor ratio is nonmonotonic as a function of the rate of interest. However, failing to offer a convincing alternative to the Solow-type reduced-form production function, the macroeconomics of growth with its classic models (exogenous growth with Hicks-neutral, labor-augmenting, or capital-augmenting variants as well as endogenous growth) kept using neoclassical production functions, which remain the ultradominant paradigm. Baqaee & Farhi's work does not impose a parametric structure on the aggregate production function but rather derives it from microeconomic foundations, allowing for arbitrary input-output and substitutability patterns but assuming that the final demand is homothetic and there are no distortions. They look at a competitive equilibrium with constant or decreasing returns to scale for the various goods in an economy in which each good is produced from the primary factors as well as from other goods (they show that these assumptions yield the existence of a production function). They give necessary and sufficient conditions for the possibility of capital aggregation.

Baqaee & Farhi's research was booming; I counted no less than seven discussion papers all dated in the last two years of Emmanuel's life, besides the published ones. There is no question that Emmanuel's contributions will have a deep influence in this field, too.

3. COAUTHORSHIP

I met Emmanuel Farhi when he was a first-year PhD student, and I had the privilege of working with him since then. I was immediately struck by how brilliant he was, even by the standards of top MIT students. I started working with Emmanuel in industrial organization. Indeed, we published a couple of papers in collaboration with Josh Lerner. For example, our 2013 article

[6]A recording of the lecture can be found at **https://www.youtube.com/watch?v=QRFRuj0myTI**.

(Farhi et al. 2013b) formalized the privately optimal arrangement between agents who are eager to get their work certified (bond issuer, academic author, etc.) and certifiers (rating agencies, scientific journals, etc.). This arrangement involves a simple and familiar form of collusion between certifier and certified at the expense of the community: Acceptances, but not applications, are disclosed. The equilibrium also shows that certified agents move down their pecking order, starting with more demanding and therefore prestigious certifiers and lowering their ambitions when rejected. However, although Emmanuel excelled at industrial organization, I quickly realized that his heart was on the macro side.

Of course I feel awkward about speaking about my joint work with him. But I will do so without too much embarrassment, such was his contribution in each of the jointly authored articles. It is also a source of pleasure because it reminds me of very fond memories. I am truly grateful for the wonderful moments of discovery and excitement experienced when working with him. I will try to describe a few articles and explain why we wrote them. I hope that in doing so, and even though I will not be able to give due credit to the other researchers who have worked along similar lines, I will not overpromote the articles. Emmanuel was humble and would not have liked that.

The selected articles share the same three running themes:

1. Public finances are exposed to an illiquid financial system. This observation holds even in the absence of connivance of officials with bankers, because the state relies on the financial system for the continuity of several core services. Such services include loans to small and medium-sized enterprises (hence a concern for a credit crunch) and the repayment of liabilities held by other economically and politically sensitive depositors, such as insured deposits (the state enables such deposits by being the only insurer of last resort)[7] and deposits held by other regulated financial institutions [through the federal funds market, credit default swaps (CDSs), and other cross-bank contracting].
2. Capital markets are imperfect. The imperfection of capital markets is a necessary condition for illiquidity, as we learnt long ago from Arrow. Factors such as agency costs prevent the pledging of the entirety of the benefits from investment to outside investors, resulting in credit rationing. In turn, the anticipation of credit rationing gives rise to a familiar demand for liquidity (i.e., hoarding of stores of value on the asset side and lengthening of the debt maturity on the liability side). Putting this idea in a general equilibrium context was the starting point of my 1998 work with Bengt Holmström on the determinants of aggregate liquidity shortages (Holmström & Tirole 1998). As we saw, imperfect capital markets had already played a key role in Emmanuel Farhi's pioneering work with Ricardo Caballero and Pierre-Olivier Gourinchas on global financial imbalances (Caballero et al. 2008).
3. The exposure of public finances to the financial system is endogenous (i.e., it is subject to moral hazard). Depending on the application we develop, the financial institution may become illiquid because of a combination of a high short-term debt and a low level of safe stores of value ("level 1+2 liquid assets," in the jargon of prudential regulation); because of investments in risky assets (stochastic bubbles, risky domestic sovereign's bond holdings, etc.); or else because of liquidity coverage that is not a real one [as when the American International Groups (AIG) insured many financial institutions through the CDS channel and defaulted, leaving these institutions exposed to the underlying risks].

[7]The state is by and large the only player in the economy that is able to tap into the taxpayers' income in adverse macroeconomic states of nature; the foundations for this lie in the inability of future and even current taxpayers to pledge a substantial fraction of their future income, an inability that admits multiple rationales.

These three ingredients generate macroeconomic effects from prudential regulation, whether done right or poorly, and ultimately advance macroprudential financial regulation recommendations.

3.1. Monetary Bailouts

Our 2012 article titled "Collective Moral Hazard, Maturity Mismatch and Systemic Bailouts" (Farhi & Tirole 2012b) connected two observations about the 2008 crisis: a wide-scale maturity mismatch in the banking sector and a monetary bailout provided by all central banks. To boost their returns on equity, many commercial and investment banks gambled on the debt maturity structure. They picked a high short-term debt and a low volume of safe assets. Such a maturity mismatch is more profitable in the short term because demandable liabilities are what investors prefer, and also because safe assets are in short supply and command low yields. But it exposes the banks to illiquidity if they incur losses.

A monetary bailout is defined as a rescue of illiquid banks through the facilitation of their refinancing (e.g., low interest rate, acceptance of low-quality collateral). This is in contrast with direct transfers, such as recapitalizations, that boost the distressed banks' net worth. The bailout terminology comes from the idea that the policy imposes a levy on savers, who receive a low rate of return on their investments. Our 2012 article built on a feedback loop between a monetary bailout and the maturity mismatch, for risk taking exhibits strategic complementarities: If I am alone in going primarily for short-term debt and rollover refinancing in financial markets, the central bank will not lower the interest rates only for me. But if we all do that, then the central bank will not have a choice. In the context of gambling on illiquidity under the prospect of a monetary bailout, we called these strategic complementarities "collective moral hazard."

Such strategic complementarities are common in many fields. They arise, for instance, when public policies are not targeted (as is the case here); for example, owners' political ability to protect an asset's value—say, a house near an airport or a savings instrument benefiting from a tax loophole—is stronger if many have invested in the asset. There is strength in numbers!

Non-targeted policies are costly: A monetary bailout applies to all actors, even the financially unconstrained ones that the state does not want to help; it makes asset owners richer; and it distorts the allocation of savings and investment. So, if one wants to support distressed banks and avoid a credit crunch, why not directly recapitalize the banks instead? Interestingly, monetary bailouts are still desirable even when fiscal bailouts are feasible. The idea hinges on asymmetric information about the banks' actual refinancing needs. A low-interest-rate policy is a screening device: It benefits primarily the institutions with actual borrowing needs.

3.2. Bubbly Liquidity

The "Bubbly Liquidity" article (Farhi & Tirole 2012a) started from the old distinction, revisited in my work with Bengt Holmström (Holmström & Tirole 1998), between inside liquidity (the value of securities issued by financially constrained entities) and outside liquidity (the assets that originate in a different sector of the economy, most notably government debt). Enter bubbles, a form of outside liquidity. Bubbles have a leverage effect and a liquidity effect, due to the fact that depending on circumstances and their life cycles, corporations and banks are both savers and borrowers. The leverage effect is the standard one: A bubble increases the supply of investment vehicles and leads to an increase in the interest rate, crowding out productive investment (Tirole 1985). The liquidity effect comes from the reduction in the price of liquidity, which crowds in investment, although only for financially constrained institutions. In the "Bubbly Liquidity" paper, risk taking is synonymous with the leveraged institutions' holding of bubbles; one may have in

mind, for example, the exposure of US or Spanish banks to their domestic real estate bubbles prior to the 2008 crisis.

The introduction of imperfect capital markets alters the standard results of the economics of bubbles. Because financial markets are imperfect, the social rate of return on internal funds exceeds that on borrowed funds. This implies that the economy can be dynamically efficient while, at the same time, the rate of interest can be lower than the rate of growth ($r < g$), and bubbles can exist. The classic test by Abel et al. (1989), comparing what the productive sector disgorges and how much it invests, remains valid as a test of dynamic efficiency, but not as a test for the possibility of bubbles: Dynamic inefficiency is a sufficient but not necessary condition for the possibility of bubbles. Finally, the crash of a bubble generates low interest rates and an increase in leverage, and so bubbles carry a risk premium even in a risk-neutral environment. Like Farhi & Tirole's (2012b) article on collective moral hazard, the piece on bubbly liquidity (Farhi & Tirole 2012a) calls for macroprudential regulation.

3.3. Doom Loops

In our article titled "Deadly Embrace: Sovereign and Financial Balance Sheets Doom Loops" (Farhi & Tirole 2018), we analyzed the vicious circles created by the mutual financial interdependence between banks and their sovereigns, which is still a major concern in Europe. Around 2009–2010, bank and sovereign CDS spreads started to move in lockstep, which suggested the possibility of a doom loop in which sovereign fragility would jeopardize banks holding domestic sovereign bonds (as in Greece), and/or bank distress would imperil public finances and sovereign debt sustainability (as in Ireland), and vice versa. To account for this, we developed a "double-decker bailout" framework, with domestic bailout of the banking system by the sovereign on the one hand and sovereign debt forgiveness by international creditors or country bailout by other countries on the other.

As we have seen, an adverse shock to the economy has two effects on the solvency of the sovereign: a direct negative effect on the fiscal revenues of the sovereign, with a resulting increase in the sovereign's spread; and, if banks own the sovereign bond, an increase in the occurrence of banking bailouts. This latter increase is financed by issuing additional debt, further increasing the spread. For every dollar of bailout that the sovereign provides to the banks, public debt must increase by more than one dollar.

The key result is that a renationalization of financial markets occurs upon the accrual of bad news about the banks' balance sheet or the sovereign's ability to reimburse its debts. There are two channels, associated with the two bailout puts. First, banks' bailout put is more valuable in bad times, and so domestic banks will devote more resources to concealing from the supervisor their direct and indirect exposures to the sovereign. Second, bad times make it more likely that the sovereign obtains assistance or debt forgiveness, and so the domestic banking supervisor may be tempted to relax its grip on the banks they supervise. This provides two rationales for externalized banking supervision: For a fragile debtor country, externalization acts as a commitment for the country not to loosen its banking supervision; and the externality created by a lax banking supervision by a country generates foreign countries' demand for centralized supervision, as they may later on have to take the country out of default.

3.4. Shadow Banking

Our article titled "Shadow Banking and the Four Pillars of Traditional Financial Intermediation" (Farhi & Tirole 2020) stresses the need for sound policies to deal with the growth of shadow banking. Traditional banking is built on four pillars: The commercial bank is prudentially supervised;

in exchange, it gets access to a lender of last resort (LOLR) and to deposit insurance; it caters to special depositors, the retail depositors who want a liquid and safe vehicle for their savings; and it caters to special borrowers, the small and medium-sized enterprises that need close oversight to secure financing. These two activities represent, in the article, core functions to which governments attach great social value.

Why do we observe such a peculiar arrangement? After all, access to the public insurance services (LOLR, deposit insurance) could be priced and offered to the entire financial system. Our simple answer is that banking supervision lowers the cost of these put options on taxpayer money to the extent that it reduces risk taking. The article's second contribution is to provide a rationale for two structural remedies: ring fencing and the migration of transactions toward central clearing counterparties. The rationale for both is to avoid the gaming of hedging among financial intermediaries, which results in banks being only partially covered as they hoard bogus liquidity (the so-called AIG syndrome) and in public liquidity being syphoned off to the shadow sector (the so-called conduit syndrome).

4. A LAST WORD

We have lost an unparalleled thinker and a great human being. When contemplating what Emmanuel Farhi had already achieved by the age of 41, one cannot help experiencing a sense of huge scholarly loss, shuddering at the thought of the missing groundbreaking work that will never happen. The best homage we can pay to his contributions, his creativity, and his generosity toward colleagues, staff, and students is to do our best to pursue his intellectual and human legacy.

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