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The Creative Destruction Approach to Growth Economics

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In this article we introduce the Schumpeterian growth paradigm, where growth results from innovations that render previous innovations obsolete. We show how this paradigm can be used to elucidate enigmas in recent growth history, such as the growth take-off, secular stagnation, and the middle-income trap. We then illustrate how the Schumpeterian paradigm can be tested using rich micro data, focusing on the relationship between product market competition and innovation-led growth. Finally, we use the paradigm to question some common wisdoms on growth policymaking.

Introduction

In our student years the dominant growth model was the Solow model, named after Robert Solow who published it in 1956 in the *Quarterly Journal of Economics*. This model rose to fame due to its high degree of elegance and parsimony. It describes gross domestic product (GDP) growth as arising primarily from capital accumulation. And capital accumulation itself is the combined result of investments (themselves financed through saving a fraction of total GDP) and capital depreciation. However, under the reasonable assumption of decreasing returns to capital (the increase in output when increasing the capital stock from one to two machines is much higher than the increase in output from increasing the capital stock from nine to ten machines), growth cannot be sustained forever if only based on capital accumulation: namely, at some point, accumulating more capital results in more capital depreciation than it increases GDP and therefore savings. At that point, capital investment ceases to generate GDP growth. But then Solow would appeal to 'technical progress' to explain sustained long-run growth, but without telling us where technical progress is coming from.

On the other hand, Joseph Schumpeter had pointed to innovation as a major source of growth; however, in our student years there was no growth model based on innovation, let alone a model that would embody Schumpeter's notion of creative destruction, the process whereby new innovations displace old technologies.

In 1987 at MIT, we created a growth model that was based on Schumpeter's celebrated idea of creative destruction. It soon became clear to us that this new framework was capable of shedding light on the interaction of growth with other economic aspects such as competition and trade, unemployment, convergence, business cycles, technological waves, exhaustible resources, learning by doing, the organization of research, etc. A theoretical exploration of some of these aspects led to our first book, *Endogenous Growth Theory*.[a]

But how to reconcile theory with data? In 1998, we started collaborating with Richard Blundell, Rachel Griffith, and Nick Bloom, on the relationship between competition and innovation-led growth.[b] We then realized that Schumpeterian theory was the first aggregate growth theory with a microstructure rich enough, and with room for enough heterogeneity, to be tested using large micro data sets, instead of being limited to the aggregate data contained in the Penn World Tables, or in Madison's historical data set.

The work that younger researchers have done since then has shown that the theory is even richer and more fruitful than we could have imagined, in many different dimensions.[c] The contributors to this festschrift have brought these different dimensions together masterfully, shedding further light on growth and competition, international trade, politics, the environment, unemployment, the productivity slowdown, finance, firm dynamics, inequality, secular stagnation, monetary policy and economic development. In these concluding remarks we will briefly comment on some of the multiple achievements of the Schumpeterian paradigm.

This article will be organized as follows. In the next section, we introduce the Schumpeterian growth paradigm, and then we show how this paradigm can be used to elucidate enigmas in recent growth history. In the third section, we illustrate how the Schumpeterian paradigm can be tested using rich micro data, focusing on the relationship between product market competition and innovation-led growth. In the fourth section, we use the paradigm to question some common wisdoms on growth policymaking. Finally, the fifth section concludes.

Some Growth Enigmas

The paradigm revolves around three main ideas. The first idea is that long-term growth results from cumulative innovation, where each new innovator builds upon previous innovations. In particular, institutions that favour the diffusion and codification of knowledge contribute to making innovation cumulative, i.e., they make it unnecessary to climb the same mountain over and over, like Sisyphus. The second idea is that innovation is motivated by the prospect of innovation rents. Institutions that secure those rents, in particular by protecting intellectual property

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rights, encourage entrepreneurs to invest more in innovation. The third idea is creative destruction: that is, new innovations render previous innovations obsolete. In other words, there is a permanent conflict between the old and the new.

At the heart of this new growth paradigm lies the following contradiction: on the one hand, innovation rents are needed to motivate innovation investments. On the other hand, yesterday's innovators are tempted to use their innovation rents to prevent subsequent innovations as they don't want to suffer from creative destruction themselves.

Regulating capitalism is primarily about how to manage this contradiction. Interestingly, even as he saw creative destruction as a potential driving force of growth, Schumpeter himself was quite pessimistic about the future of capitalism, as he anticipated that previous innovators would turn into entrenched conglomerates that would successfully impede new innovations. Even though to some extent recent economic history seems to support Schumpeter's worries, we believe that it is possible to manage the above contradiction so as to 'save capitalism from the capitalists', to use the title of Rajan's and Zingales' latest book.[d] In that sense we are more like 'Gramscian optimists' advocating an 'optimism of the will'.

We judge paradigms mainly by their ability to shed light on important phenomena and enigmas. The Schumpeterian paradigm penetrates key enigmas in the history of economic growth that growth models without creative destruction could not explain.[e] We shall focus on three enigmas: the growth take-off, secular stagnation, and the middle-income trap.

The Transition from Stagnation to Growth

Why didn't growth take off until the beginning of the nineteenth century? Why did everything start in Europe, and more specifically in the United Kingdom, and not in China, which pioneered inventions such as the wheel or the compass long before the industrial revolution? The Schumpeterian paradigm, with its three components – cumulative innovation, innovation rents, and creative destruction – helps answer these questions, and here Joel Mokyr's (Mokyr 2002; Mokyr and Voth 2010) enormous contribution takes centre stage. First, cumulative innovation was favoured in Europe by the decreasing cost of printing, by the publication of encyclopaedias that helped codify the knowledge and know-how available at the time, by the emergence of affordable postal services, and by the free circulation of ideas between inventors and between countries. Second, it was supported by the emergence of institutions protecting intellectual property rights, following the Glorious Revolution in England, and subsequently the French Revolution and Napoleon. Third, creative destruction was facilitated in Europe by competition among nations. This competition enabled innovation and creative destruction to take place despite the presence in each country of forces resisting new innovation. By contrast, in China the only innovations that were allowed were those handpicked by the emperor, which in turn explains why the Chinese economy stagnated throughout the nineteenth century and well into the twentieth century, while Europe and then the US were taking off.

Secular Stagnation

Why, after a boost between 1995 and 2005, has US productivity growth fallen since 2005? Why has productivity growth fallen despite the information technology and artificial intelligence revolutions? And why have firms' mark-ups increased over the same period? Different candidate explanations for the growth decline have been explored, for example the view that new ideas may be harder to get, or the fact that growth is mismeasured, and there is good evidence supporting these two claims. Yet two attempts using the Schumpeterian paradigm have been particularly successful at explaining both, the decline in growth and the increase in rents. These two attempts explore different dimensions of cross-firm heterogeneity.

The first attempt, by Akcigit and Ates (2021), uses an extension of the paradigm, outlined in the next section, where in each sector of the economy there is a technological leader and a technological laggard, where the leader innovates at the frontier whereas the laggard tries to catch up, and where the laggard must first catch up to the leader before it can surpass it. The authors argue that over the past few years it has become harder for the laggards to catch up with the leaders, one reason being that the leaders have become better at preventing the diffusion of their knowledge, for example by acquiring patents for defensive purposes. The result is that innovation by laggards has been discouraged, hence the growth decline, whereas leaders' rents have increased.

The second attempt, by Aghion, Bergeaud *et al*. (2019), explores another extension of the paradigm where there are two types of firms in the economy: superstar firms and non-superstar firms. The superstar firms have accumulated social capital and know-how or developed networks which other firms cannot emulate. The argument then is that the IT revolution has enabled superstar firms to control a larger fraction of sectors in the economy. This explains the surge in productivity growth between 1995 and 2005. It also explains the surge in rents as superstar firms tend to have higher mark-ups than other firms. The flipside is that as they became hegemonic, superstar firms ended up discouraging innovation and entry by non-superstar firms, hence the observed decline in growth and entry since the early 2000s.

The Middle-income Trap

After emerging from the Korean war in the late 1950s with a very low per capita GDP, South Korea experienced a very high growth rate, especially between 1960 and 1997, but then growth declined dramatically. This 'middle-income trap' phenomenon is easily explained using a straight extension of the Schumpeterian growth paradigm, where firms in any country can choose between technological catch up towards the frontier productivity level in their sectors, and frontier innovation to improve upon the current frontier technology in their sector.[f] In less advanced countries, where most firms are far below the technological frontier, catching up is the main source of growth because firms make a substantial technological leap whenever they catch up with the frontier. By contrast, in more advanced countries,

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where most firms are initially close to the frontier in their sectors, frontier innovation becomes the main source of growth. The explanation for the middle-income trap phenomenon is that some countries failed to make the transition from institutions and policies that favour catch-up growth towards institutions that favour frontier innovation. In particular, we shall argue in the next section that competition enhances productivity growth more in countries that are close to the world technological frontier than in countries that are far below the technological frontier. But why did South Korea fail to toughen its competition policy as it moved closer towards the world productivity frontier? The reason is that a catch-up growth period favours the emergence of large conglomerates which then use their accumulated wealth to pressure politicians and judges to prevent the implementation of new – for example, more pro-competitive – rules and policies in order preserve their rents. In South Korea, the conglomerates are called *chaebols*.

Whether we discuss the growth take-off, or the recent growth decline, or the middle-income trap, we come across the same basic contradiction between the need for innovation rents and the use of those rents by incumbent firms to prevent subsequent innovation. As mentioned above, Schumpeter's belief was that capitalism was doomed because he thought it was impossible to prevent incumbent firms from barring new innovations, either directly or by exploiting political connections with government authorities. However, the above discussion also suggests that Schumpeter's pessimism might have been somewhat excessive.

Thus, when discussing the growth take-off, we saw that the competition among nations could force individual countries to accept new innovations. Similarly, our discussion on secular stagnation suggested that more appropriate competition policies in the US would limit the scope for defensive patenting by leaders in the various sectors, or that they would limit the power of superstar firms to expand and thereby control most sectors of the economy, would encourage innovation by laggards and/or by non-superstar firms, thereby fostering aggregate productivity growth. Finally, our analysis of middle-income traps called for curbing the lobbying power of incumbent firms in order to hasten the transition towards institutions and policies that favour frontier innovation. Interestingly, the Asian financial crisis of 1997 and 1998 led to the bankruptcy of some *chaebols*, such as Daewoo, and weakened those *chaebols* that managed to survive. And because it limited the influence of *chaebols*, the crisis opened the Korean economy to competition, which in turn stimulated productivity growth, patenting, and entry by non-*chaebol* firms in all industries, thereby fostering aggregate productivity growth in South Korea.[g]

From Theory to Empirics: Competition and Innovation

An empirical study using UK firm-level data by Blundell *et al.* (1995, 1999) found a positive correlation between product market competition and innovation/growth. This, in turn, challenged the Schumpeterian paradigm: to the extent that competition

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should reduce the ex-post rents from innovation, competition should also reduce the incentives to innovate.

How, if at all, could we reconcile theory and evidence? Should we throw the model in the garbage bin and start again from scratch? Or should we simply ignore the empirical challenges and proceed as before?

We decided to go for a third way: namely, to look more closely at our growth model and try to identify the assumption or assumptions that generate this counterfactual prediction of a negative relationship between competition and growth.

And we finally identified the culprit: in our initial model only currently inactive firms innovate, not the currently active firms (i.e., not the current technological leaders). Thus, an innovating firm in our model would move from zero profit (pre-innovation) to a positive profit (post-innovation). No wonder, then, that competition would discourage innovation: competition reduces the post-innovation profit which here is equal to the net profit from innovation.

However, in reality one finds at least two types of firms in most sectors of the economy and these two types of firms do not react in the same way to increased competition. You first have what we call 'leaders', i.e., firms that are close to the current technological frontier in their sector. These firms are currently active and they make substantial profits even before innovating this period, and they increase their profits by innovating at the frontier. Second, you have what we call the 'laggard firms', i.e., firms far below the current technological frontier. These firms make initially low profits, and to increase their profits they first need to catch up with the current technology frontier.

To try to understand why these two types of firms react differently to competition, imagine for a moment that what you are looking at are not firms but students in a classroom. And among them you have the top students and the bottom of the class. And suppose that you are opening the class to an additional student who turns out to be a very good student. This is how one would represent an increase in competition in this context. How will the students react to this new student joining the classroom? The answer is that letting the new student in will encourage the other top students to work harder in order to remain the best, whereas it will further discourage students at the bottom of the class, as those will find it even harder to catch up.

Quite strikingly, firms react like classroom students: namely, faced with a higher degree of competition in their sector, firms that are close to the technology frontier will innovate more in order to *escape competition*, whereas firms that are far from the technological frontier and try to catch up will be *discouraged* by the higher degree of competition, and as a result innovate less: these latter firms behave like in the basic Schumpeterian model.

Overall, the effect of competition on innovation and productivity growth is an inverted U, which synthetizes the positive *escape competition effect* and the negative *discouragement effect*. The prediction of opposite reactions of frontier versus non-frontier firms to competition, and of an inverted U overall, were tested and

confirmed in joint work with Richard Blundell, Nick Bloom and Rachel Griffith using the same kind of firm-level data as in the empirical studies I mentioned above.

The prediction that more intense competition enhances innovation in 'frontier' firms but may discourage it in 'non-frontier' firms, was tested by Aghion *et al.* (2009) using again panel data of UK firms. One important implication is that competition should be more growth-enhancing in countries that are closer to the world technology frontier, as in these countries more firms are close to the technology frontier in their sectors. We made use of this prediction when discussing the middle-income trap in the previous section.

Another prediction from our enriched model with leaders and laggards is that there is complementarity between patent protection and product market competition in fostering innovation. Intuitively, competition reduces the profit flow of non-innovating frontier firms, whereas patent protection is likely to enhance the profit flow of an innovating frontier firm. Both contribute to raising the net profit gain of an innovating frontier firm; in other words, both types of policies tend to enhance the escape competition effect.

Our prediction of a complementarity between competition and patent protection was tested by Aghion *et al.* (2015) using OECD country-industry panel data.

A third prediction is that trade liberalization and, in particular, import competition on firms' output markets, should have a more positive effect on innovation for firms close to the technological frontier in their sectors than for firms far below the frontier. This prediction is confirmed in recent work by Aghion, Bergeaud *et al.* (2021) using comprehensive firm-level panel data from France.

This extended framework, with leaders and laggards and catch-up versus frontier innovation, has been used repeatedly in recent years. We have already mentioned Akcigit and Ates's (2021) explanation for the growth decline: namely that over the past years it has become harder for the laggards to catch up with the leaders, so that innovation by laggards has been discouraged. Using the same model, Liu *et al.* (2022) argue that the growth decline is explained by the fall in interest rates, which increases the value to leaders of a bigger technological lead. This in turn encourages leaders to innovate more while making it harder for laggards to catch up.

In the end, this dialogue between theory and empirics turned out to be mutually enriching. On the one hand, our empirical colleagues realized that the relationship between competition and growth was more involved and subtler than what they thought based on their initial studies. On the other hand, we understood how to enrich our model so as to bring out not one but two basic effects of competition on innovation and growth, to identify conditions under which one or the other effect dominates, and why when aggregating across all firms/sectors we obtain the inverted-U relationship which Scherer (1965) had anticipated but could not explain.

But more importantly, this collaboration inaugurated a whole new way of doing growth theory: namely, by submitting ourselves to a constant back and forth between the model and the data. In our inverted-U paper with Aghion *et al.* (2005) we used micro data to test the additional predictions of various extensions of our basic model in order to finally converge on a model of competition and growth that fits the data.

Since the inverted-U paper came out, the Schumpeterian growth literature has been considerably enriched. First with the model by Klette and Kortum (2004), which introduced entry, exit and firm dynamics into the creative destruction framework.[h] In particular, the model could account for important stylized facts such as: (i) the firm size distribution is highly skewed; (ii) firm size and firm age are highly correlated; (iii) small firms exit more frequently than large firms. All these are facts which non-Schumpeterian models could not account for.

Then, to a large extent under the leadership of Ufuk Akcigit and Pete Klenow, the literature underwent a dramatic boost with a whole new wave of Schumpeterian growth models that were confronted with the data using both regression analyses *and* highly sophisticated calibration techniques. This, in turn, made it possible to go much further than simply testing predictions. For example, using these new techniques one could assess the relative importance of small versus large firms, of creative destruction versus increased variety, of basic versus applied research, or of good rents stemming from innovation versus bad rents stemming from political connections; one could also quantify the effects of industrial policies focused on incumbent firms, or the extent to which productivity growth is mismeasured due to creative destruction, or the effects of labour market regulations on aggregate innovation.[i]

These are just a few illustrations of all that the Schumpeterian approach can deliver as we keep extending the paradigm in multiple directions, while maintaining the dialogue between the model and the data through increasingly sophisticated techniques.

Killing Bad Policy Ideas

The paradigm of creative destruction not only sheds light on various aspects of the growth process, but it also provides new glasses to look at policy design, and by doing so it allows us to identify erroneous reasonings and to question flawed policy recommendations. In this section we shall question three such wisdoms. First, the claim that we should tax robots. Second, the idea that negative growth is the best way to fight climate change. Third, the view that there is a trade-off between becoming more innovative and becoming more inclusive or protective: choosing the former would imply renouncing the latter and vice versa.

Should We Tax Robots?

A dominant view of automation is that it increases aggregate unemployment by substituting capital for labour. The fear that machines would lead to mass unemployment goes back to 1589 when William Lee introduced his knitting machine; most famous is the Luddite movement in 1811–1812 to fight manufacturers' use of machines for producing cotton and wood textiles; and in

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the 1930s economists, starting with J.M. Keynes, expressed concern about the danger of mass 'technological unemployment'.

More recently, the IT and AI revolutions revived the fear that technological progress would make labour increasingly redundant, and the idea has been put forward by economic scholars and also policymakers that robots should be taxed in order to protect aggregate employment. A dominant view indeed sees robotization and other forms of automation as primarily destroying jobs, even if this may ultimately result in new job creations by taking advantage of the lower equilibrium wage induced by job destruction. Hence, the policy recommendation that robots should be taxed in order to protect aggregate employment and also wages.

However, there is an alternative view: namely, that automating firms become more productive, which enables them to lower their quality-adjusted prices and therefore to increase the market for their products, possibly in part by stealing business from other firms – domestic or foreign – that did not automate. This productivity effect may more than offset the direct substitution effect of automation (i.e., the replacement of workers by machines), in which case automation will result in higher labour demand by the automating firms.

In Aghion, Antonin *et al.* (2022) we consider various measures of industrial capital, including Acemoglu and Restrepo's (2022) 'industrial automation' measure, and then show that an increase in any of these measures results in higher firm-level employment. Taxing robots would reduce firms' incentives to become more productive through automation, hence increase their market worldwide and therefore their labour demand. The end result of taxing robots may then be to reduce aggregate domestic employment.

Negative Growth or Green Innovation?

To fight climate change, some scholars or politicians have advocated negative growth. They find support for their view by looking at the relationship between growth and CO_2 emissions or temperature over the past centuries: as a matter of fact, temperature and aggregate CO_2 emissions worldwide started to increase precisely at the time of the growth take-off in the nineteenth century. And in China and India, CO_2 emissions initiated their accelerated rise precisely when these two countries engaged on high-growth paths. However, we know what negative growth looks like thanks to the Covid lockdowns we experienced two years ago. In France, during the first lockdown between March and May 2020, domestic GDP decreased by 35% whereas CO_2 emissions were reduced by only 8%. Fighting climate change through negative growth would be like imposing such a lockdown forever, and we know how psychologically damaging this two-month lockdown was, particularly for the younger generation.

A more promising route, and in fact the only way to reconcile climate with sustained growth and prosperity, is green innovation: to discover cleaner sources of energy, cleaner products and cleaner production technologies.

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But then comes the question: why can't we rely on firms alone to generate green innovation? The reason is that those incumbent firms that innovated in dirty technologies in the past tend to continue to innovate in dirty technologies in the future.[j] In Acemoglu *et al*. (2012) we refer to this phenomenon as 'path dependence' in the direction of incumbent firms' innovation.

A first implication of path dependence is that creative destruction should help: indeed, new entrants are not subject to path dependence since they were not around in the past, by definition. In other words, in an economy where incumbent firms innovated mainly in dirty technologies in the past, by its very nature creative destruction favours greener innovation.

A second implication is that outside intervention is needed to redirect incumbent firms' innovation towards clean technologies. The good news is that there are multiple channels and instruments that can be activated for that purpose. Some channels rely primarily on state intervention: carbon taxes and tariffs, subsidies to green innovation, industrial policy. But other channels also involve civil society: social norms and how much citizens value the environment, consumers' information about the CO_2 content of firms' production and inputs, shareholders' concern for corporate social responsibility, etc.

In the end, the key to successfully fighting climate change lies with creative destruction and with the triangle between firms, the state, and civil society. Thus, in countries with higher concern of civil society for the environment, more intense competition policy implemented by the state will induce firms to innovate greener in order to escape competition from potential rivals.[k]

Do We Have to Choose between Innovation and Inclusion?

Should we follow US capitalism, which is more innovative, or German/Scandinavian capitalism, which is more inclusive and protective? Are we bound to an 'either/or' choice between these two forms of capitalism?

What makes us depart from the 'either/or' view is, first, the strong belief that capitalism cannot be fully dynamic unless it is inclusive, it cannot be fully innovative if vested interests prevent the emergence of new talents.

Moreover, there are policies which can help move capitalism both towards more innovativeness *and* towards more protection or inclusiveness. Here we shall focus on two such policies, namely, competition policy and education.

Competition Policy

In the second section we argued that by increasing the number of product lines controlled by superstars, the IT revolution ended up reducing innovation and growth in the overall economy in the long run. And an inadequate competition policy in the US favoured this evolution: in the absence of regulations on mergers and acquisitions, the superstar firms could grow and expand without limit, thereby discouraging entry and innovation by non-superstar firms in the economy.

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Reforming competition policy so as to better take into account the effect of mergers and acquisitions on future innovation and entry,[l] should both foster innovation-led growth and make growth more inclusive by allowing new innovative entrepreneurs to enter the market.[m]

Education

Recent studies have pointed to the fact that parental income and/or parental education affects an individual's probability to become an innovator. This in turn leads to a so-called 'lost Einsteins' phenomenon: namely, highly talented children that could have become innovators if born to wealthy or well-educated parents fail to innovate if born to poor or low-educated families. The reason is that more educated parents transmit knowledge and aspirations to their children, both of which are needed to become an innovator. An interesting example is Finland. In 1970, Finland reformed its education system to make it more inclusive. As it turns out, parental income or education does not affect the probability of becoming an inventor for those individuals that started school after the reform, but it affects the probability of becoming an inventor for individuals that experienced the pre-reform schooling system. This in turn suggests that investing in a more inclusive and high-quality education system should both stimulate innovation-led growth *and* make growth more inclusive, simply by allowing more talented individuals to become innovators, i.e., by reducing the number of 'lost Einsteins'.

Overall, we are not condemned to choosing between innovation and inclusion, we can activate forces that will make our economies both more innovative and more inclusive, namely by constantly favouring the entry of new innovative firms and the emergence of new talents.

Conclusion

Schumpeterian growth theory has come a long way in the past 35 years. Our greatest hope is that the deeper understanding of capitalism that these stellar researchers have provided will lead to a more humane, harmonious and productive experience of capitalism in the twenty-first century.

Notes

a. See Aghion and Howitt (1998). For other textbook surveys of growth theory from Solow to the Schumpeterian model, see also Grossman and Helpman (1991), Barro and Sala-i-Martin (1995), Acemoglu (2009) and Aghion and Howitt (2009).
b. This collaboration built on previous work on growth with step-by-step innovation, in particular Aghion, Harris and Vickers (1997) and Aghion, Harris, Howitt, and Vickers (2001).
c. See Aghion, Akcigit and Howitt (2014).
d. See Rajan and Zingales (2004).
e. In particular Solow (1956) and Romer (1990).
f. See Acemoglu *et al.* (2006).

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g. See Aghion, Guriev and Jo (2019) and chapter 7 of Aghion, Antonin and Bunel (2021).
h. We refer the reader to the pioneering work by John Haltiwanger and his co-authors on firm dynamics and job creation and destruction in the US. In particular see Haltiwanger *et al.* (2013).
i. Some pioneering papers in this new wave are Akcigit and Kerr (2010, 2018), Acemoglu *et al.* (2018) and Garcia-Macia *et al.* (2019).
j. See Aghion *et al.* (2016).
k. See Aghion, Benabou, Martin, and Roulet (2022)
l. Such reform is advocated by Richard Gilbert (2021) in his recent book *Innovation Matters: Competition Policy for the High-Technology Economy*.
m. That entrant innovation should foster social mobility is shown in Aghion, Akcigit *et al.* (2019).

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