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Catalytic Industrial Policy – in concordia varietas:

The outcome metrics of making the EU an attractive place for green and digital businesses

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Abstract

This essay suggests that there is a need for a Catalytic Industrial Policy (CIP) aimed at maximising positive outcomes on three axes at the same time – the green, the digital and the social – in order to speed up their realisation. Respective investments need to be guided in the desired directions, while ensuring that the benefits of CIP are widely shared, for instance through conditionalities. A bold CIP needs permanent monitoring, including through the use of relevant outcome indicators with pre-defined selection criteria. This essay provides a list of criteria and examples of outcome metrics. A key objective of such indicators would be to shed light on interdependencies. Also, it is important to look beyond those indicators that are already widely used at different levels of disaggregation and also beyond typical industrial policy examples. Alternative examples of indicators provided include, for example, trust in the national government, the operational stock of robots, and the area density of high- and low-voltage circuits in the transmission of electricity. A (perhaps unusual) CIP case could thus be a Europe-wide investment programme in high-quality, technologically sophisticated and sustainable (public) housing in support of the digital revolution, CO_2 reduction and overcoming the housing crisis, thereby legitimising a tremendous ongoing structural change.

Keywords: industrial policy, ecological transformation, technological transformation, quality of life, democratic legitimation, structural change

JEL classification: D63, L16, L52, O13, O14, O15, O18, O25, O32

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1. INTRODUCTION

Article 3 of the Treaty on European Union (TEU) declares that, apart from more general goals such as peace, well-being, freedom, security, justice and free movement, the Union should establish an internal market, and it should work for the sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, the goal of full employment and social progress, and a high level of protection of and improvement in the quality of the environment.

Also, it should promote scientific and technological advance, as well as combat social exclusion and discrimination; and it should promote social justice and protection, including economic, social and territorial cohesion, and solidarity among member states. Other goals include respect for cultural and linguistic diversity, the establishment of an economic and monetary union, a global contribution to peace and security, the sustainable development of the planet earth, solidarity and mutual respect among peoples, free and fair trade, eradication of poverty, the protection of human rights and the development of international law.

More specifically, in its Article 26, the Treaty on the Functioning of the European Union (TFEU) envisages the internal market operating in such a way that the free movement of goods, persons, services and capital is ensured. The Council, acting on a proposal from the Commission, should determine the guidelines and conditions necessary to ensure balanced progress in all the sectors concerned. Article 27 expects the Commission to take account of the extent of the effort that certain economies which display differences in development will have to sustain in the drive to establish an internal market, and it may propose appropriate provisions. Importantly, Article 173 calls for the Union and the member states to ensure the presence of the conditions necessary for the Union's industry to be competitive. To that end, their actions should be aimed at speeding up the adaptation of industry to structural change; encouraging an environment favourable to initiative and to the development of businesses throughout the Union, particularly small and medium-sized enterprises (SMEs); encouraging an environment favourable to cooperation between enterprises; and fostering better exploitation of the industrial potential of policies for innovation, research and technological development.

Previous policies intended to foster the Union's internal market and its industries aimed primarily at raising efficiency at all levels and in all sectors. However, the early twenty-first century has surprised the EU and its member states with a succession of major societal and economic shocks, starting with the global repercussions of the 11 September (9/11) attacks in 2001; then the global financial crisis of 2007, with its related subprime mortgage crisis and the subsequent Great Recession; the European debt crisis from 2009 until the mid- to late-2010s; the populism crisis that led to the election of Donald Trump as US president and to the tragic outcome of the UK Brexit referendum, both in 2016; the removal of term limits on the presidency of China's Xi Jinping in 2018; the COVID-19 recession starting in 2020, which was seamlessly followed by Russia's full-scale invasion of Ukraine in 2022; and the subsequent *Zeitenwende*, which currently promises to accelerate existing structural change in so many areas of the global economic system, to an extent previously unimaginable. The energy price crisis has meanwhile been transformed into a broad-based cost-of-living crisis. The 2023 Hamas attack on southern Israel and the related retaliatory strikes against Palestine's Gaza Strip are just the most recent in a series of crises with global repercussions, against the backdrop of the formation of new alliances, such as BRICS+. The magnitude, distribution and persistence of the impact of these crises – particularly in the EU – is arguably the result of a decades-long primary focus on market-based solutions and a neglect of industrial policy (Cimoli et al., 2009).

As part of a crisis-introduced general paradigm shift, younger generations of researchers and policy makers are rediscovering the trade-off between efficiency and security, in its broadest possible definition – ranging from social security, cyber security, value-chain security, energy security, all the way to military security and, above all, climate security. Also, geographical space is being rediscovered as an important parameter of analysis (such as in geo-politics and geo-economics); this goes hand in hand with the rediscovery of time and path dependency and the related historical context of the phenomena that we observe.

Today, it is widely acknowledged that, in order to successfully tackle the twin green and digital transitions amidst an ongoing demographic transition, policies will have to take account of popular discontent with democratic decision making, related regional disparities, geo-political rifts and the need to regain the trust and the willingness of the broad majority of the population to support often painful structural change. In a more philosophical way – and in a continuation of Sigmund Freud's 'civilisation and its discontents' (Freud, 1930), Michael Sandel identifies the 'tyranny of merit' (Sandel, 2020) as a major defect of our current society. Meritocracy today functions less as an alternative to inequality than as its primary justification, with all its repercussions for the definition of policies during structural change.

Similarly, Nassim Nicholas Taleb vigorously emphasises the randomness of our social pecking order and suggests applying 'skin in the game' (Taleb, 2018) as a rule, in order to reduce the effect of divergences that evolved with civilisation – for instance, between action and cheap talk; entrepreneur and chief executive; collective and individual; but also between human beings and economists, as well as between Coventry and Brussels. Why does Taleb mention the divergence between Coventry and Brussels? Well, because Coventry is one of the declining car-manufacturing cities with high unemployment rates that voted for Brexit – which Andrés Rodríguez-Pose (2018) identified as 'the revenge of the places that don't matter'. This hints at the fact that – for all its advantages – agglomeration can trigger a number of negative externalities, and that for too long territorial inequality was considered almost irrelevant (Wolf, 2023). While the decline of Coventry and other 'left-behind' places in northern and central England is largely the result of decades of neglect by the UK's regional and economic policies (Martin et al., 2022), the strong agglomeration effects of the EU single market and the paucity of the EU budget available for the better development (or at least the compensation) of peripheral regions certainly contributed to the decline.

From the above it becomes clear that a new version of industrial policy must be at the heart of this (second) Great Transformation of Karl Polanyi's market society (Polanyi, 1944). This essay aims at discussing the political economy of a modern 'Catalytic Industrial Policy' (CIP – it is unintended, but not inconvenient, that the abbreviation could be mistaken for UNIDO's Competitive Industrial Performance Index, CIP), which could help mobilise and target investment towards structural change in line with the demise of the fossil-fuel age and the onset of the age of artificial intelligence (AI). At the same time, much can be learnt from previous episodes of structural change, such as those experienced in Central, East and Southeast Europe after the collapse of communism (Kozul-Wright, 1996) and its social and political dimensions.

Suggestions will be presented for measurable outcome indicators for each of the broad goals of the CIP in the areas of democratic legitimation and support for (particular directions of) structural change, based on a better quality of life, as well as an ecological and technological transformation in support of green and digital business. Policies that are truly catalytic must affect all three challenges – green, digital and social – in order to speed up their realisation (this is obviously somewhat different to earlier definitions of the term *catalytic* by Kozul-Wright, 1996 following Teubal, 1996, 1997). While any choice of indicators must ultimately remain arbitrary, it is of the utmost importance to measure the failure or success of new industrial policies, in order to ground them in a modern, evidence-based policy framework. Therefore, it is equally important to define certain selection criteria for these indicators, so that they are as transparent as possible.

2. THE OUTCOME INDICATORS

For the sake of continuity and comparability, the choice of CIP outcome indicators should, at least partly, take into account earlier and ongoing attempts at industrial policy metrics, such as DG GROW's Single Market Scoreboard and its Advanced Technologies for Industry dashboard; the Joint Research Centre's Industrial R&D Investment Scoreboard; the OECD's Quantifying Industrial Strategies (QuIS) project (Criscuolo et al., 2022); the UN's Sustainable Development Goals (SDGs); earlier attempts by UNIDO (2015) to quantify structural transformation; or the ongoing measurement of the performance of EU industrial ecosystems, as commissioned by the European Innovation Council and SMEs Executive Agency (EISMEA).

While some indicators will be similar to those used earlier, we will also suggest several indicators that would offer a fresh outlook on the topic, including those that operationalise certain broader concepts that might serve a CIP, such as the positive Nordic role models described in Martin Sandbu's *The Economics of Belonging* (Sandbu, 2020), or specific elements of a war economy in the organisation of a CIP that are currently being discussed – elements drawn from the darkest chapters of our history, as described in Adam Tooze's *The Wages of Destruction* (Tooze, 2006). The guiding principle for the choice of outcome metrics for making the EU an attractive place for green and digital businesses should be to find pragmatic solutions for a prosperous, democratic and peaceful Union.

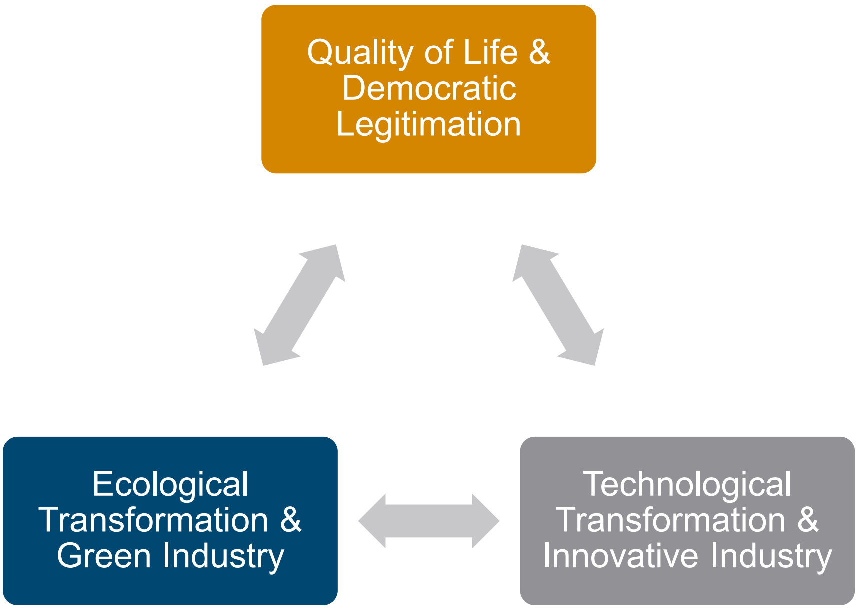
The general framework to justify the choice of indicators in different areas relies on a heuristic model of interdependencies of at least three important concepts in the context of this essay: i) ecological transformation and the establishment of a green industry; ii) technological transformation and the fostering of an innovative industry; and iii) democratic legitimation of structural change, based on a high quality of life (and dealing specifically with the distributional consequences). The common denominator of these is grounded in their strong endogenous dependencies, comparable to the basic idea of the model of endogenous production networks (Acemoglu and Azar, 2020). Different combinations of inputs generate different levels of productivity and various distortions that may affect costs and prices. As an example, a technological shock affecting a specific industry in the endogenous production network could lead to a cascade effect, with declining prices, as industries interact with each other as suppliers.

Similarly, it might be argued that the outcomes of all three focus areas of this essay are related to each other, where a vector of outcome indicators *Y* in area *i* is a function *F* of a vector of outcome indicators in the other two areas *A*, as well as a vector of area-specific input indicators *S* and a vector of policy measures *P*. The latter two factors are assumed to be more or less exogenous. The relationship can be described as follows:

$$Y_i = F_i(A_i, S_i, P_i)$$

The core relationship of this 'endogenous network of Catalytic Industrial Policy' can also be presented in graphic form, as in Figure 1, where each area is in a two-way relationship with each of the other areas. Extensions of this model can include additional areas, as well as dynamic elements, with *inter alia* a lagged *Y* being part of function *F*. Obviously, in such a framework, the difference between an outcome indicator and an input indicator becomes fuzzy.

Figure 1 / Endogenous network of Catalytic Industrial Policy



Source: Own elaboration.

An example of a two-way relationship between, for instance, the area of democratic legitimation of structural change and the area of technological transformation could be the impact that an increased concentration of information and knowledge in the process of the digital revolution has on the market, making it increasingly a centralised system, with the consequent effects on prices and income distribution (i.e. socio-economic and political power outcomes). *Vice versa*, credible and robust state capacity could provide democratic regulation of digital technologies, with an impact on the outcome of the technological transformation.

Similarly, the construction of the high-voltage transmission lines needed for a successful ecological transformation could have a regionally differentiated impact on popular support for structural change. Conversely, low levels of trust in the society and related populist governments may lead to a lack of support for the construction of much-needed green infrastructure. Finally, an unfavourable energy mix during the ecological transformation could lead to unreliable and costly electricity generation, which would in turn inhibit the development of electricity-intensive economic activities as part of the technological transformation. Also, innovations could lead to new technological solutions that may help substantially accelerate the ecological transformation in many ways.

Identification of the specific outcome indicators in the single areas is based on the following pragmatic selection criteria. The choice of each individual indicator is: a) related to its relevance to the specific area, but also to the other two areas, due to the relationships described above; b) depends on the availability of the respective indicator across time and space; c) based either on its inclusion in earlier collections of related indicators (in order for it to be rooted in ongoing analysis and research and to allow for comparability of the various collections of indicators); d) or else based on a deliberate decision to present an indicator that is not typically found in this type of metrics publication, but that is required to cover a specific aspect of the desired outcome of CIP that needs additional explanation to support the decision in the earlier-described context of a world that is moving toward less efficiency and more security. Moreover, the indicators chosen should, wherever useful and possible, be: e) presented separately from their aggregate, also in disaggregated form, in acknowledgement of the fact that aggregate figures often miss major developments (e.g. in their regional, sectoral or gender dimensions). And the indicators should be: f) related to the broad goals that are set out in Article 3 of TEU and Article 173 of TFEU. In addition to the above criteria governing the indicators, it would be useful to apply the SMART criteria (Doran, 1981), widely used in setting goals and objectives in management, but also in policy monitoring and evaluation. Thus, the indicators should also be: g) Specific (i.e. focused and not too broad); h) Measurable (i.e. a clear unit of measurement is needed); i) Achievable (originally, in Doran, 1981, this criterion was termed Assignable; but today it is rather the realistic dimension of an indicator that is addressed); j) Relevant (originally named Realistic, now the criterion aims for a clear relationship to the intended outcomes); and k) Time-bound (i.e. trackable over a particular timeframe). While there is a certain overlap with the previous selection criteria, SMART criteria are particularly useful when it comes to choosing certain operational measures for the performance of programmes and projects.

In this respect, it might make sense to present indicators that allow for comparison at the level of the EU and other economies of Europe and the world; at the level of the EU member states; where available, at the sub-national, regional level (or e.g. the level of urban, suburban and rural communities); as well as at the sectoral level. Or else they could be presented using other characteristics, such as gender. Given that many of the issues discussed describe medium- to long-term processes, the indicators' periodicity should focus on, for example, five-year averages, five-year growth rates, five-year end-of-period levels, and also longer historical time series with higher frequencies. Every five years, a new review and stock-taking could inform the public at large of the success of the EU's, member states' and regional or even municipal CIP. Some preliminary ideas for the indicators, by major CIP goals, are presented in the following. Most of the indicators are readily available from Eurostat or other EU institutions. Additional indicators may be obtained from international public and private databases. Thus, we introduce a selection of indicators in the three interrelated areas of the endogenous network of Catalytic Industrial Policy.

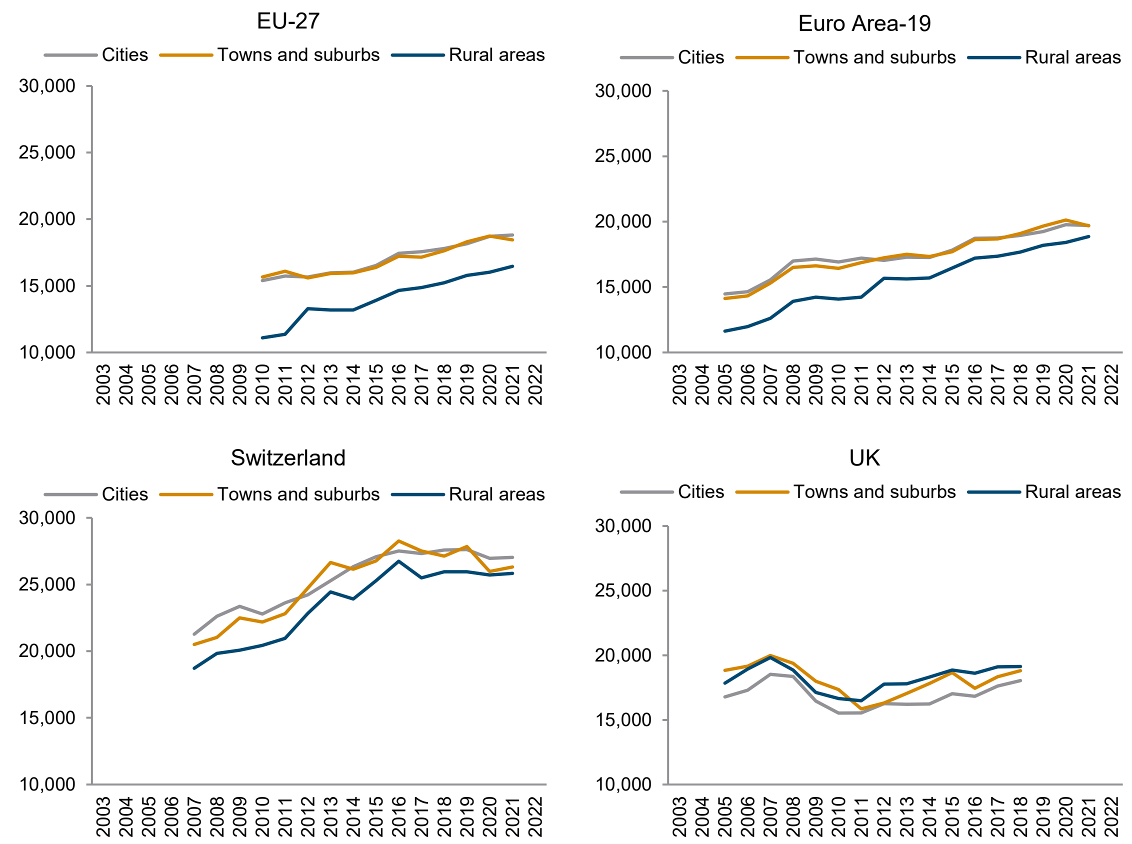
3. A BETTER QUALITY OF LIFE IN SUPPORT OF DEMOCRATICALLY LEGITIMATED STRUCTURAL CHANGE

Here, various measures of a 'good life' (WHO, 1998; Bok, 2010; Eurostat, 2017; UNDP, 2022; Helliwell et al., 2023) that supports the democratic legitimacy of the ongoing structural change could be collected, such as median income at purchasing power standards; indicators of household consumption of the finer things in life (see e.g. Holzner and Römisch, 2021; Urban Public Services and Liveability Index, UPSLIde); a measure of wage compression (allowing for automation, a competitive high-skill sector and social cohesion following the Nordic model); indicators of public services and welfare; measures of (regional) inequality; the age at which young people leave the parental household (acknowledging the ongoing housing crisis); indicators of full employment (following the logic of a guaranteed job programme, as evaluated by Kasy and Lehner, 2022); the degree of job displacement and job reallocation across regions, sectors and occupations, different skill, educational, age and gender groups (from Labour Force Survey data); as well as measures of leisure and free time, and also related indicators of participation, support and trust in the democratic system and the government (following, for instance, Massimo Morelli's research on populism – e.g. Morelli et al., 2022; Bellodi et al., 2023). One might also think of measures of a 'social-pillar-Brussels-effect' among the EU's trading partners (in view of exporting labour regulations, as well as goods and services, for a win-win outcome – as observed in economic history by Huberman and Meissner, 2010). A better quality of life and less insecurity for the vast majority of the population is a precondition for a healthy democratic process that is able to initiate necessary structural change, in particular involving technological and ecological transformation.

Let us start with median equivalised net income at purchasing power standards (PPS), differentiated by degree of urbanisation (Figure 2). This provides us with an idea of the material conditions experienced by average households in cities, towns and suburbs, as well as in rural areas. As a caveat, it needs to be mentioned that the PPS are estimated at the national, rather than the regional level. Thus, there is likely to be a downward bias for rural incomes and an upward bias for urban incomes. This indicator can be related to Article 3 of TEU, which seeks sustainable development in Europe based on balanced economic growth and price stability, also including economic, social and territorial cohesion. Indirectly, the indicator also relates to Article 173 of TFEU, since higher middle-class income across the member states has the potential to foster an environment conducive to initiative and to the development of businesses throughout the Union (particularly SMEs), both by creating enough demand for new businesses and by ensuring that the income and savings of large sections of the population are adequate to maximise the number of business founders and their investment.

For the EU and the euro area, recent PPS figures are very similar to the nominal euro figures. Cities, towns and suburbs have almost the same level of median disposable income both in the EU and in the euro area – close to about 20,000 PPS in recent years. The median incomes in rural areas in the EU and the euro area are, respectively, some 10% and 5% lower. It is reassuring to see that the gap has been narrowing over time (though this is likely due to rural-urban population movement); and given the afore-mentioned regional price differences, the actual values may already be very similar. Moreover, there has been a steady increase in median net incomes over the past decade and a half – e.g. by 2% per annum in euro area cities.

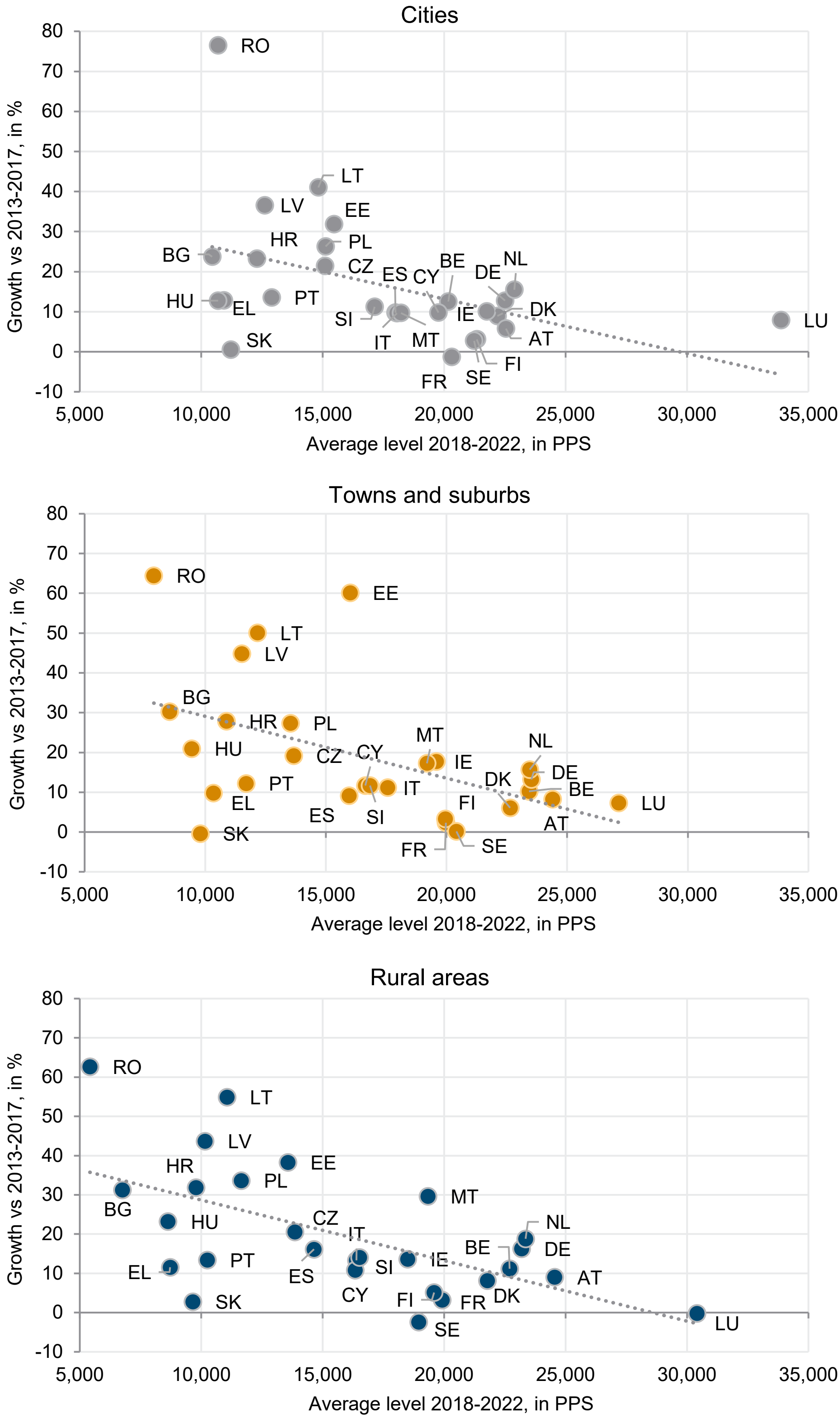
Figure 2 / Median equivalised net income at PPS, by degree of urbanisation, international comparison



Source: Eurostat Indicator ILC_DI17.

By comparison, Switzerland – one of the EU's main trading partners and a hub for global financial services – has a much higher level of median income: about 27,000 PPS in cities and some 26,000 PPS in towns and suburbs and rural areas. However, in 2015 the Swiss National Bank's interest rate on sight deposits turned negative: it is interesting to note that this – combined with an appreciating Swiss franc – has meant that disposable median incomes at PPS have largely stagnated. In the case of the United Kingdom of Great Britain and Northern Ireland (UK), it is notable that in recent years median income levels in cities, towns and suburbs have been comparable to those in the EU and the euro area, while the UK's rural areas have witnessed median income slightly above those PPS levels. If one were to remove London and a few other more prosperous cities in southern England from the aggregated data for cities, the low levels of median net income in some of the poor cities of northern and central England would become apparent. This hints at the need to further disentangle aggregated data at the regional level and along the income distribution. Another striking aspect of the UK's median disposable income data is the fact that by 2018 (the latest available Eurostat figures), income levels had still not returned to the peak of 2007 (i.e. before the outbreak of the global financial crisis). The UK's time series are characterised by massive economic volatility, as well as long-term stagnation, which may have contributed to popular discontent in the run-up to the Brexit vote and Great Britain's exit from the EU single market.

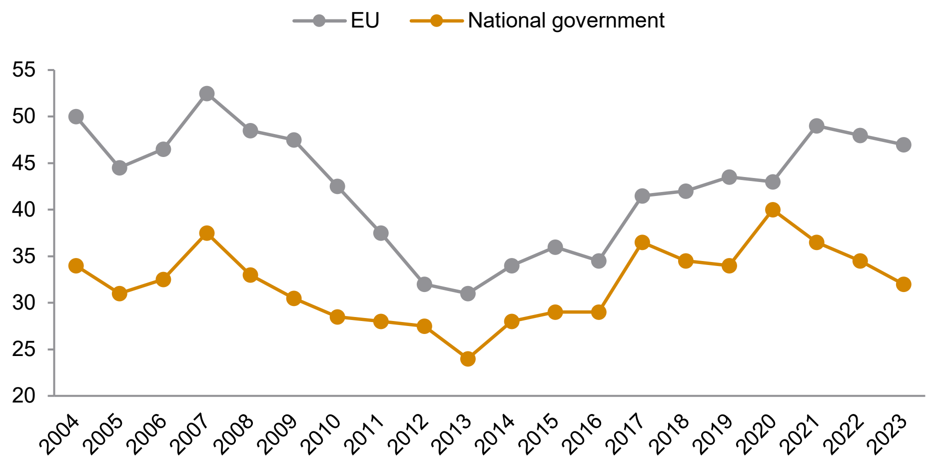
Figure 3 / Median equivalised net income at PPS, by degree of urbanisation, EU comparison



Note: The vertical axis depicts the growth rate of the average level of median equivalised net income at PPS between the period 2018-2022 and 2013-2017.
Source: Eurostat Indicator ILC_DI17.

Finally, we look at the average level of median net income in the EU member states for the period 2018-2022 and see how it has grown compared to the average level in 2013-2017 (Figure 3). While divergence analysis relates initial status to subsequent growth, here the perspective is the opposite; however, this provides similar information about differences in levels and dynamics, while at the same time reducing volatility by using averages and providing information for the more recent period. Clearly, there is a lot of heterogeneity across the member states. Cities in the Eastern and Southern EU member states have median net income levels of about 10,000-15,000 PPS on average for the period 2018-2022, while income in cities in the Northern and Western member states is in the range 20,000-23,000 PPS. Compared to the levels for the period 2013-2017, we find an even bigger variation in terms of the growth rates, particularly among Eastern and Southern cities: these range from stagnation in Slovakia all the way to a staggering 80% increase in Romania. Meanwhile income growth in Northern and Western cities was around 5-15%. Interestingly, French cities are the only ones in the Union to have seen a drop in median net incomes (incomes in French suburbs and rural areas were also close to stagnation) – something that might have contributed to the broad-based outbreak of the Yellow Vests protests in 2018. Observations in the scatter plots for towns and suburbs in the Union, as well as for rural areas, are spread more evenly along the hypothetical regression lines. This includes extremely poor rural areas in Romania and Bulgaria (with median income levels of around 6,000 PPS), as well as rich rural areas in Austria, for example, which have a higher median income level than Austrian cities.

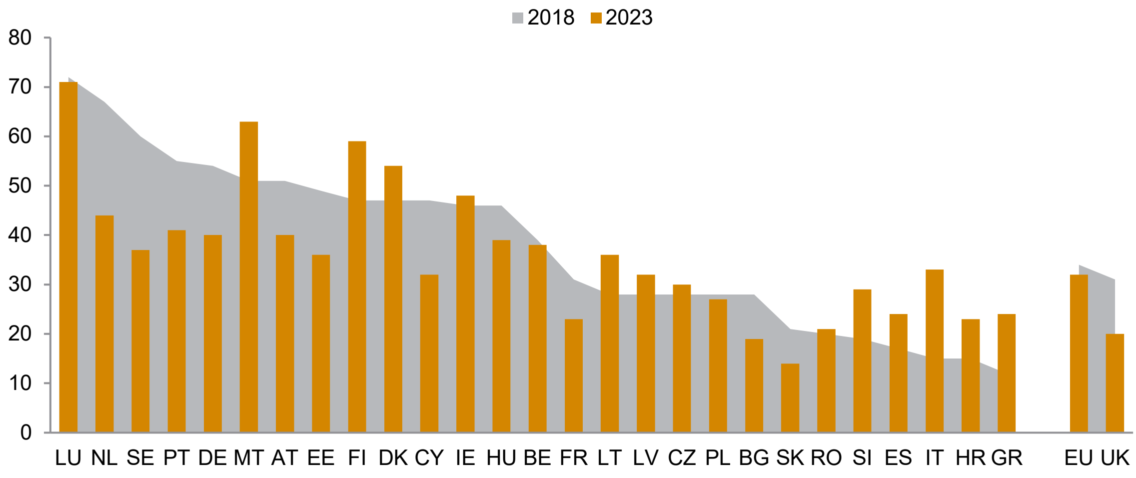
Figure 4 / EU citizens that tend to trust the EU and their national government, % of total



Source: Eurobarometer.

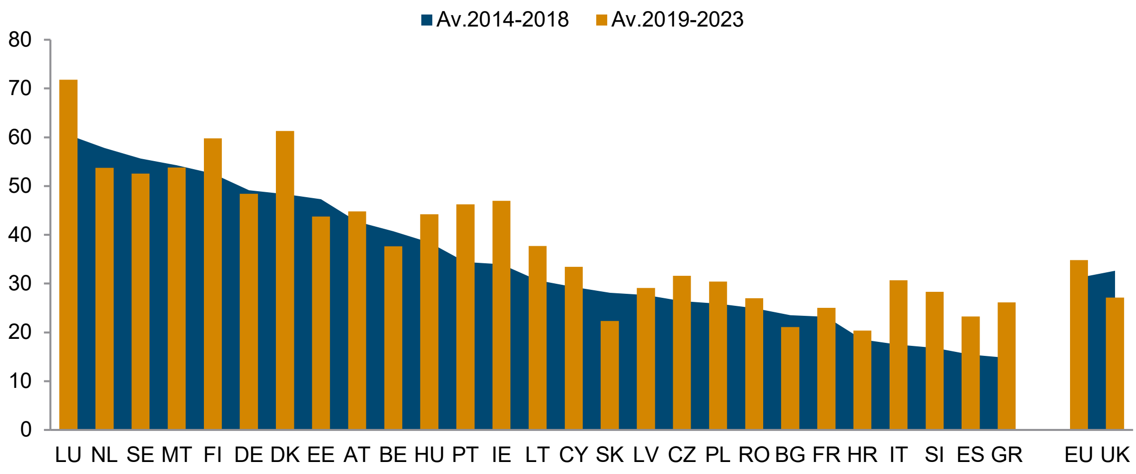
As Massimo Morelli's work has shown (e.g. Morelli et al., 2022; Bellodi et al., 2023), polities have reacted differently to economic shocks: this is manifested not only in the level and change of income, but also in the development of trust in the governing elites. A lack of trust leads to a self-reinforcing vicious circle of populism, whereby political mismanagement brings a further deterioration in incomes and trust levels, with all the consequences that has for the single market and the legitimacy of policies of structural change. Clearly, the global financial crisis and the subsequent mismanagement of the euro area crisis eroded the trust that EU citizens had both in the EU and (particularly) their national governments (Figure 4). Similarly, after some degree of recovery, the pandemic and the energy price shocks again dragged both time series down, with national governments faring even worse than the EU. It may be argued that – at least indirectly – this indicator is related to the aim of Article 3 of TEU of promoting social justice and protection, and the goal of Article 173 of TFEU of speeding up the adjustment of industry to structural change.

Figure 5 / Citizens who tend to trust the national government, 2018 and 2023, % of total



Source: Eurobarometer.

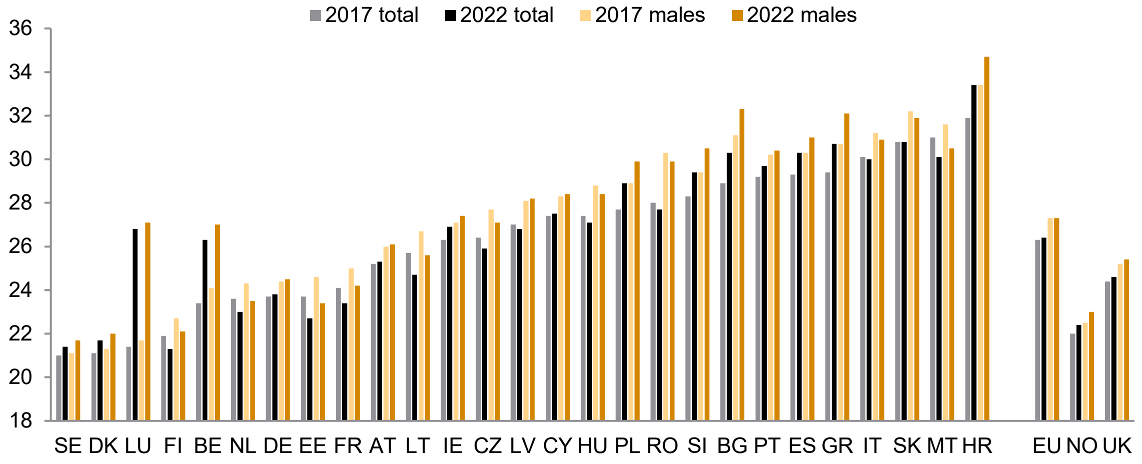
Figure 6 / Citizens who tend to trust the national government, 2014-2018 vs. 2019-2023, as % of total



Source: Eurobarometer.

When we look at trust in national government at the level of EU member states, we see that this trust has been lost in recent years, especially in those polities that previously enjoyed relatively high levels of trust (Figure 5). The largest relative fall in the most recent figures (from early 2023) from the average of 2018 can be observed in Sweden, where trust in the national government has plummeted by almost 40%. That is even greater than the fall in trust in the UK over the same period. Incidentally, Sweden is one of the EU member states that have had the most disappointing trends in median disposable income (also reflecting a marked increase in inequality over recent decades), as documented in Figure 3. Among those member states that had a low initial level of trust, Slovakia fared worst, with a decline similar to Sweden's. Again, Slovak median incomes have performed badly over recent years. Overall, with typically only around a third of the electorate trusting their government, European democracies are facing a serious problem with legitimacy – and concomitantly also with their policies of structural change. Nevertheless, trust in government is dependent not only on material well-being, but also on a number of other factors. However, when we look at the medium-to-longer-term trends, by comparing the average for the period 2014-2018 and for 2019-2023, we find fairly similar results as before – albeit with fewer extremes (Figure 6). Again, Slovakia is one of the EU member states with an extremely low level of trust in the government and where the residual trust decreased most over the medium term. Recent election results seem to bear out Massimo Morelli's conjectures.

Figure 7 / Average age of young people leaving the parental household, total and males



Note: NO 2021 and 2022, UK 2017 and 2019; ranking according to 2017 total.
Source: Eurostat (yth_demo_030).

An important source of legitimacy arises from the question of whether a society is able to satisfy the basic human needs of its people. Often, an improvement in human capital is demanded, without acknowledgement of the fact that behind human capital are human beings with human needs. A basic need for young people is to establish a household and hence a self-determined life. In this sense, the following indicator on the average age of young people leaving the parental household (Figure 7) is also related to the question of how to master the technological transformation, given that young people will need to lead the digital revolution; meanwhile the pandemic has (probably permanently) increased demand for larger homes with access to balconies or terraces, as well as with the space and infrastructure for home-office workplaces. It is thus also related to the demand of Article 3 of TEU for social progress; Article 27 of TFEU, which mentions differences in development; and Article 173 of TFEU, which requires an environment to be fostered that is conducive to initiative and to the development of businesses throughout the Union, particularly SMEs.

The average young person in the EU leaves the parental home at the age of about 26. If anything, this value has increased slightly over recent years. It is also substantially higher than in Norway or the UK, for example. Among EU member states, the youngest to establish a household of their own are the Swedes and the Danes, at about 21 years of age on average. This implies that even some Scandinavian minors have the chance to embark on an independent life. At the other extreme are young Croats, with an average age of 33, according to the most recent data. That means that even some 40-year-olds must still be living with their parents. While there may be some cultural element to these differences, it is very likely rather the lack of the material wherewithal and of a proper housing policy that explains these stark differences. Moreover, between 2017 and 2022, on average in the EU member states this figure increased by about half a year – an indication of the housing crisis that is unfolding especially in larger cities. Particularly Luxembourg, Belgium and Croatia have seen the average age at which young people leave home increase by several years between 2017 and 2022. Moreover, it is interesting to observe that young males, on average, leave home a year later than the total average. In Bulgaria and Romania, it is even two years later.

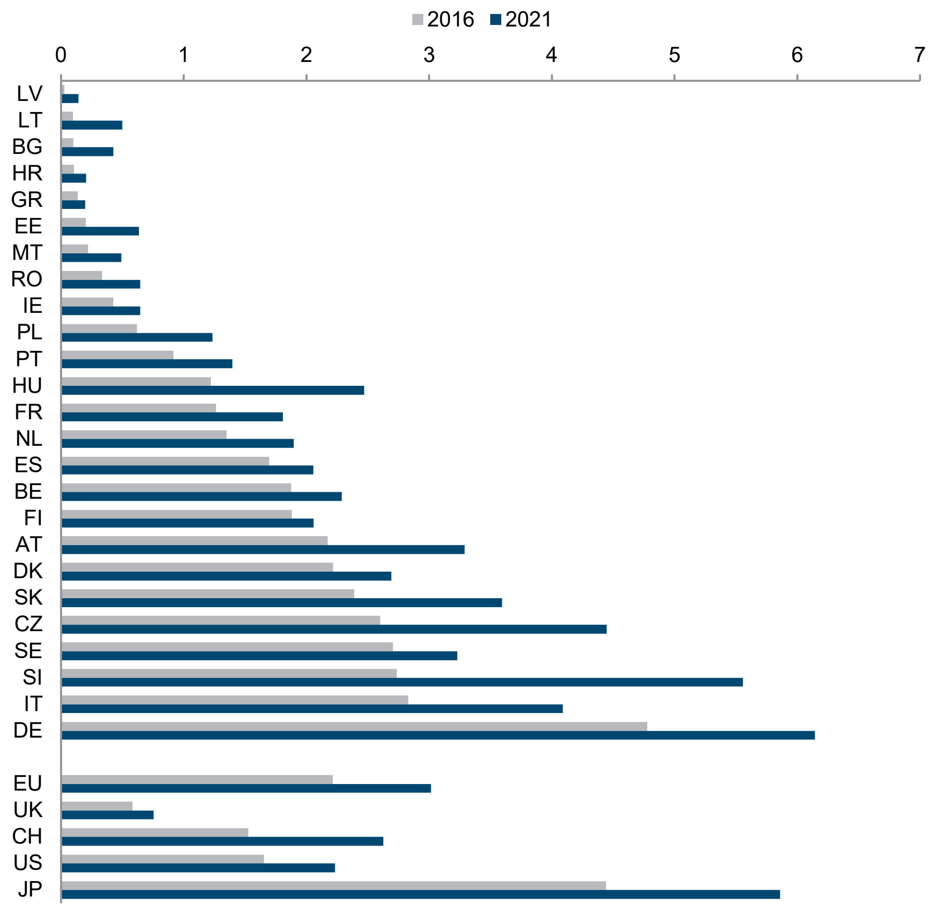
Given the greater political radicalisation potential of young men, as well as the fact that they account for a larger share of science and technology graduates (see next section), it is essential to bring about a reduction in the average age of youngsters establishing their own households, as well as to close the existing gender gap, following the example of Scandinavian societies. It is indicative that trust in the national government is particularly low in those countries where the housing crisis is the most severe. The promotion of a flexible and fair rental market and large-scale, high-quality and sustainable (public) housing projects in Europe's cities could help improve the legitimacy of the ongoing structural changes, as well as increase the likelihood that the technological and ecological transformations can be successfully mastered – thus initiating a virtuous circle in our endogenous network of Catalytic Industrial Policy.

4. MASTERING THE TECHNOLOGICAL TRANSFORMATION BY FOSTERING A STRONGER AND MORE INNOVATIVE INDUSTRY

In this section, a diverse set of indicators acknowledges the complex and sometimes even contradictory policy choices (e.g. more automation vs. full employment) that the technological transformation will render necessary and that are the foundation for a European industry that is competitive at the global level and hence able to provide the material basis for a prosperous and self-determined society. This might involve very specific measures of success for mission-oriented innovation (maybe even bolder and more concrete than those missions suggested in Mazzucato, 2018 – such as an almost utopian success in materials research leading to a functional, large-scale fusion reactor), general company-level measures of innovation (also based on data from the community innovation survey – CIS – that measures perceptions), patents and scientific publications. It could also include market concentration indices for certain high-tech industries (such as the aerospace industry or the ICT sector) and for the number of important players from the EU; rankings of top R&D tech spenders; various indicators of smart specialisation strategies (S3 or S3 2.0 and related measures, as suggested by Esparza-Masana, 2022); indicators of industrial resilience (e.g. further developing the OECD's 2021 industry dashboard on Strengthening Economic Resilience Following the COVID-19 Crisis); as well as alternative resilience indicators (which might include information on the share of cooperatives in the total number of companies). Furthermore, one might think of measures covering digitalisation, including AI-exposure indicators (Felten et al., 2021); broadband internet infrastructure, particularly in peripheral parts of the Union (the indicators of the Digital Economy and Society Index, DESI, would be a logical starting point); indicators of automation (such as International Federation of Robotics data on robots); measures of functional specialisation and upgrading in value chains (as suggested, for example, by Kordalska et al., 2022 and based on fDi Markets data for greenfield investment); standard industrial and educational indicators; and indicators of specific sub-sectors that might be of particular importance, such as electronics or the defence industry.

Given the demographic pressures, as well as the need to upskill large parts of the population, further automation of all possible activities (particularly those involving a low level of skill) is imperative. A relevant measure of automation is the operational stock of robots across all industries, as provided by the International Federation of Robotics (IFR). This indicator is clearly related to the aim of Article 3 of TEU of promoting technological advance and the goal of Article 173 of TFEU of fostering better exploitation of the industrial potential of policies of technological development. In order to make the indicator comparable across economies, we calculate the stock of robots relative to total employment (Figure 8). In comparative terms, the EU is doing very well: in 2021, there were about 3 robots per 1,000 persons employed in the EU – far more than in the UK, the US or Switzerland. Japan, with its long experience of an ageing society, has almost double the number of robots in operation. Compared to the situation in 2016, the EU stock of robots grew by 36% – more than in any of the other comparator economies, except for Switzerland (which had almost double the rate of increase).

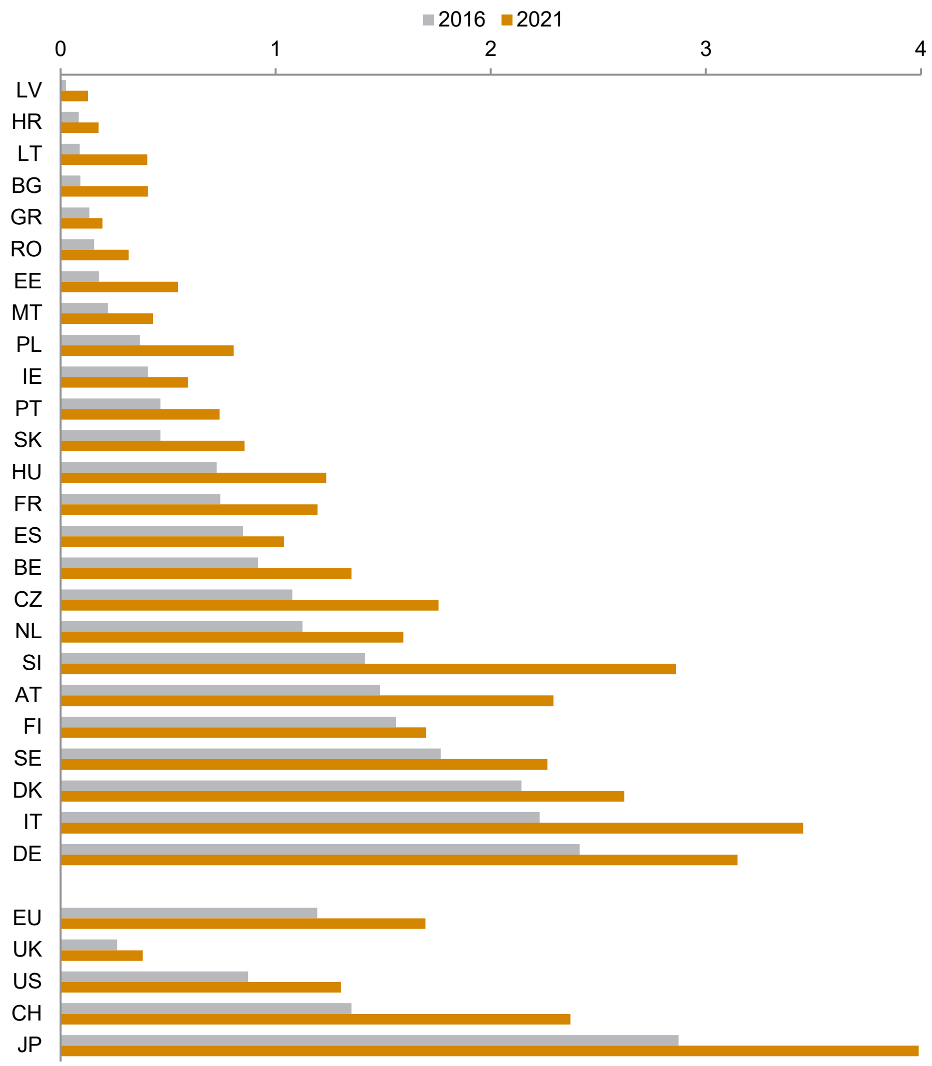
Figure 8 / Operational stock of robots in all industries relative to 1,000 employed aged 15-64



Note: Employment according to LFS. US and UK employed aged 16 and over, JP 15 and over. Ranking according to 2016.
Source: IFR, Eurostat, national statistics.

Once again, there is considerable heterogeneity among the EU member states, in terms of both level and dynamism; this also reflects the different robotisation regimes in Europe (Reljic et al., 2023). Germany clearly leads in terms of the intensity of robot use, with relative stock numbers above the Japanese level. Interestingly, Slovenia comes second, having more than doubled its robot stock between 2016 and 2021. Together with Czechia, Slovenia has surpassed Italy, which in 2016 ranked second in the EU. Member states on the periphery of the Union often have very few robots in operation. Nevertheless, we find the greatest increase in the number of robots in those member states that joined the Union after 2004. Those economies are ageing even faster than other member states further to the west and – given their lower wage levels – had previously specialised in labour-intensive functions, often in the automotive industry; they can be classified as factory economies, given their functional specialisation in the global value chains.

Figure 9 / Operational stock of robots in all industries, except the automotive, relative to 1,000 employed aged 15-64

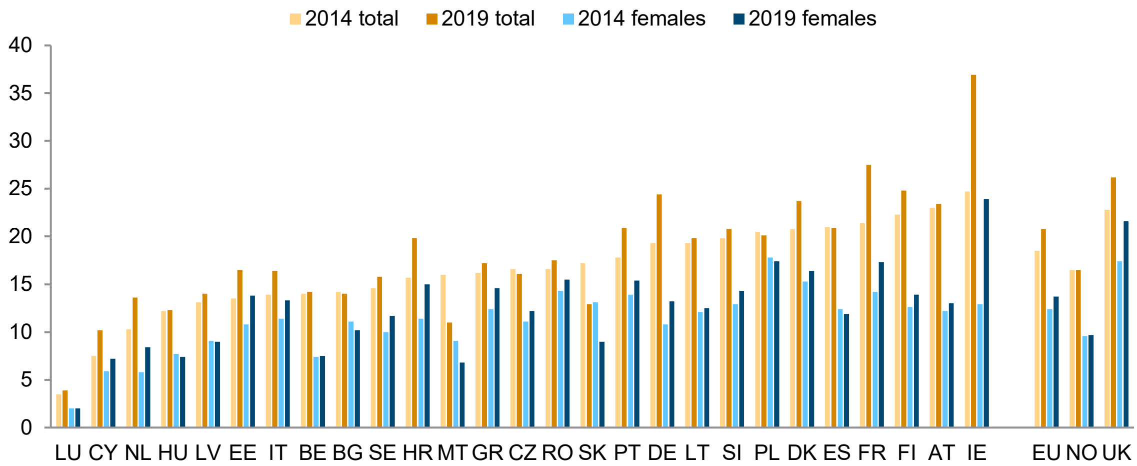


Note: Employment according to LFS. US and UK employed aged 16 and over, JP 15 and over. Ranking according to 2016.
Source: IFR, Eurostat, national statistics.

However, the picture does not change dramatically even if robots from the automotive industry are excluded – though certain changes in the ranking do occur (Figure 9). In 2021, the EU fell substantially behind Switzerland, and no EU member state now has more robots per employed person than Japan. Also, without the automotive robots included, Italy has more robots per worker than Germany. Within the EU, Slovenia comes third, followed by Denmark, Austria and Sweden. Again, most of the peripheral economies from the eastern flank of the EU have the lowest levels of robotisation, but also saw the highest growth rates between 2016 and 2021.

Moreover, in the framework of Sandbu's *Economics of Belonging*, a policy of wage compression with the aim of increasing overall productivity and competitiveness involves not only higher minimum wages and related increased automation and upskilling efforts, but also massive investment to boost the supply of highly skilled workers. One indicator that could tell us more about the necessary supply of highly skilled human capital – particularly in view of a successful technological transformation – is the share of college graduates in science and technology in the relevant age group (Figure 10). Furthermore, this indicator is also among the traditional indicators used in the EU to describe the digital transition, as collected by the European Commission for its Digital Scoreboard. The indicator relates to Article 3 of TEU, which aims at a highly competitive social market economy, as well as Article 173 of TFEU, which seeks better exploitation of the industrial potential of policies of innovation, research and technological development.

Figure 10 / Science and technology graduates per 1,000 inhabitants aged 20-29, total and females

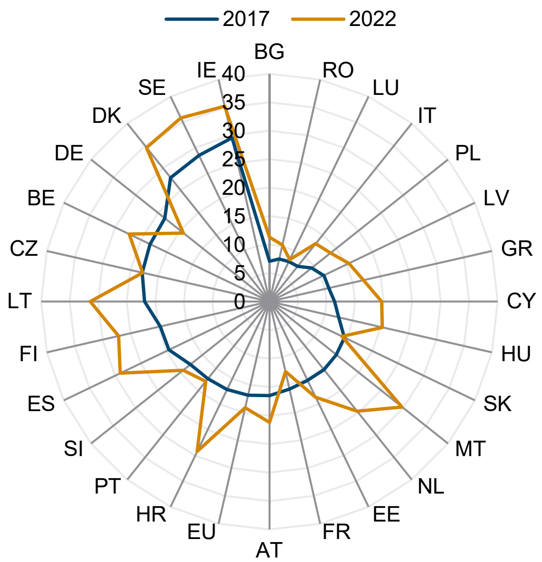


Note: New college graduates in a calendar year from both public and private institutions completing graduate and postgraduate studies, compared to an age group that corresponds to the typical graduation age in most countries. Ranking according to 2014, with data for FR and NL from 2015 and NO 2017.
Source: European Commission, Digital Scoreboard.

In recent years, the EU has been able to increase the number of science and technology graduates per 1,000 inhabitants aged 20-29, so that by 2019 the figure stood at almost 21 per 1,000. This is some 2 percentage points higher than in 2014. Interestingly, among young women, the figure increased by only 1 percentage point over the same period (to just under 14 per 1,000). Interestingly, both figures are higher than in Norway, but much lower than in the United Kingdom. In the UK especially, the relative number of female college graduates in science and technology has increased sharply in recent years, pushing up the total figure to more than 26 per 1,000 inhabitants aged 20-29. Only two EU member states have managed higher levels: France (27) and Ireland (37). Ireland must be regarded as a best-practice example: it witnessed a staggering increase of almost 50% in the total figure between 2014 and 2019, while among women the figure virtually doubled. This hints at the importance of bringing girls into science.

However, increased automation and high levels of human capital are only preconditions for a successful digital revolution: in the final analysis, there must be companies that invest and have the right business environment to take advantage of the new technologies and related best practices. In this respect, it is interesting to see how many SMEs have embraced the opportunities presented by digitalisation and that are, for instance, selling online (Figure 11). This indicator relates both to Article 3 of TEU (as it shows technological advance) and Article 173 of TFEU (as it deals with small and medium-sized businesses and with the better exploitation of the industrial potential of policies of innovation, research and technological development). The indicator is also regularly analysed within the framework of the European Commission's Digital Economy and Society Index (DESI) dashboard.

Figure 11 / Share of SMEs selling online, in %



Note: Ranking by 2017 values, clockwise, starting from the top.
Source: European Commission, Digital Economy and Society Index (DESI) dashboard.

The indicator shows that only about 19% of the EU's SME's were selling their goods and services online in 2022 – only a slight improvement of about 2 percentage points on 2017. SMEs in Eastern and Southern member states of the Union have particularly low levels of e-commerce. The top scores – with more than a third of SMEs active in e-commerce – are recorded in Ireland, Sweden and Denmark. Strong growth in recent years has been recorded in Malta, Croatia, Spain and Lithuania: those countries now have figures of around 30% of SMEs doing business online. It is shocking to discover that two EU member states have actually seen a sizeable fall in this figure over recent years – specifically the heavyweights France and Germany, whose current levels are only at or below the EU average.

On the one hand, this shows that the digital economy is an area where leapfrogging is possible. On the other hand, it also shows how slowly technological progress is being adopted by most societies. What is important to mention in this respect is that advances in this type of technological change have the potential also to improve the democratic legitimation of structural change, as well as to further the ecological transformation of the economy. Even if the current level of knowledge is still fairly low, e-commerce facilitates (at least potentially) more sustainable production processes and consumption patterns, and ensures greater circularity (Collini et al., 2022). Similarly, increased teleworking and e-commerce tend to reduce commercial real estate prices, which can also have a dampening effect on the dire situation facing young people of sky-high residential housing prices (Deghi et al., 2022). Thus, again, as in the case of housing policies, SME digitalisation initiatives can have a positive impact on the interconnections in our endogenous network of Catalytic Industrial Policy.

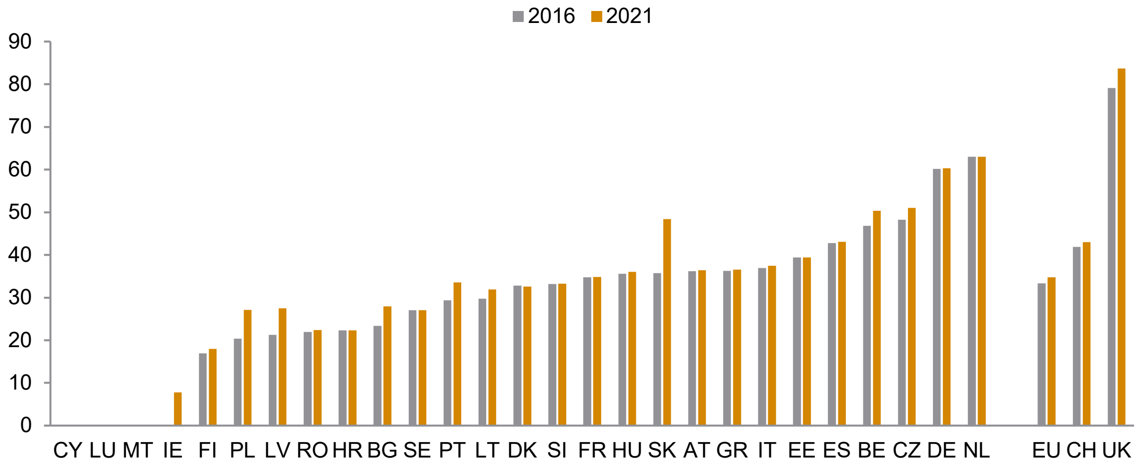
5. MASTERING THE ECOLOGICAL TRANSFORMATION BY ERECTING A LADDER FOR THE EU'S GREEN INDUSTRY

Here again, a multitude of indicators can support the medium-to-long-term evaluation of the establishment of green infrastructure and business. This includes, for instance, traditional data on green energy supply (as collected *inter alia* by the International Energy Agency's Clean Energy Transition Indicators) and related high- (and low-) voltage transmission lines; green mobility infrastructure indicators (which measure, for example, the shift from air transport to rail transport, including high-speed rail infrastructure, as suggested in the European Silk Road initiative – Holzner et al., 2022 – or, more recently, in a Europe's Rail Joint Undertaking in collaboration with ALLRAIL, CER and UNIFE – EY, 2023); indicators on sustainable finance (as collected by the European Central Bank on an experimental basis); and indicators of the decoupling of industrial production and emissions (such as *inter alia* collected in the IMF's Climate Change Indicators Dashboard). This could also include standard indicators of green growth (see, for example, the OECD's 2017 green growth indicators framework) and green transition (as depicted, for instance, in the common indicators of the Recovery and Resilience Facility's green transition pillar); data on eco-innovation performance (as gathered by the EU's Green Business Eco-Innovation Scoreboard) and the circular economy (as indicated in the EU's circular economy monitoring framework); and also indicators from global environment monitoring (as collected in the World Environment Situation Room by the UN Environment Programme). Similarly, as in the quality-of-life section, one could also think of measures of a 'Climate-Clubs-Brussels effect' among the EU's trading partners (in view of current policies such as the carbon border adjustment mechanism (CBAM) in the spirit of Nordhaus, 2015). A successful technological and ecological transition has, in turn, the potential to improve the quality of life of the population and strengthen its democratic legitimacy, thereby initiating a virtuous circle for a sustained Catalytic Industrial Policy.

A good example of an indicator in the area of ecological transformation that, at the same time, also has important repercussions for technological transformation and even the political sphere, is the relative size of the high-voltage transmission lines network and its change over time. This indicator is related to Article 3 of TEU, which aims for a high level of protection of and improvement in the quality of the environment, as well as indirectly to Article 173 of TFEU, which seeks to encourage an environment conducive to cooperation between enterprises. While the size of the territory and the related population density are quite different across the EU member states, the indicator suggested still offers a good indication of the extent of the electricity network, and its change over time is of particular importance.

High-voltage transmission lines are badly needed *inter alia* in order to connect wind energy potentials in the north of Europe with industrial consumers in the centre (BMWi, 2017) and solar energy potentials in the south of the continent. This would lead to a more stable Europe-wide electricity network (Deloitte, 2021) and thus also has the potential to reduce the price of electricity – a resource much in demand for the technological transformation. However, there is strong popular resistance to the construction of new lines in communities along the respective routes (Cruciani, 2019), as well as massive regulatory bottlenecks (Mooney, 2023). This could be why the network has grown only slightly (Figure 12).

Figure 12 / Length of high-voltage circuits ≥ 275 kV, in km per 1,000 km^2 of surface area

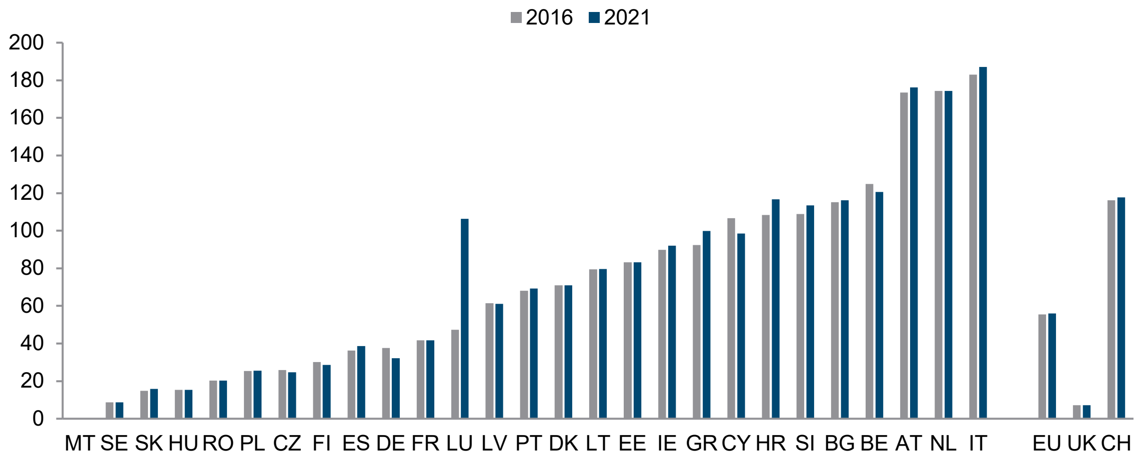


Note: Second period 2018 data for CH, CY, EE, UK, IE, LU, SE and 2017 for NL. Ranking according to first period.
Source: entsoe, Eurostat, national sources.

While some smaller EU member states do not possess high-voltage transmission lines, the vast majority have a network of about 30-40 km per 1,000 km^2 of land area. With levels of about 60 km per 1,000 km^2, the Netherlands and Germany lead these statistics in the EU context. However, by way of comparison, the UK has a network density of around 80 km per 1,000 km^2. Most importantly, when comparing 2021 data with data from 2016, we find only a few countries that were able to substantially increase their network capacities: Ireland, Slovakia, Poland, Latvia, Bulgaria and Portugal all had double-digit growth rates. However, these were increases from a rather low initial level.

While it is important to have high-voltage lines for the intra-continental transmission of electricity, it is of similar importance to have a dense low-voltage network, able to connect all the decentralised producers of green energy, as well (COP28 et al., 2023). These are often located in peripheral regions of a country. In terms of low-voltage network density, the EU seems to be doing better than the UK, but still worse than, say, Switzerland. Among the EU member states, Italy, the Netherlands and Austria are clearly outperforming all the other countries, with levels of around 180 km per 1,000 km^2 of land area (Figure 13). Most other low-voltage networks oscillate around the EU average of about 60 km per 1,000 km^2, albeit with huge variance around this average. Apart from Luxemburg, no EU member state has increased its low-voltage network substantially over the past couple of years. And in a few cases, the network even shrank between 2016 and 2021 – notably in Germany, where it contracted by as much as 14%. This is yet another indication of the dire state of German infrastructure, particularly in the energy sector.

Figure 13 / Length of low-voltage circuits ≤ 220 kV, in km per 1,000 km^2 of surface area

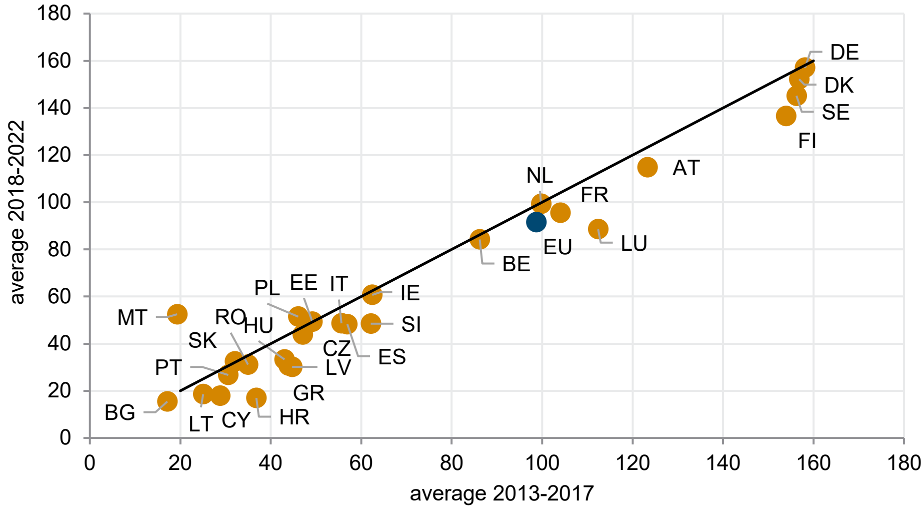


Note: First period 2017 data for DK and EE, as well as extrapolations for AT and IE. Second period 2018 data for CH, CY, DK, EE, IE, LU, PL, SE, 2017 for NL and 2016 for UK. Ranking according to first period.
Source: entsoe, Eurostat, national sources.

In a way that is comparable to the close relationship between the previous indicator and the cause of the technological transformation, the following indicator is also related to innovation, but with an ecological dimension. The European Commission's Green Business Eco-Innovation Scoreboard includes *inter alia* eco-innovation outputs that describe the immediate results of eco-innovation activities. One of these is the number of eco-innovation-related patents per million population, based on an OECD measurement framework for eco-innovation-related patents (Figure 14). These can be put into the context of the goal of Article 3 of TEU for the sustainable development of the earth, and the aim of Article 173 of TFEU of fostering better exploitation of the industrial potential of policies of innovation, research and technological development. If we look at the averages over the period 2013-2017 versus the period 2018-2022, this indicator tells a sorry story. Although there is a lot of differentiation in the levels, the trend is unfortunately very similar across the board: the EU has lost ground – from almost 100 eco-innovation patents per million population in the previous period to just over 90. The only EU member states that did not see a decline were Malta, Poland, Slovakia and Estonia. However, their increases were again from a very low level. It has to be mentioned, though, that longer-term eco-innovation patent fluctuations might also be related to cycles of technological change, as for instance due to the maturity of wind energy technology.

It is hard to think of indicators of ecological transformation without taking account of greenhouse gas emissions. However, it is important to look at specific sectors, in order to understand better where and how relevant policy measures should be introduced. According to the European Environment Agency (EEA, 2023), the buildings sector is a substantial contributor to greenhouse gas emissions, with more than a third of energy-related EU emissions in 2021. These come from the direct use of fossil fuels in buildings (e.g. oil and gas used for heating), as well as from the production of electricity and heat for use in buildings (e.g. electricity consumed by water heaters, lighting, electrical devices or cooling systems).

Figure 14 / Eco-innovation related patents per million population



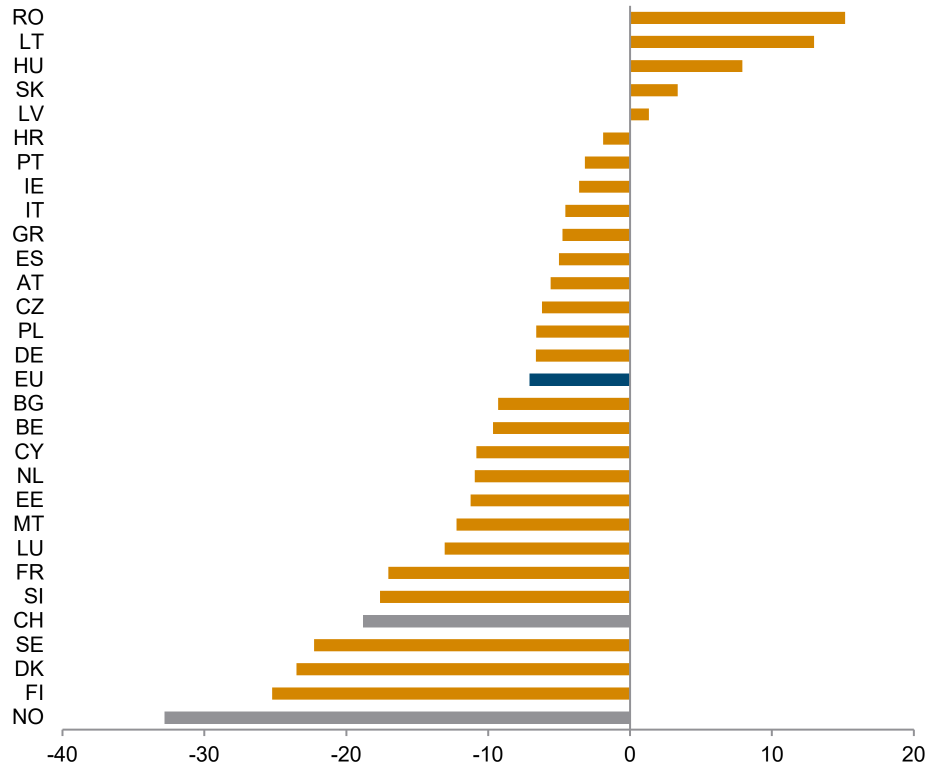
Note: 45° line included. Blue marker for the EU figure.
Source: EU Eco-Innovation Scoreboard.

While there has been a considerable reduction in emissions over recent decades – driven by higher energy-efficiency standards for new buildings, energy-efficiency improvements in existing buildings, decarbonisation of the electricity and the heating sectors, and warmer temperatures globally – a substantial acceleration is needed to reach the EU 2030 targets. Deep energy renovations are badly needed to reduce buildings' energy consumption. Improvements to buildings, such as better insulation and decarbonised heating and cooling systems, should help reduce emissions from the use of fossil fuels. At the same time, it is important to note that lower-emitting alternative heating systems (such as heat pumps) increase a building's use of electricity; and unless this is produced from renewable or decarbonised energy, it may only lead to a sectoral shift in emissions from the buildings sector to the electricity sector.

This is not to forget that the transport and industry sectors are also important emitters of greenhouse gases, and there is a clear link to the sphere of technological transformation. Moreover, it also needs to be mentioned that circularity and waste management, a reduction in the use of hazardous chemicals, and also more effective market surveillance and safer (as well as greener) products could all be linked to quality of life and the related democratic legitimacy of the structural change.

If we compare the change in residential greenhouse gas emissions from energy use in CO_2 equivalent per capita between the averages of 2012-2016 and 2017-2021 (Figure 15), we find a general decline in emissions in almost all EU member states. Overall, the Union saw a decline in residential emissions of about 7%. This is not very impressive, when we consider that Switzerland and Norway achieved reductions of around 20% and 30%, respectively. Once again, it is only the Nordic EU member states – Finland, Denmark and Sweden – that can keep up with these best practices. A few EU countries actually increased residential sector emissions: Latvia, Slovakia, Hungary, Lithuania and Romania – the last of these by as much as 15%. But even supposed 'core EU economies' such as Austria and Germany could only reduce their emissions by less than the EU average.

Figure 15 / Growth in residential greenhouse gas emissions from energy use in CO_2 equivalent per capita, averages of 2012-2016 vs. 2017-2021, in %



Source: European Environment Agency, Eurostat, own calculations.

This indicator clearly relates to Article 3 of TEU, which aims at a high level of protection of and improvement in the quality of the environment, and more importantly to Article 173 of TFEU and its goal of speeding up the adjustment of industry to structural change. This hints at the significance of involving the political, as well as the technological sphere. In order to speed up the electrification of housing in the EU, it is imperative also to think about technological innovations, as well as state regulations and interventions to encourage, for instance, the widespread use of highly energy-efficient appliances and heating systems, as well as to ensure effective insulation (Hoeller et al., 2023). This will have a substantial impact on the construction industry, too, where already the EISMEA and DG GROW are supporting the digitalisation of construction SMEs in a joint project. This project could, for instance, be augmented by a green and a social agenda. Ultimately, supplying affordable, high-quality (public) housing to young families – housing that is also suitable for home-office needs and at the same time is ecologically sustainable – is an example of a Catalytic Industrial Policy. Such a policy aims at triggering a virtuous circle in an endogenous network of technological and ecological transformation that also needs democratic legitimation, if it is to be successful in making the EU an attractive place for green and digital businesses.

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

This essay has made the claim that past policies intended to foster the EU's internal market – but without a long-term strategic industrial policy – were aimed primarily at raising efficiency and improving competitiveness. They thereby neglected the trade-off with security in its broadest definition (including social, energy, value-chain, military and other types of security) and the interplay with an electorate that (more often than not) lives in 'places that don't matter' and that has been exposed to a succession of massive crises over recent decades. Instead, a new Catalytic Industrial Policy (CIP) is suggested: one that aims at maximising investment in green and digital structural change, while also taking account of the socio-political dimension. Criteria were defined for measurable outcome indicators in the areas of democratic legitimation of structural change, ecological and technological transformation. These areas are seen as part of a heuristic model for an endogenous network of CIP interdependencies.

The indicators need to be relevant to the specific area, but also to the two other areas; each indicator needs to be available across time and space; it needs to be based either on the inclusion of related indicators in earlier collections or on a deliberate decision to present an atypical indicator; indicators should – wherever useful and possible – also be presented in disaggregated form (e.g. in their regional, sectoral or gender-specific dimensions); and finally, indicators should be related to the broad goals that are set out in Article 3 of TEU and Article 173 of TFEU. They also need to be SMART – i.e. specific, measurable, achievable, relevant and time-bound, particularly when it comes to the operationalisation of a specific programme.

For each of the three areas, three indicators were presented as suitable examples. In measuring better quality of life in support of a democratically legitimated structural change, median equivalised net income at PPS by degree of urbanisation over time was suggested. This was related to the development of trust in the national government as a second indicator. As a third and more specific indicator, the average age of young people leaving the parental household (by gender) shows the (in)ability of young people to live a self-determined life – a basic human need and an important source of legitimacy of a society. The indicators were *inter alia* discussed in terms of their relationship with the relevant articles in the TEU and the TFEU.

For mastering the technological transformation by fostering a stronger and more innovative industry, another set of three indicators was discussed. The change in the operational stock of robots in all industries, as well as in all industries *except* the automotive industry, was suggested as an appropriate indicator. Automation has the potential to increase the number of persons who can be upskilled in societies that are undergoing demographic decline. Consequently, another indicator suggested was the change in the share of science and technology graduates (by gender) in the respective age group. Finally, the proportion of SMEs doing business online was presented for different points in time; this showed the slow progress of the digital revolution, but at the same time also revealed a few cases of leapfrogging. The indicators were *inter alia* discussed with respect to their (non-)inclusion in traditional indicator collections.

Indicators that are related to the mastering of the ecological transformation by erecting a ladder for the EU's green industry include the area density of both high- and low-voltage networks in the transmission of electricity across the European continent. Both are much needed for the green energy transition. Another indicator presented was the number of eco-innovation-related patents relative to population size

– an indicator that sadly reveals a decline in eco-innovations over time in the EU member states. Finally, as a third indicator in the area of ecological transformation, the growth of residential greenhouse gas emissions from energy consumption relative to population size was presented: this showed only little progress in recent years. The indicators were *inter alia* discussed in terms of their relationship to the other areas of the endogenous network of a Catalytic Industrial Policy.

To provide an example of such a new industrial policy that seeks to initiate positive feedback loops in all three areas discussed, particularly the third indicator from each of the three areas was selected, and those three indicators were jointly contextualised: overcoming the lack of affordable housing for youngsters by building high-quality, technologically sophisticated (public) housing in an energy- and cost-saving, sustainable manner has the potential to support the digital revolution. It does so by increasing home-office and e-commerce activities; this in turn helps to potentially reduce greenhouse gas emissions and to improve the material basis for widely legitimised structural change. A joint dynamic and catalytic follow-up indicator of a transformative process could be the number of new buildings and housing units constructed that have pre-specified characteristics related to affordability, quality and size, digital infrastructure and energy efficiency. Other examples could be found that would employ a different set of indicators in the three CIP areas. These could, for instance, include a pan-European solution to the construction and operation of high-speed railways, or an Airbus-like solution for a European green maritime and inland waterways logistics and shipbuilding sector.

In any case, it should be clear that the time when political decision making seeks mainly to minimise potential failure (and hence typically does not act at all) is over. It is high time to learn from industrial policy experimentation and leave the laissez-faire concept behind (Benner, 2019). At an intellectual level, the paradigmatic shift has already occurred, and 'big thinking' is no longer regarded as (at best) naïve. Suggestions have been made for a mission-oriented 'entrepreneurial state' that will implement bold, catalytic government policy to 'transform', create and shape markets, rather than just fix them (Mazzucato et al., 2015). Think tanks advance the case for a new industrial policy (Hafele and Barth, 2023) and make suggestions for how to finance it in the EU context (Heimberger and Lichtenberger, 2023). For quite some time now, the research departments of international organisations have been discussing industrial policies to transform economies (Salazar-Xirinachs et al., 2014; Cherif and Hasanov, 2019; Terzi et al., 2022). Nevertheless, the current mainstreaming of industrial policy needs to be augmented by an understanding of the interdependencies and tensions that arise in the course of the industrialisation process. Moreover, it requires an understanding of the different institutions needed for industrialisation and the related policy alignment, as well as of conflict management alongside the entrepreneurial function of government and the importance of state organisational capacities (Andreoni et al., 2019).

With a considerable time-lag, the Western political sphere is now starting to copy East Asian industrial policy approaches. In the US, industrial policy is back, with the Infrastructure Investment and Jobs Act, the CHIPS and Science Act and the Inflation Reduction Act (Eichengreen, 2023). Others even argue that the US as a 'hidden developmental state' has never given up on industrial policy but had just officially rejected the term and any attempt to use the government to pick private-sector winners (Block et al., 2023). Europe, unfortunately, seems to have come late to the party. Only recently has the European Commission proposed a Green Deal Industrial Plan for the Net-Zero Age and the Net-Zero Industry Act, in response to US industrial policy; however, it lacks a comparable funding base and an ambitious timeline.

Even more to the point, it is of the utmost importance that a European Catalytic Industrial Policy should not only guide investments in the desired directions, but also ensure that the benefits are as widely shared as possible: conditionalities are one way to go when it comes to public subsidies, guarantees, loans, bailouts or procurement contracts (Mazzucato and Rodrik, 2023). Procurement and funding could be made conditional on, for instance, greener supply chains, profit-sharing, the reinvestment of profits (stipulating the level, the geographical localisation or the type of reinvestment) or better working conditions. The direction of innovation and economic activity could also be influenced, leading to socially and environmentally desirable technologies. All of this has to be seen in the context of a shift towards longer-term, public-value-oriented economic thinking.

More radically, Gabor (2023) advocates a state-directed approach that disciplines private capital into priority areas of investment for the green and digital transformations, away from a 'derisking state' that enlists private capital to achieve public policy priorities merely by tinkering with risk and returns on private investments. The latter approach is the mainstream method in both the US and the EU, where private capital dominates and where the sustainability and timeliness of the overall decarbonisation process is at risk. The EU's Green Deal Industrial Plan and the US's Inflation Reduction Plan can be seen as approaches to derisking under industry leadership. By contrast, the US CHIPS and Science Act is more of a state-directed industrial upgrade, via grants, tax credits and – more importantly – disciplining measures, such as construction and operational milestones, prior due diligence, upside sharing agreements for potential future profits, the activation of private capital and restraints on share buybacks. Following this example, according to Gabor (2023), a 'Big Green State' would need independent and accountable public agencies to set the pace, arrange state ownership of the low-carbon infrastructure, establish penalties on carbon credit, close state control of credit flows via captive finance, and limits on early exit. Moreover, it will require a fundamental change in the macro-financial regime away from monetary dominance under full capital mobility and towards fiscal-monetary coordination and capital controls.

Finally, as a caveat, it should be mentioned that bold action also needs independent control and permanent monitoring, including via a set of indicators (for example, as suggested in this essay), but more concretely also by dedicated institutions – institutions that need to break completely with the current public-sector compliance culture that is intolerant of mistakes and failure. Radosevic et al. (2023) propose an 'action learning' approach, incorporating the governance mechanism of 'learning networks' to handle the public accountability problems of implementing experimental governance of new and untried industrial and innovation policies. In order to maintain public support for structural change, and learning from past experiences, it is important to avoid megaprojects being systematically subject to the principle of 'survival of the unfittest', whereby the worst projects get built, rather than the best (Flyvbjerg, 2014). Accordingly, an important element in the reform of megaprojects management is for researchers to take seriously the task of feeding their research results into the public sphere in order to be part of public deliberation, policy and practice. Hopefully, this essay and the suggested outcome metrics for a CIP will contribute to this, as well as to the broader goal of making the EU an attractive place for globally competitive green and digital businesses. In an inversion of the motto of the European Union – *in varietate concordia* (united in diversity) – the suggested guiding principle should be *in concordia varietas*: only in the unity of a European Catalytic Industrial Policy can we manage the wide variety of challenges of structural change that our generation faces.

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