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CORPORATE TRANSITION PATHWAYS FROM A POLICY MIX PERSPECTIVE

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Corporate transition pathways from a policy mix perspective

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Abstract:

The paper explores the strategic role of policy mixes in steering large-scale incumbent firms towards sustainable economic pathways in Europe. The paper acknowledges the critical contribution of startups in the sustainability sector but emphasizes the need for a transition among the established firms dominating carbon-intensive industries so as to meet climate neutrality targets. Drawing upon a review of existing policy instruments in the EU and beyond and on the policy mix literature, Georghiou emphasises the complexity of aligning technological innovation, business models, and regulatory frameworks at different governance levels. Principles for a taxonomy of policy instruments and measures are proposed. These highlight the need to supplement supply-side and regulatory interventions with demand-side instruments. Systemic frameworks are needed to embrace the complexity of transition and to ensure that changes in corporate behaviour are embedded. The paper calls for more evaluation to gain a nuanced understanding of policy influences on corporate behaviour and the combination of resources, incentives, capabilities and opportunities needed to support policy frameworks that encourage innovation and the diffusion of green technology, balancing sustainability with growth and employment objectives.

Keywords: policy mix; corporate sustainability transition; green innovation; regulatory frameworks; systemic policy approaches

1. Introduction

It is widely recognised that a transition to a fair and sustainable economy will require substantial changes to take place in Europe's industrial base, including but not confined to a transition in the technological base and the business models within which current processes are embedded. To some extent such a transition is likely to rely upon the emergence and growth of new businesses which are founded on more sustainable solutions. Databases such as *EU-startups*¹ indicate that around one in four European startups are focused on environmental sustainability, in areas such as renewable energy, sustainable materials and waste management. The Horizon programmes support this trend.

Nonetheless, the principal challenge if significant progress is to be made to meet climate neutrality targets lies in achieving transition by large-scale incumbent firms. Firms on this scale dominate the most carbon intensive sectors such as energy production, transport and heavy industries producing cement, steel and chemicals. They have in principle the investment capacity and capabilities (more broadly complementary assets) to adopt green technologies. As Geels points out, these incumbents are highly invested in existing systems and regimes and may resist or at least be unlikely to pioneer sustainability transitions but their subsequent adoption of innovations could substantially accelerate the pace of change.² They also have the purchasing power to influence their supply chains in the direction of sustainable practices.³

The challenge addressed in this paper is to consider ways in which governmental actions at national or EU-level would incentivise firms to choose strategies that align with sustainable pathways and to accelerate their progress along these while, at the same time, continuing to meet other policy objectives that are more traditionally aligned with corporate (and political) goals, principally those of maintaining value creation and competitiveness.

It will be argued that the technologies are integrated with deeply embedded business models which in turn have developed in the context of market and regulatory structures which operate (not always coherently) at national, EU and global level. In addition, we typically have multiple policies and policy instruments in operation, raising issues of how they work in combination and as they address different parts of the system.

After considering the policy context in the EU and beyond, some implications of the existence of a policy mix are identified. The next step is to identify influences on firm behaviour to foster transition of business models and technology and to catalogue the instruments and frameworks that could aid progress. Conclusions are drawn about the potential interaction of such policies, and the need for greater knowledge about the most effective systemic frameworks conducive to innovation and diffusion of green technology and the challenges that are faced.

¹ <https://www.eu-startups.com>

² F.W. Geels, [The multi-level perspective on sustainability transitions: Responses to seven criticisms](#)
[Environmental Innovation and Societal Transitions](#)
[Volume 1, Issue 1](#), June 2011, Pages 24-40

³ R.D Klassen and A. Vereecke (2012) Social issues in supply chains: Capabilities link responsibility, risk (opportunity), and performance, [International Journal of Production Economics](#)
[Volume 140, Issue 1](#), November 2012, Pages 103-115

2. Policy Context

2.1. EU Policies and Measures for Corporate Sustainability

The EU promotes corporate sustainability transitions through a wide range of instruments designed to drive businesses to reduce their environmental impacts, improve their social responsibility, and integrate sustainability into their overall strategies. Measures used encompass regulation, incentives, financial support, scientific advice and support for research and innovation. The European Green Deal, sustainable finance initiatives, and climate-related legislation together provide a legal framework and financial incentives, while mandatory corporate reporting and due diligence requirements push businesses to take concrete action toward sustainability.

The European Green Deal, launched in 2019, provides the frame for the EU's sustainability agenda. Its main objective is to make Europe the first climate-neutral continent by 2050. The Climate Law provides a legal commitment to reach net-zero greenhouse gas emissions by 2050. A key intermediate target is a 55% reduction in 1990 levels of net greenhouse gas emissions by 2030. Within its scope are a series of strategic plans:

- [Circular Economy Action Plan](#), in its new iteration encompassing 35 actions to promote waste reduction, recycling, and sustainable product design, fostering a shift to a circular economy;
- [Farm to Fork Strategy](#) focusing on sustainable food systems, reducing food waste, and supporting biodiversity;
- [Zero Pollution Action Plan](#) aiming to reduce air, water, and soil pollution to levels no longer harmful to health or ecosystems.

Also within the scope of the Green Deal is the [Fit for 55](#) package of legislative actions to reduce greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels as mentioned above. Important actions here include:

- Strengthening the [EU Emissions Trading System](#) (ETS) to increase the cost of carbon emissions for industries;
- [Carbon Border Adjustment Mechanism](#) (CBAM) to prevent 'carbon leakage' by imposing carbon costs on imports of certain goods from non-EU countries (and to prevent companies based in the EU move carbon-intensive production abroad to countries where less stringent climate policies are in place than in the EU);
- The [Renewable Energy Directive](#) to speed up the clean energy transition, and measures to promote energy efficiency, and the electrification of sectors such as transport.

The EU's [Sustainable Finance](#) Framework brings environmental, social and governance (ESG) considerations into account when making investment decisions in the finance sector. It seeks to channel capital towards the green transition through sustainable investments and aligning corporate reporting with sustainability goals. The EU pioneered this area with the [European green bond standards](#), a bond being a fixed income instrument dedicated to funding environmentally-friendly and climate-related projects. It aims explicitly to address greenwashing. Specific measures include:

- [EU Taxonomy for Sustainable Activities](#): Described as the cornerstone of the EU's sustainable finance framework, the taxonomy (common classification system) defines which economic

activities are environmentally sustainable, providing clarity to investors and companies on what constitutes green activities;

- [Sustainable Finance Disclosure Regulation](#) (SFDR): This regulation requires financial market participants to disclose how they integrate environmental, social, and governance (ESG) factors in their decision-making.
- [Corporate Sustainability Reporting Directive](#) (CSRD): EU law requires all large companies and all listed companies (except listed micro-enterprises) to disclose information on what they see as the risks and opportunities arising from social and environmental issues, and on the impact of their activities on people and the environment, ensuring more consistent and comparable non-financial disclosures. The Directive seeks to integrate climate risks into corporate strategies. There are proposals to align executive remuneration with sustainability performance.

The recently adopted [Corporate Sustainability Due Diligence Directive](#) (due to be transposed into national law by July 2026, followed by an implementation timetable staggered by company size) aims to ensure that companies in the EU (and those operating in the EU) address the impacts of their activities on human rights and the environment throughout their value chains. Hence, companies are expected to implement due diligence policies covering their entire supply chain, making sustainability a core business responsibility. While companies cannot guarantee adverse impacts, they are expected to take appropriate measures meeting the objectives of due diligence.

Other climate-specific measures with implications for business include:

- EU Climate Pact is a platform for businesses, citizens, and local communities to share information, take part in climate actions, and pledge sustainability commitments:
- Just Transition Mechanism which seeks to provide public financial support and attract private investment for sustainable projects in regions with industries facing high costs for economic transformation;
- Energy Efficiency Directive (EED) which Imposes requirements on large corporations to conduct energy audits and implement energy-saving measures.

EU research and Innovation policies are clearly of major relevance to corporate sustainability transition. Horizon Europe offers support for green and sustainable projects which enable corporate participants to align their operations with sustainability goals while driving innovation and competitiveness. Key focus areas include climate action, environment, resource efficiency, raw materials and energy transition. The Mission on Adaptation to Climate Change⁴ seeks to help delivery of the Green Deal and is targeted to regions but also encourages engagement from businesses. Other themes of relevance are Circular economy, Bioeconomy, Smart Cities and Sustainable Transport and Mobility, again offering firms access to funding for research and innovation in these areas.

Corporate behaviour is likely to be constrained by firms' ability to recruit the necessary workforce to achieve transition. This is clearly acknowledged in the text of the Green Deal and in the Pact for Skills, a shared engagement initiative to bring together stakeholders from industry and government to foster

⁴ https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizoneurope/eu-missions-horizon-europe/adaptation-climate-change_en

the development of skills needed for the green and digital transitions.⁵ Various studies elucidate this agenda, for example those by the European Centre for the Development of Vocational Training (CEDEFOP).⁶

High quality information is also an important policy tool for the effective rollout of transition policies. The Joint Research Centre contributes through its mission to create, manage and make sense of scientific knowledge for EU policies. This extends to scientific and economic analyses, for example in providing an assessment framework for climate transition to assess the scientific and environmental integrity, and hence credibility, of the transition plans for industrial installations in the light of the Directives and Taxonomy described above.

A prominent report on the Future of European Competitiveness by former Italian Prime Minister and President of the European Central Bank, Mario Draghi⁷ has called for a new industrial strategy for Europe with three areas of action to reignite sustainable growth and address the productivity gap with competing nations. These are: first, closing the innovation gap with the US and China, especially in advanced technologies such as AI; second, increasing security and reducing dependencies; and third, a joint plan for decarbonisation and competitiveness. A key comment states:

“If Europe’s ambitious climate targets are matched by a coherent plan to achieve them, decarbonisation will be an opportunity for Europe. But if we fail to coordinate our policies, there is a risk that decarbonisation could run contrary to competitiveness and growth.”

Of particular relevance for the discussion here are the statements that “Europe must confront some fundamental choices about how to pursue its decarbonisation path while preserving the competitive position of its industry” and hence that “Europe will need to deploy a mixed strategy that combines different policy tools and approaches for different industries”. The three priority areas proposed (verbatim quote):

- Lowering energy costs for end users by transferring the benefits of the decarbonisation and accelerating the decarbonisation of the energy sector in a cost-efficient way, leveraging all available solutions;
- Capturing the industrial opportunities presented by the green transition, ranging from remaining at the forefront of clean tech innovation to manufacturing clean tech at scale to leveraging the opportunities from circularity; and
- Levelling the playing field in sectors more exposed to unfair competition from abroad and/or facing more exacting decarbonisation targets than their international competitors – including applying tariffs and other trade measures where warranted.

The implication if these recommendations are adopted is that a more explicit combination of policies is called for and that the mix of policy objectives and, most likely, the mix of instruments will need to be changed to place greater emphasis upon innovation for competitiveness and strategic autonomy.

⁵ <https://ec.europa.eu/social/main.jsp?catId=1517&langId=en>

⁶ Cedefop. (2024). Tracking the green transition in labour markets: using big data to identify the skills that make jobs greener. Publications Office of the European Union. Cedefop policy brief.

⁷ M. Draghi, The Future of European Competitiveness – a competitiveness strategy for Europe, European Commission, September 2024

2.2. Views of Business

The issues addressed by Draghi are highly visible in the present EU policy milieu. The recent Antwerp Declaration by European industry expresses the collective views of 72 firms and 32 industry associations in calling for a European Industrial Deal to complement the Green Deal⁸. They state that to meet climate neutrality by 2050 and the 2040 target to reduce greenhouse gases by 90%, Europe's electricity production will need to multiply, and industry investments will need to be a factor six higher than the previous decade. They argue that this challenge coincides with the most severe economic downturn in a decade, whereby demand is falling, production costs increase and investments move to other regions. Citing the US Inflation Reduction Act they call for a package of support measures including regulatory simplification, public derisking of private investment into clean technologies through a Clean Tech Deployment Fund, and investment to reduce energy costs, improve transport and training infrastructures, assuring supplies of critical raw materials and measures to improve demand and market conditions. Support for innovation is a common thread in the argument. Similar (albeit more generalised) sentiments have been expressed by Business Europe in their call for 'a REBOOT in European policies, building on EU achievements, with targeted actions to tackle the structural weaknesses that are undermining companies' efforts to deliver for people'.⁹

A supplementary open letter from Sir Jim Ratcliffe, Chairman and Founder of INEOS, to Ursula von der Leyen, President of the European Commission, warned that Europe is "sleepwalking towards offshoring its industry, jobs, investments, and emissions." This echoed an earlier such letter in 2014 from Radcliffe to President Barroso expressing fears for the future of the European chemical industry. The recent letter raises the possibility (or threat) of relocation to what they see as more favourable regimes in terms of regulation (notably carbon taxes) and incentives (the investment incentives for clean technologies in the US Act), or simply displacement of their business to rivals from those countries, with net negative effects on sustainability. This presents the issue as a dilemma between an innovationbased approach and a regulatory approach demanding compliance with low-to-zero emission technologies. It is clearly an over-simplification to reduce the challenge in this way. The debate would be advanced by a more nuanced understanding of how policy could influence major corporates in a socially desirable direction while maintaining other European goals of growth and employment.

2.3. International Comparison

US Inflation Reduction Act

The most prominent and extensive international comparator for the EU in this space is the US Inflation Reduction Act (IRA) which came into law on August 16th 2022. This supports corporate transition through a range of financial incentives, tax credits and promotion of reduction of greenhouse gases by circa 40% or 2005 levels by 2030, adoption of clean energy and sustainable practices. It is the largest ever such investment, estimated at US\$369Bn over ten years.¹⁰ Key elements include long-term tax credits for business investment in renewable energies including credits based on energy produced and

⁸ The Antwerp Declaration for a European Industrial Deal, European Industry Summit: A business case for Europe 20 February 2024, Antwerp

⁹ Business Europe, Stronger Business, Stronger European Union, April 2024 <https://rebooteurope.eu>

¹⁰ Building a Clean Energy Economy: A guidebook to the Inflation reduction Act's Investments in clean energy and climate action, The White House, January 2023 Version 2, <https://www.whitehouse.gov/wp-content/uploads/2022/12/InflationReduction-Act-Guidebook.pdf>

in investment in infrastructure, and specific credits for clean hydrogen production and for carbon capture.

Wider industrial policy objectives are addressed by incentives designed to promote domestic production including developing a supply chain. These are a mix of tax credits, grants and loans for manufacturing. There are provisions for reduction of carbon footprint and energy consumption in industrial facilities, reducing capital costs. These are particularly targeted to the most emission-intensive sectors such as cement, steel and chemicals.

As with the EU there are green financing mechanisms to make capital more accessible for sustainability projects. R&D grant support for leading-edge technologies is intended to reduce firms' risk in making a green transition. Projects in disadvantaged communities may receive bonus tax credits to support 'environmental justice' and corporate accountability.

Other National Programmes Targeting Carbon Reduction and Sustainability

In virtually all advanced industrial economies there are initiatives similar to those of the US and EU aimed at carbon reduction and sustainability. Among the most significant are China's 14th Five-Year Plan (2021-2025) which uses a state-directed approach to scale up solar, wind and electric vehicle infrastructure and the Made in China 2025 initiative to promote domestic sectors relating to clean energy and high tech manufacturing; India's Green Energy Programs and National Hydrogen Mission launched in 2021 to make the country a global hub for green hydrogen. Again, there is support for domestic production of clean energy technologies in the form of the Production-Linked Incentive (PLI) Scheme. Japan has a Green Growth Strategy targeting carbon neutrality by 2050 and supporting investments in renewables, electric vehicles and particularly hydrogen energy, the latter through hydrogen tax credits. South Korea's Green New Deal is on similar lines. Initiatives are also found in Australia, Canada, Brazil and the United Kingdom, where the new Labour Government intends to make it a central plank of its industrial policy. Emerging economies such as those in the Gulf Cooperation Council area are also making significant investments in this area despite their traditional reliance on fossil fuels.

Reviewing the landscape of these initiatives there is clearly a common thread of seeking to combine addressing the key elements of the sustainability challenge with promotion of domestic industry in the relevant sectors. The large Asian economies appear to place more relative weight on promotion of transition to a hydrogen economy. Overall, the policies range from support for innovation through to manufacturing and investment subsidies, promotion of infrastructural investment and stimulation of demand for green technologies at consumer, industrial and state level. This brief overview does not extend to regulatory disincentives for carbon-intensive activity which could be useful in assessing warnings of industrial relocation away from economies which are more regulated in this way. For the EU it underlines the importance of the Draghi approach in two ways, one being the point already understood in the Green Deal, that this sector is to be a major platform for current and future competitiveness, and following on from that competitive dimension, emphasising that the scale of investment means that only a combined and fully coordinated European approach can match the efforts of the major global economies. While there will be niches created by regional needs and capabilities, it is broadly the same set of industrial objectives being pursued. From the perspective of the sustainability challenge there is clearly much to be gained from more cooperative approaches and even a division of labour but global politics may add to competitive pressures to inhibit progress on this approach.

3. Policy Mix Approaches

Given the multiple elements which comprise efforts to influence systems in transition, it is very likely that the simultaneous action of multiple policy instruments would be needed to drive a socially desirable transition. As such the solution comes in the category of ‘policy mix’. An important review of the literature, using bibliometrics, by Rezaeian *et al*¹¹ formed the basis of a conceptual framework seeking to make sense of the interplay between policy mix, what they term moderating factors, and firms’ strategies to adapt their business models. They conclude that “... a policy mix should be customised to address the adaptation requirements on incumbent firms”.

Flanagan *et al*, in the context of innovation policy, characterise a policy mix as the strategic combination of various policy instruments to achieve specific policy objectives but they caution the need to pay attention to the interaction of such policies which may create synergies or may inhibit each other’s effectiveness¹². They also note the dynamic nature of policy formation and that policies (or instruments) are likely to have been initiated at different times and often for different reasons. Rogge and Reichardt (2016) address the specific domain of policy mixes for sustainability transitions¹³. In examining the transition of the German energy system to renewable power generation technologies, they seek to extend the concept to include a policy strategy, policy processes and characteristics. With this wider perspective they stress the importance of ‘thinking in terms of policy mixes for redirecting and accelerating technological change’. A second influential perspective in the context of sustainability transitions was proposed by Kern and Howlett¹⁴ who criticise a tendency to create policy mixes to promote sustainability by replacing elements of existing policy mixes, resulting in uncertain outcomes.

They argue that complex policy mixes are created by processes they term ‘drift’, ‘conversion’, ‘layering’ and ‘replacement’. The aim, they conclude, is to manage transitions through coherent, consistent and congruent policy regimes (and mixes) rather than the converse.

A special edition of Research Policy in 2019 continued this theme with a focus on policy mixes for sustainability transitions.¹¹³¹⁴¹⁵¹⁶ The editors carried out an extensive bibliometric review and identified two convergent streams in the policy mix literature, one founded in the field of innovation policy tracing back to (in their database) a 2002 paper by Nauwalers and Wetje¹⁷ who in examining innovation policy for SMEs in a regional context found that regional differences in innovation capabilities call for a tailored mix of policy instruments. A major boost to the understanding of innovation policy mix resulted from Flanagan *et al*’s reconceptualisation.¹⁷ Prior to this, in arguing for an evolutionary and adaptive

¹¹ M. Rezaeian, J. Pinkse and J. Rigby, Transforming titans: The role of policy mixes in business model adaptation strategies for sustainability transitions, *Energy Research & Social Science* 112 103499 (2024)

¹² K.Flanagan, E.Uyarra and M.Laranja, Reconceptualising the ‘policy mix’ for innovation, *Research Policy* [Volume 40, Issue](#)

¹³, June 2011, Pages 702-713

¹⁴ K.S.Rogge and K. Reichardt, Policy mixes for sustainability transitions: An extended concept and framework for analysis, *Research Policy* [Volume 45, Issue 8](#), October 2016, Pages 1620-1635

¹⁵ F. Kern and M. Howlett Implementing transition management as policy reforms: a case study of the Dutch energy sector, *Policy Sciences* Vol.42, pp 391-408, (2009)

¹⁶ F. Kern, K.S. Rogge and M. Howlett (eds) Policy mixes for sustainability transitions: New approaches and insights through bridging innovation and policy studies, [Research Policy](#) [Volume 48, Issue 10](#), December 2019

¹⁷ C. Nauwelaers and R. Wintjes Innovating SMEs and regions: the need for policy intelligence and interactive policies *Technol. Anal. Strateg. Manag.*, 14 (2002), pp. 201-215 ¹⁷ Op.cit.

approach to policy, Metcalfe and Georghiou in 1997 reviewed a wide range of European policy instruments and approaches and concluded *inter alia* that innovation and diffusion are closely intertwined, the need to avoid privileging supply-side measures over demand-side and how the sectoral focus of transnational companies and user-supplier linkages demands coordination of national policies and transnational bridging institutions.¹⁸

A second stream of policy mix studies in climate policy is traced from a paper of similar vintage by Sorrell and Sijm (2003) who examined the implications of the co-existence of a cap-and-trade scheme for carbon-dioxide emissions, carbon/energy taxes, support mechanisms for renewable electricity, and policies to promote energy efficiency.¹⁹ They offer a typology of policy interaction based on the target groups for Emission Trading Schemes, whereby direct interaction involves overlapping target groups affected by (say) two policies, indirect interaction, where a target group is affected directly by one policy and indirectly by another and trading interaction where there are explicit exchanges between policies – the example given being allowances from a trading scheme in one country being exchangeable for allowances in a second country. In a broader conclusion they note that “there will be trade-offs between long-term and/or non-efficiency objectives and short-term increases in abatement costs. If the policy mix is to gain legitimacy, these objectives and trade-offs need to be explicit”²⁰.

In this short paper there is not the space to delve into further detail of the policy mix literature but for addressing the issue at hand some key points can be taken:

- i) The co-existence of policy instruments often reflects their origins in different policy objectives (a normal situation in government). Any given instrument can have effects (spillovers) in domains other than that for which it was originally intended;
- ii) Even when they are addressing the same objectives, the application of multiple policy instruments can both enhance the effectiveness of a given policy through synergies and inhibit it through antagonistic interactions;
- iii) Policy mix is significant at different levels of granularity including the environment and process in which policies are formed, the mix of policies, the mix of policy instruments and the means and effectiveness with which they are implemented;
- iv) In a European context the mix is also affected by multi-level governance with policies and instruments being formulated and/or implemented at EU, national and regional levels;
- v) There may be effects of a temporal difference in the origin and effect of policies or instruments in any particular mix. Existing measures often persist while new ones are introduced;
- vi) Policymakers and analysts should caution against the assumption of Olympian rationality, accepting rather that they operate in conditions of bounded rationality and ambiguity.

¹⁸ J.S. Metcalfe and L. Georghiou *Equilibrium and Evolutionary Foundations of Technology Policy*, OECD STI Review No.22 Special Issue on “New Rationale and Approaches in Technology and Innovation Policy” pp.75-97 (2009)

¹⁹ S. Sorrell and J. Sijm *Carbon trading in the policy mix* *Oxford Rev. Econ. Policy*, 19 (2003), pp. 420-437

²⁰ *Op cit* p.434

4. Influencing Firm Behaviour

Before engaging with specific instruments, it is helpful to consider what a policy may seek to achieve in the domain of corporate transition to sustainability. There are several possible outcomes that may meet the criteria of transition. At the most extreme is one of *displacement* of an incumbent firm from a market by a rival with a product, process or service (its industrial base) that meets socially desirable levels of sustainability. This may occur in a laissez faire context if the newcomer has a superior/more economic technology or if supply-side conditions disrupt the incumbent disproportionately (for example greater sensitivity to energy price shocks or lack of availability of critical resources). Our concern here though is how an intentional transition could be induced. It may even be necessary to intervene in the first case to mitigate the effects of the displacement on jobs or a particular region (as with the Just Transition Mechanism mentioned above).

If there is to be a policy intervention intended to change the industrial base of a firm, typically the ‘deficiencies’ in its current activity can be influenced to change by one or more of four broad categories of action described by the acronym RICO:

- i) Provision of *Resources*, that is a financial input which changes the economics of its activities in the desired direction. The equity investment/grant/loan/subsidy may be to encourage innovation for sustainability (with added impetus if the support is in the context of directionality or a mission) or it may act more directly to subsidise adoption of a particular process.
- ii) Establishment of *Incentives*, which may be positive incentives such as favourable fiscal treatment for a sustainable pathway or use of public procurement to guarantee an early or lead market to de-risk an innovative sustainable solution. More generally support for the diffusion and adoption of a desirable solution will in turn provide an incentive for its supplier. On the other hand, there are also negative incentives such as use of taxation, tariffs or legal action to enforce compliance with regulations that demand higher levels of sustainability. The legal penalty may target the financial position of the firm or in some cases compliance by senior management.
- iii) Support for *Capabilities*, where for example there is a lack of available green skills in a sector or region and intervention in education and training or more directly in the labour market is needed. More specifically the firm may be inhibited from adopting a solution because it lacks key capabilities. Capabilities may also be enhanced through making the diffusion of information more effective. In reality, this is more typically a policy issue for SMEs than it is for large corporates they may also experience information failures which reinforce lock-in to existing trajectories.
- iv) Provision of *Opportunities*, meaning here support for research and innovation relevant to sustainability to create the opportunity set from which a company may replace its current base, for example moving from fossil fuel-based feedstocks to a bio-based economy.

While this framework helps in thinking about actions targeting a firm it misses the systemic dimension critical for many if not all transitions.²⁰ Even for a large corporate the deficit to be addressed may lie beyond the boundary of the firm in the necessary complementary assets for the transition. A simple

²⁰ R. Smits and S.Kuhlmann, The rise of systemic instruments in innovation policy [International Journal of Foresight and Innovation Policy Vol. 1, No. 1-2](#) pp 4-32

example is the interdependence between electric car manufacture and charging infrastructure or the dependence on a supply chain for critical minerals needed for battery manufacture. From a public policy perspective there is a coordination failure to be addressed. Such systemic changes are often at the root of the necessarily complex policy mixes that we are considering. Grand Challenges and Missions can provide a frame for coordination of this type but their role is often at risk of failure because their origin in research and innovation agencies or ministries does not create sufficient momentum for the necessary cross-governmental collaboration that is needed.

Policy instruments may act at a point in time or may have a longer-lasting effect. In most cases the policymaker will wish to achieve the second option. This takes us into the domain of *behavioural additionality*. This is an evolving concept emerging from the evaluation literature for research and innovation programmes. As the original paper on this topic argued, traditional policy rationales were founded on relatively narrow concepts of additionality, being *input additionality* which measures the increase in a firm's resources as a direct result of public funding and *output additionality* which measures outputs and outcomes resulting from public support (for example project deliverables²¹). In principle, both of these concepts are time-de-limited and their effects could decay quite quickly once support is withdrawn. Behavioural additionality, *by contrast*, as its name implies, focuses on changes in firm's behaviour and is inherently more likely to be sustained over a longer period. The effects of the support are targeted on capabilities or, at a higher level, strategy and culture. Specific behaviours which may be encouraged are collaboration (including engaging in programmes targeting systemic change) and risk-appetite (bearing in mind the conservatism of large corporates which we have noted). As such, policies inducing behavioural additionality are likely to be fundamental to achieving the corporate transitions envisioned in the Green Deal. As with other measures, those promoting behavioural additionality are sensitive to the national and policy context in which they are applied.^{22,23}

5. Principles of a Taxonomy of Policy Instruments and Measures

Within the scope of the present discussion, it is not feasible to provide a census of policy instruments which intentionally or otherwise impact upon corporate transition. It is, however, possible to consider the broad categories in which such instruments fall. There are multiple and overlapping ways in which policy instruments may be categorised beyond the RICO framework already discussed. For example, a distinction may be made between:

- i) *Supply-side instruments*: In innovation terms these are sometimes characterised as 'technology-push' but can more broadly be extended to any measures which aim initiate or accelerate investment in green solutions. The most frequent sub-category are those which provide some or all of the resources needed to innovate or to adopt more sustainable technologies. As such they are dominated by provision of resources and incentives and include fiscal incentives to encourage investment in innovation or diffusion of sustainable technologies or manufacturing methods, and the wider set of instruments to support R&D. These are usually targeted to particular sectors or technologies. Where the private sector is a direct beneficiary, this is normally a partial contribution aimed at de-risking progress.

²¹ T. Buisseret, H. Cameron and L. Georghiou (1995) What difference does it make? Additionality in the public support of R&D in large firms, *International Journal of Technology Management* 10 (4) pp. 587- 600

²² B. Clarysse and K. Frenken (2005) Evaluating the additionality of R&D subsidies: comparison of behavioural additionality across countries, *Research Policy* 34(4) pp. 471-492

²³ OECD (2005) Government R&D Funding and Company Behaviour: Measuring Behavioural Additionality

The supply-side also encompasses actions to increase capabilities. Key among these are people-focused instruments including training and education to overcome key shortages in green skills at all levels. These are particularly important in ensuring regional equity as lack of a sufficiently qualified workforce may be a major inhibitor of green investment. Mobility schemes have a role in the diffusion of necessary knowledge to implement transitions.

Diffusion is also aided by information instruments which clarify the validity of the application of other incentives to minimise the risk of green-washing (as with the Taxonomy), scientific and technology assessment and efforts to increase public awareness and ultimately acceptance and support for transition.

- ii) *Demand-side instruments:* Often neglected but crucial in this context are what (in the same mode as ‘technology-push’) are traditionally characterised as demand-pull instruments. Depending upon their precise nature these may increase or shape-demand for green technologies and their products or conversely make non-sustainable incumbent products and processes less attractive. The simplest mechanism is using subsidy to lower cost of green solutions or taxation to raise the price of competing non-sustainable products.

Public procurement of goods and services or of R&D is a powerful mechanism for providing lead markets for green technologies and accelerating their progress towards a performance level where they are competitive with the polluting technologies they seek to replace.²⁴ Private demand may also be shaped by encouraging corporates to articulate their demand and to reflect policy objectives in their supply chains (and conversely not to hide non-compliance in less scrutinised suppliers).

- iii) *Regulation and Standards:* Regulation and standards may be used both to change competitive positions, to limit the scale of non-sustainable activity, and to shape demand in desired directions. The action may operate directly upon corporate producers or it may target consumer demand and hence use market signals to change corporate behaviour. As noted above a high degree of scientific and economic information is needed to ensure that such policies are effective.

- iv) *Systemic instruments:* While they should be distinguished from the policies they seek to implement, there is a case for a category of instrument that may be labelled as systemic.²⁶ As noted by the transition of Geels (op.cit.) and many others, corporate transitions are inhibited by the incumbents being embedded in a context which is normally systemic in the sense that a series of interdependencies reinforce the status quo and raise barriers to change. These environments become embedded in business models and hence in investments made in industries with a long and expensive investment cycle.

²⁴ J. Edler and L. Georghiou, Public procurement and innovation - Resurrecting the Demand-side, Research Policy 36 (2007) 949–963

In terms of innovation this systemic character is manifested in technological interrelatedness, classically expounded by Nathan Rosenberg who noted complementarities, spillovers and cross-sectoral linkages as elements of the systemic processes that drive innovation.²⁵

Policy instruments in this domain may address wider groupings of firms, often around major corporates, with the unit of action being a sector, cluster, innovation ecosystem or supply chain. They may also have a regional focus, particularly in combating lack of equity in regional development.

A related but distinct systemic approach attempts to shift all relevant aspects including technology, education and training, market regulation and demand and societal attitudes and culture. In other words, all of the elements comprising a sustainability transition. While not yet achieved, conceptually this is the basis of the policy instruments successively labelled Grand or Societal Challenges and Missions. Experience in their application has shown the importance of mediating between the higher goals and the level of granularity at which action can be reasonably mobilised. Such instruments in turn benefit from the application of tools such as foresight and/or other strategic deliberation exercises which help to articulate the scope of action.^{26,27}

6. Conclusion

In this review the aim was to understand ways in which governmental actions would incentivise firms to choose strategies that align with sustainable pathways while maintaining value creation and competitiveness. Most policymakers around the world share the desire to pursue both sets of goals simultaneously. Arguably, the rise of green strategies has increased competitive pressure and thus returned competitiveness to the front line of policy rationales.

A wide set of policy initiatives have been put in place seeking to drive a transition but the policy mix literature suggests that they do not sit as part of a grand design and hence that insufficient attention has been paid to ways to enhance complementary action and to minimise contradiction or omission.

While the solution points towards systemic policies there is little evidence available of how these have been driven to a conclusion or what their lasting effects have been. If we accept that corporate transition is a key part of the way to meet the global sustainability challenge we need a better understanding and evaluation of the best way to achieve this, avoiding the traps of greenwashing or geographical displacement of economic activity to less rigorous jurisdictions. Ultimately such evaluation must determine which combination of resources, incentives capabilities and opportunities will induce changes in the business models and underlying routines of firms in key sectors and hence achieve behavioural additionality. If that fails the path may pivot to an approach which facilitates creative destruction of resistant incumbents and growth of a new generation of companies who have integrated sustainability into their core values and actions. The challenge for Europe is that historically it has lagged in the ability to renew its industrial base at the expense of underperforming incumbents

²⁵ N. Rosenberg *Inside the Black Box: Technology and Economics* (1982) Cambridge University Press

²⁶ M. Mazzucato *Mission-oriented innovation policies: challenges and opportunities*

Industrial and Corporate Change, Volume 27, Issue 5, October 2018, Pages 803–815

²⁷ Konnola T, Scapolo F, Desruelle P, Mu R. *Foresight tackling societal challenges: Impacts and implications on policymaking*. *FUTURES* 43 (3); 2011. p. 252-264. JRC65269

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