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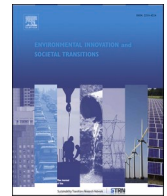
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Research article

The comparative political economy of sustainability transitions: Varying obstacles, accelerants and power in national capitalisms

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ABSTRACT

Sustainability Transition Research (STR) has increasingly recognised the importance of capitalism and the capitalist state in constraining and accelerating the adoption of low-carbon innovations, but has engaged far less with the distinctive forms of national capitalisms. This article highlights the relevant insights of comparative political economy (CPE) that provide a fuller comprehension of the capitalist diversity shaping contemporary sustainability transitions. Specifically, it calls for greater attention to be awarded to the idiosyncratic supply and demand dynamics relating to national growth models, interest coalitions and institutional coordination, and historically-constituted political tendencies of governance. Through these insights, it is argued, the complexities of instigating industrial decarbonisation through the effective application of low-carbon technologies and the geographic asymmetries of transition can be better understood. The importance of these insights is outlined theoretically and demonstrated empirically through an examination of the varying strategic and institutional dynamics characterising sustainability transitions in the contemporary global economy.

1. Introduction

Recent interventions into the sustainability transition scholarship have recognised the importance of capitalism and the power wielded by political actors and industry incumbents in determining the speed and shape of sustainability transitions (Četković and Buzogány 2016; Johnstone and Newell 2018; Feola 2020; Steffen and Schmidt 2021; Silvester and Fisker 2023). These interventions contended that understanding the barriers of transitions, and the catalysts of industrial transformation too, requires an analytical sensitivity to the vested interests, corporate and governance strategies, and capitalist logics in which any form of systemic change is mired (Feola 2020; Silvester and Fisker 2023). As such, political economy analyses have increasingly gained prominence in this research.

Yet, these analytical approaches have tended to elide the distinctive national capitalist forms that create a geographically variegated picture of industrial decarbonisation. Capitalist logics may well be powerful in shaping low-carbon transitions in each country, but the differing economic models, the structural power of vested interests, institutional arrangements, historically-constituted political tendencies and the (contingent) strategies developed by governance institutions and industry incumbents in relation to changing economic needs and circumstances mean that economic transitions taking within two capitalist economies tend to take very different paths and speeds. As such, in order to strive towards a deeper understanding of the terrain upon which sustainability transitions must

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be navigated, it is vital that Sustainability Transitions Research (STR) not only accounts for capitalism but capitalist diversity.

The rich body of comparative political economy (CPE) scholarship is useful here in illuminating this terrain. A handful of empirical studies have pioneered the use of some of CPE's heuristic tools in sustainability transitions research, most notably in the study of how differing varieties of capitalism in the EU have mediated the clean energy transition (Četković and Buzogány 2016), influenced innovation policy (Mikler and Harrison 2012; Malik 2017; May and Schedelik 2021), affected the degree of carbon 'lock in' (Rentier et al., 2019), and shaped the policy instruments utilised (Lachapelle and Paterson 2013). A series of studies have comparatively analysed energy transitions (Baker et al. 2014; Power et al. 2016; Hochstetler 2020) and the interdisciplinary study of Argyriou and Barry (2021) examined state power as a landscape factor in the socio-technical transition of the UK bus system. CPE's insights are broader and more broadly applicable, however, to STR research and could be utilised to help render intelligible the ways in which transitions are constrained or promoted by capitalist dynamics, in order to address (in collaboration with the insights of other social science insights) the historical neglect of governance, power and politics in the transition to sustainability (Geels 2019; Feola 2020; Silvester and Fisker 2023). Specifically, the CPE scholarship enshrines knowledge on the importance of differing growth models that endow strategic importance on certain supply and demand dynamics, the coalitions of vested interests that have emerged due to that growth model and the institutional arrangements that mediate conflicting domestic interests, and the governance tendencies of political actors. This article makes the case that these three features of capitalist diversity are crucial to understanding the speed, asymmetry and non-linearity of sustainability transitions across the global economy today. We can see in some countries a significant degree of consensus and strategic harmonisation amongst economic stakeholders on the need to embrace niche technological innovations in order to strengthen national competitiveness and a greater degree of political will to mobilise investment. Whilst elsewhere in the global economy the systemic changes that apply low-carbon technologies are far less compatible with pre-existing economic competitiveness strategies, investment plans, or the future of domestic employment. The article deploys existent empirics to illustrate the theoretical argument that the insights of CPE can help us understand the capitalist diversity which shapes transitions.

As such, this article responds to, and builds upon, the insights of Feola (2020) and Silvester and Fisker (2023) that sustainability transitions research must engage with capitalist structures, interests and strategies. Drawing upon CPE research it seeks to advance the claim that an analytical accommodation of capitalist diversity can aid understandings of the logics, operations and conflicts in which economic transitions are mired. The engagement with CPE would complement and further enrich the Multi-Level Perspective (MLP) on sustainability transitions which highlights the multi-scalar dimensions that shape the transition of socio-technical systems but has been criticised for insufficiently analysing power and politics (Geels 2014; Patterson et al. 2017; Geels 2019). Through differentiating the capitalist terrain in which systemic change processes take place, this analytical sensitivity would permit, alongside other political economy contributions, a more nuanced understanding of the interests and strategies of governance actors and industry incumbents in different national economies and the logics shaping interactions between the macroeconomic landscape, policy developments and meso-level regimes. The insights of CPE, it is argued, enable a more comprehensive, fine-grained and variegated understanding of contemporary sustainability transitions in the global economy.

The article begins with an overview of the sustainability transitions scholarship and its incorporation of political economy analyses to date. It then theoretically examines three key features of capitalist diversity that shape the adoption of low-carbon technologies and economic transitions; namely (i) the supply and demand dynamics specific to national growth models, (ii) the interest coalitions and institutional arrangement of coordination and consultation domestically, and (iii) national political tendencies of governance. Finally, the importance of these theoretical insights is demonstrated empirically with reference to the transitions taking place in key sectors of the global economy today.

2. The intractability of sustainability transitions

Numerous technologies and practices conducive to reducing greenhouse gas emissions via systemic changes to production or alternative business practices already exist - including solar PV, wind energy generation, green hydrogen and electric vehicle batteries inter alia. These niche innovations, however, have not been led to widespread changes to socio-technical systems. As such, industrial decarbonisation has been incremental and asymmetrical across sectors, leaving societies on the path to climate catastrophe (IPCC, 2023). What, therefore, are the barriers to the adoption of niche technologies and the conditions for accelerated transitions?

STR emerged to comprehend the interplay of technological, social, economic, financial, political, cultural and material dynamics that shape the development and employment of technologies, practices, and institutions conducive to transitions with the potential to advance decarbonisation. These co-evolutionary forces are seen to be key to destabilising, reconfiguring and supplanting entrenched systems of provision and forging new socio-ecological pathways (Loorbach et al. 2017; Köhler et al. 2019). This includes interdisciplinary research on the emergence and diffusion of technological innovations and practices that disrupt social and technical production systems (Elzen et al. 2004; Geels 2011; Markard 2018; Hebinck et al. 2022), the interaction between innovations and meso-level regime dynamics (including the ingrained rules, norms, and practices that engender path-dependencies within particular sectors and domains) and the constraints or catalysts in the macro-level 'landscape' of economic, social and political factors that shape the adoption or implementation of niche innovations (Geels 2011; McMeekin et al. 2019). These dynamics shape pathways toward more sustainable production and consumption patterns as well as structure the timescales on which they will occur.

As Feola (2020) notes, as a historically "scientific field with roots in innovation, science and technology studies, and evolutionary economics, STR [sustainability transitions research] has essentially taken capitalism for granted". Political economy analyses that embed sustainability transitions in capitalist relations have, however, increasingly shed light on the structural forces that shape the development and deployment of low-carbon technologies and practices. As has been asserted either implicitly or explicitly in this wave of political economy analyses, the relations of capitalism are not merely 'landscape factors' but rather pervade the logics and dynamics

of sustainability transitions (Feola 2020; Markard et al. 2021). The economic and political relations which have been subject to attention in recent years has been manifold. It has notably included the significance of incumbent interests, given structural power by virtue of their significance to national development strategies and employment, that serve as inhibitors or facilitators to decarbonisation in various national economies (Baker et al. 2014; Newell and Phillips 2016; Lee and Hess 2019; Sovacool and Brisbois 2019; Turnheim and Sovacool 2020; Feola 2020; Hochstetler 2020; Newell 2021; Groenewoudt and Romijn 2022). It has also included the power of finance capital in facilitating or weakening transitions (Newell and Phillips 2016; Naidoo 2020; Steffen and Schmidt 2021; Newell 2021; Hadfield and Coenen 2022). The role and capacity of the state in shaping sustainability transitions has increasing been recognised (Johnstone and Newell 2018; Roberts and Geels 2019; O'Neill and Gibbs 2020; Hochstetler 2020; Newell 2021) and the mobilisation of state power has been linked to the broader domestic landscape of vested interests in which the state is embedded (Johnstone and Newell 2018; Silvester and Fisker 2023). The largely uncontested objective of *ad infinitum* GDP growth has also been seen as crucial in limiting transitions (Feola 2020; Khmara and Kronenberg 2020; Green 2022). Meanwhile, STR scholarship has also documented the role of 'rising economic powers', such as China, India and Brazil, in driving low-carbon energy transitions through the development of niches and reinforcing or challenging existing energy regimes (Power et al. 2016).

The research agenda set out by the Sustainability Transitions Research Network in 2017 only made two cursory mentions of capitalism (STRN, 2017), but the insights of political economy analyses have collectively demystified the structural political and economic forces that constrain, distort and limit the development and deployment of innovations capable of advancing decarbonisation. Analytical approaches such as the MLP have already been enriched and developed by social science insights that have yielded deeper insights into the nature of the interactions between social groups and the structural forces acting upon path-dependencies (Geels 2019).

However, STR has not been methodically attuned to the pertinent features of capitalist divergence which shapes the development and adoption of low-carbon technologies and practices across numerous sectors. This national capitalist modalities shape incumbent strategies and the extent of resistance, governance networks and logics, policy visions, socio-economic interactions, coalition building and political struggles which all collectively affect socio-technical systemic changes that promote decarbonisation. There are notable exceptions (see Lachapelle and Paterson 2013; Četković and Buzogány 2016; Argyriou and Barry 2021), particularly in documenting the domestic and external constraints on energy transitions specifically, which have been analysed in the case of South Africa (Baker et al. 2014), South Africa and Mozambique (Power et al. 2016), and South Africa and Brazil (Hochstetler 2020). A deeper engagement with the rich theoretical modalities and empirical knowledge enshrined in CPE, however, would offer a more comprehensive and detailed picture of the structural political and economic conditions that constrain or accelerate transitions not only within the energy sector but in other unsustainable industries. As the field of CPE documents, national economies are characterised by relatively distinctive and stable growth models, institutional arrangements of consultation and coordination, and historically-constituted political cultures of interventionism and investment that have developed over long periods of time. The prospects of sustainability transitions are profoundly affected by these diverse characteristics of capitalist economies.

3. Capitalist diversity and sustainability transitions

In making the case that the sustainability transition research needs to take capitalism seriously, Feola (2020) defines capitalism as a "historically specific form of social and economic organisation, which is characterised economically by the private property of the means of production, the freedom to pursue economic gains through production and the market, the transformation of labour power into a commodity, the owners' control of the means of production and the destination of value generated through production, and the generalisation of production and exchange of commodities" (Feola 2020). This definition is uncontested here, but understanding the structural factors that make sustainability transitions so intractable requires a fine-grained and differentiated appreciation of capitalism that incorporates of the distinctive national growth models, configurations of vested interests, institutional arrangements, and strategies of competitiveness amongst corporate and political elites (Silvester and Fisker 2023). It is this set of specificities, captured in the CPE scholarship, that affect the nature and pace of systemic change in capitalist economies.

CPE scholars have developed a variety of competing analytical approaches that focus on differing aspects of capitalist diversity. The Varieties of Capitalism framework (Hall and Soskice 2001; Nölke and Vliegenthart 2009; Hay and Bailey, 2019; Schedelik et al., 2021; Palley 2022) and the Growth Models Perspective (Baccaro and Pontusson 2016; Baccaro and Pontusson 2022) represent primary reference points, with the latter adopting a demand-side focus to counterpose the supply-side focus of the former. The Varieties of Capitalism approach initially sought to understand the persistence of nationally-distinctive forms of capitalism in an age of economic globalisation, which was anticipated to be a homogenising force that would eradicate national differences, and has since documented patterns of convergence and divergence in national economic modalities (Hall and Soskice 2001; Baccaro and Pontusson 2016; Hay 2020; Clift and McDaniel 2021). The Varieties of Capitalism framework distinguishes between types of supply-side institutional configurations that bolster particular comparative advantages, conventionally conceptualised as Coordinated Market Economies (CMEs) and Liberal Market Economies (LMEs), but more recently expanded to include dependent market economies (DMEs), hierarchical market economies (HMEs), state-permeated market economies and patrimonial market economies (Hall and Soskice 2001; Nölke and Vliegenthart 2009; Nölke et al., 2019; Schedelik et al., 2021; Wood and Schnyder 2021). The Growth Models Perspective was developed as a critique to this approach through adopting a stronger focus on the national modalities of accomplishing economic growth and competitiveness in the global economy through discerning the generation or exploitation of demand, the forms of production that have emerged to meet that demand, and the durability or fragility of these dynamics (Baccaro and Pontusson 2022). Meanwhile, a much longer tradition of CPE documents the historically-constituted governance tendencies of diverse political cultures that shape market forces and are, in turn, re-shaped by macroeconomic, financial and geopolitical conditions (Schonfield 1965;

Katzenstein 1985; Bulfone 2023).

These approaches offer stylised conceptions of national economies, and as such have been criticised for engendering static and deterministic portrayals of institutional stability, disregarding variations within economies and sectors, and downplaying the global economic dynamics that have shaped national economies (Hancké, 2009; Hay 2020; Kohler and Stockhammer, 2022). The study of capitalist diversity has also been rightly criticised for its historical neglect of the natural world, its acceptance of economic growth as an overriding objective, and the analytical treatment of the global economy as ‘environmentally dis-embedded’ (Wood and Schnyder 2021; Green 2022). As such the analytical constructs of CPE should not be treated as concepts beyond reproach, nor should they be seen to have universal utility for each analysis of capitalist dynamics, but rather as heuristic devices with practical analytical applications (Hay 2020). Nonetheless, CPE models do explicate some of the distinctive elements of national capitalisms and thereby permit an understanding of the structural forces that contextualise and shape niche innovations and regime-level transitions in each country and generate considerable asymmetries between countries. It is posited here that an appreciation of the collective insights of these traditions can mitigate the limitations of each of them and thus enable a greater understanding of the supply-side, demand-side and governance elements of capitalist diversity. The insights which are particularly germane for our purposes are the following:

3.1. National growth models

The CPE scholarship has developed conceptions of distinctive national growth models, characterised by differing sources of demand and supply side configurations, which are seen as key to ensuring national competitiveness and the accomplishment of economic growth (Baccaro and Pontusson 2016; Baccaro and Pontusson 2022). These growth models are interdependent and each differing integrated within global macroeconomic trends of trade, investment, production, technological innovation and financial instability in the global economy that have profoundly shaped national capitalist developments (Clift, 2014; Schedelik et al., 2021). Protecting the success of these models are seen as strategic priorities for governance actors and the industries integral to the model’s success are seen to be nationally significant. Whilst governance actors and industry incumbents may abstractly be in favour of sustainability, maintaining or bolstering economic competitiveness and prosperity will continue to be strategic priorities throughout any transition.

This has significant and nationally-distinctive implications for the prospects of sustainability transitions, as they indicate the varying structural barriers and conflicts that will hinder pathways to industrial decarbonisation and systemic changes to production. Sustainability transitions may well require challenges to existing investment patterns of global finance, energy-intensive industrial activity and consumption in order to align national economies with the targets set in the Paris Agreement, but the degree of their systemic significance to national growth models will strongly determine the extent to which political actors feel they have the ‘room to manoeuvre’ in instigating change. For example, German capitalism is characterised by its export-led growth model that aims to tap into demand for high-end manufactured goods in foreign markets, to the extent that exports account for 40 % of Germany’s GDP (Baccaro and Pontusson 2022), which endows significant economic importance onto the needs of the domestic and energy-intensive manufacturing sector in ways which mediate Germany’s transition to sustainability. The growth of many patrimonial and hierarchical market economies, meanwhile, are dependent on the success of specialised resource-extracting sectors, which can significantly hinder systemic changes to energy production and other systems of natural resource exploitation (Schneider and Soskice, 2009; Schedelik et al., 2021). The diversity of national interests and economic strategies are laid bare in international negotiations such as the COP conferences.

The economic structures pertaining to national growth models therefore condition corporate and political decisions, in terms of investment patterns, research and development policies, regulatory measures and the pursuit of trade deals. A growth model in which certain sectors are vital for national economic performance can result in formidable resistance to changes to meso-level regimes. Yet these economic structures are not irrevocably a barrier to transition, and indeed the profit motive can help drive change if the future of competitiveness is seen to require rapid systemic changes and the embrace of technological niches.

3.2. Interest coalitions and institutional coordination

Distinctive economic strengths mean differing constellations of economic interests. There tends to be conflicts between economic stakeholders as they each formulate strategies to accomplish their own interests, but fragile and provisional coalitions can be formed between economic stakeholders (Hess 2014; Hall 2019; Rosamond 2019; Bondy and Maggor 2024; May et al. 2024). The constellation of vested interests supporting prevailing economic trajectories can be thought of as ‘growth coalitions’, that have developed over time because of them (Baccaro and Pontusson 2022). As Baccaro and Pontusson put it, “stable growth models are sustained by a coalition of organized interests that enjoy privileged access to the policy-making sphere and ensure that government policies, especially macro-economic policies, reflect its interests and the functional requirements of the growth model”. The industry representatives and trade unions seek to conflate the interests of systemically significant sectors with the notion of the ‘national interest’ and shape public perceptions of ‘how the economy works’ (Baccaro and Pontusson 2022). As a result of both formal and informal interactions between state actors and stakeholders, “the noisy politics of elections often leads to changes of government but rarely to fundamental changes in the growth regime” (Bohle and Regan 2021).

Corporate interests represent some of the most powerful elements of growth coalitions, and the objective of profitability is often articulated as the generalised national interest in economic growth (Newell and Paterson, 1998). Corporate power can be identified in the agricultural sector in France and the finance sector in the UK, which have relatively large ecological footprints, but economic prominence domestically and thereby a sizeable amount of ‘structural power’ to resist political actions designed to encourage systemic changes to existing practice (Newell and Paterson 1998). The systemic significance of fossil fuel energy throughout the global economy

means that the industry incumbents of the fossil fuel energy sector also represent important elements of interest coalitions and a formidable source of resistance to climate policy, which highlights the material foundations that national capitalisms are embedded within (Green 2022), albeit the influence of these incumbents is dependent on the country's integration in globalised energy systems and is weaker considerably in countries with domestic capacity to produce nuclear or renewable energy (e.g. Costa Rica, Uruguay, Iceland). Coalitions of interests opposing transition though can also include trade unions, for whom a systemic changes to production threatens to herald a reconfiguration of the global division of labour and domestic job losses (Lachapelle et al. 2017; While and Eadson, 2023). Although these social forces often conflict, the threat of transitions can create strange bedfellows amongst interest coalitions.

As such, prevailing economic strengths and interests shape political and corporate strategies of competitiveness, many of which result in resistance to transition in order to protect short-term profit and growth (Newell and Paterson 1998; Aklin and Mildemberger 2020). Yet in some sectors and national economies, it can also catalyse the adoption of low-carbon technologies and systemic changes to production through evolving perceptions of competitive advantage (Meckling and Nahm 2019; Turnheim and Sovacool 2020). In these scenarios, transitions can be accelerated but interest coalitions can be fragmented. This can be observed in the automotive sector where the rise of electric vehicles, the GVA of which primarily lies in the manufacturing of car batteries in Asian countries, threatens employment and livelihoods bound up with the production of fossil fuel vehicles in European economies. The rise of 'green hydrogen' similarly threatens to create structural unemployment in Europe too, as producers are relatively more able to relocate production to areas where labour is cheap than with existing forms of coal energy production.

The institutional arrangements of coordination and collaboration with economic stakeholders, in which varied economic interests are heard and accommodated, are crucial in managing the conflicting interests that are exacerbated or created by low-carbon transitions. Particularly in coordinated market economies, such as Germany, the Nordic economies and the Netherlands, dense institutional arrangements have led to tightly regulated labour markets, relatively strong forms of social protection, and a virtuous self-reinforcing cycle of patient capital, long-term investment in skills and expertise and collaborative industrial relations between firms, trade unions and the state. This is contrasted with more conflictual liberal market economies in which flexible labour markets and unregulated mobile investment capital is seen to promote innovation and adaptability to changing competitive circumstances (Hall and Soskice 2001). Patrimonial market economies in Russia and the Middle East characterised by cronyism and rent-seeking that defeat any democratic forums of coordination with marginalised stakeholders, and hierarchical market economies in Latin America characterised by atomised labour relations and the dominance of multinational and domestic business interests, also denote differing institutional approaches to managing the conflicts and social justice issues that will complicate low-carbon transitions (Schedelik et al., 2021).

It has also been shown that capitalist diversity tends to generate various types of climate policy, with CMEs more likely to employ market-based instruments such as carbon pricing and economic incentives whilst LMEs tend to invest more in R&D (Lachapelle and Paterson 2013; Lachapelle et al. 2017). As is well documented, capitalist diversity also tends to lead to varying forms of innovation as inter-firm institutions, regulatory regimes, and policy networks favour path-dependent incremental or radical changes to business models, technologies or infrastructures (Hall and Soskice 2001; Elzen et al. 2004; Mikler and Harrison 2012; Malik 2017; May and Schedelik 2021). Both configurations of interests and institutional arrangements signal the heterogeneity that will asymmetrically enable, constrain or thwart sustainability transitions across the global economy.

3.3. Diverse governance tendencies

The governance of transitions is not limited to the coordination and accommodation of conflicting societal interests. Political actors in institutions of governance also, to differing extents across the global economy, shape transitions through mobilising public investment that aims to catalyse the innovation and implementation of low-carbon technologies and practices that alter meso-level regimes in national industries. This is not to say that states intervene primarily for the purposes of coaxing sustainability transitions, even though states do have unrivalled power to do so (Eckersley, 2004; Mazzucato, 2013), rather that the state typically deploys investments primarily to promote economic competitiveness and growth which can occasionally result in the adoption of niche innovations and path-shaping industrial change (Hochstetler 2020; Newell 2021).

Following Argyriou and Barry (2021), "despite the centrality of states as critical terrains of low-carbon transitions, research has placed less attention to the state as a focal point of transition dynamics". Johnstone and Newell (2018), Patterson et al. (2017), Argyriou and Barry (2021) and Silvester and Fisker (2023) have enriched and nuanced accounts of the state and state power in the governance of sustainability transitions. There is, however, significant variation in institutions and governance across the global economy, which leads to qualitatively different public policies and approaches to decarbonisation (Lachapelle and Paterson 2013; Harrison and Mikler, 2014). The power of political authorities is organised and exercised heterogeneously, due in part to their differing historical constitutions, the ideologies of the ruling government, capacity, democratic cultures, the rules and norms of the institutional complexes comprising states, and the distinctive economic models in which each state is situated. CPE provides insights into the governance tendencies of national states in steering economic development in ways which may accelerate or frustrate sustainability transitions (Hall and Soskice 2001; Četković and Buzogány 2016, Hay and Bailey 2019, Bulfone 2023).

India and China are seen by the CPE scholarship as the archetypal models of 'state-permeated capitalism' (Nölke et al., 2019; Schedelik et al., 2021), with the Chinese state the posterchild of mobilising low-carbon investment in order to become the largest producer and exporter of manufacturing goods relating to renewable energy and EVs (Meckling and Nahm 2019). The Nordic economies are seen to be 'social-democratic economies' whilst France and South Korea oversee forms of 'state-enhanced capitalism' which also typically feature strong forms of government interventionism (Schmidt, 2002; Clift and McDaniel 2021; Schedelik et al., 2021). In contrast, the UK state tends to be far more committed to fiscal discipline and this has historically hampered attempts to promote

innovations and transition (Mazzucato, 2013; Craig 2020) and Germany is not only committed to fiscal discipline but have enshrined the principle in the rules of the European Union (Nedergaard and Snaith 2015).

These governance tendencies are informed by historically-constituted political cultures, but also the fortunes of the country's distinctive growth model, the structural power wielded by interests coalitions, issues related to domestic fiscal politics, and the global macroeconomic conditions in which states are situated (e.g. the onset of economic crises, geopolitical rivalries, etc.). In the case of sustainability transitions, as we shall see in the following section, it is the regions of the global economy where political actors are inclined to develop industrial policies that the most rapid forms of industrial decarbonisation can be observed. Governance tendencies are thus a vital element in understanding the asymmetrical sustainability transitions unfolding in the contemporary global economy, and has been another important historical constituent of CPE study (Schonfield 1965; Katzenstein 1985; Bulfone 2023).

4. Variegated sustainability transitions in the global economy

In this section, the analytical significance of CPE insights to STR is demonstrated empirically through showing how capitalist diversity shapes interests, strategies and conflicts in ways which enable or inhibit low-carbon transitions. Capitalist logics are refracted through distinctive national capitalist modalities which affects the speed, asymmetry and limits of low-carbon transitions in the global economy.

As has been noted, national growth models are particularly powerful in constraining or enabling systemic changes to production. Perhaps counter-intuitively, given the structural power of the manufacturing sector and the scale of GHG emissions related to its manufacturing operations, Nahm found that export-led growth models such as in China and Germany have the greatest incentives to adopt low-carbon niches (Nahm 2022). This is because, in the context of a global competition with countries such as the US and France for a share of rising profits in the so-called 'green economy' (in other words, the production of lithium car batteries, renewable energy equipment, etc.), Nahm argued that export-led economies have the potential to build broader domestic coalitions between firms, trade unions and governance actors in favour of systemic change. Although interest coalitions might resist systemic change, the understanding of future competitiveness in this sector provide material incentives for regime-level transition. For example, the automotive sector – an exemplar of transition at the current time and a key sector in both China and Germany – has undergone dramatic strategic shifts and heavy investment in systemic change in recent years in light of shifting demand for electric vehicles (Newell and Simms 2021; Haas 2020; Newell 2019; Newell 2021; Nahm 2021; Nahm 2022). The view of both corporations and trade unions in this sector is that automation, artificial intelligence, digitalisation and rising demand for electric vehicles threaten the future competitiveness of industry incumbents, and as a result an accord has been struck on the systemic changes necessary to ensure renewal. By contrast, growth models dependent on domestic demand have proven less inclined to develop low-carbon industrial development strategies and, equally, national growth models that rely on the competitiveness of sectors without access to equivalent low-carbon niches (e.g. aviation, agriculture, construction) manifest fierce resistance to regime change.

This is not to say that there is a consensus amongst all economic stakeholders in export-led growth models on systemic changes. Some stakeholders, such as trade unions, remain very wary of low-carbon technological change that could result in relocations of production, gross value added, and domestic job losses. In Germany – where there is a broad consensus of the political strategy of renewing the competitiveness of the existing *exportweltmeister* growth model through accelerating the adoption of low-carbon niches such as electric vehicles, 'green hydrogen' and solar energy (Haas 2020; Nahm 2022) – anxiety abounds over the consequences of some regime-level transitions. In the German steel industry, the development of green hydrogen is leading to the relocation of manufacturing to sites in China and East Europe, where labour and facilities are less expensive, with damaging consequences for the Rhine-Ruhr region. Meanwhile, the shift to electric vehicles means that the value added of new fleets will be based in China and a host of smaller companies in the German *middlestand* have been viable over recent decades because they have routinely provided parts and services to the large car firms on the basis of existing production practices but will struggle to adapt to the niche technological and geographical changes happening at the regime level in the automotive sector. The threats to national competitiveness foreshadows a fragmentation of a powerful interest coalition in Germany, which exemplifies the socio-economic and democratic complications of adopting low-carbon niches. Germany's specific integration in the global economy has afforded them an advantageous economic position in early 21st century global value chains, and the will to protect these advantages have already enabled various climate policies (Nahm, 2022; Lachapelle et al. 2017), but it has also made national competitiveness and employment vulnerable to systemic change. The potentially seismic reconfiguration of the 'global division of labour' is set to be one of the consequences of sustainability transitions for interconnected national economies, and could disadvantage regions that have already suffered from deindustrialisation in Western Europe particularly (Lachapelle et al. 2017; While and Eadson 2022). The implications of this capitalist restructuring and resultant social conflicts for decarbonisation are not yet clear, but will likely become an important aspect of STR in the near future.

This raises the question of how conflicting socio-economic interests are mediated by domestic institutional arrangements. As the Varieties of Capitalism scholarship documents, strikingly different institutional arrangements have developed in the global economy and this now conditions the governance of sustainability transitions and the negotiation of strategic dilemmas and trade-offs.

The political culture of consultation and coordination on economic development, in which stakeholder interests are heard and often accommodated, has shaped transitions in CMEs in the Nordic economies, Germany and the Netherlands in particular (Četković and Buzogány 2016; Mikler and Harrison 2012; Aklin and Mildenerger 2020). In recent years, the economic policies designed to accelerate low-carbon transitions in these countries has been informed by a variety of interests including major corporations, industry associations, trade unions and social movements. Incumbents have a markedly stronger voice in negotiations, particularly in hierarchical and patrimonial market economies, but the presence of democratic processes render some national economies better equipped to achieving a just transition – i.e. a transition which accounts for the myriad of competing interests and concerns, and one which

ensures the ‘buy in’ of citizens. Yet this coordinative culture also lends itself to incrementalism at a time when the climate science demands political and economic radicalism. Canadian and German capitalisms are partly characterised by these dense institutional processes, and both established stakeholder-driven commissions as arenas for negotiation and the development of proposals for just transition pathways (Gürtler et al. 2021). Such forums often legitimise government strategies, but also offers a platform for fierce resistance and typically results in incrementalism. According to Rentier et al. (2019), the capitalist relations and ‘employment protection’ found in coordinated market economies have slowed down coal phase out in Germany, Spain and Poland. This has consequences for the timescale on which the transition can be accomplished.

Meanwhile, in countries with more centralised political tendencies, in which governance actors are more likely to ignore or be ignorant of interests and strategies of economic stakeholders, the conflictual politics of transition are governed in less deliberative fashion. This landscape factor can lead to more rapid systemic change in state-permeated capitalisms, as in China (Meckling and Nahm 2019). Yet decisive climate policies can also be seen as unjust and result in social and political backlashes (Patterson 2023; Paterson et al. 2023; Lockwood 2018). The *gilet jaunes* movement in France is the archetypal example here. Given that disadvantaged regions are already a significant constituency underpinning the rise of far-right populists in Europe, it is also plausible that a scenario of paternalistic and punitive environmentalism in France lends itself to an even greater vote share for Marine Le Pen of the far-right *Rassemblement National*. As such, the centralisation of power and decisive interventionism in some countries can generate risks of fraught, contested and non-linear transitions, albeit the risks are far greater when climate policies take the form of punitive taxation or regulations rather than public investment.

This underlines the analytical importance of appreciating landscape-level national governance tendencies in STR, and the rise of industrial policy has become one of the noteworthy shifts in climate policy in recent years amongst numerous interconnected national capitalisms (Allan et al., 2021). France is a case in point. Aligned to its historical *dirigiste* governance inclinations, the ‘France2030’ programme mobilises public investment to strengthen the competitiveness of existing French industries through the adoption of low-carbon niches, entailing €30 billion over five years to the nationally significant automotive, aerospace, digital, green industry, biotechnology, culture and healthcare sectors (France24 2021). Similar policy trends can also be identified in many other state-enhanced and state-permeated capitalisms, most importantly China (Meckling and Nahm 2019). Some even identify an emergent (if geographically-uneven) forms of ‘state capitalism’; a governance response to the ‘wicked trinity’ of economic stagnation, labour surpluses and ecological breakdown (Alami et al. 2023).

Fiscal restraint has traditionally been a feature of other national governance institutions, but the confluence of global macro-economic circumstances of economic stagnations, energy insecurity, geopolitical fragmentation, rising international competition for a share of the profits in the ‘low-carbon economy’ and consequent anxiety over the future of domestic employment have also overwhelmed liberal traditions of fiscally-restraint in some national economies (see Meckling and Nahm 2019; Allan et al. 2021; Schindler et al. 2022; Alami et al. 2023). As such, the role of states in promoting and supervising transitions through public investment is today not only marked in state-permeated and state-enhanced capitalisms (such as China) but also identifiable in traditionally liberal economies such as the United States, in which the Inflation Reduction Act can be seen as a landmark moment in the geopolitical competition to secure future comparative advantages in the ‘low-carbon economy’ (Meckling and Nahm 2019; Mathiesen and Colman 2022). This rivalry has, in turn, generated anxiety within the EU where the principle of ‘matching aid’ has been introduced to counteract the risks of businesses re-locating investment and industry outside Europe (Jones 2024). The fear of being ‘left behind’ by other nations in the global economy is inescapable and, as a result, *dirigiste* governance tendencies are no longer as distinctive as they once were. Even in liberal market economies – where the deference to market forces typically preclude forms of economic change facilitated by government action (Mazzucato, 2013; Meckling and Nahm 2019) – liberal governance norms have, for the time being at least, been overwhelmed by the perceived need to shore up national competitiveness.

Policy design in each national landscape has been conditioned, however, by prevailing national growth models, interest coalitions, and governance systems. The deployment of public investment has sought to accomplish path-shaping innovations and transitions only where elite policy networks perceive them to be advantageous for national growth strategies and employment, and in these cases have been designed to accomplish sector-specific comparative advantages (see Allan et al. 2021, Schindler et al. 2022, Mathiesen and Colman 2022, Jones 2024), albeit they have consequences which ripple through the global economy. Just as often, industrial policy is designed to stabilise existing carbon-intensive forms of production vital to national economic strategies (Johnstone and Newell 2018; Kohler and Stockhammer, 2022). This was the case in the UK during the global pandemic, where fiscal restraint was jettisoned to shore up the existing economic model and the jobs depending on it (Berry et al., 2022), and in Indonesia where industrial policy has centred on infrastructure projects that facilitate the commodification of natural resources (Schindler et al. 2022). These policy responses have been prompted by macroeconomic instability but were profoundly shaped by capitalist diversity. The rise of green industrial policy has transformed climate governance but it has been geographically-uneven and contingent upon national economic modalities and the specific integration in the global economy (Allan et al. 2021; Schindler et al. 2022; Alami et al. 2023). Underlining the analytical importance of comparative capitalisms in STR, the governance strategies that are today catalysing the development and deployment of low-carbon niches are mediated by the specific growth strategies, fragile interest coalitions and institutional tendencies of national capitalisms.

5. Conclusion

The sustainability transition will require a myriad of complex and interconnected shifts across a diverse array of institutional sites across the global economy. Political economy analyses are essential to understanding the barriers, catalysts, conflicts and global asymmetries of such transitions. As Feola (2020) notes, “capitalism permeates the workings and logics of socio-technical systems in

ways that are critical both in the elaboration of rigorous accounts of transition trajectories and for the capacity of STR to support future societal sustainability transitions". But sustainability transitions research must appreciate not only the importance of capitalism, but the capitalist diversity captured by the CPE scholarship. Understanding, analysing and strategically navigating sustainability transitions will be enabled by an analytical awareness of capitalist diversity across time and space. This article has sought to highlight the theoretical value of three interlocking insights of CPE that are seen to be particularly important for understanding the global variations of economic transitions to sustainability: (i) national growth models (ii) powerful interest coalitions and varieties of institutional coordination and consultation in national capitalisms, and (iii) diverse governance tendencies. The significance of these theoretical features of capitalist divergence were illustrated empirically in reference to contemporary path-dependencies and low-carbon transitions being shaped by diverse and multi-scalar configurations of strategic objectives, powerful interests, socio-economic conflicts, and institutional norms in each country. These insights would complement and enrich the analytical approaches of STR, in drawing attention to the diverse capitalist interests, strategies and conflicts in which socio-technical systems and innovations are enmeshed.

This is not to say that CPE offers a comprehensive framework for understanding STR. There is an equal need for CPE to engage with STR and parallel political economy research to fully comprehend the embeddedness of national capitalisms in material eco-systems, the global interdependency of national economies and the economic trajectories being forged in the global economy today. It is also not to claim that the conceptual tools of CPE should be incorporated into STR analyses as unimpeachable constructs of universal utility rather than heuristic devices deployed selectively to aid comparative analysis (Hay 2020). Nonetheless, an engagement with capitalist diversity permits insights into the comparative barriers, catalysts and limits to sustainability transitions across the global economy, as well as aiding those seeking to devise strategies that promote sustainability transitions by enabling the identification of opportunities and pressure points for change.

STR has been criticised for a neglect of capitalist dynamics, governance, politics and power (Geels 2014; Patterson et al. 2017; Johnstone and Newell 2018; Geels 2019; Feola 2020; Argyriou and Barry 2021; Silvester and Fisker 2023). Dominant approaches in STR, such as the MLP, have already been enriched by social science insights that have deepened understandings of the structural forces and multi-scalar societal interactions in which transition process are situated (Geels 2019; Feola 2020; Silvester and Fisker 2023). An analytical awareness of capitalist diversity would complement existing analytical approaches by helping to make sense of the varied economic, political, social, technological and material obstacles to accelerating decarbonisation and the socio-economic conflicts characterising each transition. This could take numerous forms across different empirical cases. The geographically-uneven rise of industrial policy, for example, demonstrates the analytical importance of national growth models, interest coalitions and governance tendencies in rendering intelligible the (rapidly changing) public and private investment strategies that are currently accelerating the development and adoption of niche technologies and accelerating regime-level transitions in some countries. Equally, a sensitivity to capitalist diversity could render intelligible the reluctance of governance actors in other countries to accelerate a transition that would result in the loss of jobs domestically in industries of national importance. Therefore, an analytical awareness of growth models, interest coalitions and governance tendencies can enhance understandings of the ongoing interactions between social groups engaged in activities that constrain or promote innovations and sustainability transitions. It sheds further light on the operations, conflicts and logics that pervade the interactions between the macroeconomic landscape, policy-making and meso-level regimes in different national economies. An understanding of capitalist diversity can ultimately help address the question of how transitions are influenced by 'current political and societal macro developments' (Kohler et al. 2019: 21) and complement STR's dominant analytical frameworks in terms of comprehending and analysing the interests, conflicts and strategies characterising governance, politics and power (Patterson et al. 2017; Geels 2019).

CRedit authorship contribution statement

Dan Bailey: Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization.

Declaration of competing interest

The author declares no known financial interests or personal relationships that has influenced the work reported in this paper.

Data availability

The data that has been used is confidential.

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