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Unpacking policy coherence: A network analysis of the EU policy mix for the circular economy☆

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ABSTRACT

Policy coherence is a sought-after characteristic in cross-sectoral sustainability transformations. Despite the wealth of research on policy mixes and the urgent need to advance environmental sustainability in production and consumption cycles, only a limited number of studies empirically examine policy coherence in practice within policy mixes for the circular economy. To address this gap, our paper unpacks the EU's circular economy policy mix as a system of linked policies whose policy coherence is experienced by actors in the circular economy space, specifically in the electronics and ICT, batteries, automotive and critical raw materials sectors. The circular economy is an important area for studying policy coherence because it has been subject to a significant increase in policy adoption, all while the mainstreaming of circular economy practices remains insufficient at the EU level. Combining a top-down and bottom-up approach to populate the policy mix, we use network analysis to assess the synergies and conflicts among the policies in the mix through the surveyed experiences of 36 business actors. We find that on average the EU's circular economy policy mix exhibits a medium-to-high average degree of coherence. At the same time, however, our results show that the coherence between policies is not uniform within the mix as there is a diverse degree of coherence among its policies. Looking closely into inter-policy coherence reveals several cases of medium-to-low coherence. Moreover, our results indicate that the EU's policy mix for the circular economy lacks clusters of policies, which reduces the resilience of the policy mix to external shocks. We conclude that more emphasis should be given to aligning the objectives of EU circular economy, industrial and climate policies, and to providing a coherent set of requirements for EU businesses.

1. Introduction

Addressing the climate and ecological crises requires the pursuit of a societal transformation targeting consumption and production patterns (Lindberg et al., 2019; Weber and Rohracher, 2012; Schroeder et al., 2019). The idea of a circular economy responds to this by proposing a system of production and consumption "which closes the input and output cycles of the economy", recognising the biophysical limits of the Earth (Calisto Friant et al., 2020, p.1). Moving to a circular economy requires fundamental transformations across markets, technologies and institutions (Winslow and Coenen, 2023; Aarikka-Stenroos et al., 2021; Walker et al., 2021). This in turn requires the involvement and mobilisation of actors, institutions and knowledge in use today (Korhonen et al., 2018; Lieder and Rashid, 2016; Rizos et al., 2017).

Policy is expected to play a critical role in creating a circular economy (Domenech and Bahn-Walkowiak, 2019; Milios, 2018). Yet, a single policy instrument cannot spur such a profound societal transformation (Kern et al., 2019; Schmidt and Sewerin, 2019). In fact, moving to a circular economy means that actors in the production and consumption stages disrupt current behaviours and adopt new ones (Droege et al., 2023). Given the range of actors (and behaviours) involved, a mix of different policies is needed (Kern et al., 2019; Milhorance et al., 2022a) to encourage change, and ultimately encompass the complex transition towards a circular economy (Milios, 2018).

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In this context, policy mixes are the result of an ever-evolving process of policy adoption, which is not static (Schmidt and Sewerin, 2019). As policies are continually adopted, scholars find considerable agreement that policy mixes address their respective policy problems in an uncoordinated manner because they bring together a large number of policies that were not adopted at the same time or under the same circumstances (Milhorance et al., 2022a; Milios, 2018; Howlett, 2019). These policies are unlikely to be fully aligned with each other. This aspect is particularly relevant for those actors responding to the implementation of policies, who experience the unfolding of a policy mix on the ground (Huttunen, 2015; Lindberg et al., 2019). As a result, it is important that policies within a policy mix have limited conflicts and relevant synergies with each other, which scholars conceptualise as policy coherence (Kosow et al., 2022).

In recent years, the EU has adopted multiple policies to support the transition to a circular economy. Still, we know little about the extent to which the various policies for the circular economy practically cohere with each other. We bridge this research gap by zooming in on four sectors that require transformation in their production and consumption cycles to advance the EU circular economy. These are the electronics and ICT, batteries, automotive, and critical raw materials sectors.

This paper examines the EU's policy mix for the circular economy through the lens of policy coherence as an experienced policy-mix characteristic. It is crucial to uncover conflicts and synergies between policies through actors' experiences, because it turns our attention to how policies direct the behaviours and activities of those responding to policy implementation (Huttunen, 2015). To do so, this research draws on the accounts of companies and business associations involved in the EU circular economy. Their accounts allow us to gain a greater understanding of policy coherence as a lived experience by those involved in the implementation of EU policies (Walker et al., 2021). Therefore, we pose the following research question: to what extent are policies in the EU's circular economy policy mix coherent with each other, in the view of actors working in the circular economy space?

To address the guiding research question, this paper employs a mixed-methods analysis. The policies in the EU's policy mix for the circular economy are our units of analysis. In a first step, we drew the boundaries of the EU policy mix for circular economy. Here, we built a dataset of EU policy documents ($N = 16$) to populate the EU policy mix for the circular economy, by combining a top-down and bottom-up approach for policy mix delineation (Ossenbrink et al., 2019). This enables us to consider both the strategic intent of EU policymakers in forming a policy mix for the circular economy and the impact that EU policies have on creating it. In a second step, we conducted a survey to collect original data on experienced policy coherence from companies and business actors involved in the EU circular economy. The data used for the network analysis were collected through a survey of these actors (responses to the survey: $N = 36$). In a third and final step, we examined the EU's circular economy policy mix through network analysis. We investigated this policy mix as a system of policies: the nodes identified in the first methodological step (linked by experienced coherence) and the edges identified in the second methodological step. To the best of our knowledge, this is the first study that uses network analysis to provide insights about the EU's circular economy policy mix and to explore inter-policy coherence within this mix through the experiences of business actors.

While being widely discussed in the literature, so far only limited research concentrates on policy mixes for the circular economy. In this study, we identify five research gaps. First, most studies on policy mixes centre on the energy and transport sectors (Kivimaa et al., 2017; Rodríguez-Barillas et al., 2024). Scholars highlight the need to extend policy mix research beyond these sectors, for example, by unpacking the circular economy policy mix (Milios, 2018; Kosow et al., 2022). Second, the limited number of studies on circular economy policy mixes are characterised by a specific focus on waste and resource efficiency, mostly advancing theoretical contributions (e.g. Wilts and O'Brien, 2019; Milios, 2018; Fitch-Roy et al., 2021) or deal with a specific case (i.e. recycled plastics, see Pfeffer et al., 2025). Third, most studies on the EU's circular economy policy mix concern mixes prior to the 2019–2024 EU political cycle. That political cycle led to multiple policy developments that affect the circular economy, which remain understudied today. Fourth, most studies on policy mixes employ qualitative methods to assess small-n sample of policies within a policy mix (Rogge et al., 2017; Schmidt and Sewerin, 2019; Malhotra, 2022). Fifth, we know little about the interlinkages between policies within a mix (Milhorance et al., 2022a). While the literature on policy mixes underscores the importance of such interlinkages, i.e. policy interactions (Zambianchi and Biedenkopf, 2024), calls to improve them remain at the conceptual level (Sewerin, 2020).

The remainder of this paper has the following structure. Section 2 reviews literature on policy mixes and policy coherence. Section 3 describes the methodological approach for the study, including the definition of the boundaries of the assessed policy mix. Section 4 presents the results of the analysis. Sections 5 and 6 then follow with a discussion of the results and conclusions for this study.

2. Literature review

Here, we dive into the academic literature on policy mixes and policy coherence. We begin by highlighting the various bodies of literature studying policy mixes and identifying relevant conceptual and empirical gaps. Then we discuss the importance of and debates surrounding research on policy coherence, and specifically as an experienced characteristic of a policy mix.

2.1. Policy mix research

The policy mix concept originates from the economic policy literature of the early 1960s, which looked at how monetary and fiscal policies interact with each other (Kanger et al., 2020; Flanagan et al., 2011). Since then, this concept has been adopted by other bodies of literature. Remarkably, environmental social sciences literature has increasingly taken up this concept in light of the large number of policies on environmental issues and the complexity of mitigating the climate and ecological crises (Gunningham and Sinclair, 2019; Milhorance et al., 2022b). More specifically, we find many studies analysing policy mixes for the bioeconomy (e.g., Ladu et al., 2020; Imbert et al., 2017), renewable energy transition (Schmidt and Sewerin, 2019; Rosenow et al., 2017), and climate and land use nexus (e.g. Milhorance et al., 2020; Kosow et al., 2022). This has resulted in a bourgeoning scholarship on environmental policy mixes, addressing their conceptual, methodological and empirical aspects in the context of environmental sustainability (Flanagan et al., 2011; Hoel, 1997; Rogge et al., 2017).

As articulated in its simpler interpretations, the policy mix concept refers to the combination of different policies targeting a particular problem of a policy nature (Borrás and Edquist, 2013). In this vein, studying a policy mix employs an ‘actionable’ lens, where a mix solely consists of implemented policies. Expanding on this, scholars in policy studies tend to bring further attention to the policy process, discourses and politics in the analysis of policy mixes. In their seminal work, Kern and Howlett (2009) highlight that a policy mix exceeds implemented policies, as it also includes the policymaking process of gradually combining multiple policy goals to address a policy problem. This conceptualisation is used in recent work on policy mixes, e.g. for the energy transition (Jørgensen et al., 2017; Lindberg et al., 2019; del Río and Cerdá, 2017), biodiversity conservation (Barton et al., 2017; Ring and Barton, 2015; Kubo et al., 2019), and coastal management (Gonçalves et al., 2021). However, scholars point to how such a conceptualisation can lead to analytical confusion (Bouma et al., 2019). Against this backdrop and acknowledging the importance of policy processes in the formation of policy mixes, this paper conceptualises policy mixes as the combination of implemented policies.

As highlighted by Milhorance et al. (2022a, 2022b), the literature on policy mixes is becoming increasingly connected to the concept of policy integration. In fact, a policy mix can be populated with policies from a specific policy domain (Bouwma et al., 2015) or across multiple ones (Wilts and O'Brien, 2019). Specifically, scholars understand environmental policy integration as the "incorporation of environmental objectives in non-environmental policy sectors, such as agriculture, energy and transport, with the aim to target the underlying driving forces, rather than merely symptoms, of environmental degradation" (Persson et al., 2018 p. 113).

Turning our attention to the study of policy mixes for societal transformations, it is generally acknowledged that, to support the transition to a circular economy, it is necessary to adopt and implement policies from various policy sectors (Milios, 2018; Rizos and Urban, 2024). This includes, for example, industrial policies and energy policies (Justen et al., 2014; Frank et al., 2024; Grohmann and Feindt, 2024). Hence, a study of policy mixes for the circular economy can also deal with the issue of policy integration in this area.

A focal point of policy mix analysis is distinguishing which policies are considered part of a policy mix and which are not, i.e. the population of a policy mix (Ossenbrink et al., 2019; Sewerin, 2020). On this point, Ossenbrink et al. (2019) propose a framework for how to delineate the boundaries of policy mixes. They differentiate between a top-down and a bottom-up approach. The former refers to an approach that embraces the idea that the policy mix is shaped by an overall strategic intent that then shapes the various strategies and instruments. The latter allows researchers to narrow down the analysis to a specific area, namely a sector, technology or business model. Most studies follow the top-down approach (ibid.), where scholars analyse policy mixes as the intended combination of policies that policy-makers adopt to tackle specific policy problem. Nevertheless, this approach poses the risk of overlooking those policies impacting the policy problem under analysis but not included in policy strategies by policy-makers (Zambianchi and Biedenkopf, 2024; Milhorance et al., 2022a, 2022b). With this in mind, this research applies a hybrid approach in delineating and populating the EU's policy mix for the circular economy.

Furthermore, there is broad interest in the literature on policy mixes in assessing the mixes through a number of metrics or characteristics (Kosow et al., 2022; Wade et al., 2024). Rogge and Reichardt (2016) conceptualise four policy-mix characteristics for evaluation purposes: coherence, consistency, comprehensiveness and credibility. Here, the authors propose characteristics of the policymaking process (their coherence), instruments and goals (their consistency), coverage in the context of a policy problem (their comprehensiveness) and perception (their credibility). While conceptually rich and sophisticated, this framework has seen limited application in empirical studies. Indeed, scholars have subsequently cast doubts on how to do so, due to the limited clarity of the definitions and operationalisation of these characteristics (Sewerin, 2020; Kosow et al., 2022; Bouma et al., 2019).

Additionally, assessments of policy mixes through their mix characteristics tend to overlook the dynamics between individual policies within the mix (Rodríguez-Barillas et al., 2024; Milhorance et al., 2022a; Zambianchi and Biedenkopf, 2024). Thus, there remains a need to look at how policy instruments connect with each other within a mix. Most studies equate the characteristics of a policy mix with the sum of the characteristics of the policies contained (Schmidt and Sewerin, 2019; Wade et al., 2024). Yet, research on policy networks and policyscapes illustrates how systems of policies – such as policy mixes – present characteristics that are more than the sum of their parts (Milhorance et al., 2022a; Therville et al., 2020). These considerations point to a critical research puzzle, which this paper aims to address by researching how coherence unfolds between policies in a policy mix from the standpoint of policy coherence as experienced by relevant actors in the circular economy space.

2.2. Policy coherence

Policy coherence is a sought-after characteristic of policy mixes in the context of sustainability transformations (Shawoo et al., 2023; Cunningham et al., 2009; Kosow et al., 2022). In its simplest form, policy coherence can be defined as "the promotion of synergies and reduced contradictions between policies at the same level of government or at different levels within the same policy domain" (Tchinda and Talbot, 2024, p. 77). This definition suggests that policy coherence emerges when policies aim to achieve shared policy goals in a complementary manner (Howlett and Rayner, 2007, 2013).

Contrastingly, scholarship on the policy process views policy coherence as a "process where policy makers design a set of policies in a way that, if properly implemented, they can potentially achieve a larger goal" (Cejudo and Michel, 2017, p. 755). Coherence is therefore sought to ensure that policies cross-fertilise in a process promoting a common goal (or goals) and that they are not in conflict with each other. The concept of policy coherence can also be applied across different policy spheres (Theeuwes et al., 2025). For example, there are studies on coherence between policies within one or more policy domains (Kalimo and Mateo, 2025) and between policies at the same governance level or across multiple levels (Nilsson et al., 2012; Den Hertog and Stroβ, 2013). As noted earlier, Rogge and Reichardt (2016) view the coherence of policy mixes as an attribute that develops throughout the policymaking and policy implementation processes. However, scholars contend that such conceptualisation encounters methodological and analytical shortcomings, due to limited clarity on its operationalisation (Bouma et al., 2019; Sewerin, 2020) and its normative assumptions (Yunita et al., 2022; Theeuwes et al., 2025). Recognising these challenges, this paper draws on Kosow et al. (2022), whose work links policy coherence with policy mixes in a systematic manner by focusing solely on the implementation of policies and not on policy processes.

While policy mix studies generally contend that policy coherence is key to achieving environmental policy objectives, some scholars question this argument (Yunita et al., 2022; Mardero et al., 2025; Theeuwes et al., 2025). Indeed, they highlight that coherence between policy instruments is not necessarily a driver of societal transformation, as having a coherent policy mix poses the risk of perpetuating the status quo (Yunita et al., 2022; Rodríguez-Barillas et al., 2024; Theeuwes et al., 2025).

A critical understanding of policies suggests that policy coherence is an experienced characteristic, "assessed from the perspective of […] actors by focusing on the[ir] practices" (Huttunen, 2015, p. 574). Synergies and conflicts between policies stem from the responses to policy implementation by relevant actors, which are shaped by their contexts, ultimately challenging the assumption that policy coherence is a uniform policy characteristic (Theeuwes et al., 2025). On the contrary, the degree to which policies cohere (or not) is revealed by how they are implemented on the ground, beyond policy texts (Zambianchi, 2024; Barton et al., 2017). It is when policies are implemented in practice that synergies and conflicts emerge because of the institutions, interests, and ideas related to the actors responding to policy implementation (Theeuwes et al., 2025). In the context of the circular economy, these actors include business associations and companies, in light of their role in driving the circular transition (Walker et al., 2021). For this paper we conceptualise policy coherence as an experienced policy characteristic. As such, we contend that there is coherence between policies on the basis of experienced synergies and lack of conflicts in the view of relevant actors responding to policy implementation.

3. Methods

In this section of the paper, we explain the methodological steps undertaken for this research. The EU's policy mix for the circular economy is the focus of our analysis. We study it through four priority domains for the circular economy: the electronics and ICT, batteries,

automotive, and critical raw materials sectors. We first illustrate how we populated the policy mix in terms of data collection and policy selection. Next, we detail how we collected data on policy coherence. Finally, we discuss how and why we employed network analysis to unpack policy coherence as experienced by actors in the EU's policy mix for the circular economy.

3.1. Populating the policy mix

The first step of our research is populating the EU's policy mix for the circular economy. We specifically confine our mapping to EU strategies and EU secondary legislation. With regard to the former, we consider strategies to cover documents describing the overall priorities and objectives in a certain policy area and setting out actions to achieve them (Lindberg et al., 2019; OECD, 2021). Concerning the secondary legislation, we prioritised EU regulations and directives. As described below, the most recent completed political cycle (2019–2024) generally guided the selection of policies. We collected data – i.e., original policy texts – via web pages of the European Commission (Lindberg et al., 2019; Pfeffer et al., 2025).

As explained in section 2.1, in order to populate the EU circular policy mix for our analysis we followed a combination of a top-down and a bottom-up approach as described by Ossenbrink et al. (2019). Our starting point was the European Commission's (2019) Green Deal flagship strategy which outlined the EU's vision for the 2019–2024 period and a series of subsequent policy initiatives. In this strategy, the circular economy is presented as an opportunity to transform the EU's industrial sectors in line with the achievement of a climate-neutral economy by 2050. We then selected three dedicated strategies envisaged in the Green Deal that aimed at supporting the circular economy transition - namely the New Circular Economy Action Plan (European Commission, 2020a), the EU Industrial Strategy (European Commission, 2020b) and the Chemicals Strategy for Sustainability (European Commission, 2020c). We also added the Green Deal Industrial Plan (European Commission, 2023), which complements the above strategies and focuses on accelerating the manufacturing of green technologies in the EU. Together, these four EU strategies guided the subsequent selection of regulations and directives.

As a next step, we confined our analysis to four sectors identified in the New Circular Economy Action Plan and the EU Industrial Strategy as priority ones during the 2019–2024 legislative cycle: the electronics and ICT, batteries, automotive, and critical raw materials sectors. On the basis of the policies mentioned in the four EU strategies published as a follow-up to the European Green Deal, we singled out 11 regulations and directives. These 11 policies were chosen because of the strategic intent of policymakers to cover these four sectors and how these policies are expected to have an impact on them. The majority (6) of the policies were adopted during the 2019–2024 legislative cycle, while in 5 cases the policies were adopted earlier but were identified by the strategies as subject to review. Based on the above selection, we populated the EU's circular economy policy mix with 16 policies (Table 1). Fig. 1 presents the connection between the various EU regulations and directives with the selected EU strategies.

Table 1
List of policies in the assessed policy mix for the circular economy.

Name	Year of adoption	Type of policy	Policy label (used in the heat map)
European Green Deal	2019	Strategy	P1
New Circular Economy Action Plan	2020	Strategy	P2
EU Industrial Strategy	2020	Strategy	P3
Chemicals Strategy for Sustainability	2020	Strategy	P4
Green Deal Industrial Plan	2023	Strategy	P5
Batteries Regulation	2023	Regulation	P6
Critical Raw Materials Act (CRMA)	2024	Regulation	P7
Ecodesign for Sustainable Products Regulation (ESPR)	2024*	Regulation	P8
End-of-life Vehicles Directive	2000	Directive	P9
Regulation on the establishment of a framework to facilitate sustainable investment (EU Taxonomy Regulation)	2020	Regulation	P10
Regulation concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)	2006	Regulation	P11
Directive on common rules promoting the repair of goods (Right to Repair Directive)	2024	Directive	P12
Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)	2011	Directive	P13
Waste Framework Directive	2008*	Directive	P14
Waste Shipment Regulation	2024*	Regulation	P15
Waste electrical and electronic equipment (WEEE) Directive	2012*	Directive	P16

* These regulations and directives repeal previous EU legislation in their domains.

3.2. Analysing experienced policy coherence in the policy mix

3.2.1. Sampling and data collection

The second step in our research concerns the data collection and analysis of experienced policy coherence in the policy mix, which we undertook by surveying 36 expert practitioners in the EU circular economy space (see more details in the supplementary material). This step takes an actor-centred approach. Leveraging on previous research (Lindberg et al., 2019; Huttunen, 2015), we adopted an actor-centered approach and collected insights on the coherence between policies from companies and business associations in the electronics and ICT, batteries, automotive and critical raw materials sectors.

Companies and business associations are important stakeholders to analyse in the context of the circular economy, especially in the EU because of the large landscape of companies engaged in the circular economy (Walker et al., 2021). This is because they hold potential for 'real-world impacts' in advancing sustainability transformations (Walker et al., 2022) and are directly affected by the policy mix in place (Lindberg et al., 2019). What is more, they experience drivers and barriers that obstruct their transition to a circular economy (Walker et al., 2022). While this is a single stakeholder group, analysing its experiences of policy synergies and conflicts in the implementation of the EU's policy mix is insightful. It offers "an important reality check [...] for approaches which have been primarily championed in academia", such as coherence within a policy mix (Walker et al., 2021, p.832).

Hence, using a questionnaire we collected original data to measure the experienced policy coherence among companies and business associations in the selected sectors. To sample these actors, we applied the purposeful sample or judgement sample method. This means that "the researcher actively selects the most productive sample to answer the research question" (Marshall, 1996, p.23). To do so, we started by listing the industrial partners involved in the EU-funded BATRAW (2025) project. We chose this starting point because the project features companies implementing circular business models in the EU's EV battery value chain, which is one of the focus sectors of this paper. Next, we listed other companies and business associations by leveraging our network of contacts in the above-mentioned sectors. Specifically, we sought practitioners in the circular economy who: i) have extensive knowledge of both the circular economy and their sector (Van Langen et al., 2021) and ii) represent different segments of the value chains in the above sectors (Rizos et al., 2024; Serna-Guerrero et al., 2022).

Having identified our sampling population of companies and business associations, we sent them a questionnaire to identify their views on the presence of synergies and/or conflicts between policies in the

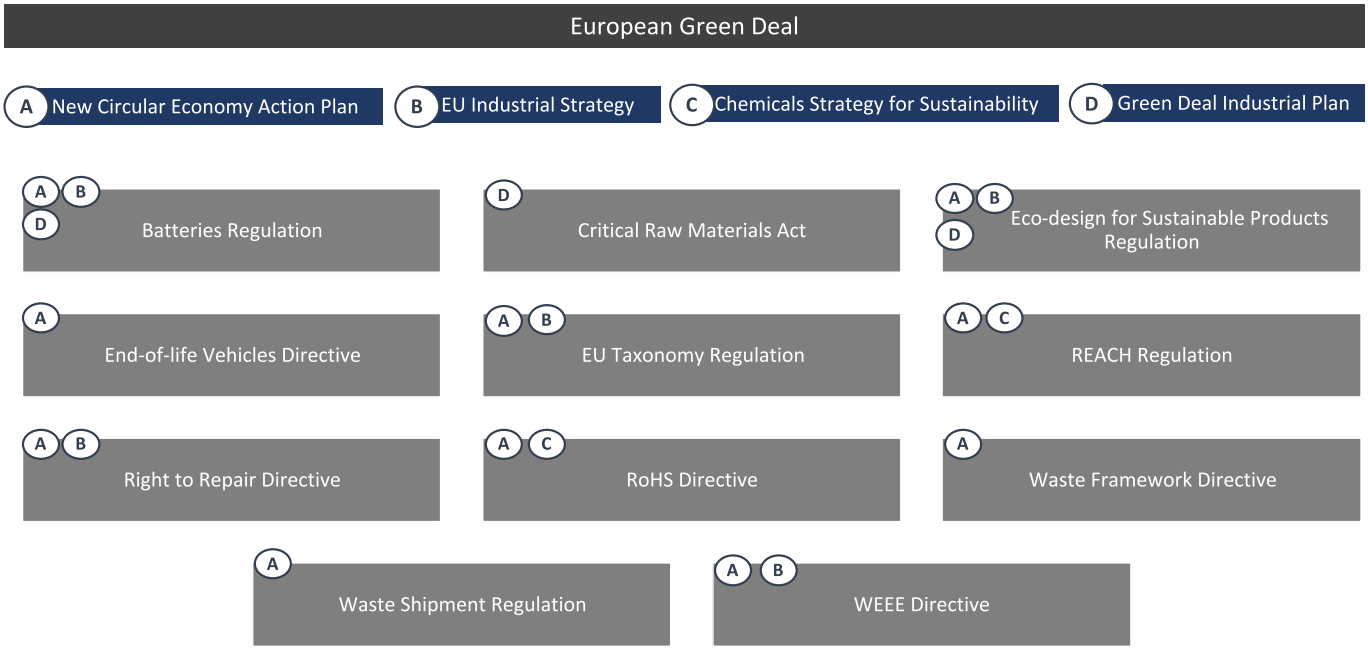

Fig. 1. Policy population of the EU circular economy policy mix
Note: The letters A, B, C and D show the connection between the four main strategies in the mix and the EU secondary legislation.

identified policy mix. We developed the questionnaire with the EUSurvey tool. This tool enables users to conduct surveys with interactive questions in both textual and multiple-choice formats (EFSA, 2018). When sharing the questionnaire with the sampled actors, we included an information sheet on the General Data Protection Regulation, which explains how collected data will be stored and processed.

To measure coherence, the questions sought to assess the presence of synergies or conflicts between all the policies in the EU's policy mix for the circular economy from the viewpoint of the respondents. To begin with, the questionnaire provided the experts with a list of policies that this study identifies as part of the policy mix. Next, the questionnaire asked them to evaluate the experienced coherence between each of the policies as:

- 'low' (if two policies have limited or weak synergies and multiple or strong conflicts),
- 'medium' (if two policies have some synergies and some conflicts), or
- 'high' (if two policies have multiple or strong synergies and limited or weak conflicts).

Finally, the questionnaire included a qualitative element and allowed experts to provide in written form their insights on coherence between the policies in the mix. We analysed the responses to the questionnaires with descriptive statistics and produced a heat map.

3.2.2. *Network analysis*

As a third and final step, we built a network of policies linked with each other by experienced policy coherence, drawing on the responses to the questionnaire. We examined the network using network analysis methods. This methodological choice allowed us to bring into conversation qualitative nuances on experienced policy coherence with quantitative approaches to unpack a system populated with a medium-n population. Importantly, network analysis helps reveal patterns through "comparative outlooks that are more robust" (Milhorance et al., 2020, p. 13). Hence, through network analysis we were able to reveal the "underlying system architecture" (Kim, 2013, p. 980) as per the experiences of actors responding to policy implementation.

A network is composed of nodes and edges. The former corresponds to the elements of a system, while the latter to the linkages between the elements (Coenen et al., 2022; Schmitz and Eimer, 2020). For the network analysis in this paper, the nodes correspond to policies in the EU's circular economy policy mix. The edges correspond to the extent to which policies cohere with each other, as per the experiences of companies and business associations in the EU's circular economy space. This network is thus unimodal (as we analyse only one type of node) and undirected (as we do not identify a source or a target in the context of policy coherence).

To identify the edges in the network, we draw on the results of the questionnaire and disentangle the extent to which policies cohere with each other through the experiences of companies and business associations. We do so by assigning weights to the edges in two steps. First, we construct a quantitative scale that allows us to translate the answers to the questionnaire into numbers. We assign 0 to answers pointing to 'low coherence' (if two policies have limited or weak synergies and multiple or strong conflicts), 5 to 'medium coherence' (if two policies have some synergies and some conflicts), and 10 to 'high coherence' (if two policies have multiple or strong synergies and limited or weak conflicts). Second, we calculate the average among all the questionnaires for each specific answer, which corresponds to a specific case of coherence between two policies. We use each average as the specific weight of coherence (i.e. the edges) between two policies (i.e. the nodes). To this end, we construct a network that we analyse with the software R and visualise with the software Gephi.

4. Results

This section presents the empirical results. It begins with descriptive statistics and continues with the findings from the network analysis.

4.1. *Descriptive statistics*

The data collected from the questionnaire show that there are variances in how experienced policy coherence unfolds within the EU's policy mix for the circular economy. Fig. 2 shows the average degree of coherence that each policy has with the whole policy mix. We notice that the European Green Deal has the highest average degree of coherence with the policy mix (0.573), followed by the Directive on the restriction of the use of certain hazardous substances in electrical and electronic

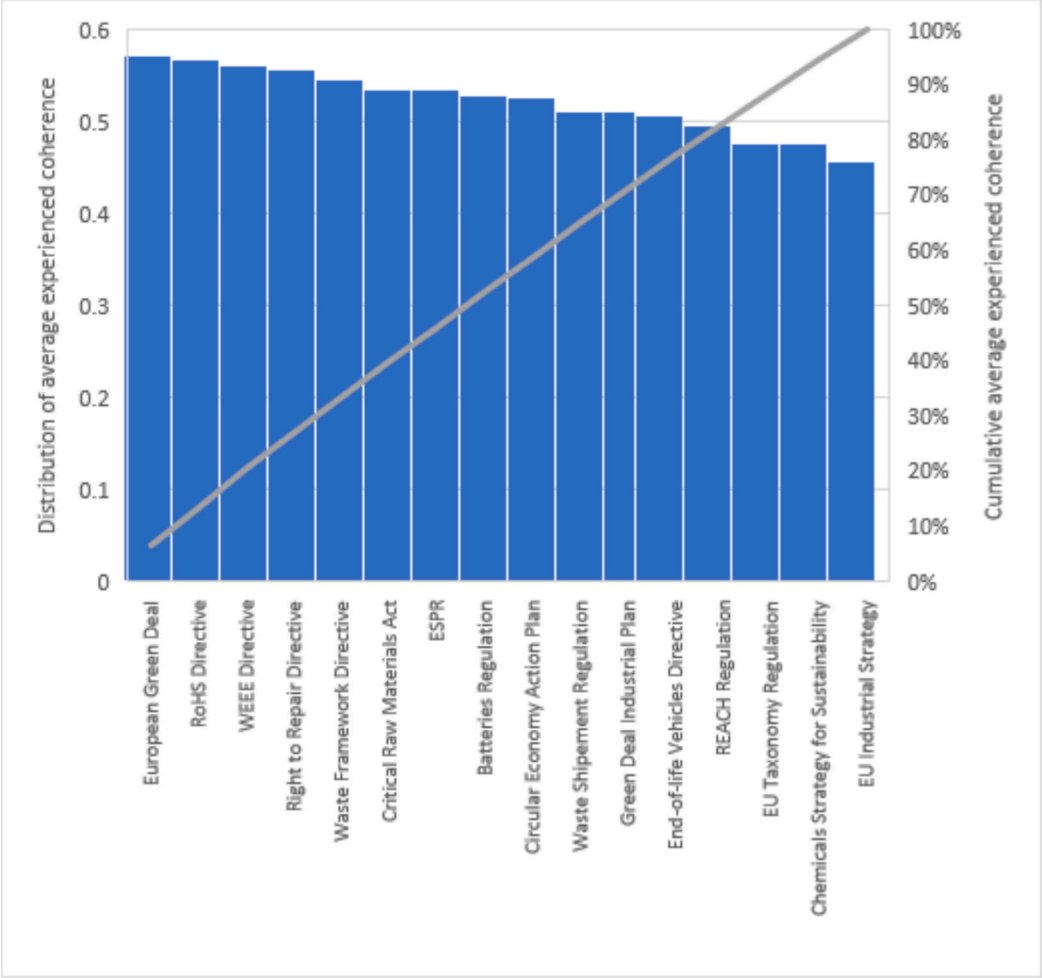

Fig. 2. Average degree of experienced coherence of each policy with the whole policy mix.

equipment (RoHS Directive) (0.569), the Waste Electrical and Electronic Equipment Directive (0.561), and the Directive on common rules promoting the repair of goods (Right to Repair Directive) (0.556). However, the data also show that four policies have an average degree of coherence with the policy mix that is less than medium, with an average degree of coherence lower than 0.5. These policies are: the Regulation concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) (0.495), the EU Taxonomy Regulation (0.477), the Chemicals Strategy for Sustainability (0.477), and the EU Industrial Strategy (0.457).

For a more nuanced understanding of experienced policy coherence within the EU's policy mix for the circular economy, we constructed a heat map based on the degree of coherence between each policy in the policy mix (Table 2). This allows us to compare the degree of coherence and highlight how policy coherence varies within a policy mix. Specifically, we notice that while the Chemicals Strategy for Sustainability (P4) has one of the lowest average degrees of coherence in the policy mix, as explained above (see Fig. 2), it demonstrates a very high degree of coherence ($\geq$0.7) with two other policies in the mix. This is also observed in the context of the European Green Deal (P1) and the Right to Repair Directive (P12), which have a high average degree of coherence. Moreover, we observe that the EU Taxonomy Regulation (P10) has coherence towards the medium-to-low end ($<$0.56) with the other policies in the policy mix, except with the RoHS Directive (P13), which notably has the highest degree of coherence (0.81) between two policies within the policy mix. This underscores that the average degree of coherence with the whole mix provides a limited view of how policies heterogeneously cohere with each other within the mix. It is thus important to examine through the heat map the degree of coherence between different policies within the mix as experienced by business actors.

Delving into the coherence of the main EU strategies, we find that the four strategies emanating from the Green Deal, namely the New Circular Economy Action Plan (P2), the EU Industrial Strategy (P3), the Chemicals Strategy for Sustainability (P4) and the Green Deal Industrial Plan (P5), showcase coherence between them towards the medium-to-low end (0.4–0.49). In the words of one expert (Secretary-General, Industry association), lack of proper implementation contributes to the low synergy as these strategies "were published without an implementation plan or roadmap and this makes their coexistence confusing and contradictory at times".

Policies on chemicals (P4, P11 and P13) provide another manifestation of low coherence. Starting with the Chemicals Strategy for Sustainability, it demonstrates low-to-medium coherence (0.3–0.49) with 10 out of the 15 other policies in the mix. In their responses, several experts called for a better coordination between, on the one hand, policies in the domain of chemicals and, on the other hand, circularity and industrial policies. The respondents raised concerns about the restrictions of "certain substances in products". According to them, these restrictions do not always stem from science-based risks and, as a result, may lead to the use of more harmful alternatives. Ultimately, these restrictions may limit opportunities for recycling and reuse. According to one respondent (Head of Department, Metallurgy), the discord between circularity and chemicals objectives is due to 'a lack of a precise

Table 2
Heat map of experienced coherence between policies within the EU's policy mix for circular economy (legend below).

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16
P1		0.721	0.429	0.537	0.5	0.565	0.603	0.688	0.605	0.519	0.537	0.708	0.61	0.55	0.464	0.567
P2	0.721		0.426	0.439	0.463	0.611	0,6	0.655	0.528	0.432	0.348	0.659	0.548	0.519	0.458	0.5
P3	0.429	0.426		0.4	0.442	0.521	0.554	0.423	0.475	0.365	0.354	0.547	0.5	0.537	0.396	0.5
P4	0.537	0.439	0.4		0.432	0.316	0.375	0.342	0.458	0.375	0.632	0.714	0.528	0.447	0.714	0.447
P5	0.5	0.463	0.442	0.432		0.614	0.756	0.659	0.528	0.429	0.329	0.571	0.5	0.479	0.457	0.529
P6	0.565	0.611	0.521	0.316	0.614		0.643	0.643	0.538	0.395	0.474	0.556	0.447	0.571		0.543
P7	0.603	0,6	0.554	0.375	0.756	0.643		0.567	0.475	0.475		0.583	0.528	0.483	0.404	0.483
P8	0.688	0.655	0.423	0.342	0.659	0.643	0.567		0.446	0.475		0.694		0.563	0.354	0.563
P9	0.605	0.528	0.475	0.458	0.528	0.538	0.475	0.446		0.395	0.461	0.324	0.583	0.574	0.614	058
P10	0.519	0.432	0.365	0.375	0.429	0.395	0.475	0.475	0.395		0.5	0.5	0.814	0.472	0.472	0.556
P11	0.537	0.348	0.354	0.632	0.329	0.474			0.461	0.5		0.5	0.684	0.543	0.523	0.643
P12	0.708	0.659	0.547	0.714	0.571	0.556	0.583	0.694	0.324	0.5	0.5		0.442	0.543	0.523	0.477
P13	0.61	0.548	0.5	0.528	0.5	0.447	0.528		0.583	0.814	0.684	0.442		0.553	0.583	0.675
P14	0.55	0.519	0.537	0.447	0.479	0.571	0.483	0.563	0.574	0.472	0.543	0.543	0.553		0.593	0.756
P15	0.464	0.458	0.396	0.714	0.457		0.404	0.354	0.614	0.472	0.523	0.523	0.583	0.593		0.605
P16	0.567	0.5	0.5	0.447	0.529	0.543	0.483	0.563	058	0.556	0.643	0.477	0.675	0.756	0.605	

Degree of coherence (range)	*0-0.09*	*0.1-0.19*	*0.2-0.29*	*0.3-0.39*	*0.4-0.49*	*0.5-0.59*	*0.6-0.69*	*0.7-0.79*	*0.8-0.89*	*0.9-1*
Colour										

definition of recycling' and limited understanding of the indirect impacts of setting certain thresholds for substances. This reflects experiences of policy conflicts in the implementation of the EU's policy mix for the circular economy.

The REACH Regulation (P11) was seen as having low-to-medium coherence (0.3–0.49) with six other policies, including the Batteries Regulation (P6), the Ecodesign for Sustainable Products Regulation (ESPR) (P8) and the End-of-life Vehicles Directive (P9). Focusing on the degree of coherence between REACH and the ESPR, some respondents observed that the definition of substances of concern in the ESPR and substances of very high concern in the REACH Regulation are not aligned, posing uncertainties and risks of double regulation. As noted by one respondent (Senior Policy Director, Industry association), '[b]ased on the REACH Regulation we have an established framework in the EU for dealing with chemical substances in products […]. We need to avoid the risk of having overlapping requirements through the ESPR, leading to double regulation'. Finally, the RoHS Directive (P13) appeared to have a medium-to-low degree of coherence with the Batteries Regulation (P6) and the Right to Repair Directive (P12).

The EU Taxonomy Regulation (P10) appears to be coherent to a low-to-medium extent (0.3–0.49) with 10 other policies in the mix. Several respondents stressed that the criteria of the taxonomy for defining sustainable activities and the selection of sectors falling into the scope of the regulation do not fully support the objectives of policies such as the EU Industrial Strategy (P3), the Green Deal Industrial Plan (P5), the Batteries Regulation (P6), the Critical Raw Materials Act (CRMA) (P7) or the ESPR (P8). The Waste Shipment Regulation (P15) demonstrates medium-to-low coherence with 7 other policies, namely the European Green Deal (P1), the New Circular Economy Action Plan (P2), the EU Industrial Strategy (P3), the Green Deal Industrial Plan (P5), the CRMA (P7), the ESPR (P8) and the EU Taxonomy Regulation (P10). Pointing to the lower administrative requirements and compliance costs involved in using primary raw materials compared with secondary raw materials (SRMs), one respondent (Policy Manager, EEE manufacturer) argued that 'while the EU Green Deal, the Circular Economy Action Plan and the CRMA aim to boost the use of SRMs in products sold in Europe, the EU Waste Shipment Regulation makes the movement of e-waste and plastics for recycling difficult'. Respondents also held that the Waste Shipment Regulation is not aligned with the Circular Economy Action Plan, which aims to boost the reuse and repair of products. According to one respondent (Manager, Waste Collector), this is due to the testing requirements ('the devices need to be tested to ensure they are functioning, otherwise they are considered waste') and administrative obligations involved in the cross-border shipment of even small quantities of used electronics.

Conflicts between circular economy and trade policies, and between circular economy and climate policies, was a common issue in several responses to the questionnaire. Importantly, respondents mentioned that the EU's policies restrict the exports of plastic waste while allowing imports of low-cost materials carrying the recycled label but not recycled according to EU standards. As a result, they contend that EU policies are not in synergy with each other for achieving circularity objectives. One respondent (Director, Industry association) called for further synergies between the CRMA and trade policies, towards "a long-term strategy that guarantees the availability and quality of SRMs in the EU market". Moreover, respondents suggested that climate policies do not

sufficiently incorporate a lifecycle perspective and circularity principles. In their view, climate policies often do not incentivise the use of processes and products that combine the highest environmental benefits in the context of a circular economy while taking climate action. For example, respondents remarked that, if properly designed, mandatory green public procurement requirements and economic incentives could promote circularity while improving coherence between circular economy and climate policies. These accounts shed light on how conflicts between policies may not be apparent in a policy mix without a more systematic view of experienced policy coherence.

4.2. Network analysis: Size, structure, and modularity

To visualise and analyse patterns in how policies within the EU's policy mix for the circular economy cohere with each other from the perspective of business actors, we employed network analysis. The network is composed of 16 nodes and 120 edges (see Fig. 3).

The network has an average weighted degree of 7.858. This measurement means that the edges between the nodes have limited weight. It suggests that, on average, policies have at least a medium-to-high degree of coherence with the other policies within the policy mix. Yet, the weighted edges between the nodes illustrate how the various degrees of policy coherence emerge within the policy mix. The thicker the edge, the higher is the degree of coherence between two policies within the policy mix, and vice versa, the thinner the edge, the lower is the degree of coherence. To identify whether there are clusters of policies based on policy coherence within the policy mix, we analyse the modularity of the network. In this network, the modularity is 0.007. This is a low modularity value, which means that the network has a limited presence of clusters based on the degree of coherence between policies within the mix.

Other metrics employed in network analysis, such as density, are not relevant in this analysis because of the nature of the data. In fact, all the nodes are linked to each other due to the questions in the questionnaire. As such, the statistical focus of this network analysis remains on the detection of clusters of policies within the policy mix.

5. Discussion

With the expansion of policies in the EU's circular economy policy mix in recent years, it is important to understand how their implementation leads to synergies and conflicts on the ground. In this study we examine the degree of coherence between these policies as experienced by actors responding to the implementation of the EU's circular economy policy mix. To address this research objective, we applied network analysis based on original data, which we collected through a survey of 36 companies and business associations engaged in the EU circular economy. The survey questionnaire also enabled us to collect qualitative insights on coherence from the business actors.

Our findings suggest that the European Green Deal – the EU's flagship strategy that shaped the overall policy direction for the 2019–2024 period – has the highest average degree of experienced policy coherence with the whole policy mix. This implies that the long-term strategic orientation provided by this overarching strategy is viewed by EU actors as synergetic with the EU's circular economy policy mix. This is an important finding, since having a strategy in place that provides long-term orientation and is consistent with the various other policies is crucial for a policy mix that aspires to drive a societal transformation, as in the case of the circular economy (Rogge and Reichardt, 2016; Bennich et al., 2021). However, this does not hold for two other strategies in the

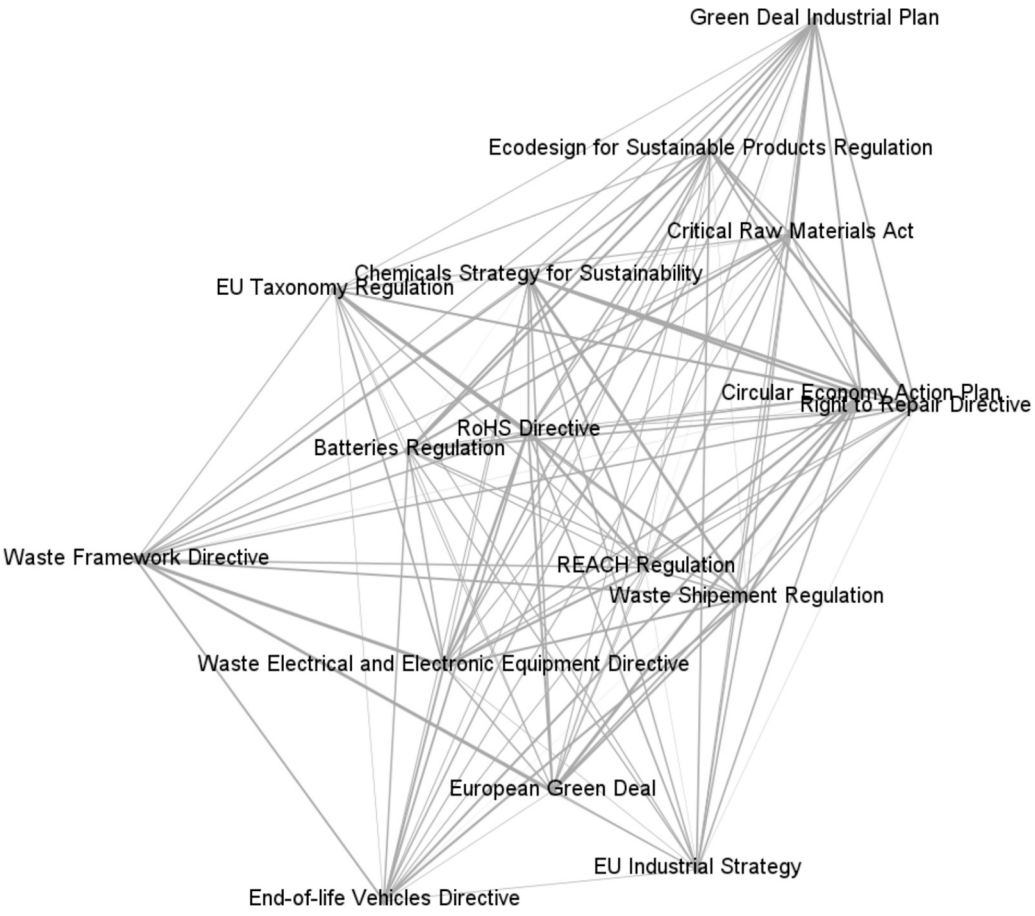

Fig. 3. Network analysis of the EU's policy mix for the circular economy.

mix, namely the Chemicals Strategy for Sustainability and the EU Industrial Strategy, which showcased the two lowest average degrees of policy coherence.

As many works on complex systems in environmental governance have attested, policy mixes and their characteristics are more than the sum of their elements (Pattberg and Widerberg, 2019; Orsini et al., 2013; Zambianchi and Biedenkopf, 2024). Approaching the characteristics of policy mixes as uniformly spread out across a mix poses the risk of overlooking those outlier cases of policy (in)coherence between policies within it. The findings of this paper underscore this point by building on cases of experienced policy (in)coherences. Notably, the first case of policy incoherences within the policy mix emerges from the four follow-up strategies of the Green Deal: the New Circular Economy Action Plan, the EU Industrial Strategy, the Chemicals Strategy for Sustainability, and the Green Deal Industrial Plan. In the views, of the respondents to our questionnaire, all four strategies demonstrate medium to low levels of policy coherence with each other because of limited synergies and the presence of conflicts between their objectives and actions.

In addition, our results indicate that the EU Industrial Strategy and the Chemicals Strategy for Sustainability have the lowest average degree of policy coherence with the whole policy mix. This is another important finding against the backdrop of recent EU policy history. Over the years, the number of policies for the EU's circular economy has expanded with various strategies. This has happened through a process described in the policy mix literature as 'layering', i.e. "adding new policy goals and instruments to existing policy mixes without discarding previous measures" (Kern et al., 2017, p.12). This process can highlight issues of inconsistencies between policies (Howlett and Rayner, 2007) that merit empirical analysis. For example, making the EU "more competitive as it becomes greener and more circular" is a goal highlighted in the EU Industrial Strategy (European Commission, 2020b, p. 3). Our results, however, indicate that the integration of industrial policy and circular economy goals into a coherent strategy has not been optimal in the experience of the surveyed actors. One possible reason for this issue is the limited guidance from institutions that is experienced by actors responding to policy implementation. As suggested by other authors (see Malhotra, 2022; Sarker et al., 2022), integrating policy objectives from different domains requires a detailed analysis – supported by ex-ante studies – of how these objectives support a common and clear goal and how different sectors would be affected by the mix of policies. Our findings indicate that accompanying individual strategies with roadmaps describing common cross-cutting goals and how individual actions can help to achieve these goals while minimising trade-offs across different sectors.

Another group of identified inconsistencies is evident in the policies on chemicals, i.e. the Chemicals Strategy for Sustainability, REACH Regulation and RoHS Directive. The conflicts between EU circularity and the objectives of chemicals legislation have been pointed out by other studies (e.g. Pfeffer et al., 2025; Rizos and Urban, 2024; Johansson and Krook, 2021). Yet, our work contributes to the literature by identifying a range of different policies in the mix that are viewed by business actors to have a low degree of coherence with the policies on chemicals.

More specifically, it is a novel insight to observe that the Chemicals Strategy for Sustainability has low-to-medium coherence with the majority of other policies in the mix (10 out of 15), while the REACH Regulation and RoHS Directive have low-to-medium coherence with some of the recently adopted regulations and directives (the former with the Batteries Regulation and ESPR, and the latter with the Batteries Regulation and the Right to Repair Directive). Our results confirm that despite efforts to integrate goals from the circularity and chemicals policy domains supported by a dedicated European Commission (2018) Communication, policy conflicts persist as shown in recent regulatory developments. Drawing on Alaranta and Turunen (2021) and Pfeffer et al. (2025), the reasons behind these tensions are twofold. On the one hand, the existence of distinct sectoral and horizontal legislations providing requirements linked to circularity leads to inconsistencies. On the other hand, policies on chemicals were adopted prior to the recent EU circular economy strategies. It may thus be necessary to shift from the current separate sectoral and horizontal policies towards more integrated ones with consistent rules for the actors implementing circularity practices across different value chains. This may require a case-by-case approach supported by consistent life cycle methodologies, where the objectives of promoting circularity and minimising health and environmental risks are carefully considered (Alaranta and Turunen, 2021; Pfeffer et al., 2025). This also raises questions on whether policies addressing chemicals are legacies in the larger EU policy landscape and on how synergies and/or conflicts arise between legacy policies and more recent ones for the circular economy (Zambianchi and Biedenkopf, 2024).

Furthermore, our findings indicate that the EU Taxonomy Regulation likewise exhibits low-to-medium policy coherence with most of the other policies within the mix, specifically with 10 of the 15 ones populating the mix. Supporting investments in circularity processes has long been considered a vital enabler and the Regulation seeks to promote this objective by putting in place a standard transparent framework for defining sustainable activities – including in the domain of circularity (Ekdahl et al., 2024; Moneva et al., 2023). Still, our results reveal that in the views of business actors, this framework cannot support the objectives of several policies in the mix, including the recently adopted regulations in the circularity and industrial policy nexus (Batteries Regulation, CRMA and the ESPR). In our survey this is largely attributed to the criteria of the taxonomy in defining sustainable investments.

The Waste Shipment Regulation has medium-to-low coherence with 7 policies within the mix. This echoes other results from this paper, pointing to the presence of conflicts and limited synergies between the overarching objectives of the EU circular economy and the industrial policy domain. This observation is consistent with various other studies (e.g. Van Acoleyen et al., 2016; Kissling et al., 2013) that have argued that the EU legislative framework for waste transportation does not contribute to circularity.

In interpreting the results of the network analysis, we find that the EU's policy mix for the circular economy has a limited modularity score. In other words, the policy mix has limited clusters of policies that support each other, and this support is based on the experienced coherence between policies. This finding suggests that the coherence within the policy mix is less resilient to shocks and stresses. In the event of an external shock or stressor, a modular policy mix would fragment into clusters, without isolating individual policies from the rest of the mix and withstanding the challenge (Kharrazi et al., 2020). By contrast, a non-modular policy mix threatens the stability of the mix because the policies within it are exposed to the risk of becoming isolated from the rest, which could affect their practical functioning. Nevertheless, the measurement of modularity in this paper is based on experienced policy coherence. Therefore, it is possible that the EU's policy mix for the circular economy is structured in clusters if we analyse a different policy mix characteristic (e.g., comprehensiveness) or through the experiences of other actors related to this policy mix (e.g., manufacturers). Still, having low modularity on the basis of experienced coherence poses a risk to the longevity and strength of the policy mix. Indeed, political shifts can lead to the adoption of policies that may conflict with the current policy mix and hence threaten the experienced coherence of the whole policy mix. Considering the politics surrounding the pursuit of sustainability transformations (Milios, 2018; Calisto Friant et al., 2020), strengthening the experienced coherence between policies (based on, e.g. specific sectors or segments of the circular economy) could lead to a clustering effect that would boost the resilience of the policy mix.

Finally, there are a number of limitations in this study to highlight. First, the population of the EU's policy mix for the circular economy was done through a hybrid top-down and bottom-up approach. Therefore,

the policy mix under analysis here may have a different policy population depending on the lens and approach of other researchers. Second, our analysis of policy coherence is based on the experiences of one group of actors in the circular economy space. Using the resources available to us, we collected original data from an extensive sample. Yet, we recognise that the experiences of policy coherence analysed in this paper are not generalisable to the full spectrum of circular economy actors and that the creation of the circular economy cannot be driven solely by one group of stakeholders. Third, this paper's methodology is limited by the construction of a unimodal network. Building two- or multi-modal networks could have revealed further patterns in the dynamics between policies within the policy mix.

6. Conclusions

Against the backdrop of a large body of literature on policy mixes, there is little research that zooms in on policy mixes for the circular economy. This paper does so by analysing the synergies and conflicts between policies within the EU policy mix for the circular economy from the experiences of companies and business associations. We employ network analysis and use primary data collected through a survey. We focus our study on the EU's circular economy and the electronics and ICT, batteries, automotive and critical raw materials sectors.

Our results suggest that on average the EU circular economy policy mix exhibits a medium-to-high average degree of policy coherence for companies and business actors. Notably, the European Green Deal strategy demonstrates the highest average degree of policy coherence with the whole mix. While these are useful observations, the averages of policy coherence alone conceal important insights on how each policy interacts with other individual policies. Our results confirm this argument by identifying several cases of experienced conflicts among policies that would be overlooked by measuring only the average policy coherence within a mix or between each policy and the whole mix. Examples of within-mix policy incoherence emerge for the four further strategies in the mix (the New Circular Economy Action Plan, the EU Industrial Strategy, the Chemicals Strategy for Sustainability and the Green Deal Industrial Plan), the group of policies on chemicals (Chemicals Strategy for Sustainability, REACH Regulation and the RoHS Directive), the EU Taxonomy Regulation and the Waste Shipment Regulation.

Based on our research, we can make actionable recommendations for improving policy coherence in the EU's circular economy policy mix. We show that the multiple policy goals stemming from the various strategies that accompanied the European Green Deal flagship strategy are not perceived by businesses to be well aligned and create synergies with each other. As the EU is currently pursuing multiple objectives in the domains of the circular economy, industrial policy and climate policy, more emphasis should be placed on achieving consistency between these objectives and providing a coherent set of requirements for EU businesses, which need regulatory certainty for their investment decisions. We recommend that future strategies in these domains are published together with a dedicated roadmap including a clear set of actions supporting cross-cutting goals and a specific monitoring framework to capture progress. Policy coherence between the objectives in these domains should also be explicitly analysed and further embedded in ex-ante assessments, paying particular attention to creating policy synergies and avoiding conflicts. For any identified risks of policy incoherence, concrete mitigation measures should be identified.

In addition, our analysis shows that the layering of sectoral and horizontal policies in the circular economy policy mix has led to several instances of experienced policy incoherence. This calls for a more integrative approach when preparing new regulatory intervention in the area of the circular economy – one that thoroughly accounts for the effects across different lifecycle stages of products, and which consistently factors in the environmental, economic and social impacts. Finally, based on the perspectives of business actors, our results point to the need for evidence about the real-world consequences of policy mixes for complex transitions such as that for the circular economy. To that effect, innovative tools such as living labs and regulatory sandboxes may provide useful insights on how circular products, service or technological innovations respond to the policy mix in place.

Drawing on our findings, we recommend a number of areas for future research. Our paper aims to open up a new research avenue for investigating the degree of coherence in the EU circular economy mix. Future studies could apply our methodological approach to other sectors (e.g. packaging or textiles) or incorporate into the analysis the views of a wider range of actors beyond businesses (e.g. NGOs, academics or civil society actors) in order to reveal other patterns of policy characteristics and even other policy mixes' characteristics. They could also use other approaches for delineating the boundaries of a policy mix. For example, they could compare the population and dynamics between a top-down and bottom-up approach in the EU's policy mix for the circular economy. Furthermore, given that the analysis of policy coherence is intertwined with the interest, positions, norms and politics of actors, future research could triangulate the findings from original data with, for example media sources, public opinions, or other secondary sources.

Moreover, our results indicate the climate policy and trade policy are two domains where the degree of coherence with circular economy policy could be further explored through dedicated assessments of how the sets of policies in these domains could be further synchronised to support shared objectives. While our analysis applied the concept of policy coherence at the same governance level (i.e. the EU), focusing on circular economy policies at various levels (i.e. the EU, national and international) is another possible vein of research. Finally, we encourage further research on the underlying discursive and normative reasons why policies on waste transportation and on chemicals lead to conflicts with the larger EU policy mix for the circular economy.

CRediT authorship contribution statement

Vasileios Rizos: Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Valeria Zambianchi:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.spc.2025.09.003.

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