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Money matters: The role of money as a regional and corporate financial resource for circular economy transition at firm-level

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ABSTRACT

This study addresses the role of different financial resources in driving circular economy activities at the firm level, which are a particular form of innovation. While the impact of financial resources on innovation activities has been widely researched, their relationship with the circular economy has not been adequately studied. Previous studies have focused primarily on corporate financial resources and investments by banks and investors. By using unique survey data from Swiss firms, we break new ground by examining the importance of regional financial resources, including regional household income and public procurement volumes. In doing so, we make a valuable contribution to the fields of (eco-)innovation and economic geography. We also examine the timing of financial resource deployment, looking at both early adopters and pioneers of the circular economy. Our results, derived from a comprehensive multivariate regression analysis that includes a representative sample of over 1000 observations, confirm that regional household income and public procurement volumes play a central role in the successful implementation of the circular economy – that is, money matters. Additionally, our research reveals distinct and independent impacts of corporate and regional financial resources, advocating for their combined influence. Importantly, we find that financial resources are crucial for both beginners and leaders in the circular economy, emphasizing the profound policy implications and central role in driving and supporting the circular economy.

1. Introduction

The circular economy will play a central role in addressing our environmental challenges. The OECD estimates that currently about 50 % of CO_2 is due to materials management (OECD, 2019). This is exactly where the circular economy wants to start. The central goal of the circular economy is to use existing resources as long and as efficiently as possible, thus minimizing the amount of waste (Esposito et al., 2017). But we do not have much time left to make the transition to a circular economy. Many countries have set targets to reduce their net CO_2 emissions to 0 by 2050. At the same time, recently collected data indicates that we have not made much progress in this transition. Based on a representative dataset for Switzerland – one of the world's first quantitative datasets to comprehensively map the circular economy at the company level - the data show that only 10 % of companies are significantly engaged in the circular economy in 2020 (Stucki and Woerter, 2021). So how can we accelerate this transition?

The implementation of circular economy activities is essentially a matter of innovation (Horbach and Rammer, 2020; Scarpellini et al., 2020). The goal of the circular economy is to reduce resource consumption per product through innovative adaptations along the entire value chain (*narrowing*), slow down resource cycles by extending product life (*slowing*), and close material cycles through recycling and reuse (*closing*) (Bocken et al., 2016). The innovation literature suggests that corporate financial resources, e.g., internal cash flows, play a central role in the implementation of innovation activities in firms (Czarnitzki and Hottenrott, 2011; Hall, 1992, 1989; Leland and Pyle, 1977). However, it is not only about corporate-specific financial resources. As Gössling and Rutten (2007) note, the wealth of a region also influences innovation activity. Previous studies indicate that investors, banks, subsidies, and public funds play a key role in promoting the circular economy and that lack of financial resources is a major barrier to the circular economy (Agyapong and Tweneboah, 2023; Aranda et al., 2019; De Schoenmakere et al., 2019; Saarinen and Aarikka-Stenroos, 2022; Spörri et al., 2022). Although subsidies and tax incentives have been considered, existing studies neglect the role of other regional financial resources, such as regional household income or the volume of public procurement, in the adoption of circular economy activities at the micro

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level. However, these sources are often considered important preconditions for the transition to a circular economy (Sönnichsen and Clement, 2020).

In the theoretical framework of the resource-based view (RBV), financial resources are also considered crucial for developing a competitive advantage. However, the RBV approach has not provided deeper insights into the importance of the different dimensions of financial resources for eco-innovation and, in particular, for circular economy innovation (Scarpellini et al., 2018).

This paper simultaneously examines the influence of (a) regional household income, (b) the volume of public procurement, and (c) the financial resources of companies in the form of cash-flows on corporate circular economy activities. This allows us to determine the relative impact of the different financial resources compared to each other. The paper also analyzes at which stage of the transformation process financing ultimately matters: Is it mainly relevant for the entry stage, i.e. the beginners, or is it also needed for the leading companies i.e. the pioneers. As research on circular economy financing is limited (for an overview see Saarinen and Aarikka-Stenroos, 2022), this study takes an explorative approach and builds on the literature on the transitions to a circular economy and RBV theory in general.

Moreover, by analyzing the role of regional financial resources, we embed our analysis in the economic geography literature. So far, the transition to a circular economy has received insufficient attention in economic geography (Tapia et al., 2021; Veyssière et al., 2022). In this context, Bourdin et al. (2022, p. 1190) note that there needs to be more research on place-based factors and the "brakes and levers to circularity". While the financial situation of the population and the public sector is rarely discussed in the literature on geographies of innovation, the literature on the geography of sustainability transition and path creation has started to consider the role of finance and the availability of capital (Geddes and Schmidt, 2020; Hadfield and Coenen, 2022). However, Geddes and Schmidt (2020) as well as Hadfield and Coenen (2022, p. 285) claim that finance and the concentration of wealth has so far been neglected in the literature on the geography of sustainability transition and that "predominant theories of change offer limited understanding of the geographical conditions shaping whether and how low-carbon innovations are scaled."

For the empirical analysis of our hypotheses, we use a dataset containing not only representative information on circular economy activities at the firm level, but also information on the financial resources of firms and regions, i.e., household income and the volume of public procurement. So far, data on circular economy transformation at the firm level is limited and only a small number of quantitative studies on the micro-level exist (e.g., Aranda et al., 2019; Horbach and Rammer, 2020). In this way, the results of this paper are relevant for different disciplines, and we lay a foundation for further research.

2. Conceptual background

Financial resources are an important prerequisite for companies to invest in innovation activities, and companies primarily use internal resources rather than external capital for financing (see Czarnitzki and Hottenrott, 2011; Hall, 1992, 1989; Leland and Pyle, 1977). However, corporate resources are usually limited, and raising new equity involves costs and time. Many studies therefore focus in particular on the role of financial constraints on companies' innovation activity. Most studies confirm that binding financial constraints influence innovation activity (Canepa and Stoneman, 2008; Hall et al., 1998; Hall and Lerner, 2010; Hottenrott and Peters, 2012).

According to the theoretical framework of the RBV, a firm's resources should be valuable, rare, imperfectly imitable, and non-substitutable (Barney, 1991; Barney et al., 2001; Hart, 1995). The natural-resource-based view (NRBV) extends the RBV to environmentally sustainable business activities. It is expected that identifying key resources that are critical to creating competitive advantage in terms of lower costs, improved reputation, and strategic alignment with future changes in the traditional business environment – such as financial resources (see for example Scarpellini et al., 2018; Stucki, 2019) – will enable environmentally sustainable business activities (Aragon-Correa and Sharma, 2003). In this study, the NRBV is applied and at the same time extended by explaining why some companies are more inclined to *circular economy* activities and specifically analyzing the role of financial resources at the company and regional levels.

There is evidence that financial resources are important for implementing the circular economy. Based on a quantitative survey of specific industries with a large environmental footprint, such as the construction industry, the chemical industry, and the food industry, Spörri et al. (2022) find that financial barriers are one of the most important obstacles to implementing circular economy activities in many industries. The Eurobarometer survey also identifies market factors as one of the most important barriers to implementing the circular economy (De Schoenmakere et al., 2019). Kirchherr et al. (2018), based on a survey and expert interviews for the EU, find that financial barriers in the form of high entry costs play a key role in the implementation of the circular economy. Finally, based on a representative company survey for Switzerland, Stucki and Woerter (2021) find that for 28 % of companies, investment costs are a key barrier to the implementation of circular economy activities, which is the second highest value of all barriers observed in the survey after the lack of suitability of products/services (37 %).

Previous studies examining the role of financial resources in the circular economy have focused primarily on corporate financial resources (Stucki et al., 2023) and funds from investors and banks (e.g., Agyapong and Tweneboah, 2023; Scarpellini et al., 2021). In addition, however, regional financial resources could also play a role. Gössling and Rutten (2007) have found a positive relationship between regional wealth, as measured by gross regional product per capita and purchasing power parities, and innovation. They also argue that prosperity affects the quality of life in the region and therefore attracts more highly skilled workers who contribute positively to firms' ability to innovate (Florida, 2002). Other authors argue that companies in wealthier regions find customers for high quality and sustainable products (Bai et al., 2020; Foellmi et al., 2014). Furthermore, certain consumer groups that want to buy sustainable products support market formation processes (Dewald and Truffer, 2012). The financial situation of the public sector also seems to play a role. Aranda et al. (2019) claim that public funding and subsidies are important drivers for the development of the circular economy. Saarinen and Aarikka-Stenroos (2022) also highlight the importance of public procurement in this context.

To obtain a comprehensive picture, this study examines the impact of both corporate financial resources and regional financial resources on circular economy activities. Corporate resources are measured as internal cash flows. Regional financial resources include both societal financial resources - measured as regional household income - and public financial resources - measured as the volume of regional public procurement (see Fig. 1). As we will argue below, all three indicators are likely to have a direct impact on corporate circular economy activities. However, their relevance may vary depending on which transitional stage (beginner or pioneer) the company is in. Such a detailed analysis is new in the literature and highly relevant. In contrast to corporate financial resources, regional financial resources are arguably even easier to influence politically. Therefore, it is important that we know more precisely how these components influence the activities of companies in the circular economy.

In the following we discuss the expected effect of the three sources of financial capital on firm circular economy activities in detail.

2.1. The role of corporate financial resources

Starting from a knowledge production function, it is clear that capital input is an important driver of innovation output (Griliches, 1979; Jaffe,

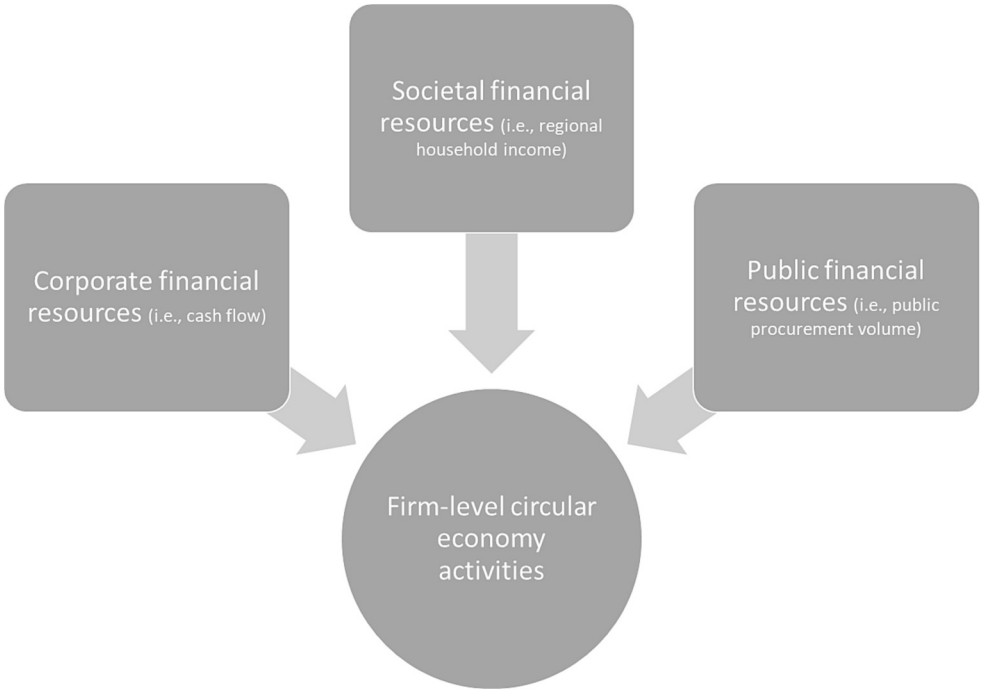

Fig. 1. The role of the different financial resources considered in the paper.

1989, 1986). For product innovation in particular, the direct relationship between financial resource inputs and innovation outcomes is well established. Implementation of innovation activities requires critical activities for experimentation, ideation, customer surveys, supplier collaboration, prototyping, testing, and commercialization, which in turn incur costs (Gibbert et al., 2014).

As with traditional innovation, such a positive correlation between financial resources and innovation is also expected for eco-innovation. For example, based on firm-level data for Germany, Horbach et al. (2012) find a positive effect of investment intensity on eco-innovation. Based on data for Switzerland, Stucki and Woerter (2016) find a positive effect of investment intensity on the intra-firm diffusion of green energy technologies. Based on international patent data, Ley et al. (2016) find that gross fixed capital formation has a positive effect on the green innovation activity of industries.

The impact of corporate financial resources in the circular economy has been addressed in only a few research papers. Aranda et al. (2019) consider the quality of companies` own financial resources as crucial for the development of the circular economy. Horbach and Rammer (2020) find that companies that have introduced circular economy innovations have a better financial standing. Agyapong and Tweneboah (2023) point out that financial readiness and investment preparedness influence the circular economy financing. Generally, the availability of financial resources and funds from investors and banks seems to be important for companies that want to develop the circular economy (for example Saarinen and Aarikka-Stenroos, 2022; Scarpellini et al., 2021, 2018). In principle, a positive correlation between financial resources and the circular economy can be assumed, because ultimately the transition from a linear to a circular company requires innovations in products and processes along the entire value chain. This is confirmed in a recent empirical study; Stucki et al. (2023) find, based on a quantitative dataset to map the circular economy at company level, that both the level of cash flow and the level of investment have a positive effect on companies' circular economy activities. With the following hypothesis, we aim to confirm the existing research with our data.

Hypothesis H1. The higher the corporate financial resources – in form of cash flow – the more circular economy activities a company implements.

2.2. *The role of societal financial resources*

There are studies finding that regional inequalities in income levels, i.e., per capita income, affect the development of innovations in general (Aghion et al., 2019; Foellmi and Zweimüller, 2006; Tselios, 2010) and of specific environmental innovations (Vona and Patriarca, 2011). In this context, Grossman and Krueger (1995) developed the Kuznets Curve Hypothesis, which states that environmental conditions improve above a critical income level. Bai et al. (2020) illustrate this hypothesis with empirical data from China and conclude that household demand for renewable energy technological innovations (RETI) can be increased by improving the ability to consume these products. They conclude that residents' income should be increased, and income inequality reduced to promote RETI. Foellmi et al. (2014) support these findings with a theoretical model by concluding that income inequality affects firms' R&D strategies through market size and price effects, claiming that low-income people consume low-quality mass-produced products and rich consumers prefer exclusive quality products. Consequently, the level of the income ceiling in a region affects the market size of new products and consequently the innovation activity of firms (Foellmi and Zweimüller, 2006). Building on this literature, we assume that household income is an indicator of people's willingness or ability to pay and thus also supports firms' innovation activities in a circular economy.

This prediction is also supported by the literature on the transition to sustainability, which points to the importance of understanding how market segments can evolve and the critical role played by consumer groups that are receptive to new products. Consumer involvement is particularly necessary at an early stage of market development to ensure feedback loops and build user profiles (Dewald and Truffer, 2012). Accordingly, customers and investment should be particularly important to the regional transition to sustainability (see for example Geddes and Schmidt, 2020; Hadfield and Coenen, 2022).

Moreover, there is another argument for the role of societal financial resources that focuses on the employee perspective rather than the customer perspective. Gössling and Rutten (2007) argue for a factor that encourages creative people to move to certain regions, work in certain

firms, and thus accelerate the development of new innovations. This line of thought draws on the work of Richard Florida on the creative class (Florida, 2002) and emphasizes the importance of a livable environment. Creative people have demands on their environment that can usually be met in wealthy neighborhoods.

As far as we are aware, the relationship between regional household income and the development of the circular economy has not been examined in the literature. However, the above literature suggests that there should be a relationship between average household income and circular economy activities in a region. Therefore, we analyze the relationship between household income and circular economy activities of enterprises controlling for corporate financial resources, and formulate the following hypothesis:

Hypothesis H2. The higher the regional average household income, the more circular economy activities a company implements.

2.3. The role of public financial resources

Several studies suggest that public procurement is an important driver of innovation (Kundu et al., 2020). A main argument in favor of public procurement is its role in creating demand and thus its role as an instrument to foster innovation (Alic, 2008; Dalpé et al., 1992; Edler and Georghiou, 2007; Edquist and Zabala-Iturriagagoitia, 2012; Zelenbabic, 2015). In this context, Kundu et al. (2020), following Edler and Georghiou (2007), distinguish between three rationalities: the buyer and user rationality (the government as user), the market failure rationality (incentives for producers), and the public service rationality (improving the provision of public services). In general, public procurement is intended to provide incentives for R&D expenditures (Lichtenberg, 1988). For the medical device industry, for example, empirical findings indicate that the quality of research-based medical device manufacturers has increased as a result of public procurement (Hutton and Hartley, 1985). However, public procurement not only leads to innovation indirectly by creating demand, but innovation-friendly procurement practices such as supplier collaboration, political support, and sufficient resource allocation also stimulate firms to innovate directly (Zelenbabic, 2015).

Such a positive relationship of public procurement can also be observed for circular innovation activities (Saarinen and Aarikka-Stenroos, 2022; Sönnichsen and Clement, 2020). As Alhola et al. (2019) note, public procurement can positively influence circular economy activities in companies by mandating product life extension and requiring efficiency and circulation of materials (see also Sönnichsen and Clement, 2020). Saarinen and Aarikka-Stenroos (2022) see the role of public procurement as creating a playing field, setting an example, and raising awareness of the circular economy. In Swedish regions, for example, public procurement has been used to introduce renewable fuels in the bus system (Aldenius and Khan, 2017). In this context, a statistical analysis from the Valencia region indicate that regional administrations are more likely to adopt environmental criteria compared to local or provincial administrations (Fuentes-Bargues et al., 2019). This could also be due to the fact that public authorities need to have significant purchasing power to trigger green innovations (Li and Geiser, 2005).

Although there is limited relevant (quantitative) research focusing on public procurement as an incentive for developing circular economy activities (Cheng et al., 2018; Ntsondé and Aggeri, 2021), the literature suggests that public procurement can stimulate circular innovation in firms. Therefore, we formulate the following hypothesis:

Hypothesis H3. The higher the volume of regional spending on public procurement, the more circular economy activities a company implements.

2.4. Beginners vs. leaders

The transition from a linear to a circular company is a continuous process. The first stage is about companies taking on initial sustainability activities. Often these are relatively simple efficiency measures, so-called "low-hanging fruit," which in themselves do not have much to do with the circular economy. But it shows that companies are aware of the sustainability issue to some extent. However, only the leading companies - which account for around 10 % of the companies - are active in various areas of the circular economy and along the entire supply chain (see Stucki et al., 2023).

The leadership literature has shown that (innovation) leadership plays a central role in shaping the contexts and behaviors of followers (e.g., Barling et al., 2002; Schneider et al., 2005). This is a necessary condition for change and adaptation (Carmeli et al., 2010), as we need to move to a circular economy. This has also been empirically demonstrated. Specific for the circular economy, Meili et al. (2023) find that the knowledge of leading companies is important to encourage other companies to participate more in the circular economy. Accordingly, it is particularly important to understand how we can support leading companies in their activities.

In relation to our study, the question then arises as to which stage of the transformation process the financial resources ultimately have an effect: are they primarily relevant for the entry stage, i.e. the beginners, or are they also needed for the technological front, the leaders. In the hypotheses, we basically expect an impact on circular economy activities as a whole. Politically, however, it is quite relevant for which stage of the transformation the financial resources have an effect. In order to motivate the large mass of companies to become more circular, it is particularly important to have leaders that demonstrate that the circular economy can be successfully implemented in practice. Accordingly, it would be important for financial resources to have an impact not only on the circular economy beginners, but also on the leaders.

3. Empirical concept

3.1. Data

For the empirical analysis, we use different datasets for Switzerland. There are two reasons for the geographic focus. First, the topic of the circular economy is particularly relevant for Switzerland because, as an innovation-intensive country, it has ideal conditions for a successful transformation and, at the same time, is also heavily dependent on such a transformation due to its scarce resource deposits. It is therefore likely that the findings from this study can be transferred to other countries with a time lag. Second, Switzerland has data that are probably unique in the world for the analysis of our research questions.

The foundation for the analysis is a company survey on the circular economy, which was conducted in 2020 on the basis of the KOF Enterprise Panel. The KOF Enterprise Panel is a stratified random sample of 8000 Swiss companies that is representative of the population of companies (industry, region and size class) and has been extensively used for high-level academic research before (e.g., Balsmeier and Woerter, 2019; Mata and Woerter, 2013; Trantopoulos et al., 2017). For each company, specific contact persons were contacted who are familiar with filling out such questionnaires and well informed about the general business activities; usually these are the CEO, the CFO or the head of the R&D department. Since >99 % of all companies in Switzerland are SMEs with <250 employees, these individuals usually have a good overview of the activities within the company and are therefore well suited to complete the questionnaire. To further ensure the representativeness of the data, an intensive round of reminders was conducted after the questionnaires were sent out. Distortions due to self-selection or non-response could thus be minimized. The response rate of 29.1 % was satisfactory despite the difficult times during the Corona pandemic (for more information on the composition of the sample, see Stucki and Woerter, 2021).

The survey is based on a specially developed concept that distinguishes 27 measures typically relevant to the implementation of the circular economy at the corporate level. The measures refer to the three building blocks of a circular economy, and include activities to (a) increase resource efficiency by using fewer resources per product (Bocken et al., 2016), (b) slow resource loops by extending product life, and (c) close resource loops through recycling and re-use (McDonough and Braungart, 2010; Stahel, 1997, 1994). Specifically, the survey asked for which of these 27 measures companies have achieved measurable change between 2017 and 2019.[1] In addition to information on the measures implemented, data were also collected on the degree of integration into the business model, investments made, and revenue generated, allowing for a comprehensive description of company activities at circular economy (for more information on the survey, see Stucki et al., 2023). With these data, we can ideally map the activities of companies in the circular economy. At the same time, the dataset also contains other company and market information, such as the intensity of competition, the skill level of employees, or the industry affiliation, which typically influence the circular economy activities of companies. Of particular importance to our study is the information on corporate financial resources. In addition to a cash flow indicator, the data also include information on the level of investment, both overall and in relation to the circular economy.

We use data from IntelliProcure to map public procurement. IntelliProcure has been collecting information on public procurement in Switzerland since 2017. Particularly relevant for us is the volume of public procurement at the municipal and district (federal statistic office distinguishes 148 districts) level until the end of 2019. In addition, we obtain information on regional household income from the Federal Statistical Office. Specifically, we use the information on average taxable per capita income at the municipal and district level and the year 2018.

3.2. Methodology

Since the implementation of circular economy activities is essentially a matter of innovation capacity, the empirical modeling is based on a broadly supported innovation model. Important explanatory variables in these models are export activities, innovation knowledge ("absorptive capacity"), firm size, industry affiliation or competitive intensity (see e.g. Cohen, 2010; Crepon et al., 1998). In addition, we control for specific factors in the model that influence circular economy activities, such as energy intensity or family ownership (see Stucki et al., 2023). We then add our various variables to this model to represent financial resources. Thus, our basic regression equation is defined as follows:

$$CE\ activity = \alpha Innovation\_drivers + \beta CE\_drivers + \gamma Financial\_resources + \varepsilon \quad (1)$$

where ε is an error term and *Financial_resources* refers to (a) corporate financial resources measured as cash flows, (b) societal financial resources measured as regional household income, and (c) public financial resources measured as the volume of regional public procurement. A detailed description of all covariates is provided in the summary statistics in Table 1 and the correlation table in Table A.1.

To characterize the transition process to a circular economy, the determinants are estimated in a first step based on a fractional logit estimation procedure, where the dependent variable is a restricted count variable ranging from 0 to 27 that can be easily transformed into a fractional dependent variable (Papke and Wooldridge, 1996; Wooldridge, 2010). To analyze differences in impacts between beginners and leaders, we estimate multinomial logit regressions (Cameron and Trivedi, 2005), setting firms with no circular economy activities as the baseline category.

Based on cross-sectional data it is hardly possible to identify causality. In general, however, we can assume that the regional data are unlikely to be actively influenced by firms and that, accordingly, we expect the regional characteristics to influence the activity of firms and

Table 1
Descriptive information.

Variable	Description	Mean	Std. Dev.	Min	Max
Dependent variable					
CE overall	Share of the 27 circular economy activities adopted	0.16	0.16	0	1
Financial variables					
cash-flow	Available cash flow, in logs	10.80	1.84	0.00	15.44
household income	Municipal average household income per capita in Swiss francs, in logs	10.41	0.25	9.77	11.93
public procurement	Top 25 % of public procurement volume at the district level, yes/no	0.26	0.44	0	1
Control variables					
export	Firm is an exporter, yes/no	0.46	0.50	0	1
foreign owned	Foreign ownership, yes/no	0.15	0.35	0	1
price comp	Intensity of price competition, 5-level ordinate variable	3.94	1.01	1	5
non-price comp	Intensity of non-price competition, 5-level ordinate variable	3.11	0.99	1	5
R&D	R&D activities, yes/no	0.33	0.47	0	1
academ education	Share of employees with academic tertiary-level education	14.25	18.20	0	100
higher education	Share of employees with non-academic tertiary-level education	16.51	14.81	0	100
apprentices	Share of employees with secondary-level education	5.07	6.98	0	100
vocational	Share of employees in vocational training	44.31	23.38	0	100
business-model	Anchoring of sustainability in the business model, transformation of 5-level ordinate variable into binary variable 0 (weak: values 1, 2, 3) and 1 (strong: values 4, 5)	0.15	0.36	0	1
energy int	Energy cost share, in logs	0.87	0.69	0	4.51
age	Firm age, in logs	3.84	0.84	0	5.56
family owned	Firm is family owned, yes/no	0.55	0.50	0	1
company size	Number of employees measured in full-time equivalents, in logs	4.00	1.35	1.61	10.54

Notes: statistics based on main regression of Column 4 of Table 2.

[1] Concretely, the following 27 measures are considered (N: narrowing; C: closing; S: slowing): *Procurement:* footprint inputs (N), used inputs (C), footprint infrastructure (N), used infrastructure (C), infrastructure with long product life (S), extending life span of infrastructure (S), resale infrastructure (C); *Design:* product life (S), repairability (S), updates/upgrades (S), recycling (C), pollution product use (N); *Production*: material use (N), renewable energy (C), pollution in production (N), reusing waste (C); *Storage/Logistics:* reduce business travel (N), optimizing routing (N), optimizing warehouse (N); *Sales:* rental/leasing (C), sharing platforms (C), footprint documentation (N); *After-sales*: warranty (S), spare parts (S), range updates/upgrades (S); *After-use:* refunds (C), resale products (C) (for more detailed information see Stucki et al., 2023).

not vice versa. For other model variables, the causality of the effect is less clear. For example, awareness of sustainability may promote circular economy activities, but the opposite is also true. Therefore, although the model includes an extensive vector of control variables that significantly reduces the risk of omitted variable bias, we refrain from making causal statements and interpret our results primarily as partial correlations.

4. Empirical results

4.1. Main results

Table 2 shows the results of Eq. (1) when we use a fractional logit regression procedure. In columns 1–3, the variables representing financial resources are included in the model individually, and in column 4 they are tested together. Consistent with hypothesis H1, cash flow shows a significant positive effect on the implementation of circular economy activities in firms. This confirms that the availability of internal finance is central to the circular economy. As formulated in hypotheses H2 and H3, household income and the volume of public procurement also show positive effects. Thus, in addition to corporate resources, regionally available financial resources also affect firms' circular economy activities. The effects hardly change when we include them simultaneously in the model; neither the level nor the standard errors of the effects change significantly as a result. This indicates that the individual financial sources affect the circular economy independently, i.e., we have identified relatively independent channels for financial resources stimulating the circular economy.

The effects of the remaining model variables confirm previous results (see Stucki et al., 2023). It turns out that innovation knowledge (but not necessarily formal knowledge), non-price competition (but not price competition), and generally awareness of sustainability are particularly relevant for implementing circular economy activities. Awareness in particular plays an important role; energy-intensive companies, companies with a strong anchoring of sustainability in their business model and also large companies - in sum, the characteristics of companies that have been in the spotlight for a long time - implement significantly more circular economy activities than other companies.

Table 2
The effect of corporate and regional financial resources on circular economy activities, fractional logit regression.

	(1)	(2)	(3)	(4)
cash-flow	0.05**			0.05**
	(0.02)			(0.02)
household income		0.19*		0.19+
		(0.10)		(0.13)
public procurement			0.16**	0.15*
			(0.07)	(0.08)
export	0.07	0.01	0.04	0.07
	(0.08)	(0.07)	(0.07)	(0.08)
foreign owned	−0.02	0.01	0.02	−0.01
	(0.09)	(0.08)	(0.08)	(0.09)
price comp	0.05	0.02	0.03	0.05
	(0.04)	(0.03)	(0.03)	(0.04)
non-price comp	0.10***	0.10***	0.10***	0.11***
	(0.04)	(0.03)	(0.03)	(0.04)
R&D	0.27***	0.24***	0.22***	0.26***
	(0.08)	(0.08)	(0.08)	(0.08)
academ education	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
higher education	0.00	0.00	0.00	−0.00
	(0.00)	(0.00)	(0.00)	(0.00)
apprentices	0.01+	0.01	0.01+	0.01+
	(0.00)	(0.00)	(0.00)	(0.00)
vocational	0.00*	0.00	0.00	0.00*
	(0.00)	(0.00)	(0.00)	(0.00)
business-model	0.77***	0.72***	0.73***	0.80***
	(0.08)	(0.07)	(0.07)	(0.08)
energy int	0.16***	0.16***	0.17***	0.17***
	(0.05)	(0.05)	(0.05)	(0.05)
age	0.03	0.02	0.02	0.03
	(0.05)	(0.04)	(0.04)	(0.05)
family owned	0.16**	0.16**	0.17**	0.17**
	(0.07)	(0.07)	(0.07)	(0.07)
company size	0.16***	0.19***	0.18***	0.16***
	(0.03)	(0.03)	(0.03)	(0.03)
constant	−4.20***	−5.42***	−3.56***	−6.25***
	(0.37)	(1.11)	(0.27)	(1.34)
Sector FE	Yes	Yes	Yes	Yes
N	1186	1497	1484	1172
Wald chi2	283.43***	320.07***	320.71***	314.82***
Log Likelihood	−369.81	−470.84	−465.51	−363.67

Notes: + $p < 0.15$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust Standard errors in parentheses; Sector fixed effects: we include fixed effects for construction, modern services, traditional services, and high-tech manufacturing (reference: low-tech manufacturing).

4.2. Beginners vs. leaders

In Table 3 we split our dependent variable in different categories: Stage 0: no circular economy activities (28 % of the companies); Stage 1:

Table 3
Differences by stage of transformation, multinomial logit regression (baseline: stage 0).

Stage	1	2	3
cash-flow	0.12***	0.09*	0.22***
	(0.04)	(0.05)	(0.06)
household income	0.80**	0.96**	0.55
	(0.36)	(0.40)	(0.49)
public procurement	−0.10	0.10	0.49*
	(0.20)	(0.23)	(0.27)
export	0.01	0.30	0.11
	(0.19)	(0.22)	(0.27)
foreign owned	0.13	−0.19	0.03
	(0.25)	(0.28)	(0.33)
price comp	0.15*	0.19*	0.25**
	(0.09)	(0.10)	(0.12)
non-price comp	0.04	0.11	0.32***
	(0.09)	(0.10)	(0.12)
R&D	0.79***	1.06***	1.09***
	(0.22)	(0.24)	(0.29)
academ education	0.01**	0.01*	0.01
	(0.01)	(0.01)	(0.01)
higher education	−0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)
apprentices	−0.01	0.01	0.02+
	(0.02)	(0.01)	(0.02)
vocational	0.01*	0.01***	0.02**
	(0.00)	(0.00)	(0.01)
business-model	0.51+	1.61***	2.36***
	(0.33)	(0.33)	(0.35)
energy int	0.03	0.35**	0.48***
	(0.13)	(0.14)	(0.17)
age	0.09	0.12	0.08
	(0.10)	(0.12)	(0.16)
family owned	0.08	0.16	0.37+
	(0.17)	(0.21)	(0.25)
company size	0.22***	0.44***	0.51***
	(0.07)	(0.08)	(0.10)
constant	−11.47***	−15.79***	−15.39***
	(3.82)	(4.24)	(5.18)
Sector FE	yes	yes	yes
N	1172		
pseudo R2	0.11		
Wald chi2	272.65***		
Log Likelihood	−1382.44		

Notes: + $p < 0.15$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust Standard errors in parentheses; Stage 0: no CE activities; Stage 1: 1–4 CE activities; Stage 2: 5–9 CE activities; Stage 3: >10 CE activities; Sector fixed effects: we include fixed effects for construction, modern services, traditional services, and high-tech manufacturing (reference: low-tech manufacturing); based on Hausman tests, no evidence could be found for a violation of IIA assumption.

1–4 circular economy activities (38 %); Stage 2: 5–9 circular economy activities (23 %); Stage 3: >10 circular economy activities (11 %). Based on multinomial logit regressions, we examine in Table 3 whether the effects of each financing variable affect circular economy beginners (stage 1) and leaders (stage 3) differently and whether the variables have any effect at all on leaders (see Table A.2 for alternative baselines). Household income is an important prerequisite for entry into the circular economy, but is not significantly more common among leaders than beginners. Thus, this financial resource seems to promote entry into the circular economy, but not the shift from beginner to leader.

The situation is different for public procurement. While the expansion of public procurement can explicitly stimulate a leading role in the circular economy, it has little effect on entry into the circular economy. Thus, the results suggest that the availability of internal funding and regional household income matter if we want to encourage the diffusion of the circular economy. However, if we really want to support the leaders, this can be promoted primarily through public procurement. This result is quite plausible, as the public sector is often seen as a role model. Public funds should be used to finance flagship projects that have a signal effect. Our results show that this is indeed the case.

Finally, corporate financial resources in the form of cash flow have a significant impact at both stages: beginner and leaders. This result indicates that the transition to a circular economy requires significant investments from companies in all phases and that learning effects are limited.

These results highlight the importance of financial resources for the successful implementation of a circular economy. Corporate financial resources are required at all stages, but regional financial resources are also important: societal financial resources especially for the initial stage and public financial resources for pushing the frontier.

4.3. Robustness

So far, we have combined all 27 circular economy activities into one indicator and used it as the dependent variable. However, such circular economy activities are diverse and therefore may have different determinants. In a first robustness test, we investigate how robust the previously discussed effects actually are for different areas of the circular economy. In grouping the activities, we follow Bocken et al. (2016), who categorize circular economy activities into three areas: narrowing, closing, and slowing. The results actually indicate some differences (see Table A.3). First, we note that the standard errors tend to become somewhat larger compared to our main regressions and, accordingly, somewhat less significance is observed in the model; this suggests that it is more difficult to characterize individual areas of the circular economy. Second, there are some interesting differences related to financial variables. Cash flow has a significant positive effect on all three areas, with no differences in the size of the effects. Household income, on the other hand, only has an effect on narrowing. The volume of public procurement, finally, has no effect on narrowing, but does have an effect on slowing and closing.

In our main results, household income is measured at the municipality level and public procurement at the district level. In Table A.4, we test alternative levels of aggregation for the two variables. However, the results show that household income only has an impact at the municipality level, but not at the district level. Public procurement, in turn, has an impact only at the district level, but not at the municipality level. Thus, the area of influence of public procurement appears to be larger than that of household income. This is quite plausible, as it is usually difficult to award public contracts within the same municipality, especially in smaller municipalities.

As our variables for public procurement and household income are not measured at company level but at a more aggregated level, the shown robust standard errors may be biased. To deal with this issue, we present in Table A.5 regressions with clustered standard errors which allow for intragroup correlation. In column (1) the standard errors are clustered at the district level, in column (2) at the municipality level. The results indicate that our results are robust to such clustering; the significance of some effects even slightly increases.

As mentioned earlier, we cannot directly account for possible endogeneity in our model. What we can do, however, is reduce a possible omitted variable bias by controlling for observable effects in the model. In our baseline model, we already control for quite many observable variables. In Table A.6, we attempt to further reduce this potential problem by selectively including more observable variables in the model. In column 1, we insert variables for the urban character of the regions where the firms are located. In principle, it is possible that the availability of regional financial resources depends on the urban character of a region. Indeed, this seems to be the case. In general, core municipalities tend to have more financial resources. However, since fewer circular economy activities are implemented in core municipalities - the direct effect of core municipality is significantly negative - the effect of regional financial resources becomes even larger.

Probably companies with more financial resources are also more aware of sustainability issues. In column 2, we add a control for the share of circular economy investment in total investments. This variable should be a good indicator of the relative prioritization of sustainability in a company. This allows us to increase the likelihood that our financing variables actually measure expected financing effects rather than corporate awareness of sustainability issues. The results show that adding the investment variables actually reduces the effect of the financing variables. This suggests that greater availability of financing generally also leads to greater prioritization of sustainability. Overall, however, the effects of the financing variables are quite robust in terms of magnitude and significance compared to the main regression.

In our main regressions we control for five sub-sectors. However, it is possible that financing effects vary from industry to industry. For example, it is possible that investment-intensive industries are more dependent on financing than other industries and that the effects there differ accordingly. To better control for such possible effects, we control in detail for firms' industry affiliation in column 3. Specifically, we add 34 additional industry fixed effects. Overall, however, this has no impact on the results; again, the size and significance of the main effects remain unchanged.

5. Discussion

Consistent with previous studies indicating that investors, banks, subsidies, and public funds play a key role in promoting the circular economy (Agyapong and Tweneboah, 2023; Aranda et al., 2019; Saarinen and Aarikka-Stenroos, 2022) and that lack of financial resources is a major barrier to the circular economy (De Schoenmakere et al., 2019; Spörri et al., 2022), our results confirm that financial resources are important for promoting circular economy activities at the firm level. Looking at the regional revel, our results indicate that it is not only subsidies or public funds that matter, as assumed in the literature, but also the purchasing power of households and public institutions. In doing so, we extend the studies that have previously analyzed financial resources for circular economy development (see, e.g., Aranda et al., 2019). Moreover, the results could also be relevant for other (eco-)innovations and can therefore extend the RBV or NRPB theory in general (Barney, 1991; Barney et al., 2001; Hart, 1995).

Our results confirm previous findings that see a positive relationship between household income and (eco-)innovation (see, e.g., Aghion et al., 2019; Bai et al., 2020), even if the effect is comparatively small compared to the other financial variables. The comparatively lower importance of household income for the development of the circular economy may suggest that regional household income is generally less important for the development of innovations in developed countries such as Switzerland. This is suggested by the findings of Vona and Patriarca (2011), who find that per capita income is indeed relevant for the development of environmental innovations in poorer countries.

Moreover, our study allows us to quantitatively confirm qualitative and region-specific findings on the impact of public procurement on the circular economy (see, e.g., Alhola et al., 2019; Saarinen and Aarikka-Stenroos, 2022) in a different geographical context.

Another line of research concerns the relevance of our finding regarding place-based factors for the development of the circular economy (Bourdin et al., 2022). The geographies of innovation and transition studies have so far neglected the impact of regional financial resources on the transition to more sustainable products and processes (Tapia et al., 2021; Veyssière et al., 2022). Therefore, our results should help to better understand, why circular innovations occur in some places and not others. Hence, this paper helps to introduce the topic of regional financial resources to this literature and induce further research. Questions concerning how regional financial resources influence the transition to a circular economy would be worthwhile investigating.

6. Conclusion

The importance of different types of financial sources and their relevance for companies at different stages of the circular economy transformation are still insufficiently understood. This paper aims to contribute to the literature by analyzing how regional financial resources, as an additional dimension of innovation financing, influences circular business activities. The results indicate that all forms of financing considered play a role – that is, money matters. Both the availability of firm-specific finance (measured as cash flow) and regional finance, divided into societal finance (measured as regional household income) and public finance (measured as public procurement volume), are positively correlated with the implementation of circular economy activities; and their effect is largely independent. However, on the one hand, the effect depends on the stage of circular economy transformation: while societal finance simulates entry into the circular economy, public finance promotes circular economy leadership, and corporate finance promotes both stages. On the other hand, the effect also depends on the area of circular economy. Cash flow has a positive effect on narrowing, closing, and slowing. Household income only has an effect on narrowing, i.e., efficiency measures, which in themselves do not have much to do with the core of the circular economy. Public procurement affects slowing and closing activities and therefore seems to be much more important for the transformation to a circular economy.

Overall, these results also yield clear implications for policymaking. The results indicate that the availability of financial resources is central to the implementation of the circular economy. Therefore, if the goal is to accelerate the transition to a circular economy, it is important to ensure broad access to financial resources, which requires both corporate financial resources and regional financial resources. A number of tools are available to governments to ensure the provision of such resources. In the area of corporate finance, for example, governments can increase pressure on financial systems to pay greater attention to sustainability criteria when allocating funds. Governments can also create more financial space by reducing corporate taxes, providing direct financial support for circular activities through subsidies, or penalizing non-circular behavior through taxes.

Regional finances take into account household income and public procurement. Household income can be affected by reducing individual taxes (especially in low-income regions) or by compensating low-income regions through fiscal equalization. The effect of household income may not only be monetary, but may also be due to the fact that higher income groups generally have a greater awareness of the circular economy. Therefore, it seems important not only to work with financial incentives, but also to sensitize especially the lower income groups to the topic through targeted awareness-raising measures.

Finally, our results underline the importance of public procurement. Even though the volume of public procurement is not very large compared to the private sector, the data shows a clear correlation with the implementation of circular economy activities. Therefore, it is important that sustainability criteria are increasingly considered in public procurement and that companies are specifically supported in developing new, sustainable solutions for public procurement. Flagship projects financed through public procurement could be presented more prominently to show other companies what is possible and motivate them to do the same. As small communities may lack the knowledge for circular procurement, regionally coordinated public procurement and supporting instruments could help to ensure that the necessary knowledge is available in the region.

In this study, the relationship between financial resources and circular economy activities of companies is broadly analyzed and tested based on currently probably unique quantitative data. Similar to the traditional innovation literature, it would of course be desirable for such data to be available over different points in time in the future. It would then also be possible to address the problem of endogeneity in a more targeted way. Moreover, future studies could test the robustness of our findings using natural experiments or specific case studies. It would also be important that such data be collected for other countries as well. This is the only way to identify and understand differences between countries.

CRediT authorship contribution statement

Tobias Stucki: Conceptualization, Investigation, Formal analysis, Writing – Original draft & reviewing.

Rahel Meili: Conceptualization, Investigation, Writing – Original draft & reviewing.

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.

Data availability

The authors do not have permission to share data.

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Appendix A

Table A.1
Correlation table (based on main regression of Column 4 of Table 2).

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	CE overall	1																
2	export	0.1107																
3	foreign owned	0.0102	0.2008															
4	price comp	0.0951	0.0015	0.0493														
5	non-price comp	0.1183	0.1386	0.0214	0.2481													
6	R&D	0.1910	0.3968	0.0547	0.0228	0.1288												
7	academ education	−0.0414	0.1816	0.1012	−0.1308	0.0394	0.1685											
8	higher education	−0.0404	0.0424	0.0844	−0.0389	0.0499	0.0410	0.1222										
9	apprentices	0.0249	−0.1430	−0.1086	0.1089	−0.0425	−0.0657	−0.1330	−0.0886									
10	vocational	0.0590	−0.1149	−0.0722	−0.0043	−0.0367	−0.1303	−0.4739	−0.3532	0.0406								
11	business-model	0.3210	0.0087	−0.0162	0.0425	0.0213	0.1060	0.0598	0.0437	−0.0156	−0.0339							
12	energy int	0.0887	−0.0288	−0.0539	−0.0604	−0.0306	0.0086	−0.1242	−0.0974	−0.0442	0.0261	−0.0058						
13	age	0.1011	0.0800	−0.0542	0.1405	−0.0237	0.0390	−0.1427	−0.0123	0.1286	0.0688	−0.0140	0.0268					
14	family owned	0.0616	0.0114	−0.1297	0.1895	0.0352	−0.0269	−0.2626	−0.1317	0.0791	0.1125	−0.0244	0.0752	0.0946				
15	company size	0.2553	0.1958	0.1372	0.0838	0.0589	0.1902	−0.0008	−0.0254	−0.0041	0.0086	0.1403	−0.0327	0.2737	−0.1366			
16	public procurement	0.0398	−0.0325	0.0470	−0.0531	0.0018	−0.0261	0.1895	0.0541	−0.0149	−0.0566	0.0187	−0.1148	0.0264	−0.1299	0.1290		
17	cash-flow	0.0113	0.0045	0.0570	−0.0552	0.0061	−0.0887	0.1222	0.0886	0.0332	−0.0307	−0.0107	−0.0673	−0.0210	−0.0281	−0.0062	0.2604	
18	household income	0.0713	0.0028	0.0142	−0.0818	−0.0180	−0.0144	0.0293	0.0333	−0.0568	0.0154	0.0585	−0.0267	0.0172	−0.0986	0.0397	0.0070	0.0124

Table A.2
Test multinomial logit regressions with alternative baselines.

Stage	0	2	3	0	1	3
cash-flow	−0.12***	−0.02	0.10*	−0.09*	0.02	0.13**
	(0.04)	(0.05)	(0.06)	(0.05)	(0.05)	(0.06)
household income	−0.80**	0.16	−0.25	−0.96**	−0.16	−0.41
	(0.36)	(0.32)	(0.41)	(0.40)	(0.32)	(0.42)
public procurement	0.10	0.20	0.59**	−0.10	−0.20	0.39+
	(0.20)	(0.20)	(0.24)	(0.23)	(0.20)	(0.24)
export	−0.01	0.29+	0.10	−0.30	−0.29+	−0.19
	(0.19)	(0.19)	(0.24)	(0.22)	(0.19)	(0.25)
foreign owned	−0.13	−0.31	−0.09	0.19	0.31	0.22
	(0.25)	(0.23)	(0.28)	(0.28)	(0.23)	(0.30)
price comp	−0.15*	0.04	0.10	−0.19*	−0.04	0.06
	(0.09)	(0.09)	(0.11)	(0.10)	(0.09)	(0.11)
non-price comp	−0.04	0.08	0.28***	−0.11	−0.08	0.21*
	(0.09)	(0.08)	(0.11)	(0.10)	(0.08)	(0.11)
R&D	−0.79***	0.27	0.30	−1.06***	−0.27	0.03
	(0.22)	(0.19)	(0.25)	(0.24)	(0.19)	(0.25)
academ education	−0.01**	0.00	−0.00	−0.01*	−0.00	−0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
higher education	0.00	0.00	0.00	−0.00	−0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
apprentices	0.01	0.02	0.03**	−0.01	−0.02	0.01
	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
vocational	−0.01*	0.01	0.01	−0.01***	−0.01	0.00
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
business-model	−0.51+	1.10***	1.84***	−1.61***	−1.10***	0.75***
	(0.33)	(0.22)	(0.25)	(0.33)	(0.22)	(0.23)
energy int	−0.03	0.32***	0.45***	−0.35**	−0.32***	0.13
	(0.13)	(0.12)	(0.15)	(0.14)	(0.12)	(0.14)
age	−0.09	0.03	−0.01	−0.12	−0.03	−0.04
	(0.10)	(0.10)	(0.15)	(0.12)	(0.10)	(0.14)
family owned	−0.08	0.09	0.29	−0.16	−0.09	0.21
	(0.17)	(0.18)	(0.23)	(0.21)	(0.18)	(0.23)
company size	−0.22***	0.21***	0.29***	−0.44***	−0.21***	0.07
	(0.07)	(0.06)	(0.09)	(0.08)	(0.06)	(0.09)
constant	11.47***	−4.32	−3.92	15.79***	4.32	0.40
	(3.82)	(3.38)	(4.42)	(4.24)	(3.38)	(4.52)
Sector FE	yes	yes	yes	yes	yes	yes
N	1172			1172		
pseudo R2	0.11			0.11		
Wald chi2	272.65***			272.65***		
Log Likelihood	−1382.44			−1382.44		

Notes: + $p < 0.15$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust Standard errors in parentheses; Stage 0: no CE activities; Stage 1: 1–4 CE activities; Stage 2: 5–9 CE activities; Stage 3: >10 CE activities; Sector fixed effects: we include fixed effects for construction, modern services, traditional services, and high-tech manufacturing (reference: low-tech manufacturing).

Table A.3
Test different areas of the circular economy.

CE strategy	Narrowing		Closing		Slowing		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
cash-flow	0.05**		0.05**		0.05*		
	(0.03)		(0.02)		(0.03)		
household income	0.27*		0.14	0.17	0.17		0.20
	(0.15)		(0.15)	(0.13)	(0.19)		(0.15)
public procurement	0.10	0.10	0.22**		0.18+	0.18*	
	(0.09)	(0.08)	(0.09)		(0.11)	(0.10)	
export	−0.00	−0.06	0.11	0.04	0.15	0.15+	0.13
	(0.09)	(0.08)	(0.10)	(0.09)	(0.12)	(0.10)	(0.10)
foreign owned	−0.02	0.02	0.01	−0.02	−0.04	0.03	0.02
	(0.11)	(0.10)	(0.11)	(0.10)	(0.14)	(0.12)	(0.12)
price comp	0.08**	0.07*	0.04	0.01	0.02	−0.02	−0.03
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)
non-price comp	0.08**	0.08**	0.09**	0.11***	0.20***	0.16***	0.16***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)
R&D	0.21**	0.16*	0.21**	0.18*	0.45***	0.45***	0.47***
	(0.10)	(0.09)	(0.11)	(0.10)	(0.12)	(0.11)	(0.11)
academ education	−0.00	0.00	−0.00	−0.00	0.01**	0.01*	0.01*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
higher education	−0.00	−0.00	−0.00	−0.00	0.01**	0.01**	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
apprentices	0.00	0.01	0.00	0.00	0.02***	0.02***	0.02***

(*continued on next page*)

Table A.3 (*continued*)

CE strategy	Narrowing		Closing		Slowing		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
vocational	0.00+	0.00	0.00	−0.00	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
business-model	1.04***	0.96***	0.79***	0.64***	0.66***	0.65***	0.64***
	(0.10)	(0.09)	(0.09)	(0.09)	(0.12)	(0.10)	(0.10)
energy int	0.22***	0.19***	0.17***	0.17***	0.14**	0.14**	0.13**
	(0.05)	(0.05)	(0.06)	(0.06)	(0.07)	(0.06)	(0.06)
age	0.12**	0.11**	−0.03	−0.03	−0.05	−0.05	−0.05
	(0.06)	(0.05)	(0.06)	(0.05)	(0.07)	(0.06)	(0.06)
family owned	0.16*	0.15*	0.17*	0.19**	0.19*	0.17*	0.16*
	(0.09)	(0.08)	(0.09)	(0.08)	(0.11)	(0.10)	(0.10)
company size	0.22***	0.25***	0.15***	0.20***	0.10**	0.11***	0.12***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.05)	(0.04)	(0.04)
constant	−7.08***	−3.52***	−5.63***	−5.33***	−6.47***	−3.83***	−5.85***
	(1.66)	(0.30)	(1.61)	(1.36)	(2.05)	(0.36)	(1.64)
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1185	1501	1175	1503	1188	1506	1519
Wald chi2	332.65***	363.96***	193.68***	183.20***	152.38***	174.73***	173.27***
Log Likelihood	−478.72	−607.61	−303.56	−396.61	−332.85	−430.50	−435.44

Notes: + $p < 0.15$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust Standard errors in parentheses; Sector fixed effects: we include fixed effects for construction, modern services, traditional services, and high-tech manufacturing (reference: low-tech manufacturing); for more detailed information on the characterization of the three areas of the circular economy see footnote 1.

Table A.4
Test alternative aggregation levels for regional financial variables.

	(1)	(2)	(3)	(4)
cash-flow		0.05**		0.05**
		(0.02)		(0.02)
household income (municipal level)				0.21*
				(0.13)
household income (district level)	0.09	−0.02		
	(0.11)	(0.14)		
public procurement (district level)		0.17**		
		(0.08)		
public procurement (municipal level)			0.08	0.10
			(0.07)	(0.07)
export	0.02	0.08	0.03	0.07
	(0.07)	(0.08)	(0.07)	(0.08)
foreign owned	0.01	−0.00	0.02	−0.01
	(0.08)	(0.09)	(0.08)	(0.09)
price comp	0.02	0.05	0.03	0.05
	(0.03)	(0.04)	(0.03)	(0.04)
non-price comp	0.10***	0.10***	0.10***	0.11***
	(0.03)	(0.04)	(0.03)	(0.04)
R&D	0.24***	0.26***	0.22***	0.26***
	(0.08)	(0.08)	(0.08)	(0.08)
academ education	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
higher education	0.00	0.00	0.00	−0.00
	(0.00)	(0.00)	(0.00)	(0.00)
apprentices	0.01+	0.01*	0.01+	0.01+
	(0.00)	(0.00)	(0.00)	(0.00)
vocational	0.00	0.00*	0.00	0.00*
	(0.00)	(0.00)	(0.00)	(0.00)
business-model	0.72***	0.80***	0.73***	0.80***
	(0.07)	(0.08)	(0.07)	(0.08)
energy int	0.16***	0.17***	0.17***	0.17***
	(0.05)	(0.05)	(0.05)	(0.05)
age	0.02	0.02	0.02	0.03
	(0.04)	(0.05)	(0.04)	(0.05)
family owned	0.16**	0.17**	0.17**	0.17**
	(0.07)	(0.07)	(0.07)	(0.07)
company size	0.19***	0.16***	0.19***	0.17***
	(0.03)	(0.03)	(0.03)	(0.03)
constant	−4.47***	−4.02***	−3.58***	−6.44***
	(1.22)	(1.50)	(0.27)	(1.35)
Sector FE	Yes	Yes	Yes	Yes
N	1499	1174	1484	1172
Wald chi2	316.11***	305.94***	322.13***	315.45***
Log Likelihood	−471.54	−364.36	−465.77	−363.78

Notes: + $p < 0.15$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust Standard errors in parentheses; Sector fixed effects: we include fixed effects for construction, modern services, traditional services, and high-tech manufacturing (reference: low-tech manufacturing).

Table A.5
Test alternative calculations of the standard errors using clustered sandwich estimator.

Level of clustering	District	Municipality
cash-flow	0.05***	0.05***
	(0.02)	(0.02)
household income	0.19+	0.19+
	(0.12)	(0.13)
public procurement	0.15**	0.15*
	(0.07)	(0.08)
export	0.07	0.07
	(0.08)	(0.08)
foreign owned	−0.01	−0.01
	(0.10)	(0.09)
price comp	0.05	0.05
	(0.04)	(0.04)
non-price comp	0.11***	0.11***
	(0.04)	(0.04)
R&D	0.26***	0.26***
	(0.09)	(0.08)
academ education	0.00	0.00
	(0.00)	(0.00)
higher education	−0.00	−0.00
	(0.00)	(0.00)
apprentices	0.01	0.01+
	(0.01)	(0.01)
vocational	0.00*	0.00*
	(0.00)	(0.00)
business-model	0.80***	0.80***
	(0.07)	(0.08)
energy int	0.17***	0.17***
	(0.05)	(0.05)
age	0.03	0.03
	(0.05)	(0.05)
family owned	0.17**	0.17**
	(0.07)	(0.07)
company size	0.16***	0.16***
	(0.03)	(0.03)
constant	−6.25***	−6.25***
	(1.31)	(1.37)
Sector FE	yes	yes
N	1172	1172
Wald chi2	428.78***	350.55***
Log Likelihood	−363.67	−363.67

Notes: $+ p < 0.15$, $* p < 0.1$, $** p < 0.05$, $*** p < 0.01$. Clustered standard errors in parentheses; Sector fixed effects: we include fixed effects for construction, modern services, traditional services, and high-tech manufacturing (reference: low-tech manufacturing).

Table A.6
Including additional controls.

	(1)	(2)	(3)
cash-flow	0.05**	0.04**	0.05**
	(0.02)	(0.02)	(0.02)
household income	0.26**	0.15	0.20+
	(0.13)	(0.13)	(0.13)
public procurement	0.25***	0.16**	0.14*
	(0.08)	(0.08)	(0.08)
export	0.06	0.10	0.07
	(0.08)	(0.08)	(0.09)
foreign owned	−0.01	−0.05	0.04
	(0.09)	(0.10)	(0.09)
price comp	0.04	0.05	0.05
	(0.04)	(0.04)	(0.04)
non-price comp	0.10***	0.10***	0.10***
	(0.04)	(0.04)	(0.04)
R&D	0.25***	0.18**	0.27***
	(0.08)	(0.08)	(0.09)
academ education	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
higher education	−0.00	−0.00	0.00
	(0.00)	(0.00)	(0.00)
apprentices	0.01	0.01**	0.01**

(*continued on next page*)

Table A.6 (*continued*)

	(1)	(2)	(3)
	(0.00)	(0.01)	(0.01)
vocational	0.00*	0.00**	0.00*
	(0.00)	(0.00)	(0.00)
business-model	0.82***	0.58***	0.81***
	(0.08)	(0.08)	(0.08)
energy int	0.17***	0.13***	0.18***
	(0.05)	(0.05)	(0.05)
age	0.03	0.00	0.03
	(0.05)	(0.05)	(0.05)
family owned	0.15**	0.15**	0.15*
	(0.07)	(0.07)	(0.08)
company size	0.16***	0.13***	0.15***
	(0.03)	(0.03)	(0.03)
core municipality	−0.39***		
	(0.10)		
agglomeration	−0.16*		
	(0.08)		
CE invest		0.25***	
		(0.03)	
constant	−6.84***	−6.16***	−6.95***
	(1.36)	(1.33)	(1.42)
Sector FE	yes	yes	yes
Industry FE	no	no	yes
N	1172	1113	1172
Wald chi2	340.52***	368.15***	424.62***
Log Likelihood	−362.43	−340.56	−359.86

Notes: $+\ p < 0.15$, $*\ p < 0.1$, $**\ p < 0.05$, $***\ p < 0.01$. Robust Standard errors in parentheses; Sector fixed effects: we include fixed effects for construction, modern services, traditional services, and high-tech manufacturing (reference: low-tech manufacturing); Industry fixed effects: we include fixed effects for 34 industry classes at NACE 2 digit level; urban character of the region: (a) core municipality, (b) agglomeration, (c) rural municipality (reference); CE invest: share of CE investment in total investments (5-level ordinate variable).

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