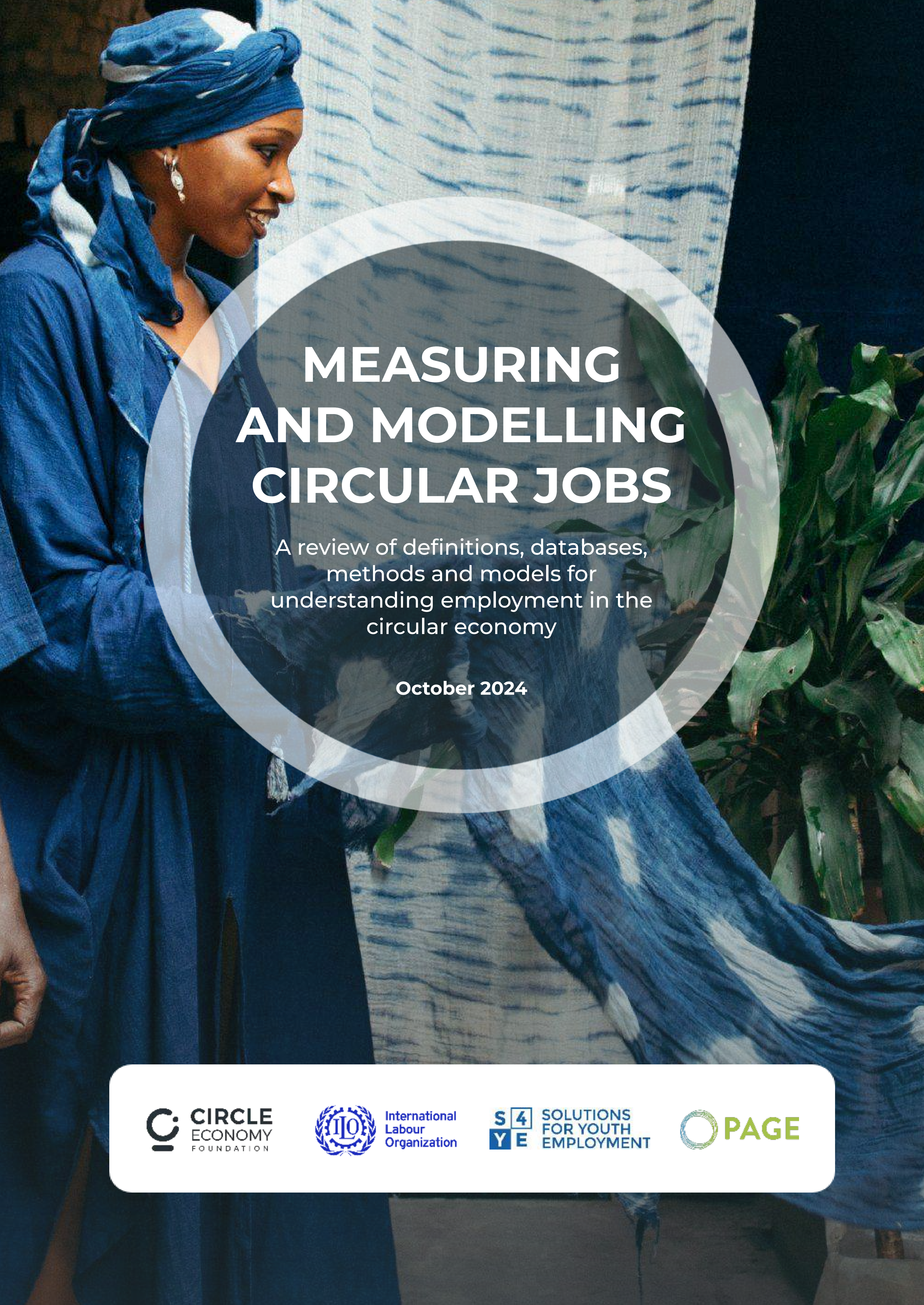

MEASURING AND MODELLING CIRCULAR JOBS

A review of definitions, databases, methods and models for understanding employment in the circular economy

October 2024

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FOREWORD

CIRCLE ECONOMY

We know that people are at the heart of the circular economy. But where these people are, what jobs they hold, and the conditions in which they work are largely unknown. This report underscores the vital role of data in illuminating the role that people play so that we can plan for and anticipate a just transition with the help of circular economy interventions. This piece of important foundational work is by the partners of the *Jobs in the Circular Economy* initiative: Circle Economy Foundation, the International Labour Organization and the Solutions for Youth Employment Programme of the World Bank Group. It highlights the importance of robust definitions, databases, methods, and models to measure employment within the circular economy. By leveraging these tools, policymakers and decision-makers can craft informed strategies that foster sustainable enterprises and decent work, ensuring a just and inclusive transition for all. The findings of this report underscore the need for greater alignment on definitions of circular jobs and enhanced data collection across global regions. Our review reveals that while substantial progress has been made in understanding circular employment in the Global North, there is a critical need to expand research and knowledge sharing to encompass diverse global contexts. This expansion is vital for creating comprehensive models and policies that accurately reflect the complexities of the circular economy. At Circle Economy Foundation, we are committed to creating the data insights and practical tools needed to support socially and environmentally fair economic policies with our partners and collaborators around the world.

Ivonne Bojoh, CEO, Circle Economy

INTERNATIONAL LABOUR ORGANIZATION

It is encouraging to see that more and more governments and companies are adopting circular economy policies and strategies. However, the links between circularity and the achievement of social and economic progress remain insufficiently understood, despite the fact that the shift towards a more circular economy offers significant opportunities for the world of work, such as the creation of new jobs and sustainable enterprises. To fully unlock the potential of this new economy, we must place people at the heart of the circular economy and promote a transition that is job-rich, just and inclusive. This in turn requires a much deeper understanding of the various aspects of the large systemic change we are facing, not just in terms of the number of jobs concerned but also of the varying and sometimes worrying quality of the jobs in the circular economy today. This report is a first step towards developing evidence-based research and tools to assist policy makers in shaping circular economy policies that help advance decent work and social justice.

Frank Hagemann, Director, Sectoral Policies Department, ILO

WORLD BANK GROUP

The shift from a linear to a circular economy supports environmental goals, whilst also impacting labour markets globally. As more circular processes are adopted, the quantity, quality, and nature of jobs will also adapt. These emerging jobs must be accompanied by labor market policies which ensure that jobs created are not only good for the environment but, also good for workers. Over 1 billion young people will become working age in developing countries in the next 10 years. At the current rate however, we are on track to create jobs only for less than half of them. With the urgent need to build back better for the environment and labor market post the COVID-19 pandemic, the transition to a circular economy will require skilling opportunities for workers to access better jobs. This is particularly relevant for countries where circular concepts of cost efficiency and extending the life cycle of a product are already enmeshed in their socioeconomic functioning. Here, the focus would lie on improving poor quality, low-paying jobs in the informal sector. The net impact of the shift to a circular economy on the labour market, therefore, varies by country and sector, and must be studied closely. As circular value chains expand, there will be a rise in demand for workers across key sectors. By systematically documenting evidence on the definitions, methods and databases that may be used to understand employment in the circular economy, this report will provide key insights for policymakers and researchers to move toward environmental sustainability and good quality jobs.

Namita Datta, Programme Manager, Solutions for Youth Employment, World Bank Group

ABOUT CIRCLE ECONOMY FOUNDATION

Circle Economy Foundation is a non-profit impact organisation within the Circle Economy Collective. We build the evidence base and capacity of stakeholders to accelerate the uptake of circular solutions across industry and government globally. We deliver multi-stakeholder programmes that encompass research, strategic roadmapping and capacity-building activities for decision-makers. Our goal is to double global circularity by 2032, envisioning an economic system where people and planet thrive.

ABOUT THE INTERNATIONAL LABOUR ORGANIZATION

The International Labour Organization is the United Nations agency for the world of work. It was founded on the conviction that universal and lasting peace can be established only if it is based on social justice. The ILO brings together governments, employers and workers of 187 Member States to set labour standards, develop policies and devise programmes promoting decent and productive work in conditions of freedom, equity, security and human dignity. The unique tripartite structure of the ILO gives an equal voice to workers, employers and governments to ensure that the views of the social partners are closely reflected in labour standards and in shaping policies and programmes.

ABOUT SOLUTIONS FOR YOUTH EMPLOYMENT

Solutions for Youth Employment (S4YE) is a global program housed in the World Bank that brings together donors, governments, foundations, private sector companies, NGOs, and youth to support catalytic actions to increase the number of young people engaged in productive work. To help address systemic and persistent unemployment and lack of quality jobs for youth across the world, S4YE's mission is to identify, curate, learn from and scale up innovations in youth employment programs.

ABOUT THE UN PARTNERSHIP FOR ACTION ON GREEN ECONOMY

The United Nations Partnership for Action on Green Economy (PAGE) puts sustainability at the heart of economic policymaking. PAGE was launched in 2013 as a response to the call at Rio+20 to support countries addressing one of the greatest challenges of our time: building economies that improve human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. The partnership brings together five United Nations agencies; UNEP, UNDP, ILO, UNIDO, and UNITAR, whose expertise and support assist and lead partner countries towards their transition to an Inclusive Green Economy (IGE) by providing policy advice, assessments, capacity building and analytical tools outputs.

LIST OF ABBREVIATIONS

ABS Australian Bureau of Statistics

ADB Asian Development Bank

ADEME French Environment and Energy Management Agency

BERT Bidirectional Encoder Representations from Transformers

BSR Business for Social Responsibility

CEAMSE Coordinación Ecológica Área Metropolitana Sociedad del Estado (Argentina)

CGE Computable General Equilibrium

CJM Circular Jobs Methodology

DSGE Dynamic Stochastic General Equilibrium

EEA European Economic Area

E3ME Energy-Environment-Economy Model of Europe

EMF Ellen MacArthur Foundation

ENVISAGE Environmental Impact and Sustainability Applied General Equilibrium

ETUC European Trade Union Confederation

EU European Union

Eurostat Statistical Office of the European Union

EXIOBASE Extended Input-Output Database

FRAMES Framework for Modelling Economies and Sustainability

FTE Full Time Equivalent

GDP Gross Domestic Product

GINFORS Global Interindustry Forecasting System

GLORIA Global Resource Input-Output Assessment

GTAP Global Trade Analysis Project

GTAP-Power GTAP-Power Database

GWS Institute of Economic Structures Research

ICLS International Conference of Labour Statisticians

ILO International Labour Organization

IMF International Monetary Fund

INDEC National Institute of Statistics and Censuses (Argentina)

INSEE National Institute of Statistics and Economic Studies (France)

IOT Input-Output Tables

IRP International Resource Panel

ISO International Organization for Standardization

KBO Crossroads Bank for Enterprises (Belgium)

LAC Latin American and the Caribbean

LFS Labour Force Survey

MID Material Import Dependency

MRIOT Multi-Regional Input-Output Tables

MFA Material Flow Analysis

NACE Nomenclature of Economic Activities

NGHo National Greenhouse Gas Inventory Office (Argentina)

OECD Organisation for Economic Co-operation and Development

ONS Office for National Statistics (UK)

PAGE Partnership for Action on Green Economy

Prodcom Production Communautaire (Community Production)

S4YE Solutions for Youth Employment

SAM Social Account Matrix

SDES Statistical Data and Studies Department (France)

SERI Sustainable Europe Research Institute

SOeS Monitoring and Statistics Directorate (France)

SUT Supply-Use Tables

TBI Trends Business Information (Belgium)

TNO Netherlands Organisation for Applied Scientific Research

NTNU Norwegian University of Science and Technology

UK United Kingdom

UNECE United Nations Economic Commission for Europe

UNEP United Nations Environment Programme

UNSD United Nations Statistics Division

VAT Value-Added Tax

WBG World Bank Group

WIOD World Input Output Database

WU Vienna University of Economics and Business

1. INTRODUCTION

BACKGROUND

The International Labour Organization (ILO), Circle Economy Foundation and the Solutions for Youth Employment (S4YE) Programme of the World Bank Group (WBG) have come together to create evidence and tools to unlock the potential of the circular economy to advance innovation, generate sustainable enterprises, and ensure decent work for all.

This joint initiative—*Jobs in the Circular Economy*—was born from the need for better data and evidence to understand how the circular economy can lead to a more just and inclusive world of work. This concerns both global progress towards this goal and the challenges and opportunities posed in specific countries, sectors and policy domains. As such, the Initiative aims to put data and practical tools in the hands of policymakers and decision-makers to inform and support pathways towards more socially fair and just environmental and economic policies and interventions. In May 2023, the ILO, Circle Economy and S4YE published the first output under the joint initiative, a comprehensive literature review of the current knowledge base on the circular economy and jobs: *Decent Work in the Circular Economy* (Circle Economy et al. 2023). The report explored research gaps and key themes that represent crucial opportunities for and challenges to creating a more just and inclusive society through the circular economy transition. Topics included the labour market and sectoral transformation, informality and the circular economy, work reallocation and skills development, working conditions and social protection, jobs and sustainable enterprises, and gender discrimination and social equity.

This report presents the findings from the next stage of the Initiative: a review of definitions, databases, methods and models that are used globally today to measure or model employment in the circular economy. The review outlined in this report was led by Circle Economy, with technical inputs from teams at the ILO and WBG in close partnership and with support from the Partnership for Action on Green Economy (PAGE), an interagency programme that brings together the expertise of five UN agencies – UNEP, UNDP, ILO, UNIDO and UNITAR. This review lays the groundwork for a global report with the first authoritative global modelled estimates of employment in the circular economy, which will be produced under the Initiative from 2024 to 2025. This global report will be guided by an advisory board of international experts from research institutions and statistical bureaus. These activities are part of the *Jobs in the Circular Economy* initiative mission to build more global consensus on indicators and models that can be used to create a comprehensive and global picture of work in the circular economy. It aims to shape a better understanding of how the circular economy impacts the world of work, both now and in the future.

CIRCULAR ECONOMY DEFINITIONS AND FRAMEWORKS

A precursor to understanding employment in the circular economy is understanding the circular economy itself. To date, the concept of the circular economy has been defined in various ways, including often cited definition from the Ellen MacArthur Foundation (EMF), which defines the circular economy as a system solution framework based on the three principles below, underpinned by a transition to renewable energy and materials (EMF 2022):

- Eliminate waste and pollution,
- Circulate products and materials, and
- Regenerate nature.

Different frameworks have been developed by various research organisations and academics, which categorise and provide greater detail on the activities and strategies that are deemed part of the circular economy. Although differences exist between these frameworks, they largely cover a similar set of core strategies, as summarised in Table one. In addition to this set of core strategies, some organisations' frameworks also include a set of enabling strategies that can be seen as partially circular. This is further outlined and discussed in Section 2.1 with respective to corresponding circular jobs definitions.

Table 1: Summary of core strategies captured within circular economy frameworks.

ELLEN MACARTHUR FOUNDATION	[CORE STRATEGIES OF] CIRCLE ECONOMY'S KEY ELEMENTS FRAMEWORK	BOCKEN FRAMEWORK	10R FRAMEWORK	5R FRAMEWORK
Regenerate ecosystems, Design out waste	Prioritise regenerative resources	Regenerate flows, Narrow flows	Refuse, Reduce, Rethink	Reduce
Keep products in use for longer	Stretch the lifetime	Slow flows	Reuse, Repair, Refurbish, Remanufacture	Reuse, Repair, Refurbish,
Design out waste	Use waste as a resource	Close flows	Repurpose, Recycle, Recover	Recycle

In May 2024, the International Organization for Standardization (ISO) released a definition and set of standards for the circular economy. The ISO defines the circular economy as an 'economic system that uses a systemic approach to maintain a circular flow of resources, by recovering, retaining or adding to their value, while contributing to sustainable development' (ISO 2024). This definition is accompanied by ISO 59004 (Circular economy—Vocabulary, principles, and guidance for implementation), ISO 59010 (Circular economy—Guidance on the transition of business models and value networks), ISO 59020 (Circular economy—Measuring and assessing circularity performance) and draft standards for performance-based approach, value networks and data sheets (ISO n.d.). This represents a key milestone in the standardisation and clarification of the concept of the circular economy, providing an internationally agreed upon framework that can help align global efforts, facilitate collaboration, and ensure consistency in implementing circular economy principles across many different stakeholders.

METHODOLOGICAL APPROACH

The review comprised of a systematic literature review of two main stages:

1. **A review of definitions used to measure current jobs in the circular economy, and**
2. **A review and comparative analysis of methods, models, and related databases used for understanding employment in the circular economy.**

This review spanned academic and grey literature published in English, French, Spanish, and Mandarin. The search and retrieval of publications for review focused on publications studying employment in the circular economy. As such, studies measuring or modelling employment related to broader greening or sustainability strategies were not included. The full inclusion criteria and details of the methodological approach can be found in Annex one.

This report lays out the findings of the review following the two main stages laid out above, beginning with findings related to approaches to defining employment in the circular economy before moving onto a comparative analysis of methods, models and related databases used for understanding employment in the circular economy.

2. KEY FINDINGS

2.1 DEFINING EMPLOYMENT IN THE CIRCULAR ECONOMY

215 publications were initially retrieved and deemed relevant to include in the review due their focus on employment in the context of the circular economy. This included 177 publications in English, 12 in French, six in Spanish and 20 in Mandarin. When these publications were analysed for their use of definitions, 59 publications attempted to define jobs in the circular economy. The review of these publications revealed that this was largely approached in four main ways:

1. Use of a named definition of circular jobs. In these cases, Circle Economy's Circular Jobs Definition (Circle Economy 2021a) was widely cited.
2. Use of an existing indicator for employment in circular economy sectors, for example, Eurostat's 'persons employed in circular economy sectors'.
3. Development of a definition of circular jobs for the purpose of the study.
4. Use of a circular economy definition, taxonomy or framework to explore their impact on labour markets, such as the EMF definition and activities mapped against the R-framework.

Most studies (n = 156) relied on a circular economy definition, taxonomy, or framework and applied this to sectors of the economy to understand the impact of circular economy activity on the labour market. As such, few studies use an explicit definition of circular jobs within their analysis. It is possible that the difficulty or lack of definitions used for circular jobs stems from the diverse range of definitions that exist for the circular economy itself. Many circular economy frameworks exist without a single internationally agreed-upon definition.

A small number of the extracted studies (n = 4) referred to 'green jobs in a circular economy'. In these cases, circular jobs were not defined nor was the ILO's definition of green jobs used. Studies explored employment impacts within particular sectors, such as apparel manufacturing and the automotive industry, driven by specific circular economy interventions. Table two outlines the approaches used to define circular jobs in the reviewed publications.

Table 2. Summary of the main circular jobs definitions used in the reviewed publications.

APPROACH TO DEFINING CIRCULAR JOBS	USERS	GEOGRAPHICAL SCOPE
Eurostat's indicator of 'persons employed in circular economy sectors' (% of total employment)(Eurostat n.d./c). Circular Jobs are expressed as the number of persons employed full time equivalent (FTE) and as a percentage of total employment in recycling, repair, reuse and rental.	EEA (29 studies) (2022); Trinomics & ETUC (2021); Heyen et al. (2020); European House & Enel (2020); Ferrante & Germani (2020); Arion et al. (2023); Ministry for the Ecological Transition- France (2021).	• National (29 countries): Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Kosovo, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland • Regional: EU
Circle Economy's Circular Jobs Definition (Circle Economy 2021a). A circular job is any occupation that directly involves or indirectly supports an activity of the circular economy as according to Circle Economy's Key Elements Framework (Circle Economy 2021d). This includes: • *Direct circular jobs:* ○ *Core circular jobs* are all jobs that ensure the closure of raw material cycles, including jobs in repair, renewable energy, and waste and resource management. They form the core of the circular economy. ○ *Enabling circular jobs* are jobs that remove barriers to and enable the acceleration and upscaling of core circular activities, including jobs that arise in leasing, education, design and digital technology. They form the supporting shell of the circular economy. • *Indirectly circular jobs* are jobs that indirectly uphold the circular economy. These jobs occur in other sectors that do not play a direct role in furthering the transition to the circular economy but can still adopt circular strategies. They include jobs that provide services to core circular strategies, including jobs in information services, logistics and the public sector.	(Circle Economy n.d.); Circle Economy (2019, 2020a-e, 2022a-b, 2022, 2023); Circle Economy & EHero (2017); ReLondon (2022); Circle Economy et al. (2018); Muñoz et al. (2020)	• City: Brussels, Amsterdam, London, Recife, 150+ cities on the Circular Jobs Monitor • Sub-national: Basel, Bern, Cornwall & the Isles of Scilly, Zurich, Vaud • National: Belgium, Denmark, Ireland, Northern Ireland, Netherlands, Scotland
The French statistical agency, the Monitoring and Statistics Directorate (SOeS), used, until recently, the French Environment and Energy Management Agency (ADEME)'s circular economy definition to build a circular employment indicator for monitoring circular jobs (French Ministry for the Environment 2017).	French Ministry for the Environment (2017); Institut de l'economie circulaire (2015); France strategie (2016).	• National: France

This definition was based on three areas of action (waste management, supply from economic stakeholders, and consumer demand and behaviour) and seven pillars. Core *circular activities* are defined via the seven pillars of the circular economy*:* organic agriculture, rental, reuse/secondhand use/repair, recovery/sale of secondary raw materials, waste collection and processing, recycling and repurposing. Adjacent *circular activities* are those whose primary objective is not the circularity of production processes or the reduction of resources used: waste (incineration with energy recovery), energy management, and transport.		
Higher-value *circular jobs* involve closed-loop recycling, where waste is used to make new products without altering the material's inherent properties. Lower-value *circular jobs* involve open loop recycling or downcycling, using recovered materials to create products of lower value than those from closed loop recycling, servitisation (services instead of products), remanufacturing reuse, and biorefining.	WRAP/Green Alliance: Morgan & Mitchell (2015); Coats & Benton (2015); James & Mitchel (2015).	● National: UK, Poland, Italy, and Germany
Circular jobs in textiles: garment collection and sorting, recycling, repair, and resale.	BSR (2021)	● National: India, China, USA ● Regional: EUR (EU 27 + UK) ● Rest of the world (all other countries)
Circular jobs as employment roles that are part of or support the circular economy. These include activities such as repairing, maintaining, refurbishing, and recycling products, which are essential to minimising waste and maximising resource use.	Willeghem & Bachus (2019)	Sub-national: Flanders

KEY TAKEAWAYS

The differing ways in which circular jobs are defined is indicative of the range of circular economy definitions and frameworks currently in use and as a result studies using these differing frameworks to address employment in the circular economy often have different starting points. More standardised definitions would allow policymakers and researchers to assess labour market shifts resulting from circular economy interventions based on a more common understanding of what the circular economy itself constitutes. National authorities, such as ADEME, have previously noted that several organisations, namely the French Government's Statistical Data and Studies Department (SDES) and Eurostat, have worked on approaches in parallel (Vialeix 2022). At the time of publication, the French Ministry for

Environment is revising its 2017 methodology for quantifying employment in the circular economy and corresponding guidelines.

The publications that defined circular jobs had a strong European (EU) and Anglophone bias, with 58 of the 59 publications that defined circular jobs having an EU (+UK)-focus. Among the publications in scope, nine were exclusively focused on non-European countries. This finding is in line with the outcome of the Circle Economy Foundation, the ILO and S4YE's Decent Work Report (2023), which found that 84% of publications published in English that address employment in the circular economy are focused on understanding this in the context of the Global North. This suggests that there is little evidence about the reality of the circular economy in labour markets in other parts of the world. This confirms the need to increase the involvement of research and knowledge institutions from across global regions in discussions concerning and the future development of circular jobs definitions and methods.

2.2 METHODS USED TO MEASURE OR MODEL EMPLOYMENT IN THE CIRCULAR ECONOMY

From the publications retrieved and reviewed for their definitions and databases during phase one of the review, a subset employed a methodological approach to measure or predict employment in the circular economy. These publications and an additional set of publications also identified were analysed at the next stage of the review in terms of the methods they used to measure or model employment in the circular economy. Publications were grouped into five main categories based on the method they employed:

1. Current state analysis (for example, Eurostat's indicator of persons employed in circular economy sectors and Circle Economy's Circular Jobs Methodology);
2. Static Single or Multi-regional Input-Output (IO);
3. Computable General Equilibrium (CGE), both static and dynamic;
4. Macroeconometric Models; and
5. Alternative or more novel approaches (for example, accounting, regression modelling, material flow analysis (MFA), agent-based, and dynamic stochastic general equilibrium (DSGE) models).

CURRENT STATE ANALYSES

The two most commonly employed methodologies for measuring current circular jobs across sectors were Eurostat's indicator of persons employment in circular economy sectors, and Circle Economy's Circular Jobs Methodology (CJM) (Circle Economy 2021b). There are many similarities between the two methodologies: they both use and map NACE economic activity classifications (Open Risk Manual n.d.) to circular activities, and both methodologies utilise input-output tables (IOT)—albeit in different capacities—to classify circular economic activities where they cannot be mapped directly to a NACE code (NACE Rev 2 ranges from 21 high level section to 615 detailed classes) (Eurostat n.d./b). Broadly speaking, both Eurostat's and Circle Economy's methodologies identify that there are primary circular economy activities (for example, waste collection, recycling activities), and secondly, there are economic activities that support circular economy products and activities. Lastly, these methods consider all other economic activities to be non-circular and are thus not considered. Thus, defining the set of economic activities that are primarily circular—also defined as a 'core' circular sector in the CJM—becomes a key part of subsequently calculating the number of circular jobs. In both approaches, employment in core circular economic activities are directly counted towards the total number of circular jobs. The methodologies diverge in their approach to estimating and calculating circular jobs for those economic activities that are 'partially' circular, either due to the aggregated nature of the economic activity classifications or due to the extent that they service circular economic activities (for example, administration, communication, research, and development). A comparison of sectors classified as 'core' is provided in Annex two.

EUROSTAT

The Eurostat indicator consists of a set of circular economic activities that are linked (in the case of employment indicators) to NACE economic activities. While some can be mapped directly (such as repair), other NACE activities can only be linked partially (for example, a subset of paper manufacturing may be considered due to its use of recycled paper). Where only partial links could be established, a share is derived based on an estimation of how much of that economic activity is deemed circular.

Deriving this share is based on the following procedure, from more robust to less robust:

- NACE codes are considered fully (a 100% share);
- Prodcom codes are considered fully;
- Secondary statistics from Eurostat (such as waste statistics) are considered;
- Supply/IO tables are considered; and
- Secondary data sources, literature, and expert interviews are considered.

The underlying employment data is based on the number of people employed, supplied by structural business statistics (SBS), converted into FTE using coefficients derived from the Labour Force Survey (LFS). The FTE per economic activity is then multiplied by the shares calculated earlier. Data is available from 2005 onwards, with 2021 being the latest year at the time of writing. Results are also produced on an annual basis via the EU Monitoring Framework (Eurostat n.d./a).

The Eurostat indicator has been used in various publications from Trionomics & ETUC (2021), the French Ministry for the Ecological Transition (2021), and in numerous EEA country reports (2022).

CIRCLE ECONOMY'S CIRCULAR JOB'S METHODOLOGY

Similarly to the Eurostat methodology, Circle Economy's CJM (Circle Economy 2021b) classifies economic activities into circular economic activities, based on the percentage of that economic activity that is considered circular. It was originally developed in partnership with the Erasmus Institute at Rotterdam University (EHero) (Circle Economy & EHero 2017) and later updated in partnership with the United Nations Environment Programme (UNEP) (Muñoz et al. 2022). These shares are computed based on the interactions between different economic activities through the use of IOTs.

The CJM first defines each economic activity as either 'core', 'enabling', or 'indirectly' circular. Then, whereas the Eurostat indicator estimates the shares for the non-core activities using a variety of methods (including IO), the CJM utilises the nature of the IOT directly using Input-Output analysis (IOA).

The inter-industry IOT is used to compute the extent to which non-core activities service core activities. Core activities are counted in full, enabling activities are counted to the extent that they output to core activities, and lastly, indirect activities are counted to the extent that they use input (import) from core activities, weighted by a material import dependency (MID) modifier. The resulting coefficients are used to modify the final demand vector, after which IOA is used to compute the sector output needed to fulfil the (modified) final demand for circular activities. The circular sector output divided by the original sector output becomes the final share that determines how much of an economic activity is deemed circular, and can be multiplied by (bottom-up) employment data.

Data requirements for the CJM are flexible: IOTs for the region in scope (with Eora as a backup in case local IOTs are not available), employment data at granular sectoral level (which is mapped to the sectors used in the IOT, while also classified as core, enabling, or indirectly circular), and material data (to compute the MID). As the data is dependent on bottom-up employment data there is no fixed temporal coverage, although all recent years should generally be available. In the case of the IOTs, there is a broad availability of historical data, although the most recent year usually lags behind (at the time of writing the latest version of Eora, for example, is 2022).

The CJM has been used for a wide number of studies in the European context that have been conducted by Circle Economy and other organisations, including EHero, UNEP Relondon (2022) and as part of national *Circularity Gap Reports* produced by Circle Economy (2019; 2020; 2021; 2022), Circle Economy & EHero (2017), and Circle Economy, Metabolic, Blue City, & Spring Associates (2018). The full list of studies can be found in Table three and the reference list at the end of this report. Circle Economy's CJM has also been used to analyse circular jobs in 150 cities from across global regions in partnership with UNEP in 2021, the findings from which are displayed on the Circular Jobs Monitor (Circle Economy n.d.), a digital tool produced by Circle Economy in partnership with UNEP, along with the findings from other baseline studies conducted by Circle Economy.

The strengths and limitations are such current state analyses are discussed together with the methodological and data-limitations also relevant to methodological approaches for modelling employment impacts, outlined in section three.

METHODOLOGICAL APPROACHES AND DATABASES FOR MODELLING EMPLOYMENT IMPACTS

From the publications retrieved and reviewed for their definitions during phase one of the review, 41 publications employed a methodology for measuring or predicting employment in the circular economy (34 in English, two in French, four in Mandarin and one in Spanish). The following methodological approaches were used:

- 12 employed IO analysis;
- Six employed a CGE model;
- Five employed macroeconometric analysis;
- 18 employed other or novel modelling approaches.

Mandarin publications largely focused on breaking down changes in economic indicators, including employment, into their contributing factors. Publications in English primarily focused on predicting and anticipating the potential impacts of environmental policies and targets. French publications largely comprised policy research commissioned by the Government of France. The Spanish publication reviewed was a country-specific IOA. Table three outlines the methods, databases and scope of each of the studies reviewed.

INPUT-OUTPUT ANALYSIS

The majority of forecasting studies reviewed employed IOA, largely a static structural model that provides a high resolution of sectors and structural economic composition. Static IO results often represent gross effects, and the model identifies the monetary linkages between production sectors in an economy and between production sectors and consumers of output. The IOTs provides a snapshot understanding of the nature of production and consumption flows in an economy during a specific period, usually a year. IO can be dynamic, whereby these models allow for incorporating time-dependent changes, such as technological change, capital accumulation or consumer preferences. Dynamic IO models allow us to see transition dynamics in employment and how the sectoral interdependencies evolve over time. By comparing these snapshots over subsequent years using extended methodologies, policymakers can gain better knowledge on how production and consumption sectors have changed, and how different sectors contribute to the economy and employment. Multi-regional IOTs (MRIOTs) also reflect these dynamics between countries.

SCOPE & DATABASE (TIME PERIOD, REGIONAL AND SECTORAL)

Time period: The studies employed different baselines for their starting points and used 2030 as the main forecast year.

Databases: The main data source in the studies analysed was Exiobase v3, which covers 164 sectors, 44 countries and five world regions: Africa, Asia, Latin America and the Caribbean, Europe, and the Middle East.[1] There is an aggregation of 30 countries in Europe, nine in Asia and the Pacific, four from the Americas, one from Africa, and only regional-level data available for the Middle East. Exiobase V3.3 has high sectoral coverage (Zendo 2021). It has the most disaggregated upstream production structure, differentiating between forestry, fisheries, 11 agricultural sectors, four fossil fuel sectors, and 11 mining sectors. Furthermore, the sale, maintenance, and repair of vehicles is separated from all other retail trade—however, this is still insufficient to model impacts on the repair sector (Zendo 2021).

One study used the World Input Output Database (WIOD), which covers 27 EU countries and 13 other major countries, as well as covering 40 sectors (Koesler & Pothen 2013). One study used the Bel-First database, which covers 133 sectors in Belgium. Three studies employing the FRAMES model for low-data countries considered highly aggregated sectors, 12 or 26 (Trinomics et al. 2020a-b; Ex'Tax 2019b) due to its use of the Eora database. Three country-specific static IO models looked at the employment potential of the circular economy in Argentina (Romero et al. 2024; ILO 2021) and Germany (Sartorius 2015). These studies used country-specific databases to construct IOTs. These tables were then extended to the 21 sectors to provide more granular data on waste management (Romero et al. 2024), extended to include social indicators by incorporating a Social Account Matrix (SAM), or expanded to provide more specificity on the impacts of various types of efficiency-increasing technologies on employment (Sartorius 2015).

ASSUMPTIONS, STRENGTHS AND LIMITATIONS

Assumptions

- **Fixed labour market:** IO models usually assume fixed production coefficients and do not account for the flexibility of labour markets. IO studies therefore do not model workers moving across sectors or wages adjusted to equalise labour supply and demand. Instead, IO models provide a static snapshot of economic activities and sectoral linkages, meaning they do not inherently account for dynamic adjustments such as changes in labour supply or wage adjustments over time.
- **Exogenous policy changes:** Changes implemented in IO models are typically exogenous, meaning they are imposed from outside the models and not influenced by the internal

[1] The Exiobase v3.3 database provides detailed data for 44 countries, including both EU and non-EU nations. The EU countries covered are Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. The non-EU countries included in the database are Australia, Brazil, Canada, China, India, Indonesia, Japan, Mexico, Norway, Russia, Saudi Arabia, South Africa, South Korea, Switzerland, Taiwan, Turkey, and the United States. Additionally, the rest of the world is aggregated into five regions: Africa, Asia, Latin America and the Caribbean (LAC), North America, and the Middle East. Retrieved from: EXIOBASE 3

systems dynamic. This makes it challenging to model rebound effects, such as the effects of material taxes and subsidies.

- **Fixed technological coefficients:** IO models generally assume fixed technological coefficients, implying that the IO relationships don't change over time. This ignores potential technological advancements and efficiency improvements that could impact demand for labour, potentially leading to inaccurate predictions.
- **Constant production value:** The value of production, for example using labour, capital, and resources, remains the same across countries studied, ignoring differences in domestic production capacity. This limits the regionality of the predictions and could unfairly attribute dominant [western] production patterns to the rest-of-world.
- **Homogeneous prices:** IO often assumes that products from recycled materials have the same price as those produced from raw materials. This simplification overlooks potential price variations due to differences in production costs, market demand, and other economic factors that could in turn impact the labour market.

Strengths

- IOA can be extended to include more granular environmental data or socioeconomic disaggregation to meet a study's different analytical needs and data resources. They can incorporate SAM or provide the baseline framework for CGE models. The incorporation of the SAM into IOA is particularly useful for employment modelling, as it allows for breakdown of actors in an economy (i.e. households, firms and governments), thereby tracking and matching their demand and supply transactions. The SAM allows for further differentiation such as product group or household groups (income, gender, employment status). IOA is already widely used within circular economy modelling and analysis. Existing methods from circular economy analysis can easily be adopted to enable the analysis of circular employment.
- IOA is less time-intensive and often utilises more readily available datasets than other models, such as CGE models.

Limitations

- IOA is often not dynamic, meaning it is only able to assess the direct one-time impact of a specific scenario, which ignores the transition period. It is therefore not able to account for ripple effects, such as rebound and spillover effects of workforce reallocations, which can lead to the overestimation of job creation through inflated employment figures that don't account for interim, transitional job losses that could occur when reallocating funding across sectors to reflect investment in circular economy activities.
- While dynamic IOA allows for temporal dynamics to be understood, it still relies on linear relationships and does not capture nonlinear behaviours and feedback loops. This can be a significant limitation as it does not account for technological advancements or improvements in efficiency over time.
- IO models cannot take limits into consideration, such as those to household and government budgets. The model treats new spending as if it comes without limits, ignoring the real-life opportunity costs such as the potential need to cut spending in

other areas, increased taxes to fund new initiatives, or the long-term sustainability of government debt.

- IO models lack supply side constraints and assume perfectly elastic factor supply curves (for example, no scarcity of workers). This means that they consider every job as an economic gain without accounting for the limitation in the availability of labour or other resources.
- IO models often use EXIOBASE which has limited regional coverage outside of Europe. This hampers accurate assessment of global employment impacts from circular economy policies, potentially underestimating effects in underrepresented regions
- While other databases—such as GLORIA—have better regional coverage, they come with their own considerations and no single IO database is perfect. An important caveat is to always consider the source data that is available, because while a highly detailed database like GLORIA implies there is full sector coverage for every region, in practice this is not the case and data may be disaggregated.

COMPUTABLE GENERAL EQUILIBRIUM MODELS

CGE models provide insights into long-term structural changes and equilibrium adjustments across an economy following policy shifts or major external shocks, including how external changes affect endogenous variables like consumption, production, and employment. The latest CGE models include dynamic features such as endogenous inclusion of price dynamics, investment, and tax relations, making them suitable for assessing long-term impacts and interactions of policies, such as those related to the circular economy, and their rebound effects on employment and other economic facts. These new dynamic features help gain insights into how labour markets adjust to new circular economy policies over time. For instance, these models can show how efficiency gains from sorting technologies might lead to increased overall consumption, affecting labour demand either by creating new jobs or causing redundancies.

They provide insights into the net effects of comprehensive policy measures that lend themselves to supporting policymakers to understand how shifts in trading patterns or resource allocation could lead to job losses or gains. Many CGE models use IOTs as their analytical framework, thereby benefiting from the flexibility to extend them to include more granular environmental or social dimensions in their models. In the publications reviewed, CGE models were used to simulate the economic impacts of energy, environmental, and circular economy policies. Dynamic CGE models appear to be the most commonly used, mainly employed by the World Bank and OECD. A Static CGE model was employed for the textile value chain analysis by BSR.

SCOPE & DATABASE (TIME PERIOD, REGIONAL AND SECTORAL)

Time period: The studies employed different baselines for their starting points and largely forecasted impacts in 2030 and 2040.

Databases: CGE uses IOA tables and national accounts. The main data sources in the CGE studies analysed were largely GTAP 9, GTAP10, and GTAP-Power 10, favoured due to their suitability for CGE models.[2] Given the larger global coverage, GTAP regions can represent individual countries or composite regions. GTAP 9 covers 140 regions (GTAP 2016a) and 55 sectors (GTAP 2016b), while GTAP10 covers 141 regions (GTAP 2019a) and 65 sectors (GTAP 2019b). An updated version, GTAP-Power 10 covered 141 regions yet expanded to 76 sectors, providing more granular data on the energy sector.

ASSUMPTIONS, STRENGTHS AND LIMITATIONS

Assumptions

- **Equilibrium:** CGE models assume that markets are in equilibrium, meaning that supply equals demand in all markets, allowing them to assess the reallocation of resources across the entire economy.
- **Flexible labour market:** These models assume that a share of the population in each region is engaged in employment and that workers are free to move to the sectors that offer higher wages within their own region.
- **Fixed labour supply:** CGE models assume that workers are neither under nor overpaid and instead assume that differences in sectoral wages reflect differences in productivity across sectors. More broadly, this means that the models assume there is an inherent fixed supply of labour and that people move through the market due to supply and demand.
- **Constant economic growth:** CGE models largely assume constant economic growth due to factors such as technological progress, and population and productivity growth.
- **Neoclassical:** Most CGE models are based on neoclassical economics and as such assume that households and companies optimise their behaviour and that markets operate without friction and that workers are optimal.

Strengths

- They are able to consider both direct and indirect effects of the policies (for example, through changes in trade and production structure, gender and wage disparities) and thus quantify the overall economy-wide consequences of policies on the labour market, although they tend to assume full employment and ignore under and unemployment as well as labour force participation rates. They are particularly useful for assessing the impact of a package of measures and interventions, such as packages of circular economy policies being put forward by the EU.
- The dynamic nature of CGE models allows for the adjustment of different inputs that can replace each other over time. For example, the OECD ENV-Linkages model includes all major economies and regions in the world. It considers inter-sectoral, inter-regional, and international trade interdependencies, providing an integrated and coherent framework. This helps in understanding, for example, the global economic drivers of primary and secondary metal production sectors, as well as recycled goods.

[2] Please note there is one older report that used GTAP8 with 129 regions and 57 sectors being covered. Newer versions have expanded regional coverage and have addressed the over-aggregation in key circular economy sectors. As an example: output from repair services was aggregated with a number of other activities including all retail sales and hotels and restaurants. For more details see reference: Ellen MacArthur Foundation. (2015). *Potential for Denmark as a Circular Economy. A Case study from: Delivering the circular economy – a toolkit for policy makers*. Retrieved from: Ellen MacArthur Foundation website

Limitations

- Due to the assumption of equilibrium, all changes to the equilibrium bear a cost. As such, standard CGE models cannot account for structural changes (such as green and circular economy induced structural changes) which may lead countries to shift to a higher growth path, because it is assumed that if this is more efficient then it would have happened already.
- Standard CGE models assume the crowding out of private investment when government investment in green infrastructure, manufacturing and other circular economy activities.
- Standard CGE models have limitations to price negative externalities, and as such are not well-suited to study the impact of carbon or waste taxation or subsidies (as it is assumed to be a cost to the economy slowing GDP growth).
- CGE models are costly and time-intensive due to the use of the GTAP database and the requirement for many assumptions to be explicitly defined. This is because CGE models involve complex computations and detailed data, which require significant resources to manage and process.
- These models only allow for the movement of workers within their own region and therefore does not allow for the international migration of workers.
- The assumption that there is a fixed supply of labour ignores unemployment and gender-based labour force participation, and underestimates how job distribution may be impacted by the implementation of new policies. It also ignores the complexity of reallocating workers from one industry or occupation to another as demand for labour shifts through the introduction of circular economy strategies, for example from primary to tertiary sectors.
- Their basis in neoclassical economics means that CGE models do not realistically account for individual choices made by workers, companies, and governments. For example, they assume that governments will collect and distribute extra revenues from raw material taxes to households via reduced taxes, rather than modelling the redistribution of raw material taxes to subsidising secondary material use and recycling.

MACROECONOMETRIC MODELS

Macroeconometric models use historical data to understand the economic relationships between interventions and employment metrics through various probability models for macroeconometric analysis. Unlike other models reviewed, macroeconometric models prioritise data trends and projecting over achieving internal consistency or theoretical equilibrium, making them suitable for detailed sectoral and regional heterogeneity. The most well-known macroeconometric model is the E3ME model developed by Cambridge Econometrics. It was originally developed through the European Commission’s research framework and is now widely used for policy assessment, forecasting, and research, highlighting the detailed linkages between the economy, environment, and energy. It is used extensively by the European Commission, such as in the EU 2030 Climate Target Plan's impact assessment. The studies analysed largely used E3ME (Cambridge Econometrics 2019) in an EU context to project the impacts of circular economy interventions on employment, such as job creation in the waste management sector due to recycling programmes. A less common macroeconometric model is the Global

Inter-Industry Forecasting System (GINFORS) model, produced by the Institute of Economic Research. Its focus is on global trade and industry interactions, combining IOA with econometric modelling. GINFORS is particularly useful for understanding the global economic impacts of circular economy policies and their interactions with employment metrics across different countries and sectors.

SCOPE & DATABASE (TIME PERIOD, REGIONAL AND SECTORAL)

Time period: E3ME's historical database covers the period 1970 to 2014 and the model projects forward annually to 2050. GINFORS model's time coverage extends from historical data starting from 1995 up to 2050, relying on annual forward projections.

Data sources: The E3ME studies analysed used the proprietary E3ME database, which integrates extensive historical and forecast data from various sources. Depending on the version used, this E3ME database covers 69 (v6) or 70 sectors (v9) and 61 global regions: 28 EU +31 rest-of-world regions (v6) or 71 global regions: including the EU28, EU candidate countries, and rest-of-world regions (V9). Conversely, the GINFORS model primarily relies on WIOD, UNSD, National Accounts, and IMF financial data, allowing coverage of 35 industrial sectors, 38 countries and one Rest of World region. It takes a global perspective, with less emphasis on regional dynamics but rather greater focus on global economic interactions and trade flows.

ASSUMPTIONS, STRENGTHS AND LIMITATIONS

Assumptions

- **Spare capacity:** E3ME allows for spare capacity in labour and capital, meaning it can accommodate scenarios where there is underused labour (underemployment), unused labour (unemployment) and capital (underutilised production capacity). It also allows for both voluntary and involuntary unemployment and therefore reflects more real-world features of the labour market.
- **Labour intensity:** Macroeconometric models allow for differences in labour intensity between sectors and activities. This is particularly relevant to modelling the employment impacts of circular economy interventions where, for example, recycling activities are more labour-intensive compared to waste landfill management, and higher-value strategies like remanufacturing are more labour intensive than recycling.
- **Household spending:** The shift in the economy from profits to wages is assumed to lead to higher household spending, generating economic multiplier effects, rather than only assuming the transfer of revenue from governments to households via taxes as in CGE models.
- **Technology diffusion:** A core feature of E3ME is its focus on technology diffusion, which is used to address policy challenges related to adopting new technologies and its impact on employment across incomes, regions, time, and industries.
- **Economic drivers, environmental and energy focus:** The E3ME model assumes that economic growth is driven by demand, government policies and technological change. It assumes that there are strong interactions between the economy and the environmental and energy sectors. Conversely, GINFORS assumes economic growth is driven by global

trade and industrial interdependencies are the primary drivers of environmental outcomes.

Strengths

- E3ME, the most common macroeconomic model, integrates the economy, energy systems, and environment with detailed sectoral disaggregation, allowing for a nuanced analysis of global and national economic scenarios, including employment and wage differences between sectors. The model provides a detailed depiction of the labour market, incorporating econometric equations for employment, average working hours, wage rates, and participation rates, which also allows for sectoral disaggregation.
- The model creates predictions based on historical time-series data rather than on the basis of stringent theoretical assumptions.
- E3ME and GINFORS provide an arguably more realistic assessment of policy impact than other models, as they both incorporate potential spare capacity, allowing for the inclusion of unemployment and unused capacity, as well as allow for the consideration of progressive impacts of taxes like VAT, which may affect low-income households differently than high-income households. They include measures to target low-income groups to achieve progressive outcomes.
- E3ME uses cointegration and error correction techniques to allow for short-term dynamic outcomes moving towards long-term trends, making it suitable for analysing impacts of employment at different stages of the transition.
- Macroeconometric models such as E3ME and GINFORS lend themselves to both *ex-ante* (forward-looking) and *ex-post* (evaluating past developments) analyses**.** These models can assess impacts of price changes (tax rates, energy prices, emission trading schemes) and regulatory impacts (for example, vehicle fuel-efficiency standards) on the economy, considering secondary effects and rebound effects.

Limitations

- Macroeconometric models themselves are costly, complex to manipulate, and are owned by private-for-profit organisations: Cambridge Econometrics or The Institute of Economic Structures Research (GWS).
- The models are less focused on optimising behaviour of economic agents, leading to underestimating how individuals and firms will adapt to policy changes over time.
- Their dependence on historical data means that they can only model outcomes on the basis of things that have occurred in the past. This limits their ability to incorporate considerations such as new technologies, sudden external economic shocks or new geopolitical and economic developments, such as the adoption of circular economy strategies at scale that could also shift the baseline projections. This means that proposals that have not yet been translated into policy or policies that have not been active for long enough to be captured in datasets are not included in the analysis.
- Their reliance on historical data also limits their applicability to countries and regions with historically poor or unreliable data. In the context of studying the circular economy, E3ME has only been applied in the EU and US, which raises questions about its

international applicability. The acknowledgement of this limitation led to the development of the FRAMES model, a country-specific IO model that relies on pre-established parameters for behavioural relationships from its related E3ME model (Cambridge Econometrics 2019) It only requires a single year of historical data along with baseline projections for population and GDP.

LESS COMMON OR NOVEL APPROACHES

Several publications reviewed used more novel or less common approaches to model the impacts of circular economy interventions or to attain more granular data on circular economy activity within companies or sectors. These approaches were often applied in smaller-scale studies, for example for understanding employment impacts in a single sub-national region or country. Whilst many of these approaches will be more challenging to scale and replicate due to the bespoke nature of the methods or data used, they demonstrate the range of approaches that have been employed to date in studying employment in the circular economy and potential supplementary approaches that researchers may use alongside the common approaches discussed within this report.

Accounting models use expert judgement and stakeholder participation to identify key drivers of change, such as reuse and recycling rates, and estimate their future values in various scenarios. These models have been used in various publications from WRAP and Green Alliance. They rely on qualitative inputs and data inputs for their existing baseline to analyse changes in final demand and production in directly affected sectors, which then indirect economic impacts on the broader economy are calculated using IOTs. Their main limitations are that they may not be generalisable, lack a price mechanism, and have transitional period considerations. Despite these limitations, they are cost-effective, easy to construct and interpret, and best utilised in sub-national contexts with specific datasets like EU-wide or National Labour Force Surveys.

Regression models, including linear, multiple, logistic, and time series models, are used for estimating relationships and forecasting future outcomes. They are flexible, handling various data types and structures, and can predict how circular economy policies impact employment rates across sectors. However, their effectiveness relies on the quality and completeness of data. Extrapolating beyond the data can lead to unreliable predictions, and the use of historical data may reinforce biases and fail to accurately predict future changes in rapidly evolving environments.

Material Flow Analysis (MFA) offers a detailed understanding of material flows within an economy (ADEME 2020) or value chain (Circle Economy 2021c), identifying the potential impacts of circular economy interventions through sectoral analysis. It helps pinpoint sectors likely to be affected by specific circular economy policies. However, MFA requires extensive and costly databases, and integrating employment perspectives needs sophisticated tools and expertise. Limited data granularity can lead to oversimplified conclusions, and the analysis is static, not capturing dynamic changes over time. Integrating MFA with economic models is also challenging due to methodological differences.

Several organisations have been experimenting with **self-learning algorithms** to perform **web-crawls** to gather circular job advertisements and better understand circular activities within companies or sectors. For instance, the Dutch Statistics Office used web-crawls to assess circular activities beyond industry classifications (Rood & Kishna 2019), while in Belgium, novel methods like semantic analysis and data scraping with the BERT model and databases from sources like Graydon, Facebook, and Google My Business have been used (HIVA et al. 2022; Borms et al. 2024). Circle Economy, in collaboration with Inoopa, has utilised AI-based natural language analysis to enhance a CJM baseline study, providing detailed insights into Belgium's manufacturing sector (Circle Economy 2019). Overall, these methods suggest that traditional methods significantly underestimated circular employment.

Finally, while the literature on more robust models and their circular economy application is still developing, **agent based modelling and DSGE models** are said to provide valuable insights into how circular economy and green policies more broadly can affect and interact with labour markets and economic growth. Agent-based models are bottom-up simulations of interactions between various actors, such as businesses, consumers, and policymakers, to evaluate the impacts of circular economy strategies on employment and resource utilisation (Gleiser & Bydlon 2023). Conversely, with a broader scope, DSGE models are top-down, equilibrium-based macroeconomic models, with a heightened focus on policy analysis. The main challenge lies in the complexity of the model's structure, which requires highly granular data and calibration techniques.

Table 3. Summary of the methods, models and scopes used in the publications reviewed.

STUDIES EMPLOYING CURRENT STATE ANALYSES					
AUTHOR	**METHODOLOGY/ INDICATOR**	**DATABASE(S)**	**PERIOD**	**REGION**	**SECTORS**
Circle Economy & EHero (2017) & Circle Economy, Metabolic, Blue City, & Spring Associates (2018)	CJM	LISA 1996-2014; IOS LISA 2015	2000–2015; 2015	Scope: Netherlands, Rotterdam	2,000 NACE (level 5) sectors
Circle Economy's *Circular Jobs Baseline reports* (2018, 2019, 2020a, 2020d, 2020e, 2022a)	CJM	Various country-specific labour force surveys and business surveys	Various years	Scope: Amsterdam; Belgium; Cornwall & Scilly; New York City; Scotland; Swiss Cantons (Switzerland)	2,000 NACE (level 5) sectors; NAICS level 6
Circle Economy's *Circularity Gap Report Jobs Chapters* (2020b, 2020c, 2022b, 2023, 2024)	CJM	Various country-specific labour force surveys and business surveys	Various years	Scope: Netherlands; Norway; Northern Ireland; Denmark; Ireland	2,000 NACE (level 5)
Ministry for the Ecological Transition (France) (2021)	Eurostat Indicator	EU Labour Force Survey and the Structural Business Survey	2017	Scope: France	Two sectors: 'extending the product lifespan' and 'recycling'
EEA (2022, 29 country reports)	Eurostat Indicator	EU Labour Force Survey and the Structural Business Survey	2018	Scope: 29 European country-specific reports[3]	Four sectors: the recycling sector, repair and reuse sector and rental and leasing sector

[3] The countries with circular economy country profiles include Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Kosovo, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and Switzerland.

Muñoz et al. (2022)	CJM	Exiobase, Eora & Brazil & Belgium Labour Force Surveys	2015	Scope: Brussels & Recife cities	20 Eora sectors
Relondon (2022)	CJM	ONS BRES 2019	2019	Scope: London city	21 broad sectors
Trinomics & ETUC (2021)	Eurostat Indicator	EU Labour Force Survey and the Structural Business Survey	2017	Scope: Belgium, Czechia, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Poland, Slovenia, and Spain	Four sectors: the recycling sector, the repair and reuse sector, and the rental and leasing sector
France Strategie (2016)	ADEME's circular economy employment baseline methodology	Eurostat, CLAP (INSEE), and SOeS	2008 & 2014	Scope: France	Four sectors: repair, waste, renewable energy, and water management
Institut de l'economie circulaire (2015)	ADEME's circular economy employment baseline methodology	ONEMEV 2014, ADEME 2012	2012	Scope: France	Nine sectors: sustainable development, eco-design, industrial ecology, economy of functionality, reuse, repair, waste management, recycling and recovery, and remanufacturing
INSEE (2023)	Regional descriptive analysis with national ratio adjustments	INSEE	2018	Scope: Ile de France (France)	Seven sectors: sustainable procurement, eco-design, service economy, responsible consumption, extending product life, waste management, and recycling

STUDIES EMPLOYING IO ANALYSES					
AUTHOR	**MODEL**	**DATABASE(S)**	**PERIOD**	**REGION**	**SECTORS**
ILO (2021)	Static IO model	WIO Argentina 2015, NGHo 2012, MCS-ARG-2015, Cuenta de Generacion de Ingresos 2015	2015 baseline, 2019–2030	Scope: Argentina	12 sectors: Four circular economy sectors & eight impacted sectors
Romero et al. (2024)	Waste extended input-output model (WEIO)	Country-specific data sources: Income Generation Account 2015 CEAMSE 2015, INDEC 2015	2015 baseline, 2030	Scope: Argentina	21 sectors
Sartorius (2015)	Integrated Mesoeconomic Simulation System for Sustainability Assessment (ISIS)	DeStatis IO matrix 2007	2007 baseline, 2020	Scope: Germany	71 productive sectors and six final demand sectors
ILO (2018)	MRIO	Exiobase v3 (OECD STAN database & ILOSTAT), World Development Indicators, National Labour Force Surveys	2014 baseline & 2030	Scope: Global Coverage: 44 countries aggregated into EU+ five rest-of--world regions.	163 sectors
Donati et al. (2020)	EEIOA (Environmentally Extended Input-Output Analysis)	Exiobase V3.3	2011 baseline & 2030	Scope: Global Coverage: EU28 and rest-of-world(using 44 countries aggregated into EU+ five rest-of-world regions)	163 sectors
Wiebe et al. (2019)	EEIOA (Environmentally Extended Input-Output Analysis)	Exiobase v.3.3	2014–2030	Scope: Global Coverage: 43 countries and five rest-of-world regions	163 sectors
Willeghem & Bachus (2019)	RIOT	Bel-First database 2010-2016, NACE, , RSZPPO, Steunpunt WSE,	2010–2030	Scope: Flanders (Belgium)	133 sectors aligned to NACE

		DynaM-dataset, Rijksdienst voor Sociale Zekerheid			
Wijkman & Skånberg (2015)	IO Model- IPAT equation	WIOD 2013	2009–2030	Scope: Five EU countries: Finland, France, the Netherlands, Spain and Sweden. Coverage: WIOD 2013 countries including 27 EU and 13 other major countries	40 sectors
Ex'Tax (2019b)	FRAMES: Dynamic IO model+E3ME linkages	E3ME database, Government of Bangladesh statistics, OECD, IEA, IMF, and World Bank databases	2017, 2020–2025	Scope: Bangladesh	12 sectors
Trinomics et al. (2020)	FRAMES: Static IO Model + E3ME linkages	E3ME database, ILOSTAT, Eora (2015), World Bank, IEA, and IMF databases	2015, 2020–2030	Scope: Senegal Coverage: Senegal & Rest-of-Africa	26 sectors
Trinomics et al. (2020a)	FRAMES: Static IO Model + E3ME linkages	E3ME database, ILOSTAT, Eora (2015), World Bank, IEA, and IMF databases	2015, 2020–2030	Scope: Egypt Coverage: Egypt & Rest-of-Africa region	26 sectors
Yanjuan & Weipeng (2023)	Static IO model	Statistical yearbooks by province, China Labor Statistics Yearbook, China's interregional IO table for 2012–2017	2012–2017	Scope: China (31 provinces)	Two sectors highly aggregated: the manufacturing and services industries

STUDIES EMPLOYING CGE MODELS					
AUTHOR	**MODEL**	**DATABASE(S)**	**PERIOD**	**REGION**	**SECTORS**
EMF (2015)	New ERA Global Model	Statistics Denmark IO table 2011 & GTAP8	2011 baseline, 2015–2035	Scope: Denmark Coverage: five regions: Denmark, EU, China, OPEC, and rest-of-world (GTAP8: 129 regions)	DK: 21 sectors (16 non-energy and 5 energy sectors), Other regions: 17 sectors (12 non-energy and 5 energy) GTAP 8: 57 sectors
Chateau & Mavroeidi (2020)	Dynamic OECD Env-Linkages Model	GTAP 9, Eurostat, OECD's 'Environmentally related tax revenue' database, UNEP-IRP global material flows database	2017–2040	Scope: Global Coverage: 141 GTAP9 regions, grouped into ENV-Linkages countries and regions[4]	55 of 57 GTAP sectors
KPMG (2020)	Dynamic KPMG+CGE Model	IO tables from ABS 2015-2016	2018, 2019–2048	Scope: Australia	117 sectors
Bibas et al. (2021)	Dynamic OECD Env-Linkages Model	GTAP 9, Eurostat, OECD's 'Environmentally related tax revenue' database, UNEP-IRP global material flows database	2017–2040	Scope: Global Coverage: 141 GTAP9 regions, grouped into ENV-Linkages countries and regions[5]	55 of 57 GTAP sectors

[4] Specifically included: OECD countries, emerging economies of Brazil, Russia, India, Indonesia, China and South Africa (the BRIICS) and the rest of the world.

[5] Specifically included: OECD countries, emerging economies of Brazil, Russia, India, Indonesia, China and South Africa (the BRIICS) and the rest of the world.

BSR (2021)	Static KWIL CGE Model	GTAP 10, WITS	2019 & 2030	Scope: Global Coverage: five regions: US, Europe (EU 27 + UK), India, China, rest-of-world (all other countries) of the 141 regions (including rest-of-world)	27 of 65 GTAP10 sectors
World Bank (2022)	Dynamic ENVISAGE Model	GTAP-Power 10-CE database	2014–2030	Scope: EU Coverage: 20 countries and regions aggregated from the 141 GTAP countries and regions	Ten circular economy sectors aggregated from the 76 GTAP—Power 10 sectors
STUDIES EMPLOYING ECONOMIC MACROECONOMETRIC MODELS					
	MODEL	**DATABASE(S)**	**PERIOD**	**REGIONS**	**SECTORS**
Distelkamp & Meyer (2016)	Dynamic GINFORS Model	WIOD, UNSD, National Accounts, IMF financial data, and LPJmL database (including data on water and land availability and their impact on crop demand, supply and prices)	2015–2050	Scope: Global Coverage: EU27 Member States & Non-EU G7 members[6]	12 sectors
Cambridge Econometrics et al. (2018)	Dynamic E3ME Model	E3ME Database, Eurostat and IEA, OECD's STAN, Structural Business Statistics databases	2015–2030	Scope: Europe Coverage: 59 of 61 regions (including EU28 countries)	69 sectors in Europe and 43 sectors for rest-of-world
Trinomics et al. (2020c)	Dynamic E3ME Model	E3ME Database, World Bank, UN National Accounts, IMF, and ILOSTAT	2016–2050	Scope: Nigeria Coverage: 61 regions (G20, EU28 & candidate countries, rest-of-world, including Nigeria)	43 sectors

[6] Non-EU countries include Canada, Japan, the US, India, and China. Remaining world regions include countries like Russia, Turkey, Brazil, Mexico, South Korea, Australia, and others.

Ex'Tax (2019a)	Dynamic E3ME Model	E3ME Database, Eurostat and IEA, OECD's STAN, Structural Business Statistics databases	2016, 2019–2050	Scope: Finland Coverage: One (Finland) of 59 countries	Ten sector aggregations from the 69 sectors
Ex'Tax (2022)	Dynamic E3ME Model	E3ME Database, Eurostat and IEA, OECD's STAN, Structural Business Statistics databases	2021–2025	Scope: EU27 Coverage: EU27 of 61 regions	70 sectors
Studies using less common or novel approaches					
ADEME (2020)	MFA	FLORES (Insee), ADEME, and regional socioeconomic databases	2015 baseline, 2030 & 2050	Scope: Hauts-de-France (France)	Four region-specific sectors: plastics, construction, textiles, and food
Arion et al. (2023)	Regression analysis using Eurostat Indicator	EU Labour Force Survey and the Structural Business Survey	2012–2020	Scope: EU27	Three sectors: recycling, repair and reuse, and rental and leasing sectors
Circle Economy (2019)	AI-based natural language model by Indoopa	WIOD 2014 & Graydon 2017	2017	Scope: Belgium	Three circular economy manufacturing activities: use of regenerative resources, lifetime extension, and recycling
Circle Economy (2021c)	MFA	LISA 2019 database	2019 baseline & 2050	Scope: the Netherlands	Textile value chain activities across eight sectors
Ferrante & Germani (2020)	Regression analysis using Eurostat Indicator	EU Labour Force Survey and the Structural Business Survey	2008–2017	Scope: 23 European countries[7]	Three sectors: recycling, repair and reuse, and rental and leasing sectors
Morgan & Mitchell (2015); Coats & Benton (2015); Alvis Avison (2021); Mitchel & James 2021)	Accounting models	2014 ONS data & ONS BRES 2013	2014/2019 baseline & 2030/2035 scenario	Scope: Germany, Italy, Poland, and the UK	All 21 NACE sectors

[7] European countries include Austria, Belgium, Bulgaria, Cyprus, Croatia, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the UK.

Haijian & Huaguang (2023)	Regression analysis: difference-in-differences model	Company data, China Industrial enterprise database data, city panel data	2009–2021	Scope: China	Three high-level industries: primary, secondary, and tertiary
HIVA et al. (2022); Borms et al. (2024)	Semantic analysis using Bidirectional Encoder Representation from Transformer (BERT) model	Graydon, Facebook, Google My Business, TBI, and KBO	2020; 2015–2021	Scope: Flanders (Belgium) Coverage: Belgium	Six circular economy sectors: repair, rental and leasing, waste management and material recovery, maintenance of motor vehicles, secondhand sales, building restoration); 21 NACE sectors
INSEE (2023)	Regional descriptive analysis with national ratio adjustments	INSEE	2018	Scope: Ile de France (France)	Seven sectors: sustainable procurement, eco-design, service economy, responsible consumption, extending product life, waste management, and recycling.
Moreno-Mondejar et al. (2021)	Regression model	Flash Eurobarometer 456 (European Commission 2018)	2017	Scope: EU28 & US Coverage: EU28, neighbour countries, and US (15,019 firms)	All 12 NACE sections
Rood & Kishna (2019)	Circular economy-adapted self-learning algorithm & web crawl	2018 LISA dataset and survey data	2018	Scope: the Netherlands	Five broad sectors: biomass and food, construction, consumer goods, plastics, and manufacturing
European House & Enel (2020)	Regression analysis using Eurostat Indicator	EU Labour Force Survey and the Structural Business Survey	2014–2018	Scope: Italy, Romania & Spain Coverage: EU27+UK	Three sectors: recycling, repair and reuse, and rental and leasing
Xingji & Tangjun (2024); Meng et al. (2023)	Global Multi-Regional Input-Output Model (GMRIO), and Structural Decomposition Analysis (SDA)	WIOD, ADB MRIO, China Labor Statistics Yearbook	1995–2021; 2000–2014	Scope: China	97 sectors; 21 sectors

FREQUENTLY EMPLOYED DATABASES

The majority of macroeconomic data is sourced from National Accounts. This data is often provided nationally as Supply-Use Tables (SUTs) and/or symmetric IOTs. MRIOs attempt to harmonise the different regional data sources, with different databases utilising different methodologies to address the unification and balancing of the data discrepancies that are bound to occur (for example, trade and sectoral coverage). More specifically: Exiobase was built for environmental purposes, which requires transactional information that often exceeds the level of detail provided by national statistical offices, thus requiring modelling to fill these data gaps. The WIOD database keeps transactions as close as possible to the data reported in the national statistics, at the cost of having high level aggregated sectors so that they can satisfy this constraint. Lastly, the Eora and GLORIA databases also choose to stay close to the national data. GTAP is one of the oldest globally available databases, with data based on the national IOTs for each of the regions it supports. Table four provides an overview of frequently used databases in the modelling studies reviewed. Many of the databases listed in Table four will have basic employment data built-in for ease of use. This data is generally based on global employment data sources such as those gathered by the ILO, by mapping the employment data per economic activity to the sectoral classification employed in the given database.

Table 4. Summary of the main databases used in the modelling studies reviewed.

DATABASE	OVERVIEW	PRODUCER
Exiobase	Freely available, large focus on environmental extensions, high sectoral detail, low global regional coverage with strong EU focus.	EXIOBASE consortium (NTNU, TNO, SERI, Universiteit Leiden, WU, and 2.-0 LCA Consultants)
WIOD	Freely available, data is close to reported statistics, average sectoral detail, low global regional coverage with strong EU focus.	WIOD Project (funded by European Commision)
GLORIA	Freely available, high sectoral detail, high global regional coverage, one of the newest MRIOs.	University of Sydney
Eora	Paid database, low sectoral detail, high global regional coverage.	University of Sydney
GTAP	Paid database, average sectoral detail, high global regional coverage.	Center for Global Trade Analysis at Purdue University

3 • CONSIDERATIONS AND WAYS FORWARD FOR ADVANCING THE EVIDENCE BASE

3.1 CONSIDERATIONS COMMON ACROSS METHODS

Across the publications reviewed there are a common set of considerations and limitations that relate to the use and availability of data and methods. Some of these limitations are in line with challenges in the broader study of both employment and circularity globally and are complex to overcome. Where possible, ways to overcome these challenges are suggested in the sections below. These support the recommendations for advancing this field of study laid out in the conclusions of this report in Section 3.2.

DATA-RELATED CONSIDERATIONS

- **Informality** is prevalent in the circular economy but only captured in four of the publications reviewed, with all using the informal employment ILO database as the main reference. With the exception of one publication, there were limited bottom-up corrections for country-specificities (ILO 2021). This omission is significant because it means that the baseline understanding of employment largely does not reflect the true composition of the labour market. Assessing the potential unintended impacts of circular economy interventions requires mapping current informal employment in circular economy interventions. This is needed to fully grasp the complex relationships between suppliers and sectoral dynamics that can help build a more complete picture of the labour market impacts of circular economy policies, both intended and unintended. Identifying regions where informal circular employment is most prevalent can help determine its depth and breadth. The recent adoption of standards on measuring informal employment at the 21st International Conference of Labour Statisticians (ICLS) will aid in this effort. Such guidelines and improved data collection methodologies will help to enhance the understanding of informal work in the circular economy and support the development of targeted policies to address both decent work deficits and the overall impact of circular economy interventions on the labour market (ILO 2023).
- **Disaggregating employment by age, gender, and income** in both the monitoring and modelling of employment in the circular economy helps to provide an indication of the distribution of jobs across socioeconomic groups. As such, disaggregated data and insights can be a valuable tool for informing targeted circular economy policies and

interventions that seek to increase employment opportunities for a particular population at risk of social exclusion, such as women, low-income groups and young people. Despite it being possible to disaggregate by age, gender, and income in most databases used in the studies reviewed, or to extend the analysis through adding additional datasets, this was not commonly carried out in the studies reviewed. Where possible, updating existing studies to include a breakdown of results by age, gender, and income would provide a better understanding of the distribution effects of circular economy policies, alongside additional research, including qualitative research, to better understand how the circular economy impacts the jobs of people of different groupings.

- **Current sectoral classifications** are limiting. This is because circular economy strategies, such as repair services, do not have their own distinct category and instead are often aggregated into 'retail, or automotive & retail'. Another limitation is that databases are not applicable for identifying companies that are engaged with circular economy activities as a secondary activity: for example, an IT sales company that also offers repair services and leasing schemes (CEPS 2023). Where it is not yet possible to update labour force surveys due to the fact that maturing circular economy classifications are not yet reflected in these sectoral classifications, there are alternative approaches that can be used to mitigate these challenges. This includes bottom-up corrections and research, such as through surveys and expert interviews or web crawling approaches, which could be used to create a more accurate understanding of current employment in circular activities in lieu of official statistics.
- Current databases **lack granular and updated data for low-to-middle income countries.** This regional data gap could explain the absence of single-region assessment for countries with large extractive sectors (Laubinger et al. 2020). Circular economy scenarios are also often treated as external shocks that are implemented uniformly across various countries or regions. When considering the global employment impacts of circular economy interventions, it is important to note that circular economy policies are currently predominantly EU-led and will have divergent impacts on non-EU countries. General data scarcity will not be easily overcome, however, qualitative or alternative approaches to evaluating baselines of circular employment could be developed and tested in data-scarce countries. Modelling the impacts of circular transitions at the national or local level for data-scarce regions could also be explored through simpler techniques such as cost-benefit analysis.

METHOD-RELATED CONSIDERATIONS

- The findings of the review suggest that **the methodology used influences the magnitude of the employment impact**, with CGE and IO models generally showing lower employment effects compared to E3ME modelling. This could be because E3ME doesn't require a balance to be achieved and instead allows for market disequilibrium, including unemployment and sectoral reallocation, which means it can capture short-term dynamics and sectoral shifts more realistically and potentially result in higher estimated employment effects. Indicating the results of models relative to a benchmark—for example, total number of jobs—and transparently including the potential over/under estimations of employment impacts due to the methods used or data gaps in the study's methodological approach would support comparison across studies that employ different models.

- **A limited range of circular economy policies are modelled**, with many studies largely focused on modelling technological changes and resource taxes. Modelling the impact of plastic bans, Extended Producer Responsibility schemes and other circular economy instruments could increase understanding of aggregate jobs shifts or net job gains in both consuming and producing countries. As well as the relative labour impact of push and pull policies, for example, subsidies and rebates, versus penalties and taxes. Circular economy scenarios are also largely modelled individually rather than in combination. This may result in the overall impact that a combined approach could have on achieving more significant net employment gains or undermining the potential readjustments between sectors being overlooked.
- Assumptions about public investments needed and potential rebound effects vary. Among the publications reviewed, **the public investments needed to realise circular interventions is not explicitly stated**. This is particularly important as different sectors and countries may require varying levels of investment to meet similar circular economy overall outcomes. In terms of the potential rebound effects from resource efficiency gains, the studies reviewed did not explicitly address the potential indirect economic activities and additional labour demand or the potential negative environmental impacts that affect employment.
- There is an **absence of *ex-post* studies**, which suggests that the impacts of current circular economy policies are largely unknown. The development of the EU monitoring framework is a crucial step towards tracking progress, identifying issues and providing baseline data for future assessments. However, it is essential to complement these efforts with other sectoral or country-specific studies in order to integrate a more accurate understanding of the current employment impacts of circular economy policies. Understanding the status quo is a high priority that could create valuable understanding both for baselines and future forecasting studies.
- Many of the studies reviewed had an **EU focus,** highlighting a clear need to create evidence that elucidates global employment impacts. This will require more comprehensive, coordinated international efforts and impact assessments. This is particularly important considering that current circular economy policies are predominantly EU-led. EU-led policies are likely to lead to varying impacts on non-EU countries based on the degree and type of engagement between trading partners and EU countries, such as job losses in countries heavily reliant on raw material exports or manufacturing sectors. Understanding these impacts as well as how other regions and countries can advance socioeconomic objectives through the enactment of circular economy policies, is needed to advance global progress towards an inclusive, circular economy.

3.2 CONCLUSIONS

The *Jobs in the Circular Economy* initiative aims to put data and practical tools in the hands of policymakers and decision-makers to inform and support pathways towards more socially fair and just environmental and economic policies and interventions. To achieve this—and with it, a better understanding of employment in the circular economy—there are steps that can be taken in the short- and long-term.

To strengthen research and policy efforts in this space, the long-term objective is to have widely available statistics that better reflect employment involved in circular economy activities and more comprehensive data coverage (both regionally and sectorally, and disaggregated by age, gender and income) that can support baseline studies. In turn, this will inform and enable the creation of dynamic models that more accurately project how circular economy policies will impact the rates and distribution of employment at different transition points and across the labour markets of different countries. In the short-term, greater alignment on how circular activities, jobs and sectors jobs are defined is needed. This relates to both policy-related and statistical definitions. For the latter, corresponding coefficients should be developed that denote the circularity of an economic activity. Collaboration with national research organisations and statistical bureaus is essential in both the short- and long-term, in order to build a more accurate picture of current circular employment through baseline studies and bottom up studies, and to inform data collection and modelling to fill current gaps and ensure projections better reflect regional contexts and differences.

To work towards these short and long-term objectives, organisations working on the improvement of data and tools for understanding employment in the circular economy should consider the following recommendations.

In the short-term:

- **Align on definitions of circular jobs:** Greater alignment on which jobs can be defined as contributing to the circular economy is an important stepping stone for improving data and methods. Across the studies reviewed, there was general agreement on the process for developing such definitions. The priority should be to align on activities that partially contribute to circular economy employment. Definitions should reflect the demands circular economy will create for labour enabling sectors, such as services, as well as 'core' sectors that can also be an important indicator of regional competitiveness. Given their maturity, it is recommended that Eurostat's indicator of 'persons employed in circular economy sectors' and Circle Economy and UNEP's CJM are used as a basis for this exploration, with strong collaboration with other partners in different global regions to ensure definitions are internationally applicable. Such efforts should be done in coordination with bodies currently leading processes to create alignment on circular economy definitions and indicators such as the United Nations Economic Commission for Europe (UNECE) and ISO.
- **Develop corresponding coefficients:** Considering the data and methodological limitations above, developing coefficients that indicate the amount of circular activities per sector, as well as related labour coefficients of circular versus non-circular/traditional activities, is needed in the short-term. When made available, these coefficient tables can act as a practical tool for unifying research in the area of circular economy employment, regardless of database or model employed. Development of these coefficients may first

be approached at a general 'global' level, however ,it is recommended that coefficients are further contextualised in the future to better reflect regional differences in the prevalence of circular activities within sectors.

In the medium to long-term:

- **Update labour force surveys and create satellite accounts:** Where possible, maturing circular economy classifications and the aforementioned definitions and coefficients should be used in the update of labour force surveys. These will in turn help to gather official statistics about employment in circular economy activities at the organisation and country level, and can be used to strengthen the aforementioned coefficients and apportion traditional sectors into circular and non-circular. Alternatively, satellite accounts for the circular economy could be created to better capture activities within current sectoral codes that could be considered circular. Such satellite accounts have been created for renewable energy to capture renewable energy and use and could serve as valuable inspiration for better capturing circular activities and could become absorbed into national accounts over time.
- **Ensure national-level studies and collaboration:** National studies conducted in collaboration with national research institutions and statistical bureaus will be critical for establishing better baselines, understanding and filling data gaps through bottom-up corrections or other methods (such web crawling or SAM), and updating surveys or developing locally appropriate models, such as the FRAMES model used to understand employment impacts in Senegal or Egypt. This may be approached through a preliminary set of priority baseline studies, for example based on their perceived exposure to impacts from current EU circular economy policies already in place.
- **Develop models to more accurately project impacts across transition periods:** Dynamic models, be they CGE or macroeconometric, will be necessary for understanding the transition period, including varied short-, medium- and long-term impacts of circular economy policies on different labour markets segments and sectors. These will also be needed to inform the required accompanying labour, education and social protection policies. This could include, for example, the timing and focus of unemployment support during periods where job losses are projected in certain sectors, or targeted training where spikes in labour demand in certain occupations are foreseen. Given the need outlined in this report to conduct *ex-post* as well as projection studies, macroeconometric models, such as E3ME, which can draw on historic data, lend themselves well to this exercise and may provide more opportunity for models to be developed that are applicable for understanding both international and national impacts. With its ability to be extended with some of the less common approaches discussed in this report and data such as SAM, IOA also offers a valuable, lower-cost approach.

As a next step under the *Jobs in the Circular Economy* initiative, the project partners will use the considerations put forward as part of the development of a global study of employment in the circular economy. This global study will be guided by an advisory board of experts from research institutions and statistical bureaus across global regions. We invite and encourage collaboration from stakeholders around the world on this initiative. You can find out more about this initiative and ways to collaborate here.

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APPENDICES

ANNEX ONE

METHODOLOGICAL APPROACH, INCLUDING EXCLUSION CRITERIA

DATA RETRIEVAL

- Systematically retrieved academic literature from academic database searches and employ snowballing sampling, and expert and systemic web searches for insights for grey literature, including policy and governmental reports. In particular, suggestions are welcomed on approaches for retrieving relevant policy and governmental reports.
- Databases: Lens.org, GoogleScholar, Scopus, Web of Science, and CORE, PolicyCommons.

SCOPE

- Time frame: Review academic studies and grey literature from 1995 to 2024. 1995 was selected as the starting year because the first academic article on decent work in the circular economy was written in 1995 by Renstrom and Roszbach, focused on a new economic arrangement based on employee share ownership.
- Geographical and language coverage:
    - We aimed to broaden the geographical representation, with an emphasis on increasing focus on the Global South and expanding language coverage beyond English.
    - Languages: English, French, Spanish, and Mandarin.
- Academic and grey literature, including policy reports relating to meso and macro level (as opposed to firm-level or micro-level surveying studies).
- Studies related to employment within the circular economy were prioritised and all key terms translated into French, Spanish and Mandarin by native speakers.
- Key terms: Utilise specific search criteria focusing on circular economy and employment key terms:
    - Circular Economy Equivalent key terms: circular economy, circular society, resource/material efficiency, material circular*, closed loop economy/system, zero waste, circular supply chain, product lifetime extension.
    - Employment equivalent key terms: employment, job*, position*, occupation*, posting*, gig.

ANNEX TWO

While table A2.1 showcases a high level comparison of the many similarities, and differences, between Eurostat's circular jobs indicator and Circle Economy and UNEP's CJM. This comparison compares where either methodology "fully considers" an entire economic activity to be circular. Where differences are encountered, either methodology often considers this economic activity through alternative means (e.g. "enabling", or estimates based on other classifications/expert judgement).

Table A2.1: Core sector comparison of the current state analysis methodologies.

ECONOMIC ACTIVITY	EUROSTAT[8]	CJM[9]
Repair of fabricated metal products	core	core
Repair services of machinery	core	core
Repair services of electronic and optical equipment	core	core
Repair services of electrical equipment	core	core
Repair and maintenance services of ships and boats	core	core
Repair and maintenance services of aircraft and spacecraft	core	core
Repair and maintenance services of other transport equipment	core	core
Repair services of other equipment	core	core
Electric power generation, transmission and distribution	not considered	core
Water collection, treatment and supply	not considered directly	core
Sewerage	core	core
Waste collection	core	core
Waste treatment and disposal	other estimation based on secondary sources required	core
Materials recovery	core	core

[8] Prognos & DevStat. (2022). Project 'economic aspects of circular economy' - identifying circular economy activities. Retrieved from: Europa website

[9] Circle Economy & UNEP. (2021). *The circular jobs methodology.* Retrieved from: Circle Economy website

Remediation activities and other waste management services	core	core
Demolition	not considered	core
Maintenance and repair of motor vehicles	core	core
Wholesale of waste and scrap	core	core
Retail sale of second-hand goods in stores	core	enabling
Rental and leasing of cars and light motor vehicles	core	enabling
Rental and leasing of trucks	core	enabling
Rental and leasing of recreational and sports goods	core	enabling
Rental of video tapes and disks	core	enabling
Rental and leasing of other personal and household goods	core	enabling
Rental and leasing of agricultural machinery and equipment	core	enabling
Rental and leasing of construction and civil engineering machinery and equipment	core	enabling
Rental and leasing of office machinery and equipment (including computers)	core	enabling
Rental and leasing of water transport equipment	core	enabling
Rental and leasing of air transport equipment	core	enabling
Rental and leasing of other machinery, equipment and tangible goods n.e.c.	core	enabling
Library and archives activities	core	enabling
Repair of computers and peripheral equipment	core	core
Repair of communication equipment	core	core
Repair of consumer electronics	core	core
Repair of household appliances and home and garden equipment	core	core
Repair of footwear and leather goods	core	core
Repair of furniture and home furnishings	core	core

Repair of watches, clocks and jewellery	core	core
Repair of other personal and household goods	core	core
Washing and (dry-)cleaning of textile and fur products	core	enabling

FRONT AND BACK COVER IMAGES

The city of Kano in Northern Nigeria has been home to Kofar Mata dye pits and craftsmen since the 16th century. Kofar Mata fabrics largely use ancient techniques, locally sourced and natural ingredients, like the Indigo plant, to dye the clothes.

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