



Economic Impact Assessment of Reuse, Repair and Recycle Activities in Hamilton County

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This report was prepared by the following ASU personnel:

- Dr. Raj Buch, Circular Economy Practice Lead, Director of Business Development, Rob and Melani Walton Sustainability Solutions Service
- Dr. Anthony Evans, Senior Researcher, L. William Seidman Research Institute
- Kristen Osgood, Program Manager, Rob and Melani Walton Sustainability Solutions Service
- Kelly White, Student BSE, Industrial Engineering

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- Peter Fadoul, Associate Manager of Sustainability and Circular Economy, U.S. Chamber of Commerce Foundation
- Molly Yeager Broadwater, Corporate Communications Manager, Rumpke



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Executive Summary

The purpose of this study is to estimate the *maximum* gross impact of circular economy activities in Hamilton County, Ohio, in 2018. The study is published by the [L. William Seidman Research Institute](#), W. P. Carey School of Business, Arizona State University on behalf of Beyond 34, the U.S. Chamber of Commerce Foundation, and the [Rob and Melani Walton Sustainability Solutions Service](#).

This study was commissioned as part of the [U.S. Chamber of Commerce Foundation](#) program *Beyond 34: Recycling and Recovery for a New Economy*. [Beyond 34](#) is aimed at increasing the baseline 34% recycling rate (EPA, 2017) in the U.S. by providing a scalable model to optimize recycling and recovery systems. Beyond 34 launched in 2017 with a pilot program in Orlando, Florida. It is now partnering with Arizona State University (ASU) and municipal, private sector, and nonprofit partners across Cincinnati, Ohio to apply its model to that region in an expansion effort.

Through technical research and stakeholder engagement, the Beyond 34 model identifies and facilitates implementation of system interventions that optimize key waste diversion processes unique to the given target region. This study will be used to demonstrate the current value of certain circular economy activities, repair, reuse, and recycling, in the Greater Cincinnati region and establish a baseline against which progress can be measured.

The Seidman Research Institute method is similar to previous studies implemented in the City of Phoenix (2016), City of Austin (2015), State of Colorado (2014), and NERC (2009). Consistent with the City of Phoenix study (but not the others listed), this study also extends beyond recycling to additionally take into account repair and maintenance activities, and reuse activities for insight into greater circular economy drivers and their impact in the region. Seidman's estimates of the *maximum* gross impact of circular economy activities are built on the Bureau of Labor Statistics' Quarterly Census of Employment and Wages data by NAICS code for the calendar year 2018, used in conjunction with national and/or local estimates of the percent of operations focused on recycled, repaired and maintained, or reused activities.

Table-ES 1 estimates the *maximum* gross economic impact of circular economy activities in Hamilton County in 2018.

Table-ES1: Maximum Gross Economic Impact of CE Activities in Hamilton County, 2018

ECONOMIC IMPACTS	COUNTY BASELINE TOTALS	DIRECT IMPACTS	INDIRECT/ INDUCED IMPACTS	TOTAL ECONOMIC IMPACTS
Gross Domestic Product (Millions 2018 \$)	\$76,097.0 ¹	\$923.5	\$620.7	\$1,544.2
Employment (Jobs)	518,172 ²	7,652	6,785	14,437
Labor Income (Millions 2018 \$)	\$31,303.0 ³	\$638.8	\$392.2	\$1,031.0

Source: Authors' Calculations

The *maximum* gross economic impact of circular economy firms and activities in 2018 is estimated at \$1.5 billion Gross Domestic Product (GDP), and 14,437 jobs paying over \$1.0 billion in labor income. Circular economy activities as a whole in 2018 are estimated to contribute a *maximum* of 2.0% of the annual GDP within Hamilton County. For every one person directly employed in the circular economy, a *maximum* addition of 0.9 new jobs is estimated to be created elsewhere in the Hamilton County economy.

The circular economy in Hamilton County in 2018 is directly responsible for a *maximum* of 1.5% of average annual employment in the County. When multiplier effects are additionally taken into consideration, the *maximum* total (direct, indirect, and induced) employment contribution of the circular economy in Hamilton County in 2018 is estimated at approximately 2.8%.⁴

Seidman's estimate of *maximum* gross economic impact consists of recycling activities, repair and maintenance activities, and reuse activities. The *maximum* gross economic impact of recycling in Hamilton County in 2018 is estimated at \$370.6 million GDP, and 2,895 jobs paying \$221.7 million in labor income. The *maximum* gross economic impact of repair and maintenance in Hamilton County in 2018 is estimated at \$711.1 million GDP, and 6,538 jobs paying \$515.7 million in labor income.

The *maximum* gross economic impact of reuse activities in Hamilton County in 2018 is estimated at \$462.6 million GDP and 5,034 jobs paying \$293.6 million in labor income

¹ \$76,096,986,000 for all industries. (Source: Bureau Economic Analysis GDP by County and Metropolitan Area, available at: bea.gov)

² Source: Quarterly Census of Employment and Wages 2018 Annual Averages, available at: www.bls.gov

³ \$31,302,969,000 for all covered industries and establishment sizes. (Source: Quarterly Census of Employment and Wages 2018 Total Wages, available at: www.bls.gov)

⁴ Hamilton County's total annual employment in 2018 was 518,172, including 466,647 in the private sector (Source: Quarterly Census of Employment and Wages 2018 Annual Averages, available at: www.bls.gov).

1. Introduction

The U.S. Chamber of Commerce Foundation and Beyond 34

The [U.S. Chamber of Commerce Foundation](#) (USCCF) is the nonprofit affiliate of the U.S. Chamber of Commerce and is dedicated to strengthening America's long-term competitiveness. USCCF educates the public about the conditions necessary for business and communities to thrive, how business positively impacts communities and emerging issues and creative solutions that will shape the future.

[Beyond 34: Recycling and Recovery for a New Economy](#) is a multi-stakeholder, public-private initiative aimed at increasing the baseline 34% recycling rate (EPA, 2017) in the U.S. by providing a scalable model to optimize recycling and recovery systems. Led by the U.S. Chamber of Commerce Foundation, Beyond 34 launched in 2017 with a pilot program in Orlando, Florida. It is now partnering with Arizona State University (ASU) and municipal, private sector, and nonprofit partners across Cincinnati, Ohio to apply its model to that region in an expansion effort..

Rob and Melani Walton Sustainability Solutions Service

The [Rob and Melani Walton Sustainability Solutions Service](#) is an education and research program at ASU that was established to advance sustainability solutions locally and globally. The Solutions Service engages diverse teams of faculty, students, entrepreneurs, researchers, and innovators to collaborate and deliver sustainability solutions throughout the globe, to provide learning opportunities for future and current sustainability leaders, and to engage audiences of all ages to take action on and celebrate sustainability solutions.

In 2015, the Solutions Service focused its waste diversion and circular economy expertise under the Resource Innovation and Solutions Network (RISN) to advance integrated resource management through a global network of partners using collaboration, research, innovation, and application of technologies to create economic value, driving a sustainable circular economy.

L. William Seidman Research Institute

The [L. William Seidman Research Institute](#) is the economic consulting and contract research arm of the W. P. Carey School of Business, Arizona State University. First established in 1985 to serve as a center for applied business research alongside a consultancy resource for the Arizona business community, Seidman offers a diverse

range of economic and fiscal consulting services to public and private sector clients based primarily but not exclusively in the Southwest region.

Seidman's team is led by and primarily consists of academics who are solely interested in the pursuit of independent, objective, state-of-the-art analysis. Thanks to the academic training of all personnel, the level of rigor required by Seidman to address clients' needs is far greater than the insights provided by private consultancies. Recent clients include the City of Phoenix, Freeport McMoran, Intel, the NFL, Raytheon, Republic Services Inc., and Wells Fargo.

Report Purpose

The purpose of the current report is to estimate the *maximum* gross economic impact of reuse, repair and maintenance, and recycling activities in Hamilton County.

Reuse means to extend the life of a product, package or resource by either using it more than once with little to no processing (same or new function), repairing it so it can be used longer, and/or sharing, renting, selling or donating it to/with another party.

Repair refers to fixing or mending a product, rather than discarding it in favor of buying a new product – for example, repairing the broken screen of an iPhone.

Recycling is a series of activities by which material that has reached the end of its current use is processed into material utilized in the production of new products.

2. Economic Impact Methodology And Data Inputs

Introduction to Economic Impact Analysis

Economic impact analysis traces the full impact - direct, indirect and induced - of economic activity on jobs and incomes in a local economy.

For example, a firm directly affects the local economy through the jobs provided to operational staff, and its supplier purchases. Indirect effects arise when the firm's suppliers hire staff to fulfill their purchasing needs, or the suppliers place upstream demands on their own vendors. Induced effects occur when workers either directly or indirectly associated with the firm spend their incomes in the local economy, and when governments spend new tax revenues.

The impact of a firm on the local economy is, therefore, greater than its total direct spending on payroll, supplier purchases, and program/service delivery costs. A chain reaction of indirect and induced spending continues, with subsequent rounds of additional spending gradually diminished through savings, taxes, and expenditures made outside the geography of study. Economists usually refer to these secondary effects as ripple effects and estimate their value using a series of multipliers.

An IMPLAN model is used by Seidman to estimate the impact of reuse, repair and recycling activities for Hamilton County in 2018. IMPLAN is a commercially-licensed input-output model originally developed by the Minnesota IMPLAN Group, Inc. (MIG). The model consists of a system of linear equations describing the inter-industry relationships in an economy.

The IMPLAN model organizes the economy into 536 separate industries and has comprehensive data on every geographic area of the United States. It is widely used for economic assessments and can provide detailed estimates of secondary expenditures and income generated as a result of business investment or operation for a finite period of time (typically one full calendar or fiscal year).

The IMPLAN model requires all data inputs to be entered according to its own industry classification. IMPLAN provides a crosswalk to The North American Industry Classification System (NAICS), which is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy.

Seidman's estimates of the impact of reuse, repair and recycling activities in Hamilton County are built on Bureau of Labor Statistics' Quarterly Census of Employment and Wages data by NAICS code for the 2018 calendar year, used in conjunction with national and/or local estimates of the percent of operations focused on reused, repurposed, or recycled activities.

The study's economic impacts are measured in terms of three variables:

- **Gross Domestic Product (GDP):** this is synonymous with value-added. It represents the dollar value of all goods and services produced for *final* demand in the county. It excludes the value of intermediate goods and services purchased as inputs to final production.
- **Employment:** this is a count of full- and part-time jobs. It includes both wage and salary workers, and the self-employed.
- **Labor Income:** this includes all forms of employment income, including employee compensation (wages and benefits) and proprietor income.⁵

Seidman estimates three types of impact – total, direct and indirect/induced – for each of the above measures for Hamilton County in 2014.

Consistent with prior studies, Seidman's economic impact analysis assumes that the reused, repaired and recycled goods and services within the economy generate additional demand, rather than replace existing demand for goods and services produced using "virgin" inputs. As a result, the current economic impact estimates are **gross** and represent the current **maximum** impact of reuse, repair, and recycled activities.

Data Inputs and Assumptions

A four-stage approach is implemented to arrive at estimates of economic impact in Hamilton County:

1. A list of NAICS codes reflective of reuse, repair and recycling firms is initially compiled, drawn from four prior studies of the circular economy described.
 - NERC's (2000) and (2009) recycling economic information study of Delaware, Maine, Massachusetts, New York, and Pennsylvania;

⁵ Please note: labor income is part of GDP. As a result, the two measures should not be added together.

- ENVIRON’s (2014) study of recycling in the State of Colorado; and
 - TXP’s (2015) study of recycling and reuse activity in the City of Austin.
 - Seidman’s (2016) study of circular economy activities in Maricopa County, AZ.
2. This list of NAICS codes is then translated into the current NAICS format (adjusted in 2017) and compared with Bureau of Labor Statistics’ Quarterly Census of Employment and Wages data by NAICS code for calendar year 2018, to identify the number of firms assigned operating in Hamilton County by relevant NAICS code, along with their employment profiles.
 3. Local and/or national estimates of the percentage of circular economy activities by NAICS code category are identified based on the prior studies and current literature.
 4. The resulting inputs are entered into an IMPLAN input-output model, customized specifically for Hamilton County, to estimate the impact of aspects of the circular economy in 2018.

The full list of NAICS codes previously used by one or more of the Austin, Colorado, NERC and Maricopa County studies can be found in Table-A 2 in APPENDIX II on page 14. There are several versions of NAICS codes available – specifically 1997, 2002, 2007, 2012 and 2017. The codes in Table 1 on page 7, therefore, reflect multiple versions of NAICS codes.

Table-A 3 in APPENDIX III on page 17 illustrates the presence of firms in Hamilton County by NAICS code in 2018, along with their total employment profiles. NAICS codes included at different levels of abstraction (that is, at 2-, 4- and 6-digit) are grouped together in Table-A 3. All of the NAICS featured in this Table have appeared in prior studies.

Table-A 4 in APPENDIX IV on page 20 identifies the recycled rates applied to each of these industries, drawn from an extensive literature review and a survey of manufacturing firms implemented by Seidman in fall 2019.

From an economic perspective, in the absence of regulation and/or subsidy in Hamilton County, recycling can only exist if it provides inputs that are cost-effective for downstream users. Effectively, this means that recycled materials must be cost competitive with virgin materials. In this context, counting the economic impact of recycling (or other aspects of the circular economy) is an acceptable practice since it represents part of the input supply industry. However, if the recycled inputs are supplied at the same price as the cost of “virgin” inputs in the absence of those recycled

inputs, the downstream economic impacts and multiplier effects emanating from recycling must be tempered. A full economic multiplier effect should only be applied to recycling (or other aspects of the circular economy) if the downstream economic activity grows in addition to that attributable to “virgin” materials. In short, recycled materials must add to economic activity in downstream production and not just substitute for “virgin” inputs.

In this context, the estimates of economic impact presented in Section 3 must be viewed as maxima or upper bounds, because at present it is very difficult to discern the fraction of downstream activity additional to a “zero recycling” counterfactual.

3. Current Economic Impact Of Circular Economy Activities In Hamilton County

Tables 1 to 4 estimate the *maximum gross* economic impact of aspects of the circular economy in Hamilton County, based on NAICS codes consistent with the Austin, Colorado, Hamilton County, and NERC studies.⁶ The recycled rates for the NAICS included in this analysis were shown in Table 3. Impacts are estimated in total and by type of circular economy activity in 2018. All dollar amounts are expressed in 2018 dollars (2018 \$).

Economic Impact of the Circular Economy in Hamilton County, 2018

Table 1 estimates the *maximum gross* economic impact of circular economy activities in Hamilton County in 2018. Three types of impact are examined: Gross Domestic Product (GDP); employment; and labor income.

The direct impacts of the circular economy activities as a whole in Hamilton County in 2018 are estimated at \$923.5 million GDP, and 7,652 jobs paying \$638.8 million in labor income. These refer to people directly working in the circular economy.

Table 1: Maximum Gross Economic Impact of Circular Economy Activities in Hamilton County, 2018

ECONOMIC IMPACTS	DIRECT IMPACTS	INDIRECT/INDUCED IMPACTS	TOTAL ECONOMIC IMPACTS
Gross Domestic Product (Millions 2018 \$)	\$923.5	\$620.7	\$1,544.2
Employment (Jobs)	7,652	6,785	14,437
Labor Income (Millions 2018 \$)	\$638.8	\$392.2	\$1,031.0

Source: Authors' Calculations

The multiplier (indirect and induced) impacts in 2018 are estimated at \$620.7 million GDP and 6,785 jobs paying \$392.2 million labor income.

⁶ This is because at present it is very difficult to discern the fraction of downstream activity additional to a "zero recycling" counterfactual.

The *maximum* gross economic impact of circular economy firms and activities in 2018 is therefore estimated at more than \$1.5 billion GDP, and 14,437 jobs paying more than \$1 billion in labor income.

To put the estimated impacts into perspective:

- The Bureau of Economic Analysis estimates the GDP of Hamilton County in 2018 at \$76.1 billion (2018 \$). The economic impact estimates, therefore, suggest that circular economy activities in Hamilton County as a whole contributed a *maximum* gross of approximately 2.0% of the county's total GDP in 2018.⁷
- For every person directly employed in the circular economy, an additional 0.9 new jobs are created elsewhere in the Hamilton County economy.
- The circular economy in Hamilton County in 2018 is directly responsible for a *maximum* gross of 1.5% of average annual employment in the County. When multiplier effects are additionally taken into consideration, the total (direct, indirect, and induced) *maximum* gross employment contribution of the circular economy in Hamilton County in 2018 is approximately 2.8%.⁸

Economic Impact of Reuse Firms in Hamilton County, 2018

Table 2 estimates the *maximum* gross economic impact of reuse firms in Hamilton County in 2018. The types of firms that engage in reuse activities can include, but not be limited to: second-hand stores like Goodwill Industries or Habitat for Humanity, dairy firms who deliver milk in glass bottles, auto shops that retread tires, and logistics firms that deliver produce in reusable plastic boxes to grocers. For the Hamilton County analysis, Seidman selected reuse firms from three NAICS codes. These are: wholesale trade (42), retail trade (44-45) and used household and office goods (484210). Three types of economic impact are again examined: Gross Domestic Product (GDP); employment; and labor income.

The direct impacts of reuse firms in 2018 are estimated at \$261.4 million GDP, and 2,810 jobs paying \$164.9 million in labor income. These refer to people directly working in reuse activities.

⁷ Bureau of Economic Analysis Regional Data, available online at bea.gov

⁸ Hamilton County's total annual employment in 2018 was 518,172, including 466,647 in the private sector. (Source: Quarterly Census of Employment and Wages 2018 Annual Averages available at: www.bls.gov).

The multiplier effects of reuse firms in Hamilton County in 2018 are estimated at \$201.2 million GDP, and 2,224 jobs paying \$128.7 million labor income.

The *maximum* gross economic impact of reuse firms in Hamilton County in 2018 is therefore estimated at \$462.6 million GDP, and 5,034 jobs paying \$293.6 million in labor income.

Table 2: Maximum Gross Economic Impact of Reuse Firms in Hamilton County, 2018⁹

ECONOMIC IMPACTS	DIRECT IMPACTS	INDIRECT/INDUCED IMPACTS	TOTAL ECONOMIC IMPACTS
Gross Domestic Product (Millions 2018 \$)	\$261.4	\$201.2	\$462.6
Employment (Jobs)	2,810	2,224	5,034
Labor Income (Millions 2018 \$)	\$164.9	\$128.7	\$293.6

Source: Authors' Calculations

To put the reuse activity impacts into perspective:

- Reuse firms account for a *maximum* gross of 28.3% of the direct and 30.0% of the total *maximum* gross GDP contribution of circular economy activities in Hamilton County in 2018.
- For every 1 reuse job in the Hamilton County economy, approximately 0.8 indirect/induced jobs are created elsewhere in the county.
- The *maximum* gross total (direct, indirect, and induced) employment contribution of reuse firms in 2018 is 1.0% of Hamilton County's average annual employment.¹⁰

Economic Impact of Repair Firms in Hamilton County, 2018

Table 3 estimates the *maximum* gross economic impact of repair and maintenance activities in Hamilton County in 2018. Firms and jobs that constitute repair and maintenance include, but are not limited to: auto repair and maintenance, home repairs such as painters, plumbers and builders, and firms that refurbish electronics such as computers and phones. For the Hamilton County analysis, Seidman selected repair

⁹ Row totals may not tally exactly due to rounding.

¹⁰ Hamilton County's total annual employment in 2018 was 518,172, including 466,647 in the private sector. (Source: Quarterly Census of Employment and Wages 2018 Annual Averages available at: www.bls.gov).

and maintenance firms from four NAICS codes. These are: automotive repair and maintenance (8111), electronic/precision equipment repair and maintenance (8112), commercial/industrial equipment repair and maintenance (8113), and personal and household goods repair and maintenance (8114).

The direct impacts of repair and maintenance firms in 2018 are estimated at \$457.4 million GDP, and 3,691 jobs paying \$358.8 million labor income. These refer to people directly working in repair and maintenance activities.

Table 3: Maximum Gross Economic Impact of Repair Firms in Hamilton County, 2018¹¹

ECONOMIC IMPACTS	DIRECT IMPACTS	INDIRECT/INDUCED IMPACTS	TOTAL ECONOMIC IMPACTS
Gross Domestic Product (Millions 2018 \$)	\$457.4	\$253.7	\$711.1
Employment (Jobs)	3,691	2,846	6,538
Labor Income (Millions 2018 \$)	\$358.8	\$156.8	\$515.7

Source: Authors' Calculations

The multiplier effects of repair and maintenance activities in Hamilton County in 2018 are estimated at \$253.7 million in GDP, and 2,846 jobs paying \$156.8 million labor income.

The *maximum* gross economic impact of repair and maintenance firms in Hamilton County in 2018 is estimated at \$711.1 million GDP, and 6,538 jobs paying almost \$515.7 million in labor income.

To put the repair and maintenance impacts into perspective:

- Repair and maintenance activities account for a *maximum* gross of 49.50% of the direct and 46.0% of the total *maximum* gross GDP contribution of circular economy activities in Hamilton County in 2018.
- For every 1 person employed to implement repair and maintenance, a further 0.8 indirect/induced jobs are created elsewhere in the Hamilton County economy.

¹¹ Row totals may not tally exactly due to rounding.

- The *maximum* gross total (direct, indirect, and induced) employment contribution of repair and maintenance firms in 2018 is 1.3% of Hamilton County’s average annual employment.¹²

Economic Impact of Recycling Firms in Hamilton County, 2018

Table 4 estimates the *maximum* gross economic impact of recycling firms in Hamilton County in 2018. Examples of recycling firms can include, but not be limited to: roadside collectors, materials recovery facility employees, recycled paper mills, and manufacturers that use recycled components. For the Hamilton County analysis, Seidman selected reuse firms from several NAICS codes. These are: textiles (313-314), wood container and pallet manufacturing (321), paper manufacturing (322), asphalt paving mixture and block manufacturing (32412), fertilizer manufacturing (325310), plastics and rubber products manufacturing (326), glass manufacturing (3272), primary metal manufacturing (331), waste collection (5621), waste treatment and disposal (5622), and remediation services (5629).

The direct impacts of recycling firms in 2018 are estimated at \$204.7 million GDP, and 1,151 jobs paying \$115.0 million in labor income. These refer to people directly working in jobs that include a recycling component.

The multiplier effects of recycling in Hamilton County in 2018 are estimated at \$165.9 million GDP, and 1,714 jobs paying approximately \$106.7 million labor income.

Table 4: Maximum Gross Economic Impact of Recycling Firms in Hamilton County, 2018

ECONOMIC IMPACTS	DIRECT IMPACTS	INDIRECT/INDUCED IMPACTS	TOTAL ECONOMIC IMPACTS
Gross Domestic Product (Millions 2018 \$)	\$204.7	\$165.9	\$370.6
Employment (Jobs)	1,151	1,714	2,895
Labor Income (Millions 2018 \$)	\$115.0	\$106.7	\$221.7

Source: Authors’ Calculations

¹² Hamilton County’s total annual employment in 2018 was 518,172, including 466,647 in the private sector. (Source: Quarterly Census of Employment and Wages 2018 Annual Averages available at: www.bls.gov).

The *maximum* gross economic impact of recycling in Hamilton County in 2018 is therefore estimated at \$370.6 million GDP, and 2,895 jobs paying \$221.7 million in labor income.

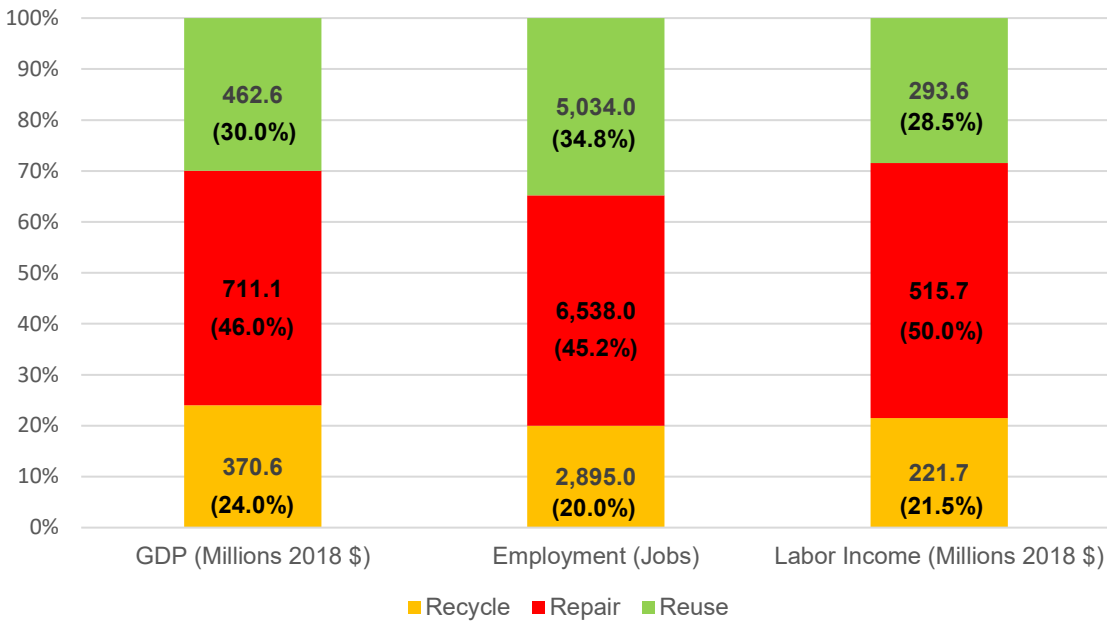
To put the recycling impacts into perspective:

- Recycling activities account for a *maximum* gross of 22.2% of the direct and 24.0% of the total *maximum* gross GDP contribution of circular economy activities in Hamilton County in 2018.
- For every job associated with recycling in Hamilton County in 2018, 1.5 indirect/induced jobs are created elsewhere in the Hamilton County economy.
- The *maximum* gross total (direct, indirect, and induced) employment contribution of recycling in 2018 is 0.6% of Hamilton County's average annual employment.¹³

Figure 1 summarizes the estimated contribution of circular economy activities to *maximum* gross impacts in Hamilton County. It suggests that repair and maintenance activities potentially contribute the greatest percentage of the *maximum* gross GDP, employment and labor income impacts in 2018. Figure 1 also suggests that reuse activities potentially contribute to a higher percentage of all three *maximum* impacts in 2018 than recycling.

¹³ Hamilton County's total annual employment in 2018 was 518,172, including 466,647 in the private sector. (Source: Quarterly Census of Employment and Wages 2018 Annual Averages available at: www.bls.gov).

Figure 1: Estimated Contribution of Circular Economy Activities to Maximum Gross Impacts Studied in Hamilton County, 2018¹⁴



Source: Authors' Calculations

¹⁴ The column values for GDP and labor income are displayed in millions of 2018 dollars. The column values for employment are displayed in single unit job years.

Appendix I

Table-A1: Circular Economy NAICS Codes Compiled from Prior Studies

NAICS	DESCRIPTION	AUSTIN	COL.	NERC	MC
321219	Wood Reuse			X	
321920	Wood Reuse		X	X	X
322120	Paper Mills			X	X
322130	Paperboard Mills			X	X
3222	Converted Paper Product Manufacturing				X
322215	Paper-based Product Manufacturers			X	
322299	Paper-based Product Manufacturers		X	X	
324121	Pavement Mix Producers		X	X	X
325311	Compost/Organics Processors			X	
325314	Compost/Organics Processors		X	X	
325991	Plastics Reclaimers		X	X	
3261	Plastic Products Manufacturing	X	X		
32611	Plastic Products Manufacturers			X	X
32612	Plastic Products Manufacturers			X	X
326122	Plastic Pipe & Pipe Fitting Manufacturing		X		
326150	Urethane and Other Foam Product Manufacturing		X		
326160	Plastic Products Manufacturers			X	X
32619	Plastic Products Manufacturers			X	X
326191	Plastics Plumbing Fixture Manufacturing		X		
326199	All Other Plastics Product Manufacturing		X		
3262	Rubber Product Manufacturers		X		X
326211	Tire Manufacturing (except Retreading)		X		
326212	Tire Retreaders		X	X	
326220	Rubber and Plastics Hoses and Belting Manufacturing		X		
326291	Rubber Product Manufacturing for Mechanical Use		X		
326299	Rubber Product Manufacturers		X	X	
3272	Glass Manufacturing				X
327211	Glass Product Producers			X	
327212	Glass Product Producers			X	
327213	Glass Container Manufacturing Plants		X	X	
327215	Glass Product Manufacturing	X			
327993	Glass Product Producers			X	
331	Nonferrous Product Producers			X	

NAICS	DESCRIPTION	AUSTIN	COL.	NERC	MC
331110	Iron and Steel Mills and Ferroalloy Manufacturing		X	X	X
331111	Iron and Steel Mills		X		
331221	Rolled Steel Shape Manufacturing				X
331314	Secondary Aluminum Smelting			X	X
331315	Nonferrous Product Producers		X	X	X
331316	Nonferrous Product Producers		X	X	
331318	Other Aluminum Rolling, Drawing, and Extruding		X		X
331319	Nonferrous Product Producers			X	
3314	Nonferrous Metal Production	X			
331420	Copper Rolling, Drawing, and Extruding				X
331421	Nonferrous Product Producers		X	X	
331423	Secondary Copper Smelting		X	X	
331491	Nonferrous Metal Rolling, Drawing, and Extruding				X
331492	Secondary Smelting		X	X	X
33151	Iron and Steel Foundries			X	X
33152	Nonferrous Foundries			X	
331521	Aluminum Die-casting Foundries		X		
331522	Nonferrous (excluding aluminum) Die-casting		X		
331523	Nonferrous Metal Die-casting Foundries		X		X
331524	Aluminum Foundries		X		X
331525	Copper Foundries		X		
331529	Other Nonferrous Metal Foundries (excluding Die-casting)				X
411690	Other Electronic Parts and Equipment Wholesale		X		
423110	Used Car Merchant Wholesalers				X
423130	Tires, Used (except Scrap), Merchant Wholesalers				X
423140	Motor Vehicle Parts (Used) Wholesalers	X	X	X	X
423690	Other Electronic Parts/Equipment Merchant Wholesalers			X	
423840	Wholesale Machinery Equipment & Supplies Other Reuse		X		
423930	Recyclable Material Merchant Wholesalers	X		X	X
441120	Used Car Dealers				X
441210	Used Recreational Vehicle (RV) Dealers				X
441222	Used Boat Dealers				
441228	Used Utility Trailer, Aircraft, Motorcycle Dealers				X
441310	Retail Sales of Auto Parts and Accessories		X	X	X
441320	Used Tire Dealers				X
441310	Retail Used Merchandise Sales			X	

NAICS	DESCRIPTION	AUSTIN	COL.	NERC	MC
453310	Used Merchandise Stores		X	X	X
453930	Used Manufactured (Mobile) Home Dealers				X
484210	Used Household and Office Goods Moving				X
491	Nonferrous Product Producers			X	
54199	Materials Exchange Facilities		X		
562	Waste Management and Remediation Services				X
562111	Solid Waste Collection	X	X	X	
562112	Solid Waste Collection		X		
562920	Materials Recovery Facilities	X	X	X	X
811110	Automobile Mechanical/Electrical Repair & Maintenance				X
811120	Automotive Body, Paint, Interior, & Glass Repair				X
811198	All Other Automotive Repair & Maintenance				X
8112	Electronic & Precision Equipment & Maintenance				X
811212	Computer & Office Machine Repair & Maintenance		X		
8114	Personal & Household Goods Repair & Maintenance				X

Sources: TXP (2015), Environ (2014), NERC (2000) (2009), and Seidman (2016).

Appendix II

Table-A2: Hamilton County Firms with Potential Circular Economy Activities by NAICS 2018¹⁵

NAICS	DESCRIPTION	EMPLOYEES
313	TEXTILE MANUFACTURING	492
314	TEXTILE PRODUCT MILLS	264
321	WOOD PRODUCT MANUFACTURING	145
321920	<i>Wood Container and Pallet Manufacturing</i>	145
322	PAPER MANUFACTURING	928
322110	<i>Pulp Mills</i>	31
322120	<i>Paper Mills</i>	31
322130	<i>Paperboard Mills</i>	91
32222	<i>Converted Paper Product Mfg.</i>	775
324	PETROLEUM AND COAL PRODUCTS MANUFACTURING	224
32412	<i>Asphalt Paving Mixture & Block Manufacturing</i>	111
32419	<i>Re-refining used petroleum lubricating oils</i>	113
325	CHEMICAL MANUFACTURING	34
325310	<i>Fertilizer Manufacturing</i>	34
3261	PLASTIC PRODUCTS MANUFACTURING	1,185
32611	<i>Plastics Packaging Materials, & Unlaminated Film and Sheet Mfg.</i>	552
32613	<i>Laminated Plastics Plate, Sheet (except Packaging), & Shape Mfg.</i>	3
32614	<i>Polystyrene Foam Product Mfg.</i>	3
32615	<i>Urethane and Other Foam Product (except Polystyrene) Mfg.</i>	111
32616	<i>Plastics Bottle Manufacturing</i>	3
32619	<i>Other Plastics Product Manufacturing</i>	513
3262	RUBBER PRODUCT MANUFACTURING	94
326290	<i>Other Rubber Product Manufacturing</i>	94
3272	GLASS MANUFACTURING	62
327211	<i>Flat Glass Manufacturing</i>	62

¹⁵ Seidman's modeling only uses primary NAICS. It does not double-count secondary NAICS codes.

NAICS	DESCRIPTION	EMPLOYEES
331	PRIMARY METAL MANUFACTURING	814
331110	<i>Iron and Steel Mills and Ferroalloy Mfg.</i>	61
331221	<i>Rolled Steel Shape Mfg.</i>	123
331318	<i>Other Aluminum Rolling, Drawing, and Extruding</i>	123
331410	<i>Nonferrous Metal (except Aluminum) Smelting and Refining</i>	61
331492	<i>Secondary Smelting, Refining and Alloying of Nonferrous Metals</i>	61
331511	<i>Iron Foundries</i>	107
331513	<i>Steel Foundries</i>	27
331523	<i>Nonferrous Metal Die-Casting Foundries</i>	25
331524	<i>Aluminum Foundries (except Die-Casting)</i>	176
331529	<i>Other Nonferrous Metal Foundries (except Die-Casting)</i>	50
42	WHOLESALE TRADE	328
42311	<i>Merchant Wholesalers Motor Vehicles</i>	323
42314	<i>Used Motor Vehicle Parts</i>	5
44-45	RETAIL TRADE	1,558
441120	<i>Used Car Dealers</i>	698
4533	<i>Used Merchandise Stores</i>	860
48-49	TRANSPORTATION & WAREHOUSING	325
484210	<i>Used Household and Office Goods Moving</i>	325
562	WASTE MANAGEMENT AND REMEDIATION SERVICES	1,877
56211	<i>Waste Collection</i>	962
5622	<i>Waste Treatment and Disposal</i>	462
5629	<i>Remediation</i>	453
8111	AUTOMOTIVE REPAIR AND MAINTENANCE	2,474
811111	<i>General Automotive Repair</i>	1,352
811112	<i>Automotive Exhaust System Repair</i>	57
811113	<i>Automotive Transmission Repair</i>	46
811118	<i>Other Automotive Mechanical and Electrical Repair & Maintenance</i>	13
811121	<i>Automotive Body Paint and Interior Repair & Maintenance</i>	724
811122	<i>Automotive Glass Replacement Shops</i>	84
811191	<i>Automotive Oil Change and Lubrication Shops</i>	189
811198	<i>All Other Automotive Repair and Maintenance</i>	9
8112	ELECTRONIC & PRECISION EQUIP. REPAIR & MAINTEN.	149
811212	<i>Computer and Office Machine Repair and Maintenance</i>	46
811219	<i>Other Electronic and Precision Equipment Repair and Maintenance</i>	103

NAICS	DESCRIPTION	EMPLOYEES
8113	COMMERCIAL/INDUSTRIAL EQUIP. REPAIR & MAINTEN.	854
811310	<i>Commercial/Industrial Machinery & Equipment Repair & Maintain.</i>	854
8114	PERSONAL & HOUSEHOLD GOODS REPAIR & MAINTEN.	214
811411	<i>Home and Garden Equipment Repair and Maintenance</i>	48
811412	<i>Appliance Repair and Maintenance</i>	69
811420	<i>Reupholstery and Furniture Repair and Maintenance</i>	61
811430	<i>Footwear and Leather Goods Repair and Maintenance</i>	8
811490	<i>Other Personal and Household Goods Repair and Maintenance</i>	28

Source: QCEW (2020)

Appendix III

Table-A3: Final List of Hamilton County NAICS Used with Circular Economy Business Percentage

NAICS	DESCRIPTION	PERCENT	5RS TYPE	SOURCE
313-314	Textiles	15.2%	Recycle	EPA (2019) ¹⁶
321	Wood Container & Pallet Manufacturing	16.8%	Recycle	Bush (1994) ¹⁷
322110	Pulp Mills	10%	Recycle	IP
322120	Paper Mills	10%	Recycle	IP
322130	Paperboard Mills	51.5%	Recycle	AF&PA (2016)
3222	Converted Paper Product Manufacturing	23%	Recycle	EPA (2015)
32412	Asphalt Paving Mixture & Block Manufacturing	55.6%	Recycle	NAPA (2015)
325310	Fertilizer Manufacturing	13.0%	Recycle	EIC (2014)
32611	Plastics Packaging Materials, & Unlaminated Film/Sheet	43%	Recycle	ACC (2015)
32613	Laminated Plastics.	10%	Recycle	MRA(2014)
32614	Polystyrene	10%	Recycle	MRA (2014)
32615	Urethane	10%	Recycle	MRA (2014)
32616	Plastics Bottle Manufacturing	31.8%	Recycle	ACC & APPR (2015)
32619	Other Plastics Product Manufacturing	10%	Recycle	MRA (2014) ¹⁸
3262	Rubber Product Manufacturing	5% ¹⁹	Recycle	SHAW (2011)
3272	Glass Manufacturing	16.8%	Recycle	BG (2017)
331110	Iron and Steel Mills and Ferroalloy Mfg.	52%	Recycle	USGS (2016)
331221	Rolled Steel Shape Manufacturing	52%	Recycle	USGS (2016)
331318	Other Aluminum Rolling, Drawing, & Extruding	50%	Recycle	USGS (2016)
331410	Nonferrous (except Aluminum) Smelting & Refining	50%	Recycle	USGS (2016)
331420	Copper Rolling, Drawing, Extruding, and Alloying	33%	Recycle	USGS (2016)
331492	Secondary Smelting, Refining Nonferrous Metal	45.9%	Recycle	USGS (2016)
33151	Ferrous Metal Foundries	52%	Recycle	USGS (2016)
331523	Nonferrous Metal Die-Casting Foundries	45.9%	Recycle	USGS (2016)
331524	Aluminum Foundries (except Die-Casting)	50%	Recycle	USGS (2016)
331529	Other Nonferrous Metal Foundries (except Die-Casting)	45.9%	Recycle	USGS (2016)

¹⁶ EPA, (2019). Textiles: Material-Specific Data. Available at: <https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/textiles-material-specific-data>

¹⁷ Bush et. al. originally estimated 13.2% in 1994 for recycling in 1992. Seidman has conservatively increased this recycling rate by 1% each year.

¹⁸ Seidman additionally applied this recycling estimate to 36613, 32614, and 32615.

¹⁹ This is the midpoint of Shaw's 3%-7% estimate.

NAICS	DESCRIPTION	PERCENT	5RS TYPE	SOURCE
42	Wholesale Trade	96%	Reuse	Walton/SI
44-45	Retail Trade	100%	Reuse	Walton/SI
484210	Used Household and Office Goods	100%	Reuse	Walton/SI
5621	Waste Collection ²⁰	13.7%	Recycle	Cascadia (2015)
5622	Waste Treatment and Disposal	13.7%	Recycle	Cascadia (2015)
5629	Remediation Services	92%	Recycle	EIC (2014)
8111	Automotive Repair & Maintenance	100%	Repair	Walton/SI
8112	Electronic/Precision Equipment Repair & Maintenance	100%	Repair	Walton/SI
8113	Commercial/Industrial Equipment Repair & Maintenance	100%	Repair	Walton/SI
8114	Personal & Household Goods Repair & Maintenance	100%	Repair	Walton/SI

Source: Authors

Key:

ACC American Chemistry Council
 ACC & APPR American Chemistry Council and Association of Postconsumer Plastic Recyclers
 AF&PA American Forest & Paper Association
 BG Brandon Gaille
 EIC ENVIRON International Corporation
 EPA United States Environmental Protection Agency
 IP (Local) International Paper (Local firm estimate)
 MRA Moore Recycling Associates, Inc.
 NAPA National Asphalt Paving Association
 SHAW David Shaw
 Walton/SI Walton Sustainability Solutions Service/Seidman Institute estimate

²⁰ The waste remediation services (e.g. MRFs) included within this NAICS category are included at 92% and not 13.7%, consistent with the ENVIRON State of Colorado 2014 study.

Appendix IV

The *maximum* gross impacts estimated in this study are built on the Bureau of Labor Statistics' Quarterly Census of Employment and Wages data by NAICS code for 2018, used in conjunction with national and/or local estimates of the percent of operations focused on recycled, repaired and maintained, or reused activities.

In an attempt to increase understanding of circular economy activities in the manufacturing sector, a contact list of manufacturing firms by NAICS code for Hamilton County was also sourced from the NAICS Association LLC. The research team then created a 6-question survey to try to understand the extent to which these manufacturers used recycled rather than virgin inputs in their manufacturing processes. The questions featured on this survey are as follows:

Q1. Does your firm make or manufacture something in Hamilton County?

Yes No

Q2. Does your firm or organization currently use recycled material on a regular basis in Hamilton County?

Yes No

Q3. Please list up to 10 recycled or reused materials used in your manufacturing in the Type of Material column below. Then, please state the percentage of recycled content used for each identified material in the adjacent column.

Type of Material	Percentage of Recycled Content

Q4. Where do you sell your products containing recycled materials? Please select all that apply.

- To customers within Hamilton County
- To customers within other counties in Ohio
- To customers in other states outside Ohio
- To customers in countries outside the United States

Q5. How many people do you employ in Hamilton County?

- ___ Full-time employees
- ___ Part-time employees

Q6. What is your total annual payroll for your Hamilton County employees?
 (Optional)
 \$ _____

Over 500 firms were contacted by phone or email to request participation in the survey; and one Hamilton County student also personally visited 30 firms. To maximize participation, firms were offered a choice of different response mechanisms (phone, online or mailed paper copy).

The response rates by type of manufacturing are shown in the table below.

Table-A4: Seidman’s Manufacturing Survey

TYPE OF FIRM	TOTAL RESPONDENTS	NUMBER THAT MANUFACTURE	NUMBER THAT RECYCLE
Textiles & Apparel	7	4	1
Wood & Furniture	22	16	5
Chemicals	31	17	4
Rubber	6	3	1
Leather	3	1	0
Machinery	28	22	5
Electronics	22	11	5

Source: Authors’ Calculations

The Table-A 1 shows that the response rates for several types of manufacturing failed to surpass a small sample bias threshold of 30. Some respondents also failed to correctly answer Q3. That is, they either ignored the percentage column altogether or opted for the wrong denominator, estimating, for example, their recycled plastic as a percent of total recycled content rather than total plastic. As a result, The Rob and Melani Walton Sustainability Solutions Service, in partnership with Seidman, decided against the reliability and use of this primary survey data in the current study. The authors recommend a greater focus on survey data specific to a geography, implemented by a locally-based team, to enhance future economic impact estimates.

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