CUYAHOGA LAND BANK: 15-YEAR ECONOMIC IMPACT ANALYSIS

Technical Report
October 2024

Over the past 15 years, the Cuyahoga Land Bank has been instrumental in revitalizing Cleveland and Cuyahoga County. It has demolished nearly 10,000 blighted properties, renovated over 2,600 homes, and facilitated the construction of approximately 250 new residences. These efforts have led to a significant economic impact—estimated at $3.6 billion—by increasing property values, attracting private investments, restoring property tax revenue, and improving neighborhood stability.

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A Tribute to Gus Frangos - President & General Counsel of the Cuyahoga Land Bank - (2009 - 2024)

Gus Frangos, the late Founder and President of the Cuyahoga Land Bank, was a visionary whose tireless work reshaped communities, uplifted neighborhoods, and created lasting economic impact. His influence extends far beyond Cuyahoga County, where his groundbreaking work began, into the very fabric of the land banking industry across the United States. Frangos' leadership and foresight in drafting the legislation that paved the way for Ohio's county land banks are a testament to his innovative thinking and commitment to solving complex community challenges.

Fifteen years ago, Frangos spearheaded the establishment of the Cuyahoga Land Bank, Ohio's first county land bank, which has since transacted more than 14,000 properties and played a critical role in Cuyahoga County's revitalization. Under his leadership, the Land Bank’s work generated more than $3 billion in economic impact—an astounding figure that illustrates the breadth of his vision. Blighted homes were rehabilitated, vacant land was repurposed, and entire neighborhoods were given new life, directly benefiting the residents of Cuyahoga County.

But Gus Frangos' legacy reaches far beyond the borders of Cuyahoga. Through his work, more than 70 county land banks have been established across the state, providing communities with powerful tools to combat urban decay and promote revitalization. His efforts helped build a model that is now followed by other states, demonstrating that creative, dedicated, and thoughtful leadership can transform local economies and community landscapes.

At the core of Frangos' work was his deep faith, a work ethic that few could match, and a profound love for the community. He was not just a leader but a servant—someone who gave of himself for the betterment of others. His passion for helping communities reclaim blighted properties and reinvest in the places people call home was more than just a job; it was a mission he pursued with unwavering commitment.

As the land banking movement continues to grow, Frangos' contributions will live on, his impact indelible and his vision enduring. His legacy stands as a beacon of hope for struggling communities, a reminder that even the most daunting challenges can be met with faith, perseverance, and a heart for service. Gus Frangos will forever be remembered as a pioneer and a community champion whose life’s work made the world a better place.

- *Ricardo León*
  President, Cuyahoga Land Bank

Letter from the President

Dear Colleagues, Partners, and Community Members,

As we reflect on 15 years of progress and transformation, I am proud to share with you the results of a comprehensive analysis of Cuyahoga Land Bank's work. Since its inception in 2009, the Land Bank has been dedicated to revitalizing neighborhoods, repurposing distressed properties, and generating economic growth across Cuyahoga County. The findings presented in this 15-Year Impact Analysis highlight the remarkable success of our efforts and are a testament to the vision of our late founder.

Over the past decade and a half, the Land Bank has demolished nearly 10,000 blighted properties, renovated over 2,600 homes, and facilitated the construction of nearly 250 new residences. These efforts have not only increased property values and improved public safety but have also catalyzed private investment and generated property tax revenue.

The total economic impact of the Land Bank's activities is an impressive $3.6 billion. This achievement underscores the importance of our continued collaboration as we work toward a brighter, more equitable, and prosperous future for Cleveland and Cuyahoga County.

Thank you for your continued commitment and partnership in this transformative journey.

Onward,
Ricardo León
President & CEO
Cuyahoga Land Bank

Letter from the Ohio Land Bank Association

Dear Colleagues and Partners,

It is with great pride that I acknowledge the transformative work of the Cuyahoga Land Bank, which has played a pivotal role in reshaping communities and serving as a catalyst for the establishment of over 70 land banks across Ohio. Founded by Gus Frangos in 2009, the Cuyahoga Land Bank set the standard for community land banking, demonstrating the power of strategic interventions to address blight and stimulate development.

Across Ohio, land banks have become vital tools for reclaiming distressed properties, stabilizing neighborhoods, and fostering sustainable development. The success of Cuyahoga's approach has inspired counties statewide, proving that with the right leadership and vision, even the most challenging issues can be tackled effectively.

As we continue to work together, I am confident that land banks will remain a cornerstone of Ohio's efforts to build stronger, more resilient communities. Kudos to the Cuyahoga Land Bank, may their work continue to inspire communities across the state to work towards a more prosperous future.

Sincerely,
Shawn Carvin
Executive Director
Ohio Land Bank Association

ES.1 Executive Summary

Cuyahoga County, once an industrial powerhouse known for its steel, automotive, petroleum, and chemical industries, faced significant economic challenges in the latter half of the 20th century. Global industrial shifts, urban sprawl, and local economic restructuring led to widespread economic decline. As the population dwindled, neighborhoods were left with vacant, deteriorating properties, driving down property values and creating blight. The 2008 financial crisis exacerbated this situation, causing a surge in foreclosures and leaving many houses abandoned and unsafe.

In response, the Cuyahoga County Land Reutilization Corporation, commonly known as the Cuyahoga Land Bank, was established in 2009. Its mission is to acquire and repurpose distressed properties, transforming them from community liabilities into valuable assets. This executive summary outlines the findings from a comprehensive 15-year analysis (2009–2024) of the Land Bank's efforts. The study evaluates how its activities have influenced property values, local economies, and neighborhood stability across Cleveland and Cuyahoga County.

ES.2 Study Overview

This study aims to evaluate the economic impact of the Cuyahoga Land Bank over its first 15 years (2009–2024). The analysis focuses on six key areas:

1. **Demolition of Blighted Properties**: Nearly 10,000 unsalvageable structures have been demolished, removing dangerous buildings, improving neighborhood safety, and increasing local property values.
2. **Renovation of Distressed Properties**: More than 2,600 homes were renovated, restoring property value and contributing to neighborhood stabilization.
3. **New Residential Construction**: The Land Bank facilitated the construction of approximately 250 new homes on previously vacant lots, providing new housing opportunities.
4. **Restored Property Tax Revenue**: Nearly 12,800 properties to productive use, restoring over $48 million in property tax revenue.
5. **Catalyzed Private Investment**: The Land Bank’s efforts spurred more than $395 million in private investment, including large-scale projects such as the Amazon Fulfillment Center.
6. **Economic Impact of Land Bank Expenditures**: Over 15 years, the Land Bank invested $330 million in the local economy. These investments resulted in an estimated $632.7 million in total spending within the local economy.

The total estimated economic impact of the Cuyahoga Land Bank’s activities is $3.6 billion, underscoring its substantial contributions to urban revitalization and economic resilience across Cleveland and Cuyahoga County.

ES.3 Key Findings

The Cuyahoga Land Bank has made a substantial positive impact on Cuyahoga County over its first 15 years of operation. By removing blighted properties, renovating homes, building new housing, and catalyzing private investment, the Land Bank has played a critical role in stabilizing neighborhoods, increasing property values, and boosting the local economy.

The total economic impact of the Land Bank's activities is estimated at **$3.6 billion**, with significant increases in property values and property tax revenue, as well as the creation of new opportunities for private investment and development. Detailed findings are presented below for each of the six core components of the study discussed in section ES.2.

ES.3.1 Demolitions

The demolition of blighted properties is a critical component of the Land Bank's strategy, as vacant, unsafe buildings can have a domino effect on nearby properties, driving down property values, increasing crime, and deterring investment. By removing these structures, the Land Bank has helped eliminate public safety hazards and prevent the spread of further blight.

The study found that the demolition of nearly 10,000 properties led to a significant increase in surrounding property values, totaling approximately $1.47 billion. The average increase in value per demolition was $148,000, resulting in a benefit-cost ratio (BCR) of 9.74, meaning that for every dollar spent on demolitions, nearly $10 in property value was gained.

ES.3.2 Renovations

In 15 years, more than 2,600 homes have been renovated and returned to the housing market. These renovations not only restore individual homes but also stabilize and revitalize entire neighborhoods.

On average, each renovation increased the surrounding property values by about $359,000, with a BCR of 13.52, meaning that every dollar spent on renovations generated more than $13 in increased property values. The total impact of these renovations was approximately $950 million in increased property values.

ES.3.3 New Construction

In areas where properties were beyond repair or vacant lots were available, the Land Bank facilitated the construction of new homes. Building new housing helps attract new residents, boosts neighborhood appeal, and signals investment in the community's future.

The construction of nearly 250 new homes contributed approximately $143 million in property value increases, with each new home adding an average of $588,000 to local property values. The BCR for new construction was 1.75, meaning every dollar spent on building new homes generated $1.75 in increased property value.

ES.3.4 Property Tax Revenue

One of the primary objectives of the Cuyahoga Land Bank is to return vacant and abandoned properties to productive use, generating tax revenue for local governments. Between 2009 and 2023, the Land Bank returned nearly 12,800 properties to the tax rolls, which collectively generated over $48 million in property tax revenue.

This influx of tax revenue supports essential public services, such as schools, public safety, and infrastructure. The average tax revenue generated per property was about $3,777, and the amount continues to grow each year as more properties are returned to productive use.

ES.3.5 Catalyzed Private Investment

The Land Bank's efforts have also played a pivotal role in catalyzing private sector investment. By assembling land, clearing titles, and preparing properties for development, the Land Bank has created opportunities for large-scale private investments that drive economic growth. One of the most notable examples is the construction of an Amazon Fulfillment Center on land assembled by the Land Bank.

In total, the Land Bank's activities have sparked over $395 million in private investment, contributing to job creation, commercial development, and new housing projects across Cuyahoga County.

ES.3.6 Economic Impact of Land Bank Expenditures

From 2009 to 2024, Cuyahoga Land Bank spent about $330 million on demolitions, renovations, new constructions, and other activities. These expenditures generated a total economic output of $632.7 million in the local economy, with a multiplier effect of 1.9. This means that for every dollar the Land Bank spent, an additional $0.90 was generated in the local economy, benefiting contractors, local businesses, and workers.

ES.3.7 Benefit-Cost Analysis

The Cuyahoga Land Bank's activities have yielded substantial returns on investment, as demonstrated by the benefit-cost ratios for each of its core programs:

- **Demolitions**: BCR of 9.74 — every $1 spent generates $9.74 in increased property values.
- **Renovations**: BCR of 13.52 — every $1 spent generates $13.52 in increased property values.
- **New Constructions**: BCR of 1.75 — every $1 spent generates $1.75 in increased property values.

When considering all activities together, the Land Bank generates approximately $11 in total economic impact for every dollar it spends. This demonstrates that the Land Bank's investments are highly effective in driving local economic growth and revitalization.

1. Introduction

Cleveland, Ohio, a city with a rich industrial heritage, has long been recognized for its strategic location on the southern shore of Lake Erie, providing pivotal access to major shipping routes and trade. During the 20th century, Cleveland experienced significant economic growth and became a hub for manufacturing, particularly in steel production and automotive industries. The city's robust infrastructure, including its port and rail systems, further catalyzed its expansion, attracting a diverse population and fostering a vibrant urban culture.

Despite its prosperous history, Cleveland faced considerable challenges late in the 20th century. The diffusion of manufacturing industries across the globe, coupled with suburbanization and economic restructuring, led to significant changes within the city and county. From a peak of nearly 915,000 residents in 1950, the city's population dwindled to less than 400,000 by 2020. This demographic shift initiated a housing surplus crisis, which drove down property values and led to vacancy and abandonment of older properties as their values fell below renovation costs. The result was a vicious cycle that further depressed property values, leading to urban blight and the deterioration of surrounding properties as the housing stock aged over time.

The crisis became particularly acute in the wake of the 2008 financial crisis (Alexander, 2011). Foreclosures surged, leaving thousands of additional properties vacant and abandoned. These distressed properties not only blighted neighborhoods but also depressed property values, strained municipal resources, and posed significant public safety hazards. The situation demanded urgent and innovative interventions to prevent further urban decay and stimulate economic recovery.

In response to these pressing challenges, the Cuyahoga County Land Reutilization Corporation, commonly known as the Cuyahoga Land Bank (henceforth referred to as the Land Bank), was established in 2009. The Land Bank was conceived as a strategic tool to address the burgeoning issue of vacant and abandoned properties. Its creation was grounded in the notion that conventional market mechanisms were insufficient to tackle the scale of the housing crisis, particularly in the wake of the Great Recession.

The Land Bank's mission is to acquire, manage, and repurpose distressed properties, transforming them back into productive community assets. By leveraging public and private partnerships, grants, direct property sales, and a funding stream derived from the allocation of a small percentage of penalties and interest collected from delinquent property taxes, the Land Bank aims to stabilize neighborhoods, enhance property values, and foster economic development. The organization employs a multifaceted approach, including the demolition of unsafe and unsalvageable structures, renovation of salvageable homes, and facilitation of new construction on vacant lots.

Since its inception, the Land Bank has made significant strides in mitigating the adverse effects of the housing crisis. It has strategically demolished blighted properties to eliminate public safety hazards and assembled parcels of land for future development. Additionally, the Land Bank has worked with local stakeholders to renovate homes and return them to the market, thereby stabilizing declining markets, revitalizing neighborhoods, and restoring community pride.

In 2019, the Cuyahoga Land Bank commissioned Dynamo Metrics (Dynamo Metrics, 2019) to complete a 10-year impact study. This comprehensive study utilized spatial autoregressive hedonic price models to quantify the economic impacts of the Land Bank's activities from 2009 to 2019. The findings demonstrated that Land Bank demolitions and renovations had substantial positive effects on residential property values that contributed to neighborhood stabilization, increased tax revenues, and improved community well-being.

The current 15-year impact study builds upon and extends the methodology of the 2019 study. Building on the strengths of the previous analysis, this study adopts similar frameworks for consistency and comparability while also introducing methodological enhancements to improve the precision and depth of the estimates. This analysis employs Bayesian methods in the context of the Spatial Durbin Model (SDM) in the econometric analysis—a more flexible spatial econometric specification that captures spatial dynamics in both the dependent and independent variables and facilitates the computation of direct, indirect (spillover), and total effects of the Land Bank's interventions on property values.

By integrating the foundational work of the 2019 study and incorporating updated data and methods, this analysis provides an enriched perspective on the Land Bank's cumulative economic impact over its first 15 years.

2. Study Overview

This study aims to provide a comprehensive estimation of the measurable economic impacts of the Cuyahoga Land Bank's activities over its first 15 years of operation. The analysis focuses on six primary components that collectively represent the Land Bank's economic impact in addressing the housing crisis and stimulating economic growth in Cuyahoga County:

- **Impacts of Demolitions on Residential Property Values**: Evaluating how the demolition of nearly 10,000 blighted and unsalvageable structures by the Land Bank has influenced surrounding residential property values across different housing submarkets. By removing these hazards, the Land Bank has helped eliminate public safety risks and curb the spread of urban blight.
- **Impacts of Renovations on Residential Property Values**: Assessing the effect of more than 2,600 property renovations on nearby residential property values. These renovations have not only restored individual properties but have also contributed to neighborhood stabilization and revitalization, enhancing overall community desirability.
- **Impacts of New Constructions on Residential Property Values**: Measuring the impact of nearly 250 new residential constructions on local property values. These new houses have filled vacant lots, improved neighborhood aesthetics, and attracted new residents, thereby fostering economic development.
- **Generation of Property Tax Revenue**: Calculating the direct property tax revenue generated from nearly 12,800 properties returned to productive use by the Land Bank. This influx of revenue, totaling over $48 million, supports municipal services and contributes to the financial health of local governments.

- **Catalyzed Private Sector Investment**: Identifying and quantifying direct private sector investments induced by the Land Bank's activities. The Land Bank's efforts have spurred over $395 million in private investments through projects such as the Amazon Fulfillment Center and various housing developments, amplifying economic growth, and job creation.
- **Economic Impact of Land Bank Expenditures on Local Activity**: Analyzing how the Land Bank's expenditures, amounting to $330 million over 15 years, have stimulated local economic activity using well established Economic Impact Analysis methodologies.

Each of these components is meticulously examined and quantified in this study. The aggregated total economic impact is estimated to be approximately **$3.6 billion**, highlighting the substantial contributions of the Cuyahoga Land Bank to urban revitalization and economic resilience across Cuyahoga County and the City of Cleveland.

This comprehensive assessment underscores the effectiveness of the Land Bank's multifaceted approach, which includes strategic demolitions, targeted renovations, new constructions, and fostering partnerships that catalyze private investment. The findings demonstrate how the Land Bank's interventions have not only addressed the immediate challenges of residential blight and abandonment but have also laid the groundwork for sustained economic development and improved quality of life for residents.

3. Property Value Impacts

Numerous studies have documented the negative impact of residential blight on nearby property values. Blighted properties—characterized by neglect, abandonment, and physical deterioration—are associated with decreased aesthetic appeal, increased crime rates, lower property tax revenue, and lower overall neighborhood desirability. Consequently, the market value of adjacent properties diminishes significantly (Spelman, 1993; Cui, 2010; Hirokawa and Gonzalez, 2010; Whitaker and Fitzpatrick, 2012; Whitaker and Fitzpatrick, 2014; Han, 2014; Stacy, 2017; vom Hofe, Parent, and Grabill, 2019).

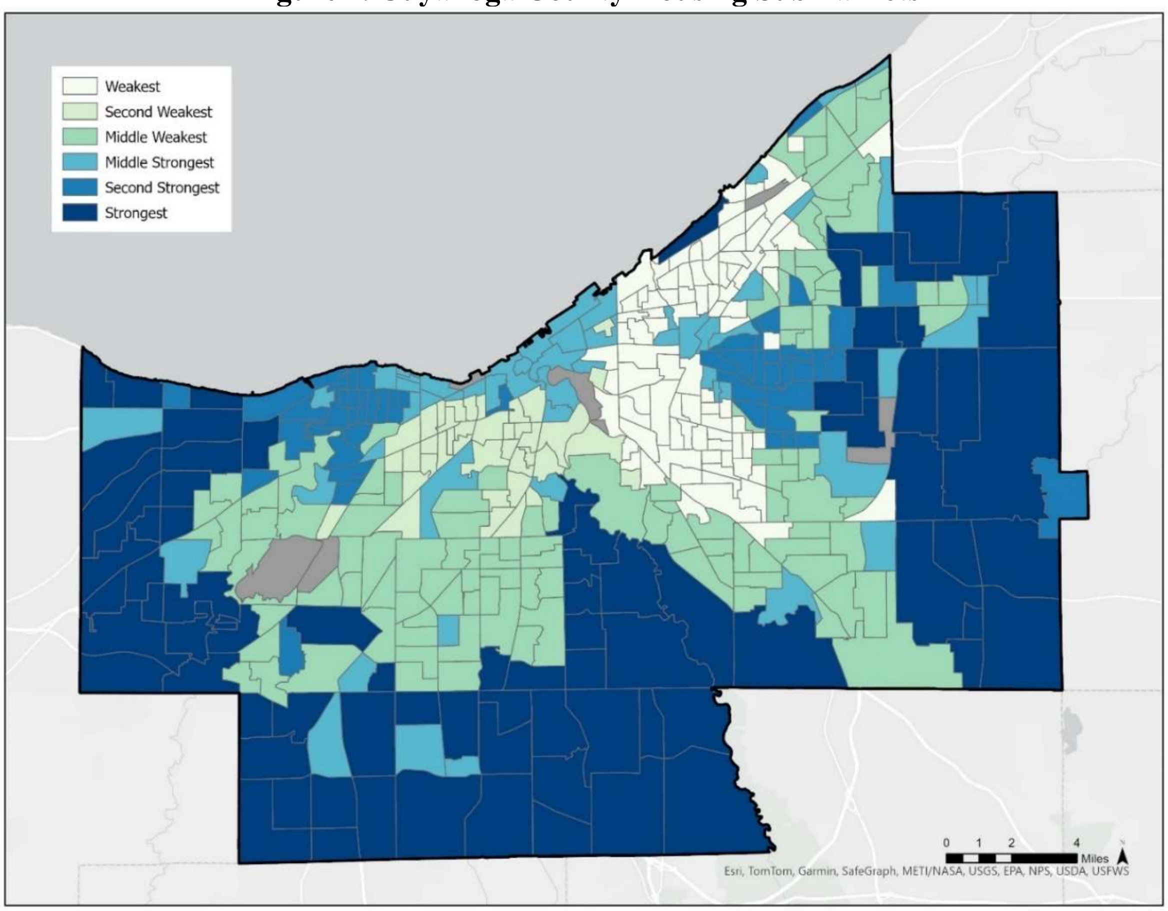
In the 2019 economic impact study conducted on the Cuyahoga Land Bank by Dynamo Metrics, it was found that strategic demolition and renovation efforts had a substantial positive impact on surrounding property values in Cuyahoga County. That study estimated that the demolition of nearly 7,000 blighted properties and the renovation of over 2,000 more led to an aggregate increase of approximately $735 million in property values over a ten-year period (Dynamo Metrics, 2019).

The economic impact of land banks on residential blight is significant in other places as well. For example, the Cook County (Illinois) Land Bank Authority reported that the renovation of just 66 single and multi-unit properties in Fiscal Year (FY) 2023 resulted in an estimated increase in nearby home values between $54 million and $101 million (Griswald Consulting Group, 2024a). Similarly, a FY 2023 study of the South Suburban Land Bank and Development Authority (Chicago, IL) estimated that each FY 2023 renovation increased the property values of surrounding houses by 13.1 percent per property, while vom Hofe, Parent, and Grabill (2019) find that vacant structures decrease local property values by 4.1 percent in Cincinnati Ohio and that demolishing and reconstructing them increases values by 14.1 percent (Griswald Consulting Group, 2024b; vom Hofe, Parent, and Grabill, 2019).

4. Methodological Framework for Estimating Property Value Impacts

To estimate the total 15-year economic impact of the Land Bank, the current study employs multivariate clustering algorithms and an appropriate spatial econometric framework to estimate the total effects of the Land Bank's activities on residential property values by market segment. Given that impacts vary both theoretically and empirically across housing markets, the first step of the analysis is to identify appropriate submarkets to be individually modeled. To do this, Cuyahoga County is decomposed into six submarkets using machine learning (k-means clustering algorithms). The elbow method was used to determine that six submarkets best fit the data[1]. The resulting submarkets are shown in Figure 1.

Figure 1. Cuyahoga County Housing Submarkets



[1] Hierarchical clustering algorithms were also employed as a sensitivity analysis. The clustering results from both algorithms are nearly the same. K-means were employed in the final analysis to facilitate a databased determination of the appropriate number of clusters to use.

Upon constructing the submarkets, a Spatial Durbin Model (SDM) specification is applied to each of the resulting submarkets for several reasons[2]. First, the SDM accounts for the complex spatial interactions in local housing markets within and, potentially, across each submarket, depending on the specification. LeSage and Pace (2009) originally describe this phenomenon as the influence of a property on its neighbors being projected back onto the original property via higher order reactions to the neighbors' changes (vom Hofe, Parent, and Grabill, 2019). Second, the SDM is robust to the influence of omitted variables, including situations where included variation in the various explanatory variables is correlated with excluded variation among them (See LeSage and Fischer, 2008 or Sutter, 2010 for more details). Lastly, the SDM facilitates the decomposition of the partial derivatives into direct, indirect and total effect estimates. See Appendix 1 and 2 for more information on estimating the submarkets and the SDM.

In simpler terms, the current approach recognizes property values are interconnected and vacant or abandoned houses reduce the values of their neighbors' houses. Those reductions not only impact neighboring houses but ripple through the entire local area as the impacts they have on their neighbor's houses impacts the neighbors of their neighbors' houses, and the neighbors of their neighbors' neighbors' houses, and so on. The SDM approach implemented in this study facilitates estimating how individual property characteristics and the conditions of nearby properties influence house values and how those influences ripple through the local housing markets. This approach provides a richer assessment of the impact of residential blight on property values in Cuyahoga County.

By accounting for the direct, indirect, and total effects, this analysis offers a comprehensive account of the housing market dynamics and provides complete impact estimates for demolitions, renovations, and new housing constructions on local housing values.

5. Data Sources: NEO CANDO and Cuyahoga Land Bank Property Profile System

The data for this analysis are sourced from the Northeast Ohio Community and Neighborhood Data for Organizing (NEOCANDO), a comprehensive database managed by Case Western Reserve University and the Cuyahoga Land Bank's Property Profile System (PPS), a centralized cloud based property management solution that contains all information related to properties that are either acquired, in inventory, or completed by the Land Bank[3], from 2010 to 2024. Integrating these two sources results in an extensive dataset that allows for modeling the impacts of the Land Bank's activities on property values to quantify and sum the impacts of demolishing blighted unsavable properties, renovating blighted savable properties, and constructing new houses on vacant available lots over the 15 years of the Land Bank's existence[4].

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[2] It should be noted that alternative specifications were implemented that included estimating spatial fixed effects for the submarkets using the block diagonal structure of vom Hofe, Parent, and Grabill (2019). While the total impact estimates were similar, we rely on separate regression because including fixed effects for the submarkets forces the coefficient estimates on the variables of interest to be the same across them.

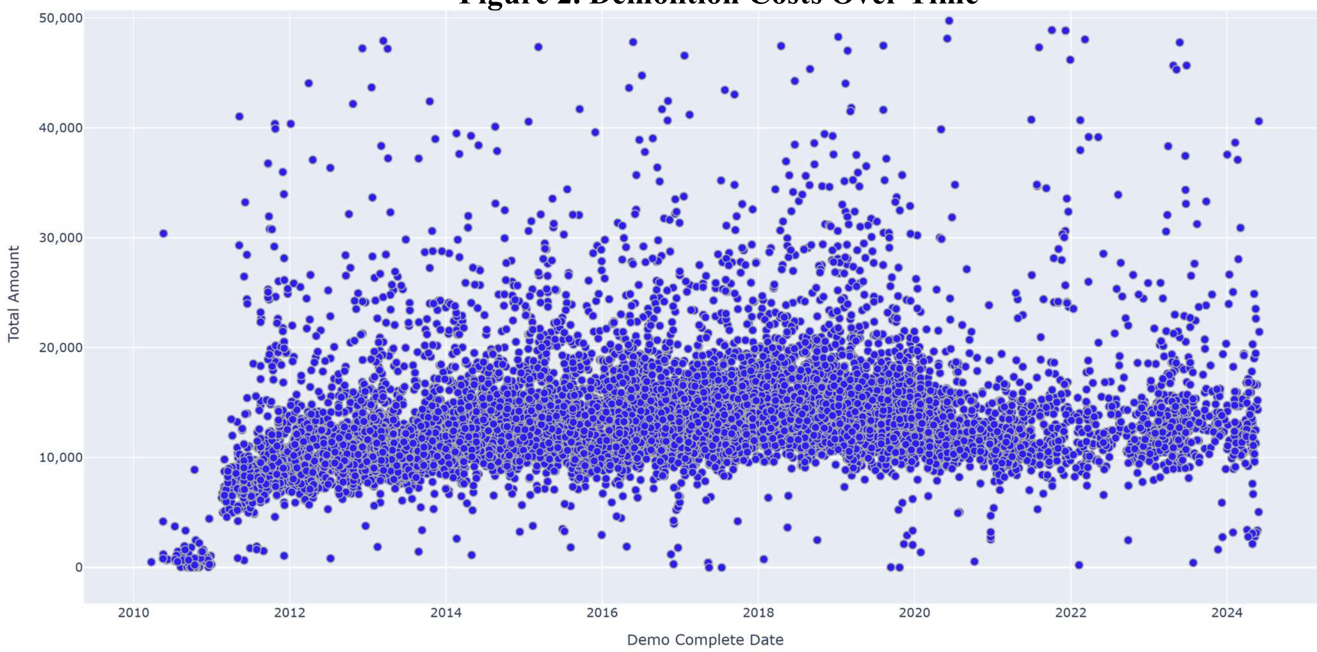
[3] https://pps.land/

[4]

6. The Economic Impacts of Demolitions

Since its inception through June 2024, the Land Bank has spent more than $150.4 million on demolition. These funds were used for 9,883 demolitions, resulting in an average cost of $15,223 per demolition. Most of these activities took place in the county's weakest submarkets, with 78% (7,704 of 9,883) occurring in the weakest submarket alone, and 96% in the three weakest submarkets combined. In contrast, 3% of demolitions were carried out in the mid-strong market, with only 1% in the two strongest submarkets.

Figure 2. Demolition Costs Over Time[5]



RESIDENTIAL PROPERTY VALUE IMPACT FROM CUYAHOGA LAND BANK DEMOLITIONS, 2009 – 2024				
SUBMARKET TITLE	**NUMBER OF DEMOS**	**RESIDENTIAL PROPERTY VALUE IMPACT**	**AVERAGE IMPACT PER DEMO**	**AVERAGE BCR**
Weakest	7704	$384,750,039	$59,021	$3.88
Second Weakest	960	$410,411,426	$1,102,733	$72.44
Mid-Weakest	786	$136,728,430	$384,271	$25.24
Mid-Strongest	290	$373,331,035	$2,675,944	$175.78
Second Strongest	85	$160,677,844	$3,467,099	$227.75
Strongest[6]	56	$0	$0	$0.00
TOTALS[7]	**9883**	**$1,465,898,774**	**$148,325**	**$9.74**

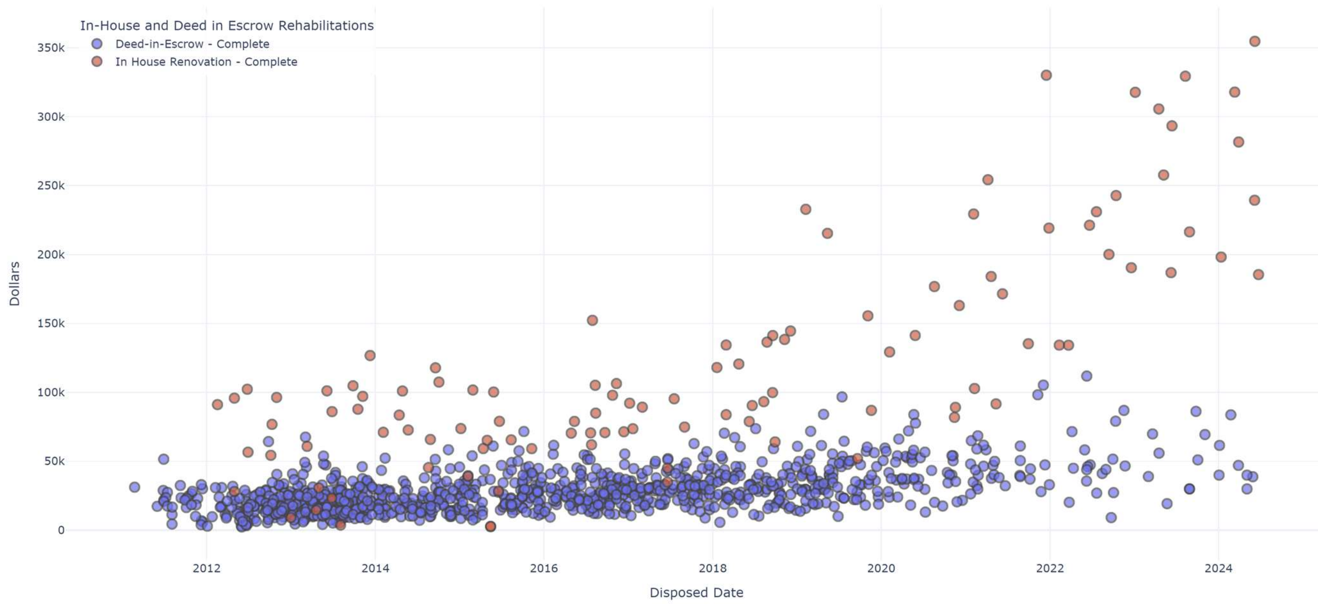
[5] This figure excludes outliers (demolitions over $50,000) for visualization purposes.
[6] Coefficients were not statistically significantly different from zero at the 95% level.
[7] The submarkets do not sum to the total because two demolitions were conducted in Summit County.

As anticipated, the impacts vary significantly across the submarkets, with an average increase of $148,325 in property value per demolition. Given the average demolition cost of $15,223, this equates to a BCR of 9.74. In other words, every dollar spent on demolition generates $9.59 in increased residential property values across the county. Overall, Land Bank demolition expenditures have boosted local property values by approximately $1.47 billion.

7. The Economic Impacts of Residential Renovations

From 2009 through June 2024, the Land Bank and its partners are estimated to have spent $87.6 million on renovations. These funds supported 2,646 renovations, resulting in an average cost of $33,117 per renovation. In-house renovations by the Land Bank are significantly more intensive than Deed in Escrow renovations, which focus on bringing deteriorated structures up to code. In contrast, the in-house projects have evolved into more extensive renovations, often resembling new construction.

Figure 3. Land Bank In-House and Deed in Escrow Renovations Costs over Time[8]



More than 90% of renovations were concentrated in the three weakest submarkets, with only nine occurring in the strongest markets. While the impacts vary across submarkets, the total property value increase is estimated at just under $1 billion. On average, each renovation is estimated to have a property value impact of $358,808, resulting in a BCR of $13.52 for every dollar spent on renovation.

[8] This Figure excludes renovation projects that are underway but not yet completed, renovations that were transferred to other organizations, and outliers for visualization purposes.

RESIDENTIAL PROPERTY VALUE IMPACT FROM LAND BANK RENOVATIONS, 2009 – 2024				
SUBMARKET TITLE	**NUMBER OF RENOVATIONS**	**RESIDENTIAL PROPERTY VALUE IMPACT**	**AVERAGE IMPACT PER REHAB**	**AVERAGE BCR**
Weakest	876	$60,669,030	$69,257	$2.61
Second-Weakest	642	$277,833,898	$432,763	$16.31
Mid-Weakest	882	$233,330,573	$264,547	$9.97
Mid-Strongest	123	$160,432,305	$1,304,328	$49.15
Second Strongest	114	$217,140,693	$1,904,743	$71.78
Strongest[9]	9	$0	$0	$0.00
TOTALS	**2646**	**$949,406,499**	**$358,808**	**$13.52**

8. The Economic Impacts of Residential New Constructions

From 2009 through June 2024, the Land Bank and its partners are estimated to have spent $81.7 million on new residential construction. These funds supported the construction of 243 new homes, with an average cost of $336,447 per home.

Over 80% of these new constructions took place in the three weakest submarkets, while 5.3% were built in the strongest market. As with other activities, the economic impacts vary significantly across submarkets. The total property value impact from new construction is estimated at just over $142.8 million, with an average impact of $587,841 per home, resulting in a BCR of $1.75 for every dollar spent on new construction.

RESIDENTIAL PROPERTY VALUE IMPACT FROM LAND BANK NEW CONSTRUCTIONS, 2009 – 2024				
SUBMARKET TITLE	**NUMBER OF REHABS**	**RESIDENTIAL PROPERTY VALUE IMPACT**	**AVERAGE IMPACT PER NEW CONSTRUCTION**	**AVERAGE BCR**
Weakest	88	$21,595,938	$245,408	$0.73
Second-Weakest	90	$62,903,160	$698,924	$2.08
Mid-Weakest	23	$26,800,072	$1,165,221	$3.46
Mid-Strongest	29	$17,223,761	$593,923	$1.77
Second Strongest	9	$11,797,927	$1,310,881	$3.90
Strongest	4	$2,524,473	$631,118	$1.88
TOTALS	**243**	**$142,845,330**	**$587,841**	**$1.75**

[9] Coefficients were not statistically significantly different from zero at the 95% level.

9. Neglected Properties Returned to Tax Rolls

Generating property tax revenue is one goal in the Land Bank's mission of returning vacant and abandoned properties to productive use. To estimate the total cumulative impact of the Land Bank's activities on property tax revenue, properties influenced by the Land Bank were identified using NEOCANDO data and the Land Bank's PPS. These properties were then linked with property tax data to quantify the total property tax revenue generated over the past 15 years.

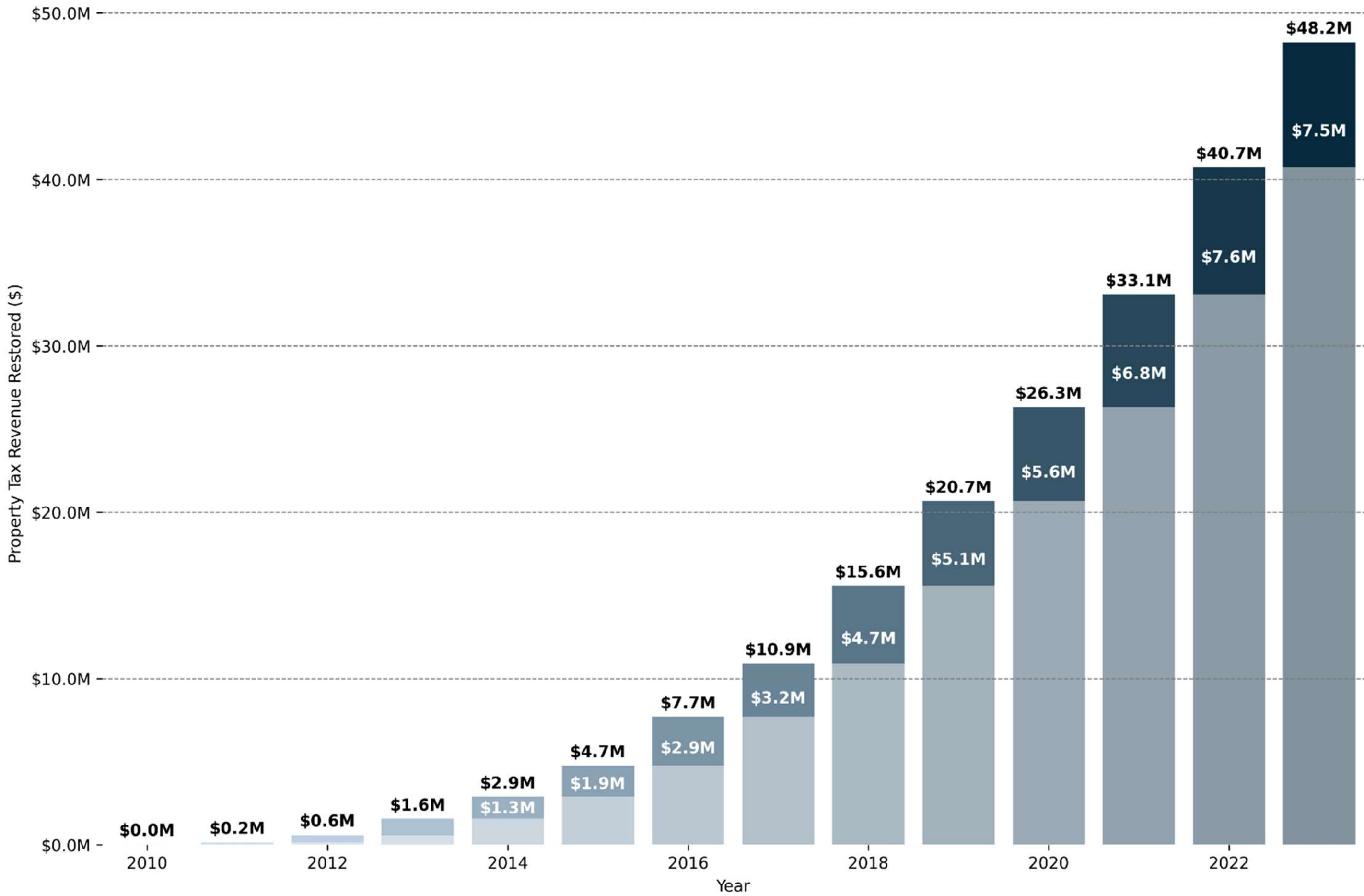
As shown in the table below, a total of 12,772 properties were owned or impacted by the Land Bank and returned to the tax rolls between 2009 and 2023. The cumulative property tax revenue generated by these activities is estimated at just over $48.2 million. On average, a vacant lot resulting from a demolition generated $2,920 in property taxes between 2009 and 2024 period. Renovated properties generated nearly $6,000 per property, while new constructions averaged $14,500 per property. Overall, the 12,772 properties impacted by the Land Bank generated an average of $3,777 in cumulative property tax revenue per property over the entire period.

CUMULATIVE PROPERTY TAX REVENUE RESTORED, 2009 – 2024			
Land Bank Activity Before Sale	**Property Count**	**Revenue Generated**	**Average Revenue Per Property**
Demolition	9,883	$28,857,744	$2,920
Renovation	2,646	$15,861,071	$5,994
New Construction	243	$3,523,472	$14,500
Total Impact	12,772	$48,242,288	$3,777

Property tax revenues generated by the Land Bank grow over time through a compounding effect. Properties returned to the tax rolls in 2010, for example, continue to generate tax revenue for many years, while new properties added in subsequent years further contribute to the total. As a result, the overall tax revenues increase as more properties are returned to the tax rolls, while those from previous years continue to pay taxes.

Figure 4 shows the tax revenue generated by Land Bank properties returned to the tax rolls by year. The chart shows the cumulative total through each given year, labeled in bolded black. In 2010, the first year of the organization, the Land Bank generated $28,000 in property tax revenue. By 2017, property tax revenue generated by Land Bank activities surpassed $10 million, with $3.2 million (labeled in white) being generated in 2017 alone. By the end of 2023, Land Bank activity generated more than $48 million in property tax revenue, with $7.5 million being added in 2023.Considering the Land Bank expended about $28 million in 2023, $7.5 million in newly generated property tax revenue represents about 25 percent of the annual expenditures of the Land Bank. If these revenues continue to compound at their current rate of increase, property tax revenue the Land Bank generates could exceed their expenditures within the next decade. In other words, the Land Bank could be expending less than it is returning in property tax revenues at some point in the future.

Figure 4. Tax Revenue Restored by Properties Back on the Tax Rolls by Year



10. Catalytic Private Investment

The Land Bank also plays a catalytic role in the community, acquiring properties for various purposes. In many cases, it prepares these properties for traditional economic development activities, such as assembling land for the construction of an Amazon fulfillment center or for new homes built by Habitat for Humanity.

The table below highlights 29 economic development projects where the Land Bank played a pivotal role by providing services such as land acquisition, land assemblage, demolition, technical assistance, foreclosure research and tracking, remediation, conveyance, title clearing/lien removal, and/or creative financing.

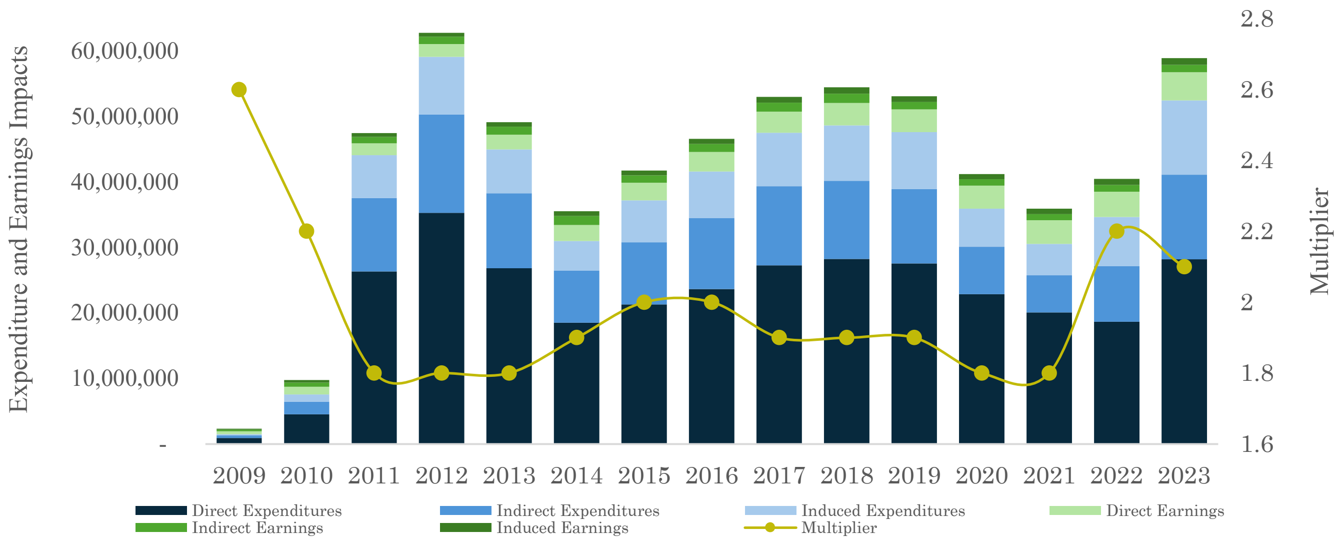
Cuyahoga Land Bank Catalyzed Projects, 2009-2024	
PROJECT	**AMOUNT OF PROJECT**
Randall Mall Amazon Fulfillment Center	$171,000,000
Detroit Ave. Redevelopment	$47,000,000
Bedford Hemisphere Land Acquistion and Development	$34,000,000
Mueller Electric Building	$16,000,000
Micelli's Dairy	$16,000,000
YMCA Housing First	$13,900,000
Euclid Avenue Ave. Housing First	$12,130,000
HGR Industries	$12,000,000
Fisher House Circle North Initiative	$11,000,000
West 98th St.	$9,047,000
Heinen's	$9,000,000
Children's Museum	$7,000,000
Circle East District	$5,600,000
Chevybrook Estates Housing Project	$4,800,000
LaSalle Theater	$4,100,000
Universal Windows	$3,500,000
Circle East (Town Homes)	$3,500,000
Newburgh Heights Police	$2,800,000
Jordan Community Resource Center	$2,050,000
Swingos on the Lake	$2,000,000
E. 62nd St. Redevelopment	$1,820,000
12 Homes in Shaker Heights Redevelopment	$1,500,000
St. Michael's Arch	$1,400,000
Habitat for Humanity W. 128th Homes	$1,250,000
Trencher Industrial Site	$1,000,000
Crossburn Avenue	$650,000
Lakeside Avenue Industrial Complex	$600,000
HELP Inc.	$500,000
Meyers Dairy	$300,000
TOTAL	**$395,447,000**

11. Impact of Cuyahoga Land Bank Expenditures on Local Economic Activity

The economic impact of Land Bank expenditures, along with private sector renovation investments, was estimated from 2009 to 2024 using established Economic Impact Analysis methodologies. This process accounted for the specific characteristics of Cuyahoga County's economy, tracing the flow of Land Bank spending through the local economy. This approach allowed for the estimation of total economic output generated by both the Land Bank's direct expenditures and the associated private sector investments. See Appendix 3 additional details.

From 2009 to 2024, the Land Bank's total expenditures amounted to approximately $330.2 million. This spending was analyzed using the IMPLAN model for the relevant industry sectors to calculate the direct, indirect, and induced impacts on expenditures and employee earnings.

Figure 5. Land Bank Annual Expenditures and Cuyahoga County Impacts



LAND BANK ANNUAL EXPENDITURES AND CUYAHOGA COUNTY IMPACTS, 2009 – 2024										
Year	**Direct Expenditures**	**Indirect Expenditures**	**Induced Expenditures**	**Total Expenditure**	**Direct Earnings**	**Indirect Earnings**	**Induced Earnings**	**Total Earnings**	**Total Economic Output**	**Multiplier**
2023	$28,210,000	$12,921,000	$11,331,000	**$52,462,000**	$4,317,000	$1,134,000	$1,016,000	**$6,467,000**	**$58,929,000**	**2.1**
2022	$18,648,000	$8,541,000	$7,490,000	**$34,679,000**	$3,867,000	$1,016,000	$910,000	**$5,793,000**	**$40,472,000**	**2.2**
2021	$20,077,000	$5,702,000	$4,789,000	**$30,567,000**	$3,597,000	$963,000	$815,000	**$5,375,000**	**$35,942,000**	**1.8**
2020	$22,866,000	$7,264,000	$5,784,000	**$35,913,000**	$3,565,000	$954,000	$808,000	**$5,328,000**	**$41,241,000**	**1.8**
2019	$27,566,000	$11,339,000	$8,735,000	**$47,640,000**	$3,448,000	$1,163,000	$885,000	**$5,495,000**	**$53,135,000**	**1.9**
2018	$28,229,000	$11,970,000	$8,452,000	**$48,651,000**	$3,425,000	$1,448,000	$963,000	**$5,836,000**	**$54,487,000**	**1.9**
2017	$27,270,000	$12,077,000	$8,176,000	**$47,524,000**	$3,264,000	$1,370,000	$869,000	**$5,503,000**	**$53,027,000**	**1.9**
2016	$23,668,000	$10,840,000	$7,096,000	**$41,605,000**	$2,981,000	$1,251,000	$794,000	**$5,026,000**	**$46,631,000**	**2.0**
2015	$21,296,000	$9,507,000	$6,385,000	**$37,188,000**	$2,722,000	$1,142,000	$725,000	**$4,589,000**	**$41,777,000**	**2.0**
2014	$18,503,000	$7,986,000	$4,496,000	**$30,985,000**	$2,445,000	$1,366,000	$729,000	**$4,540,000**	**$35,525,000**	**1.9**
2013	$26,852,000	$11,425,000	$6,708,000	**$44,985,000**	$2,250,000	$1,248,000	$688,000	**$4,186,000**	**$49,171,000**	**1.8**
2012	$35,309,000	$15,023,000	$8,821,000	**$59,153,000**	$1,963,000	$1,089,000	$601,000	**$3,652,000**	**$62,805,000**	**1.8**
2011	$26,334,000	$11,204,000	$6,579,000	**$44,118,000**	$1,805,000	$1,001,000	$552,000	**$3,358,000**	**$47,476,000**	**1.8**
2010	$4,503,000	$1,916,000	$1,125,000	**$7,544,000**	$1,179,000	$654,000	$361,000	**$2,193,000**	**$9,737,000**	**2.2**
2009	$883,000	$376,000	$221,000	**$1,480,000**	$444,000	$246,000	$136,000	**$826,000**	**$2,306,000**	**2.6**
Total	$330,214,000	$138,091,000	$96,188,000	**$564,494,000**	$41,272,000	$16,045,000	$10,852,000	**$68,167,000**	**$632,661,000**	**1.9**

The total economic output generated by the $330.2 million in Land Bank expenditures is estimated at $632.7 million, yielding a multiplier of 1.9. This means that every dollar of Land Bank spending generated $1.90 in economic output within the County.

12. Summary of Findings

This study employs academically robust methods from fields such as spatial econometrics, regional economic impact analysis, and data science, combined with Land Bank leadership reports on catalyzed private sector investment, to estimate the total economic impact of all Land Bank activities and expenditures over its first 15 years. The table below summarizes the impact of each component of the evaluation. Overall, Land Bank activities have generated an estimated economic impact of $3.6 billion in Cuyahoga County.

Increased Property Values and Blight Reduction

- $1.5 billion in increased home values for local residents from nearly 10,000 demolitions.
- $1 billion in increased home values for local residents from over 2,600 home renovations.
- $143 million in increased home values for local residents from nearly 250 new home constructions.

Neglected Properties Back on the Tax Rolls

- $48.2 million in property tax revenue generated by Land Bank activities.
- $395 million in direct private investment catalyzed by Land Bank activities.

Local Economic Impacts

- $632.7 in local economic impact created from Land Bank budget expenditures between 2009 and 2024.
- Land Bank 15-year expenditures of $330.2 has an estimated BCR of**:** $11 in total economic impact for every $1 spent by the Land Bank.

TOTAL ESTIMATED ECONOMIC IMPACT OF THE CUYAHOGA LAND BANK, 2009 – 2024	
Component	**DOLLAR IMPACT**
Residential Property Value Impact from Land Bank Demolitions	$1,465,898,774
Residential Property Value Impact from Land Bank Renovations	$949,406,499
Residential Property Value Impact from Land Bank New Constructions	$142,845,330
Direct Property Tax Revenue of Land Bank Properties Back on Tax Rolls	$48,242,288
Direct Private Investment Induced by the Land Bank	$395,447,000
Land Bank Economic & Employment Impact	$632,661,000
TOTAL ESTIMATED 15-YEAR ECONOMIC IMPACT	**$3,634,500,891**

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Appendix 1: Submarket Details and Summary Statistics

To accurately estimate the impact of the Land Bank's activities on residential property values across different housing markets in Cuyahoga County, it was essential to segment the county into distinct submarkets. This appendix provides a detailed explanation of the methodological framework used for this segmentation, including the data preparation, clustering algorithm, determination of the optimal number of clusters, and validation of the clustering results.

A comprehensive dataset was compiled using NEOCANDO data to capture the multifaceted nature of the housing markets within Cuyahoga County. The variables selected for clustering included in the table of summary statistics below. All continuous variables were standardized (z-scores) to ensure that each variable contributed equally to the clustering process. Standardization was necessary because variables were measured on different scales.

AVERAGED CENSUS TRACT VARIABLES BY SUBMARKET						
VARIABLE	WEAKEST	SECOND WEAKEST	MID WEAKEST	MID STRONGEST	SECOND STRONGEST	STRONGEST
Median Household Income	$30,927	$38,131	$61,641	$45,466	$90,812	$111,521
Median Rent	$824	$855	$1,066	$966	$1,131	$1,426
Median Housing Value	$67,325	$87,429	$132,890	$192,788	$237,313	$291,572
Unoccupied	22.6%	14.1%	6.6%	13.0%	7.4%	5.0%
Owner Occupied	40.3%	41.5%	66.7%	25.4%	67.0%	87.3%
Bachelor's Degree or More	13.1%	12.4%	25.4%	37.4%	60.3%	51.1%
Below Poverty Line	35.2%	34.6%	13.5%	23.8%	9.0%	4.7%
Unemployment	17.1%	13.4%	6.4%	7.9%	4.4%	3.6%
1-Bedroom Homes	11.4%	10.0%	8.1%	37.5%	9.6%	3.5%
2-3 Bedroom Homes	47.0%	48.1%	30.4%	71.1%	32.1%	19.0%
4 Bedroom Homes	13.2%	12.0%	12.4%	5.2%	21.2%	34.2%
Built 2010 - Present	1.7%	2.4%	0.8%	5.7%	0.8%	4.2%
Built 2000 - 2009	3.6%	3.4%	1.9%	4.1%	1.2%	7.6%
Built 1980 - 1999	6.5%	3.4%	6.0%	13.5%	3.7%	26.3%
Built 1960 - 1979	11.9%	9.4%	27.1%	32.2%	12.7%	34.2%
Built 1940 - 1959	21.5%	18.9%	50.2%	16.3%	27.0%	21.7%
Built Before 1939	54.9%	62.4%	14.0%	28.1%	54.5%	6.0%
Household Size	2.2	2.5	2.3	1.7	2.3	2.4
Under Age 17 in Household	24.8%	26.4%	20.0%	12.0%	18.6%	20.1%
Median Age of People	38.6	34.0	42.3	39.3	37.9	48.2
Caucasian	8.5%	43.3%	55.7%	50.1%	73.9%	84.2%
African American	85.0%	19.9%	33.0%	32.0%	15.7%	4.7%
Hispanic	2.1%	29.1%	5.6%	6.8%	3.7%	3.3%

The k-means clustering algorithm was employed to partition the dataset into *k* distinct submarkets. K-means is an unsupervised machine learning algorithm that groups data points into clusters based on feature similarity. Euclidean distance was used as the distance metric for determining the similarity between data points and centroids. The elbow method and silhouette analysis were used to identify the appropriate number of clusters. As was the case in Dynamo Metrics (2019), six clusters best fit the data and so were used to define the submarkets. Summary statistics for each of the included variables are shown in the table below for each submarket.

Appendix 2: Data for Econometric Analysis

The data for this analysis comes from two primary sources: the Northeast Ohio Community and Neighborhood Data for Organizing (NEOCANDO) and administrative data from the Cuyahoga Land Bank's Property Profile System (PPS).

NEOCANDO is a comprehensive database developed by the Center on Urban Poverty and Community Development, a research institute at the Mandel School of Applied Social Sciences at Case Western Reserve University. Within NEOCANDO is the Property Data Portal, which provides parcel-level data for Cuyahoga County. Available data include property characteristics and tax information from 1990 onward, property transfers (sales) from 1975 onward, foreclosure filings from 2005 onward, and sheriff's sales from 2000 onward. These data are sourced from a variety of entities, including the Cuyahoga County Fiscal Office and the Cuyahoga County Clerk of Courts. Data updates are frequent, with some sources refreshed on a weekly basis.

The Cuyahoga Land Bank's Property Profile System (PPS) is a centralized, cloud-based property management solution used by the Cuyahoga Land Bank and other land banks across the state and country. It is a robust system that can be adapted to the needs of any land bank or organization managing a property portfolio. PPS contains information related to properties that are acquired, in inventory, or completed by the Land Bank. This data was essential for assembling information on demolitions, renovations, and new constructions used in this study.

Integrating these two sources results in an extensive dataset, enabling the modeling of the Land Bank's impact on property values. This dataset supports quantifying and summing the effects of demolishing unsalvageable blighted properties, renovating savable blighted properties, and constructing new homes on vacant lots over the Land Bank's 15-year history.

Following the methodology of Dynamo Metrics (2019), we began by reconstructing their dataset, extending it with five additional years. The final dataset covers the period from 1/1/2010 to 5/31/2024. To address the potential adverse effects of collinear relationships among the variables, we applied the Belsley, Kuh, and Welsch (1980) collinearity diagnostic. This diagnostic utilizes the Singular Value Decomposition of the variance-covariance matrix to create a table of variance-decomposition proportions. Based on their guidelines, we considered condition indices greater than 30 and variance decomposition proportions exceeding 0.5 to signify collinearity issues and to identify problematic variables. This led to the removal and combination of certain variables.

Specifically, we discovered strong evidence that owner-occupied, renter-occupied, and unoccupied tax current statuses were collinear, prompting us to merge them into a single tax current indicator. A similar issue arose with tax delinquencies and mortgage foreclosures, leading to the creation of a unified tax delinquency and mortgage foreclosure variables. The number of bedrooms and bathrooms (both full and half) were also combined into one variable due to collinearity concerns. Variables for porch, terrace, and fireplace were excluded due to missing data in recent years. Additionally, variables representing sales as quitclaims and sales while exiting real estate-owned status were dropped, as they exhibited very high condition indices due to their infrequency in some submarkets and their collinearity with the mortgage and tax foreclosure variables.

The final set of variables is shown in the table below. Spatial lags of each variable were included as the econometric model followed the Spatial Durbin form.

Dependent and Independent Variables	
Variable	**Definition**
Dependent Variable	The log sale price of each residential property sold
Tax Current	# of tax current residential properties within 500 feet
Tax Delinquent	# of tax delinquent residential properties within 500 feet
Mortgage Foreclosed	# of mortgage foreclosed residential properties within 500 feet
Tax Foreclosed	# of tax foreclosed or CCLRC owned residential properties within 500 feet
Vacant Residential Lot	# of vacant residential lots within 500 feet
New Construction	# of new constructions of residential properties, built within the last year, within 500 feet
Bed + Bath	# of bedrooms + number of bathrooms in each sold residential property
Lot Size	The lot size in feet/1000 associated with each sold residential property
Square Footage	The livable square footage in feet/1000 associated with each sold residential property
Air Conditioning	A binary indicator for air conditioning for each sold residential property
Finished Attic	A binary indicator for a finished attic for each sold residential property
Finished Basement	A binary indicator for a finished basement for each sold residential property
Garage	A binary indicator for the presence of a garage for each sold residential property
Brick	A binary indictor for a brick exterior for each sold residential property
Sold While Tax Delinquent	A binary indicator for the sale occurring while the residential structure was tax delinquent
Sold While Foreclosed	A binary indicator for the sale occurring while the residential structure was in any type of foreclosure

Appendix 3: Econometric Specification and Estimation

Understanding the spatial dependencies inherent in housing markets is crucial for accurately estimating the impacts of interventions like demolitions, renovations, and new constructions on property values. The SDM provides a flexible framework that accounts for these spatial interactions by incorporating spatial autocorrelation in both the dependent variable and the explanatory variables. This appendix details the SDM's specification, and the Bayesian methods employed for its estimation in the study, incorporating specific hyperparameters, estimation procedures, and the construction of the spatial weights matrix.

Model Specification

The SDM extends the traditional linear regression model by incorporating spatial lag terms. The general form of the SDM is:

$$y = \rho Wy + X\beta + WX\theta + \varepsilon \quad (1)$$

Where:

- y is an N×1vector of the dependent variable (log-transformed sale prices).
- X is an N×K matrix of exogenous explanatory variables.
- β is a K×1 vector of parameters.
- ρ is the spatial autoregressive parameter for the dependent variable.
- W is the spatial weights matrix.
- θ is a K×1 vector of parameters for the spatially lagged explanatory variables.
- ε is an N×1 vector of independently and identically distributed error terms, $\varepsilon \sim N(0, \sigma^2 I_N)$.

Spatial Weights Matrix Construction

The spatial weights matrix W captures the spatial relationships between observations. In our study, we follow vom Hofe, Parent, and Grabill (2019) and Dynamo Metrics (2019) and construct W based on the six nearest neighbors for each property based on Euclidean distance[10]. As a result, W has elements $w_{ij} = 1$ if property j is among the six nearest neighbors of property i, and $w_{ij} = 0$ otherwise. The matrix W is row-standardized so that each row sums to one:

$$w_{ij} = \frac{w_{ij}}{\sum_{j=1}^{N} w_{ij}} \quad (2)$$

This approach ensures that the spatial influence of neighboring properties is proportionally weighted and comparable across observations.

[10] Alternative specifications from a W selecting 1 nearest neighbor to 15 nearest neighbors were estimated but 6 was associated with the largest posterior model probability.

Interpreting the Coefficients

Interpreting coefficients in spatial regression models like the Spatial Durbin Model (SDM) requires careful consideration due to the presence of spatial dependence and simultaneous feedback effects. Unlike traditional regression models, where coefficients directly represent the effect of explanatory variables on the dependent variable, spatial models involve complex interdependencies among observations across different locations. This means that a change in an explanatory variable at one location can affect not only the dependent variable at that location but also at neighboring locations, which may, in turn, feedback to influence the original location.

In the SDM, like with any spatial model, the presence of spatially lagged dependent variables and spatially lagged explanatory variables introduces simultaneous feedback loops. This interconnectedness implies that the direct interpretation of coefficients β and θ is inappropriate because they do not capture the full extent of the impacts, including spillover and feedback effects.

As shown above, the SDM is specified as:

$$y = \rho W y + X\beta + WX\theta + \varepsilon \tag{3}$$

Rewriting this equation to solve for y:

$$(I_N - \rho W)y = X\beta + WX\theta + \varepsilon \tag{4}$$

The data-generating process for y in the SDM is thus:

$$y = (I_N - \rho W)^{-1}(X\beta + WX\theta) + (I_N - \rho W)^{-1}\varepsilon \tag{5}$$

This expression shows that y depends on both the explanatory variables at each location and the spatially lagged explanatory variables, all filtered through the spatial multiplier $(I_N - \rho W)^{-1}$.

Simultaneous Feedback Effects in the SDM

To explain the simultaneous feedback, we can expand the spatial multiplier using the Neumann series expansion (assuming $|\rho| < 1$):

$$(I_N - \rho W)^{-1} = I_N + \rho W + \rho^2 W^2 + \rho^3 W^3 + \cdots \tag{6}$$

Substituting (6) into (5) results in the data generating process for the spatial multiplier shown in (7):

$$y = (I_N - \rho W)^{-1}(X\beta + WX\theta) + (I_N - \rho W)^{-1}\varepsilon \tag{7}$$

$$y = (I_N + \rho W + \rho^2 W^2 + \rho^3 W^3 + \cdots)(X\beta + WX\theta) + (I_N + \rho W + \rho^2 W^2 + \rho^3 W^3 + \cdots)\varepsilon$$

$$y = X\beta + WX\theta + \rho WX\beta + \rho WWX\theta + \rho^2 W^2 X\beta + \rho^2 W^2 WX\theta + \cdots \varepsilon + \rho W\varepsilon + \rho^2 W^2\varepsilon + \cdots$$

This expansion illustrates how the expected value of y at each location depends on:

- Own characteristics: $X\beta$
- Neighboring characteristics: $WX\theta$
- Spatial lags of own characteristics: $\rho WX\beta$, $\rho^2W^2X\beta$, …
- Spatial lags of neighboring characteristics $\rho WWX\theta$, $\rho^2W^2WX\theta$, …
- Error terms from neighboring locations: $\rho W\varepsilon$, $\rho^2W^2\varepsilon$, …

The higher-order terms (W^2, W^3, ...) represent indirect effects through neighbors of neighbors and so on; creating feedback loops that eventually influence the originating location again.

Decomposing Effects in the SDM: Direct, Indirect, and Total

To properly interpret the impacts in the SDM, we decompose the effects into:

- Direct Effects: The impact of a change in an explanatory variable at location *i* on the dependent variable at the same location *i*, including feedback effects from other locations back to *i*.
- Indirect Effects (Spillover Effects): The impact of a change in an explanatory variable at location *i* on the dependent variable at other locations $j \neq i$, capturing how changes propagate through the spatial network.
- Total Effects: The sum of direct and indirect effects, representing the overall impact of a change in an explanatory variable at location *i* on the entire system.

Calculating the Direct, Indirect, and Total Effects

The matrix of partial derivatives of the expected value of *y* with respect to the explanatory variables *X* is:

$$\frac{\partial E[y]}{\partial X} = (I_N - \rho W)^{-1}(\beta + W\theta) \tag{8}$$

This matrix captures both direct and indirect effects. Diagonal elements represent the direct effects on each location i from its own explanatory variables X_i. Off-diagonal elements represent the indirect effects on location *i* from the explanatory variables at other locations $j \neq i$.

The average direct effect is computed as:

$$\frac{1}{N} trace\left[\frac{\partial E[y]}{\partial X}\right] \tag{9}$$

This averages the diagonal elements of the matrix above, reflecting the average impact on a location from a change in its own explanatory variables, including feedback loops.

The average indirect effect is computed as:

$$\frac{1}{N}\iota'\left[\frac{\partial E[y]}{\partial X} - diag\left(\frac{\partial E[y]}{\partial X}\right)\right]\iota \qquad (10)$$

Where ι is an $N\times 1$ vector of ones and diag extracts the diagonal elements. This averages the off-diagonal elements, representing the spillover effects to other locations. The average total effect then becomes:

$$Avg.Total\ Effect = Avg.Direct\ Effect + Avg.Indirect\ Effect \qquad (11)$$

Implications for Interpretation in the SDM

Due to the simultaneous feedback inherent in the SDM, directly interpreting the coefficients β and θ is misleading. These coefficients do not capture the full magnitude of the effects because they do not account for the spatial multiplier $(I_N - \rho W)^{-1}$ that amplifies and spreads the impacts through the spatial network.

For example, the coefficient β represents the immediate effect of X on y at the same location, but it doesn't include the feedback effects from neighboring locations. The coefficient θ captures the immediate spillover effect of neighboring explanatory variables WX on y, but it doesn't account for higher-order spillovers and feedback loops.

By decomposing the effects, we can fully account for the fact that changes in an explanatory variable at one location affect not only that location but also others, and these effects can loop back. Using only β and θ will underestimate the effects by relying solely on the coefficients from any spatial model.

In spatial regression models like the SDM, the presence of spatial dependence and simultaneous feedback necessitates a decomposition of effects to fully understand and interpret the impacts of explanatory variables. Directly interpreting coefficients without considering the spatial multiplier and the resulting feedback loops can lead to incorrect conclusions. By decomposing the effects into direct, indirect, and total impacts, we can achieve a more accurate and meaningful interpretation, which is essential for accurately estimating the economic impacts of demolitions, renovations, and new constructions.

Bayesian Estimation of the SDM

Bayesian estimation provides a coherent framework for estimating complex models like the SDM, particularly when maximum likelihood estimation becomes computationally intensive due to high-dimensional integration (which is the case here). The Bayesian approach updates prior beliefs about the parameters with information from the data to obtain posterior distributions.

The joint posterior distribution of the parameters is proportional to the product of the likelihood function and the prior distributions:

$$p(\rho,\beta,\theta,\sigma^2|y,X) \propto L(y|\rho,\beta,\theta,\sigma^2,X) \times p(\rho) \times p(\beta) \times p(\theta) \times p(\sigma^2) \qquad (12)$$

Prior Specification

In our Bayesian estimation of the SDM, we follow LeSage and Pace (2009) and specify non-informative or weakly informative priors, allowing the data to primarily influence the posterior distributions. For the prior on ρ we follow LeSage and Pace (2009) and vom Hofe, Parent, and Grabill (2019) and used a uniform distribution. We use multivariate normal priors for both β and θ with prior means of 0, reflecting a non-informative stance without prior inclination toward any direction. The prior covariances are diffuse, Σ_β and $\Sigma_\theta = cI_k$ by setting $c = 10^{12}$. An inverse-gamma prior is assigned to σ^2 with degrees of freedom and scale parameters set to 0.

The Spatial Durbin Model, estimated within a Bayesian framework offers a robust approach to quantify the complex spatial dynamics present in housing markets. By incorporating the specific construction of the spatial weights matrix based on the six nearest neighbors and row-standardization, we ensure that spatial interactions are appropriately modeled. This approach provides a nuanced understanding of how the Cuyahoga Land Bank's interventions have propagated through local property markets, ultimately affecting residential property values across different submarkets. The Bayesian estimation ensures that parameter uncertainty is properly accounted for, leading to more reliable and informative inference.

Dealing with Time Dynamics in an Unbalanced Panel Data Context

Incorporating time dynamics into spatial econometric models presents unique challenges, especially when dealing with unbalanced panel data. An unbalanced panel occurs in this application because the dependent variable represents house sales, the majority of which are sold one time over the period. This irregularity complicates the analysis of temporal effects and requires careful methodological considerations.

Challenges with Including Time Period Fixed Effects

A common approach to account for temporal variations is to include time period fixed effects in the explanatory variables matrix. Time fixed effects control for unobserved factors that change over time but are constant across units, capturing common shocks or trends affecting all regions simultaneously. However, in the context of spatial models with unbalanced panels, incorporating time fixed effects directly into the set of explanatory variables X can be problematic.

Including time fixed effects in X introduces bidirectional (forward and backward) temporal impacts. This means that the model would entail that future house sales could influence past house sales, which is illogical and violates the causal structure of temporal relationships. Specifically, the spatial lag structure inherent in spatial models can cause these time fixed effects to create feedback loops that are not theoretically justifiable.

Limitations of Running Separate Regressions for Each Submarket for Each Year

An alternative solution is to run separate regressions for each submarket and each year, thereby treating each submarket and each time period independently. While this approach avoids the issue of bidirectional temporal impacts, it introduces other significant challenges. With data spanning 6 submarkets and 14 years, this method would require estimating 84 separate models. Furthermore, dividing the data by submarket and year reduces the sample size for each regression. Smaller samples decrease the degrees of freedom, making it more difficult to detect significant effects. This increases the likelihood of Type II errors (failing to detect an effect when one exists).

Aggregating Years into Groups

Aggregating several years into broader time periods is another option that was explored. Grouping years can increase sample sizes within each period, potentially improving statistical power. However, this approach still faces limitations. Even when years are grouped, the sample sizes may remain insufficient for robust statistical inference, particularly because the data is highly unbalanced many of the variables are observed infrequently. Aggregating up to two time periods (2010-2016 and 2017-2023) results in estimates that don't vary substantially over the time periods, which defeats the entire purpose of doing so.

Combining Submarkets into One Dataset

Another strategy is to combine all submarkets into a single dataset and estimate a unified model, using submarket spatial fixed effects to control for submarket differences. While this approach increases the overall sample size and allows for variation over time, it imposes a crucial restrictions. For one, this approach implicitly assumes that the coefficients on the variables of interest are the same for all submarkets, allowing them to vary only over time. This restriction overlooks the likely fact that different submarkets respond differently to the same variables due to unique characteristics or conditions. Secondly, spatial fixed effects account for unobserved submarket differences but do not capture variation in how explanatory variables impact the dependent variable across submarkets. Finally, forcing coefficients to be identical across diverse submarkets can lead to biased economic impact estimates if the true relationships differ regionally.

Preferred Approach: Estimating Submarkets Individually and Pooling Years

Given the challenges associated with the alternative methods, the preferred approach is to estimate models for each submarket individually while pooling the data across all years. This strategy offers several advantages. Estimating separate models for each submarket allows the coefficients on the variables of interest to vary across regions. This recognizes that different submarkets have unique responses to demolitions, renovations, and new constructions due to local economic conditions, policies, or market dynamics. Pooling data across years increases the sample size within each submarket model. Larger samples enhance statistical power, making it more likely to detect significant effects. By pooling years, the current study assume that the impacts of the explanatory variables are relatively stable over time within each submarket. This is a reasonable assumption for variables like demolitions and renovations, which have consistent effects across the different time periods we were able to estimate. Finally, this approach reduces the complexity associated with estimating a large number of models (e.g., one for each year or submarket-year combination) and facilitates more straightforward computation of the economic impact estimates.

In summary, dealing with time dynamics in spatial econometric models with unbalanced panel data requires careful methodological choices. Including time period fixed effects directly in the explanatory variables is problematic due to the introduction of illogical bidirectional temporal impacts. Running separate regressions for each year or aggregating years into groups either reduces statistical power or oversimplifies temporal dynamics to the point where it makes more sense to just pool the years.

By estimating models for each submarket individually and pooling the data across years, we strike a balance between acknowledging spatial heterogeneity and maintaining sufficient sample sizes for robust statistical analysis. This approach allows the coefficients on key variables to vary across submarkets—reflecting submarket differences—while assuming consistent effects over time within each submarket. It provides a theoretically sound and practically feasible solution to the challenges posed by unbalanced panel data in spatial econometric modeling. This was the approach used in the economic impact estimates presented in this study.

Appendix 4: IMPLAN Model

To assess the economic impact of the Cuyahoga Land Bank's expenditures from 2009 to 2024, we utilized the IMPLAN (Impact Analysis for Planning) model. IMPLAN is a widely recognized economic analysis tool used by universities and government agencies to estimate the ripple effects of spending within a specific region.

IMPLAN is an input-output economic model that maps out the interconnections between different sectors of a local economy. It helps quantify how spending in one area can lead to additional economic activity in others. By understanding these relationships, we can estimate not just the immediate effects of the Land Bank's expenditures but also the broader impacts on employment, income, and economic output in Cuyahoga County.

When the Land Bank invests in property demolitions, renovations, or other activities, it directly purchases goods and services from local businesses. These initial expenditures are known as direct effects. The businesses supplying these goods and services then need to purchase additional inputs to meet this demand, leading to indirect effects. Furthermore, employees of both the Land Bank and its suppliers spend their earnings in the local economy, generating induced effects.

By inputting the Land Bank's expenditures into the IMPLAN model and categorizing them according to relevant industry sectors, we traced how each dollar spent flows through the county's economy. The model accounts for:

- **Direct Effects**: Immediate economic activity from the Land Bank's spending.
- **Indirect Effects**: Secondary economic activity from suppliers ramping up production.
- **Induced Effects**: Additional economic activity from increased household spending by employees.

An essential concept in this analysis is the economic multiplier, which quantifies the total economic impact relative to the initial spending. For instance, a multiplier of 1.9 suggests that every dollar the Land Bank spends generates an additional $0.90 in economic activity within the county.

- **Data Sources**: We used the latest available IMPLAN data specific to Cuyahoga County to ensure our analysis reflects current economic structures and relationships.
- **Expenditure Adjustments**: Only expenditures made within the county were included to accurately measure local impacts.
- **Price Levels**: All monetary values were adjusted to constant dollars to account for inflation over the study period.