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Original article

Geography, Demographics, and Urban Commercial Resilience in Seoul's Commercial Alleys: Focusing on the COVID-19 Pandemic Era

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Abstract

Commercial alleys ("golmok") in Seoul are vital cultural and economic hubs whose resilience is influenced by geographic and demographic factors. The COVID-19 pandemic disrupted these dynamics, yet existing studies rarely integrate spatial, demographic, and temporal shifts within a gendered framework. Our study analyzed quarterly sales from 1,085 commercial alleys in Seoul across 2020-2021 (8,680 observations) during the COVID-19 period. Excluding non-foot-traffic businesses, we applied four machine learning models: Random Forest, XGBoost, LightGBM, and CatBoost. Hyperparameter tuning was conducted using a 100-iteration randomized search with 3-fold cross-validation for computational efficiency. Final model performance was then evaluated using 10-fold stratified group cross-validation for each gender subset, using commercial alley ID as the grouping variable to reduce information leakage across repeated quarterly observations. Among the four models, XGBoost achieved the best predictive performance across all subgroup-period datasets. During COVID-19, female sales importance shifted toward resident-linked spatial interactions and intrinsic location effects; the worker population was one of the important factors that affects male sales. This study uniquely integrates gender-segmented sales data during COVID-19 and GeoShapley's spatial explainability to reveal how geography and demographics jointly shaped urban commercial resilience, spatial equity, and more sustainable neighborhood-scale retail planning.

Keywords : GeoShapley, urban resilience, sustainable retail, spatial equity, gendered consumption, commercial alleys, Seoul.

1. Introduction

Seoul has a dynamic retail landscape that is deeply influenced by its urban economic framework as a global city. Commercial alleys, often referred to as "golmok" in Korean, play a vital role in this framework. Commercial alleys in Seoul are more than just retail spaces; they are integral to the city's economic and social fabric (Joo, 2018; Ryu *et al*., 2020). According to research, the density and diversity of commercial alleys are key factors in their ability to attract pedestrians and sustain economic vitality (Lee, 2014; Yi & Gim, 2018).

A growing body of research shows that retail activity and spatial behavior are strongly gender-differentiated

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due to distinct mobility patterns, time-use constraints, risk perceptions, and caregiving roles (Giurge *et al*., 2021; Ackerman *et al*., 2023; Alam *et al*., 2023). Women typically engage in localized, routine, and multi-stop retail trips tied to household responsibilities, whereas men exhibit more linear and work-oriented spatial consumption patterns. These differences produce measurable variation in how commercial districts are used, accessed, and valued across the city. COVID-19 increased these differences, as mobility restrictions and care burdens disproportionately altered women's activity spaces relative to men. Therefore, disaggregating commercial sales by gender is not only descriptive, but also necessary to reveal structural differences in urban retail resilience (Lee and Lee, 2024) and spatial equity before and during crisis conditions.

The social and cultural significance of commercial alleys in Seoul is deeply rooted in their role as communal spaces. These alleys often serve as platforms for social interaction, where residents and visitors can engage in informal conversations, share cultural practices, and participate in local events (Lee & Bae, 2013). The importance of community engagement in the development and maintenance of these spaces is well-documented, with studies showing that active participation by residents can lead to more sustainable and vibrant commercial environments (Suh, 2015; Kim *et al*., 2023).

The exploration of the combined effects of geographic and demographic factors on commercial sales, particularly through a gendered lens, reveals significant research gaps that current studies have only partially addressed. Existing literature predominantly focuses on either geographic or demographic factors in isolation, with limited integration of both aspects. For instance, Kim *et al*. highlights the influence of spatial characteristics on gendered retail consumption in Seoul, emphasizing the need for gender-sensitive urban planning to address diverse needs across genders (Kim & Lee, 2023). However, previous studies do not fully integrate demographic factors such as residential population, worker population, and economic status, which are crucial for a comprehensive understanding.

Despite these contributions, three important gaps remain. First, much of the existing literature is either descriptively spatial or conventionally econometric, making it difficult to capture nonlinear relationships and localized heterogeneity in retail dynamics. Second, studies that use machine-learning models often emphasize predictive accuracy but provide limited explanation of how geography changes the contribution of demographic and commercial predictors across locations. Third, few studies combine gender-disaggregated sales data during COVID-19 at the alley scale. In this context, GeoShapley is useful not only because it improves interpretability, but because it allows the decomposition of model predictions into intrinsic geographic effects and spatially varying feature contributions, offering insight that differs from both standard black-box prediction and conventional spatial regression.

To address these gaps, we employ machine-learning models that can capture nonlinear relationships and complex interactions in alley-level commercial sales. One study used linear regression to examine the association between geographical factors and sales (Kang and Lee, 2018). However, this study is focused on non-linear and complex relationship compared to the previous study. We then apply GeoShapley to move beyond prediction alone and identify how intrinsic geographic effects and spatially varying predictor contributions differ by gender and pandemic period. Machine learning models are powerful at capturing complex relationships but are largely black boxes. To overcome this, we incorporate GeoShapley, an GeoXAI (Geospatial eXplainable AI) method that quantifies contribution of geographic and demographic factors in predicting sales outcomes (Li, 2024). Of particular interest, GeoShapley enables us to extract spatial effects and capture the intrinsic impact of location on commercial sales performance. This differs from the previous study regarding commercial alleys, which did not consider the spatial effect on the association between sales and geographical factors (Lee, 2022). This spatial component is critical in understanding how certain areas inherently contribute to economic outcomes, beyond the influence of observable predictors. The primary aim of this research is to accurately assess the effects of geographical and demographic variables on the sales performance of commercial alleys in Seoul. This analysis seeks to uncover the complex interplay between location, demographic makeup, and economic activity, providing a detailed map of

factors driving commercial success in urban settings. In this sense, the study contributes both substantively to urban retail and resilience research and methodologically to the use of explainable spatial machine learning in urban data science.

This study also provides a differentiated contribution by integrating gender-disaggregated sales data and location-based spatial analysis. These insights are critical for developing public areas that meet diverse community needs. Local businesses can use the findings to refine marketing strategies and operations, aligning more closely with consumer behavior trends.

Beyond predictive modeling, this study contributes to sustainability research by examining how neighborhood-scale retail systems responded to the COVID-19 shock. Commercial alleys are not only economic spaces but also part of the localized urban service environment that supports walkability, social interaction, and everyday access to goods and services. By identifying which geographic and demographic conditions were associated with stronger commercial resilience during the pandemic, this study provides evidence relevant to sustainable urban planning, spatial equity, and strengthening neighborhood-based retail systems.

2. Methods

2.1 Data description and variables

This study utilizes an extensive dataset, drawn from 1,085 commercial alleys throughout Seoul (Table 1). This dataset includes quarterly observations over two years, from 2020 through 2021. The data categorization by gender further enriches our analysis, enabling a focused examination of sales dynamics influenced by male and female consumer behaviors. Across this temporal framework, our dataset integrates a total of 8,680 data points, each contributing to the depth of our analytical models.

We excluded business types that generate revenue but do not attract foot traffic and do not connect to consumption in other industries/establishments. In addition, we excluded industries that, while not business trip-based, have very high average customer spending, as they could artificially inflate the overall sales of the commercial alleys. Therefore, in this study, businesses such as restaurants, convenience stores, supermarkets, general clinics, pubs, cafes, hair salons, and clothing stores were included as part of the commercial alley businesses. The dependent variable is total quarterly alley sales, which represents the overall economic output of each commercial alley. Because alleys differ in size and store density, we include the number of stores as an explanatory variable to control for scale effects, allowing the model to separate the influence of commercial density from other spatial and demographic factors.

The variables included in our study involve several dimensions that enhance our urban economic analysis with added complexity and relevance. Temporal variables such as the year are integrated to capture essential annual

Table 1. Detailed variable description of data

Variable	Description	Type
Quarterly sales	Quarterly sales	Response
Years	Year of data record	Predictor
Quarters	Quarters	Predictor
X coordinate	Geographic longitudinal coordinate of the alley	Predictor
Y coordinate	Geographic latitudinal coordinate of the alley	Predictor
Number of stores	Total stores within the commercial alley	Predictor
Dynamic population	Count of temporary population in the area	Predictor
Worker population	Count of working population in the area	Predictor
Resident population	Count of permanent residents in the area	Predictor
Number of facilities	Number of facilities within the commercial alley	Predictor
Average monthly income	Average income in the vicinity of the alley	Predictor

Table 2. Optimized hyper-parameter combinations

Model	Optimized hyper-parameters
RF	maximum depth = 7, minimum samples leaf = 4, minimum samples split = 7, number of estimators = 1200, cost complexity alpha = 0.001
XGB	learning rate = 0.01, minimum child weight = 2, gamma = 5, subsample = 0.8, subsample ratio of columns for each tree = 0.6, maximum depth = 7, number of estimators = 1200
LGBM	number of leaf = 30, minimum child weight = 7, subsample = 1.0, subsample ratio of columns for each tree = 0.6, L1 regularization = 2, L2 regularization = 10, learning rate = 0.2, iteration = 200
CAT	iteration = 2000, learning rate = 0.1, maximum depth = 7, L2 regularization = 2, minimum child sample = 32

trends that may significantly influence alley sales. Location coordinates of alley are included in the model to account for location-specific effects that would otherwise be neglected in typical machine learning models. Dynamic population was especially derived from mobile-based estimates of temporary population inflow and outflow in the surrounding area. Before model fitting, the quarterly alley-level datasets were organized separately by gender and period. The final predictor set included year, quarter, X coordinate, Y coordinate, number of stores, dynamic population, worker population, resident population, number of facilities, and average monthly income.

2.2 Machine Learning Models and GeoShapley

In our study, we selected four tree-based machine-learning models: RF (Random Forest), XGB (Extreme Gradient Boosting), LGBM (Light Gradient Boosting Machine), and CAT (CatBoost) because they are well suited to nonlinear relationships, higher-order interactions, and mixed predictor structures in alley-level retail data. To ensure the optimal performance of these models, we conducted extensive hyperparameter tuning. We used randomized search to optimize the hyperparameters of each model. During tuning, all models were evaluated using 100 random hyperparameter combinations with 3-fold cross-validation. After selecting the optimal hyperparameters, we performed final model evaluation using 10-fold stratified group cross-validation separately for each gender subset. In this final validation procedure, commercial alley ID was used as the grouping variable so that repeated quarterly observations from the same alley could not appear in both training and test folds. Predictive performance was assessed using R2, MSE (Mean Squared Error), MAE (Mean Absolute Error), and RMSE (Root Mean Squared Error). The optimized combinations of the hyper-parameters are shown in Table 2.

To complement predictive modeling, this study incorporates GeoShapley, a spatial machine learning interpretation framework that allows for the decomposition of predictive outcomes into spatial and non-spatial effects which is not possible from other XAI methods such as SHAP (Li, 2024).

GeoShapley utilizes the Shapley value to assign importance to each predictor by simulating the insertion of predictors into a model in all possible orders and measuring the marginal contributions.

3. Results and Discussion

3.1 Descriptive statistics

The descriptive statistics for variables are presented in Table 3 for commercial alleys in Seoul from 2020 to 2021 as a total. This highlights substantial variability in quarterly sales, with figures ranging from a minimum of $1,844 to a maximum of $54,094,975, and a high standard deviation of $3,575,720 suggesting uneven commercial success. Sales data segmented by gender indicate that male consumers potentially outspend females, with male sales peaking at $23,238,466 compared to female sales at $21,222,125. The total population figures are relatively stable with minor fluctuations between years, while worker populations show more variability, indicating

Table 3. Descriptive statistics of the commercial alleys in Seoul (2020-2021)

Variable	Minimum	Maximum	Mean ± standard deviation
Quarterly Total Sales ($)	1,844	54,094,975	3,516,316 ± 3,575,720
Male Sales ($)	1,042	23,238,466	1,688,674 ± 1,686,936
Female Sales ($)	801	21,222,125	1,430,022 ± 1,509,778
Number of Stores	3	923	165 ± 147
Number of Facilities	13	377	110 ± 52
Male Dynamic Population	18,712	8,507,870	2,128,615 ± 1,218,165
Female Dynamic Population	19,468	9,472,315	2,402,222 ± 1,404,844
Male Resident Population	452	26,012	8,336 ± 4,085
Female Resident Population	460	27,161	8,624 ± 4,238
Male Worker Population	58	88,002	3,834 ± 6,035
Female Worker Population	63	37,342	2,921 ± 3,726
Average Monthly Income ($)	1,465	4,790	2,209 ± 537

Table 4. Predictive performance of the four machine-learning models under 10-fold stratified group cross-validation across gender

Group	Model	R^2	MSE	MAE	RMSE
Female	RF	0.571	1,038,091,374,637.148	523,257.893	983,154.981
	XGB	0.595	969,688,236,717.798	521,413.790	952,182.938
	LGBM	0.570	1,018,833,424,845.792	543,010.034	980,337.749
	CAT	0.580	994,351,074,494.124	543,028.598	969,128.563
Male	RF	0.600	1,145,789,725,563.428	569,128.237	1,051,713.200
	XGB	0.624	1,087,401,651,769.204	570,841.933	1,019,431.357
	LGBM	0.593	1,159,962,586,171.250	604,018.511	1,059,272.434
	CAT	0.613	1,091,529,618,884.934	585,576.805	1,028,059.585

commuting influences. The average monthly income across the areas ranges from $1,465 to $4,790, pointing to a low to upper-middle-class consumer base.

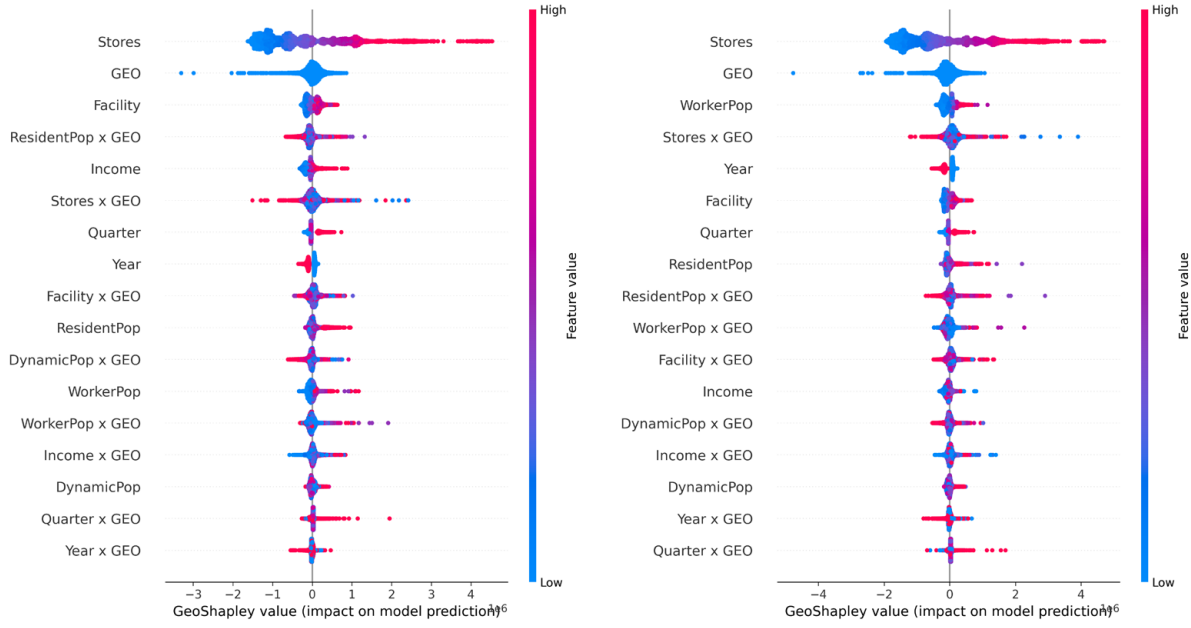
3.2 Model Validation and Predictive Performance

To assess the robustness and predictive performance of the four machine-learning models, we conducted final 10-fold stratified group cross-validation separately for each gender subset: female during COVID-19 and male during COVID-19. Table 4 reports the resulting R^2, MSE, MAE, and RMSE values. This validation framework provides a consistent basis for comparing model performance across genders, time periods, and model types while reducing leakage from repeated quarterly observations of the same commercial alleys.

Table 4 shows that XGBoost achieved the strongest overall predictive performance across gender. The R^2 value was 0.595 for female sales, while it was 0.624 for male sales. Although the differences among the top-performing models were modest in some subsets, XGBoost consistently yielded the highest R^2 values and was therefore selected for the subsequent GeoShapley-based interpretation analysis.

3.3 Shapley Feature Importance in Commercial Sales Dynamics

To investigate the drivers of commercial alley sales in Seoul, we analyzed feature importance scores generated by the GeoShapley-explained XGBoost models, separated by gender during COVID-19 (2020-2021). The results show



(a) (b)

Fig. 1. Female (a) and Male (b) Feature Importance During COVID-19.

distinct shifts in the spatial and demographic variables that contributed most significantly to the predictive performance of the models. Fig. 1. shows the GeoShapley summary plots for female commercial alley sales during COVID-19. In these plots, each feature's influence on the model's prediction is outlined horizontally, with wider dispersion indicating greater variability in impact across the dataset. Features are ordered vertically based on their overall ranks, with the most influential features positioned at the top. Each point represents an individual alley's observation, colored by the actual feature value from blue (low feature value) to red (high feature value), which shows how different levels of the feature relate spatially and numerically to their predictive impact on commercial sales.

Stores, GEO, Facility, and Resident population × GEO had relatively high feature importance for female (Figure 1 (a)). Except for the Stores, Resident population played an important role in the prediction of female sales. For male, Stores, GEO, Worker population, and Stores × GEO had the relatively high feature importance. Unlike female, the Worker population showed higher feature importance than Resident population in male.

3.4 Female Spatial Contribution During COVID-19: Resident, Worker, and Intrinsic Effects

During the COVID-19 pandemic, the spatial impact of female-related commercial activity across Seoul shifted remarkably in character. Mobility restrictions, remote work transitions, and localized consumption reshaped how residence, employment, and geographic setting affected alley-level sales (Fig. 2).

Female residential presence contributed less consistently to commercial sales. Many areas such as Seongdong-gu, Jungnang-gu, and Dongdaemun-gu were neutral or negative (dark blue and purple). At the same time, some clusters of positive influence (green and yellow) emerged in Gwanak, Geumcheon, and Gangseo, which may reflect relatively stronger localized, home-based consumption in lower-income or less central districts during the pandemic period (Fig. 2(a)).

Female worker impact during the pandemic was less widespread but highly localized. Nowon, Dobong, and

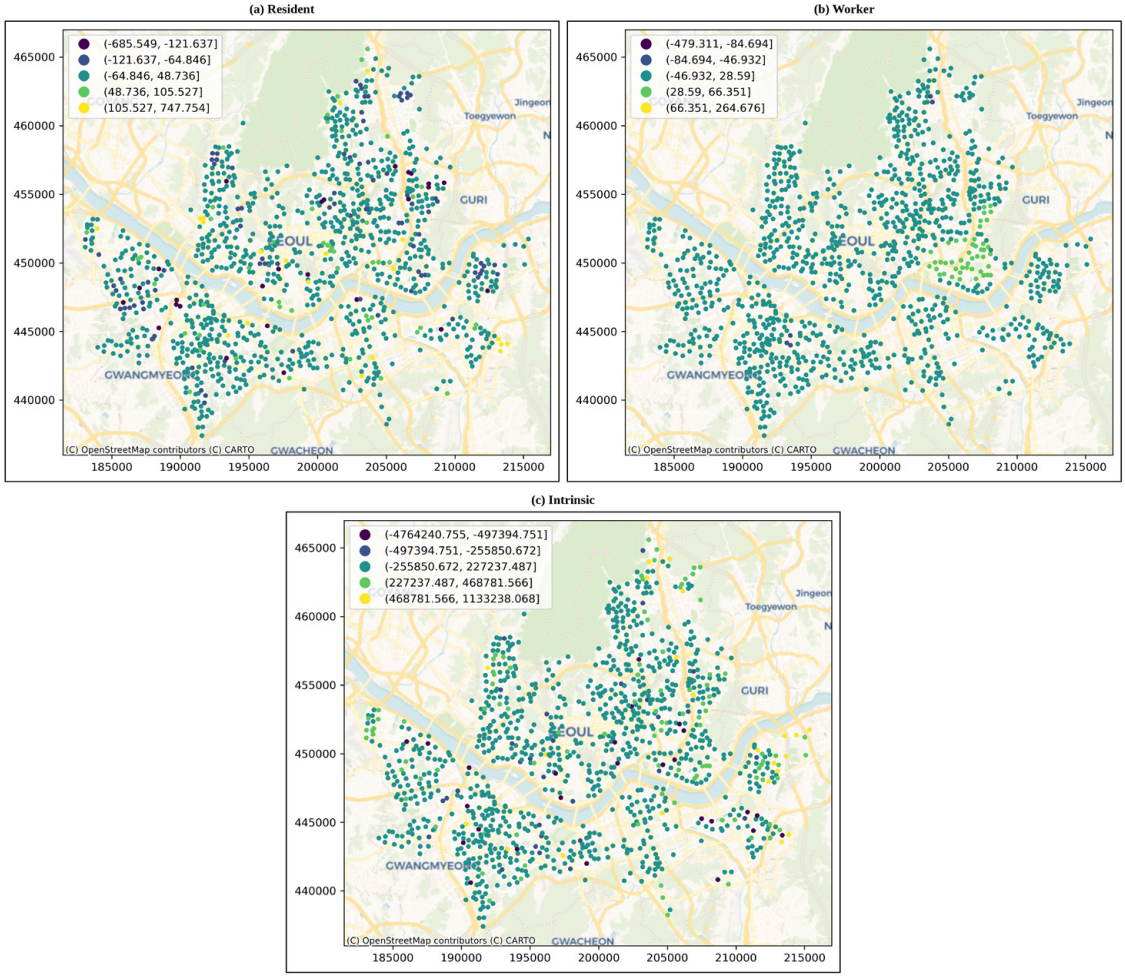


Fig. 2. Female Spatial Contribution during COVID-19: (a) Resident, (b) Worker, and (c) Intrinsic Effects

Jungnang reflected either job loss or lower economic engagement in those areas. In contrast, positive influence clusters (yellow, green) became concentrated in Seongdong-gu, Songpa, and Gangdong, which may indicate districts where female worker-linked activity remained relatively stronger during the pandemic, although the specific mechanisms behind this pattern were not directly tested in this study (Fig. 2(b)).

The intrinsic location effect was a stronger and clearer predictor of female-driven sales. High-impact zones (yellow) were observed in Nowon, Dobong, Jungnang, Songpa, and parts of Gangdong and Gangnam (Fig. 2(c)). Female intrinsic GEO effects, initially strongest in commercial centers, were presented in peripheral and secondary districts during COVID-19, suggesting decentralized consumption and strengthened neighborhood-based sales.

3.5 Male Spatial Contribution During COVID-19: Resident, Worker, and Intrinsic Effects

The COVID-19 pandemic introduced significant disruptions to daily routines, employment, and urban mobility, reshaping commercial activity across Seoul overall. The spatial contribution of male-related factors to alley-level sales reflected both structural continuity and geographic divergence (Fig. 3).

Most districts were shaded in teal and green, indicating

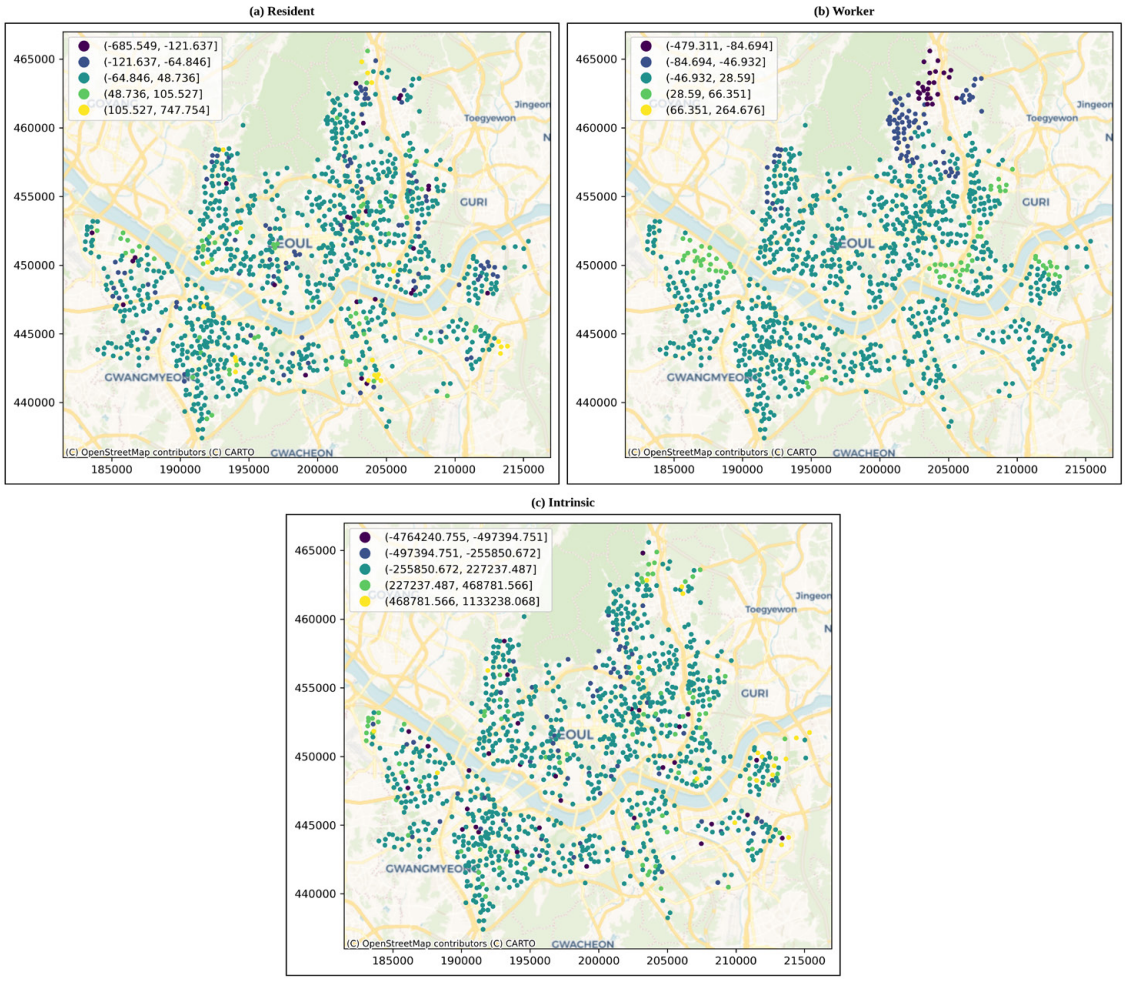


Fig. 3. Male Spatial Contribution during COVID-19: (a) Resident, (b) Worker, and (c) Intrinsic Effects

a stable, moderate level of contribution to alley sales. However, no dominant high-impact zones (yellow) emerged, reinforcing the idea that male residential behavior was spatially stable and less responsive to pandemic-specific conditions (Fig. 3(a)).

In contrast to residential trends, the influence of male workers declined sharply, especially in the northeastern corridor. Districts such as Nowon, Dobong, and Jungnang-gu, which previously showed strong sales contribution, shifted into dark purple and blue zones, reflecting a substantial loss in commercial engagement from male employees (Fig. 3(b)).

During COVID-19, intrinsic spatial effects became more scattered. No single region emerged as a dominant commercial hub for male-driven sales based on geography alone. However, a noticeable shift in high-impact zones (yellow) occurred in the southern and southeastern districts, particularly around Gangnam, Gangdong-gu, and Songpa, which may reflect the continued relative importance of these southern and southeastern districts during restrictive periods, although the specific factors underlying this pattern were not directly evaluated in the present analysis (Fig. 3(c)). Male intrinsic effects were also presented with reduced relevance in central business zones, like female, and increased importance in southern and eastern districts. These patterns reveal a more diffuse spatial structure of consumption during the pandemic.

3.6 Urban Resilience, Mobility Restrictions, and Retail Restructuring

The spatial distribution of commercial activity illustrates how resilience varied across districts. Especially, female-driven sales persisted in districts with essential workplaces and local services, aligning with research showing that mixed-use districts with diversified consumer bases weather crises more effectively (Wrigley & Dolega, 2011; Che *et al*., 2023). Mobility restrictions, although moderate in Korea relative to strict lockdowns elsewhere, significantly altered consumption geographies (Sung, 2022; Lee & Eom, 2023). Social distancing and remote work reduced long-distance trips, especially among women (Reisch, 2021), increasing the importance of hyperlocal retail. This shift was reinforced by the rise of neighborhood-based platforms like the Danggeun Market (Carrot), which strengthened local commerce. Districts such as Songpa and Gangdong exhibited relatively high intrinsic GeoShapley values (Fig. 2c), which may be consistent with proximity-based urban resilience and related "15-minute city" ideas, although this study does not directly test that planning framework (Moreno *et al*., 2021).

Neighborhoods showing relatively stronger female-driven or resident-linked sales contributions may represent areas of continuing commercial importance. However, these implications should be interpreted cautiously, as the study does not directly track business relocation, investment decisions, or real estate outcomes (Kim & Lee, 2023).

From a policy perspective, the findings suggest the potential value of promoting land-use diversity in office-heavy zones, expanding mixed-income housing near retail corridors, and strengthening neighborhood-level commercial infrastructure through investments in walkability, safety, and public services. Supporting alley markets that functioned as important neighborhood commercial spaces during the pandemic may also contribute to more locally resilient urban systems (Che *et al*., 2023). Comparing model-derived hotspots with known commercial centers suggests that GeoShapley captures both major commercial cores and neighborhood markets, which rose in importance as mobility shifted.

Ultimately, the pandemic exposed both vulnerabilities and adaptive capacities rooted in gendered behaviors and local urban conditions. Female consumers helped stabilize demand in peripheral districts, while male consumers engaged with neighborhood-scale commerce. These insights emphasize the importance of flexible, localized, gender-aware planning for future shocks.

4. Conclusion

This study examined how geographic and demographic factors shaped alley-level commercial sales in Seoul during the COVID-19 pandemic using gender-disaggregated sales data, machine-learning prediction, and GeoShapley-based spatial interpretation. The intrinsic spatial effects gained importance for both genders, underscoring the role of neighborhood context in shaping commercial resilience under disruption.

Beyond these substantive findings, the study contributes methodologically by demonstrating how explainable spatial machine learning can be used to move beyond prediction alone and interpret how location modifies the contribution of demographic and commercial predictors. Rather than treating geography as background control only, the GeoShapley framework allows intrinsic place effects and spatially varying feature effects to be examined directly.

At the same time, the findings should be interpreted within the limits of a single-city, alley-level case study. Future research should extend this framework to other urban settings, test whether similar gendered and spatial-commercial patterns emerge in different institutional and retail contexts and further evaluate the robustness of GeoShapley outputs across alternative modeling choices and explanation settings. In particular, comparative applications across cities and post-pandemic periods would help clarify which observed patterns are specific to Seoul and which may generalize more broadly. In addition, future research should evaluate the continuity of spatial resilience by comparing these findings with the post-pandemic recovery phase.

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References

Ackerman, J. M., Borinstein, A., Kaji, J., Bekier, J., Wrinn, C., and Dockendorf, T. (2023), A dynamic segmentation of U.S. women during the COVID-19 pandemic. *International Journal of Consumer Studies*, Vol. 47, No. 4, pp. 1226-1240. https://doi.org/10.1111/ijcs.12932

Alam, M. M., Bagnoli, L., and Kerzhner, T. (2023), The ABCs of the role of Public Transport in Women's Economic Empowerment, *In World Bank, Washington, DC eBooks*. https://doi.org/10.1596/1813-9450-10404

Che, J., Lee, J. S., and Kim, S. (2023), How has COVID-19 impacted the economic resilience of retail clusters?: Examining the difference between neighborhood-level and district-level retail clusters, *Cities*, Vol. 140. https://doi.org/10.1016/j.cities.2023.104457

Giurge, L. M., Whillans, A. V., and Yemiscigil, A. (2021), A multicountry perspective on gender differences in time use during COVID-19, *Proceedings of the National Academy of Sciences*, Vol. 118, No. 12. https://doi.org/10.1073/pnas.2018494118

Joo, Y.M. (2018), Megacity Seoul: Urbanization and the Development of Modern South Korea (1st ed.), *Routledge*. https://doi.org/10.4324/9781315278018

Kang, H.M. and Lee, S.K. (2018), An analysis of the effects of customer characteristics on sales of alley market area using geographically weighted regression, *Journal of the Korean Society of Surveying, Geodesy, Photogrammetry and Cartography*, Vol. 36, No. 6, pp. 611-620. https://doi.org/10.7848/ksgpc.2018.36.6.611

Kim, H., Kiura, M., Leach, R., and Cho, H. J. (2023), The role of community engagement and entrepreneurship in the sustainability performance of social ventures in South Korea. *Contemporary Management Research*, Vol. 19, No. 2, pp. 81-105. https://doi.org/10.7903/cmr.22107

Kim, H. and Lee, H. (2023), COVID-19 pandemic and sales resilience factors?: Focus on alley-type traditional markets in Seoul, South Korea. *Journal of Korea Planning Association*, Vol. 58, No. 6, pp. 5-22. https://doi.org/10.17208/jkpa.2023.11.58.6.5

Lee, I. and Bae, J.H. (2013), Transition of Building Uses in the Culture-based Vitalization of Commercial Streets - A Case Study of Garosu-gil, Seoul. *Journal of the Urban Design Institute of Korea*, Vol. 14, No. 5, pp. 127-140.

Lee, J. (2014), The Study on Factors Influencing Pedestrian Volume based on Physical Environment of Street - Focused on Main Commercial Street of Seoul -, *Journal of Korea Planning Association*, Vol. 49, No. 2, p. 145. https://doi.org/10.17208/jkpa.2014.04.49.2.145

Lee, J. and Lee, J. (2024), Analysis on heterogeneous resilience patterns of retail clusters from post-COVID-19 endemic ? A case of Seoul, Republic of Korea, *Journal of the Korean Society of Surveying, Geodesy, Photogrammetry and Cartography*, Vol. 42 No. 4, pp. 363-382. https://doi.org/10.7848/ksgpc.2024.42.4.363

Lee, K. (2022), Analysis of changes in geographical factors affecting sales in commercial alleys after COVID-19 using machine learning techniques, *Heliyon*, Vol. 8, No. 9. https://doi.org/10.1016/j.heliyon.2022.e10708

Lee, K., and Eom, J. K. (2023), Systematic literature review on impacts of COVID-19 pandemic and corresponding measures on mobility, *Transportation*, Vol. 51, No. 5, pp. 1907-1961. https://doi.org/10.1007/s11116-023-10392-2

Li, Z. (2024), GeoShapley: A game theory approach to measuring spatial effects in machine learning models. *Annals of the American Association of Geographers*, Vol. 114, No. 7, pp. 1365-1385. https://doi.org/10.1080/24694452.2024.2350982

Moreno, C., Allam, Z., Chabaud, D., Gall, C., and Pratlong, F. (2021), Introducing the "15-Minute City": Sustainability, resilience and place Identity in future Post-Pandemic Cities, *Smart Cities*, Vol. 4, No. 1, pp. 93-111. https://doi.org/10.3390/smartcities4010006

Reisch, L. A. (2021), Shaping healthy and sustainable food systems with behavioural food policy, *European Review of Agricultural Economics.* https://doi.org/10.1093/erae/jbab024

Ryu, H., Kim, D., and Park, J. (2020), Characteristics Analysis of commercial gentrification in Seoul focusing on the vitalization of streets in residential areas, *Sustainability*, Vol. 12, No. 21, 8877p.

https://doi.org/10.3390/su12218877

Suh, K. (2015), Analysis on the types and characters of alley in Seochon district in Seoul. *Journal of the Korean Housing Association*, Vol. 26, No. 4, pp. 63-73. https://doi.org/10.6107/jkha.2015.26.4.063

Sung, H. (2022), Non-pharmaceutical interventions and urban vehicle mobility in Seoul during the COVID-19 pandemic, *Cities*, Vol. 131, 103911p. https://doi.org/10.1016/j.cities.2022.103911

Wrigley, N., and Dolega, L. (2011), Resilience, Fragility, and Adaptation: New Evidence on the Performance of UK High Streets during Global Economic Crisis and its Policy Implications, *Environment and Planning A: Economy and Space*, Vol. 43, No. 10, pp. 2337-2363. https://doi.org/10.1068/a44270

Yi, Y. and Gim, T. (2018), What makes an old market sustainable? An empirical analysis on the economic and leisure performances of traditional retail markets in Seoul, *Sustainability*, Vol. 10, No. 6, 1779p. https://doi.org/10.3390/su10061779