Outline

Introduction (4 paragraphs)

1. The relationship between incidences, mobility and policy.

Add literature review: Key findings from previous studies that have examined the relationship between these three factors, highlighting the interdependencies and influences among them.

1. Moreover, the temporal dimension of these interactions cannot be overlooked.

Add literature review: Discuss studies that focus on static snapshots of these relationships, noting their limitations in capturing the evolving nature of these interactions over time. Include references to research that has incorporated time effects, emphasizing the importance of analyzing these dynamics in a temporal context.

1. In the case of Seoul, as one of the biggest metropolitan cities in world, these interactions are particularly complex.

Identify gaps in the existing literature, particularly those related to dynamic interactions or the specific context of Seoul.

1. The purpose, data, and methodology of our study

State the objective of our study

Based on period of social distancing policy in Seoul, June 2020 ~ November 2021. We utilized high frequently weekly data to analyze this dynamic relationship throughout whole Seoul and within each district. By analyzing how these factors interact, the study aims to uncover patterns and causality that are not immediately apparent through static analysis. This will provide a deeper understanding of how changes in one variable, such as a policy intervention, can ripple through to affect mobility patterns and incidence rates.

Emphasize the urgent and future meaning to understand this relationship.

Understanding these interactions over time is crucial because the effects of a policy change or a spike in incidence are not instantaneous but evolve and manifest over days, weeks, or even months. This temporal aspect is particularly important in a dynamic urban environment like Seoul, where rapid policy adjustments can lead to varying responses in mobility and incidence.

Data description

Describe the data sources

Discuss the data preprocessing (policy index)

|  |
| --- |
| Social distancing policy level during pandemic time from July 2020 to November 2021 |
| 图表, 折线图  描述已自动生成 |

Methods

Explain the VAR model used in detail

State the choice of lags (we use 2 weeks) and variables included in the model

Results

1. Overall analysis

Summary the findings from overall VAR model across all variables. Highlight the overall significance of the relationship between variables, focusing on the coefficients and their statistical significance as shown in Table 1.

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Model 1:**  **Incidences**  **(in hunderd)** | **Model 2:**  **Mobility**  **(in million)** | **Model 3:**  **Policy level**  **(from 0 to 1)** |
|
|  | Coef (SE) | Coef (SE) | Coef (SE) |
| incidences.l1 | 1.292 (0.116) \*\* | -0.039 (0.015) \*\* | -0.004 (0.004) |
| mobility.l1 | -0.151 (1.154) | 0.508 (0.145) \*\* | -0.073 (0.039) \* |
| policy.l1 | 6.581 (7.562) | -1.409 (0.953) | 0.618 (0.252) \*\* |
| incidences.l2 | -0.465 (0.123) \*\* | 0.024 (0.016) | 0.008 (0.004) \*\* |
| mobility.l2 | 3.620 (1.202) \*\* | 0.259 (0.151) \* | -0.032 (0.040) |
| policy.l2 | 7.596 (6.743) | 1.923 (0.850) \*\* | -0.369 (0.225) |
| const | -33.613 (11.261) \*\* | 1.432 (1.419) | 1.149 (0.376) \*\* |
| trend | 0.019 (0.056) | 0.008 (0.007) | 0.003 (0.002) |

.l1 = data from the 1st previous week

.l2 = data from the 2nd previous week

Coef = coefficient; SE = standard errors

\*\* Significant at 5% level

\* Significant at 10% level

Interpretation of the coefficients for each model:

Model 1(incidences): Explain the positive relationship between past incidences and current incidences, and the significant effects of mobility variables (focus on time lag).

Model 2 (Mobility): Discuss how mobility is influenced by previous mobility patterns and incidences and policy (different time lag).

Model 3 (Policy Level): Address how policy levels are affected by the lagged variables. Particularly focus on different time lag between mobility and incidences.

1. Regional analysis

Table 2.A

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Estimation results for equation incidences:  incidences = incidences.l1 + mobility.l1 + policy.l1 + incidences.l2 + mobility.l2 + policy.l2 + const + trend | | | | | | | |
| DIST | Incidence.l1 | Incidence.l2 | Mobility.l1 | Mobility.l2 | Policy.l1 | Policy.l2 | trend |
| Jung | 1.140 (0.102) \*\* | -0.491 (0.103) \*\* | 0.447 (0.355) | 1.173 (0.368) \*\* | 0.586 (0.227) \*\* | 0.111 (0.206) | -0.001 (0.002) |
| Jongno | 1.040 (0.123) \*\* | -0.294 (0.126) \*\* | -0.393 (0.546) | 0.941 (0.571) | 0.211 (0.305) | 0.075 (0.277) | 0.001 (0.002) |
| Gangnam | 0.875 (0.125) \*\* | -0.001 (0.133) | -0.535 (0.467) | 0.818 (0.476) \* | -0.898 (0.577) | 0.605 (0.530) | 0.008 (0.005) |
| Yeongdeungpo | 0.614 (0.126) \*\* | 0.362 (0.133) \*\* | -0.156 (1.255) | 3.097 (1.292) \*\* | 0.737 (0.562) | -0.218 (0.489) | -0.001 (0.005) |
| Seocho | 0.854 (0.129) \*\* | -0.079 (0.136) | 0.354 (0.612) | 0.606 (0.610) | 0.114 (0.417) | -0.185 (0.385) | 0.006 (0.003) \* |
| Geumcheon | 0.781 (0.163) \*\* | 0.222 (0.166) | 1.496 (1.982) | 6.750 (1.997) \*\* | 0.328 (0.305) | 0.097 (0.291) | -0.000 (0.002) |
| Yongsan | 0.590 (0.124) \*\* | -0.051 (0.129) | -2.261 (1.574) | 3.354 (1.668) \*\* | 0.254 (0.358) | -0.026 (0.334) | 0.006 (0.003) \* |
| Mapo | 1.076 (0.126) \*\* | -0.336 (0.132) \*\* | -0.119 (1.148) | 0.479 (1.188) | 0.202 (0.461) | -0.132 (0.420) | 0.006 (0.003) \* |
| Seongdong | 0.565 (0.128) \*\* | 0.048 (0.137) | -0.120 (1.617) | 2.841 (1.667) \* | 0.287 (0.376) | 0.005 (0.334) | 0.004 (0.004) |
| Dongdaemun | 0.971 (0.120) \*\* | -0.286 (0.123) \*\* | -3.645 (3.163) | 11.920 (3.278) \*\* | 0.365 (0.550) | 0.782 (0.509) | 0.001 (0.004) |
| Seodaemun | 0.666 (0.131) \*\* | 0.079 (0.142) | -2.027 (1.894) | 4.231 (1.961) \*\* | 0.497 (0.336) | -0.237 (0.309) | 0.003 (0.002) |
| Guro | 0.830 (0.121) \*\* | 0.128 (0.122) | -6.948 (3.037) \*\* | 10.435 (3.078) \*\* | -0.276 (0.571) | 0.593 (0.570) | 0.003 (0.004) |
| Songpa | 1.043 (0.121) \*\* | -0.390 (0.121) \*\* | 1.573 (2.322) | 3.356 (2.516) | 0.897 (0.824) | 0.449 (0.752) | 0.003 (0.006) |
| Gangseo | 0.872 (0.140) \*\* | 0.029 (0.147) | 0.540 (3.923) | 4.071 (3.904) | -0.135 (0.707) | 0.202 (0.679) | 0.002 (0.005) |
| Seongbuk | 1.021 (0.143) \*\* | -0.207 (0.156) | 2.809 (5.272) | 2.330 (5.725) | 0.317 (0.585) | 0.165 (0.568) | 0.002 (0.004) |
| Gwangjin | 0.475 (0.125) \*\* | 0.137 (0.130) | -4.056 (3.692) | 6.519 (4.008) | 0.247 (0.532) | 0.210 (0.505) | 0.006 (0.003) |
| Dongjak | 0.790 (0.127) \*\* | 0.052 (0.137) | 3.303 (2.732) | -2.339 (2.807) | 0.869 (0.428) \*\* | -1.088 (0.395) \*\* | 0.006 (0.003) \*\* |
| Gangdong | 0.802 (0.129) \*\* | -0.047 (0.138) | 4.178 (4.423) | 2.769 (4.762) | 1.098 (0.525) \*\* | -0.477 (0.496) | 0.003 (0.004) |
| Nowon | 0.816 (0.138) \*\* | -0.042 (0.154) | 2.819 (3.919) | 0.532 (4.118) | 0.346 (0.533) | -0.178 (0.500) | 0.005 (0.003) |
| Gangbuk | 0.730 (0.146) \*\* | -0.034 (0.142) | 5.373 (4.337) | 0.193 (4.621) | 0.408 (0.426) | -0.060 (0.404) | 0.004 (0.003) |
| Yangcheon | 0.821 (0.149) \*\* | -0.103 (0.163) | 1.957 (4.373) | -0.136 (4.293) | 0.417 (0.467) | -0.156 (0.451) | 0.004 (0.003) |
| Jungnang | 0.700 (0.145) \*\* | -0.106 (0.148) | 0.295 (5.336) | 2.447 (5.330) | 0.538 (0.491) | -0.295 (0.458) | 0.007 (0.003) \*\* |
| Dobong | 0.832 (0.127) \*\* | -0.215 (0.145) | 5.693 (4.016) | -1.642 (4.293) | 0.496 (0.366) | -0.242 (0.325) | 0.005 (0.002) \*\* |
| Gwanak | 0.853 (0.143) \*\* | -0.063 (0.148) | -3.266 (6.198) | 4.958 (6.466) | 0.605 (0.837) | -0.568 (0.805) | 0.009 (0.005) \* |
| Eunpyeong | 0.935 (0.153) \*\* | -0.274 (0.158) \* | 0.484 (4.954) | 4.925 (5.130) | 0.732 (0.492) | -0.237 (0.450) | 0.006 (0.003) \*\* |

Table 2.B

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Estimation results for equation mobility:  mobility = incidences.l1 + mobility.l1 + policy.l1 + incidences.l2 + mobility.l2 + policy.l2 + const + trend | | | | | | | |
| DIST | Incidence.l1 | Incidence.l2 | Mobility.l1 | Mobility.l2 | Policy.l1 | Policy.l2 | trend |
| Jung | -0.033 (0.044) | 0.015 (0.044) | 0.243 (0.151) | 0.086 (0.157) | -0.269 (0.097) \*\* | 0.156 (0.088) \* | 0.001 (0.001) \* |
| Jongno | -0.037 (0.034) | 0.031 (0.035) | 0.467 (0.151) \*\* | 0.301 (0.158) \* | -0.180 (0.084) \*\* | 0.204 (0.077) \*\* | 0.000 (0.001) |
| Gangnam | -0.066 (0.039) \* | 0.040 (0.041) | 0.168 (0.144) | 0.006 (0.147) | -0.506 (0.178) \*\* | 0.168 (0.164) | 0.004 (0.001) \*\* |
| Yeongdeungpo | -0.016 (0.015) | -0.005 (0.016) | 0.379 (0.151) \*\* | 0.180 (0.155) | -0.132 (0.068) \* | 0.126 (0.059) \*\* | 0.001 (0.001) \* |
| Seocho | -0.075 (0.030) \*\* | 0.024 (0.032) | 0.181 (0.144) | 0.095 (0.144) | -0.216 (0.098) \*\* | 0.064 (0.091) | 0.002 (0.001) \*\* |
| Geumcheon | -0.016 (0.011) | 0.014 (0.012) | 0.058 (0.140) | 0.006 (0.141) | -0.057 (0.022) \*\* | 0.013 (0.021) | 0.000 (0.000) \*\* |
| Yongsan | -0.018 (0.012) | -0.001 (0.012) | 0.643 (0.150) \*\* | 0.236 (0.159) | -0.052 (0.034) | 0.086 (0.032) \*\* | 0.000 (0.000) |
| Mapo | -0.043 (0.016) \*\* | 0.014 (0.016) | 0.587 (0.142) \*\* | 0.291 (0.147) \* | -0.051 (0.057) | 0.130 (0.052) \*\* | 0.000 (0.000) |
| Seongdong | -0.009 (0.012) | -0.015 (0.013) | 0.395 (0.149) \*\* | 0.125 (0.153) | -0.059 (0.035) \* | 0.050 (0.031) | 0.001 (0.000) \*\* |
| Dongdaemun | -0.011 (0.005) \*\* | 0.008 (0.005) | 0.590 (0.138) \*\* | 0.195 (0.143) | -0.052 (0.024) \*\* | 0.064 (0.022) \*\* | 0.000 (0.000) |
| Seodaemun | -0.028 (0.010) \*\* | 0.015 (0.010) | 0.588 (0.139) \*\* | 0.162 (0.144) | -0.043 (0.025) \* | 0.057 (0.023) \*\* | 0.000 (0.000) |
| Guro | -0.011 (0.006) \* | 0.009 (0.006) | 0.702 (0.143) \*\* | -0.227 (0.145) | -0.038 (0.027) | 0.009 (0.027) | 0.000 (0.000) \* |
| Songpa | -0.012 (0.008) | 0.004 (0.008) | 0.644 (0.154) \*\* | 0.217 (0.167) | -0.068 (0.055) | 0.115 (0.050) \*\* | 0.000 (0.000) |
| Gangseo | -0.009 (0.005) | -0.001 (0.006) | 0.683 (0.152) \*\* | 0.115 (0.151) | -0.031 (0.027) | 0.055 (0.026) \*\* | 0.000 (0.000) |
| Seongbuk | -0.011 (0.004) \*\* | 0.004 (0.004) | 0.914 (0.143) \*\* | 0.119 (0.155) | 0.001 (0.016) | 0.037 (0.015) \*\* | -0.000 (0.000) |
| Gwangjin | -0.008 (0.005) \* | -0.002 (0.005) | 0.862 (0.141) \*\* | 0.171 (0.153) | -0.014 (0.020) | 0.058 (0.019) \*\* | -0.000 (0.000) |
| Dongjak | -0.022 (0.007) \*\* | 0.009 (0.007) | 0.726 (0.147) \*\* | 0.153 (0.151) | 0.000 (0.023) | 0.029 (0.021) | 0.000 (0.000) |
| Gangdong | -0.006 (0.004) | 0.001 (0.005) | 0.767 (0.153) \*\* | 0.191 (0.165) | -0.022 (0.018) | 0.048 (0.017) \*\* | -0.000 (0.000) |
| Nowon | -0.012 (0.005) \*\* | 0.001 (0.006) | 0.794 (0.144) \*\* | 0.175 (0.151) | -0.014 (0.020) | 0.049 (0.018) \*\* | -0.000 (0.000) |
| Gangbuk | -0.010 (0.005) \*\* | 0.003 (0.004) | 0.712 (0.135) \*\* | 0.196 (0.144) | -0.013 (0.013) | 0.032 (0.013) \*\* | 0.000 (0.000) |
| Yangcheon | -0.018 (0.005) \*\* | 0.008 (0.005) | 0.849 (0.133) \*\* | -0.051 (0.130) | -0.016 (0.014) | 0.030 (0.014) \*\* | 0.000 (0.000) |
| Jungnang | -0.011 (0.004) \*\* | 0.004 (0.004) | 0.558 (0.130) \*\* | 0.257 (0.130) \* | -0.008 (0.012) | 0.021 (0.011) \* | 0.000 (0.000) |
| Dobong | -0.005 (0.004) | -0.004 (0.005) | 0.605 (0.127) \*\* | 0.203 (0.135) | -0.013 (0.012) | 0.023 (0.010) \*\* | 0.000 (0.000) |
| Gwanak | -0.006 (0.003) \* | 0.001 (0.004) | 0.914 (0.148) \*\* | -0.079 (0.155) | -0.008 (0.020) | 0.030 (0.019) | 0.000 (0.000) |
| Eunpyeong | -0.007 (0.004) \* | 0.004 (0.004) | 0.545 (0.127) \*\* | 0.252 (0.131) \* | -0.020 (0.013) | 0.029 (0.012) \*\* | 0.000 (0.000) |

Table 2.C

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Estimation results for equation policy:  policy = incidences.l1 + mobility.l1 + policy.l1 + incidences.l2 + mobility.l2 + policy.l2 + const + trend | | | | | | | |
| DIST | Incidence.l1 | Incidence.l2 | Mobility.l1 | Mobility.l2 | Policy.l1 | Policy.l2 | trend |
| Jung | -0.050 (0.107) | 0.134 (0.108) | -0.866 (0.371) \*\* | -0.348 (0.384) | 0.703 (0.237) \*\* | -0.337 (0.215) | 0.003 (0.002) \* |
| Jongno | 0.028 (0.102) | -0.023 (0.104) | -0.952 (0.452) \*\* | -0.499 (0.472) | 0.664 (0.252) \*\* | -0.320 (0.229) | 0.004 (0.002) \*\* |
| Gangnam | 0.037 (0.050) | 0.074 (0.053) | -0.303 (0.187) | -0.162 (0.191) | 0.611 (0.231) \*\* | -0.156 (0.212) | -0.002 (0.002) |
| Yeongdeungpo | -0.039 (0.057) | 0.059 (0.061) | -1.127 (0.573) \* | -0.505 (0.590) | 0.694 (0.257) \*\* | -0.326 (0.223) | 0.004 (0.002) \* |
| Seocho | -0.000 (0.077) | 0.150 (0.081) \* | -0.423 (0.365) | -0.262 (0.364) | 0.614 (0.249) \*\* | -0.152 (0.230) | -0.000 (0.002) |
| Geumcheon | 0.172 (0.122) | -0.188 (0.124) | -1.682 (1.481) | -1.344 (1.492) | 0.945 (0.228) \*\* | -0.309 (0.218) | 0.002 (0.002) |
| Yongsan | 0.068 (0.082) | 0.159 (0.086) \* | -2.679 (1.044) \*\* | 0.176 (1.106) | 0.445 (0.238) \* | -0.103 (0.222) | 0.001 (0.002) |
| Mapo | -0.031 (0.066) | 0.170 (0.069) \*\* | -0.834 (0.599) | -0.498 (0.620) | 0.564 (0.241) \*\* | -0.300 (0.220) | 0.001 (0.002) |
| Seongdong | 0.009 (0.083) | 0.126 (0.088) | -2.236 (1.045) \*\* | -0.832 (1.077) | 0.582 (0.243) \*\* | -0.202 (0.216) | 0.003 (0.002) |
| Dongdaemun | -0.022 (0.052) | 0.050 (0.053) | -1.851 (1.368) | -1.524 (1.418) | 0.777 (0.238) \*\* | -0.317 (0.220) | 0.003 (0.002) |
| Seodaemun | 0.145 (0.090) | 0.081 (0.098) | -1.818 (1.311) | -1.429 (1.357) | 0.584 (0.233) \*\* | -0.317 (0.214) | 0.001 (0.002) |
| Guro | -0.022 (0.052) | 0.008 (0.053) | -1.162 (1.313) | 0.362 (1.331) | 1.000 (0.247) \*\* | -0.247 (0.247) | 0.001 (0.002) |
| Songpa | -0.051 (0.036) | 0.086 (0.036) \*\* | -1.618 (0.685) \*\* | -0.165 (0.742) | 0.602 (0.243) \*\* | -0.249 (0.222) | 0.004 (0.002) \* |
| Gangseo | -0.045 (0.052) | 0.092 (0.054) \* | -1.181 (1.451) | -0.786 (1.444) | 0.815 (0.262) \*\* | -0.363 (0.251) | 0.003 (0.002) |
| Seongbuk | -0.060 (0.062) | 0.073 (0.068) | -3.668 (2.290) | -0.179 (2.486) | 0.628 (0.254) \*\* | -0.192 (0.247) | 0.004 (0.002) \*\* |
| Gwangjin | 0.068 (0.055) | 0.120 (0.058) \*\* | -2.350 (1.637) | -1.850 (1.777) | 0.472 (0.236) \* | -0.299 (0.224) | 0.001 (0.002) |
| Dongjak | 0.147 (0.077) \* | -0.027 (0.083) | -1.202 (1.667) | -2.024 (1.713) | 0.609 (0.261) \*\* | -0.257 (0.241) | 0.001 (0.002) |
| Gangdong | -0.137 (0.063) \*\* | 0.123 (0.067) \* | -3.440 (2.148) | -1.059 (2.313) | 0.728 (0.255) \*\* | -0.299 (0.241) | 0.004 (0.002) \*\* |
| Nowon | -0.122 (0.065) \* | 0.128 (0.073) \* | -1.356 (1.865) | -1.697 (1.959) | 0.881 (0.254) \*\* | -0.413 (0.238) \* | 0.003 (0.002) \* |
| Gangbuk | -0.115 (0.081) | 0.133 (0.078) \* | -1.347 (2.401) | -1.407 (2.558) | 1.021 (0.236) \*\* | -0.391 (0.224) \* | 0.002 (0.001) |
| Yangcheon | 0.022 (0.075) | 0.131 (0.082) | -0.434 (2.214) | -1.877 (2.173) | 0.791 (0.236) \*\* | -0.379 (0.228) | 0.001 (0.002) |
| Jungnang | 0.098 (0.069) | 0.006 (0.071) | -0.019 (2.557) | -4.745 (2.554) \* | 0.789 (0.235) \*\* | -0.318 (0.220) | 0.001 (0.002) |
| Dobong | -0.149 (0.074) \*\* | 0.231 (0.085) \*\* | -1.291 (2.349) | -3.837 (2.510) | 0.809 (0.214) \*\* | -0.303 (0.190) | 0.001 (0.001) |
| Gwanak | -0.043 (0.044) | 0.082 (0.045) \* | -1.556 (1.900) | -3.080 (1.982) | 0.739 (0.257) \*\* | -0.445 (0.247) \* | 0.003 (0.002) \* |
| Eunpyeong | 0.056 (0.066) | 0.092 (0.068) | -1.474 (2.130) | -4.140 (2.206) \* | 0.688 (0.212) \*\* | -0.368 (0.193) \* | 0.000 (0.001) |

5% significance into dark color.

10% significance into light color.

Red = positive relationship.

Blue = negative relationship

Discussion (3 paragraphs)

1. Summary of key findings:

• Incidence: Reiterate how past incidence and mobility (in commercial areas)/policy (in residential areas) levels have influenced current incidence rates.

• Mobility: Discuss the dynamic effects of past mobility and policy (compare comm/resi districts) on current mobility, emphasize the negative effect from incidences in most districts, focusing on how these effects vary across different time lags.

• Policy: Highlight how past incidence and mobility (mainly in commercial areas) affect policy adjustments, emphasizing regions where these effects are most pronounced.

1. Comparison with Existing Literature

• Highlight consistencies, such as the observed influence of mobility on incidence, which may support existing theories or models.

• Identify any discrepancies or novel findings, such as specific regional differences in policy responsiveness.

1. Limitations of the Study

• Data Limitations: Acknowledge any limitations related to the data used.

• Model Limitations: Reflect on the limitations of the VAR model, such as its sensitivity to lag selection, the potential for omitted variable bias.