경제학 석사학위 논문

Evaluating Sejong Special Self-governing City's Impact on Local Economic Growth and Standard of Living Using the Synthetic Control Method (SCM)

세종특별자치시가 지역경제발전과 삶의 질 개선에 미치는 영향의 SCM 분석

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김 채 민

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이 논문을 경제학 석사학위 논문으로 제출함

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Abstract

This paper explores the efficacy of the South Korean government's balanced national development plan, which entails establishing innovation cities in provincial areas to promote balanced growth by dispersing the capital's infrastructure as well as its population. Previous literature have focused on the effects of relocating Seoul's public institutions and government-funded research institutes to the rest of the nation's provinces on Seoul's employment, economic, and population outcomes, and less on the outcomes of the provinces themselves, where the public institutions have been relocated and innovation cities have been established. This paper aims to explore the impact of the new administrative capital in South Chungcheong Province—Sejong City—on local economic growth and standard of living. The synthetic control method is used to compare the GRDP and GRDP per capita of Sejong and the synthetic Sejong to investigate whether Sejong's establishment as an administrative capital has improved the area's economic output and standard of living. Results show that while the average treatment effect of Sejong on regional economic growth is an increase of GRDP by 4.1 trillion won, its growth seems to be driven largely by an increase in population, rather than the establishment of Sejong as an administrative capital. Given these results, this paper discusses the implications of population inflow and comments on the progress and cost-effectiveness of the government's balanced national development plan.

Key Words: innovation city, Sejong City, GRDP, synthetic control method
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Contents

Tables and Figures

1. Introduction

While South Korea achieved unprecedented growth with development strategies that emphasize highly compressed growth in the Seoul metropolitan area, such efforts have led to a severe polarization of the nation's territory. In stark contrast with the booming and bustling Seoul, the rest of the provinces are experiencing downturn in all aspects of life. Thus the Korean government's concern for balanced growth has led to several nationwide attempts to disperse the capital's population as well as its infrastructure. One of the most representative attempts is the 'Seoul Population Dispersion Policy' implemented three times from 1973 to 1990. At the time, the government promoted regional development by moving small national research institutes or minor departments that could be easily transferred to provinces (e.g. Daejeon Daedeok Research Complex). As a result, the concentration of population in the metropolitan area has gradually decreased, but the concentration of the metropolitan area in terms of its economic and administrative functions was not resolved.

Likewise, continuous attempts have been made by the South Korean government to relieve such issues of polarization, but there have been concerns that the implemented policies were not unified in their directivities and goals. Thus the 2005 Roh Moo-hyun governmental set out to promote a major attempt to establish innovation cities in several rural regions.

Innovation cities were born out of the President Roh's government to promote equitable and balanced national development. The innovation city project had three step-wise objectives; send public institutions and government-funded research institutes to provinces, establish small planned cities in the area, and foster them as regional hubs. The innovative cities were categorized into four types: (1) innovation hub cities that promote innovation through collaboration among industries, academia, and public institutions, (2) specialized cities with regional themes, (3) eco-friendly green cities with a high standard of living, and (4) educational and cultural cities that allow creative exchange of knowledge. Considering South Korea's regional characteristics, where the territory is divided into 17 administrative districts consisting of one metropolitan city, six megalopolis, eight provinces, and one special self-governing province, the innovation cities were established in each of these provinces. The current 17 administrative districts of South Korea can be seen in Figure 1.

Figure 1. The Regional Map of South Korea with 17 Administrative Districts

With the advent of innovation cities, the administrative capital of Sejong was established in 2012 in South Chungcheong Province (Chungchungnam-do); Sejong City harbors public institutions that have been relocated from Seoul and is structured to encourage small and medium-sized

enterprises in subsidiary industries. A detailed map of South Chungcheong Province and Sejong City is represented in Figure 2 below.

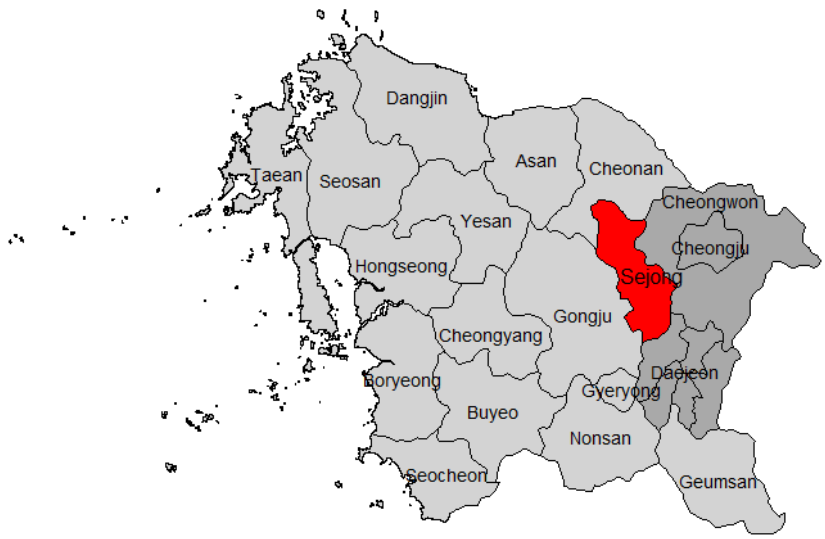

Figure 2. The Regional Map of Chungnam, Sejong, and Some Boardering Cities

While previous governments have mainly focused on the relocation and settlement of public institutions in these new administrative cities, the current Moon Jae-in administration announced that ‘Innovation Cities Season 2’ will be launched to again boost the economy of these provincial regions. However, before such grand scheme is fully under operation, it is crucial to evaluate whether the decade-old ‘Innovation Cities Season 1’ carried under the previous Roh administration has had a palpable positive impact on

regional growth to fully justify and support 'Innovation Cities Season 2.' Thus in this study, we aim to observe whether amongst several designated innovation cities, the representative of all, Sejong administrative capital, has promoted the regional boost of GRDP, proving the success of governmental policy implementation.

2. Previous Literature

There are two main bodies of research regarding South Korea's innovation cities; the first focuses on the impact of the relocation of public institutions from Seoul on Seoul and the surrounding metropolitan area, while the second focuses on the impact of the relocation on the areas the institutions are relocated to.

Previous literature on the economic impact of the relocation on metropolitan areas have estimated that about 0.35% to 1.5% of jobs will leak from the region, and about 0.58% to 1.35% decrease in production is to be expected due to the extensive relocation of public institutions (Park, Kim, & Park, 2003; The Seoul Institute, 2006; Kim et al., 2013). While most previous research are in agreement that such reduction in employment and production is anticipated to be mostly harmless for Seoul and the surrounding metropolitan area, few point out that the consequences will not be benign for

all the districts, with some anticipated to suffer at most a 4% decrease in employment (Kim et al., 2012).

On the other hand, research on the impact of the relocation on provincial regions (where the public institutions have been relocated to) have focused less on economic growth and more on equitable growth. Previous research are unanimous in their conclusions about the net impact of innovation cities: national GDP will fall, but regional GRDP will grow (Kim & Seo, 2004; Gyeonggi Research Institute, 2005; Kim, Yoon, Shin, & Kim, 2005; Kim & Cho, 2006). A small body of research focused on the performance of individual innovation cities. One of the most representative and recent of such research investigates the impact of Busan Innovation City on Busan's GRDP, and concludes that the relocated public institutions contribute to about 1.35-1.42% of the total GRDP of Busan (Lee, Choi, Oh, & Kang, 2017).

3. Synthetic Control Methods for Comparative Case Studies

3.1 A comparative case study of Sejong City

This paper will use the Synthetic Control Method (SCM) to evaluate the role of Sejong City on local economic growth and standard of living. As highlighted by Abadie, Diamond, and Hainmueller (2010), the idea behind the synthetic control approach is that a combination of units often provides a

better comparison for the unit exposed to the intervention than any single unit alone. In other words, rather than lamenting the absence of the counterfactual, the synthetic control approach synthesizes the counterfactual to estimate the impact of a particular policy or change. In this paper, SCM is used to create a synthetic Sejong City to enable direct comparison with the actual Sejong City in order to estimate its impact on GRDP and GRDP per capita.

3.2 Model Setup

Suppose there are J+1 regions. WLOG, suppose also that only the first region is exposed to the intervention of interest, so that we have J remaining regions as potential controls. Let Y_{it}^N be the outcome observed for region i at time t in the absence of the intervention, where i = 1, . . . , J +1, and t = 1, . . . , T. If T_0 is the number of pre-intervention periods, where $1 \leq T_0 \leq T$, then Y_{it}^I is the outcome observed for region i at time t if the region is exposed to the intervention in periods $T_0 + 1$ to T. Thus, for $t \in \{1, \dots, T_0\}$ and $i \in \{1, \dots, N\}$, $Y_{it}^I = Y_{it}^N$ holds by construction. The effect of the intervention for region i at time t can be expressed as $a_{it} = Y_{it}^I - Y_{it}^N$, which renders the observed outcome for region i at time t as:

$$Y_{it} = Y_{it}^N + a_{it}D_{it} \quad (1)$$

when D_{it} is a binary variable of value 1 when region i is exposed to the intervention at time t, and 0 otherwise.

Consequently,

$$Y_{it} = Y_{it}^N + (Y_{it}^I - Y_{it}^N)D_{it}$$
$$= Y_{it}^I D_{it} + (1 - D_{it})Y_{it}^N \quad (2)$$

The aim is to estimate $(a_{1T_0+1}, \ldots, a_{1T})$, where $\alpha_{1t} = Y_{1t}^I - Y_{1t}^N = Y_{1t} - Y_{1t}^N$ for $t > T_0$. Suppose Y_{it}^N is given by the following model,

$$Y_{it}^N = \delta_t + Z_i\theta_t + \lambda_t\mu_i + \varepsilon_{it} \quad (3)$$

where

δ_t is an unobserved (common) time-dependent factor,

Z_i is a (1 × r) vector of observed covariates,

θ_t is a (r × 1) vector of unknown parameters,

λ_t is a (1 × F) vector of unknown common factors,

μ_i is a (F × 1) vector of unknown factor loadings,

ε_{it} are unobserved transitory shocks.

Notice that $\boldsymbol{\lambda_t\mu_i}$ are the heterogeneous responses to multiple unobserved factors. The fundamental insight of the synthetic control method is to reweight the control group such that the synthetic control unit matches $\boldsymbol{Z_i}$ and (some) pre-treatment $\boldsymbol{Y_{it}}$ of the treated unit. The resulting μ_i is then automatically matched.

3.3 Theory

Let $\boldsymbol{W_{JX1} = (w_2, \dots, w_{J+1})'}$ with $\mathbf{w_j \geq 0}$ for $\boldsymbol{j = 2, \dots, J+1}$ and $\boldsymbol{w_2 + \cdots + w_{J+1} = 1}$. Then each particular value of $\boldsymbol{W_{JX1}}$ represents a potential synthetic control, a particular weighted average of control regions. Let $\boldsymbol{\bar{Y}_i^{K_1}, \dots, \bar{Y}_i^{K_M}}$ be $\boldsymbol{M}$ linear functions of pre-intervention outcomes, where $\boldsymbol{M \geq F}$. Suppose we can choose $\boldsymbol{W^*}$ such that

$$\boldsymbol{\sum_{j=2}^{J+1} w_j^* Z_j = Z_1 \; and \; \sum_{j=2}^{J+1} w_j^* \bar{Y}_j^{K_1} = \bar{Y}_1^{K_1}, \dots, \sum_{j=2}^{J+1} w_j^* \bar{Y}_j^{K_M} = \bar{Y}_1^{K_M}} \quad (4)$$

Then, if T_0 is large relative to the scale of ε_{it}, an approximately unbiased estimator of α_{1t} is

$$\widehat{a_{it}} = Y_1 - \sum_{j=2}^{J+1} w_j^* Y_{jt} \; for \; t \in \{T_0 + 1, \dots, T\} \quad (5)$$

3.4 Implementation

Let $X_1 = \left(Z'_1, \bar{Y}_1^K, \dots, \bar{Y}_1^{K_M} \right)'$ be a $(k \times 1)$ vector of preintervention characteristics for the exposed region. Similarly, let X_0 be a $(k \times J)$ matrix that contains the same variables for the rest of the unexposed regions,

$$X_0 = \begin{bmatrix} Z'_2 & \bar{Y}_2^K \cdots & \bar{Y}_2^{K_M} \\ \vdots & \ddots & \vdots \\ Z'_{J+1} & \bar{Y}_{J+1}^K \cdots & \bar{Y}_{J+1}^{K_M} \end{bmatrix}' \quad (6)$$

W^* is chosen as the optimal synthetic control for the exposed region,

$$W^* = \; argmin_W \parallel X_1 - X_0 W \parallel \quad (7)$$

This renders the average treatment effect in the post-intervention period to be

the following:

$$RMSPE = \left(\frac{1}{T-T_0+1}\sum_{t=T_0}^{T}\left(Y_1 - \sum_{j=2}^{J+1} w_j^* Y_{jt}\right)^2\right)^{\frac{1}{2}} \quad (8)$$

4. Estimating Sejong City's Impact on Local Economic Growth and Standard of Living

4.1 Data and sample

Annual Si-Gun level panel data for the South Chungcheong Province for the period 2000-2017 is gathered from the Korean Statistical Information Service (KOSIS), and the South Chungcheong Province statistical database. Sejong City was established in 2012, which consequently provides 13 years of preintervention data. The sample period begins in 2000 and ends in 2017 as they are the earliest and the latest year for which Si-Gun level panel data are available for all our control states, respectively.

4.1.1 Predictors of GRDP

Net migration, total fertility, population growth, employment rate, number of business, land prices, and the aged population are considered as predictors of GRDP. The rationale for such selection of predictors is intuitive when a typical functional form of a production function is considered; while net migration, total fertility, population growth, and aged population represent labor input, number of business represent capital input. While land prices is

not a typical choice for analyzing growth in the short run since it affects demand rather than supply, it is selected to incorporate the wealth effect, which is expected to be prominent in Sejong where land prices have been surging since its foundation in 2012.

4.1.2 Construction of pre-2012 Sejong City predictors

Since Sejong was established in 2012, its data for the 2000-2011 period is missing by construction. Thus the preintervention data of Sejong prior to 2012 is constructed as a weighted average of Gongju-si and Yeongi-Gun. For the construction of GRDP, net migration, and number of business the ratio of incorporated area to original Si-Gun area is used, and for total fertility, population growth, employment rate, land prices, and aged population the ratio of incorporated area to Sejong is used (Table 1). While a part of Cheongwon-gun was added to Sejong, its influence is ignored for the construction of preintervention data since only a very small portion of Cheongwon-gun was incorporated into the new city.

Table 1. Weights used to construct pre-2012 Sejong predictors

Region	Area (km^2)		Ratio	
	Incorporated Area	Original Si-Gun Area	Incorporated Area to Original Si-Gun Area	Incorporated Area to Sejong
Yeongi-gun	361.381	361.381	1	0.777086568
Gongju-si	76.315	940.39	0.081152501	0.164102046
Cheongwon-gun	27.35	814.17	0.033592493	0.058811386
Total (Sejong)	465.046	2115.941	-	1

4.2 Synthesis of GRDP

Figure 3 plots the trends in GRDP in Sejong and the rest of the Chungcheongnam-do districts. Since the time series of GRDP in the Sejong area and the rest of Chungnam differ significantly even before Sejong was founded in 2012, the rest of Chungnam serve as a poor comparison to study the impact of Sejong on GRDP.

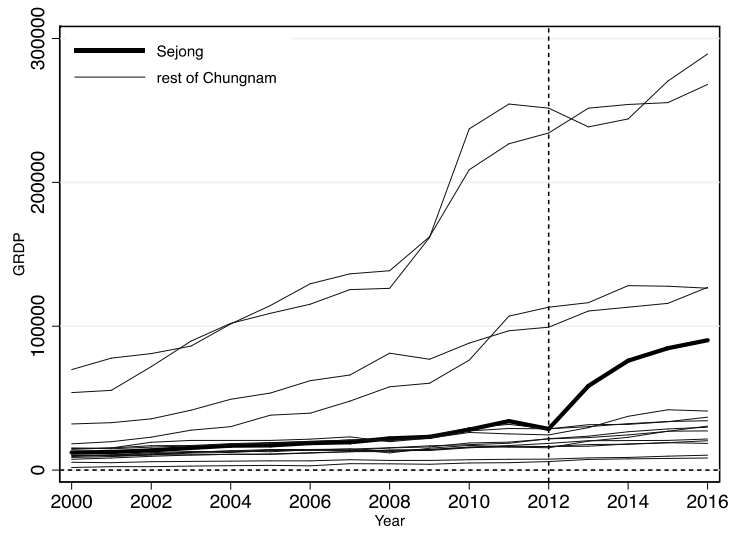

Figure 3. Trends in GRDP: Sejong vs. the rest of the Chungnam

As outlined above, the synthetic Sejong is constructed as a convex combination of districts in the donor pool that most closely resembled pre-2012 Sejong in terms of pre-2012 values of GRDP predictors. The resulting predictor means are displayed in Table 2, in which the pre-2012 predictor means of Sejong are compared to that of the synthetic Sejong. It shows that the synthetic Sejong correctly regenerates the values of GRDP predictors of Sejong prior to 2012. Table 3 displays the weights used to produce the synthetic Sejong as a weighted average of regions chosen from the donor pool. The weights indicate that GRDP trends in pre-2012 Sejong is best regenerated by a combination of Gongju-si, Asan-si, Dangjin-si, Cheongyang-gun, and Yesan-gun.

Table 2. GRDP predictor means (2000-2011)

Variables	Sejong City	
	Real	Synthetic
Net migration	1197.855	1194.586
Total fertility	1.325631	1.369628
Population growth (%)	1.311701	1.473528
Employment rate (%)	53.67719	58.8664
Number of business	5755.358	6051.778
Increase in land prices (%)	6.123945	3.521388
Aged population (%)	13.97525	18.63236
GRDP (2011)	33994.02	33408.51
GRDP (2005)	17106.91	17379.04
GRDP (2000)	12161.64	11836.87

Table 3. District weights in the synthetic Sejong City

District	Weight
Cheonan-si	0
Gongju-si	0.52
Boryeong-si	0
Asan-si	0.005
Seosan-si	0
Nonsan-si	0
Gyeryong-si	0
Dangjin-si	0.121
Geumsan-gun	0
Buyeo-gun	0
Seocheon-gun	0
Cheongyang-gun	0.35
Hongseong-gun	0
Yesan-gun	0.005
Taean-gun	0

Figure 4 shows the GRDP trends for Sejong and its synthetic counterpart for the period 2000-2017. While GRDP of the synthetic Sejong closely follows the level of GRDP of the actual Sejong prior to 2012, it deviates greatly from the GRDP of the actual Sejong after 2012. This means that the synthetic Sejong provides an adequate approximation to the level of GRDP that would have been in the Sejong area in the absence of Sejong. The increasing discrepancy between the two lines after 2012 suggests an increasing positive impact of the establishment of Sejong on the area's GRDP. Specifically, the average treatment effect of Sejong on regional economic

growth is an increase of GRDP by 4.1 trillion won.

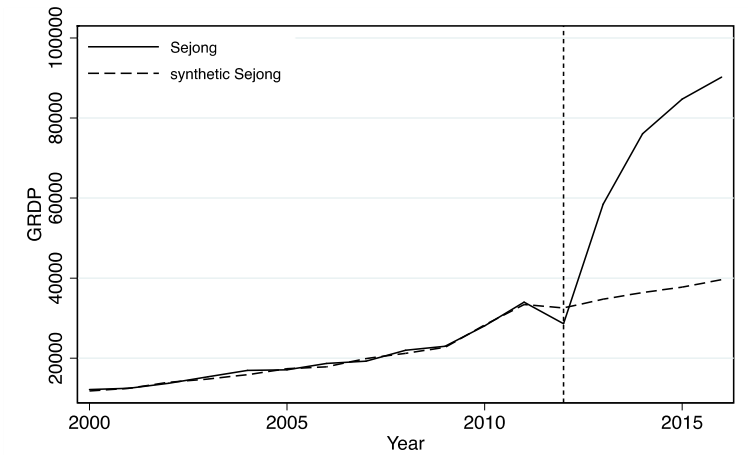

Figure 4. Trends in GRDP: Sejong vs. Synthetic Sejong

4.3 Inference about Sejong City's impact on GRDP

To evaluate the significance of the large discrepancy between Sejong and the synthetic Sejong, placebo tests are used by applying the synthetic method iteratively to the control regions that did not experience any large scale administrative change such as that of the Sejong area. In the scenario that the placebo test reveals the gap estimated for Sejong to be exceptionally large in comparison with gaps for other control regions, it can be concluded that the synthetic control method provides significant evidence of a positive impact of Sejong on the area's GRDP.

Placebo tests are used to estimate the impact of Sejong to every other district in the donor pool. Figure 5 provides the results for the placebo test.

The gray lines portray the estimated GRDP gap for each of the 15 control districts, and the black line in bold portrays the estimated GRDP gap for Sejong. The placebo test results show that the GRDP gap of Sejong is exceptionally large relative to the gaps of other control districts after 2012. However, notice from Figure 3 that for some districts the synthetic control method does not accurately reproduce the level of GRDP prior to 2012; this means that it fails to provide an adequate approximation to the level of GRDP that would have been in the area in the absence of the treatment after 2012.

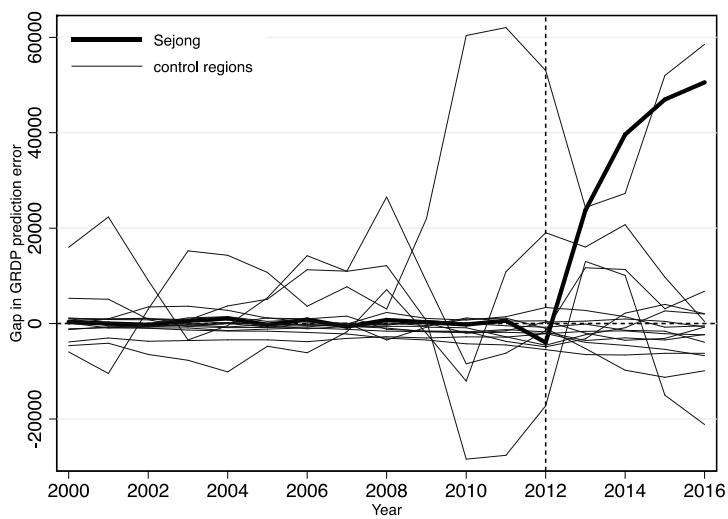

Figure 5. GRDP gap in Sejong and placebo gaps in all 15 control regions

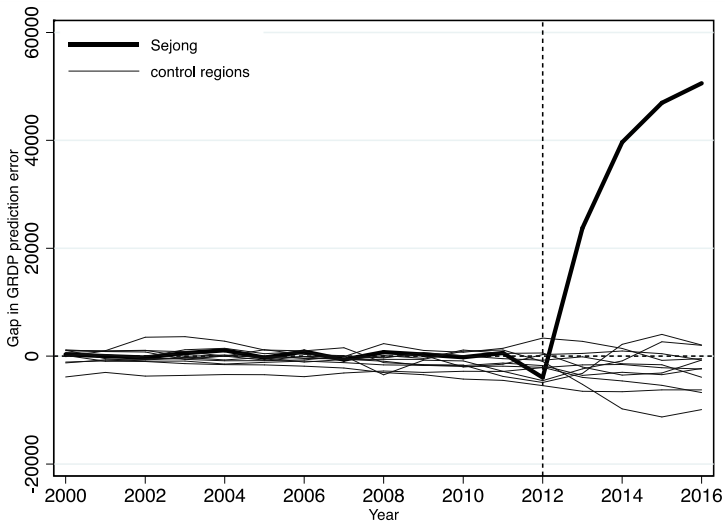

Figure 6. GRDP gap in Sejong and placebo gaps in 11 control regions

Figure 6 excludes the districts that had pre-2012 RMSPE of more than 5 times that of Sejong. Despite such a cutoff, only 4 districts are excluded from the donor pool, and the GRDP gap of Sejong is now the largest of all. An alternative way to evaluate Sejong's GRDP gap is to examine the distribution of the post/pre-2012 RMSPE. Comparing the frequencies of the post/pre-2012 RMSPE does not require one to choose an arbitrary cutoff to exclude the districts that are unfit to analyze with the synthetic control method. Figure 7 displays the post/pre-2012 RMSPE for Sejong and all 15 control districts. Sejong is clearly an outlier, which means that the estimated GRDP gap between Sejong and synthetic Sejong is unlikely to have occurred by chance. Thus, the true causal impact of Sejong on regional economic growth

is estimated to be an increase of GRDP by 4.1 trillion won.

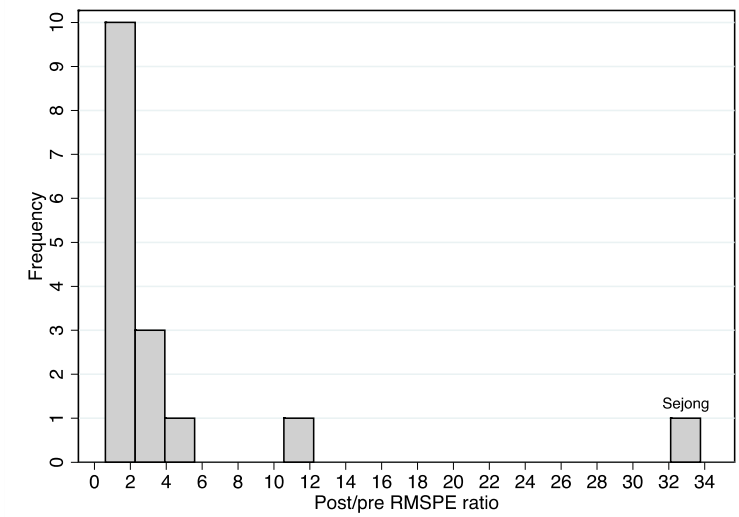

Figure 7. Ratio of post- and pre-Sejong RMSPE: Sejong and 15 control regions

4.4 Synthesis of GRDP per capita

Figure 8 plots the trends in per capita GRDP in Sejong and the rest of the Chungnam districts. Since the time series of per capita GRDP in the Sejong area and the rest of Chungnam differ significantly even before Sejong was founded in 2012, the rest of Chungnam serve as a poor comparison to study the impact of Sejong on per capita GRDP.

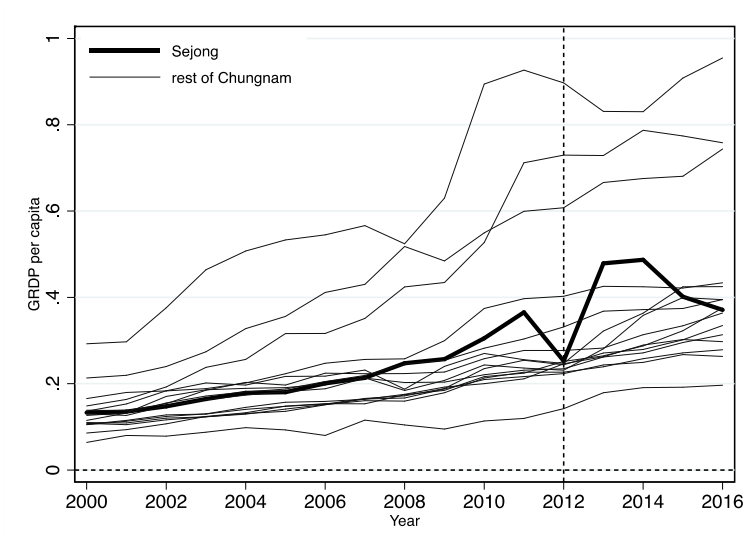

Figure 8. Trends in per capita GRDP: Sejong vs. the rest of the Chungnam

As outlined above, the synthetic Sejong is constructed as a convex combination of districts in the donor pool that most closely resembled pre-2012 Sejong in terms of pre-2012 values of per capita GRDP predictors. The resulting predictor means are displayed in Table 2, in which the pre-2012 predictor means of Sejong are compared to that of the synthetic Sejong. It shows that the synthetic Sejong correctly regenerates the values of per capita GRDP predictors of Sejong prior to 2012. Table 3 displays the weights used to produce the synthetic Sejong as a weighted average of regions chosen from the donor pool. The weights indicate that per capita GRDP trends in pre-2012 Sejong is best regenerated by a combination of Gongju-si, Seosan-si, Dangjin-si, Geumsan-gun, and Cheongyang-gun.

Table 4. Per capita GRDP predictor means

Variables	Sejong City	
	Real	Synthetic
Net migration	1197.855	1330.52
Total fertility	1.325631	1.379172
Population growth (%)	1.311701	1.47335
Employment rate (%)	53.67719	59.74075
Number of business	5755.358	6513.929
Increase in land prices (%)	6.123945	3.478232
Aged population (%)	13.97525	17.75964
GRDP per capita (2011)	0.3654736	0.3464854
GRDP per capita (2005)	0.1804215	0.1959591
GRDP per capita (2000)	0.1329513	0.1234861

Table 5. District weights in the synthetic Sejong City

District	Weight
Cheonan-si	0
Gongju-si	0.477
Boryeong-si	0
Asan-si	0
Seosan-si	0.035
Nonsan-si	0
Gyeryong-si	0
Dangjin-si	0.178
Geumsan-gun	0.081
Buyeo-gun	0
Seocheon-gun	0
Cheongyang-gun	0.229
Hongseong-gun	0
Yesan-gun	0
Taean-gun	0

Figure 9 shows the per capita GRDP trends for Sejong and its synthetic counterpart for the period 2000-2017. While per capita GRDP of the synthetic Sejong closely follows the level of per capita GRDP of the actual Sejong prior to 2012, it deviates greatly from the per capita GRDP of the actual Sejong around 2012. This means that the synthetic Sejong provides an adequate approximation to the level of per capita GRDP that would have been in the Sejong area in the absence of Sejong. The discrepancy between the two lines after 2012 suggests that Sejong's impact on the area's per capita GRDP had been unsteady and inconsistent. The average treatment effect of Sejong

on regional economic growth is an increase of per capita GRDP by 7.7 million won.

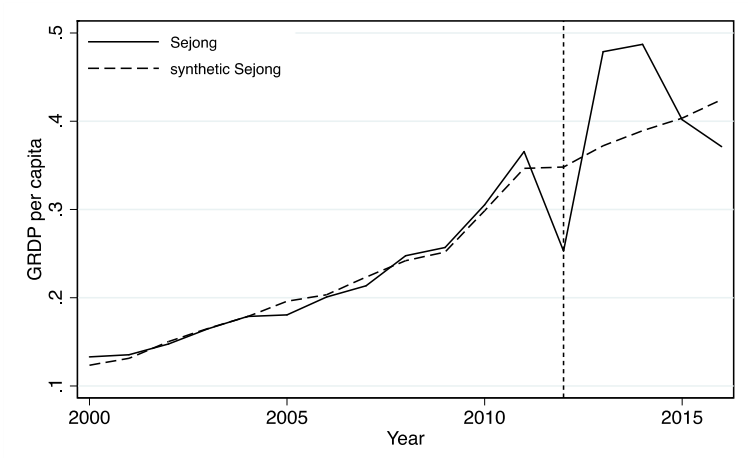

Figure 9. Trends in GRDP per capita: Sejong vs. Synthetic Sejong

4.5 Inference about Sejong City's impact on GRDP per capita

To evaluate the significance of the unsteady discrepancy between Sejong and the synthetic Sejong, placebo tests are used by iteratively applying the synthetic method to the control regions that did not experience any large scale administrative change such as that of the Sejong area. In the scenario that the placebo test reveals the gap estimated for Sejong to be exceptionally large in comparison with gaps for other control regions, it can be concluded that the synthetic control method provides significant evidence of a significant impact – however positive or negative – of Sejong on the area's GRDP per capita.

Placebo tests are used to estimate the impact of Sejong to every other district in the donor pool. Figure 10 provides the results for the placebo test. The gray lines portray the estimated per capita GRDP gap for each of the 15 control districts, and the black line in bold portrays the estimated per capita GRDP gap for Sejong. The placebo test results show that the per capita GRDP gap of Sejong is not exceptionally large relative to the gaps of other control districts after 2012. However, notice from Figure 10 that for some districts the synthetic control method does not accurately reproduce the level of per capita GRDP prior to 2012; this means that it fails to provide an adequate approximation to the level of per capita GRDP that would have been in the area in the absence of the treatment after 2012.

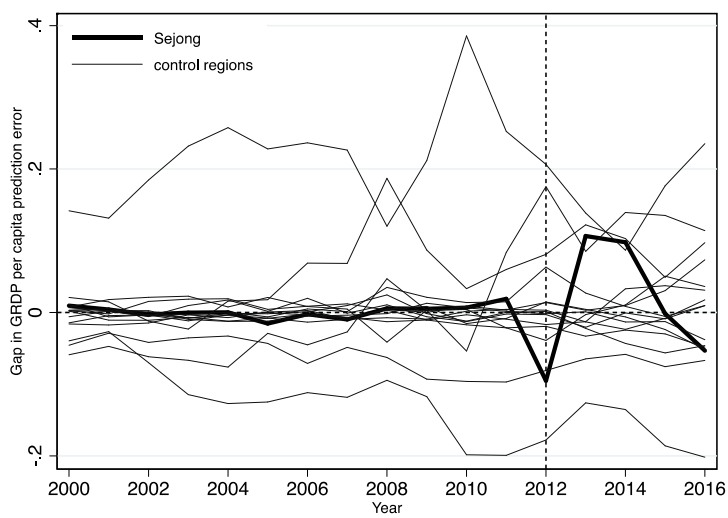

Figure 10. Per capita GRDP gap in Sejong and placebo gaps in all 15 control regions

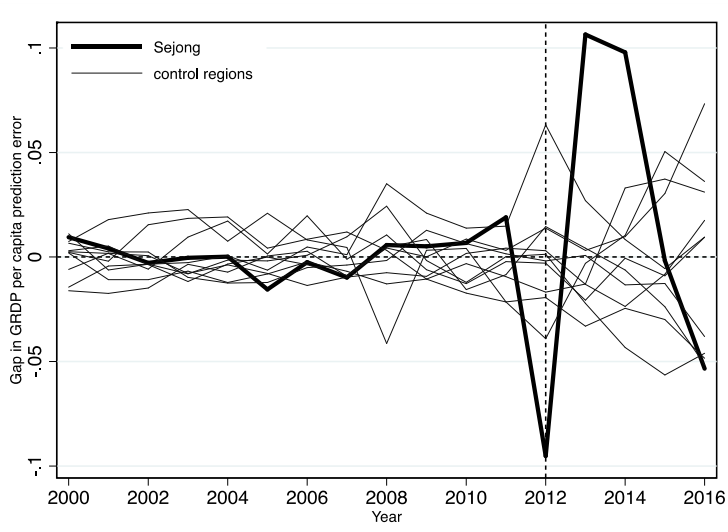

Figure 11. Per capita GRDP gap in Sejong and placebo gaps in 10 control regions

Figure 11 excludes the districts that had pre-2012 RMSPE of more than twice that of Sejong. Despite such a stringent cutoff, only 5 districts are excluded from the donor pool, and the per capita GRDP gap of Sejong is now among the most extreme. However, there are still a number of districts for which the synthetic control method does not accurately reproduce the level of per capita GRDP prior to 2012. This suggests that in contrary to GRDP, GRDP per capita values may be unfit to be approximated by the synthetic control method for comparative case studies. An alternative way to evaluate Sejong's per capita GRDP gap is to examine the distribution of the post/pre-2012 RMSPE. Figure 10 displays the post/pre-2012 RMSPE for Sejong and all 15

control districts. Sejong is clearly not an outlier, which means that the estimated per capita GRDP gap between Sejong and the synthetic Sejong may have occurred due to chance.

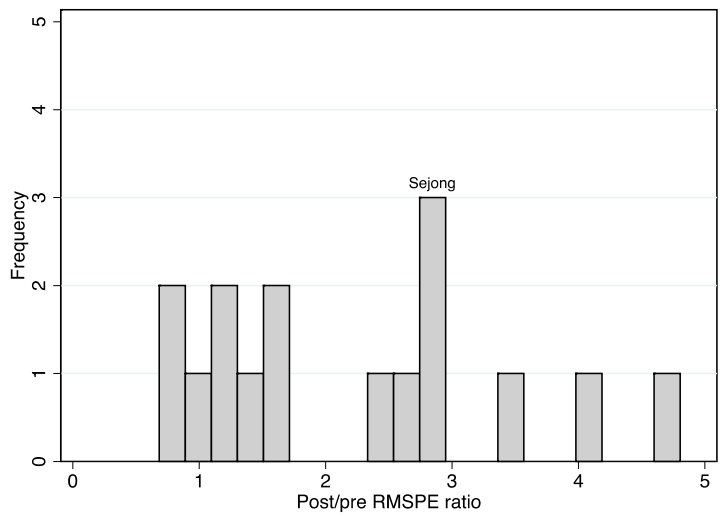

Figure 12. Ratio of post- and pre-Sejong RMSPE:

Sejong and 15 control regions

4.6 Implication

As shown above, while the establishment of Sejong City seems to have had a positive impact on the area's GRDP, such influence vanishes when analyzed in per capita terms. This suggests that a surge in population may have diluted the effects of the increased GRDP in Sejong; Sejong City's GRDP growth seems to be driven by a sheer increase in population size, rather than the establishment of Sejong as an administrative capital.

Figure 13 plots the population trends in Sejong and the rest of the Chungnam districts. Notice that in contrast with the rest of the Chungnam districts, which maintains a consistent population size during the 2000-2017 period, Sejong alone experiences a surge in population after 2012. Figure 14 plots the trends in population growth in Sejong and the rest of the Chungnam districts. It shows that such trend is due to unprecedented population growth in Sejong after 2012. Population grows at an increasing rate immediately after 2012 and the growth rate continues to rise until 2015; yet, even after 2015 the population growth rate in Sejong is the highest of all.

Examining Figure 13 and 14 with Figure 3, it seems highly probable that the increase in Sejong area's GRDP has been driven by population growth, rather than the establishment of Sejong as an administrative capital.

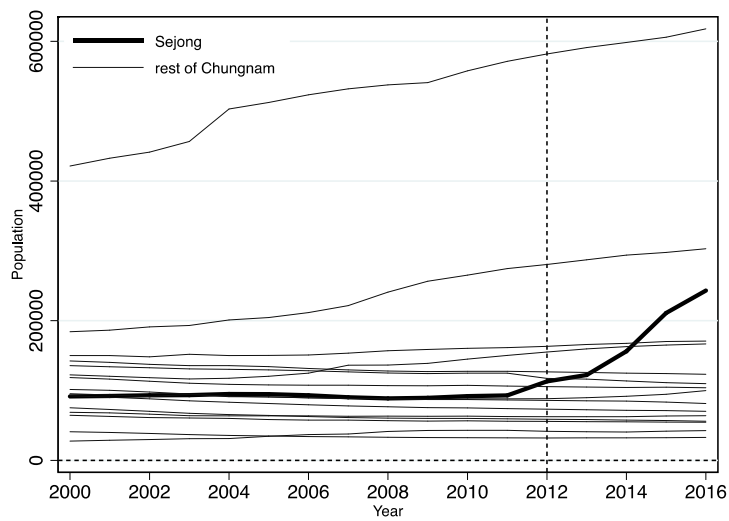

Figure 13. Population trends: Sejong vs. the rest of the Chungnam districts

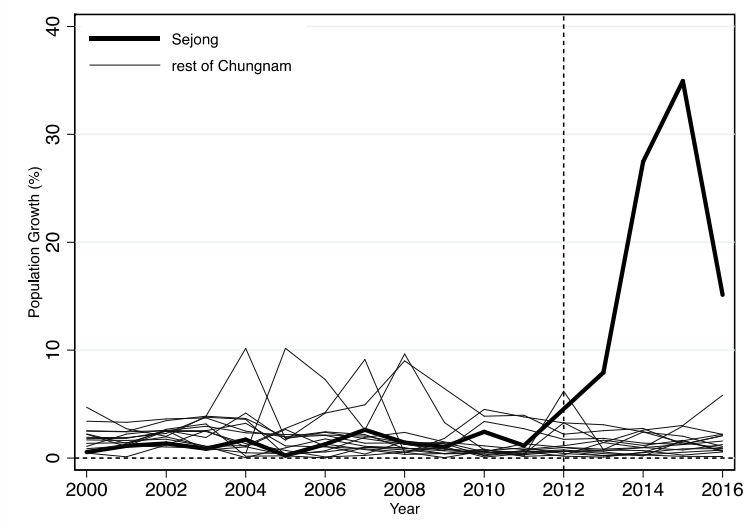

Figure 14. Population growth trends:

Sejong vs. the rest of the Chungnam districts

Further examination of Sejong's net migration and GRDP per capita trends in Figure 15 also reveals that while population growth may be largely responsible for the increase in Sejong's GRDP growth, such treatment effect is less conclusive in per capita terms. Notice that post-2012 population growth trends in Figure 14 closely resembles the post-2012 net migration trends in Figure 15. Net migration was used in Figure 15 in place of population growth to enable an approximate comparison between general population trends and GRDP growth. Despite obvious limitations in directly comparing the two trends, notice that when net migration is low, GRDP per capita is high as is the case in 2013, and that when net migration is high, GRDP per capita is low

as is the case in 2015.

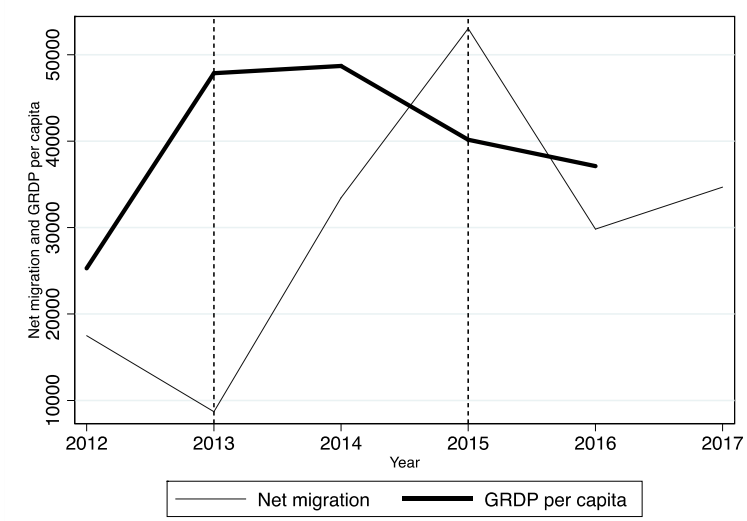

Figure 15. Trends in Sejong's Net migration and GRDP per capita

5. Conclusion

Using the synthetic control method, the true causal impact of Sejong on regional economic growth is estimated to be an increase of GRDP by 4.1 trillion won. Yet such growth seems to be driven by a sheer increase in population size, rather than the establishment of Sejong as an administrative capital. This is unexpected but not surprising as Sejong was founded with public institutions that have been relocated from Seoul, and with them their bureaucrats and their families. However, the relocation of ministries and agencies alone cannot account for such surge in population growth, and the

sharp decrease in the rate of growth in 2015 seems inconsistent with the continued relocation of the government institutions from Seoul to Sejong since 2012. Therefore, an in-depth case study of Sejong's increased population growth may aid future policy makers to further alleviate the population congestion problem in Seoul by promoting population outflow to provincial areas.

While economic growth in Sejong (measured by GRDP) is conclusive and in harmony with the government's objective for promoting development in provincial areas, the standard of living (measured by GRDP per capita) is inconclusive and requires further research. In Figure 9, Sejong's per capita GRDP is among the lowest in 2012 and 2016. What is more curious and alarming is that its per capita GRDP has been decreasing rapidly since 2013. Even when accounting for the surge in population, the downturn in Sejong's per capita GRDP may be interpreted as an indication of the futility of new administrative cities and innovation cities to promote the standard of living in provincial areas.

The purported goal of the Korean government in establishing innovation cities around the nation is to reduce the influence and dominance of Seoul on national governance and economics, whilst promoting growth in provincial areas. As such, further analysis on the underlying model for the intended growth process is deemed necessary to fully evaluate the efficacy of

the government's plan for balanced national development. If a sheer increase in GRDP was what was intended in the current stage of the balanced national development plan, than the plan is in smooth sailing; if an improved standard of living was also an implicit objective of the plan, than the importance of the task at hand is great.

Moreover, an extensive cost-benefit analysis should be undertaken to enable a rigorous evaluation of the government's plan for balanced national development. The National Agency for Administrative City Construction (NAACC) disclosed that the total budget for the construction of Sejong City will be approximately 107 trillion won by 2030, and that 27.1% of the construction had been finished by 2017. This means that about 28.9 trillion won had been invested for the construction of the city by 2017.

Given such estimates, one can compare the construction costs with the ATE on GRDP as estimated by the SCM to evaluate the efficacy of Sejong as an administrative capital in promoting economic growth in provincial regions. As of 2017, the total budget used for the construction of Sejong is 28.9 trillion won while the treatment effect of Sejong on the region's GRDP is estimated to be 20.5 trillion won as estimated by the SCM; more was spent on Sejong than was gained. Extending this comparison to 2030 illustrates that even by 2030, the input on Sejong outstrips the output from Sejong. By 2030, the total budget used for the construction of Sejong is 107 trillion won while

the treatment effect of Sejong on the region's GRDP is estimated to be 73.8 trillion won as estimated by the SCM. However, assuming that no additional construction costs are be needed for Sejong after 2030, it is predicted that by 2038, the aggregate output as measured by Sejong's GRDP will surpass the aggregate input on Sejong as measured by the total construction cost. Thus, from 2038 and on, the boost in GRDP from Sejong may prove to be well worth the initial construction costs.

All in all, further analysis on the underlying model for the intended growth process and an extensive cost-benefit analysis should be undertaken to enable a more rigorous evaluation of the government's plan for balanced national development.

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세종특별자치시가 지역경제발전과 삶의 질 개선에 미치는 영향의 SCM 분석

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초록

이 논문은 균형 성장을 촉진하기 위해 서울의 인구와 기반시설을 분산시켜 지방에 행정중심복합도시와 혁신도시를 설립하는 한국 정부의 국가균형발전계획의 실효성에 대해 탐구한다. 기존 문헌들은 서울의 공공기관과 정부출연 연구소를 지방으로 이전하는 것이 서울의 고용, 경제, 인구 결과에 어떠한 영향을 미치는 지에 대해 초점을 맞추고 있다. 이에 본 연구는 공공기관과 정부출연 연구소들이 실제 이전한 지역에 어떠한 영향을 미치는지 알아보기 위해, 새로운 행정중심복합도시인 충남의 세종시가 지역경제 성장과 생활수준에 미치는 영향을 탐구하였다. Synthetic Control Method(SCM)을 이용해 세종시와 가상(synthetic) 세종시의 GRDP와 1인당 GRDP를 비교해 세종시가 행정중심복합도시로 자리매김한 것이 지역의 경제적 생산량과 생활수준을 얼마나 향상시켰는지 추정하였다. 연구 결과 세종시로 인해 해당 지역의 GRDP가 약 4.1조원 가량 늘어난 것을 확인할 수 있었다. 반면, 그러한 GRDP 증가는 행정중심복합도시로 인한 효과보다 유입인구증가에 의해 크게 좌우되는 것으로 보인다. 이러한 결과를 감안하여 본 논문은 세종시의 인구 유입 효과, 정부의 국가균형발전계획의 진척상황, 그리고 행정중심복합도시의 비용대비효과에 관해 논한다.

주요어: 혁신도시, 행정중심복합도시, 세종시, GRDP, synthetic control method
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