Estimating the effect of the special employment promotion zone project in Tongyeong City using synthetic control method

Hyejin Kim*

ABSTRACT

As Tongyeong suffered from the recession of the shipbuilding industry, the Ministry of Employment and Labor designated Tongyeong as a Special Employment Promotion Zone (SEPZ). We use the synthetic control method to investigate its impact on the employment rate in Tongyeong. Our results indicate that the SEPZ project has a positive effect, although the magnitude of estimated effect is not substantial, and the effect dissipates after the government support ended.

Keywords: Special Employment Promotion Zone; synthetic control method; Tongyeong.

* Department of Economics, Seoul National University. E-mail: hyjnkm@snu.ac.kr

1. Introduction

The global economic downturn in 2008 caused the recession of the shipbuilding industries, which led to the bankruptcies and closures of major shipbuilders in the Tongyeong city. According to the 2010 Economic Census, the shipbuilding industry accounts for only 1.4% of the total number of enterprises in Tongyeong, but accounted for 18.7% of the total number of employees and 28.2% of sales. Therefore, shipbuilding industry can be regarded as the local main industry in terms of number of workers and sales (Shim & Lee, 2014). The boom in shipbuilding industry of early 2000s brought the expansion of local restaurants, real estate, and various rental businesses in Tongyeong during this period. However, in the aftermath of recession in small and medium shipbuilders, the employment situation has worsened due to mass unemployment. As the labor market got worse, there was a 'hollowing out' of the shopping street and the local economic situation deteriorated.

To cope with such a serious situation, the Ministry of Employment and Labor designated Tongyeong as a Special Employment Promotion Zone (SEPZ) in January 2013 and started a policy support. It was originally planned for one year but extended to two years in total and the total support amount is 17.1 billion won. In accordance with the designation of the Tongyeong city as the SEPZ, various support projects were carried out in three areas: employee retention, creation of local employment, extension of payment for employment insurance and industrial accident compensation insurance premiums.

Figure 1 shows the Gross Regional Domestic Product (GRDP) of Tongyeong from 1995 to 2014. GRDP of Tongyeong City has increased steadily since 1998, and it increased sharply from mid-2000 when the shipbuilding boom began. After peaking in 2009, it sharply dropped in 2010 due to downturn in the shipbuilding industry. There has been a slight upswing since then, and after the implementation of the policy, recovery continued, but it has not recovered to its previous level.

As it hasn't been long since the SEPZ project ended in January 2015, there is not enough empirical literature analyzing the impact of the SEPZ. Yoon et al. (2014) used the propensity score matching method in order to estimate the average effect of treatment on the treated (ATT) between the treatment group and the control group. However, since this report was written at the initial stage of implementation of SEPZ, it predicted employment effects indirectly using case of Pyeongtack, which was designated as the first SEPZ in 2009. Shim and Lee (2014) extracted part of Yoon et al. (2014) and suggested several amendments for the SEPZ program.

In this paper, we use synthetic control method to evaluate the effect of a government initiative to relieve employment crisis in Tongyeong. To our knowledge, we are the first paper to use the econometric method, especially synthetic control method, to study the effect of the SEPZ project. We follow Abadie et al. (2010) and Abadie et al. (2015) to construct a synthetic control group that provides a counterfactual employment rate against which we can compare the evolution of the employment rate in Tongyeong during a post-intervention period. Our counterfactual uses data from other cities in Korea, with weights chosen so that the resulting synthetic Tongyeong best reproduces the values of a set of predictors of employment rate in Tongyeong before the SEPZ project operated.

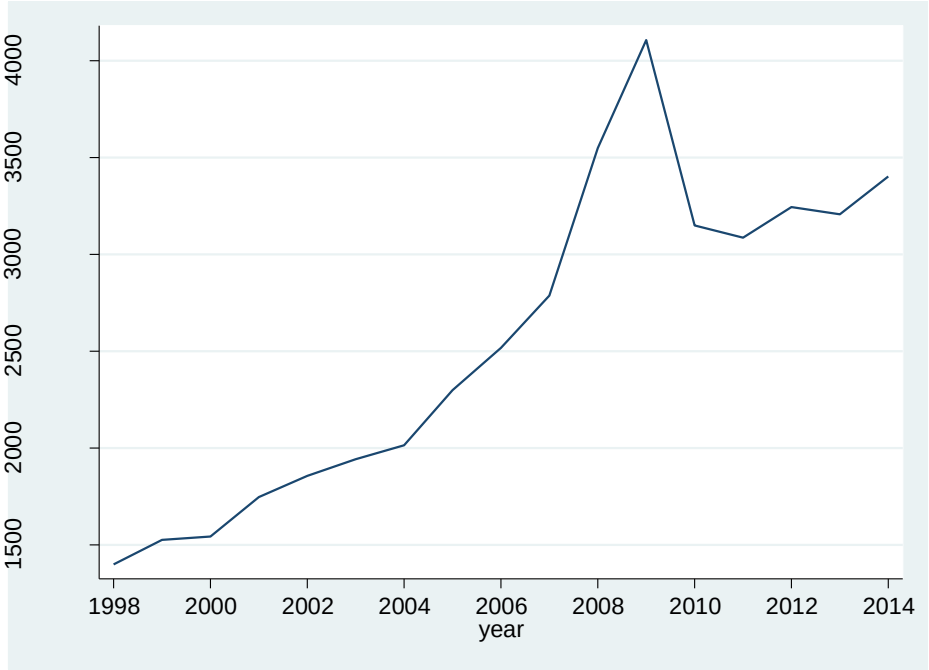


Figure 1: Gross Regional Domestic Product (GRDP) of Tongyeong (1998-2014). Source: Statistics South Kyeongsang

Our findings suggest that the SEPZ project had a positive and significant impact on the employment rate, although the magnitude of the effect was not substantial and the effect dissipates after the government support ended. While Tongyeong's employment rate is higher than that of the synthetic control group during policy implementation, it became sharply lower than that of synthetic Tongyeong right after the support policy program was over.

The rest of the paper is organized as follows. Section 2 offers an institutional account on the SEPZ in Tongyeong. Section 3 outlines the methodologies used and section 4 presents data description. Section 5 is devoted to our empirical results. Finally, section 6 briefly concludes.

2. Background

On January 25, 2013, the Ministry of Employment and Labor designated Tongyeong as the SEPZ in response to the deterioration of Tongyeong's labor market due to bankruptcy of small and mid-sized shipbuilders. Prior to Tongyeong, Pyeongtaek was designated as a SEPZ, and it is the first case since the special employment promotion zone policy was established. In order to solve the labor market deterioration in Pyeongtaek caused by the large-scale restructuring of SsangYong Motor in 2009, about 10 billion won of fund was provided for a year and a number of policy supports were provided.

In order to be designated as the SEPZ, the business survey index (BSI) of the previous three months should be reduced by more than 30% compared to the same period of the previous year for those industries where the number of employees account for more than 15% of the total number of workers in the region. (The number of employees based on the number of employees who are covered by employment insurances programs.) In addition, one of the

following three indicators must meet certain criteria: the average number of employees who left a job involuntarily in the last three months, the number of employees, and the ratio of unemployed to the number of employees.From September to November 2012, the BSI of the shipbuilding industry, where the number of employees accounts for 33.6% of the total number of employees in Tongyeong, dropped by an average of 36.3% over the same period of the previous year. In addition, the number of employees in Tongyeong decreased by more than 5% compared to the previous year. Consequently, Tongyeong met the requirements to be designated as the SEPZ.

The contents of the policy support according to the SEPZ designation can be divided into three categories: employee retention, creation of local employment, extension of payment for employment insurance and industrial accident compensation insurance premiums. The details are as follows.

First, in order to maintain the employment status of the worker, the Ministry of Employment and Labor provided up to 90% of the necessary expense of paid leave. In addition, the expenses of the incumbent worker training were supported. Workers who are on unpaid leave are also allowed to receive support for living expenses after screening. Second, in order to create local employment, the government gave employment subsidies to the employers who relocated, newly established, or expanded their workplaces in Tongyeong or hired local residents. Support was also provided for local job creation support projects, for example, yacht schools and marine specialist schools. In addition, the scope of support for existing employment promotion projects expanded. Finally, the time limit for payment of employment insurance and industrial accident insurance premiums was extended to shipbuilders located in Tongyeong, and execution of delinquency was also delayed.

The ultimate goal of these policies was to prevent mass unemployment and contribute to the creation of new jobs, thereby eliminating the employment crisis across the region. The period that had originally been planned for one year was extended to two years, and the project was terminated in January 2015. [1]

3. Method

In Section 3, we present the synthetic control approach proposed by Abadie et al. (2010) and Abadie et al. (2015). Suppose that we observe $J+1$ units (cities in Korea in our case) indexed by j in periods $1,2,\ldots,T$. Assume without loss of generality, region 'one' is the case of interest and units $j=2$ to $j=J+1$ are potential comparisons. Borrowing from the statistical matching literature, we refer to the set of potential comparisons as the "donor pool."

Let Y_{it}^{N} be the outcome that would be observed for region i at time t in the absence of the intervention, for units $i=1,\ldots,J+1$, and time periods $t=1,\ldots,T$. Let T_0 be the number of pre-intervention periods, with $1 \leq T_0 < T$. Let Y_{it}^{I} be the outcome that would be observed for region i at time t if region i is exposed to the intervention (the SEPZ project in Tongyeong) in periods T_0+1 to T. We assume that the intervention has no effect on the

[1] For a detailed discussion of the SEPZ project in Tongyeong, please refer to Yoon et al. (2014).

outcome before the intervention, so for $t \in \{1, \ldots, T_0\}$ and all $i \in \{1, \ldots, J+1\}$, we have $Y_{it}^N = Y_{it}^I$.

Let D_{it} be an indicator that takes a value one if unit i is exposed to the intervention at time t, and zero otherwise. Then, the observed outcome for unit i at time t is $Y_{it} = Y_{it}^N + \alpha_{it} D_{it}$. Because we assume region "one" is exposed to the intervention and only after period T_0, we have that

$$D_{it} = \begin{cases} 1 & if\ i = 1\ and\ t > T_0 \\ 0 & otherwise \end{cases}$$

The goal of the study is to estimate the effect of the intervention of interest on the treated unit given by $\alpha_{1t} = Y_{1t}^I - Y_{1t}^N = Y_{1t} - Y_{1t}^N$ from period $T_0 + 1\ to\ T$ (post-intervention period). Since Y_{1t}^I is observed, in order to estimate α_{1t}, we just need to estimate Y_{1t}^N using synthetic control method.

The synthetic control method is based on the premise that combination of comparison unit which we term "synthetic control" often does a better job of reproducing the characteristics of the treated unit than any single comparison unit alone. Motivated by this consideration, we define a synthetic control as a weighted average of units in the donor pool that best resembles the characteristics of the case of interest. That is, a synthetic control can be represented by a $(J \times 1)$ vector of weights $W = (w_2, \ldots, w_{J+1})'$, with $0 \leq w_j \leq 1$ for $j = 2, \ldots, J+1$ and $w_2 + \cdots + w_{J+1} = 1$. Suppose that there is optimal weight vector W^* such that characteristics of the treated unit are precisely replicated by the characteristics of the synthetic controls unit. Abadie et al. (2010) show that under regular conditions $Y_{1t}^N - \sum_{i=2}^{j+1} w_i^* Y_{it}$ close to zero. Then, we can use $\widehat{\alpha_{1t}} = Y_{1t} - \sum_{i=2}^{j+1} w_i^* Y_{it}$ for $t = T_0 + 1, \ldots, T$ as an estimator of α_{1t}.

To implement the synthetic control method numerically, we need to measure the distance between the synthetic controls unit and the treated unit. Let X_1 be a $(k \times 1)$ vector containing the values of the pre-intervention characteristics of the treated unit and X_0 be the $(k \times J)$ matrix collecting the values of the same variables for the units in the donor pool. The pre-intervention characteristics may include pre-intervention values of outcome variables. We select the synthetic control based on optimal weight vectors W^* which minimizes $\|X_1 - X_0 W\|$. Abadie et al. (2010) choose W^* as the value of W that minimizes

$$\|X_1 - X_0 W\|_v = \sqrt{(X_1 - X_0 W)' V (X_1 - X_0 W)} \qquad (1)$$

where V is some $(k \times k)$ symmetric and positive semidefinite matrix.

The solution to equation (1), $W^*(V)$, depends on the diagonal matrix V whose diagonal elements are weights which reflects the relative importance of each variable in X_1 and X_0 according to their predictive power on the outcome variable. Sometimes the choice of V^* can be based on subjective assessment of the importance of the variables in X_1 and X_0. Alternatively, the choice can be data-driven. Following a data-driven procedure proposed Abadie et al. (2010), we chose optimal V^* among all positive definite and diagonal matrixes such that the Mean Squared Prediction Error (MSPE) of the outcome variable is minimized over some set of pre-intervention periods. MSPE measures lack of fit between the path of the

outcome variable for the treated unit and its corresponding synthetic control units. That is, we select optimal V^* such that path of employment rate of Tongyeong during the some set of pre-intervention period is best reproduced by the synthetic control defined by $W^*(V)$. Let Z_1 be the $(T_p \times 1)$ vector containing the values of the outcome variable for the treated unit for some set of pre-intervention periods and Z_0 be the $(T_p \times J)$ analogous matrix for the control units, where T_p $(1 \leq T_p \leq T_0)$ is the number of pre-intervention periods over which the MSPE is minimized. Then V^* is chosen to minimize

$$\arg\min(Z_1 - Z_0 W^*(V))'(Z_1 - Z_0 W^*(V)) \qquad (2)$$

where weights for the synthetic control are given by $W^* = W^*(V)$. We solve a optimization problem that minimized equation (2), for $W^*(V)$ given by equation (1) (Abadie et al., 2003; Abadie et al., 2011; Abadie et al., 2015). If the number of pre-intervention periods in the sample large enough, we can also use the cross-validation method by dividing pre-intervention periods into a training period and a validation period. Given a V, $W^*(V)$ can be computed using data from the training period. Then, the diagonal matrix V can be chosen to minimize the MSPE produced by the weights $W^*(V)$ during the validation period (Abadie et al., 2011). Unfortunately, we do not have enough number of pre-intervention periods to use cross-validation.

The use of large sample inferential techniques is not suitable for comparative studies in when the number of units in the comparison group and the number of periods are relatively small. Therefore, Abadie et al. (2010) propose "placebo test" of which the basic principle is to iteratively apply the synthetic control method by randomly assigning the intervention across units (i.e., to control units where the intervention did not occur.). Subsequently, we can assess whether the effect for the actual intervention is relatively large to the effect for each "placebo control" chosen at random. By construction, this exercise produces exact inference regardless of the number of available comparison units and time periods (Abadie et al., 2011).

4. Data

We use region-level panel data for the period from 2008 to 2016. The data source is the Regional Employment Survey, which is a household survey that can identify the city-level regional employment structure. The target population of this survey is over 15 years of age who live in Korea. It was conducted annually from 2008 to 2010, quarterly from September 2010 to December 2012, and semi-annually from 2013 to 2016 (see Table A.1). As Tongyeong city was designated as the SEPZ in January 2013, we set the treatment period to April 2013, the nearest time since SEPZ implementation, giving a pre-intervention period of four and a half years. Our sample period ends in April 2016 when the most recent regional employment survey was conducted, so a post-intervention period is 3 years. Recall that the synthetic Tongyeong is constructed as a weighted average of potential comparison cities in donor pool. Our donor pool includes 161 cities in Korea. [2]

[2] To construct this sample, samples for Changwon City, Masan City, and Jinhae City, which were integrated in 2010, have been added since 2008 for consistency. Cheongju City and Cheongwon County also were integrated in 2015 and took the same approach. Finally, Sejong City, which was created in 2012, was excluded from the sample because it was not included in the original sample in Regional Employment Survey.

Our outcome variable, Y_{it}, is the employment rate in region i at period t based on place of work employment information. More specifically, employed persons are counted at their place of work rather than at their place of residence. The reason for calculating the employment rate based on the place of work is that the target for the SEPZ project was the employers and workers whose workplace is Tongyeong, irrespective of the location of their residence.

As the pre-intervention characteristics in X_1 and X_0, we use percentage of men, percentage aged 15-64, schooling rate (percentage of high school graduates or higher), percentage of manufacturing workers. We also include the employment rates of the pre-intervention period, therefore X_1 is a (16×1) vector of predictors of Tongyeong and X_0 is a (16×161) matrix of values of the analogous variables for the 161 control regions in the donor pool. Since we set T_p equal to T_0, thus chose V^* to minimize the MSPE over the entire pre-intervention periods, Z_1 is a (12×1) vector and Z_0 is a (12×161) matrix which contain the values for the outcome variable for Tongyeong city and the control regions for 12 pre-intervention periods.

5. Results

A. Synthetic control method

Using the synthetic control method presented in the Section 3, we construct the synthetic Tongyeong that best reproduces the values of the predictor variables of employment rate of Tongyeong in the pre-intervention period. Table 1 shows the weights of each region in the donor pool. The synthetic Tongyeong is a weighted average of Suwon City, Gwacheon City, Namyangju City, Siheung City Geoje City, Haman County, Seogwipo City.

Province	City/County	Weight
Gyeonggi	Suwon	0.142
Gyeonggi	Gwacheon	0.190
Gyeonggi	Namyangju	0.266
Gyeonggi	Siheung	0.134
South Gyeongsang	Geoje	0.073
South Gyeongsang	Haman	0.102
Jeju	Seogwipo	0.094

Note: Weight assigned to the any other regions in the donor pool except the above regions are zero.

Table 1: Region weights in the synthetic Tongyeong

Table 2 compares the pre-intervention characteristics of Tongyeong to those of the synthetic Tongyeong and also to those of population-weighted average of the 161 regions in the donor pool. Overall, the results in table 2 suggest that the synthetic Tongyeong provides a much better comparisons for Tongyeong than the average of other regions in Korea. In particular, the synthetic Tongyeong is quite similar to the actual one in terms of lagged employment rate and percentage of manufacturing workers compared to the average of rest of Korea. However, there is considerable discrepancy between the ratio of men, percentage of

aged 15-64, and schooling rate of synthetic Tongyeong and that of actual Tongyeong. This is because the resulting value of diagonal element of V associated to these variables is close to zero. In other words, these variables have much less power for predicting the employment rate of Tongyeong before the implementation of the SEPZ. As explained in the methodological section above, we chose optimal V^* among all positive definite and diagonal matrices to minimize MSPE of employment rate during pre-intervention periods. V weight chosen by the minimization of MSPE indicates that the most important predictors are the employment rate of September 2011 (0.0967), June 2011 (0.0923), September 2010 (0.0882), October 2009 (0.0862), March 2011 (0.0823), September 2011 (0.0813), June 2011 (0.0807), December 201 (0.0801), December 2012 (0.0801), December 2012 (0.0795), October 2008 (0.0794), March 2011 (0.073). Sum of weights of lagged employment rate is 0.9998, which shows the explanatory power of the employment rate in the pre-intervention period is absolutely high. Conversely, the weight of each covariate was less than 0.0001.

		Tongyeong	synthetic Tongyeong	rest of Korea
	sex	0.4872	0.4732	0.4930
	percent aged 15-64	0.8399	0.8779	0.7814
	high-school diploma or Higher	0.5653	0.7120	0.5618
	manufacturing industry	0.1244	0.1252	0.0944
Employment rate	October 2008	0.5510	0.5544	0.6206
	October 2009	0.5461	0.5502	0.6189
	September 2010	0.5416	0.5372	0.6177
	December 2010	0.5197	0.5250	0.5901
	March 2011	0.5523	0.5471	0.6112
	June 2011	0.5296	0.5390	0.6397
	September 2011	0.5319	0.5338	0.6298
	December 2012	0.5407	0.5366	0.5970
	March 2011	0.5636	0.5585	0.6011
	June 2011	0.5642	0.5670	0.6294
	September 2011	0.5599	0.5652	0.6318
	December 2012	0.5697	0.5638	0.5907

Note: All variables except employment rate are averaged for 2008-2012.

Table 2: Predictor means before implementation of SEPZ

Figure 2 plots the trends of employment rate in Tongyeong and the rest of Korea. As illustrated in this figure, the rest of Korea does not provide an appropriate comparison group for Tongyeong to examine the effect of the SEPZ project. Even before Tongyeong was designated as the SEPZ, Tongyeong and in the rest of Korea experienced different paths in the employment rate. The difference in the level of employment rate between Tongyeong and the rest of Korea was the huge in October 2008. Trends started to converge from September 2011 when Tongyeong's employment rate began to rise. However, the employment rate of the rest of Korea increased rapidly in December 12, causing the gap to reappear. Even during the SEPZ project, the gap remains thereafter and it becomes bigger after the policy support over as the employment rate dropped sharply. To estimate the effect of SEPZ project on employment rate in Tongyeong, it is central to figure out how employment rate in Tongyeong would have evolved after April 2013 in the absence of SEPZ project. Synthetic Tongyeong provide a sensible comparison for the treated unit.

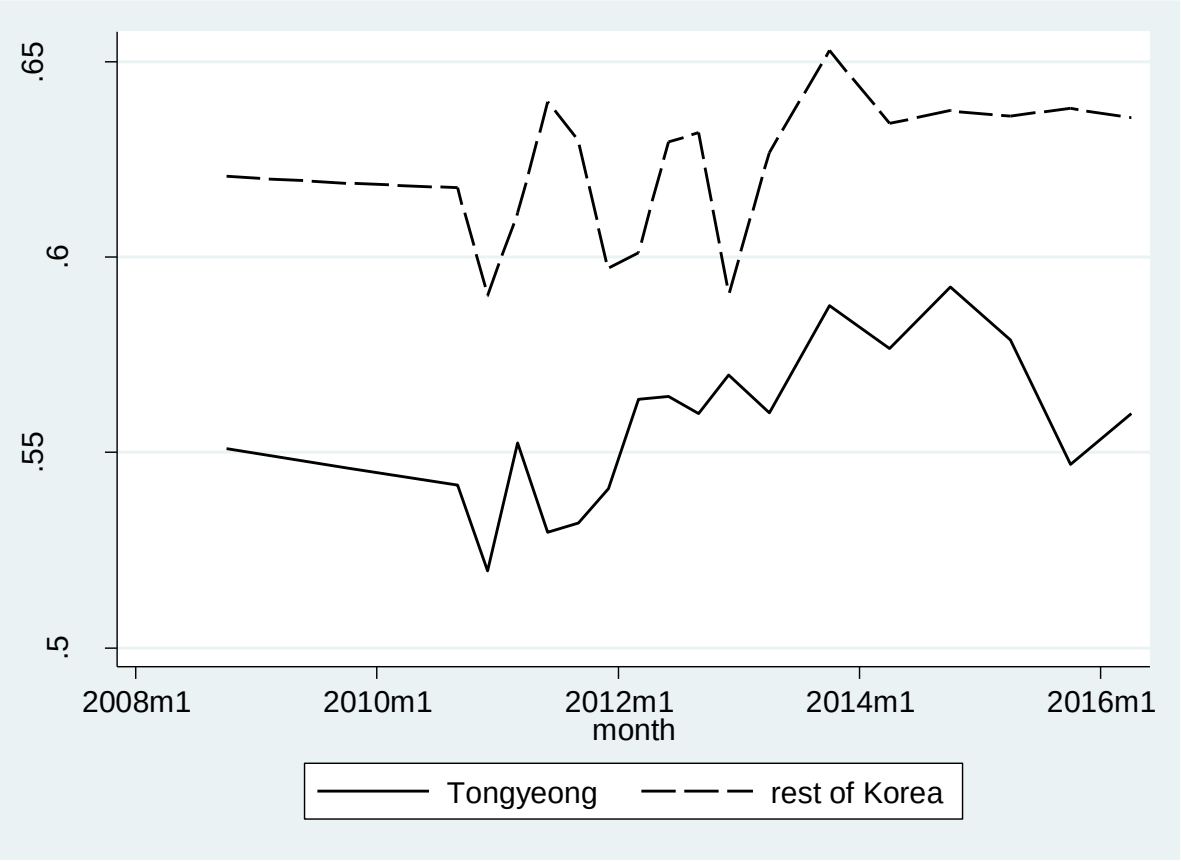
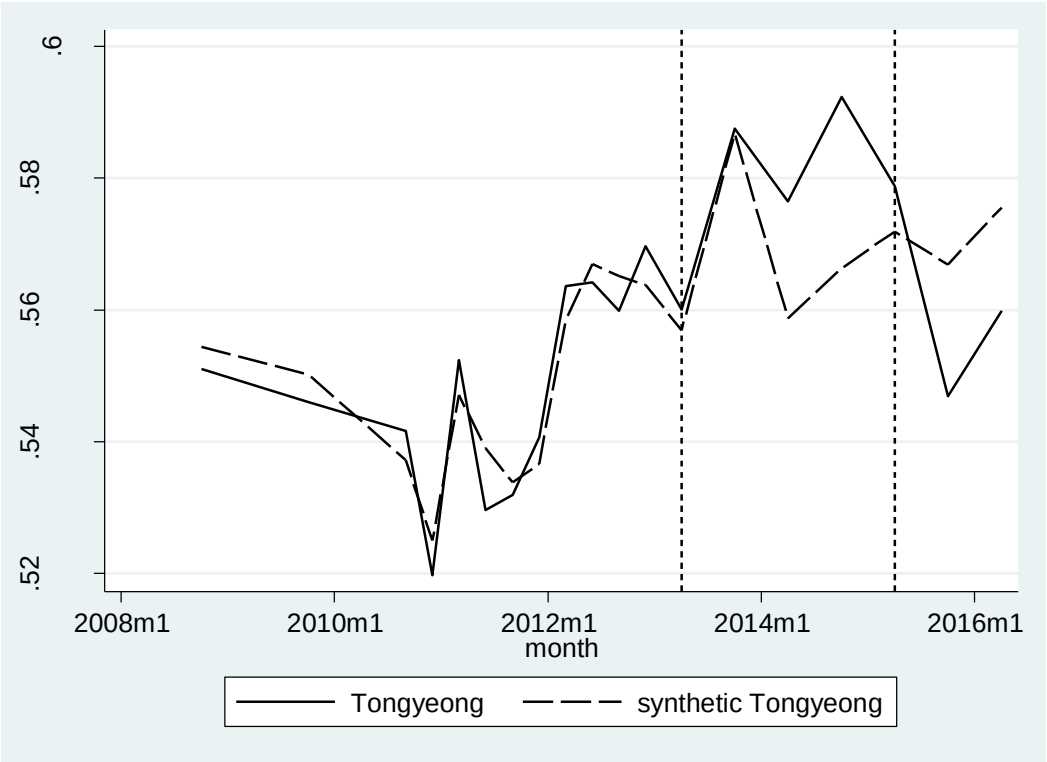


Figure 2: Employment rate of Tongyeong and the rest of Korea

Figure 3 displays the trends in employment rate of Tongyeong and synthetic Tongyeong for October 2008- April 2016 period. In contrast to employment rate in the rest of Korea, employment rate in the synthetic Tongyeong closely track the trajectory of employment rate in Tongyeong during pre-intervention periods even though it is not perfectly fitted. This may be because that the number of entire pre-intervention period is relative small and the regional scale in our sample also is quite small compared to units in the primary literature in synthetic control analysis (e.g. states, countries). Nevertheless, the close fit for pre-intervention employment rate in Figure 3 and the close fit that we obtain for predictor variables in Table 2 demonstrate it is possible to construct the combination of other cities in Korea which reproduce the economic characteristics of Tongyeong before the SEPZ project started. Therefore, it seems that synthetic Tongyeong provides an appropriate approximation to the employment rate that would been evolved in Tongyeong from April 2013 to April 2016 in the absence of policy implementation.

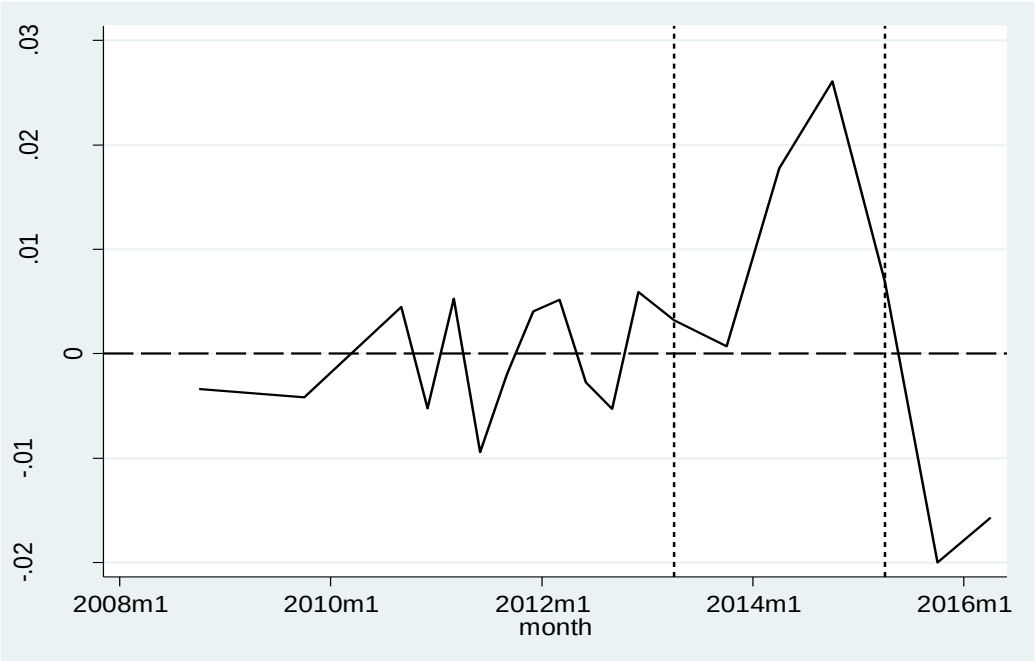
Our estimate of the SEPZ project in Tongyeong is the difference between employment rate in Tongyeong and in synthetic one after the implementation of the SEPZ, illustrated in Figure 4. Immediately after the designation of Tongyeong as the SEPZ, employment rate of Tongyeong began to rise and two lines diverged notably. Specifically, in October 2014, the employment rate in actual Tongyeong is estimated to be about 2.61 percentage points higher than in the synthetic one. We find that during the policy implementation, from April 2013 to April 2015, employment rate increased by approximately 1.09 percentage points. However, when the SEPZ project was over, Tongyeong experienced the sharp decline and employment rate while synthetic Tongyeong keeps ascending at a pace.

One valid concern in this study is that the designation of Tongyeong as SEPZ could have affected the labor market of other cities, especially Geoje City and Goseong County, both of which are located near Tongyeong and the spillover effect might happen. . In our judgement, this potential problem does not appear to be serious. Even though Geoje City is included in the synthetic control units, its weight is smallest among other cities. We can also obtain the similar result and synthetic control estimates were not affected when conducting the analysis after excluding Geoje city in the donor pool.



Note: First dashed vertical line corresponds to the time when Tongyeong was designated as the SEPZ and second one refers to the time when the SEPZ project ended.

Figure 3: Employment rate of Tongyeong and synthetic Tongyoneg

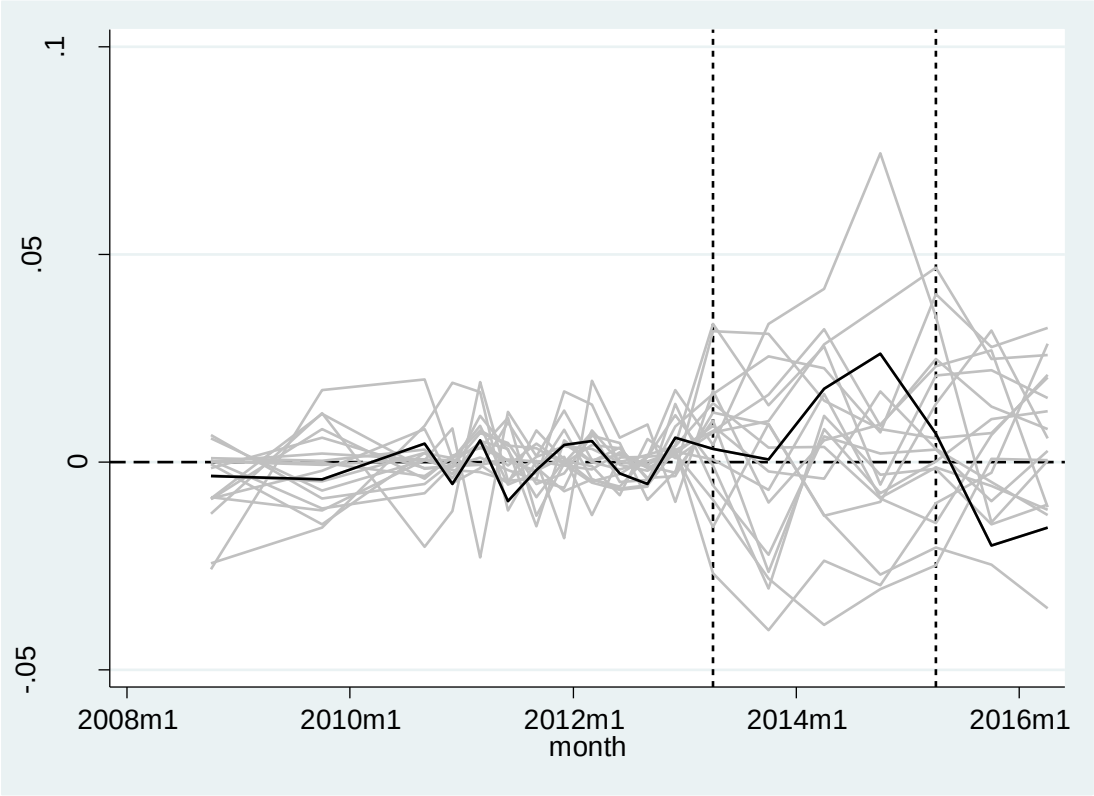


Note: First dashed vertical line corresponds to the time when Tongyeong was designated as the SEPZ and second one refers to the time when the SEPZ project ended.

Figure 4: Gaps in employment rate between Tongyeong and synthetic Tongyoneg

To assess the credibility of our results, we conduct placebo tests where the treatment is reassigned to different cities from Tongyeong, which are chosen randomly. If there is a large placebo estimate, it would harm our confidence in Figure 4. We iteratively apply the synthetic control method to every other cities in South Kyeongsang Province where Tongyeong belongs. That is, we proceed as if one of the cities in the South Kyeongsang Province would have been designated as the SEPZ in April 2013, instead of Tongyeong. The donor pool is the same as before, the 161 cities except the treated region. We then compute the estimated effect for every placebo test. This procedure provides us with the distribution of estimated gaps for Tongyeong and placebo units. We will deem the effect for Tongyeong significant if the estimated gap for Tongyeong is unusually large compared to the distribution of placebo effects.

Figure 5 displays the result of placebo test. The gray lines represent the estimated gap associated with each of the 17 runs of placebo test. In other words, the gray lines show the difference in employment rate between each city in South Kyeongsang Province and its corresponding synthetic control. The superimposed black line is the estimated gap for Tongyeong. As visualized in Figure 5, the estimated gap for Tongyeong during post-treatment period is positive and but the magnitude of effect is modest relative to the distribution gaps for the 17 cities. However, after the end of SEPZ project, the estimated gap for Tongyeong during post-treatment period is unusually large comparing to placebo cities.



Note: First dashed vertical line corresponds to the time when Tongyeong was designated as the SEPZ and second one refers to the time when the SEPZ project ended.

Figure 5: Gaps in employment rate in Tongyeong and placebo gaps in 17 cities in South Kyeongsang Province

We also conducted a synthetic control method analysis using outcome variables as manufacturing employment rates. The manufacturing employment rate is defined as the number of persons employed in manufacturing divided by the working age population. The result illustrated in Figure A.2 is very similar to those obtained on the baseline analysis. However, decline of employment rates between the post-economic recession and the policy implementation is more visible in the manufacturing industry than in the whole industry. This might be because that the manufacturing sector was hit most directly and hardest by the economic downturn. Figure A.3 and A.4 shows that the effect of the SEPZ project differed by gender. Although the overall trend is similar, the magnitude of the impact on male employment rates is relatively greater for female.

B. Difference in Difference

As a robustness check, we use the difference in difference technique in a regression framework. Following the typical model, we estimate:

$$\mathrm{Y_{it}} = \beta_0 + \beta_1\alpha_i + \beta_2\lambda_t + \rho T_{it} + \mathrm{X_{it}'}\gamma + \epsilon_{\mathrm{it}} \qquad (3)$$

where α_i is a dummy which equals one if a region is Tongyeong and zero otherwise and λ_t is a time dummy which indicates whether the observation is from before or after the policy intervention. We use two time dummies to separate the effects of the policy period and the period after policy implementation. First one is a dummy variable set to one if the observation is from the policy period (from April 2013 to April 2015) and zero if it is from the pre-intervention period (before April 2013) and second one is a dummy variable set to one if the observation is the date is after the end of the policy period (After April 2015) and zero if it is from the pre-intervention period. T_{it} is the interaction dummy for $\alpha_i = \lambda_t = 1$ and ρ is the difference in difference (DID) estimate of the treatment effect. $\mathrm{X_{it}}$ is the vector of explanatory variables such as percentage of men, percentage aged 15-64, schooling rate, percentage of manufacturing workers.

Table 3 reports the results from difference in difference analysis if we use all control cities. The results in first column of Table 5 shows 0.87 percentage points increase in employment rate in Tongyeong during the implementation of SEPZ project. Third column indicate the effect of end-of-policy is negative on the employment rate. With additional explanatory variables, the size of estimated effect becomes smaller. We examine the change of coefficients when we restrict the control group to the seven cities in synthetic control group and regress equation (3) with the set of weights chosen above Synthetic control group produces a stronger results for policy period, however after end of policy there was no significant effect on employment rate.

Variable	Control: rest of Korea			
Tongyeong	-0.0673***	-0.0260***	-0.0673***	-0.0262***
	(0.0059)	(0.0069)	(0.0059)	(0.0067)
time1	0.0229***	0.0106**		
	(0.0018)	(0.0042)		
did1	0.0087***	0.0050*		
	(0.0018)	(0.0029)		
time2			0.0217***	0.0037
			(0.0020)	(0.0063)
did2			-0.0074***	0.0025
			(0.0020)	(0.0023)

sex		1.2967***		1.3270***
		(0.1230)		(0.1253)
young		-0.6325***		-0.6181***
		(0.1044)		(0.1024)
schooling		-0.0350		-0.0447
		(0.0834)		(0.0801)
manufacturing		0.1142*		0.1010
		(0.0665)		(0.0680)
Constant	0.6148***	0.4787***	0.6148***	0.4592***
	(0.0059)	(0.0707)	(0.0059)	(0.0719)
Observations	2,592	2,592	2,430	2,430
R-squared	0.0197	0.6899	0.0164	0.6888

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3: Difference in Difference results (Control group: rest of Korea)

Variable	Control: synthetic control group	
Tongyeong	-0.0208	-0.0208
	(0.0402)	(0.0402)
time1	0.0179***	
	(0.0050)	
did1	0.0137**	
	(0.0050)	
time2		0.0070
		(0.0101)
did2		0.0073
		(0.0101)
Constant	0.5683***	0.5683***
	(0.0402)	(0.0402)
Observations	128	120
R-squared	0.0482	0.0275

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 4: Difference in Difference results (Control group: synthetic control group)

6. Conclusion

This paper shows the SEPZ project had a positive and significant impact on the employment rate, although the magnitude of the effect seems to be not great. Furthermore, the effect dissipates after the government support was over. While Tongyeong's employment rate is higher than that of the synthetic control group during policy implementation, it became sharply lower than that of synthetic Tongyeong right after the support policy program was over.

Identifying causal inference not only gives the measurement of real effects of policies (i.e. ex-post policy evaluation) but also essential and valuable evidence for future polices in the same area (i.e. ex-ante policy impact assessment tool). Our results suggest that project negatively affected the local labor market after the end of policy, so policy design should be more effective for future geographically-targeted subsidies. Also, this synthetic control

method can be applied for identifying policy effects for other policies, such as the Special Employment Promotion Zone (SEPZ) in Pyeongtack, which was designated prior to Tongyeong. More work is needed to provide sufficient evidence on the causal effects of subsidies for disadvantaged areas.

Appendix

Survey cycle	Year	Month
Annually	2008	October
	2009	October
Quarterly	2010	September
		December
	2011	March
		July
		September
		December
	2012	March
		July
		September
		December
Semi-annually	2013	April
		October
	2014	April
		October
	2015	April
		October
	2016	April

Table A.1: Sequence of time periods

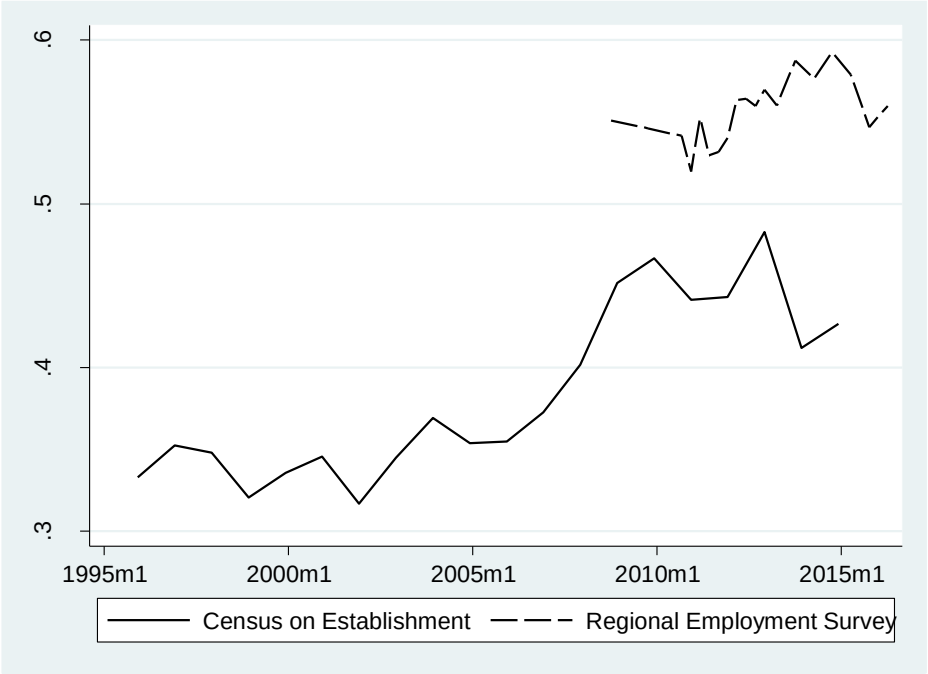


Figure A.1: Comparison between Census on Establishment and Regional Employment Survey

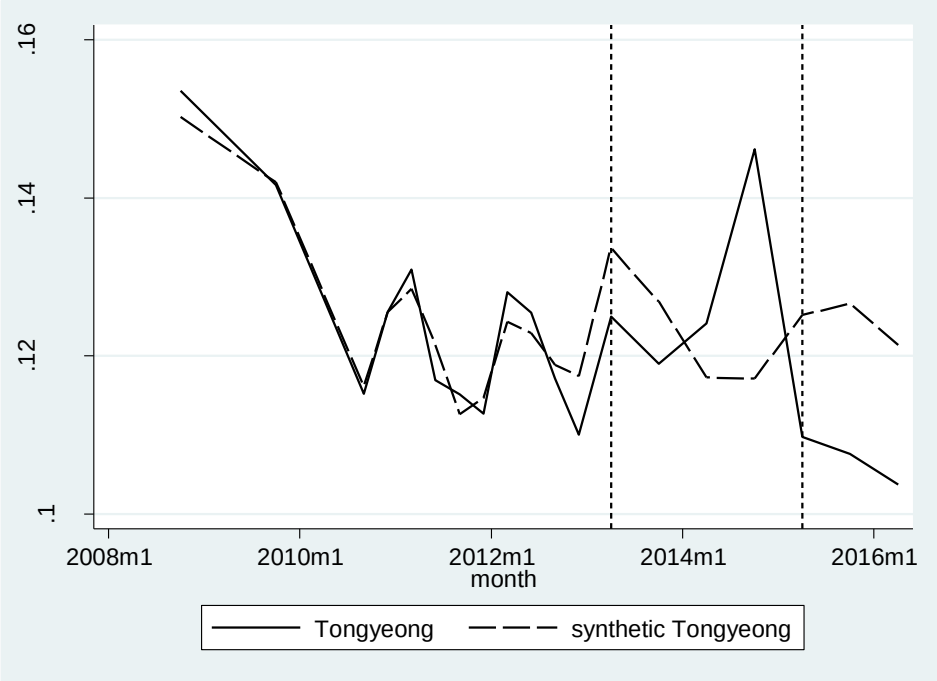


Figure A.2: Employment rate of manufacturing factor in Tongyeong and synthetic Tongyoneg

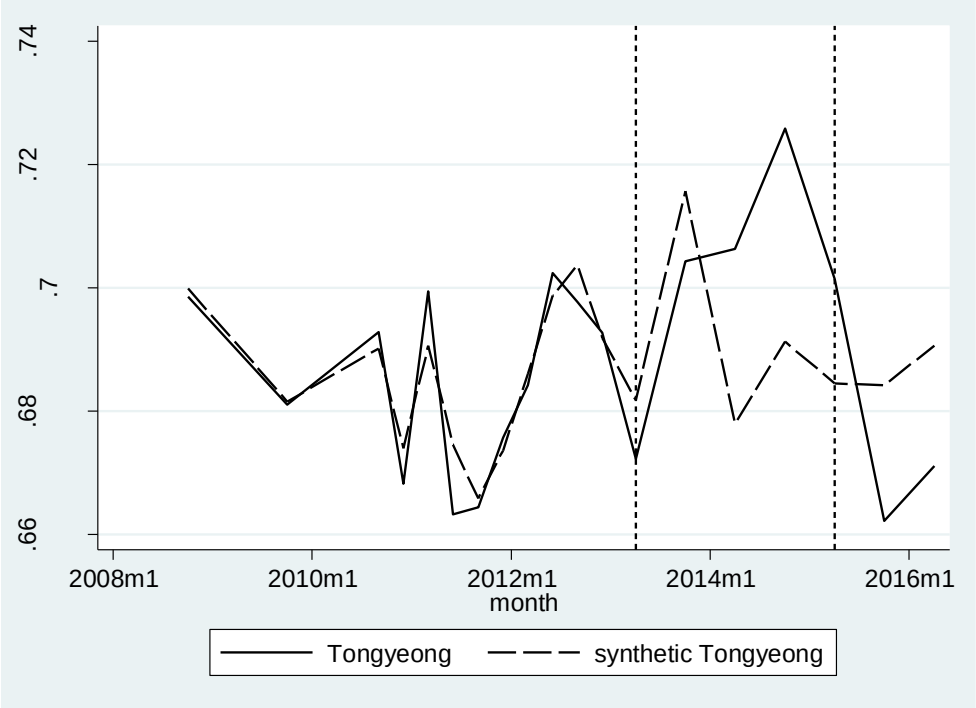


Figure A.3: Male employment rate in Tongyeong and synthetic Tongyeong

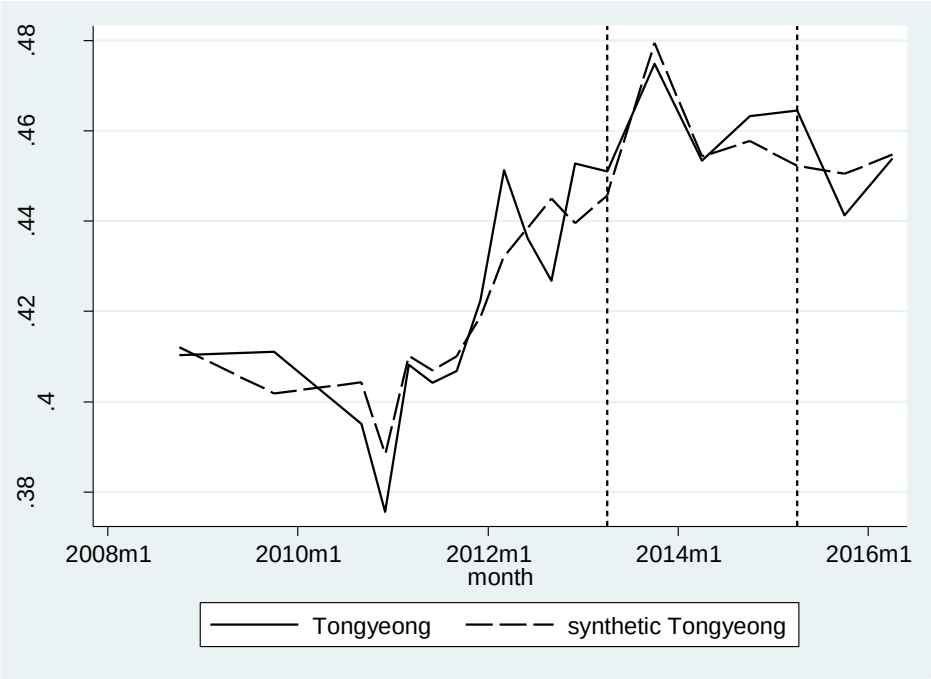


Figure A.4: Female employment rate in Tongyeong and synthetic Tongyeong

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