The Short Run and Long Run Relationship among Fertility and Female Labor Force Participation Rate and Childcare Availability

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Abstract

The objective of this study was the short run and long run relationships among fertility and female labor force participation rate and childcare availability. The results showed that there were the short and long run relationships among fertility and female labor force participation rate and childcare availability which measured in terms of number of children to nursery ratio; however, there was no long run relationship between fertility and female labor force participation rate. Moreover, there were short run relationships between childcare availability and fertility in all aged groups of females except female aged 25-34. There were also short run relationship from the female aged 35-49 labor force participation rate to their fertility and the childcare availability. Thus, childcare availability access and development, in terms of accessibility and quality would increase fertility rate.

Keywords: 1) Fertility 2) Female labor force participation rate 3) Childcare Availability

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Introduction

The previous and nowadays research in foreign countries both demonstrate that the female fertility rate is determined by female labor force participation rate and childcare availability (De Tray, 1973, pp. 70-95; Buhari and Mürsel, 2017, pp. 33-54). The female labor force participation rate was another reason decreasing the fertility rate because most females could not access the labor market or they must leave out due to childcare; therefore, this made some females must retire from labor force participation in order to have more time to nurture their children. So, the only one choice making these females back to labor participation was to have others take care of their children. Apart from family member's help, nursery was considered as another important tool or mechanism that made mothers be able to come back to labor market and also affected the increase of female fertility if the nursery was developed in both quantity and quality until it reached the worthiness or the standard acceptable in society. Hereby, Stolzenberg and Waite (1984, pp. 157–170) found that the childcare availability and the female labor force participation were positively relevant, and the ability to access nursery could increase more female labor force participation and eventually it could possibly affect the female fertility (Floge, 1989, pp. 51–63). Besides, Kanjanachitra and Liengromruen (2014, pp. 26-27) found that in Thailand, the female labor force participation still depended on childcare availability. As the government policy determined that mothers would still get wage during childcare leave, this made mothers could be able to maintain their jobs without choosing between job progress and family including the fact that the government's tax measure needed to encourage female fertility upward while Thailand has been entering into the era of low birth rate, which has almost 800-thousand newborn babies yearly. Furthermore, when it was measured with the female fertility rate together with number of children averagely that a female could have throughout the fertility period, it was found that the children ratio was only 1.6, which was not sufficient enough to substitute the previous generation, fathers and mothers, which would depart in the future (Samutchak, 2015, pp. 54-58).

From above, it could be viewed that the relation between fertility, female labor force participation, and childcare availability were one way or another related to one another, which could happen in both short and long term. Nowadays, in Thailand, there was still no any research that studied about the short and long run relationships of fertility, female labor force participation, and childcare availability, and this research finding would be applied to contribute the government and relevant departments to plan the policy and find the measure to encourage the increase of female fertility and female labor force participation including the development of child availability in terms of nursery that must be standardized and acceptable in society.

Literature Review

Female fertility and female labor force participation

Children are the products of family that conduct considerable advantages to their parents and families, (Becker 1960, pp. 209-

231). Viewpoints of children demand or the demand of having children were conformed together with considerable advantages within the costs both father and mother had to pay in return, which were a lot of time and money in raising their children. Moreover, Becker (1985, pp. 33-58) found that the reason why females had less children than they ever did was because the well-educated females would have chances to take more advantages of any businesses. Female labor force participation caused females to spend their time mostly working in labor market and did not have time enough to nurture their children, which affected female fertility, (Willis, 1987, pp. 68-81). This circumstance was consistent with the study of Buhari and Mürsel (2017, pp. 33-54) that revealed well-educated females could be able to find more satisfactory and higher-wage jobs than lower-educated females. Hence, to decrease the number of children was considered as an important tool causing more female labor force participation, while many-children females could not access labor force market as they had to work at home and lacked of any chances to take economically advantages in terms of labor force participation (De Tray, 1973, pp. 70-95). Besides, the study of Smith-Lovin and Tickamyer (1978, pp. 541- 557) shown that fertility was negatively related to the employment in the United States of America as well as the study of Willis (1987, pp. 68-81; Hotz, Klerman and Willis, 1997, pp. 275-347) that demonstrated the negative relation between fertility and female labor force participation, and from the study of Liefbroer and Corijn (1999, pp. 45-75; Winkler-Dworak and Toulemon, 2007, pp. 273-314; Kreyenfeld, 2010,pp. 351-366; Ozcan, Mayer and Luedicke, 2010, pp. 807-846 and Santarelli, 2011, p. 311) still expressed that for well-educated female employment factor, the study reflected that female labor force participation negatively affected fertility, especially for the first-child period; whereas, the study of Rica and Ferrero (2003, pp. 153–172) in Spain explained that female labor force participation was negatively affected considerably from fertility whether fertility was external variable or internal variable. As well, the study of Heckman (1978, pp. 200-207) discovered that for the modern technology processes that need more labor force, the society opened for the education and accepted more well-educated females to work, which made the fertility ratio decline.

From many research above, it could be considered that the female fertility negatively affected the female labor force participation, which the critical factor was time. Because when females were in fertility period, got pregnant, and gave childbirths, females must spend time at leats 1-2 years, from getting pregnant until delivery, nurturing and breastbreeding throughout 3-6 months, this made lower and lower female labor force participation. And although they passed this period, their young children were not matured enough and still needed their mothers' nurture intimately. Accordingly, some females had to retire to nourish their children. In addition, the role in family based on the social and cultural contexts, the first-period children nurture duty was on mother side, so the fertility period negatively affected female labor force participation.

Childcare Availability and Female Labor Force Participation

Childcare availability (CA) has a critical role in females' decision in female labor force participation. The study of Floge (1989, pp. 51-63) shown that the households that family members could nurture children instead of mothers contributed to increae more female labor force participation. For the families that had no members to help look after children, Nakamura and Ueda (1999, pp. 73-89) supported that having the nursery would assist married females to likely get employed continuously after the children delivery, while Herbst and Barnow (2008, pp. 128-151) discovered that having more ways to nurture children was related to higher female labor force participation. In Thailand, Kanjanachitra and Liengromruen (2014, pp. 26-27) revealed that females who had children and got assistance from other family members such as grandparents who could loof after children would be able to have more time for working effectively, which was consistent to the study of Ikeda (2010, pp. 119-139) that explained females who used the nursery service and got help from family members were likely to have continual working with higher ratio. Nowadays, one thing obviously seen in Thailand society was the schools were the nursery place or nursery center because of the chaning social circumstance. For the growing nursery, it did not increase due to the high children population, but it did because of the change of population and social structure, from big families to single familes, and it increased because the females' role in working places was more acceptable. Therefore, the duty of raising children went to the nursery schools of the nursery centers. Previously, female and male working was not critical for raising children because there were grandparents or relatives to support, but nowadays, most families had less members (a father, a mother, and a child) ,or single families that had no grandparents ,or relatives to help or skipped-generation families such as grandmother, grandfather, and mother/ grandchild (grandchildren)/ grandmother/ mother. These reasons were primarily responsible for some females had to retire from labor force to nurture children or needed to send children to be nurtured in the nursery places or nursery centers for themselves to work effectively.

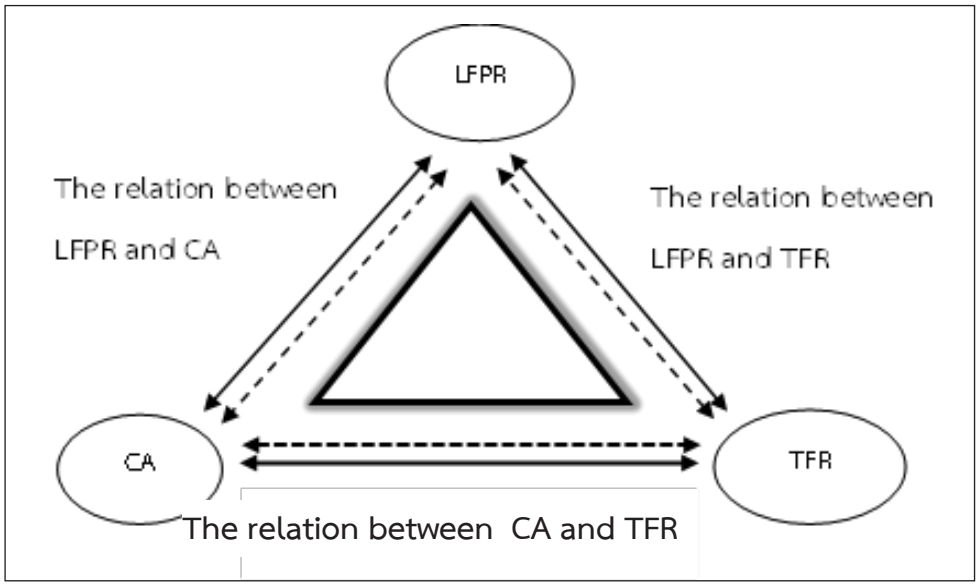
Fertility and Childcare Availability

Presser and Baldwin (1980, pp. 1202–1213) conduected the research and found that females with childcare limitation such as nobody could raise children or they could not access childcare effectively, which the limitation was likely to affect female fertility as well as the study of Baizan (2009, pp. 803–841) and Rindfuss, et al. (2010, pp. 725–748) that revealed females who got encouragement in terms of chidcare availability could have positive result to female fertility. Similarly, Castles (2003, pp. 209-227) discovered there was a positive relation between fertility and having nursery for children under three-year age. In Thailand, the study of Richter, et al. (1994, pp. 651–662) also confirmed that females who experienced childcare limitation would decreasingly respond to fertility, and the study of Kanjanachitra and Liengromruen (2014, pp. 26-27) found that in many countries, they had the measure for supporting childbirth ratio, which motivated

families to have children by focusing on the financial assistance and the privilege for families causing them need to have more children. For example, many countries provided families with monthly childcare money, bonus for newborn babies, special money for the pregnant moment, money for child milk, tax deduction rights, and rights to get a low-interest loan. Even though, these policies were not aimed to directly increase fertility, providing families with money could reduce the cost of having children, which might possibly affect the decision to have a child and help increase fertility in Thailand in the long run.

In summary, fertility, childcare availability, childbirth encouragement, and the policy motivating families to have a child all influence female labor force participation because females' fertility and the policy encouraging childbirth ratio triggered them make a decision to have a child, and when females had a child, mostly if they did not have readiness for childcare, they had to retire from work to take care their children themselves. However, if there were family's members or the nursery to support, the problem might be resolved. Still, the retirement tendency was on the rise because in Thai social context, the main duty to nurture children was on females. Moreover, love and intimacy between mothers and children started from the pregnanct moment, which most females preferred nurturing children to working further. From the literature review, the relevant documents about female labor force participation, fertility, and childcare availability as mentioned above could

Conceptual Framework



Note: ⟷ refers to Co-integration test in the long run from A-B

⟷ refers to Granger causality test from A-B

LFPR refers to female labor force participation

TFR refers to fertility

CA refers to childcare availability

determine conceptual framework as the following.

Methods

This study was a quantitative research to test the short run and Long run relationship among fertility and female labor force participation rate and childcare availability, which was composed of the variables as the following.

1. Fertility Rate: TFR means the averaged number that females could have childbirth throughout their fertility rate in fertility age from 15 to 49 years. This research studied by dividing the participants into four groups: (1) overall female fertility rate 15-49 years (TFR1), (2) female fertility rate 15-24 years (TFR2), (3) female fertility rate 25-34 years, and (4) female fertility 35-49 years (TFR4).

2. Female Labor Force Participation Rate: LFPR was female labor force participation aged 16 – 60 years divided into four groups: (1) overall female labor force participation (LFPR1), (2) female labor force participation aged 15 – 24 years (LFPR2), (3) female labor force participation aged 25-34 years (LFPR3), and (4) female labor force participation aged 35 – 49 years (LFPR4)

3. Childcare Availability: CA in this research, the researcher used the variable about number of children per childcare center as proxy variable, which reflected childcare availability because the limitation about time series data in Thailand that the data, especially number of children and nurseries, were collected and compiled through the governmental sectors only. This was data limitation for this research; therefore, the variable about number of children per childcare center was utilized to reflect the childcare availability in supply or governmental service ability. Although the proportion of children number per childcare center was merely proxy variable, it could reflect the quality of service from the governmental sectors in certain levels; namely, in case the low proportion of children per childcare center, it could reflect the better quality of service than the high proportion of children per childcare center, which the less crowded center would indicate the better service accessibility. In addition, there was a study of Grace and Sing Ping (2014, pp. 71-85) that utilized the variable about number of children per childcare center and number of children per teacher in finding relationship between fertility rate and childcare availability in Japan. Nevertheless, childcare availability could be conducted with other variables such as the variable about having family's members, relatives, nurture children, but this study was conducted by time series data, which utilized the variable about proportion of children number per childcare center as childcare availability readiness.

Data Analysis

1. To answer the research question 1, the researcher did the experiment about co-integration in the long run between the three variables of fertility rate, female labor force participation, and childcare availability, or did co-inegration test based on Johensen's method to demonstrate whether in preliminary, time series data of the relevant variables was consistent or not, or whether time series data was co-integrated or not in order to test the relationship in both the short

run and the long run in the next steps further.

2. To test the relationship in both the short run and the long run of the three relevant variables, the researcher determined the model pattern as Vector Error Correction Model (VECM) and evaluated Ordinary Least Square (OLS).

In data analysis, this research was determined with 5 steps as the following.

1. The validity check about the structure change of data that was conducted in this research

Due to the fact that the utilized data was time series data from 1900 to 2018, 29 years, the long-time data might have been changed in the data structure in some time or various periods of time. Hence, the researcher rechecked the validity of time series data with Chow-test to see if there was the structure change of data or not. The model of Chow-test was determined as the following: the dependent variable used to recheck data was fertility rate, and the independent variables were composed of female labor force participation and childcare availability, which was validated from the proportion of children number per childcare center. Hereby, the researcher divided the test model into 4 models based on the dependent variable of female fertility, which was composed of (1) overall fertility rate 15-49 years (TFR1), female fertility rate 15-24 years (TFR2), (3) female fertility rate 25-34 years (TFR3), and female fertility rate 35-49 years (TFR4) respectively. In this research, the researcher determined Chow-test in 4 periods of time: 1997, 2002, 2007, and 2012 respectively. Namely, the researcher did the Single Breakpoint test, and the reason the research was started in 1997 was because the year 1997 was the period of time that Thailand was in business crisis, and then the researcher put spaces from the year 1997 to 2012, 5 years per each round of tests respectively.

2. Unit Root test

Because the data studied were time series data, and most of the time series data were non-stationary; therefore, the researcher had to consider if the data were stationary or not. In Unit Root Test, the test method of Augmented Dickey Fuller test (ADF Test) Dickey and Fuller (1979, pp. 427-431) was conducted, and there were 3 patterns of test as the following.

$$\Delta X_t = \gamma X_t + \sum_{i=1}^{p} \delta_i \Delta X_{t-1} + \varepsilon_t$$

(Random walk process) ---- (1)

$$\Delta X_t = \alpha + \gamma X_t + \sum_{i=1}^{p} \delta_i \Delta X_{t-1} + \varepsilon_t$$

(Random walk with drift) ---- (2)

$$\Delta X_t = \alpha + \beta_t + \gamma X_t + \sum_{i=1}^{p} \delta_i \Delta X_{t-1} + \varepsilon_t$$

(Random walk with linear and trend) ---- (3)

The hypothesis utilized in the research was null hypothesis: $H_0 : \gamma = 0$ and alternative hypothesis: $H_a : \gamma \neq 0$. Hereby, H_0 would be rejected when the statistic calculated was more than critical values, which it was that the variable X_t was stationary, and H_0 would be accepted when the statistic calculated was less than the critical values, which it was that the variable X_t was non-stationary. However, it was found that the series of variables data studied mostly

were non-stationary, so the researcher had to make these data more stationary by using First Difference or higher difference until the data was stationary.

3. Finding Suitable Optimal Lag Length

Finding suitable Optimal Lag Length was to find number of data lag that was suitable for the model used for co-integration test in the long run. In this research, the researcher utilized Optimal Lag Length by considering the statistic AIC (Akaike's Information Criterion) to calculate suitable Optimal Lag Length

4. The co-integration test in the long run by Johansen's method

The co-integration test in the long run was to test whether time series data of any pair of variables co-integrated or not. In this research, the researcher used the co-integration test in the long run by Johansen's method, which was composed of the following.

Step 1: check the order of stationary test of time series mentioned previously. After Order of Integration, it was found that (1) if the series of variable data was I (0) totally, the researcher would evaluate the relationship in the long run relying on Regression Analysis, but if (2) it was found that the series of variable data was I (1) completely, the researcher would test the relationship with Co-integration test based on Johansen's method. And if (3) time series data were disorderly I (0) or I (1) or I (2), the data could not be utilized with Co-integration Test of Johansen's method (Johansen, 1988, pp. 231–254). With Johansen's method, the researcher could evaluate co-integration vector in the long run more than 1 method and brought the concept of the model VAR to evaluate co-integration vector in the long run that would explain the relationship between the model VAR and the model Vector in the short run application for returning the co-integration in the long run as the following details: X_t was Vector (n × 1), which was composed of time series data, n series, as I (1) totally such as X_{1t} , X_{2t} , ... ,X_{nt} and the model VAR(p) written in Vector X_t as the following.

$$X_t = A_1 X_{t-1} + A_2 X_{t-2} + \dots + A_p X_{t-p} + u_t$$

$$X_t = \begin{bmatrix} X_{1t} \\ X_{2t} \\ \vdots \\ X_{3tn} \end{bmatrix}_{x\ 1} \quad A_t = \begin{bmatrix} a_{11,i} & \cdots & a_{1n,i} \\ a_{21,i} & \cdots & a_{2n,i} \\ \vdots & \ddots & \vdots \\ a_{n1,i} & \cdots & a_{nn,in} \end{bmatrix}_{x\ n}$$

$$, i = 1,\dots,p \text{ and } u_t = \begin{bmatrix} u_{1t} \\ \vdots \\ u_{ntn} \end{bmatrix}_{x\ 1}$$

Namely, A_i (i = 1,..,p) was metrix of parameter n x n, u_t was vector n × 1 of error random variable in the model VAR when u_t was determined as I (0), so time series data X_{1t} , X_{2t} , ... , X_{nt} would have co-integration one another in the long run. The researcher could adapt the model VAR (p) into the model VECM, which triggered the long run effect data in matrix Π n x nas the following.

$$\Delta X_t = \Pi X_{t-1} + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \dots + \Gamma_{p-1} \Delta X_{t-(p-1)}$$

with $\Pi = -(I - A_1 - A_2 - \dots - A_n)$ was matrix n x n

$\Gamma_1 = -(A_2 + A_3 + A_4 + \dots + A_p)$ was matrix n x n

$\Gamma_2 = -(A_3 + A_4 + \dots + A_p)$ was matrix n x n

⋮

$\Gamma_{p-1} = -(A_p)$ was matrix n x n

Or written in common form as

$$\Gamma_{p-1} = -(A_{i+1} + A_{i+2} + \dots + A_p)$$

$$= -\sum_{m=i+1}^{p} A_m$$

Step 2: create the model of recession between variables by determining the model

of recession between variables in the 1st equation to create the residual equation in the 2nd equation as the following.

$$Y_t = \alpha_0 + \beta_1 X_t + \hat{\varepsilon}_t \quad \text{---- (1)}$$

The 1st equation would be determined as the model of co-integration in the long run between X and Y.

$$\hat{\varepsilon}_t = Y_t - \hat{\alpha}_0 - \hat{\beta}_1 X_t \quad \text{---- (2)}$$

By making $\hat{\varepsilon}_t$ as coefficient of X_t, called Cointegrating Parameter

Step 3: check Unit Root of residual series derived from the 2nd step by checking Unit Root of residual series based on Augmented Dickey Fuller Test (ADF Test), which Constant would not be considered and Time Trend in the model in order to check the data stationary (Asteriou and Hall, 2007, pp. 278-340; Gujarati and Porter, 2009, p. 787).

$$\Delta\hat{\varepsilon}_t = \beta_1\hat{\varepsilon}_{t-1} + \sum_{i=1}^{p}\beta_{2i}\Delta\hat{\varepsilon}_{t-1} + V_t \quad \text{---- (3)}$$

By making V_t as White Noise, which the hypothesis test of residual series could be considered in 2 cases:

The 1st case: if the main hypothesis was rejected, and H_0: Non-stationary was in Level stage, it shown that X and Y had Cointegration: the relationship of X and Y in the 1st equation was co-integration relationship in the long run and it did not cause Spurious Relationship.

The 2nd case: if the main hypothesis was acceptable, and H_0: Non-stationary was in Level stage, it shown that X and Y had no Cointegration: there was no co-integration relationship between X and Y in the long run, and it may cause Spurious Relationship in the 1st equation.

5. Vector Error Correction Model (VECM)

This research was the study relying on more than 2 variables, so the researcher had to test the relationship in the long run based on the concept of Johansen and created the model vector, the short run adaptation of all time series data into co-integration in the long run by Vector Error Correction Model: VECM as the following.

$$\Delta X_t = \Pi X_{t-p} + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \ldots + \Gamma_{p-1} \Delta X_{t-(p-1)} + u_t$$

with $\Pi = -(I - A_1 - A_2 - \ldots - A_p)$ was matrix n x n

$\Gamma_1 = -(I - A_1)$ was matrix n x n

$\Gamma_2 = -(I - A_2)$ was matrix n x n

$\vdots$

$\Gamma_{p-1} = -(I - A_1 - A_2 - \ldots - A_p)$

Or written in common form as

$\Gamma_i = -(I - A_1 - A_2 - \ldots - A_i)$

$= -(1 - \sum_{m=1}^{p} A_m)$ for i = 1,...,

Results

In the first step of the study, it was the test of time series data features studied in this research, which took time from 1990 to 2018, 29 years altogether. The researching finding discovered whether these time series data had been structurally changed in terms of the time series data or not by conducting Chow-test, which was the structural change test of time series data with one-period of time. In this Chow-test, the main hypothesis was the regression coefficient of independent variables that were pretested and postested, which the duration of time was equivalent to zero. According to F-statistic, in case of the main hypothesis rejected, it represented the time series data was structurally changed (the regression coefficient both pretested and postested was valaued different from zero). Therefore, the duration of time used in the data or the study method should be adapted. While, in case of the main hypothesis accepted,

it meant that there was no any change in the time series data structure (the regression coefficient both pretested and postested was not differently valued from zero), and the time series data could be utilized throughout the duration of the collected data.

The Chow-test finding was found that the time series data studied from 1990 to 2018 had been structurally changed in 1997 and in 2002, except the data of female fertility rate aged between 35-49 years that was only structurally changed in 2002. When lowering the duration in the Chow-test, the researcher found that using the time series data during 2002 – 2018, 17 years altogether, was the duration that had no any structural change of time series data. In the duration, it could be used to study the relationship between overall, 15-24 years, and 25-34 years female fertility rates, and female labor force participation in total and discriminated based on ages of females together with the proportion of number of childcare centers. In case of the study of the relationship of female fertility rate, 35-49 years, female labor force participation, 35-49 years, and the proportion of number of children per chilcare center could be studied relying on the data the longer length of which was between 1997 and 2018. It was because the Chow-test finding shown that the time series data of these females had been no any structural change problem since 1997 until 2018. However, these time series data would be problematic in terms of the structural change statistically significantly if the duration of time was reduced only 17 years (2002 – 2018), so using the longer time series data would be more suitable.

In the second step of the study was the stationary test of data, and this was time series data with Augmented Dickey-Fuller (ADF). The reseach finding was shown in the table No. 2, reflecting that all 9 variables data had no any stationary at Level Data or I (0), altogether 3 test patterns: Constant, Trend and Constant, and None. As a result, the researcher studied to find First Differencing, and retested the stationary of new data, and found that all 9 variables had the stationary a first differencing (1) and all 3 test patterns were Constant, Trend and Constant, and None. So, the long run relationship could be tested by using Co-integration Test based on Johansen's method (Johansen, 1988, pp. 231-254).

In the third step of the study was finding number of Optimal Lag Length by considering from the statistic of AIC (Akaike's Information Criterion), and the result shown that the number of Optimal Lag Length was equivalent to 1, which the number of time series data would be used in the test of co-integration in the long run or Co-integration based on Johansen's method (Table No. 3).

Table No. 1 The structural change of time seires data by Chow-Stability Diagnosis test

The variables studied	Chow-test (F-statistic)					
	The data in years 2533 - 2561				The data in years 2545 - 2561	
	The years tested				The years tested	
	2540	2545	2550	2555	2550	2555
Overall Fertility Rate	4.573***	3.892***	2.525*	1.094	2.805*	1.901
Female Fertility Rate aged 15-24 years	6.631***	8.648***	4.028**	1.168	1.832	1.985
Female Fertility Rate aged 25-34 years	20.388***	10.207***	1.149	0.289	1.378	1.013
Female Fertility Rate aged 35-49 years	5.886***	0.759	0.426	0.061	14.995**	2.392

Note 1) *, **, *** refers to levels of confidence 90, 95, and 99 respectively. 2) the model used in this test was composed of the independent variables such as female labor force participation in a whole and discirmintaed based on age groups of females, the proportion of number of children per childcare center, and the dependent variables such as overall fertility rate and fertility rate discriminated based on age groups of females.

Table No. 2 The Test Result of The Stationary of Time Series Data for The Variables Studied

The variables studied	ADF test (t-statistic)					
	Level			First Differences		
	constant	trend	none	constant	trend	none
Overall Fertility Rate	-1.377	-0.615	-0.614	-3.771**	-3.304	-3.101***
Female Fertility Rate aged 15-24 years	-0.113	0.047	-0.678	-1.879	-4.388**	-1.890*
Female Fertility Rate aged 25-34 years	-3.518**	-3.373*	-0.090	-3.878**	-3.500*	-4.103***
Female Fertility Rate aged 35-49 years	0.530	-4.470**	1.943	-4.605***	-4.521**	-3.834***
Overall Female Labor Force Participation	-0.857	-2.970	-2.199**	-4.570***	-4.671**	-4.320***
Female Labor Force Participation aged 15-24 years	-0.809	-4.050**	-2.054**	-6.513***	-5.920***	-5.336***

Table No. 2 (Continued)

The variables studied	ADF test (t-statistic)					
	Level			First Differences		
	constant	trend	none	constant	trend	none
Female Labor Force Participation aged 25-34 years	0.281	-2.110	-1.259	-6.812***	-7.426***	-6.547***
Female Labor Force Participation aged 35-49 years	-0.693	-1.086	-0.492	-3.487**	-4.637**	-3.653***
The proportion of number of children per childcare center	-1.916	-1.980	0.104	-3.517**	-4.193**	-3.624***

Note *, **, *** refers to levels of confidence 90, 95, and 99 respectively.

Table No. 3 The Number of Optimal Lag Length

The dependent variables studied	The Number of Optimal Lag Length		
	Lag=0	Lag=1	Lag=2
	The Statistic AIC		
Overall Fertility Rate	12.373	10.551**	11.000
Female Fertility Rate aged 15-24 years	16.857	14.065**	13.208
Female Fertility Rate aged 25-34 years	11.567	11.174**	11.742
Female Fertility Rate aged 35-49 years	9.245	7.379**	7.551

Note 1) *, **, *** refers to levels of confidence 90, 95, and 99 respectively. 2) the model used to test the number of Optimal Lag Length was composed of the independent variables such as female labor force participation in a whole and discirmintaed based on age groups of females, the proportion of number of children per childcare center, and the dependent variables such as overall fertility rate and fertility rate discriminated based on age groups of females.

The fourth step of the study was the Co-integration Test based on Johansen's method.

The research result in table No. 4 found that all of the four models, the variables or time series data used in this study all had similar features together or Co-integrated statistically significant with confidence level 95. To put it in another word, time series data of overall and based on age groups fertility rate all had similar features together or Co-integrated with time series data of female labor force participation in a whole and discriminated based on age groups of females. And all had the similar features together or Co-integrated with time series data of the proportion of children number per childcare center statistically significant respectively. Therefore,

from the result, it could be said that the researcher could test Vector Error Correction Model due to the fact that time series data not only had the stationary condition at the same differencing level at 1 or I (0), but these data also had the similar features together or Co-integrated.

The fourth step of the study was to evaluate Vector Error Correction Model or VECM to show that (1) the relationship in the long run (2) the relationship in the short run, and (3) the adapation into co-integration in the long run of the variables studied, which in this study, the researcher determined the variables interested in or the dependent variables such as female fertility rate, divided into 4 model groups according to the discrimination of the dependent variables or the variables interested in. Namely, the first model was the dependent variable with overall female fertility rate (TFR1), the second model was the dependent variable with female fertility rate 15-24 years (TFR2), the third model was the dependent variable with female fertility rate 25-34 years (TFR3), and the fourth model was the dependent variable with female fertility rate 35-49 years (TFR4). All of the four models had each 4 independent variables; the first independent variable was Error Correction term, the second one was female fertility rate, the third one was female labor force participation, and the last one was the proportion of number of children per childcare center, which all of the independent variables would have data delay each one period of time.

Table No. 4 The Test Result of Co-Integration Test based on Johansen's method

The dependent variables studied		**Overall Fertility Rate (Model 1)**			
The main hypothesis	Eigenvalue	Trace-statistic	Critical Value	Max-Eigen statistic	Critical Value
None**	0.8699	38.115**	29.797	30.593**	21.131
At most 1	0.3231	7.521	15.495	5.854	14.264
At most 2	0.1052	1.667	3.842	1.667	3.841
The dependent variables studied		**Female Fertility Rate aged 15-24 years (Model 2)**			
The main hypothesis	Eigenvalue	Trace-statistic	Critical Value	Max-Eigen statistic	Critical Value
None**	0.8059	39.166**	29.797	24.588**	21.131
At most 1	0.4701	14.578	15.495	9.524	14.264
At most 2	0.2860	5.054	3.842	5.054	3.841
The dependent variables studied		**Female Fertility Rate aged 25-34 years (Model 3)**			
The main hypothesis	Eigenvalue	Trace-statistic	Critical Value	Max-Eigen statistic	Critical Value
None**	0.8485	37.590**	29.797	28.311**	21.131

Table No. 4 (Continued)

The dependent variables studied		Female Fertility Rate aged 25-34 years (Model 3)			
At most 1	0.3546	9.729	15.495	6.569	14.264
At most 2	0.1653	2.710	3.842	2.710	3.841
The dependent variables studied		**Female Fertility Rate aged 35-49 years (Model 4)**			
The main hypothesis	Eigenvalue	Trace-statistic	Critical Value	Max-Eigen statistic	Critical Value
None**	0.8026	31.065**	29.797	24.341**	21.131
At most 1	0.3506	6.723	15.495	6.475	14.264
At most 2	0.0164	0.247	3.842	0.247	3.841

Note: 1) ** refers to levels of confidence 95.

2) the independent variables used in the test was composed of female labor force participation in a whole and discirmintaed based on age groups of females and the proportion of children number per childcare center. All of the models used data delay equivalent to 1.

The evaluation finding of the model Vector Error Correction Model (VECM) discriminated based on female fertility rate, altogether 4 groups, was demonstrated in Co-integration Equation as the following.

$$\Delta TFR1 = -0.5382ECT_{t-1}^{***} + 0.2713\Delta TFR1_{t-1} - 0.1123\Delta LFPR1_{t-1} - 0.1904\Delta CA_{t-1}^{***} + 0.0280 \quad \text{---------- (1.1)}$$

$$\Delta LFPR1 = -0.0586ECT_{t-1} + 0.0674\Delta TFR1_{t-1} - 0.4348\Delta LFPR1_{t-1} - 0.0156\Delta CA_{t-1} - 0.4496 \quad \text{---------- (1.2)}$$

$$\Delta CA = -0.8888ECT_{t-1}^{***} + 0.4794\Delta TFR1_{t-1} - 0.7703\Delta LFPR1_{t-1} - 0.1323\Delta CA_{t-1} + 0.0223 \quad \text{---------- (1.3)}$$

Model 2 for the dependent variables, Female Fertility Rate aged 15-24 years (TFR2), were composed of 3 sub-equations as the following:

$$\Delta TFR2 = -0.1674ECT_{t-1}^{***} + 0.2258\Delta TFR2_{t-1} - 0.1522\Delta LFPR2_{t-1} - 0.4288\Delta CA_{t-1}^{**} - 0.4680 \quad \text{---------- (2.1)}$$

$$\Delta LFPR2 = 0.0757ECT_{t-1} + 0.4512\Delta TFR2_{t-1} - 0.5362\Delta LFPR2_{t-1}^{*} - 0.1433\Delta CA_{t-1} - 0.9754 \quad \text{---------- (2.2)}$$

$$\Delta CA = -0.1543ECT_{t-1}^{*} + 0.0347\Delta TFR2_{t-1} - 0.3519\Delta LFPR2_{t-1} - 0.1915\Delta CA_{t-1} + 0.0547 \quad \text{---------- (2.3)}$$

Model 3 for the dependent variables, Female Fertility Rate aged 25-34 years (TFR3), were composed of 3 sub-equations as the following:

$$\Delta TFR3 = -0.4323ECT_{t-1}^{***} + 0.2422\Delta TFR3_{t-1} - 0.3671\Delta LFPR3_{t-1} - 0.2140\Delta CA_{t-1} - 0.3120 \quad \text{---------- (3.1)}$$

$$\Delta LFPR3 = 0.0366ECT_{t-1} + 0.0094\Delta TFR3_{t-1} - 0.1342\Delta LFPR3_{t-1} - 0.0165\Delta CA_{t-1} - 0.1442 \quad \text{---------- (3.2)}$$

$$\Delta CA = -0.4689ECT_{t-1}^{***} + 0.3238\Delta TFR3_{t-1} - 0.4809\Delta LFPR3_{t-1} - 0.0766\Delta CA_{t-1} + 0.2274 \quad \text{---------- (3.3)}$$

Model 4 for the dependent variables, Female Fertility Rate aged 35-49 years (TFR4), were composed of 3 sub-equations as the following:

$$\Delta TFR4 = -0.2357ECT_{t-1}^{***} + 0.7887\Delta TFR4_{t-1}^{***} + 0.1721\Delta LFPR4_{t-1}^{**} - 0.0960\Delta CA_{t-1}^{***} + 0.1010 \quad \text{---------- (4.1)}$$

$$\Delta LFPR4 = -0.4125ECT(t-1) - 0.0977\Delta TFR4_{t-1} - 0.0430\Delta LFPR4_{t-1} + 0.0931\Delta CA_{t-1} + 0.0171 \quad \text{---------- (4.2)}$$

$$\Delta CA = -2.9734ECT_{t-1}^{***} + 5.2714\Delta TFR4_{t-1}^{**} + 1.9429\Delta LFPR4_{t-1}^{**} - 0.4616\Delta CA_{t-1}^{*} - 0.2556 \quad \text{---------- (4.3)}$$

Note *, **, *** refers to levels of confidence 90, 95, and 99 respectively.

Conclusion and Discussion

The evaluation result of Vector Error Correction Model (VECM) discriminated based on female fertility rate, altogether 4 altogether, it was found that in the model 1, there was the relationship in the long run between female overall feriltiy rate and the proportion of children number per childcare center statistically significant, and there was the relationship in the short run between the proportion of children number per childcare center and overall female fertility rate statistically significant with the one-direction relationship. That was, the variable about proportion of children number per childcare center still was a cause of the change in overall female fertility rate; moreover, it was discovered that if there was any changes from external factors beyond the variables studied in the short run (the short run was within 1 year according to the features of time series data used in the study), which made the relationship between overall female fertility rate and the proportion of children number per childcare center out of co-integration in the long run, there would be enough time for adaptation into co-integration in the rong run as previously. To put in in another word, the velocity as usual in adapation into co-integration in the long run was equal to 53.82%, which could be reckoned from the coefficient in front of the variableECT_{t-1} of the model 1.1.

For the model 2, the finding shown that there was the relationship in the long run between female fertility rate aged 15-24 years and the proportion of children number per childcare center statistically significant, and it revealed that the relationship in the short run between overall female fertility rate aged 15-24 years and the proportion of children number per childcare center statistically significant with the one-direction relationship. In addition, the proportion of children number of childcare was the reason why female fertility rate aged 15-24 years was changed, and it still shown that if there was any changes from external factors beyond the variables studied in the short run (the short run was within 1 year according to the features of time series data used in the study), which made the relationship between female fertility rate aged 15-24 years and the proportion of children number per childcare center out of co-integration in the long run, there would be enough time for adaptation into co-integration in the rong run as previously, or it was called the velocity in adaptation into co-integration in the long run equal to 16.74%, which was calculated from the coefficient in front of the variable ECT_{t-1} of the model 2.1.

For the model 3, the result clarified that there was the relationship in the long run between overall female fertility rate aged 25-34 years and the proportion of children number of childcarecenter statistically

significant; however, there was no any relationships in the short run among all of the variables used to study every female group aged 25-34 years. Hereby, it was because the females in this group were not in high-level fertility rate when compared to females in fertility rate in other age groups. From the study of Kaewbuadee and Pothisiri (2019, pp. 57-74), the study explained that famales in fertility rate under aged 20 years and aged between 20-24 years both were females in fertility rate who had the first child, both of which were the highest proportion among all of the females in fertility rate, or it could be easily said that in Thai society, there were a lot of first children born from young mothers. Accordingly, females in fertility rate aged between 25-34 years did not play an important role for fertility rate in Thailand. Besides, presently based on the critical summary report of females' working in Thailand in 2016 of National Statistical Office (2017) demonstrated that females aged between 25-34 years were not the same group as females whose high labor force participation level when compared to females in other age groups, especially females aged between 45-59 years were the group whose the highest labor force participation level, following by females aged between 35-44 years. As a result, it could be viewed that females aged between 25-34 years were the group that did not play an important role on both fertility rate and labor force participation in the labor market of the nation when compared to females in other age groups as mentioned above; therefore, it might caused no any relationships in the short run among all of the variables used in the study for females whose age between 25-34 years. Furthermore, the research finding still discovered that if there was any external changes in the short run causing the relationship between female fertility rate aged between 25-34 years and the proportion of children number per childcare center out of co-integration in the long run, there would be enough time for adaptation into co-integration in the rong run as previously, and the velocity as usual in adapation into co-integration in the long run was equal to 43.23%, which could be reckoned from the coefficient in front of the variable ECT_{t-1} of the model 3.1.

For the model 4, there was the relationship in the long run between female fertility rate aged between 35-49 years and thr proportion of children number per childcare statistically significant, and it was found that there was the relationship in the short run between the proportion of children number per childcare center and female fertility rate aged between 35-49 years statistically significant with the two-direction relationship. Namely, either the variable about proportion of children number per childcare center or the variable about female fertility rate aged between 35-49 years, each was reason and result of each other. The research finding shown that there was the relationship in the short run with one-direction relationship between female labor force participation aged 35-49 years and the proportion of children number per childcare center, which female labor force participation aged 35-49 years was a cause of the change in female fertility rate aged between 35-49 years and the change of the proportion of children number per childcare center respectively. Also, it was

found that if there was any external changes in the short run causing the relationship between overall female fertility rate aged between 25-34 years and the proportion of children number per childcare center out of co-integration in the long run, there would be enough time for adaptation into co-integration in the rong run as previously, equivalent to 23.57%, which could be reckoned from the coefficient in front of the variable ECT_{t-1} of the model 4.1.

From above, it could be seen that when there were any external changes during the short run within 1 year causing the relationship among all of the three groups of female fertility rates and the proportion of children number per childcare center out of co-integration in the long run, there would be enough time in adaptation into co-integration in the long run as usual, or it could be called the velocity in adaptation into co-integration in the long run with different proportions. That was, females in fertility rate aged between 15-24 years, 25-34 years, and 35-49 years respectively had the velocity in adaptation into co-integration equivalent to 16.74%, 43.23%, and 23.57% respectively. The velocity in adaptation into co-integration of females in fertility rate aged between 25-34 years was the highest level, so it meant that the females could fastest adapt into co-integration, while females in fertility rate aged between 15-24 years possed the slowest adaptation into co-integration when compared to females in fertility rates of other groups.

For the cause of different velocity in adaptation, it was triggered from the different fertility rate data and the different ratiot of female labor force participation based on age groups of female in fertility rate, whereas the data of proportion of children number per childcare center would not vary as the fertility rate and ratio of female labor force participation.

From the different time series data used in this study, when the data were evaluated with Vector Error Correction Model (VECM), the result shown that VECM caused the velocity in adaptation into co-integration of females in each age group differently, and the finding was consistent to the study of Grace and Sing Ping (2014, pp. 71-85) studying the relationship in the long run between female fertility rate and childcare availability in Japan. The research was studied from females in fertility rate in various age groups and it was discovered that the velocity in adaptation into co-integration of females in fertility rate was different based on age groups as well.

From the test of relationship both in the long run and in the short run using Vector Error Correction Model (VECM), it was found that female fertility rates both in total and discriminated based on age groups of females were related in the long run with the proportion of children number per childcare center that used as the variable representing childcare availability. It indicated that the increasing childcare availability caused higher female fertility rate in every age group except females aged between 25-34 years; however, the research finding could find out any long run relationships between fertility rate and female labor force participation, which was consisten to the study of Grace and Sing Ping (2014, pp. 71-85) revealing the long run relationship between female fertility rate and childcare availability in Japan. At the same

time, the study did not find any relationships between fertility rate and female labor force participation in Japan as same as this research finding. Moreover, the research finding also was in accordance with Castles (2003, pp. 209-227) that unveiled the positive relationship between fertility rate and having childcare center for children under 3 years due to the fact that there was encouragement in terms of childcare availability positively affecting female fertility rate (Baizan, 2009, pp. 803–841; Rindfuss, et al., 2010, pp. 725–748). Hence, if females in fertility period that had childare limitation such as no any other family members looking after children or not be able to access the childcare center service, their fertility ability would decrease as well (Presser and Baldwin, 1980, pp. 1202–1213; Richter, et al., 1994, pp. 651–662).

Research Suggestions

1. From research findings, there was the relationship in the long run between female fertility rate in a whole both females from every age group in fertility period and females from each age group compared with the proportion of number of children per childcare center, which in this study, the variable substituted childcare availability. This study suggested that the government should determine the policy and the measure to encourage the development of childcare centers or nurseries in both quantity and quality of service, which would influence and increase Thailand's fertility rate in the long run.

2. From research findings, it revealed that there was the relastionship in the short run between childcare availability and female fertility rate in total and classified by age group of every female group except the females aged between 25-34 years, which the velocity in adaptation into co-integration in the long run was differently found based on age groups of females in fertility periods. The females aged between 15-24 years had the slowest adaptation into co-integration following by the females in fertility period aged between 35-49 years. This study would like to suggest that the government should settle the policy and the measure that could support the childcare centers or nurseries accessibility by focusing on young mothers, old mothers, and especially mothers who extremely slowly had the first child.

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