Analyzing the Relationship between Increased Female Employment Rates and Lower Birth Rates*

An Analysis of Canada's Female Employment Rate and Birth Rate

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This paper utilizes data from The World Bank to examine the relationship between Canada's female employment rate and birth rate between 2009 to 2019. The analysis shows a negative correlation between the two variables, indicating that as the female employment rate increased, the birth rate falls. Third sentence. Fourth sentence

1 Introduction

The relationship between a country's female employment rate and birth rate is a topic that has attracted considerable attention and debate among economists, population scientists and policymakers. The relationship is complex and multifaceted, often reflecting broader social and economic dynamics, cultural norms and policy environments. The female employment rate, defined as the proportion of the female population aged 15 and older that is employed, is a crucial indicator of gender equality and economic participation (TheWorldBank 2024). As a developed country with a diversified economy and progressive social policies, the study of this relationship in Canada can shed light on broader discussions about work-life balance, gender equality and demographic trends. Over the past several decades, Canada has seen a significant increase in female labor force participation, mirroring trends in other advanced economies. This shift has been attributed to a variety of factors, including increased educational attainment among women, changes in societal attitudes towards female employment, and the implementation of policies aimed at facilitating work-life balance, such as maternity leave and childcare support (Blau and Kahn 2017).

*Code and data are available at: https://github.com/xuqi2002/female-employment-and-birth-rate.git

At the same time, birth rates have been declining in many developed countries, including Canada. The birth rate, measured as the number of live births per 1,000 population per year, is influenced by myriad factors, including economic conditions, access to contraception and reproductive health services, and personal choices regarding family size and childbearing timing (Sobotka 2017). In the case of Canada, the birth rate has experienced fluctuations over the past few decades, with recent trends showing a gradual decline. This decline in birth rates is a feature common to many advanced economies and is often associated with factors such as increased female educational attainment and labor force participation, urbanization, and changes in family planning preferences (Sobotka 2017).

In this paper, we will examine the relationship between Canada's female employment rate and birth rate through a linear regression analysis. The estimand here is how female employment rate and birth rate are related. We will download data from the Data Bank website of The World Bank (DataBank 2024b). Our respondents of interest are the percentage of the female working-age population, as they represent the potential labor force and have a significant impact on a country's economic growth and development. Based on the analysis, we found that there is a negative relationship between female employment rate and birth rate.

In the data section, we discuss the source of data used in this paper, the strengths and weaknesses of The World Bank, methodologies that follow it, and data terminology. Then we present the data visualization, focusing on the trajectory of female employment rate and birth rate from 2009 to 2019 in Canada. In the model section, we will analyze the trend by creating a linear regression model. In the result section, we will present the result of the model in a graph. Finally, we explore the factors that contribute to this negative relationship between female employment rate and birth date. We will also examine the weakness, and potential next step of this analysis.

2 Data

2.1 Data Description and Methodology

The data used in this paper is obtained from the Data Bank website of The World Bank, it is public data which available through the Data Bank website (DataBank 2024b). The World Bank's Data Bank is a comprehensive database that offers free and open access to a vast collection of global development data. It encompasses a wide array of statistical indicators and data sets covering various aspects of economic and social development. These include, but are not limited to, population demographics, economic performance, health and education statistics, environmental indicators, and much more.

The data in the World Bank's Data Bank comes from a variety of sources, with a significant portion being collected and compiled by the World Bank itself, as well as from specialized agencies of the United Nations (UN), international organizations, national statistical offices,

and other authoritative public and private sector sources. These data are then aggregated and analyzed by the World Bank to identify trends and inform policy recommendations.

The two datasets that I will be using are: 'Birth rate, crude, per 1000 people' (DataBank 2024a), and 'Employment to population ratio, 15+, female (%) (national estimate)' (DataBank 2024c). The two original datasets include data from 265 countries around the world for the period 1960-2022, although data are not available for every country in every year. I processed these two datasets, keeping only Canada's data for 2009-2019, and merged them into one dataset for analysis. The birth rate dataset presents the number of live births per 1,000 people in a given population over one year. The observations recorded in the processed dataset was 11.4 in 2009, and 9.9 in 2019. The female employment rate dataset presents the percentage of a country's female population aged 15 years and older that is employed. The value is expressed as a percentage of the total female population within the same age group. The observations recorded in the processed dataset was 57.958 in 2009, and 58.453 in 2019.

Table 1: A summary table of cleaned data

Year	Birth_Rate_per_1000_people	Female_Employment_Rate
2009	11.4	57.958
2010	11.2	57.802
2011	11.0	57.696
2012	11.0	57.896
2013	10.9	58.141
2014	10.9	57.687
2015	10.7	57.591
2016	10.6	57.517
2017	10.3	57.892
2018	10.1	58.028
2019	9.9	58.453

Table 1 presents the overview of the cleaned dataset. There are 11 observations which are years from 2009 to 2019. The variables in the dataset include Year (in years), Birth Rate (in per 1000 people) and Female Employment Rate (in percentage).

In this paper, the analysis is carried out using the statistical programming language `R` (R Core Team 2023), with the help of extra packages including `dplyr` (Wickham et al. 2023), `ggplot2` (Wickham 2016), `here` (Müller 2020), `kableExtra` (Zhu 2021), `knitr` (Xie 2014), `modelsummary` (Arel-Bundock 2022), `readr` (Wickham, Hester, and Bryan 2024), `tibble` (Wickham, Müller, and Hester 2021), and `tidyverse` (Wickham et al. 2019).

2.2 Data Visualization

2.2.1 Trend of Female Employment Rate

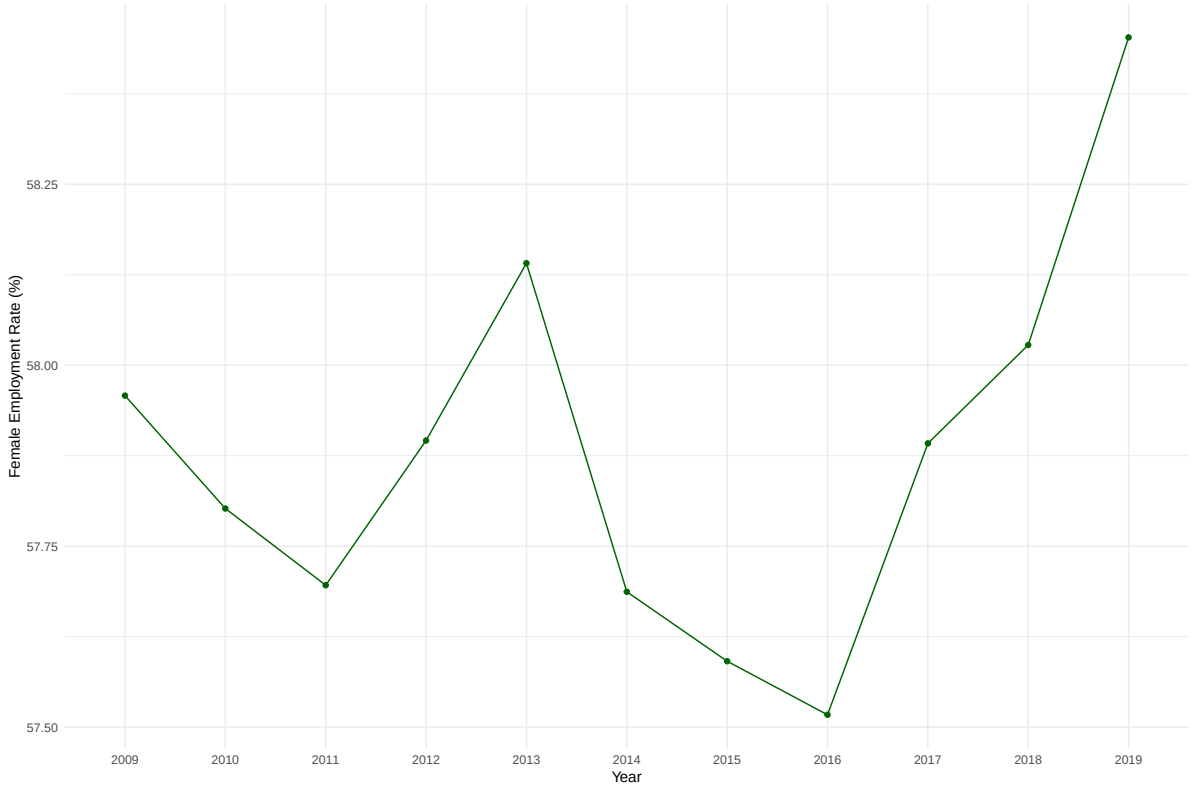

Figure 1: Canada's female employment rate from 2009 to 2019.

Figure 1 shows the trend in the female employment rate in Canada from 2009 to 2019. The line graph indicates an overall upward trajectory in the rate of female employment during this decade. The female employment rate was initially 54.616% in 2009. After that, there is a sharp decrease until 2011. From 2011 to 2016, there are some volatility, with the female employment rate experiencing both increases and decreases but generally trending downwards during this period. After 2016, the rate begins to rise again, with reaching the peak in 2019 with 58.453%. This figure suggests that more women are participating in the Canadian labor force over time, though social, economic and policy changes may have influenced the rate's variability throughout these years.

2.2.2 Trend of Birth Rate

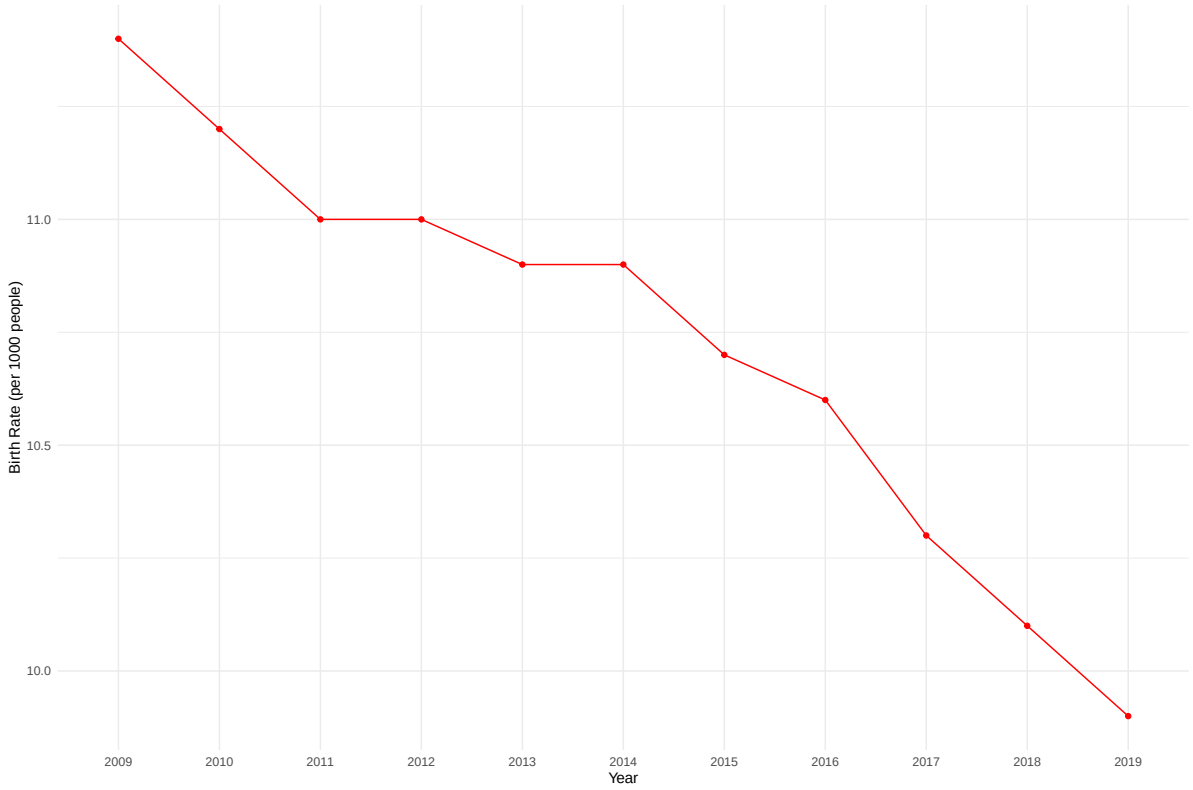

Figure 2: Canada's birth rate from 2009 to 2019.

Figure 2 presents a line graph showing the trend of Canada's birth rate for a decade from 2009 to 2019, which is a clear downward trend. Starting at 11.4 births per 1,000 people in 2009, the birth rate consistently declines year over year, reaching its lowest point after a decade in 2019, with only 9.9 newborns per 1000 people. Such a descending trend may suggests various social and economic changes, such as shifts in societal norms regarding family size, economic incentives or disincentives for having children, or other demographic changes within the country. The consistent downward trajectory suggests that these factors are persisting over time, contributing to a sustained reduction in the number of births.

3 Model

After conducting basic analysis on the dataset, we have observed a negative correlation between the female employment rate and the birth rate, indicating a potential linear relationship. To gain further insights, we will be implementing a linear regression model.

Here is the equation of the linear regression model.

$$Yij = \beta 0 + \beta 1 Xij + \varepsilon ij$$

where:

- Y is the Birth Rate
- X is the Female Employment Rate
- Y_{ij} is the Birth Rate for observation j in year i.
- X_{ij} is the Female Employment Rate for observation j in year i.
- β_0 is the intercept/constant term, which represents the expected value of Birth Rate when the Female Employment Rate is equal to zero.
- β_1 is the slope coefficient or the estimated change in Birth Rate for a one-unit increase in the Female Employment Rate.
- ϵ_{ij} is the error term or the deviation of the actual value of Birth Rate from the predicted value based on the regression equation.

The purpose of a linear regression model in this case is to estimate the values of 0 and 1, so that the model fits the data well, and predicts the expected value of the newborn birth rate for different values of the female employment rate. The statistical significance of 1 can be assessed using a t-test, which tests whether the estimated coefficients are significantly different from zero. If the p-value of the t-test is less than the selected level of significance, we can conclude that there is a significant relationship between the female employment rate and the newborn birth rate.

4 Result

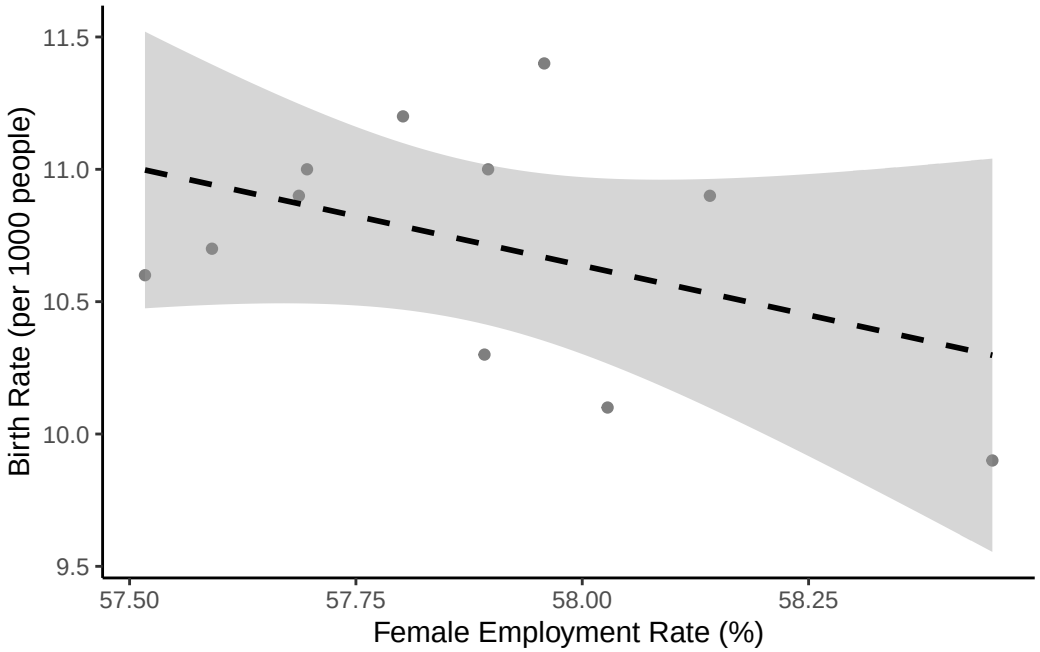

Figure 3: The model shows the relationship between Female Employment Rate and Birth Rate

Figure 3 illustrates a fitted graph of the linear regression model, showing the relationship between the Female Employment Rate (on the x-axis) and the Birth Rate per 1,000 people (on the y-axis). The dashed line indicates the trend as estimated by the linear regression model. The grey shaded area around the dashed line represents the confidence interval for the regression line, giving a visual indication of the uncertainty around the estimated relationship. The plot suggests a negative relationship between the two variables: as female employment rate increases, the birth rate rate decreases. The regression line confirms this trend, with a negative slope that is statistically significant. Overall, this figure provide strong evidence of the negative association between female employment rates and birth rates. With the confidence interval indicating the range, we can be reasonably sure that the true regression line lies in this area.

Table 2: T-Value and P-Value of Regression

	t_value	p_value
(Intercept)	1.786750	0.1076225
Female_Employment_Rate	-1.431875	0.1859783

Table 2 and Table 3 are summaries of the linear regression model, they provide several key

Table 3: Summary of the linear regression model

	Female_Employment_Rate
(Intercept)	54.01
	(30.23)
Female_Employment_Rate	−0.75
	(0.52)
Num.Obs.	11
R2	0.186
R2 Adj.	0.095
AIC	17.1
BIC	18.3
Log.Lik.	−5.531
RMSE	0.40

pieces of information about the relationship between the female employment rate and the birth rate:

- The intercept is approximately 54.01, suggesting that when the female employment rate is 0, the birth rate is predicted to be around 54 births per 1000 people. However, this interpretation of the intercept may not be meaningful if a female employment rate of 0 is not feasible or outside the range of the data.
- The coefficient for Female Employment Rate is approximately -0.75, with a standard error of 0.52. This suggests that for each one percent increase in the female employment rate, the birth rate is expected to decrease by 0.75 births per 1000 people.
- The R-squared value is 0.186, meaning that approximately 18.6% of the variability in the birth rate is explained by the model. This is a relatively low value, indicating a weak fit of the model to the data.
- The t-value for the Female Employment Rate coefficient is approximately -1.43, indicating the estimate is -1.43 standard deviations away from 0. The negative sign shows that the relationship is negative.
- The p-value for the intercept is approximately 0.1076, suggesting that the intercept is not statistically significant at the common alpha levels

In summary, this linear model suggests a negative relationship between the Female Employment Rate and the Birth Rate, but neither the intercept nor the slope is statistically significant. Given the low R-squared value, this model also does not appear to be a particularly strong predictor of the birth rate based on the female employment rate. This implies that while the model estimates a negative effect of the increased Female Employment Rate on Birth rate, we

do not have sufficient evidence to claim a statistically significant relationship from this sample of data.

5 Discussion

5.1 Evolution of Female Employment in Canada

5.2 Evolution of Birth Rate in Canada

5.3 Impact of Female Employment on Birth Rate

5.4 Weakness and Next Step

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