Semiparametric Bivariate Probit Model in Data Working Mother Status and Exclusive Breastfeeding

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Abstract. The high rate of under-five mortality can be an indication that the maternal and neonatal services are in alarm, boost immunity can reduce it. Immunity in infants can be obtained by exclusive breastfeeding. One of the factors influencing the success and failure of an exclusive breastfeeding is a working mother. In this work, we analyze the relationship between working mother status and exclusive breastfeeding by applying a semiparametric bivariate probit model. We also determine the factors that influence the working mother status and giving of exclusive breastfeeding. The data used are National Socio-Economic Survey (SUSENAS) data of Bangkalan 2016. Exclusive breastfeeding and working mother status as the endogenous variables but working mother status can be exogenous variable. Endogeneity causes the result in inconsistent or biased parameter estimation. Covariate-outcomes relationships can exhibit non-linear patterns. The parameter estimation method is penalized likelihood estimation. The resulting information is working mother status and exclusive breastfeeding have correlation, so it can be identified as the problem of endogeneity. The father’s job has a significant effect on working mother status. Mother’s education, father’s education, father’s job and working mother status as the exogenous variables have a significant effect respectively on exclusive breastfeeding.

1. Introduction
The probit model is a model used to analyze the relationship between response variables in the form of qualitative and the predictor variables are in the form of quantitative and qualitative. The probit model with one response variable is called the univariate probit model. The probit model that has two response variables with the assumption of both response variables have a correlation called the bivariate probit model. The correlation between two binary response variables arises because of endogenous problems [1]. Endogenous problems occur in modeling where the endogenous variables are as the exogenous variables [1]. Endogenous problems cause non-linear relationships between predictor variables in the
form of quantitative data with response variables and inconsistent or biased parameter estimation, so we use a semiparametric bivariate probit model to solve it. Research on semiparametric bivariate probit model has been done. A semiparametric bivariate probit model for joint modeling in STEMI patients [2]. The estimation of a semiparametric recursive probit bivariate model with endogenous problems [1]. A spline bivariate probit regression model with a partial approach to exogenous testing [3]. Hypothesis testing in the absence of unobserved confounding variables in the semiparametric probit bivariate model [4].

WHO research in 2015 says that 42 percent of the leading causes of under-five mortality in the world are malnutrition. Malnutrition is a condition of the body that has nutritional deficiencies or nutritional status is below average standards, both in the form of protein, carbohydrates, and calories in children under five [5]. Malnutrition is often associated with breast milk intake (breast milk). Increased nutritional status of children can be done with exclusive breastfeeding. Breast milk has some nutrients that are very appropriate for toddlers, such nutrients are carbohydrates, fats, proteins, vitamins, and minerals. Based on Indonesia's health data profile in 2012 shows exclusive breastfeeding in Indonesia is still very low, the presentation of exclusively breastfed infants 0 to 6 months only 61.5%. This is due to public awareness in encouraging the increase of exclusive breastfeeding is still relatively low [6]. The main issues are socio-cultural factors, public awareness of the importance of exclusive breastfeeding, health services that have not fully supported exclusive breastfeeding, incessant promotion of formula milk and working mother.

Bangkalan regency is one of the regencies in East Java province located on the island of Madura. According to the Central Bureau of Statistics in 2016, four districts on the island of Madura are included in 112 disadvantaged regions in Indonesia [7]. Child mortality rate or toddlers become one of the problems faced in Bangkalan district. The results of the Bangkalan District Health Office number of the child or under-five mortality has been constant from the previous year [8]. In 2014 as many as 9 cases of death and in 2015 also as many as 9 cases of death. East Java Provincial Health Office reports on exclusive breastfeeding only reached 47.88%, while exclusive breastfeeding data in Bangkalan District in 2015 reached 69.3%. Based on the data report of nutrition field of Bangkalan District Health Center in February 2016, exclusive breastfeeding in infants 0-6 months from 655 babies examined, only 75 babies were given exclusive breastfeeding [8]. The achievement of exclusive breastfeeding on the data is still below the MDG's (Millennium Development Goals) target of 2015 by 80%. Barriers to exclusive breastfeeding or stopping early breastfeeding less than 6 months are often ignored with working motherhood and continue to increase the number of the female labor force [8]. The immediate desire to return to work after childbirth, distance, facility (space, freezer) milked milk is often associated with the success of mothers giving exclusive breastfeeding.

Research on exclusive breastfeeding and working mother status has been done. The relationship of the employment status with exclusive breastfeeding in Polebon Subdistrict, Semarang Displacement Subdistrict [9]. Exclusive breastfeeding success, in mothers working mothers, obtained only 35.5% of respondents who breastfeed exclusively [10]. The qualitative analysis of factors affecting exclusive breastfeeding of working mothers in the Bangkalan Puskesmas area [11]. The relationship of mother's work with the success of exclusive breastfeeding to children in Posyandu Bina Putra Tirto Triharjo Pandak Bantul Yogyakarta [12]. The paper analyzes the relationship between working mother status and exclusive breastfeeding by applying a semiparametric bivariate probit model and determine the factors that influence the working mother status and giving of exclusive breastfeeding with Rx64 3.3.2 program.

2. Case Studies
This study uses secondary data derived from the results of the National Socioeconomic Survey (SUSENAS) Bangkalan District conducted by the Central Bureau of Statistics (BPS) in 2016 [7]. The data taken are households who have children aged 0-24 months of age. Variable response Y1 (working mother or not), variable response Y2 (giving exclusive breastfeeding or not). Predictor variable:

1. Age at the first marriage of mother (X1)
2. Father’s job (X2), divided into two categories based SUSENAS’s questionnaire:
Factors affecting the success and the failure of exclusive breastfeeding one of them is the working mother. The mothers turned to formula milk because the cessation of exclusive breastfeeding occurs in working mothers, especially in urban areas. Cheatterji and Frick [13] stated that returning to work within the first three months after delivery is closely related to the decrease of breastfeeding by 16% -18%, and reduction in breastfeeding duration by 4-5 weeks. According to Weber et. al [14] back to work is the main reason to stop breastfeeding, of the 60% of women who intend to continue breastfeeding but only 40% do so.

3. Semiparametric Bivariate Probit Model
The Semiparametric bivariate probit model is a model that describes the relationship between two response variables in the form of binary categorical data with one or more predictor variables in the form of categorical data as well as continuous data with an attention to the problem of endogeneity. The problem of endogeneity is the case of a model in which the endogenous variable can be an exogenous variable. The semiparametric bivariate probit model is used to overcome the problem of inconsistent and biased parameter estimation. Another problem of concern is the non-linearity effect of continuous predictor variables to response variables. So the semiparametric bivariate probit model is proposed to prevent mismatch model due to the non-linearity in the model [2].

\[
\begin{align*}
\eta_1^\prime &= x_1^\prime \alpha_1 + \sum_{k=1}^{K_1} f_{k1}(z_{1k1}) + \varepsilon_{1q}, \\
\eta_2^\prime &= f_{k2}(z_{2k2}) + \varepsilon_{2q}
\end{align*}
\]

Where \( n \) denotes the sample size, \( x_{1i}^T \) : ith row vector of \( x_1^T \) the \( n \times p_1 \) model matrix for any strictly exogenous parametric model components (such as dummy and categorical variables), with corresponding parameter vector \( \alpha_1 \), \( f_{k1} \) is an unknown smooth function of the exogenous continuous covariate \( z_{1k1} \), for \( k_1 = 1,..,K_1 \), represented using regression splines. Similarly, \( x_{2i}^T \) is the ith row vector, the \( n \times p_2 \) model matrix \( x_{2i}^T \) with coefficient vector \( \alpha_2 \) and \( f_{k2} \) is an unknown smooth term of the continuous regressor \( z_{2k2} \), for \( k_2 = 1,..,K_2 \). The target of inference is \( \beta \), the parameter of the endogenous binary variable \( y_{1i} \). Error term \( (\varepsilon_{1q}, \varepsilon_{2q}) \) are assumed to be identically distributed as bivariate normal with zero means, unit variance and correlation coefficient \( \theta_3 \), independently across observation. That is,

\[
\begin{bmatrix}
\varepsilon_{1q} \\
\varepsilon_{2q}
\end{bmatrix} \sim N \left( \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \theta_3 \\ \theta_3 & 1 \end{bmatrix} \right)
\]

Since the error term of the two equations are assumed to be correlated, simultaneous parameter estimation is advisable. The linear predictors are given as \( \eta_{1i} = x_{1i}^T \theta_1 \), \( \eta_{2i} = x_{2i}^T \theta_2 \). Where \( \theta \) contains...
\[ \alpha, \text{ for two binary response } y_{1i} \text{ and } y_{2i} \text{ the bivariate probit model has the form } P(y_{1i} = 1, y_{2i} = 1|x_{1i}, x_{2i}) = \Phi_2(\eta_{1i}, \eta_{2i}; \boldsymbol{\theta}_3), \text{ where } \Phi_2 \text{ is the distribution function of a bivariate normal with zero means, unit variance, and correlation } \boldsymbol{\theta}_3. \text{ Because } \boldsymbol{\theta}_3 \text{ is bounded in } [-1, 1], \text{ we allow for endogeneity in the inverse hyperbolic arctangent of } \boldsymbol{\theta}_3 \text{ instead. Using } \boldsymbol{\theta}_3 = \tanh^{-1}(\boldsymbol{\theta}_3). P(y_{1i} = m_1, y_{2i} = m_2) \text{ as } P_{m_1m_2}, \text{ where } m_v = (0, 1) \text{ for } v = 1, 2. \]

\[ y_{m_1m_2} = \begin{cases} 1, & \text{if } (y_{1i} = m_1 \text{ and } y_{2i} = m_2) \\ 0, & \text{otherwise} \end{cases} \]

The method used in the estimation of semiparametric bivariate probit model is Penalized Likelihood Estimation. The equations generated in the estimation of semiparametric bivariate probit model parameters are not closed form so it uses Fisher Scoring iteration [1]. The log likelihood function is

\[ \ell(\boldsymbol{\theta}) = \sum_{i=1}^{n} y_{1i}\ln(p_{11i}) + y_{01i}\ln(p_{01i}) + y_{10i}\ln(p_{01i}) + y_{00i}\ln(p_{00i}) \]  

(3)

where \( \boldsymbol{\theta} = (\theta_1, \theta_2, \theta_3) \), in the model (1) replacing the smooth components with regression spline yields a classic bivariate probit model be estimated by maximization of (3) [15]. However, in a smoothing spline context, unpenalized parameter estimation is likely to result in smooth component estimates that are too wiggly. This can be overcomed by penalized likelihood maximization. In particular, the regression spline basis used to represent the generic smooth component \( f_k(z_k) \) has an associated measure of roughness \( \delta_k^T S_k \delta_k \), where \( S_k \) is a smoothing positive semi-definite penalty matrix of known coefficients. The model can be fitted by maximization of the penalized log-likelihood.

\[ \ell_p(\boldsymbol{\theta}) = \ell(\boldsymbol{\theta}) - \frac{1}{2} \boldsymbol{\theta}^T S_\lambda \boldsymbol{\theta} \]  

(4)

where \( S_\lambda = \sum_{k=1}^{K} \sum_{k'=1}^{K'} \lambda_{k,k'} S_{k,k'} \).

The \( \lambda_{k,k'} \) are smoothing parameter that controls the trade-off between fit and smoothness. Notice that overall penalty matrix \( S_\lambda \) is set up so that the elements corresponding to any strictly parametric model component are equal to zero since such term are not penalized. Given value for the \( \lambda_{k,k'} \). This can be achieved by Fisher scoring iterating.

\[ \hat{\theta}^{[a+1]} = \hat{\theta}^{[a]} + (\mathbf{I}[\hat{\theta}] + S_\lambda)^{-1}(g^{[a]} S_\lambda \hat{\theta}^{[a]}) \]  

(5)

Until convergence, here the gradient vector \( g \) is defined by the two subvectors \( g_1 = \frac{\partial \ell}{\partial \theta_1} \) and \( g_2 = \frac{\partial \ell}{\partial \theta_2} \), and a scalar \( g_3 = \frac{\partial \ell}{\partial \theta_3} \), while the Fisher information matrix is given as

\[ \mathbf{I} = -\mathbb{E} \begin{bmatrix} \frac{\partial^2}{\partial \theta_1 \partial \theta_1} & \frac{\partial^2}{\partial \theta_1 \partial \theta_2} & \frac{\partial^2}{\partial \theta_1 \partial \theta_3} \\ \frac{\partial^2}{\partial \theta_2 \partial \theta_1} & \frac{\partial^2}{\partial \theta_2 \partial \theta_2} & \frac{\partial^2}{\partial \theta_2 \partial \theta_3} \\ \frac{\partial^2}{\partial \theta_3 \partial \theta_1} & \frac{\partial^2}{\partial \theta_3 \partial \theta_2} & \frac{\partial^2}{\partial \theta_3 \partial \theta_3} \end{bmatrix} \]

In (5), the \( \lambda_{k,k'} \) are not estimated but fixed to some values. This is because the joint estimation of \( \theta \) and \( \lambda \) via maximization of (4) would lead to very wiggly smooth function estimation since the highest result in severe overfitting, so produce a biased estimate of the parameter of interest \( \beta \). Hence the need to select the \( \lambda_{k,k'} \) using the smoothing selection. Fisher scoring step (5) can be written,

\[ \hat{\theta}^{[a+1]} = (\sum_{i=1}^{n} X_i^T W_i X_i + S_\lambda)^{-1} (\sum_{i=1}^{n} X_i^T W_i z_i) \]  

(6)

Where
The $\lambda_k$ should be selected so that the estimated smooth functions are as close as possible to the true functions. Given an estimate for $\theta$, multiple smoothing parameter selections can be achieved by minimization of a prediction criterion such as the approximate UBRF score.

$$W_i = \begin{bmatrix} \frac{\partial^2 \ell_i}{\partial \eta_{1i}^2} & \frac{\partial^2 \ell_i}{\partial \eta_{1i} \partial \eta_{2i}} & \frac{\partial^2 \ell_i}{\partial \eta_{1i} \partial \eta_{3i}} \\ \frac{\partial^2 \ell_i}{\partial \eta_{2i} \partial \eta_{1i}} & \frac{\partial^2 \ell_i}{\partial \eta_{2i}^2} & \frac{\partial^2 \ell_i}{\partial \eta_{2i} \partial \eta_{3i}} \\ \frac{\partial^2 \ell_i}{\partial \eta_{3i} \partial \eta_{1i}} & \frac{\partial^2 \ell_i}{\partial \eta_{3i} \partial \eta_{2i}} & \frac{\partial^2 \ell_i}{\partial \eta_{3i}^2} \end{bmatrix}$$

The $\lambda_k$ enters (8). The trace of $A$ represents the estimated degrees of freedom or number of effective parameters of the penalized model. $\gamma$ is a tuning parameter which can be increased from its usual value of 1 obtain smoother models, that using $\gamma \approx 1,4$ [1].

4. Testing the Hypothesis of Exogenous Variable

The hypothesis of an exogenous variable can be stated in term of $\rho$, which can be interpreted as the correlation between the unobserved variables in the two equations. If $\rho = 0$ then $\varepsilon_{1i}$ and $\varepsilon_{2i}$ are uncorrelated and hence there is no a problem of endogeneity. On the contrary, $\rho \neq 0$ implies that there is a problem of endogeneity. This leads us to the following hypotheses.

$H_0 : \rho = 0$

$H_1 : \rho \neq 0$

The LM statistic for the semiparametric bivariate probit models is

$$LM = \left\{ \mathbf{g}_{\delta_{h_0}} - \mathbf{S}_{h_0} \delta_{h_0} \right\}^T \mathbf{I}^{-1} \left\{ \mathbf{g}_{\delta_{h_0}} - \mathbf{S}_{h_0} \delta_{h_0} \right\}$$

The LM statistic follows the chi-square distribution, so $H_0$ is rejected if $LM > \chi^2(1, \alpha)$. Under $H_0$ function becomes the sum of the penalized log-likelihood function of two semiparametric univariate probit models. Under $H_1$ simultaneous estimation is required to obtain consistent parameter estimates [4].

5. Conclusion Results and Discussion (Exclusive Breastfeeding Picture)

The data used in this study is the National Socio-Economic Survey (SUSENAS) data with 510 households who have children aged 0-24 months. The descriptive response variable of working mother status shown in Table 1. It suggests that the corresponding frequency and percentage of working mothers and unemployed mothers. The percentage of working mothers is 41 percent and those who do not work as much as 59 percent.

Table 1. Descriptive Table of Response Variables ($Y_1$)

| Category    | Frequency | Percent |
|-------------|-----------|---------|
| No Working  | 303       | 59 %    |
| Working     | 207       | 41%     |
| Total       | 510       | 100%    |
The descriptive response variable of exclusive breastfeeding shown in Table 2. It suggests that the corresponding frequency and percentage of mother who gave exclusive breastfeeding or not. the percentage of children aged 0-24 months who received exclusive breastfeeding as much as 59 percent and who did not receive exclusive breastfeeding 41 percent.

**Table 2.** Descriptive Table of Response Variables (Y2)

| Category                  | Frequency | Percent |
|---------------------------|-----------|---------|
| No Exclusive Breastfeeding| 211       | 41%     |
| Exclusive Breastfeeding   | 299       | 59%     |
| Total                     | 510       | 100%    |

The contingency table between working mother status and exclusive breastfeeding shown in Table 3. working mothers did not give exclusive breastfeeding of 22.75%, greater than working mothers who gave exclusive breastfeeding. This can be said to be still low efforts to improve the nutritional status of children by giving exclusive breastfeeding to working mothers.

**Table 3.** Percentage Table of Working Mother Status and Exclusive Breastfeeding

| Exclusive Breastfeeding | No Exclusive Breastfeeding | Exclusive Breastfeeding | Total |
|-------------------------|----------------------------|-------------------------|-------|
| Working Mother Status   |                           |                         |       |
| No Working              | 18.63                      | 40.78                   | 59.41 |
| Working                 | 22.75                      | 17.84                   | 40.59 |
| Total                   | 41.37                      | 58.63                   | 100   |

Exclusive breastfeeding is an important component in children's health, in this case, the nutritional status of children. Low nutritional status of children can cause children susceptible to disease. The government's effort to reduce child mortality rate in addition to socialization about the importance of exclusive breastfeeding, the government also improve the quality of health services and health service mapping. Other government efforts are to improve people's nutritional status, increase community participation and improve health management. Based on research data, average age and standard deviation of the first marriage of working mothers and unemployed mothers shown in Table 4. It can be seen that the average age of the first marriage of mothers with working status is 16.51 years. While the average age of the first marriage mother with working status is 18.52 years.

**Table 4.** Descriptive Table of Variables of Age at the First Marriage of Mother by Category Working Mother Status

| Status    | Average | Std. Deviation |
|-----------|---------|----------------|
| No working| 18.52   | 7.41           |
| Working   | 16.51   | 8.57           |

Average age and standard deviation of the first marriage of mother who gave exclusive breastfeeding or not shown in Table 5. It can be seen that the average age of the first marriage of mothers giving exclusive breastfeeding is 19.06 years. While the average age of the first marriage of mothers who gave exclusive breastfeeding was 15.78 years.
Table 5. Descriptive Table of Variables of Age at the First Marriage of Mother by Category Exclusive Breastfeeding

| Status                  | Average | Std. Deviation |
|-------------------------|---------|----------------|
| No Exclusive Breastfeeding | 15.78   | 7.94           |
| Exclusive Breastfeeding  | 19.06   | 7.69           |

Number of household characteristics based on working mother status and exclusive breastfeeding on predictor variable are categories shown in Table 6. It can be seen that 69.40 percent of households with father’s job are in agriculture sector exclusively breastfed. For households with 9-year-olds, 69.81 percent of housewives’ status is unemployed and for households with a 9-year-old mother of 74.75 percent providing exclusive breastfeeding. In the education category of the father of 9 years and above 68.36 percent give exclusive breastfeeding.

Table 6. Number of Households by Variable Response and Variable Predictors of that Category

| Working Mother Status | Exclusive Breastfeeding |
|-----------------------|-------------------------|
| No Working            | Working                 |
| Father’s Job          |                         |
| Non-Agriculture       | 57.19                   | 42.81                   |
| Agriculture           | 62.07                   | 37.93                   |
| Mother’s Education    |                         |
| under 9 years         | 69.81                   | 30.19                   |
| above 9 years         | 43.56                   | 56.44                   |
| Father’s Education    |                         |
| under 9 years         | 58.56                   | 41.44                   |
| above 9 years         | 61.02                   | 38.98                   |

6. Semiparametric Bivariate Probit Model

Working mothers status and exclusive breastfeeding is thought to be correlated and there is an endogenous problem. Based on the result of Lagrange Multiplier test, it can be concluded that between working mother status and exclusive breastfeeding there is correlation so that there can be identified an endogenous problem. It can be seen that p-value value is 0.000 (p-value less than α = 10%).

Based on the result of processing, the parameter significance test and smoothing parameter significance test of working mother status shown in Table 7 and Table 8.
**Table 7. Parameter Significance Test at Y<sub>1</sub>**

| Working Status          | Coef  | Std Err | p-value | Information        |
|-------------------------|-------|---------|---------|---------------------|
| Intercept               | -0.521| 0.100   | 0.000   | Significant         |
| Father’s Job (X<sub>2</sub>) | -0.017| 0.116   | 0.881   | Not Significant     |
| Mother’s Education (X<sub>3</sub>) | 0.759 | 0.117   | 0.000   | Significant         |
| Father’s Education (X<sub>4</sub>) | -0.066| 0.121   | 0.587   | Not Significant     |

**Table 8. Significance Test of Smoothing Parameters at Y<sub>1</sub>**

| Working Status          | Edf | Est rank | p-value | Information |
|-------------------------|-----|----------|---------|-------------|
| Age at the first marriage of mother (sX<sub>1</sub>) | 1   | 1        | 0.000   | Significant |

The significant variables in the model based on working mother status are mother’s education (X<sub>3</sub>) and age at the first marriage of mother f<sub>1</sub>(sx<sub>11</sub>). The parameter significance test and smoothing parameter significance test of exclusive breastfeeding shown in Table 9 and Table 10.

**Table 9. Parameter Significance Test at Y<sub>2</sub>**

| Exclusive Breastfeeding | Coef  | Std Err | p-value | Keterangan     |
|-------------------------|-------|---------|---------|----------------|
| Intercept               | 0.415 | 0.093   | 0.000   | Significant    |
| Working Mother Status (Y<sub>1</sub>) | -2.127| 0.102   | 0.000   | Significant    |
| Father’s Job (X<sub>2</sub>) | 0.275 | 0.108   | 0.011   | Significant    |
| Mother’s Education (X<sub>3</sub>) | 1.136 | 0.120   | 0.000   | Significant    |
| Father’s Education (X<sub>4</sub>) | 0.192 | 0.113   | 0.091   | Significant    |

**Table 10. Significance Test of Smoothing Parameters at Y<sub>2</sub>**

| Exclusive Breastfeeding | Edf  | Est rank | p-value | Information |
|-------------------------|------|----------|---------|-------------|
| Age at the first marriage of mother (sX<sub>1</sub>) | 2.03 | 2.456    | 0.091   | Significant |
The significant variables on exclusive breastfeeding were an age at the first marriage of mother $f_1(sx_{1i})$, father’s job ($X_2$), mother’s education ($X_3$), father’s education ($X_4$), and exogenous variables ($Y_1$) ie working mother status. Based on Table 7, Table 8, Table 9 and Table 10 then the semiparametric bivariate probit model are:

\[
y_{1i}^* = -0.521 - 0.017x_{2i} + 0.759x_{3i} - 0.066x_{4i} + f_1(sx_{1i})
\]

\[
y_{2i}^* = 0.415 - 2.127y_{1i} + 0.275x_{2i} + 1.136x_{3i} + 0.192x_{4i} + f_2(sx_{1i})
\]

\[
f_1(sx_{1i}) = 0.3147 - 2.258 e^{-12sx_{1i}}
\]

\[
f_2(sx_{1i}) = 0.486 - 0.311y_{1i} - 0.076 sx_{1i} + 0.001sx_{1i}^2
\]

Based on the above-mentioned semiparametric bivariate probit model, a negative relationship between working mother status and exclusive breastfeeding is produced. So it can be concluded that if the mother works, then the opportunity to give exclusive breastfeeding is getting smaller. Non-linear relationships between predictor variables in the form of quantitative data with response variables shown in Figure 1.

![Figure 1. Smoothing Estimation Function on the Working Mother Status and Exclusive Breastfeeding](image)

The two graphs above show the estimation of the smoothing function for the age at the first marriage of mother at the working mother status and exclusive breastfeeding, with the y-axis being the estimated degree of freedom (edf). Obtained value $\lambda_{11} = 971.676$ and $\lambda_{12} = 5.8447$. The larger the lambda value and the edf value are equal to one, then direct the line of smoothing estimation on a straight line. From the graph above shows a nonlinear effect on exclusive breastfeeding. In the first graph showing the increasing age of a mother’s decision to work smaller. On the second chart starting at the age of 17 years exclusive breastfeeding continues to increase because at this age is the age of the marriage age of a mother.

7. Conclusion

Working mother status and exclusive breastfeeding have correlation so it can be identified problem of endogeneity. Father’s job has a significant effect on working mother status. Mother’s education, father’s education, father’s job and working mother status as an exogenous variable which have a significant effect on exclusive breastfeeding.
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