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The Effect of Residential Location and Housing Unit Characteristics on Labor Force Participation of Childbearing Women in Indonesia: Using Twin Births As A Quasi-Natural Experiment

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Abstract
I empirically investigated the influence of residential location and housing unit characteristics on the labor force participation of childbearing women by applying quasi-experimental methods and taking a developing country's perspective – where the family size tends to grow faster. While the choices of residential location and housing unit characteristics are rarely exogenous, it is important to deal with the endogeneity problem. I use instrumental variable models, with twin births and gender composition as the exogenous sources of variation in the family size, and exploit an enormous micro dataset from the Indonesian Census Population 2010. Previous works of literature have examined the effect of twin birth on the female labor supply, but less attention given to the housing decision. This study provides new evidence of a forward-looking behavior about the residential location and housing consumption due to household size effects and shows that such behavior will most likely influence the female labor supply.

JEL Classification: J01; J21; J22; R21; O18

Keywords
residential location — housing — labor force — childbearing women — twin births

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1. Introduction

The linkage between residential settlement and the supply of labor has become an important topic in the urban literature for last few decades. Both theoretical model and empirical evidence often discuss two important considered aspects of residence: location and housing unit characteristics (e.g. floor space and building materials). People choose to reside in the urban areas because they realize a higher chance for employment, while those who live at the edge or outside the urban areas maximize the economic opportunities by choosing a residential location that gives the minimum travel cost.

In addition, people freely decide what house size required to meet the future needs. For example, to choose a house which is suitable for parents with many children or for the multigenerational families. Putting it into context, the family size will determine the choice of house size. Moreover, in a traditional culture-influenced country like Indonesia, the male spouse generally bears the main responsibility to provide housing and to decide where the family will be living, while other family members will follow. In that sense, the decisions on residential location and housing characteristics are endogenous.

One of the family's future plan is to decide how many children to have within the household. From the author's perspective, such decision making is also endogenous. One presumably argues that the decision of having children is exogenous because people were always having children due to either religion or cultural reasons. Some families were child-free in the past because of the failure of having a child (e.g. fertility problem), not because of the unwillingness to have a child. However, I provide a counter-argument by convincing that the modern societies now have a different situation with the past. There has been an increasing trend of child-free families in recent years, where many spouses decide to have no child at all (OECD, 2011). Thus, the decision on having children is always endogenous for whatsoever reason. Fortunately, there is still a situation in which the decision of having children can be exogenous. It refers to the twin birth event. Parents might be able to decide to have children, but not be able to control the number of children at any birth event. Conditional on the decision to have children, the decision on giving birth to twins is exogenous.

Planning the family's future plan will be more difficult with the presence of the twin children. Obviously, it leads a family to a higher consumption of food and non-food. The presence of twin births even may change the initial family plan in many ways (Grogger & Bronars, 1993; Gunes, 2016; Ou & Reynolds, 2012; Silles, 2016), especially in the developing countries (Li, Zhang, & Zhu, 2008; Rosenzweig & Zhang, 2009). For example, parents decide to stop having children after giving birth to twins because it affects mother's labor supply and earnings (Black, Devereux, & Salvanes, 2007; Braakmann & Wildman, 2016; Gangadharan & Rosenbloom, 1996; Roistacher, 1974; Silles, 2016) and it gives an incentive to working mothers to work closer to home (Lundborg, Plug, & Rasmussen, 2016; Madden,

1981; Vere, 2011).

The parents cannot determine the number of baby boys and baby girls every time the mother delivers the twin births. Suppose that the twins consist of one boy and one girl, then it would imply more demand for bedrooms because it is very common family's behavior – providing separate bedrooms between son and daughter. A higher consumption for the bedrooms leads to a higher demand for the large-sized house, which of the price will depend on the location. Therefore, an increasing housing consumption will push the parents of twins to earn higher income in the long run.

The one-earner households might respond to the increasing consumption by taking following options: (1) The male spouse has to spend more time for working; (2) The male spouse tries to find a new job which offers a higher salary; or (3) the female spouse decides to search for a job. The latter implicitly suggests that a family with twins might behave differently in the labor market in terms of labor supply. That is, the presence of twins may convert the family from one-earner to two-earner household.

Eventually, the parents of twins face a trade-off about housing location decision, as well as house size, and household supply of labor to maximize the household utility. The parents understand that higher salary jobs are available within the cities, but it means that paying a higher price for a smaller house as the land prices increase with the lesser distance to the center of cities. Given such situation, a labor economist would think that the twin children may influence mother's decision to work, while urban economist may argue that the twin children can affect the parents' decision to change the residential location and the housing unit characteristics.

Although many works of economic literature have discussed the linkage between residential location and female labor supply (e.g. Antipova, 2015; Bayer, Ross, & Topa, 2008; Buchinsky, Gotlibovski, & Lifshitz, 2014; Madden, 1980; Madden & Chiu, 1990; Madden & White, 1980; Matas, Raymond, & Roig, 2010; Thompson, 1997), I find none of these literature takes the presence of twin children into account. Therefore, there is a challenge to provide the new evidence – incorporating the exogenous variation of multiple births into the analysis. Not only it brings new insight to explain the behavior of household in the housing market, but also it gives a further understanding of female labor supply.

To fill the research gap, I propose an empirical study which aim is to investigate the relationship between the residential location, housing unit characteristics, and the labor force participation of childbearing women by treating the twin birth as an exogenous instrument. To author's knowledge, this is the first empirical study that examines the relationship between residential location, housing unit characteristics, and the female labor supply from a quasi-natural experiment simultaneously by using a developing country's perspective. Noteworthy, the main research interest here is to investigate the changes of female labor supply due to the housing-related decision, rather than male labor supply because the childbearing women are more likely to face the trade-off between working and caring for children.

Speaking in the developing country's context, I figure the issue very relevant only if taking Indonesia as a study case. Not only because Indonesian women have a quite high fertility rate – approximately 2.4 births per woman at the national level (Mcdonald, 2014), but also because Indonesia is a country with the largest population of Muslims (around 207 million and equal to 24% of the world's Muslims). Moreover, a Muslim woman in Indonesia gives 2.7 births on the average, which is higher than the national level. On top of that, around 83% of twin children in Indonesia comes from the Muslim families. No doubt that Muslim societies have a prominent contribution to the new population bomb in the world (Goldstone, 2010).

The main question is as follows: "*Does the presence of twins cause the families behave differently about the residential location, housing characteristics, and household labor supply decisions?*". In practical, I detail the main question into three sub-questions: (1) "*Are families with twins more likely to live in the urban area?*"; (2) "*Do families with mixed-gender twins tend to live in a larger house?*"; and (3) "*Do childbearing women with twins tend to work or to stay at home?*".

This paper proceeds as follows. In Section 2, I discuss the literature of residential location and the labor supply. I elaborate the literature review by including a discussion of fertility and work decision among childbearing women. I also provide a general review of recent labor studies related to the presence of twins. Section 3 follows with a description of data and estimation strategy. In Section 4, I present and discuss the econometric results. Last, Section 5 gives the conclusion.

2. Literature Review

2.1 Residential location and labor supply

There is a consensus in the urban economic theory that workers vary the residential locations, by assuming a fixed employment location. Based on the circular city model, a worker faces a trade-off between higher commuting cost and lower housing prices at any location (e.g. Dubé, Thériault, & Rosiers, 2013; Giuliano & Small, 1993; Glaeser, Kahn, & Rappaport, 2008; Paleti, Bhat, & Pendyala, 2013; Simpson, 1987; Weinberg, 1979; Yang, Zheng, & Zhu, 2013). The farther from the central business district (CBD), the lower house price and the higher commuting cost are (e.g. Abelson, 1997; Archer et al., 1996; Hsu & Guo, 2006; Kulish et al., 2012; Thibodeau & Basu, 1998). Theoretically, a person chooses a residential location which offers the optimum utility. If the travel time and monetary cost to the workplace are substantial, then making an adjustment about residential location will be a sensible choice. In line with the theoretical model, early empirical studies have shown that the demand distribution for housing is higher in the urban area (Glaeser, Gyourko, & Saks, 2006; Goodman, 1988; Goodman & Kawai, 1982; Green & Hendershott, 1996; Wang & Zhang, 2014).

Besides the measures of distance, there are two other indicators that commonly used in analyzing the choice of residential location: family size and household type. Oi (1976) develops a theoretical model to examine how the family size can determine the household's choice of residential location and thus affect the labor supply. The model shows that families without children tend to have smaller

income elasticities of demand for housing and thus prefer to reside closer to the CBD. By assuming that the employment mostly concentrated at a CBD, it predicts that two-earner households are more likely to live closer to CBD if the female spouse works due to the higher market productivity. Meanwhile, the one-earner household with two-person family prefers to reside farther from the CBD. An empirical evidence by Dickinson (1974) and Roistacher (1974) confirmed these predictions. Both studies utilize the *Michigan Panel Study of Income Dynamic* data and reveal that families with more children tend to live farther from the CBD, given that the income and education are constant.

The household type is also a crucial determinant of residential location. One- and two-earner households behave differently in selecting the residential location due to demographic characteristics such as marital and employment status, and the family size as well (Kohlhase, 2017). Madden (1980) examined the tradeoff between house size and quality of housing at an equilibrium condition by using the US Census 1976 dataset and later found that households with children choose to live in larger houses with fewer other amenities – suggesting that the presence of children affects the housing choices. Despite the commuting cost, the career women with children in two-earner households reside significantly farther to the workplaces. The decision of residential location, housing consumption, and labor supply are interrelated and might vary across gender and household type (Plaut, 2006). However, making a decision of residential location based on the male spouse's job location can disadvantage the female spouse in the labor market (Gimenez-nadal & Molina, 2016; Legault, Patterson, & El-geneidy, 2013; Singell & Lillydahl, 1986). In fact, the married women tend to have a heavy share of household responsibilities, lower wages, and long hours of work (Assadian & Ondrich, 1993; Grönlund & Magnusson, 2013; Lyonette & Crompton, 2015; Wharton & Blair-loy, 2006).

2.2 Fertility and childbearing women's decision to work

There are two theoretical reasons on why it is important to have an understanding of the relationship between fertility and marriage women's decision to work. First, it helps labor economist to explain how the household labor supply would change after the mothers gave childbirths. Second, the changes in female labor supply due to fertility motivates urban economist to analysis what would happen to the household's residential choice, particularly between one- and two-earner households.

Fertility and women's preferences for childbearing have a linkage with the decision to enter the labor market. Empirical evidence from the early literature of female labor supply shows that there is a negative correlation between the number of children and labor supply of married women (e.g. Bronars & Grogger, 1994; Connelly, 1992; Fuchs, 1989; Kalwij, 2000; Nakamura & Nakamura, 1992; Ribar, 1992). More recent studies such as Del et al. (2015) and Cazzola et al. (2016) also confirm similar results. However, these studies treated the number of children and family size as an exogenous variable. To estimate the effect of childbearing on the changes of female labor supply without considering the endogeneity, in turn, will potentially lead to a misleading conclusion.

Several studies have been more aware of the endogeneity issue in examining the effects of the number of children in female employment (see Baranowska-rataj & Matysia, 2016; Gangadharan & Rosenbloom, 1996; Noseleit, 2014). Gangadharan & Rosenbloom (1996) incorporate the exogenous variation of childbirth to estimate the impact of the presence of twins on the mother's decision to work.and found that twin births have caused married women to reduce workdays in the short period, but the magnitude weakened over time. Later, more women enter the labor market and search for jobs. Meanwhile, Noseleit (2014) suggests that women have a higher likelihood of becoming self-employed when additional mixed-sex children are present in the household. Baranowska & Matysia (2016) reveal that there is a negative correlation between the probability of working and the number of children due to the twin births.

As argued by Fuchs (1989), Pagani & Marenzi (2008) and Schult (2014), the main motivation to not participate in the labor force temporarily is due to the familial obligation. Angrist & Evans (1998), Henly & Lyons (2000), Dodson (2013) and Adda et al. (2017) supported this argument. Angrist & Evans (1998) and Adda et al. (2017) suggest that women's level of education reduces the effect of childbearing on the decision to work. The authors also reveal that a high-educated woman is unlikely to leave the labor market permanently for providing child care responsibilities. Perhaps, it is the greater preference for child caring that brings incentive to married women to entirely leave the labor market. A study by Lundborg, Plug, & Rasmussen (2016) supports such rationale after introducing the in-vitro fertilization as a new instrument in IV estimation strategy to examine whether the decision to have children in Denmark has a causal effect on the mother's career. The results indicate that the effect of fertility is large, long lasting, and negatively correlated with labor supply.

2.3 Twin birth as an exogenous instrumental variabel

In the vast majority of labor literature, researchers often use the twin birth as an exogenous source of variation to instrument the family size. The most popular research topic that employs twin birth as an exogenous instrument is the investigation of the relationship between family size and children education outcomes (e.g. Angrist & Lavy, 2010; Aslund & Gronqvist, 2010; Black, Devereux, & Salvanes, 2005; Cáceres-delpiano, 2006; Li et al., 2008; Ponczek & Souza, 2015), after Becker & Lewis (1973) propose a theory of quantity-quality tradeoff[1]. Although the first study that uses twin birth as an instrumental variable for family size conducted by Rosenzweig & Wolpin (1980), the famous work of twin birth studies was provided by Angrist & Evans (1998). The latter made a comparison of estimates using mixed-sex children composition and twins instruments to estimate the effect of childbearing on labor supply. Still, many economists in recent literature prefer to use twin birth than another instrument variable because twin birth is essentially random by nature, unrelated to parental characteristics, and

[1]The theory of quantity-quality tradeoff suggests that an increase in quantity of children forces the parents to decrease the human capital investments per child.

thus can be used to distinguish causation from correlation (Aslund & Gronqvist, 2010; Black et al., 2005).

The second most prevalent topic among twin birth studies is the investigation of the causal relationship between the number of children and household labor supply, particularly the female labor force participation (e.g. Aguero & Marks, 2011; Angrist & Evans, 1998; Silles, 2016). Many pieces of urban literature discussed the relation between family size and the residential location, but the presence of twins has received less attention. The only evidence provided by Willemsen, Posthuma, & Boomsma (2005) who examined the degree of residential area urbanization among twins in the Dutch population. Yet, the analysis focuses on adult married twins.

3. Data and Estimation Methods

3.1 Data sources

I utilize microdata from two sources. First is the Indonesian Population Census 2010. The dataset contains complex demographic information such as individual characteristics, family composition, mortality, and employment status. Also, it provides information related to the housing unit characteristics. A full data set of the Indonesian Population Census 2010 consists of 237,641,326 individuals and 60,552,541 households, spreading over 33 provinces with more than 500 districts (*Kabupaten*) and municipalities (*Kota*). Due to its size, the Census data offers more flexibility in making sample selection. Ponczek & Souza (2015) also suggest using the Census dataset because the twin birth is a rare event, and thus we need a large sample size to obtain a sufficient number of observations of twins.

The second data set is the Indonesia Village Potential Survey. It contains information about the characteristics of villages (*Desa*), i.e. spatial and topography, economic activities, land use, environment, population, crimes, and social capitals. The number of observations in the dataset reaches 65.000 villages which roughly cover 98% of the total villages in Indonesia. Unlike the Census, the village survey collects the data for every three years. For the study purpose, I select the Village Potential Survey 2011 due to its closeness to the year of Indonesian Population Census 2010. By combining these, a rich and powerful dataset will be available for the study. Despite its advantages, the large size dataset sometimes can be problematic. Estimation with large dataset requires a very high-performance computing machine. Given such limitation, a sample selection thus required. Otherwise, the estimation will be very time-consuming.

3.2 Sample selection

To make the estimation of hundred million observations with a limited computing machineability become more convenient in the process, I draw a one percent random sample of the total population. The first step is to divide the households into two groups: families with and without twins. I fully use the former and randomly draw one percent sample from the latter, then combine both into one group afterward. The second step is to merge the combined Census sample with the village survey dataset to add more information about neighborhood characteristics. Additionally, some restrictions on the Census sample data are needed as follows:

1. **Parents must be in the productive age.**
   The productive age of Indonesian people ranges between 15-64 years old. People legally start working at 15 years old and completely retire at 65 years old. Since age variable is always exogenous, we can always justify any age-based selection. For a validity check, it is possible to use a few different age intervals for further analysis. For example, excluding a small proportion of households whose male spouse's age under 18 years old. In such case, we cannot fully trust the data because, according to the Indonesia marriage law, a marriage can only be formally registered until the spouses have reached 18 years old. Moreover, in the practical sense, many Indonesian youths at 18-23 years old are still not available for work because they are continuing the education to a higher level such as an academy and university. It is also plausible to set a maximum limit for female spouse's age at 40 because average Indonesian women usually stop giving natural birth beyond this age.
2. **Children must be in the nonproductive age.**
   The unproductive ages of children range between 0-15 years old. The six years old children must present in the primary education and attend nine years compulsory education due to the Indonesian National Policies for Education mandates. However, in some underdeveloped provinces, children might work after school (e.g. children of farmers). Including such observations will potentially lead to an overestimated result. If the children work, it is irrational to think that mothers would face a trade-off between working and providing home-based parental child care.
3. **Children and the parents live in the same house.**
   It is important to assure that children were permanently living in the same house with the biological parents at the time of the survey held. Otherwise, the presence of twin children will not influence the parental decision on residential location and house size and hence the labor supply.
4. **Polygamous families are excluded.**
   There is a possibility that a husband has more than one female spouse. In that case, the presence of twin children could influence the mother's working status (i.e. the first wife), but it would have no effect on the second wife. Thus, to include polygamous families could lead to an overestimated result unless we identify the natural mother of twins. Unfortunately, there is no information available to do such process.
5. **No unemployed male spouse within the household.**
   Since the main interest of research is to focus on the labor supply behavior of childbearing women, the unemployed male spouses are not included in the analysis. This selection step convinces us that there is no correlation between female spouse's work decision and father's status of employment.
6. **A family must have at least three children.**
   The sequence of twin birth events can be exogenous. For example, in a family of three children, we consider whether the eldest or the youngest child who

has a twin sibling. Suppose that the first birth produces the twins and the parents decide to have one additional child, thus the first twin birth becomes no matter regardless the next childbirth results other twins. If the parents have more than two children and the last two children are twins, however, then the parents are more likely to accustom the family program. Therefore, it is more interesting to incorporate the exogenous variation of the last childbirth into the analysis. We might assume that parents are more likely to change the labor supply once they obtain twins in the last childbirth. We may also take the gender variation of twins into account. For general purpose, I only use households with an employed male spouse who has more than two children.

3.3 Estimation strategy

3.3.1 Discrete choice model

I define the childbearing woman's decision to work (W) as a function of residential preferences – can be the location or unit characteristics (RP), the number of children (CD), mother's age (AG), parents' education (ED), and religion (RG). It is important to control the mother's age because the probability of having twins increases with the mother's age (Aslund & Gronqvist, 2010). I also control the parents' education because it might affect the attitude toward the children (e.g. highly educated parents set a higher standard of living for the family). Finally, the religion might influence female employment decisions because different religions specify different lifestyles (Amin & Alam, 2008). Because I also examine the effect of housing size, I define a similar function and replace the residential location with the house size (HS). Therefore, I write these two theoretical relationships in separate equation forms as follows:

$$W = f(RP, CD, AG, ED, RG) \tag{1a}$$

$$W = f(HS, CD, AG, ED, RG) \tag{1b}$$

By definition, W is a binary dependent variable. Therefore, the discrete regression technique is required to estimate the empirical model. Considering the number of observations, the Logit model is preferred because the assumption of the cumulative standard logistic distribution can affect the speed of computation (Maddala, 1987; Sellar, Chavas, & Stoll, 1986). The Logit models for estimating Eq. (1a) and (1b) are as follows:

$$P(W = 1|RP, CD, AG, ED, RG) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 . RP + \beta_2 . AG + \beta_3 . ED + \beta_4 . CD + \beta_5 . RG)}} \tag{2a}$$

$$P(W = 1|HS, CD, AG, ED, RG) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 . RP + \beta_2 . AG + \beta_3 . ED + \beta_4 . CD + \beta_5 . RG)}} \tag{2b}$$

The presence of endogenous regressors in the Eq. (2a) and (2b) cause a problematic issue in the estimation process (Griliches, 1977). The residential location and housing size are more likely endogenous (e.g. Madden, 1980; Simpson, 1987). The choice of residential location and housing unit characteristics may have a significant correlation with the error term and other exogenous regressors. For example, the house size positively depends on the number of children (e.g. Goodman, 1988; Lee & Trost, 1978; Quigley, 1976). Therefore, I employ a general IV regression model with an exogenous instrument Z.

3.3.2 IV-2SLS model

As mentioned earlier, the number of children is an endogenous variable because the spouses decide to or not to have a child. Also, the parents manage the time and frequency of giving birth. Thus, the number of children may be not an appropriate instrumental variable. Nevertheless, we can utilize the exogenous variation of the childbirth event. For example, to determine whether or not the mother had twin births at either first- or last birth event. I develop such instruments further by introducing the gender variation of twins.

For the first stage, I estimate the choice for residential location and house size by household i. The residential location ($HLOC$), as well as the house size ($HSIZE$), is regressed on the variation of twin births ($TWINS$) and gender ($MIXTWIN$). I also add age variable (AG) as controls, while vi denotes an error term. To control for unobserved heterogeneity, we add M dummies F_n for family attributes (i.e. number of children and parents' background in education and religion), where $m = 1, \ldots, M$. Thus, my specification models are as follows:

$$HLOC_i = \pi_0 + \pi_1 TWINS_i + \pi_2 MIXTWIN_i + \sum_{m=1}^{M} \gamma_{2+m} F_{ni} + \delta_{2m+r} AG_i + v_i \tag{3}$$

$$HSIZE_i = \omega_0 + \omega_1 TWINS_i + \omega_2 MIXTWIN_i + \sum_{m=1}^{M} \gamma_{2+m} F_{mi} + \delta_{2m+n} AG_{ni} + v_i \tag{4}$$

For Eq. (3) and (4), it should be noted that using 'mixed-gender twins' is preferred than 'mixed-gender children' due to two advantages. First, 'mixed-gender twins' is more exogenous than 'mixed-gender children' because it is virtually randomly assigned. Although the parents cannot fully control the gender of a child at any birth event, the parents can expect a higher probability of having mixed gender children by giving more birth events (see Aslund & Gronqvist, 2010; Butcher & Case, 1994). Suppose that the female spouse decides to have four children with a different sex combination. Statistically, the probability of having children with different gender at the second birth event is 0.5. It then increases to 0.75 at the third birth event and 0.875 at the last birth event. Such behavior makes the 'mixed-gender children' variable becomes less exogenous. In contrast, the parents cannot apply the same behavior to influence the probability of having mixed-gender twins at any birth event.

Secondly, the presence of mixed-gender twins allows the parents to obtain many children with different sex in a single time. Due to its instantaneous outcome, it is plausible to expect the parents to adjust the behavior in terms of the residential location and housing size in a shorter length of time, compare to the case of mixed-gender children which resulted from a few of single births. Consequently, we can capture the effect of children in a more convincing way.

Thirdly, the presence of mixed-gender twins allows us to avoid a potential bias in the IV estimates. There is a possibility that the parents have a preference for gender because of cultural reasons. Suppose that the parents want to have one baby girl at the minimum. It encourages the female spouse to give another childbirth if not satisfied with the latest attempt, which in turn, increase the family size (Aslund & Gronqvist, 2010). Consequently, our IV estimates are no longer unbiased.

In the second stage, I identify households with and without the employed female spouse. Two-earner households have value equal to one. Otherwise, the value is zero. Finally, I regress the female spouse's decision to work on the predicted residential location or housing size, where α, β, γ, δ are parameters to be estimated. Meanwhile, u_i denotes an error term:

$$W_i = \alpha_0 + \alpha_1 \widehat{HLOC_i} + \sum_{m=1}^{M} \gamma_{1+m} F_{mi} + \delta_{2m+1} AG_{mi} + u_i \quad (5)$$

$$W_i = \beta_0 + \beta_1 \widehat{HSIZE_i} + \sum_{m=1}^{M} \gamma_{1+m} F_{mi} + \delta_{2m+1} AG_{mi} + u_i \quad (6)$$

3.3.3 IV-Probit model

Besides the IV-2SLS technique, we may also use the alternative regression model, i.e. IV-Probit. Lewbel, Dong, & Yang (2012) suggested using the technique when we have binary dependent variable and continuous endogenous regressors. The IV-Probit uses general maximum likelihood estimation by default. However, it cannot estimate a model with binary endogenous regressor. This because IV-Probit is a control function estimator, not an IV estimator. A control function estimator is similar to the first stage in the IV-2SLS, which apply the error from as an additional regressor in the second-stage model (Wooldridge, 2015).

Noteworthy, the control function methods require continuous endogenous regressors, instead of binary or censored (Dong & Lewbel, 2015). Otherwise, it violates the necessary assumptions to derive estimates of the error term in the first-stage and lead the estimator becomes inconsistent. Both Dong & Lewbel (2015) and Lewbel et al. (2012) suggest using the special-regression in the case of the binary choice model with a binary endogenous regressor. By using such method, we assume the model inserts a particular "special-regressor" V, which is exogenous and emerge cumulatively in the model. The distribution of V is necessarily continuous within the large-sized observations. It often has thick tails, indicates a greater kurtosis. The special-regression method is better than the linear probability model (either OLS or IV) and maximum likelihood method.

4. Estimation Results

4.1 Family structure, residential location, and housing size

To motivate the empirical work, Table 2 reports the residential location and housing size among four groups of households based on the family structures. It shows that 49% of total 391,445 selection-based households live in urban areas, while only around 48% of these urban families are one-earner families. As the number of children increases, there are fewer families live in urban. There are 176,731 twin-children families in total, but only 31% are two-earner households. In these two-earner families of twins, only 18% are living in urban area. The table also shows a substantial difference of in the average for housing size among four groups. On average, regardless the type of households, the urban families always have smaller house size than those who reside in rural. Compare to the one-earner, a two-earner family in urban and rural have 1.12 and 1.03 times larger house respectively. The house size of twin children family is about 1.13 times as large as the house of no-twins family. Twin children families in rural have housing 1.33 times as spacious as the same type family in urban. In the urban area, the average house size of the two-earner family with twins is 1.12 times as large as the one-earner family with twins. Meanwhile, in the rural area, the average house size of the two-earner family with twins is only 1.02 times as big as the one-earner family with twins. It implicitly shows that converting from two-earner to one-earner does not matter when a family of twins decided to relocate to rural.

Table 3 presents the average distance from housing location to several proximities in urban and rural. In urban, the one-earner households live about 1.06 times as far as two-earners to the city center and live about 0.98 times as distant as two-earner in rural. It suggests that one-earner households tend to reside to rural, however, still try avoiding higher commuting cost when the housing location is getting farther. The similar pattern apparently applies for twin children families, regardless the number of the household earner. Compare to the two-earner family, a one-earner with twins in urban lives farther to the city center (15.43 km), but live closer once the households reside to rural (41.38 km).

The similar pattern apparently applies for twin children families, regardless the number of the household earner. Compare to the two-earner family, a one-earner with twins in urban lives farther to the city center (averaged 15.43 km), but live closer once the households reside to rural (averaged 41.38 km). Additionally, all four types of households in urban seemingly live in the similar distance to the primary and the secondary schools because schools are more available in urban areas. Interestingly, the rural households live closer to the primary school but farther to the high schools. One plausible explanation for such pattern is because the rural area has a poor spatial distribution of high schools. The presence of twin children, as well as the gender variation of twins, may cause families to adjust the choices of high-quality floor material usage. Table 4 provides the share of four types households that use high-quality floor material, given the exogenous variation of childbirth.

Without twins, the shares of urban and rural families who use high-quality floor material tend to be similar at around 48%. The shares increase for the families with mixed-gender children (approximately 51%). The increasing usage of high-quality floor material is reasonable because the parents with mixed-gender children (but not twins) can determine the appropriate time to have an additional bedroom. Because the parents of twins cannot freely set

Table 1. Descriptive Statistics

Variables	Mean	S.D	Min	Max
Urban residential area	0.517	0.500	0	1
Twin children	0.773	0.419	0	1
Mixed-gender twins	0.149	0.356	0	1
First child a twin	0.173	0.378	0	1
First child a mixed-gender twin	0.033	0.179	0	1
Last child a twin	0.480	0.500	0	1
Last child a mixed-gender twin	0.095	0.293	0	1
Husband's highest education	3.209	1.364	1	6
Wife's highest education	3.063	1.295	1	6
Age of husband	38.599	6.030	18	64
Age of wife	34.183	5.252	17	64
Family's religion	1.298	0.750	1	6
Number of children	3.657	0.941	3	11
Distance to City Centre (in km)	28.898	48.628	0.1	1315
Distance to stores (in km)	9.036	19.439	0.1	998
Distance to traditional market (in km)	5.330	13.645	0.1	998
Distance to hospital (in km)	17.873	26.311	0.1	998
Average distance to primary school (in km)	1.108	2.788	0.1	99.9
Average distance to junior high school (in km)	2.109	6.055	0.1	435
Average distance to senior high school (in km)	4.794	11.002	0.1	998
Population Density (people per km2)	2610.616	6085.249	1.008335	50628.19
Above sea level (in m)	210.948	348.813	0	5000
House size (in m2)	104.685	55.921	18	996
Floor Quality	0.421	0.494	0	1
Housemaid	0.025	0.156	0	1
Grandparents	0.097	0.297	0	1
Work wife	0.413	0.492	0	1
Number of observations (households)		159,934		

Table 2. Type of households, family size, residential location, and housing size

	One-earner household		Two-earner household	
	With twins	Without twins	With twins	Without twins
Living in urban area (total households)				
1 child	-	29,732	-	16,066
2 children	18,326	27,869	10,575	14,617
3 children	26,536	9,759	13,390	4,420
4 children	12,625	2,266	5,294	908
> 4 children	4,970	645	1,896	239
Living in rural area (total households)				
1 child	-	23,232	-	25,576
2 children	11,951	19,243	13,365	20,762
3 children	16,205	6,688	16,179	7,114
4 children	7,803	1,921	8,183	2,280
> 4 children	4,291	678	4,831	813
Average house size in urban (m^2)				
1 child	-	69.48	-	79.89
2 children	82.44	78.46	93.71	89.21
3 children	88.9	83.95	100.34	93.67
4 children	91.66	80.99	103.32	100.04
> 4 children	92.34	92.79	111.77	97.85
All urban households	87.63	75.54	98.52	85.89
Average house size in rural (m^2)				
1 child	-	103.6	-	109.91
2 children	123.4	107.12	129.19	110.23
3 children	120.01	106.47	123.32	107.19
4 children	117.09	106.28	117.06	102.07
> 4 children	125.92	132.92	111.92	109.6
All rural households	120.05	105.4	122.8	109.24

Source: *Indonesia Population Census 2010*

the time to have an additional bedroom and knowing that instantly purchasing a housing with high-quality floor material will be very costly, thus the households will adjust to having a larger house but with medium- or low-quality floor material. For example, the share of high-quality floor material usage among urban families with twins decreases from 80% to 19% once the parents get mixed-gender twins.

4.2 Fertility, childcaring duty, and mother's decision to work

Table 5 provides the average number of children that the childbearing women have based on the unemployment status. The average number of children prominently increases with the mother's age since 24 years old, but then becomes slowly when the age reaches 40 years old. It, indeed, shows the marginal diminishing of woman's fertility (illustrated

Table 3. Type of households and proximities of residential location

Proximity	One-earner household		Two-earner household	
	With twins	Without twins	With twins	Without twins
Average distance in urban (kilometres)				
To the city centre	15.43	14.87	14.68	13.93
To the stores	2.20	2.18	2.19	2.18
To the traditional market	2.05	2.10	1.95	2.01
To the hospital	6.09	6.44	6.25	6.66
To the primary school	1.00	1.00	1.01	1.01
To the junior high school	1.19	1.20	1.23	1.25
To the senior high school	1.70	1.76	1.84	1.91
Average distance in rural (kilometres)				
To the city centre	41.38	42.23	42.53	43.20
To the stores	12.74	12.33	16.50	15.57
To the market	7.50	7.47	8.81	8.53
To the hospital	27.48	28.21	30.39	8.81
To the primary school	1.05	1.05	1.31	1.30
To the junior high school	2.41	2.36	3.42	3.26
To the senior high school	6.76	6.79	8.65	8.51

Notes: All proximities are measured in kilometres

Table 4. The share of high quality floor material usage by type of household

Type of household	Without twins			With twins		
	Same sex	Mixed sex	Total	Same sex	Mixed sex	Total
Urban two-earner	49.00%	51.00%	9,741	80.40%	19.60%	7,372
Urban one-earner	48.70%	51.30%	17,682	81.00%	19.00%	11,916
Rural two-earner	48.70%	51.30%	5,447	81.00%	19.00%	3,757
Rural one-earner	48.50%	51.50%	5,576	82.30%	17.70%	3,591

Notes: All households consist of two children

by Figure 1). As expected, women with twins tend to have more children on average. Moreover, women who reside in rural have more children than those who live in urban. Due to having fewer children, the childbearing women in urban are more likely to work. It indicates that trade-off between working and providing childcaring exists.

The selection-based data shows that, on average, the women's employment rates in urban and rural are 34% and 52% respectively. In rural, the employment rate is higher because women whose family live in rural and work in the agriculture sector are less likely to stay at home. In Indonesia, it is a traditional cultural behavior for a wife to assist the husband who works as a farmer (Panjaitan-Drioadisuryo & Cloud, 1999).

Having many children can influence mother's decision to work, but the presence of twins can even result in a bigger impact. Table 6 shows how the twin birth can alter the employment rate of childbearing women, which categorized into three age-based groups. Assuming that a family has four children, the table reveals that the impact of twin birth can be different, depends on residential location and the age.

In rural, the presence of twin children reduces the share of employed women by 3.0–4.6%. If the women get twins at the first-birth, then the women's employment rate is lower by 1.2–5.5%. While the twins at the last birth only reduce the employment rate by 1.4–2.3%. This fact presumably suggests that twins from the first birth have a stronger effect on women's decision to work. Contrast with the rural, the share of employed women in urban increase due to the twins. The mother of twins who aged between 30 and 34 only have 0.9–2.1% higher employment rate, while the employment rate of those who aged between 35 and 39 is 2.6–2.8% higher. Interestingly, a lower employment rate occurred to women who aged between 24 and 29. These differences suggest that the opportunity cost of not working because of twin birth is higher for older women, especially if the family remain to live in urban. The childbearing women often face a trade-off between working and childcaring. Going to work means sacrifice some proportion of leisure time which can be allocated for child care activities and thus increase the utility. Meanwhile, providing parental child care service will reduce the allocation of working hours and lead to a lower productivity and earnings as well. However, the final decision depends on the net benefit of providing child care at home.

Given that the mother wants a home-based child care, therefore, it is sensible for working parents to hire a housemaid to stay at home to provide the child care service. Alternatively, the parents can demand the grandparents to live within the household and carrying child care responsibilities during the working hours. About 7.3% and 8.9% of urban and rural families live with the grandparents respectively. In some circumstances, it often applies to parents who cannot afford a housemaid service (e.g. high wages, limited supply, unmatched quality, etc.). From the sample dataset, there is only 3% and 0.3% of urban and rural households that use the housemaid services respectively. Using the similar family size, Table 7 reports the average employment rate of childbearing women who perform the child care duties by self-providing, assisted by grandparents and assisted by the housemaid.

It shows that the childbearing women who perform child care without assistance would have lower employment rate. Furthermore, the rate of employment among childbearing women revives to a higher level after grandparents or housemaid assists the mothers to carry the child care duties. Additionally, it suggests that the presence of housemaid within

Table 5. The average number of children among childbearing women by type of household

Childbearing women	One-earner households		Two-earner household	
	Without twins	With twins	Without twins	With twins
Living in urban				
24–29 years old	1.54	2.72	1.40	2.54
30–34 years old	2.03	3.22	1.84	2.97
35–39 years old	2.22	3.39	2.07	3.19
Living in rural				
24–29 years old	1.63	2.85	1.60	2.85
30–34 years old	2.11	3.37	2.04	3.29
35–39 years old	2.24	3.54	2.13	3.43

Source: *Indonesia Population Census 2010*

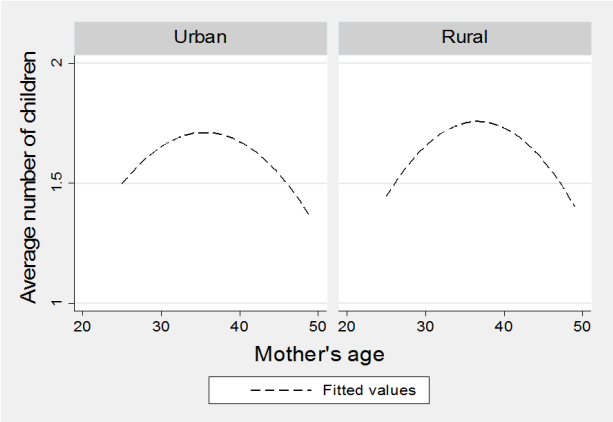

Figure 1. The relationship between mother's age and average number of children

Table 6. The average share of employed women with four children by residential location (in %)

Woman's age	Without twins	With twins		
		At least have twins	First-child twin	Last-child twin
Living in urban				
24–29 years old	24.4	18.4	18.1	20.2
30–34 years old	23.2	24.4	24.1	25.3
35–39 years old	30.2	32.8	32.8	33.0
Living in rural				
24–29 years old	50.3	46.9	45.7	51.4
30–34 years old	52.9	48.3	47.4	50.6
35–39 years old	54.8	51.8	51.3	53.4

Source: *Indonesia Population Census 2010*

Table 7. The average share of employed women with four children by child care provider (in %)

Woman's age	Not assisted	Assisted by grandparents	Assisted by housemaid	Assisted by grandparents and housemaid
All households				
24–29 years old	36.7	43.7	50.4	50.0
30–34 years old	41.1	49.2	56.7	61.1
35–39 years old	44.8	53.7	58.8	65.3
Twin children households				
24–29 years old	34.6	39.9	46.8	50.0
30–34 years old	39.3	47.3	53.7	55.7
35–39 years old	43.5	51.9	57.0	60.2

Source: *Indonesia Population Census 2010*

the household has a stronger effect than the grandparents in supporting the childbearing women's career. A family with more children has a higher probability of hiring a housemaid (illustrated by Figure 2). The last three rows in Table 7 confirms there is also a similar pattern within the twin-children families.

4.3 First-stage results

4.3.1 Twin children and residential location

Table 8 presents the results of regressions based on equation (3) with four specifications. In the first two specifications, I use the linear probability model of residential location on the exogenous variation of multiple births, with the addition of dummy explanatory variables. For the last two specifications, I use logistic probability model and provide the marginal effect of each regressor. I use two different measures to identify the exogenous variation of multiple births, that is, whether or not: (1) the family has twins and (2) the family obtained twins at the last birth event.

The reason to include the sequence of twin birth is because there is an expectation that the parents whose last child is a twin would behave differently than those whose

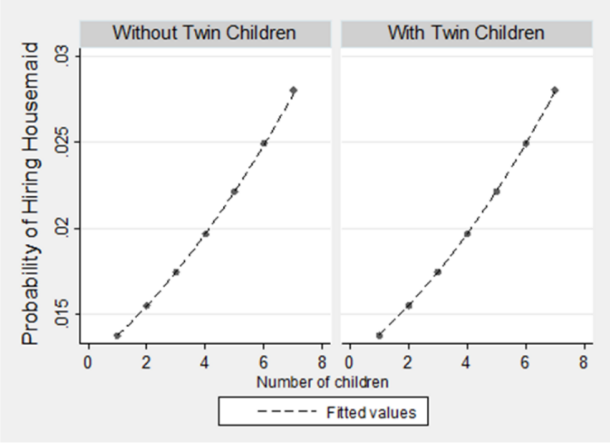

Figure 2. The marginal probability of hiring housemaid for one unit additional child

first child is a twin. That is, the presence of twins at the first birth event does not necessarily mean there is no additional childbirth in the future. Getting female twins at the first birth event will not stop the mother to give another childbirth if the parents prefer to have one boy at the minimum. Intuitively, the last birth twins probably indicate the parents relatively have many children at the end. Also, I expect the presence of twins at the last birth event will have a lower impact on the probability of living in the urban residential area. Consequently, it is important to take the gender variation of the twins for each category into account.

Both linear and logistic probability model produce similar coefficient estimates. The estimated coefficient of twin children is 0.021. The presence of twins is significant and positively correlated with the urban residential area, as expected. It confirms the initial prediction that a family with twins is more likely to live in the urban areas. Surprisingly, the effect of gender variation of twins appears in the opposite direction. The estimated coefficient of mixed gender twins is -0.014. The presence of twin children may have encouraged the parents to live in urban areas, but the opposite gender twins will reduce such possibility. Although the results in all columns are consistently showing the direction of correlation between twin children and the urban residential location, the net effect of twin children has a different sign after taking the gender and the sequence of the birth event into account.

Column (2) and Column (4) demonstrate that the net effect of the presence of mixed-gender twins at the last birth event has a negative value. Perhaps, the net effect reflects the behavior of the parents with twin children in the short- and long-run. If the parents obtain mixed-gender twins, then the households are more likely to live in the rural areas. Still, the parents cannot easily relocate to a new location in the short run (i.e. move to the rural area immediately after the mother give births to twins). As a matter of fact, the parents might temporarily live in the urban area until they are ready to adapt and finally decide to move to the rural area. Possibly, the reason for relocation is because the households with mixed-gender twins require living in a larger house, while the large houses are more affordable if located in the rural area. To support such future looking-based explanation, I compare the estimation results between the first- and last birth event among the twin children families. Table 9 provides the results, where the first- and last two columns provide the results of linear and logistic probability model respectively. It shows that the net effect of twins is only positive at the first birth attempt.

To test the mixed gender-based explanation, I regress the residential location on the gender composition of children. Suppose that we only observe all families that have four children and none of children are twins. If sex matters, then a combination of gender should have a significant correlation with the residential location. The first and the second column in Table 10 provide the results of linear and logistic probability model respectively. It shows that a family is more likely to live in the rural area when same-sex children do not appear, regardless the children are twins. The estimates are significant for any combination of boys and daughters. Both linear and logistic regression model have similar marginal effects. Intuitively, the results in Table 8, Table 9, and Table 10 have confirmed the future-looking behavior of parents with twin children regarding the residential location.

One could argue that the selection on women' age can affect the expectation of giving childbirth and hence the number of children. Due to the fertility, it is sensible to expect that women aged above 15 will have more children than women aged above 23 years old. Women aged above 40 tend to stop giving childbirth. In such case, using smaller age range will reduce the expectation of having children. In Table 11, I replicate specifications which used in Table 8 but exclude families whose mothers aged between 24 and 40 years old. The first- and last two columns indicate the linear and logistic probability model respectively. The new sample selection gives similar coefficient values with the previous results, but slightly higher estimates. The estimated coefficient of twins increases from 0.021 to 0.023. These results emphasize that the sample-selection whose parental age range of 15–64 is not different too much with age range of 25–64 years old.

The results of Table 8 not only show that twin children have positive correlation but also confirm that the number of children has a negative correlation with the urban residential area. These facts underline a justification that the effect of twin children is not always similar to the effect of the number of children.

Besides the dummy for the urban residential area, I also

Table 8. The marginal effect of twin births on the residential location

Dependent variable: Urban residential area	(1)	(2)	(3)	(4)
Twin children	0.021*		0.021*	
	(0.002)		(0.002)	
Mixed gender twins	-0.014*		-0.014*	
	(0.003)		(0.003)	
Last child: twins		0.008*		0.007*
		(0.002)		(0.002)
Last child: mixed gender twins		-0.010*		-0.010*
		(0.004)		(0.004)
Age of wife	0.025*	0.024*	0.024*	0.024*
	(0.001)	(0.001)	(0.001)	(0.001)
Age of wife sq.	-0.000*	-0.000*	-0.000*	-0.000*
	(2.10-5)	(2.10-5)	(2.10-5)	(2.10-5)
Husband's education dummies (5)	Yes	Yes	Yes	Yes
Wife's education dummies (5)	Yes	Yes	Yes	Yes
Religion dummies (5)	Yes	Yes	Yes	Yes
Num. of children dummies (9)	Yes	Yes	Yes	Yes
Observations	159934	159934	159934	159934
R^2 *(Pseudo* R^2*)*	0.198	0.198	(0.154)	(0.154)

Notes: robust standard error in parentheses. *** p<0.10, ** p<0.05, * p<0.010

Table 9. The marginal effect of twin births on the residential location by the sequence of birth

Dependent variable: Urban residential area	(1)	(2)	(3)	(4)
First child: twins	0.014*		0.014*	
	(0.003)		(0.003)	
First child: mixed gender twins	-0.011***		-0.011***	
	(0.006)		(0.006)	
Last child: twins		0.007*		0.007*
		(0.002)		(0.002)
Last child: mixed gender twins		-0.010*		-0.010*
		(0.004)		(0.004)
Age of wife	0.0242*	0.024*	0.0242*	0.024*
	(0.001)	(0.001)	(0.001)	(0.001)
Age of wife sq.	3.10-4*	3.10-4*	3.10-4*	3.10-4*
	(2.10-5)	(2.10-5)	(2.10-5)	(2.10-5)
Husband's education dummies (5)	Yes	Yes	Yes	Yes
Wife's education dummies (5)	Yes	Yes	Yes	Yes
Religion dummies (5)	Yes	Yes	Yes	Yes
Num. of children dummies (9)	Yes	Yes	Yes	Yes
Observations	159934	159934	159934	159934
R^2 *(Pseudo* R^2*)*	0.198	0.198	(0.154)	(0.154)

Notes: robust standard error in parentheses. *** p<0.10, ** p<0.05, * p<0.010

Table 10. The effect of gender composition of non-twin children on the residential location

Dependent variable:	(1)		(2)	
Urban residential area	Coeff.	S.E	Coeff.	S.E
Gender variation of children				
1 boy, 3 girls	-0.018***	(0.010)	-0.018***	(0.010)
2 boys, 2 girls	-0.033*	(0.010)	-0.032*	(0.010)
3 boys, 1 girls	-0.029*	(0.010)	-0.028*	(0.010)
4 boys, no girls	0.001	(0.010)	0.001	(0.010)
Husband's education dummies (5)	Yes		Yes	
Wife's education dummies (5)	Yes		Yes	
Religion dummies (5)	Yes		Yes	
Observations	41280		41280	
R^2 *(Pseudo* R^2*)*	0.0010		(0.0010)	

Notes: the observations are non-twins families with four children.
robust standard error in parentheses
Significance level: *** p<0.10, ** p<0.05, * p<0.010

employ other variables, such as distance to the city center and population density as proxies to identify the residential location. The estimation results are given in Table 12 and Table 13 respectively. I find a negative correlation between 'twin children' and the distance to city center, but a positive correlation with the population density. Given that the urban area is more densely populated and closer to the city center, these results amplify suggestion that a family with twins wants to live in the urban area.

The distance to the city center positively correlated with

Table 11. The marginal effect of twin births on the residential location

Dependent variable: Urban residential area	(1)	(2)	(3)	(4)
Twin children	0.023*		0.023*	
	(0.002)		(0.002)	
Mixed gender twins	-0.012*		-0.012*	
	(0.003)		(0.003)	
Last child: twins		0.006**		0.007*
		(0.002)		(0.002)
Last child: mixed gender twins		-0.009**		-0.009**
		(0.004)		(0.004)
Husband's education dummies (5)	Yes	Yes	Yes	Yes
Wife's education dummies (5)	Yes	Yes	Yes	Yes
Religion dummies (5)	Yes	Yes	Yes	Yes
Num. of children dummies (9)	Yes	Yes	Yes	Yes
Observations	140311	140311	140311	140311
R^2 *(Pseudo* R^2*)*	0.192	0.191	(0.149)	(0.148)

Notes: the observations are only families whose wife aged 24–40 years old.
robust standard error in parentheses
Significance level: *** p<0.10, ** p<0.05, * p<0.010

Table 12. The marginal effect of twin births on the distance to city center from residential location

Dependent variable:	(1)		(2)	
Ln Distance to City Center	Coeff.	S.E	Coeff.	S.E
Twin children	-0.089*	(0.01)		
Mixed gender twins	0.021**	(0.01)		
Last child: twins			-0.036*	(0.01)
Last child: mixed gender twins			0.025**	(0.01)
Number of children:				
4 children	0.019**	(0.01)	0.009	(0.01)
5 children	0.0891*	(0.01)	0.073*	(0.01)
6 children	0.220*	(0.02)	0.201*	(0.02)
7 children	0.281*	(0.04)	0.257*	(0.04)
8 children	0.388*	(0.01)	0.365*	(0.01)
Husband's education dummies (5)	Yes		Yes	
Wife's education dummies (5)	Yes		Yes	
Religion dummies (5)	Yes		Yes	
Observations	159934		159934	
R^2	0.002		0.001	

Notes: robust standard error in parentheses. *** p<0.10, ** p<0.05, * p<0.010

the gender variation of twins. A family with twins tends to live at an average distance 8.9% closer to the city center than those without the twins. Meanwhile, the average distance from the residential location of families with twins to the city center increases by 2.1% when taking the sex into account. Also, the results show that the increasing number of children will lead a family to live at a longer distance of residential location to the city center.

The population density positively correlated with the gender variation of twins. A family with twins tends to live in cities which are 35.2% more populated than those without the twins. Meanwhile, a family with twins would live in less dense cities when taking the sex of twins into account. It strongly affirms that families with mixed-gender twins are more likely to live in the rural area which has a lower density. Finally, the results show that the increasing number of children boost the family to reside in a less-populated area.

4.3.2 Twin children and housing unit characteristics

Table 14 presents the estimated coefficient of the house size model, which specified in equation (4). I estimate the house size model separately, with and without control variables. Only Column (2) and (4) provide the results of OLS regression with control variables. There is statistically significant evidence that a household with twins lives in the larger house, as expected. The estimated coefficient of twin children is roughly 0.06. It means that the average size of a house for the family of twins is 6% larger than a family who has no twins. Interestingly, the estimated coefficient of mixed gender twins is even higher (0.12). It implies that the presence of mixed-gender twins has a stronger effect on the housing size.

A family with same-sex twins might have a large house, but a family with mixed-gender twins consumes more spaces than the average house size of the former. One plausible explanation of estimated coefficient differences is that the parents would put the twins in the separate bedrooms only if the children have different gender (i.e. a boy and a girl).

Meanwhile, a family with same-sex twins might put the twins in a single large bedroom. A house with more bedrooms more likely to be larger in size. Given that the house price increases with the size and the average house price in the urban areas are more expensive than in the rural, then it is rational to expect the parents of twins to afford a bigger house in rural or less urban area.

Besides the house size, I employ the high-quality floor materials as another proxy to identify the housing unit characteristics. The estimation results are in Table 15. I find a

Table 13. The marginal effect of twin births on the population density of residential location

Dependent variable: Ln Population Density	(1) Coeff.	(1) S.E	(2) Coeff.	(2) S.E
Twin children	0.352*	(0.01)		
Mixed gender twins	-0.132*	(0.01)		
Last child: twins			0.255*	(0.01)
Last child: mixed gender twins			-0.091*	(0.01)
Number of children:				
4 children	-0.354*	(0.01)	-0.312*	(0.01)
5 children	-0.709*	(0.02)	-0.640*	(0.02)
6 children	-1.056*	(0.03)	-0.967*	(0.03)
7 children	-1.069*	(0.06)	-0.958*	(0.06)
8 children	-1.136*	(0.10)	-1.029*	(0.10)
Husband's education dummies (5)	Yes		Yes	
Wife's education dummies (5)	Yes		Yes	
Religion dummies (5)	Yes		Yes	
Observations	159934		159934	
R^2	0.024		0.022	

Notes: robust standard error in parentheses. *** p<0.10, ** p<0.05, * p<0.010

Table 14. The marginal effect of twin births on housing unit characteristic

Dependent variable: Ln House Size	(1)	(2)	(3)	(4)
Twin children	0.061*	0.053*		
	(0.002)	(0.002)		
Mixed gender twins	0.122*	0.123*		
	(0.002)	(0.002)		
Last child: twins			0.018*	0.016*
			(0.002)	(0.002)
Last child: mixed gender twins			0.126*	0.127*
			(0.003)	(0.003)
Age of wife	0.014*	0.008*	0.013*	0.005*
	(0.001)	(0.001)	(0.001)	(0.001)
Age of wife sq.	-7.10-5*	-3.10-5*	-5.10-5*	-4.10-5*
	(2.10-5)	(2.10-5)	(2.10-5)	(2.10-5)
Husband's education dummies (5)	No	Yes	No	Yes
Wife's education dummies (5)	No	Yes	No	Yes
Religion dummies (5)	No	Yes	No	Yes
Num. of children dummies (9)	No	Yes	No	Yes
Observations	159934	159934	159934	159934
R^2	0.028	0.071	0.021	0.065

Notes: robust standard error in parentheses. *** p<0.10, ** p<0.05, * p<0.010

positive correlation between the use of high-quality floor materials and twin children, but a negative correlation with mixed-gender twins. Given that the averaged house size of mixed-gender twins is larger than the house size of same-gender ones, the estimates lead to an interesting finding.

A high-quality flooring indicates a higher value of housing. The parent of twins is more likely to possess a house with the high-quality floor material. However, the presence of mixed-gender twins could reduce the probability of such flooring options. The previous finding shows that the parents of mixed-gender twins tend to live in a larger house to provide separate bedrooms for the twins. Equipping high-quality floor to more bedrooms would increase the material cost and thus escalate the housing valuation. With a budget constraint problem, the parents who provide separate bedroom choose houses with the medium- or lower-quality floor material.

There is a challenge to test the reverse causality between family size and the housing consumption. Previous estimation results show there is an evidence that the parents with twin children live in the urban residential area, which is densely populated and close to the city center and thus implicitly means living in smaller houses. However, several households may already be living in a large-size house for some reasons (e.g. grandparents properties, pre-marital assets). Under such situation, we should test whether a large-size house leads to a large-size family. I estimate such relationship and provide the estimation results in Table 16. The results suggest a significant and positive correlation between the house size and the number of children within the household. Because the magnitude is very low, we can ignore the effect. When the parents are making the family plans, therefore, the housing demand follows the family size and not the other way around.

4.4 Second-stage results

In Table 17, I present the result of the second stage, which are regressions of the residential location on the childbearing woman's decision to work. Before analyzing the results, it is better to check the instrument validity and endogeneity issue. I incorporate the presence of twins, as well as mixed-gender twins, as the instrument variables. The F-test for identifying weak instruments shows that the F-values are above 10. Thus, it indicates that twins and mixed-gender

Table 15. The marginal effect of twin births on the usage of flooring material

Dependent variable: High quality floor material	(1)	(2)	(3)	(4)
Twin children	0.052*		0.053*	
	(0.002)		(0.002)	
Mixed gender twins	-0.017*		-0.017*	
	(0.003)		(0.003)	
Last child: twins		0.043*		0.043*
		(0.002)		(0.002)
Last child: mixed gender twins		-0.015*		-0.015*
		(0.004)		(0.004)
Age of wife	0.036*	0.035*	0.038*	0.036*
	(0.001)	(0.001)	(0.001)	(0.001)
Age of wife sq.	-4.10-4*	-4.10-4*	-4.10-4*	-4.10-4*
	(2.10-5)	(2.10-5)	(2.10-5)	(2.10-5)
Husband's education dummies (5)	Yes	Yes	Yes	Yes
Wife's education dummies (5)	Yes	Yes	Yes	Yes
Religion dummies (5)	Yes	Yes	Yes	Yes
Num. of children dummies (9)	Yes	Yes	Yes	Yes
Observations	159934	159934	159934	159934
R^2 *(Pseudo* R^2*)*	0.205	0.205	(0.1655)	(0.1653)

Notes: robust standard error in parentheses. *** p<0.10, ** p<0.05, * p<0.010

Table 16. The marginal effect of house size on the family size

Dependent variable: Number of children	(1)	(2)	(3)
Ln House size	0.000212*	0.0000274	0.000226*
	(3.10-5)	(4.10-5)	(4.10-5)
Twin children		0.280*	
		(4.10-3)	
Mixed gender twins		0.0763*	
		(0.006)	
Last child: twins			0.126*
			(0.004)
Last child: mixed gender twins			0.0777*
			(0.007)
Age of wife	0.161*	0.172*	0.157*
	(3.10-3)	(3.10-3)	(3.10-3)
Age of wife sq.	-0.00204*	-0.00218*	-0.00198*
	(5.10-5)	(5.10-5)	(5.10-5)
Husband's education dummies (5)	Yes	Yes	Yes
Wife's education dummies (5)	Yes	Yes	Yes
Religion dummies (5)	Yes	Yes	Yes
Observations	159934	159934	159934
R^2	0.052	0.075	0.057

Notes: robust standard error in parentheses. *** p<0.10, ** p<0.05, * p<0.010

twins are strong instruments.

The overidentification test in Column (3) is not statistically significant because the p-value is higher than 0.05. It suggests that both instruments in Column (3) are exogenous and have no correlation with the error term. The urban residential area is endogenous. The values of Hausman test in all three columns are 11.98, 12.12, and 30.78 respectively. These numbers are higher than the 5% critical value of 3.841. Column (1), (2), and (3) show that there is a significant impact of residential location on the decision to work among childbearing women.

Regardless the gender variation of twins, the childbearing women who live in the urban are more likely to choose to allocate more hours for caring the children with the cost of missing opportunities to earn higher wages in the city. The estimated coefficient ranges between -0.44 and -0.55, and it is statistically significant at the 0.05 level. It indicates that a childbearing woman who lives in urban has 44.7–55.2% lower probability of working than those who reside in rural areas, ceteris paribus. Since the labor economic theory suggests that more people are more willing to work when they live in the urban where the jobs agglomerated, thus we need to be careful to interpret the estimation results.

There are four explanations on why the coefficient of the urban residential area has a negative sign. First, a lower probability of working among the childbearing women does not necessarily imply that there are fewer job opportunities at the urban. Rather, the coefficient indicates that the childbearing women in the urban have a lower willingness to work, especially if the parents live with twin children. Thus, it implicitly suggests that there is a trade-off between working and performing the home-based parental child caring duties. One plausible answer for explaining that low employment rate of childbearing women is due to the cost and benefit of performing child care responsibilities, which in turn affect the labor supply (Ribar, 1992). Also, the estimation results show that the probability of work among

Table 17. Regression results – Second stage

Dependent variable: Childbearing women' decision to work	(1)	(2)	(3)
Urban residential area	-0.447**	-0.552***	-0.484*
	(0.210)	(0.320)	(0.160)
Age of wife	0.022*	0.024*	0.023*
	(0.001)	(0.001)	(0.001)
Age of wife sq.	-1.10-4*	-2.10-4*	-2.10-4*
	(1.10-5)	(1.10-5)	(1.10-5)
Constant	0.608*	0.094	0.229**
	(0.170)	(0.120)	(0.110)
Husband's education dummies (5)	Yes	Yes	Yes
Wife's education dummies (5)	Yes	Yes	Yes
Religion dummies (5)	Yes	Yes	Yes
Num. of children dummies (9)	Yes	Yes	Yes
Instrument(s)	Twins	Mixed-twins	Twins, Mixed-twins
Test for exogeneity (*Hausmann*)	11.98	12.12	30.78
F-test for weak instruments	23.39	11.45	22.35
Overidentification test (χ^2 p-value)	-	-	0.8054
Observations	159934	159934	159934
R^2	0.063	0.013	0.047

Notes: robust standard error in parentheses. *** p<0.10, ** p<0.05, * p<0.010

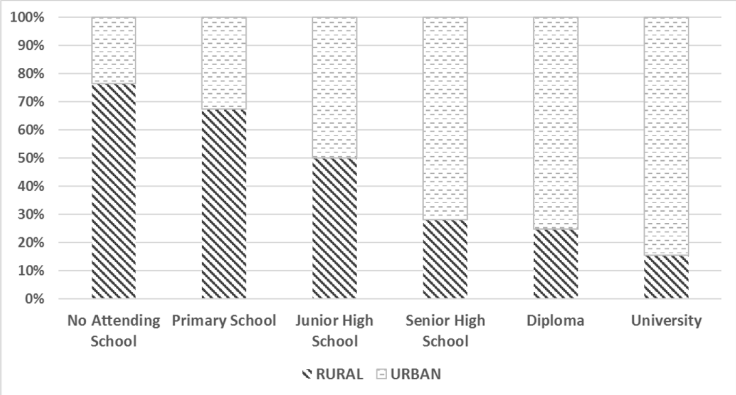

Figure 3. The Distribution of Indonesian Women by Education Level and Residential Location

childbearing women decreases with the number of children. Women with better education level are more aware of effects of child care on children's development and thus give a higher valuation to child caring duties (Cryer & Bwchinal, 1997; Pungello & Kurtz-costes, 1999). The distribution of women by education level in the urban justify this explanation. High-educated women are more concentrated in the urban area (see Figure 3). Perhaps, it is not only because the schools and other higher education institutions are more concentrated in the urban area, but also because the women have a higher school attendance rate (see Cho, 2007; Jacob, 2002; Zhang & Kanbur, 2005).

The second reason is the male spouse education. A childbearing woman is more convenient to leave the job when the husband has a higher education. When the two-earner family shifts to one-earner family, the male spouse shifts to a higher paid employment to maintain the household income level. In such case, the education determines the success rate of job-shifting because it is a valuable signal of productivity in the job market (Arrow, 1973; Spence, 1973). The third reason is the male spouse's religion. Few religions rule the married women to stay at home and preserves the house as the primary occupation. This finding is in line with Heineck (2004) who found that the presence of a male spouse with a strong belief negatively affects a woman's supply of labor. The final reason is due to the initial endowment of male spouse. A childbearing woman is not afraid of leaving the job because the male spouse's income and wealth are more than sufficient to cover the household expenditures. In that sense, to have or not to have a job is not an issue for a childbearing woman.

Table 18 summarizes the second stage result, which is the regression of the childbearing woman's work decision on the house size. The values of Hausman test in all three columns are much higher than the 5% critical value of 3.841, which indicate that the housing size is endogenous. The F-test shows the instruments strong enough to isolate the exogenous part of house size. The over-identification test suggests that both instruments are uncorrelated with the error term. The second-stage result demonstrates that there is a significant positive effect of the house size on the probability of working among the childbearing women. In Column (1), the estimated coefficient of the house size is 0.07. It suggests that, given other factors constant, a 10% increase of house size leads to an increase in the average probability of working for the childbearing women of about 0.7%. The estimated coefficient of housing size is quite inelastic, possibly because the male spouse takes the main responsibility to provide the housing. The positive coefficient is simple to explain. A family with twin children

would need a larger house. As the price of housing increase with the size, the parents would find it difficult to afford a large-size house if the households are a one-earner household. To be experiencing housing affordability problems or housing cost burdens has motivated the childbearing women among one-earner households to work and generate more household income (Cook, Bruin, & Winter, 1994).

4.5 The importance of a home-based and nonparental child caring provider

It has been a common phenomenon among urban families in Indonesia to employ a housemaid to perform domestic services. Frequently, the housemaid lives within the employer's household. It implies that the parents need to provide an additional bedroom. In the selection-based sample, there is roughly 2% of total households who employ a housemaid. Interestingly, 83% of these housemaid-equipped households are the twin-children families. Besides doing the daily routine of the light cleaning duties to maintain private households, the working parents also ask the housemaid to perform child care activities. In such situation, the female spouse is the dominant decision-maker in the selection process of a housemaid (Lalwani & Mehta, 2000). Thus, in a two-earner family with twin children, we would expect that the parents to hire a housemaid. The purpose is to reduce the workload in performing the home-based and nonparental duties, which in turn, allowing the female spouse to allocate more hours to work.

In a case of limited access to the housemaid services (e.g. low supply, higher fees, etc.), however, the parents often involve the presence of grandparents. The empirical evidence across all countries for the involvement of grandparents in the grandchildren's care studied by Hank & Buber (2009). Similar to the housemaid, the grandparents will live with the spouses. Thus, the parents always need to provide extra bedrooms. Thus, we would expect a positive correlation between the presence of twin children and the non-parental home-based childcare provider, which will influence the house size and the childbearing woman's decision to work.

Using a similar framework from Section 4.3 and 4.4, I employ an IV model to estimate the relationships between the twin children, child care services provider, woman's decision to work and to what extent these relationships can affect the housing unit characteristics – i.e. house size. Both Table 19 and 20 summarize the results of the first-stage regressions.

The first-stage results link the presence of twin children and the probability of hiring either housemaids or grandparents to help the childbearing women performing the home-based child-caring activities. The estimates in Table 19 show that women with twin children are more likely to hire a housemaid, as well as the grandparents. The corresponding estimate for the housemaid is 0.012, which suggests a woman with twin children has a 1.2 higher probability on average to hire a housemaid, ceteris paribus. Meanwhile, the corresponding estimate for the grandparents is roughly 0.039. It indicates that the childbearing woman prioritizes the home-based child care vacancy to the grandparents than a housemaid. Since it would be more expensive to hire a housemaid, which in turn sharply increasing the household expenditure, the childbearing women will have another strong reason to have a job and earnings. Table 20 provides evidence to justify such argument.

There is a positive correlation between childcare provider and the childbearing woman's decision to work. Note that the estimated coefficient of housemaid is 0.576, much higher than the grandparents which only 0.175. Hiring a housemaid leads to a higher probability to work by 57.6%. The decision on hiring a nonparental home-based childcare service provider is also with a consequent increase in the house size. Because the child care provider must live in the same household, then the parents should provide more spaces (i.e. an extra bedroom). Table 21 reports the estimates of the impact of childcare provider on the house size. The results suggest that the parents upgrade the size of the house by 27.1% higher on average due to the presence of housemaid.

The scale is substantially higher when the grandparents play the role of the housemaid. A household that including the grandparents are more likely to live in a 35.9% larger house. It is plausible to have higher estimated coefficient of the grandparents because it is almost not possible to force the grandmother to join the household without including the grandfather. Given the evidence that the presence of twins has made the households behave differently in determining the residential location and housing size, and thus had affected childbearing women's decision to not participate in the labor market, hereafter, what should policymakers do? The main problems to be addressed here is how to prevent the childbearing women with twin children from leaving the labor force. The empirical results in Table 19 and 20 send a signal that there is a high demand for home-based nonparental childcare services, especially from urban families with twins. Thus, the policymakers may assign a policy which aims to open more access to child care provider.

5. Concluding Remarks

People choose where to live and to work by minimizing the sum of housing and commuting costs. Besides the location, people decide what house size they will need to meet the family size in the future. In that sense, the residential location, housing size, and the number of children are endogenous. Moreover, the number of children determines the net benefit of parental time devoted to child caring duties and influences the childbearing women's decision to leave the labor market either temporarily or entirely.

Since the presence of twin birth can interfere the parents' pre-determined decision on residential location, as well as housing size and family size, the parents of twins face two interrelated problems. The first is whether to live in the city to earn high salaries or to move farther from city to reside in the larger house. The second is what more compelling for childbearing women: whether to work to obtain more household earnings or to leave the labor market to take care of children. The former is more likely to affect the latter. This study applies the IV method to investigate the outcome of the trade-off by treating the exogenous variation of childbirth as the instrument.

To author's knowledge, this is the first empirical study that examines the relationship between residential location, housing unit characteristics, and the female labor supply

Table 18. Regression results – Second stage

Dependent variable: Childbearing women' decision to work	(1)	(2)	(3)
Ln Housing size	0.073**	0.042***	0.012
	(0.030)	(0.020)	(0.020)
Age of wife	0.013*	0.012*	0.012*
	(0.001)	(0.001)	(0.001)
Age of wife sq.	-7.10-5**	-7.10-5**	-6.10-5**
	(2.10-5)	(2.10-5)	(2.10-5)
Husband's education dummies (5)	Yes	Yes	Yes
Wife's education dummies (5)	Yes	Yes	Yes
Religion dummies (5)	Yes	Yes	Yes
Num. of children dummies (9)	Yes	Yes	Yes
Instrument(s)	Twins	Mixed-twins	Twins, Mixed-twins
F-test for weak instruments	994.77	2863.79	1687.28
Test for exogeneity	30.135	10.964	25.41
Overidentification test (χ^2 p-value)	-	-	0.401
Observations	159934	159934	159934
R^2	0.053	0.077	0.073

Notes: robust standard error in parentheses. *** p<0.10, ** p<0.05, * p<0.010

Table 19. The effect of twin children on the provision of home-based nonparental childcare service

Dependent variable: Providing nonparental childcare service	Types of childcare provider	
	Housemaid	Grandparents
Twin children	0.012*	0.039*
	(0.001)	(0.001)
Age of wife	2.10-4***	0.001*
	(1.10-4)	(2.10-4)
Age of wife sq.	-3.10-6***	-1.10-6*
	(3.10-6)	(4.10-6)
Wife's education dummies (5)	Yes	Yes
Religion dummies (5)	Yes	Yes
Num. of children dummies (9)	Yes	Yes
Observations	159934	159934
R^2	0.079	0.005

Notes: robust standard error in parentheses. *** p<0.10, ** p<0.05, * p<0.010

Table 20. The effect of home-based nonparental childcare service on mother's decision to work

Dependent variable: Childbearing women' decision to work	(1)	(2)
Assisted by the housemaid	0.576**	
	(0.290)	
Assisted by the grandparents		0.175**
		(0.090)
Wife's education dummies (5)	Yes	Yes
Religion dummies (5)	Yes	Yes
Num. of children dummies (9)	Yes	Yes
Instrument(s)	Twin children	Twin children
F-test for weak instruments	1607.845	5476.08
Test for exogeneity	3.91	7.47
Observations	159934	159934
R^2	0.0664	0.069

Notes: robust standard error in parentheses. *** p<0.10, ** p<0.05, * p<0.010

from a quasi-natural experiment simultaneously by taking a developing country's perspective – where the family size tends to grow faster. This study uses two-stage regression procedures. For the first stage regression, I estimate the effect of twin birth on residential location and housing size. In utilizing the twins, I also consider the variation of gender and birth sequences into account. In the second stage, I expand the analysis of instrumented residential location and housing size on the labor force participation of childbearing women.

The first-stage results show that the presence of twin children has influenced the households to behave differently in searching for a residential location as well as a housing unit characteristics. Firstly, I find statistically significant evidence that families with twin children are more likely to live in the urban areas, closer to the city center and more densely populated location. However, the presence of mixed-gender twins would reduce the probability of doing such behavior. Secondly, families with twin children are more likely to live in large houses because the parents need to

Table 21. The effect of providing home-based and nonparental child care service on the house size

Dependent variable: Ln House Size	(1)	(2)
Assisted by the housemaid	0.271*	
	(2.900)	
Assisted by the grandparents		0.359*
		(0.480)
Wife's education dummies (5)	Yes	Yes
Religion dummies (5)	Yes	Yes
Num. of children dummies (9)	Yes	Yes
Instrument(s)	Twin children	Twin children
F-test for weak instruments	1624.031	5476.078
Test for exogeneity	1980	1860
Observations	159934	159934
R^2	0.045	0.046

Notes: robust standard error in parentheses. *** p<0.10, ** p<0.05, * p<0.010

provide separate bedrooms between the twins and other siblings. The same-sex twins do not share the bedroom with the siblings due to age differences, while the mixed-sex twins cannot share the bedrooms because of cultural-based reasons. On average, the mixed-sex twins require more space than the same-sex ones.

The second-stage results suggest that the twin children household's behavior of housing consumption would influence the childbearing woman's decision to work. The childbearing women who live urban are more likely not to work because of two possibilities: (1) they might experience a net positive benefit of child-caring duties while the male spouses take all responsibility to finance the household expenditures, or (2) the childbearing women find it difficult to get a job with a flexible working arrangement. The second-stage results also suggest that the cost burden of having large-size house might cause the childbearing women motivated to search for a job and thus generate more household income. The presence of twins also pushes the parents to provide a home-based nonparental child caring services, which in turn, leads to a consequence of providing more space for the housing. To sum up, this study provides new evidence of a forward-looking behavior about the residential location and housing consumption due to household size effects and shows how such behavior influence the labor supply of childbearing women.

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