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13　2005年以降の合計出生率反転の要因：都道府県別データを用いた空間分析の応用

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和文抄訳

本研究は、2005年以降上昇傾向にある日本の合計出生率（Total fertility rate: 年齢標準化した出生力指標で、仮に女性が当該年次の年齢別出生率に従って生涯にわたって子どもを生んだ場合に実現する子ども数に相当する）が、どのような要因で上昇したかを理解するために、都道府県別の出生率変化を説明する回帰モデルを用いた検証を試みたものである。その際、都道府県別データのような空間データでは、人口規模の違いによる分散不均一性の問題や、近隣県の指標間で高い相関がみられる点に配慮し、誤差項における空間自己相関を明示的にモデル化した重みつき空間誤差モデル weighted spatial error model を利用した。

日本は南欧諸国や東欧諸国、東アジアの一部の地域と同様、1.3を下回る極めて低い合計出生率を経験している。これらの国はしばしば超低出生力国 lowest-low fertility countries と呼ばれ、そうした地域では、出産の先送り傾向（晩産化）が著しいこと、出生力の高い移民などが少ないこと、経済の低成長やグローバル経済によって若者の雇用情勢が悪いこと、高学歴化によって出産・子育ての機会費用が高まっているにもかかわらず、十分な両立支援体制が整っていないこと、家族のネットワークが強力で、子育てに女性以外が参加することを期待しない文化的風潮をもつこと（家族主義）、などが指摘されている(Kohler, Billari, and Ortega 2002 ,Frejka and Westoff 2008, Perelli-Harris 2005, Zuanna and Micheli 2004, Reher 2007, McDonald 2006)。こうしたことから、超低出生力地域の出生率は長期にわたって低迷するとの見通しが主流であったが、2000年前後から、一部の地域で出生率の反転上昇が見られ、日本でも2005年に1.26の最低値を記録して以降、2009年の1.37まで回復した。南欧など欧州についての先行研究によれば、晩産化の進展がとまり（人口学的にはテンポ効果の消滅とみなせる）、移民の増加や景気の回復、子育て支援、とくに両立支援政策の充実などが要因として指摘できるという(Castiglioni and Dalla Zuanna 2008, Billari 2008, Goldstein et al. 2009, Caltabiano et al. 2009)。また南欧では、本来、再生産に有利であった家族主義的な南部地域よりも、西欧諸国に特徴的な家族ライフスタイルが急激に進展している北部地域で出生率の回復が著しいことが指摘されている。これらの要因が日本における出生率の上昇の説明としても有効かどうかを検証した。

都道府県別出生率の2005年～2008年の変化分を、テンポ効果の縮減(Bongaarts-Feeney(1998、2005)の period didtortion index の変化を使用)、外国人母による出生割合の変化、経済の回復（就業率の変化）、両立支援策の充実を示す母親の就業率の変化、家族主義を示す三世代家族割合の各効果で説明する回帰モデルを推定する。その際、都道府県による人口規模の違いを考慮し、再生産年齢女性の人口を重みにした重み付け最小二乗回帰モデルを用いるとともに、近隣県間で誤差項に相関がある場合は、重み付き空間誤差モデルを用いることを検討した。空間誤差モ

デルは以下のように定式化される。

$$y = X\beta + u,$$
$$u = \lambda Wu + \varepsilon,$$
$$\varepsilon \sim N(0, \sigma^2 I)$$

ここでyは従属変数を示す(n x 1)ベクトルである。Xはk-1の独立変数をしめす(n x k)行列である。βは推定されるべき(k x 1)ベクトルである。uは(n x 1)の誤差項を示すベクトルであるが、次行の式で示された構造をもつ(Anselin 1988, Ward and Gleditsch 2008)。そこでは空間自己回帰係数であるλと、地域間の関係を示す(n x n)の加重行列Wによって空間自己相関が表現され、εが独立に分布した（地域間で相関しない）誤差項ベクトル(i.i.d.)を示す。加重行列のための近隣構造の定義に際しては、当該都道府県に全方向で隣接する場合を近隣と見なす一重クイーン方式 first order queen convention を採用した。モデルは以下のように表される。Δは差分を示す。推定は出生順位別に行った。推定にはRのspdepパッケージを利用した。

ΔTFR (2005-2008) = 切片
+Δテンポ効果指標 (2004-2007)
+Δ外国人母による出生割合 (2005-2008)
+Δ就業率 (2002-2007)
+Δ核家族世帯に暮らす未就学児を持つ母親の就業率 (2002-2007)
+ 未就学児を含む世帯に占める三世代家族割合（固定効果）(2005)
(+ 空間自己相関誤差項 λWu)

いずれのモデルでも、誤差項に空間相関が認められたので、通常の最小二乗法ではなく空間誤差モデルによる推定が望ましいことが分かった。テンポ効果指標の変化、就業率の変化、外国人母による出生割合の変化が出生率の変化と正の関係を示し、晩産化の停止、景気の回復、外国人の増加が近年の出生率上昇の一翼を担っていることがわかった。家族主義を示す三世代家族世帯割合は、第1子や第2子など、低い出生順位で、南欧における結果と同様、負の関係を示していた。また分散全体の15%程度を説明していた。子どもをもつ母親の就業率の変化は明確な正の関係を示さなかった。ただし、説明変数で説明できる部分は3割程度であり、残りは全国に共通する要因が存在したと解釈できる。

両立支援策の効果については、3歳未満の子どもをもつ母親の就業率変化を代理変数として関係性を検証したが、有意な関係は確認することはできなかった。出生率が上昇した都市部では保育園の待機児童が増加するなど、両立のニーズはありながらも体制が追いついていない可能性がある。また2006年以降国際結婚が減少し、2008年以降は失業率も再上昇していることから、今後上昇効果が一時的に薄れる可能性も考えられる。しかしその効果は0.02程度と限定的であろう。空間相関の高さは、その地域で、説明変数では説明できない出生率上昇の要因が存在していたことを意味する。誤差項の空間相関の高い地域を地図上で示すと九州地方で顕著であった。こうした地域に特有な文化や施策と出生率との関係を検証していくことが有効であろう。

Explanations for the fertility reversal after 2005 in Japan

Miho Iwasawa
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Abstract

The goal of this paper is to evaluate explanations for the total fertility rate (TFR) upturn in Japan after 2005. Drawing on recent research on the retreat from lowest-low fertility in European countries, we focus on diminished tempo effects, increasing numbers of foreign mothers, improving economic conditions, and policy efforts to support work-family balance. We also examine the role of familistic culture. Decomposition analyses based on the results of weighted spatial error models indicate that TFR upturn at the national level is partially explained by diminished tempo effects, increases in foreign mothers, and economic improvement. However, change in maternal labor force participation – an indirect measure of policy efforts to improve work-family balance – was not significantly associated with the TFR reversal. Our measure of familistic culture – the proportion of extended family households – was negatively associated with fertility increase for lower-order births. Our results also suggest that over half of the TFR increase is not explained by the factors in our models. Subsequent decline in the number of international marriages and the recent economic downturn may contribute to a slow-down or reversal in the upward trend in TFR, but the impact of these changes should be relatively small.

This research was contributed by Kenji Kamata (National Institute of Population and Social Security Research), James M. Raymo (University of Wisconsin), and Kimiko Tanaka (Rochester Institute of Technology).

1. Introduction

Contrary to the expectations of classic demographic transition theory, post-transitional total fertility rates (TFR) range from nearly replacement level to below 1.2 (Morgan 2003).[1] The future of below-replacement fertility is an open question and efforts to identify the causes and characteristics of extremely low fertility have been a central part of demographic research since the late 1990s. Some scholars have proposed comprehensive explanations for lowest-low fertility – defined as TFR under 1.3 – and suggested that such levels may persist for several decades (Kohler, Billari, and Ortega 2002, Lutz, Skirbekk, and Testa 2006, McDonald 2006, Reher 2007). However, fertility rates have recovered steadily since the end of the 1990s in Italy and Spain, two of the first countries to reach lowest-low fertility. Since 2000, an increase in TFR has also been observed in other lowest-low fertility nations in Central

[1] TFR is an age-standardized period measure that can be interpreted as the number of births a woman would have if she experienced current age-specific rates throughout her lifetime (and did not die prior to the end of reproduction). Replacement-level fertility is slightly over two births per women (Morgan and Taylor 2006).

Europe, Eastern Europe, and East Asia, including Japan (Goldstein, Sobotka and Jasilioniene 2009).

The magnitude of the increase in TFR for these low-fertility countries is quite small relative to long-term historical changes and current cross-national differences. However, interpretation of this small change is of critical importance for understanding the nature of lowest-low fertility. On one hand, evidence that the small rise in TFR is explained by demographic mechanisms or response to emerging socioeconomic incentives and institutional changes would suggest that lowest-low fertility may be a transitional phenomenon. On the other hand, evidence that this change is simply a temporal fluctuation, would suggest that further fertility decline and extended periods of lowest-low fertility cannot be ruled out. This information is of obvious importance for the formulation of policies to address the social and economic implications of low fertility and population aging.

Recent studies propose various explanations for the retreat from lowest-low fertility (Castiglioni and Dalla Zuanna 2009, Billari 2008, Goldstein, Sobotka and Jasilioniene 2009, Caltabiano, Castiglioni and Rosina 2009). These include slowing or reversal of the trend of postponed childbearing, increasing acceptance of new patterns of family formation, more favorable economic conditions, implementation of public policy measures to support families with children, and increasing numbers of immigrant women with relatively high fertility.

This work has focused primarily on the fertility upturn in Europe and it is not clear whether these explanations are relevant for understanding the reversal of fertility decline in other regions. A second limitation of past work is the tendency to discuss and examine the influence of various factors independently without evaluating the relative importance of each factor. In this paper, we focus on the recent fertility upturn in Japan and examine the generalizability of explanations for the European fertility upturn using a more comprehensive modeling approach than that employed in previous studies.

Specifically, we estimate ecological regression models using spatial analytical techniques to investigate how prefecture (state)-level TFR change in Japan since 2005 is associated with the factors examined in previous studies of European countries. Spatial analytic techniques not only allow for more reliable inferences than conventional modeling based on geographically aggregated data, but also allow us to consider the possibility that fertility dynamics in a given area may influence, and be influenced by, neighboring areas. We then use decomposition techniques to evaluate the relative impact of each factor on TFR increase at the national level.

2. Background

2.1 Explanations for lowest-low fertility

Previous research on lowest-low fertility has emphasized the features common to lowest-low fertility countries such as postponement of childbearing, the absence of high-fertility sub-populations, low rates of economic growth, increasing opportunity costs of childbearing, and familistic welfare regimes.

The influence of delayed childbearing on period fertility measures like TFR is typically referred to as tempo effects or tempo distortion (Ryder 1964, Bongaarts and Feeney 1998, 2005). If lowest-low fertility is due entirely to tempo effects, it should be a short-lived phenomenon, with recuperation in TFR expected as women who were postponing childbearing begin to have children at older ages. However, in most lowest-low fertility countries, delayed childbirth is linked with lower completed fertility, a

phenomenon referred to as postponement-quantum interaction (Kohler, Billari, and Ortega 2002). Techniques for eliminating tempo effects (Bongaarts and Feeney 1998) show that Japan's tempo-adjusted TFR has always been above the lowest-low threshold of 1.3 (Kaneko 2009). Tempo effects are thus likely to explain all of the emergence of lowest-low fertility in Japan.

Countries with relatively high levels of sub-replacement fertility often have relatively large high-fertility sub-populations such as immigrants from high-fertility countries (Sobotka 2008, Coleman 2006) or religious groups (Frejka and Westoff 2008). The small numbers of immigrants and religious groups with relatively high fertility is likely part of the explanation for lowest-low fertility in countries like Japan (Kojima 2008).[2]

Low economic growth in Western societies and the collapse of secured job systems in former communist countries are also thought to be part of the explanation for the emergence of lowest-low fertility (Blossfeld et al. 2005, Perelli-Harris 2005). Japan experienced three recessions over the past twenty years (1991 to 1993, 1997 to 1999, and 2001 to 2002), resulting in relatively high unemployment rates at young ages and significant growth in unstable, non-standard employment (Ministry of Health, Labour and Welfare 2006). These unfavorable economic circumstances have likely pushed young people away from family formation.

Among working women, remaining childless may be a rational response to increases in the opportunity costs of having children. The opportunity costs of motherhood are thought to be particularly high in Japan where only a small proportion of women continue working after childbirth. Although several policy efforts to improve conditions for working mothers have been implemented since the 1990s, only 20 percent of new mothers remained in the labor force in 2005, a level that has remained unchanged since the 1980s (NIPSSR 2007b, Kaneko et al. 2008).

Broad agreement exists among scholars that familistic welfare systems based on "strong family ties" also contribute to lower fertility (Dalla Zuanna and Micheli 2004, McDonald 2006, Billari 2008). In such contexts, public welfare systems are weak and families are expected to support their own members. Like Southern European countries, Japan is characterized by familistic culture and limited public support for families (Atoh 2005, Suzuki 2006) which places a heavy burden on women and is thought to be an important reason for the trends toward later and less marriage and very low fertility.

2.2 TFR reversal in lowest-low fertility countries

Despite the unfavorable conditions for family formation, most of the lowest-low fertility countries (TFR below 1.3) have experienced steady increases in fertility over the past 10-15 years. Efforts to understand this fertility upturn have focused mainly on southern European countries. For example, Castiglioni and Dalla Zuanna's (2009) analysis of the TFR reversal in Italy in the latter half of the 1990s showed that the decline in cohort fertility has come to a halt and birth rates among the older age groups have increased. They also emphasized that the fertility upturn is observed primarily in northern Italy where economic circumstances are more favorable and where new family formation behaviors associated with the Second Demographic Transition (e.g., divorce and nonmarital childbearing) are more prominent. A significant fertility upturn was not observed in southern Italy where close intergenerational

[2] In Japan, the percentage of foreign nationals is extremely low, at only 1.4 percent of the total population, and their fertility rates are actually lower than those of Japanese women (NIPSSR 2007a).

relationships and familistic culture, which contributed to high fertility rates in the past, are strong (Castiglioni and Dalla Zuanna 2009). Billari (2008) demonstrated that rapid increase in immigrant populations also contributed to the recent upturn in fertility rates in Italy and Spain.

Goldstein and his colleague (2009) showed that recovery from lowest-low fertility was observed not only in Southern European countries, but also in Central Europe, Eastern Europe, and East Asia. Their analyses suggested that a decline in the tempo effect—driven by a slowdown in the postponement of childbearing, and dramatic increases in immigrant women with fertility rates higher than those of native-born women explain part of the TFR increase in some countries (e.g. Italy and Spain). Based on panel regressions of data from 27 OECD countries, they also suggested that economic recovery may have contributed to the fertility recovery for some countries (e.g. Poland, Slovakia, and Spain).

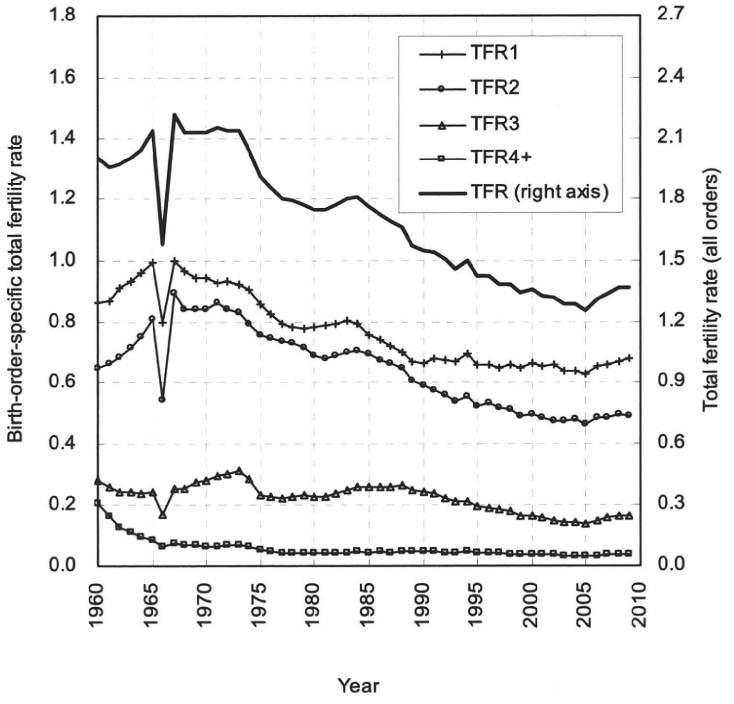
In summary, factors emphasized in this work on the retreat from lowest-low fertility include; (1) diminished tempo effects, (2) increase in immigrant sub-populations, (3) economic improvement, and (4) improvement in work-family balance. We also examined the relationship between fertility recovery and familistic culture. In the following sections, we examine the extent to which each factor explains fertility upturn in Japan.

3. TFR reversal in Japan

Japan's TFR has been below the replacement rate since the early 1970s and was below 1.3 from 2003 to 2005. In recent years, the Japanese TFR has risen above the lowest-low level, reaching 1.37 in 2009 (MHLW 2010) (Figure 1).

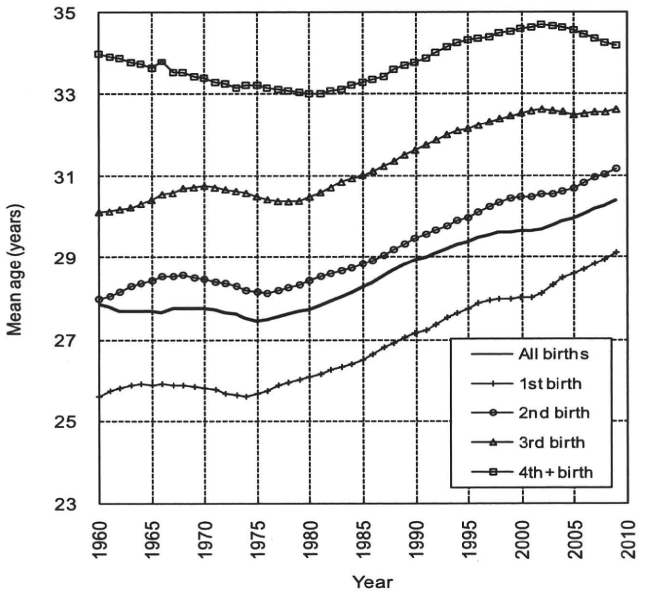
Mean age at childbearing continues to rise for first and second births, but the pace of increase in age at first birth seems to have slowed between 2005 and 2008. Furthermore, the mean age for higher-order births decreased slightly (Figure 2). These trends suggest that the impact of tempo-distortion may have diminished in recent years.

Figure 1: Overall and order-specific total fertility rates: 1960 ~ 2009



Source: Vital Statistics, various years (Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare).

Figure 2: Mean age of the age-specific fertility schedule by birth order: 1960 ~ 2009



Source: Vital Statistics, various years (Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare).

Trends in the number of foreign women would not seem to be relevant for understanding trends in the Japanese TFR given that the official measure provided by the Ministry of Health, Labour and Welfare is calculated only for newborn children with Japanese nationality. This means that the official TFR does not include children born to foreign couples living in Japan. Importantly, however, it does include children born to foreign mothers married to Japanese men despite the fact that the denominator used to calculate TFR is limited to Japanese women.[3,4] The TFR may thus increase as a result of growth in the number of Japanese children born to foreign mothers, even if the actual fertility of Japanese women remains unchanged. This is important given that the percentage of marriages involving Japanese men and foreign women increased from 2.8 percent in 1990 to 4.6 percent in 2005. Recent upturn in the Japanese TFR may thus be partly due to increase in the number of foreign wives who gave birth to Japanese children since 2005.

Economic improvement may also be relevant for understanding the recent upturn in the Japanese TFR. According to Labour Force Surveys, the national unemployment rate fell from 5.4 in 2002 to 3.9 in 2007. The unemployment rate for young people aged 20-24 is still relatively high but it also declined from 9.3 to 7.5 over the same period.

Since 2000, the Japanese government has been promoting a range of work and family reconciliation efforts seeking to promote family formation (Ogawa 2003, Moriizumi 2008).[5] These efforts include improvements in child-care leave benefits and implementation of the After-school Childcare plan which secures places of activity for children after school in all elementary school districts. In 2007, the "Action Agenda for Promoting Work-Life Balance" was resolved as a priority task of the "Strategies for Japan to Support Children and Families." These results of these efforts by government may be encouraging young people, particularly young working women, to start families.

4. Data and methods

To examine the impact of the factors discussed above, we estimate weighted least squares models (WLS) and weighted spatial error models (WSE) using data from the 47 Japanese prefectures. In Japan, population size varies significantly across prefectures, ranging from 12 million in Tokyo to 600,000 in

[3] In Japan, nationality is difficult to receive even for foreign mothers married to Japanese men.

[4] The definition of the TFR in the Vital Statistics is as follows:

$$TFR = \sum_{x=15}^{49}\left(\frac{B_x}{N_x^j}\right) = \sum_{x=15}^{49}\left(\frac{B_x^j + B_x^f}{N_x^j}\right),$$

where N_x^j represents the number of Japanese females age x, B_x is the number of births with Japanese nationality born to mothers of age x, B_x^j is the number of births born to Japanese mothers, and B_x^f is the number of births born to foreign mothers and Japanese fathers.

[5] In addition to the "New Angel Plan" in 2000-2004 (reinforcement of child-rearing services, improvement of employment environment for reconciliation of work and family life, improvement of the corporate climate where gender division of labor and priority in the workplace is taken for granted), the Zero Children on Waiting List Strategy was started in 2001 with the goal of building up sufficient child-care centers. The 2003 Law for Measures to Support the Development of the Next Generation requires every municipality and business owner in Japan must develop their own action plan to support families with children.

Tottori. To deal with heteroscedasticity, we estimate the weighted regression models using the square root of the reproductive age (15-49) female population as weights.

When analyzing geographically aggregated data, it is important not only to deal with heteroscedasticity but also to pay attention to that fact that such data are often characterized by spatial autocorrelation. Spatial autocorrelation refers to systematic relationships between variables of interest and geographic location. Because ordinary least-squares regression models assume that error terms are independently, identically, and normally distributed, spatial autocorrelation may result in underestimation or overestimation of standard errors for regression coefficients (Chi and Zhu 2008). We therefore estimate weighted spatial error models which explicitly account for spatial autocorrelation in the error terms. The general form of spatial error models is as follows (Anselin 1988, Ward and Gleditsch 2008):

$$y = \mathbf{X}\beta + u,$$
$$u = \lambda \mathbf{W} u + \varepsilon,$$
$$\varepsilon \sim N\left(0, \sigma^2 \mathbf{I}\right)$$

where y is a (n x 1) vector representing the dependent variables, $\mathbf{X}$ is a (n x k) matrix comprised of a constant term and k-1 independent variables, β is a (k x 1) vector of regression parameters to be estimated, and u is a (n x 1) vector of error terms presumed to have the covariance structure described in the second equation. λ is a spatial autoregressive coefficient to be estimated, $\mathbf{W}$ is a (n x n) weight matrix defining the potential relationship between neighboring locations (e.g., a binary indicator of neighbor or not), and ε is a (n x 1) vector of independently distributed (spatially uncorrelated) errors. We used a first-order queen convention to define neighbors for the weight matrix.[6] Three prefectures have only one neighbor and one prefecture has eight neighbors. Eighteen prefectures have four neighbors – the modal number.

We select a preferred model by comparing fit statistics for the WLS and WSE models and considering the significance of the spatial autoregressive coefficients. We then use this preferred model to evaluate the contribution of each factor to the increase in Japan's TFR after 2005. Model estimation is conducted using the "spdep" package in R.

5. Measurement and variables

The dependent variable is change in birth-order-specific TFR between 2005 and 2008, taken from the Japanese Vital Statistics. Our four independent variables reflect the posited explanatory mechanisms: diminished tempo effects, increase in foreign mothers, economic improvement, and implementation of policies facilitating work-family balance. We also include the measure for familistic culture as a fixed prefectural characteristic.

[6] In this convention, the neighbors for any given prefecture are other prefectures that share a common boundary in any direction. Although Hokkaidō and Okinawa don't share borders with any other prefecture, we defined Aomori as Hokkaidō's neighbor and Kagoshima as Okinawa's neighbor. Because Hokkaidō and Aomori are connected by an undersea tunnel and Okinawa and Kagoshima have a long history of frequent interchanges, it is reasonable to assume neighbor relationships between them.

Diminished tempo effect

Tempo effects that lead to "distorted" observed period measurements of TFR compared to its "true" tempo-free level are caused by the postponement or acceleration of childbearing. We measured the tempo effect using the index proposed by Bongaarts and Feeney (1998, 2005). They demonstrate that the relationship between the observed TFR in any given year and the TFR that would have been observed in the absence of tempo effects can be expressed as:

$$TFR_i = (1 - m_i)TFR_i'$$

TFR_i is the observed TFR for birth-order i in a given year, TFR_i' is the tempo-adjusted TFR for birth-order i, and m_i is the absolute change in the mean age at childbearing for birth-order i during the year the in which TFR is observed. Multiplying the tempo-free TFR_i' by the period distortion index ($1-m_i$) yields the observed TFR_i. We calculate this distortion index over three-year periods for each prefecture and measure change as the difference between the values for 2002-05 and 2005-08.[7] We expect that increase in this period distortion index (i.e., a reduction in the impact of postponement) will be positively associated with fertility increase.

Increase in foreign mothers

We measure the influence of foreign mothers as change between 2005 and 2008 in the proportion of births (with Japanese nationality) to foreign mothers. We expect that increase in births to foreign mothers will be positively associated with increase in TFR. Because tabulations of births by mother's nationality are not available by birth order in the Vital Statistics, we used values calculated based on all births for the birth-order-specific models. We are thus assuming that the contribution of births to foreign mothers does not depend on parity.

Economic improvement

To measure economic improvement, we use change in the unemployment rate. Annual Labour Force Survey reports provide estimated unemployment rates for each prefecture based on data from sample surveys. Because these measures may be influenced by short-term fluctuations, we calculated three-year-moving averages and measured change from 2002 (2001-2003) to 2007 (2006-2008) assuming that economic improvement does not exert an immediate influence on fertility. In the model we estimate, we use the employment rate (1.0 minus the unemployment rate), and we expect that increase in that index will be positively associated with change in fertility.

Policies to promote work-family balance

Although there are no established methods of measuring the effectiveness of policies, utilizing variation in policies across space is an effective way to assess the effect of policies on fertility (Neyer and Anderson 2008). In our study, we measure shifts in policies related to work-family balance indirectly

[7] For example, if the mean age at first childbearing is 28.6 years in 2005 and 28.9 in 2008, the period distortion index ($1-m_i$) for 2005-2008 is calculated as (1-(28.9-28.6)/3) =0.9.

by using change in the labor force participation rate of mothers of preschool children (under six years of age).[8] Because public and corporate efforts to improve work-family balance are expected to have the strongest impact on women who cannot easily receive childcare support from their parents(-in-law), we limited our measure to mothers of preschool children living in a nuclear family household. Using data obtained from the Employment Status Surveys in 2002 and 2007, we calculated change in these women's labor force participation rate for each prefecture. To the extent that increase in maternal labor force participation reflects improvements in work-family balance, we expect that this measure will be positively associated with fertility increase.

Familistic culture

In addition to posited mechanisms of change just described, we include a measure of familistic culture. Because familistic culture does not change in a short period of time, we treat it as a fixed prefecture effect that might be related to both the prefecture-specific level of fertility change and the other explanatory variables. Japanese scholars have documented strong relationships between familistic culture and patterns of living arrangements (Katō 2008). Living arrangements in eastern Japan, where familistic culture is particularly strong, have historically been characterized by coresidence of an older couple (parents) and a younger couple (son and daughter-in-law). In contrast, older couples in western Japan are more likely to live in an independent household, often on the same lot as their children's home.

We therefore measured the extent of familistic culture by the prevalence of extended family households. Using 2005 Japanese census data for each prefecture, we calculated the proportion of extended family households among households that included children under six years of age. We expect the proportion of extended family households to be negatively associated with fertility change to the extent that women's heavy domestic responsibilities in strong familistic cultures act as a disincentive to family formation at young ages.

Model

The model used to examine the contributions of diminished tempo effects, increase in foreign mothers, economic improvement, improvement in work-family balance, and the role of familistic culture can be expressed as follows.

$$\begin{aligned}\Delta TFR_i\ (2005\text{-}2008) = \text{Constant} \\ &+ \beta_1\ [\Delta \text{ Period distortion index for birth-order } i\ (2004\text{-}2007)] \\ &+ \beta_2\ [\ \Delta \text{ Proportion of birth to foreign mothers } (2005\text{-}2008)\ ] \\ &+ \beta_3\ [\ \Delta \text{ Employment rate } (2002\text{-}2007)\ ] \\ &+ \beta_4\ [\Delta \text{ Labor force participation rate among mothers of preschool children} \\ &\quad \text{living in a nuclear family household } (2002\text{-}2007)] \\ &+ \beta_5\ [\text{Proportion of extended family households among households including}\end{aligned}$$

[8] Because the Law for Measures to Support the Development of the Next Generation (implemented in 2005) obligates each municipality and business owner in Japan to take measures to support families with children, we assume that development in policies and programs varies across regions.

preschool children (2005)]

$+\lambda \mathbf{W}u$ (Spatially autocorrelated error term)

5. Results

5.1. Descriptive statistics

Table 1 shows descriptive statistics for all variables used in the analysis. The values of Moran's *I* suggest that all of the dependent variables are spatially autocorrelated.[9] Among the explanatory variables, significant spatial autocorrelation is observed in: change in the period distortion index for second-order TFR, change in the proportion of births to foreign mothers, change in employment rate, and the proportion of extended family households.

Figure 3 shows geographical patterns of birth-order-specific TFR change. Increase in first-order TFR is consistently higher in the Pacific coastal areas of Kantō and Chūbu and the coastal areas of Chūgoku and Kyūshū; and it is lower in Hokkaidō and the Tōhoku region except for Miyagi prefecture (See the appendix for a map with names of prefectures and regions). Increase in the second-order TFR is higher in Saitama, Chiba, Aichi, Hyōgo, Shimane, Hiroshima, and northern Kyūshū. Increase in third and higher-order TFR is largest in the Kyūshū region.

Figure 4 displays geographical patterns of change in the period distortion index for birth-order-specific TFR and Figure 5 shows geographical patterns of the other independent variables. From Figure 5, we can see that increase in the proportion of births to foreign mothers is most prominent in coastal Chūbu (Aichi and Shizuoka) and Chūgoku areas (e.g., Tottori and Okayama). This pattern likely reflects an influx of descendants of Japanese immigrants to South American countries who came to work in auto industry jobs concentrated in Aichi and Shizuoka. Tottori and Okayama have recently received increasing numbers of foreign technical intern trainees, especially in the seafood processing industry. Increase in the employment rate was most pronounced in the Kinki region, northern Kyūshū, and the Tokyo metropolitan area. Increase in the employment rate of mothers of preschool children living in nuclear family households was highest in Toyama, Nagasaki, Fukui, and Gunma, and lowest in Hiroshima, Ehime, and Fukushima. As expected, the proportion of extended family households was higher in the Tōhoku Region (e.g. Yamagata, Akita, and Niigata) and lower in large metropolitan areas (e.g. Tokyo, Osaka, and Kanagawa) and the western part of Japan.

[9] Moran's *I* statistic measures the degree of linear association between an attribute (y) at a given location and the weighted average of the attribute in its neighboring locations ($\mathbf{W}y$), and can be interpreted as the slope of the regression of $\mathbf{W}y$ on y (Cliff and Ord 1973, Moran 1950). As noted above, we specify neighborhood structure using a queen's case contiguity weight matrix of order one.

Table 1: Descriptive statistics for variables used in the analyses

	Variable		Period of change	Source	National-level value	Min	Max	Moran's *I*
Dependent variables	Change in TFR	Overall	2005-08	Vital Statistics [5]	0.1069	0.0089	0.1628	0.343 ***
		1st order		Vital Statistics [5]	0.0472	-0.0275	0.0818	0.304 **
		2nd order		Vital Statistics [5]	0.0291	-0.0186	0.0470	0.252 **
		3rd order		Vital Statistics [5]	0.0242	-0.0116	0.0429	0.136 #
		4th and higher-order		Vital Statistics [5]	0.0064	0.0003	0.0182	0.494 ***
Explanatory variables	Change in period distortion index [1]	Overall	2004-07	Vital Statistics [5]	-0.0135	-0.1193	0.0507	-0.105
		1st order		Vital Statistics [5]	0.0529	-0.0740	0.1373	-0.031
		2nd order		Vital Statistics [5]	-0.0668	-0.1717	0.0617	0.123 #
		3rd order		Vital Statistics [5]	-0.0663	-0.2114	0.1921	-0.075
		4th and higher-order		Vital Statistics [5]	0.0511	-0.3631	0.7932	0.078
	Change in the proportion of births to foreign mothers		2005-08	Vital Statistics [5]	0.0005	-0.0033	0.0041	0.381 ***
	Change in employment rate [2]		2002-07	Labour Force Surveys [6]	0.0113	-0.0010	0.0223	0.299 **
	Change in labor force participation rate among mothers of preschool children [3]		2002-07	Employment Status Surveys [6]	0.0554	-0.0066	0.1636	-0.051
	Proportion of extended family households [4]		2005	Census [6]	0.1878	0.0789	0.5011	0.379 ***

*** p<.001 ** p<.01 * p<.05 # p<.1

1) Period distortion index is defined as $(1-m_i)$. m_i is the absolute value of change in the mean age at childbearing for birth-order i during the year the in which TFR is observed. We calculate this distortion index for three years and measure change as the difference between the values for 2002-05 and 2005-08.
2) We use difference in the average employment rates from 2001-2003 to 2006-2008.
3) For mothers who live in nuclear family households.
4) For households including preschool children.
5) Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare.
6) Statistics Bureau, Ministry of Internal Affairs and Communications.

Figure 3: Geographic patterns of change in the total fertility rate from 2005 to 2008, by birth order

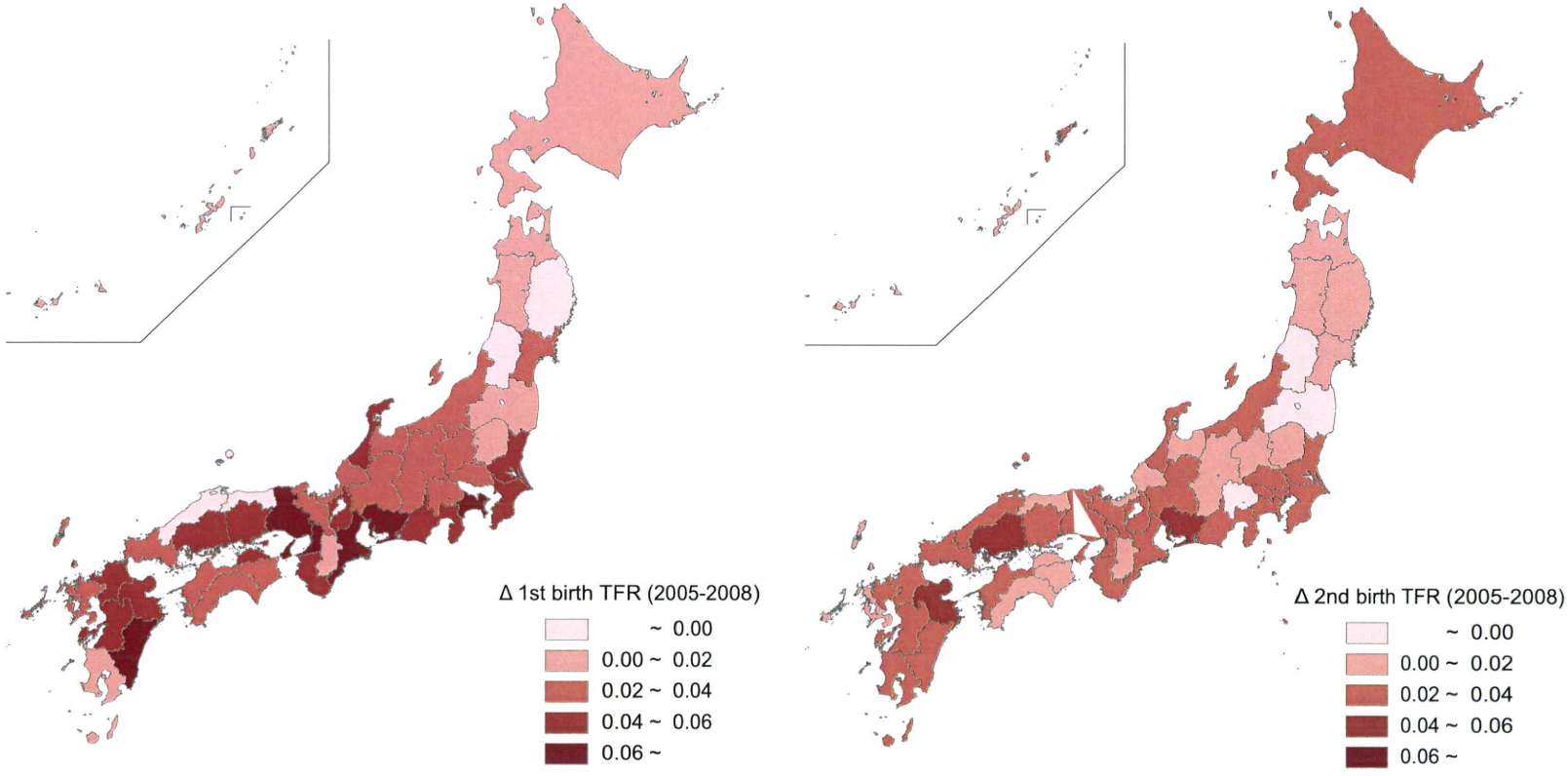


Figure 3: Geographic patterns of change in the total fertility rate from 2005 to 2008, by birth order (continued)

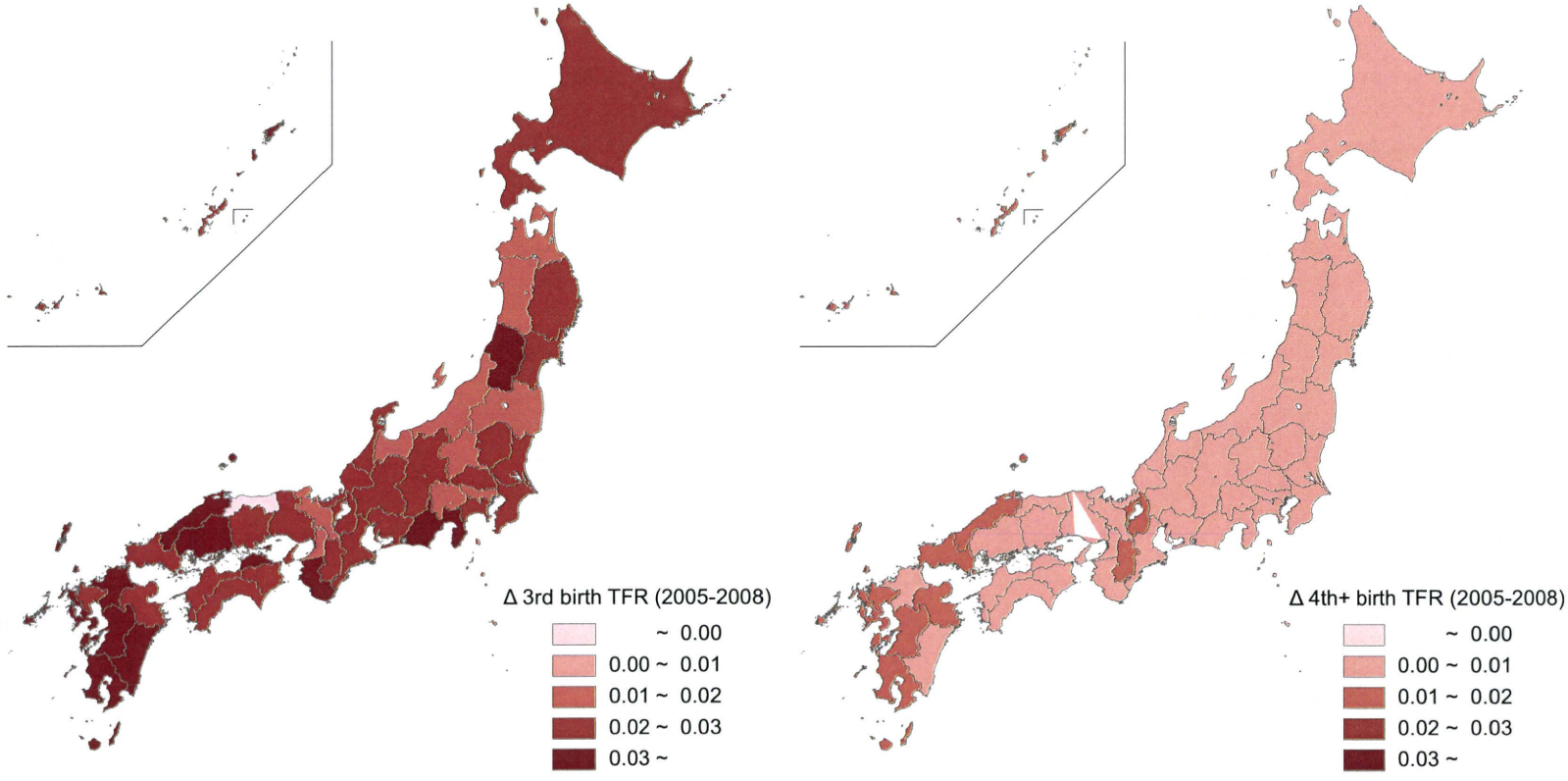


Figure 4: Geographic patterns of explanatory variables (1): Change in the period distortion index, by birth order

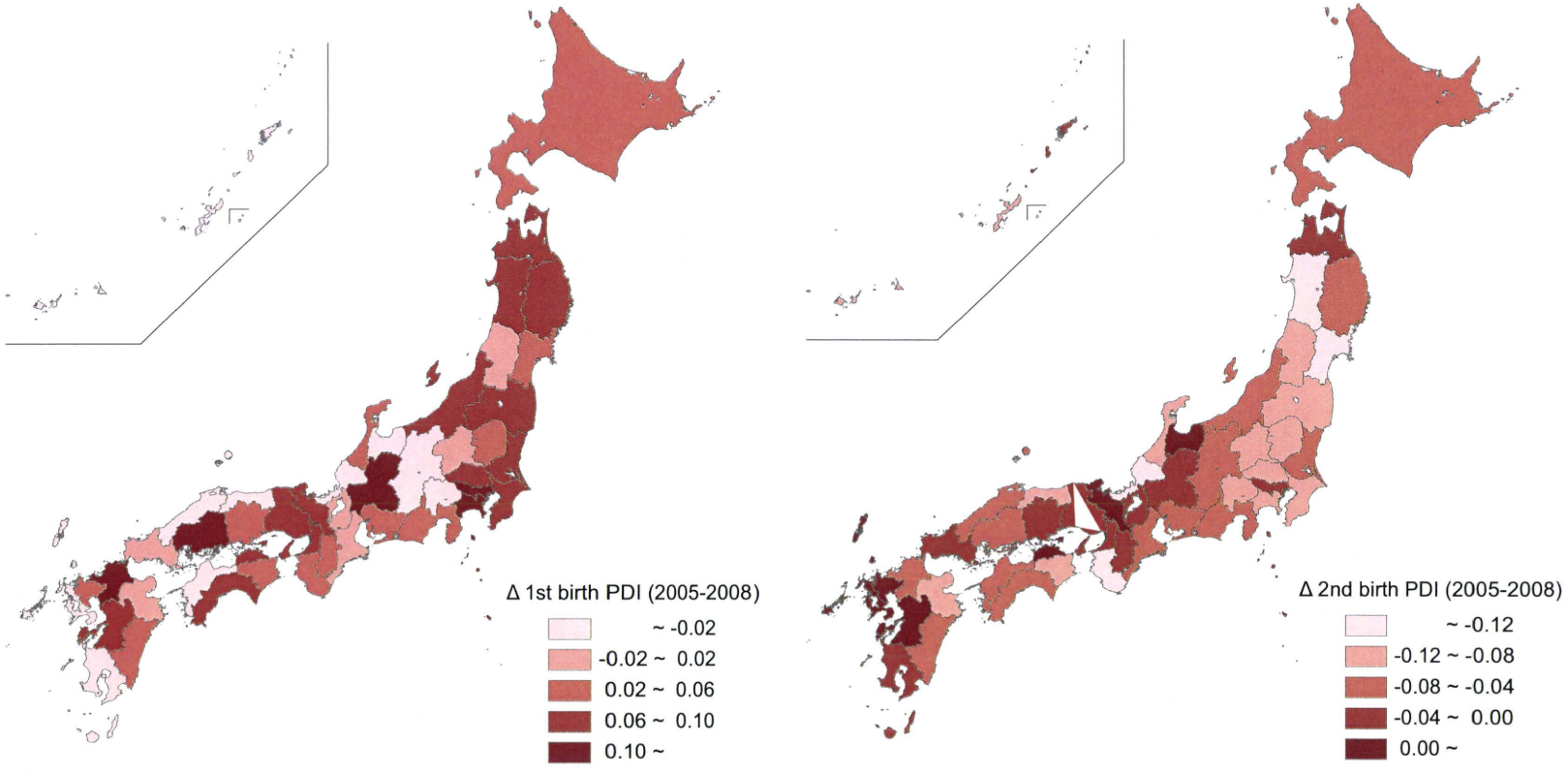
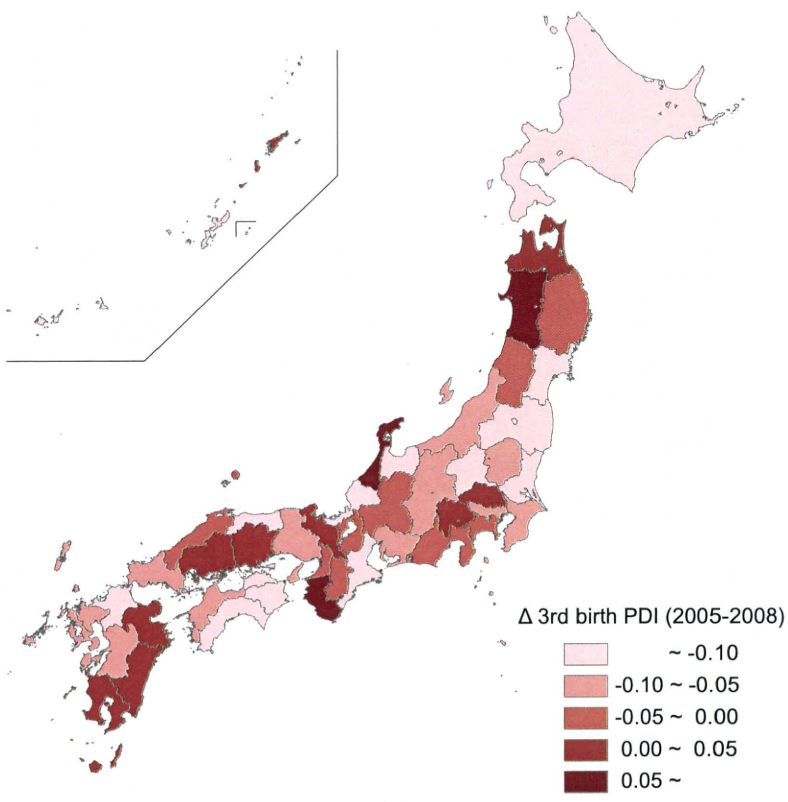


Figure 4: Geographic patterns of explanatory variables (1): Change in the period distortion index, by birth order (continued)



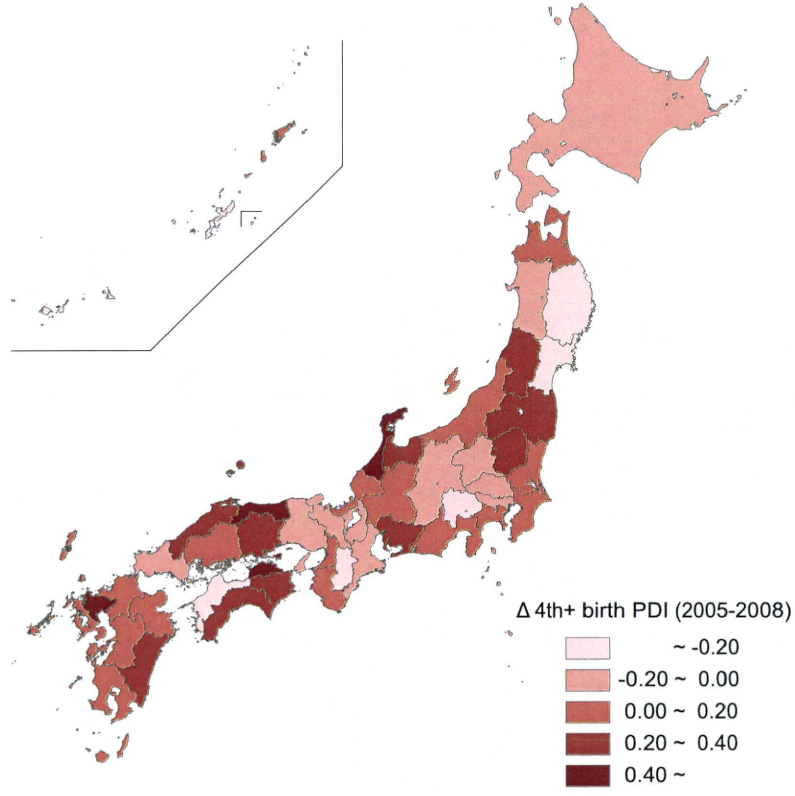


Figure 5: Geographic patterns of explanatory variables (2)