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Young Scientists Summer Program

Cohort fertility differentials from rural/urban migration at the onset of fertility transition in Brazil

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Abstract

The rapid transformation of Brazilian society from a rural into an urban population in a short period of time may have influenced fertility developments in the country. This study analyses cohort fertility differentials according to the migration status of women born between 1921 and 1945. Using census data from 1970 and 1980, we reconstruct cohort fertility at the beginning of the Fertility Transition for two regions, Southeast and Northeast. We use decomposition to quantify the effect of migration on fertility by decomposing the overall change in the CFRs into migration composition effect and rate effects. The differential between migrants and non-migrants and the fertility levels differs remarkably between NE and SE, but fertility declined among both, non-migrants and migrants. In the case of the Northeast, a less urbanised region, the fertility differentials between the groups of migrants were smaller, while in the Southeast, urbanisation already reached lower rates at the beginning of the transition, the differentials are more pronounced. The decomposition shows that the decline in cohort in CFRs being caused mostly by changes in fertility behaviours, but migration significantly contributed to the fertility decline of the 1931-1935 birth cohort.

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Cohort fertility differentials from rural/urban migration in Brazil

1. Introduction

Brazil's population has experienced rapid fertility decline which coincided with a rapid transformation from a rural into an urban society. It is, thus, essential to understand how intensive internal migration towards urban areas may impacted fertility. It is well established that urban population has lower fertility rates as compared to rural. Migration from rural areas may have slowed down fertility decline in urban areas if rural to urban migrants have higher fertility than lifetime urban residents. At the same time, rural fertility may have persisted at higher levels longer if the rural to urban migrants were selected in terms of their characteristics and had lower fertility intentions than those stayed living in rural areas.

The relationship between migration and fertility in developing countries did receive attention during the 1980s (Goldstein and Goldstein, 1981; Hervitz, 1986) when urbanisation process in many developing contexts was gaining momentum. This comparison could indicate the relative contribution of non-migrants and migrant fertility to urban fertility and total fertility (Goldstein and Goldstein, 1981).

Recently, Lerch (2019a, 2019b) studied the regional variations in rural-urban fertility in the global South using census and survey data for a large number of developing countries across the globe. In Latin America, the results showed a large and constant fertility differential between migrants and non-migrants from urban areas. The study confirmed the inflating effect of rural to urban migrants on urban fertility levels, however, it was negligible in the first transition cohorts. It is only in the last stages of the transition when fertility felt closer to replacement level that fertility inflation is more pronounced (Lerch, 2019).

In Brazil, several studies focused on the impact of urbanisation on fertility, but many restrict to selected cities or states in the country. For example, Iutaka et al. (1971) analysed the fertility of lifetime residents and migrants from Brazilian urban regions[1]. Signorini (2017) compared fertility levels of female immigrants from Northeastern region residing in São Paulo,

[1] More specifically in the cities of São Paulo, Rio de Janeiro, Belo Horizonte, Juiz de Fora, Volta Redonda, and Americana.

to levels of non-migrants born in the state of São Paulo and non-migrants born in the Northeast. The differences in fertility levels between these groups decrease over time, that is, the behaviour of migrants became closer to non-migrants in the destination, supporting an adaptation hypothesis. Boccucci and Wong (1998) studied reproductive behaviour of migrants in the Federal District and compare it with women living in the place of origin (Northeast, Minas Gerais and Goiás) of the migrants, seeking to understand whether migration causes changes in fertility or if there are selective characteristics of migratory flows. The authors used and longitudinal measurement of cohort fertility to determine completed lifetime fertility of women. Their results showed that migrants had lower rates compared to non-migrants in their origin regions (Boccucci and Wong, 1998).

The first aim of this study is to identify if there is an association between migration and completed (lifetime) fertility and, if so, how much was the effect of migration on fertility. Boccucci and Wong found an association but just using the Federal District. Despite using a cohort analysis, they don't explore rural/urban migration. Thus, the first contribution of this present paper is to fill this gap in rural/urban migration in two specific regions in Brazil, the Northeast and Southeast. The aim is to respond if there is an association between rural/urban migration and the fertility transition in the Northeast and Southeast. The second aim of this study is to identify how much was the effect of migration on fertility and if this effect between rural and urban regions slowed Brazil's fertility decline and changed the pace of this process. We already know from other cohort analyses that there is some effect, as Lerch (2019a) showed. But Lerch (2019a) did not explore how much this effect was. With the decomposition, we permit to quantify the effect of migration on fertility by decomposing the overall change in the CFRs and advancing in the study with the results found by Lerch (2019a).

We chose to analyse two Brazilian regions that are very different, both in terms of urbanisation levels and fertility, the Northeast (NE) and the Southeast (SE). The Southeast of Brazil was a region that attracted migrants, in addition to being the pioneer in fertility decline (Merrick and Berquó, 1983). On the other hand, the Northeast was largely a rural region sending internal migrants mainly towards the Southeast. We focus on the cohorts that were in their prime childbearing ages at the beginning of the fertility transition in Brazil. During the same time, there was a strong migration flow from Northeast to Southeast. For this study, we start with the first censuses to pilot the methodology, which coincides with the period of intense internal migration in the country. To achieve the main objective of this study, it is important to have a general view about the transition fertility and urbanisation processes in Brazil. Thus, the section below will provide a review with the main points of these processes.

2. Background

2.1 Fertility transition in Brazil

Until the 1960s, fertility in Brazil was at an equilibrium typical for pre-transitional populations (Paiva, 1987). After 1960s Brazil experienced a rapid fertility decline that lasted until about 2000 when total fertility rates reached close to replacement level of about 2 children per woman. Fertility transition was associated to the country's rapid economic development (Schmertmann, Potter and Cavenaghi, 2008). This rapid decline happened in the absence of strong governmental family planning policies which were important tool in some other developing settings. Compared to developed countries, Brazil witnessed a decline in fertility in a very shorter period.

In the 1960s, Brazil started its fertility transition process, first initiated in the more developed social strata. This process intensified around the 1970s, with the drop in fertility, rural regions, and lower social strata (Martine, 1996; Wood and Carvalho, 1994; Paiva, 1987). The 1960s and 1970s were also of paramount importance regarding rural-urban migration, a process of social transformation of the proletarianisation of the Brazilian population (Brito, 2009). The large flow of rural-urban migration increases subsistence costs and adds to other costs such as education and transport. Paiva (1987) related the process of falling fertility with institutional changes, such as proletarianisation and differences in access to subsistence goods. For him, the union of these two changes is essential to understand the interrelation between proletarianisation and fertility transition.

Regarding fertility control, sterilisation played a fundamental role in Brazilian fertility decline (Perpétuo and Wajnman, 1998). The government's failure to develop family policies made private bodies responsible for distributing contraceptive pills and providing access to sterilisation (Potter, 1999). But, the 1980s represented an important landmark for women's health with the incorporation of the Comprehensive Assistance Program for Women's Health

(Programa de Assistência Integral à Saúde da Mulher - PAISM), among others. In the case of sterilisation, its use, initially, was limited to women of high social class, later spreading to poor regions of the Northeast, as it was a cheap means of birth control among low socioeconomic strata (Perpétuo and Wajnman, 1998; Potter, 1999; Patarra and Oliveira, 1988; Lima and Myrskyla, 2013). When looking at contraceptives in household situations, the prevalence of women using some means was higher in urban areas but also significant in rural areas, with sterilisation predominant (Simões, 2006). The result was a drop in the marital fertility rate and women with better socioeconomic conditions (Patarra and Oliveira, 1988; Lima and Myrskyla, 2013). It was only in the middle 1980s that contraceptives became widespread among the poorest classes as a need for smaller families due to socioeconomic reasons, increased schooling and increased female participation in the labour market (Carvalho and Wong, 1996; Merrick and Berquó, 1983; Carvalho and Brito, 2005).

With these measures and incentives, fertility fell from high to very low levels, as shown and differentiated when disaggregated by regional levels. The fertility decline for all regions and social groups occurred only from the 1970s onwards (Simões, 2006); and this decline was significant strong for the and Northeast regions only from 1980 to 1991, that is after the cohorts that we used for this study completed their fertility. Meanwhile, the more developed areas such as the South and Southeast already had a fertility rate close to replacement in 2000. In 2010, all Brazilian regions had reached rates below replacement.

The South, Southeast and Midwest regions began the process of decline in the 1960s, while the North and Northeast still had high fertility. Fertility differentials also appear when disaggregated by household status. In 1970, urban fertility was almost three children less than rural fertility. The decline in fertility was more significant in the urban region than in the rural region in 1980. It was only in 1991 that a relatively similar reduction was observed between rural and urban areas. The urbanisation process directly impacted these rural and urban fertility differences due to rural-urban migration.

In addition to regional issues and household status, there is a strong correlation between fertility and schooling (Merrick and Berquó, 1983; Monteiro da Silva et al., 2022). The drop in fertility happened concomitantly with the expansion of education, directly impacting the decline in fertility rates (Rios-Neto et al., 2018; Guzmán, 1991). Schooling differentials accompany the fertility transition process from the beginning, but the educational expansion was a gradual process (Merrick and Berquó, 1983; Berquó and Cavenaghi, 2014;

Monteiro da Silva et al., 2022). An increase in schooling, especially for women, raises the opportunity cost of motherhood, leading to a later age pattern. Since 1970, there has been a considerable increase in women's schooling. In 1970, approximately 62% of women of reproductive age were classified as having functional illiteracy; in 2010, 66% of women had at least completed elementary school (IBGE, 2012).

2.2 Urbanisation

Internal migration is seen as a means to change the rigidity of social stratification and improve living conditions (Brito, 2016), and it was no different in Brazil. Between 1960 and the end of the 1980s alone, 43 million people left the countryside for the cities (Martine, 1990), coinciding with the beginning of the fertility transition. In Brazil, the process of urbanisation started with changes from a traditional agricultural society to an urban-industrial one, generating economic development, social modernisation, and regional and social imbalances. Migrations redistributed the population from the countryside to the cities, between states and Brazilian regions, including the expanding agricultural frontiers, where cities were the centres of economic activities. The advances in the means of transport and communication systems were essential for the mobility of migrants. With the development of the economy between 1950 and 1980, they contributed to the consolidation of large cities, with the expansion of the urban industrial economy in the Southeast, with migratory flows coming from agricultural or stagnant areas to urban regions (Brito, 2009; Martine, 1990; Matos and Baeninger, 2009).

Due to the spatial concentration of the industrial activity, the process of urbanisation was not homogeneous among Brazilian regions (Vergolino and Dantas, 2005). Urbanisation has been started in the Southeast in the 1950s. Meanwhile, the process started only in the 1970s in the Northeast. In 1970, the level of urbanisation in the Southeast reached 72% (TABLE 1), against 42% in the Northeast. Even in more recent years, the differences between the two areas have continued; in 2010, 93% of the population in Southeast lived in urban areas, against 50% in Northeast. The rural/urban migration predominated from 1930-1980 (Vainer and Brito, 2016).

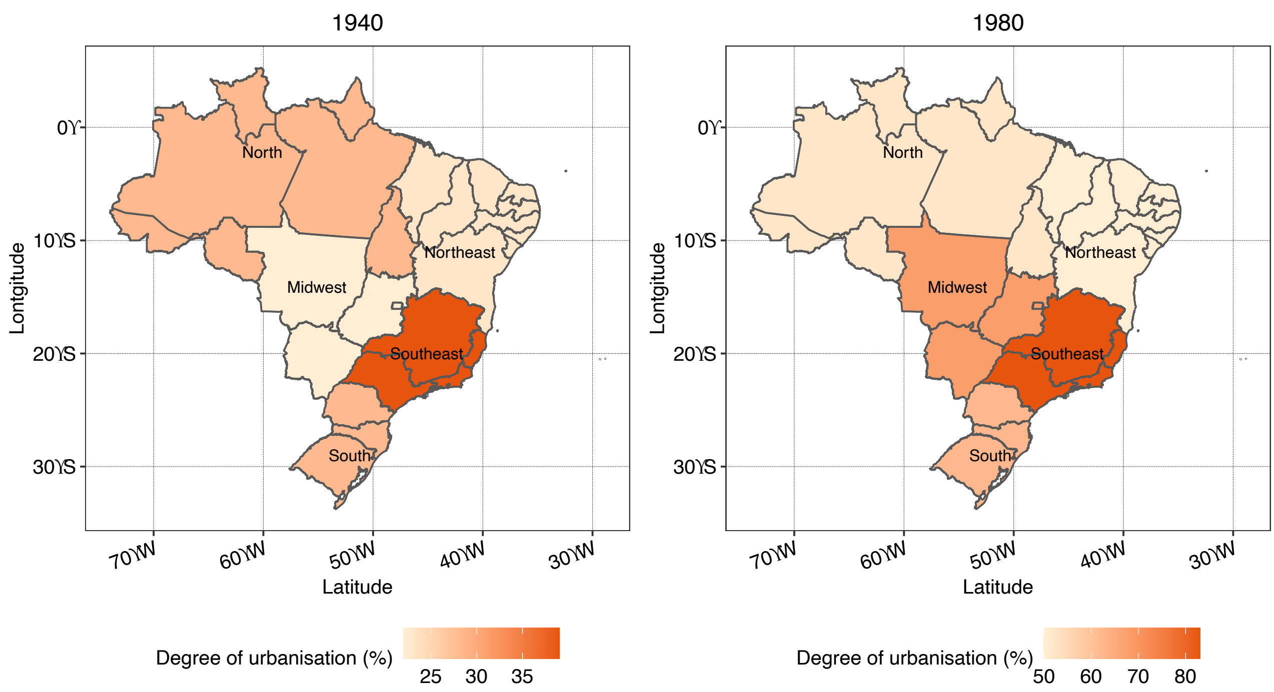
Table 1 shows the degree of urbanisation in Brazil from 1940-2010, and Figure 1 shows a map of 1970 and 2010. The Northeast has the lowest population in urban areas, while the Southeast has the most population living in urban areas, which explains the decision to study the two regions and understand their differences.

TABLE 1 – Degree of urbanisation in Brazil and regions, 1940-2010

Region	1940	1950	1960	1970	1980	1991	2000	2010
Brazil	31	36	45	55	68	76	81	84
North	28	31	37	45	52	59	69	74
Northeast	**23**	**26**	**34**	**42**	**50**	**61**	**69**	**73**
Southeast	**39**	**48**	**57**	**73**	**83**	**88**	**91**	**93**
South	28	30	37	44	62	74	81	85
Midwest	22	24	34	48	68	81	87	89

Sources: Instituto Brasileiro de Geografia e Estatística – IBGE

FIGURE 1 – *Degree of urbanisation in Brazilian regions, 1940 and 1980*



Sources: Authors’ calculations using data from Instituto Brasileiro de Geografia e Estatística – IBGE

Between 1940 and 1950, the Southeast was the region with the greatest number of migrants and the greatest urban-industrial development. Figure 2 shows the main migratory flows over four decades when the cohorts of women we study were in childbearing age. Migratory flows came from agricultural or stagnant areas to urban regions with a high degree of urban-industrial growth, such as the Southeast (Brito, 2016; Baeninger, 2011). Most of the migrants were from the Northeast, especially from 1950-1970. Northeast and Minas Gerais contributed 65% of emigrants in the 1940s and 70% in the 1950s (Brito, 2016).

FIGURE 2 – Interregional migration flows, Brazil, 1950/1970, 1970/1990, 1990

Sources: SIMIELLI, M. E. R. Geoatlas

In the 1960s, the urban population surpassed the rural population due to the rapid process of Brazilian urbanisation (Brito, 2009; Martine, 1990). In the 70s and 80s, migratory flows were concentrated in the flow to Southeast, rural-urban migration, due to urbanisation and metropolisation (Baeninger, 2015). Until the 1980s, interstate migration flows were reduced, replaced by migrations of shorter distances, intra-metropolitan, and return migration (Brito, 2002). These changes resulted from changes in production arrangements and the need for regional production (Signorini, 2017).

The Brazilian migratory process changed from the 1970s onwards. States with large volumes of immigrants showed a reduction in this volume. The entire Southeast region had a drop in the volume of migrants (Matos and Baeninger, 2009). In addition, a process of migratory reversal began (Matos and Baeninger, 2009; 2011). This process changed the status of several states, previously losers, to population gainers, emphasising the return migration between 1980-1991 (Matos and Baeninger, 2009). Migration from rural to urban areas lost intensity, a fact shown by the 1991 Census (Cunha, 2005).

3. Data and Methods

3.1 Data

We analyse changes in completed cohort fertility of women born between 1921-1945 concerning their urban/rural[2] residence and migration status using IPUMS microdata from Brazilian censuses from 1970 and 1980. The women we studied were in prime childbearing age between 1940s to 1970s – during the period of intense migration and decreased fertility as we saw in the previous section. Hence, analysing these cohorts we capture both the onset of fertility transition and urbanisation process. The IPUMS data use harmonised variables, assuring comparability across census samples (Minnesota Population Center, 2021).

We selected cohorts of women born in 1921-1945 (aged 35-49 years at the date of data collection). Cohort fertility at time of censuses is measured by a variable on total number of children ever born to a woman and is directly used to compute cohort fertility rates at ages reached at census date. We do not include older cohorts in the analysis because the quality of the reporting declines for older women (who have non-resident and possibly also deceased children) and also because of the potential selectivity due to differential mortality. For women with incomplete fertility (below age 45), we estimate their lifetime fertility, as explained in section 3.2.1.

The information on the type of current residence (binary urban/rural), the situation of the previous residence, and the duration of residence in the current municipality enabled us to identify non-migrants (life-long residents of either rural or urban municipality) and internal migrants by type of residential move between the previous and current municipality: rural to urban, rural to rural, rural non-migrants, urban to rural, urban to urban, urban non-migrants. We first calculated detailed results by all categories and due to very similar cohort fertility rates we decided to combine the rural-rural and rural non-migrants into one category (labelled rural non-migrants); and we did the same for the urban to urban and urban non-

[2] The definition of rural/urban has been the same since 1938, and follows DECREE-LAW No. 311, OF MARCH 2, 1938.

migrants (urban non-migrants). Thus, it results in four categories, and we added the rural total and urban total, which is the cohort fertility of women who lived in rural/urban at the time of the survey. The resulting typology without little represented groups is better suited for the decomposition analysis.

Because we are interested in the impact of migration on childrearing, we only consider those moves those women made before achieving late reproductive age. We have only considered residential moves before age 40 and disregarded any later residential moves because these would not have major impact on the formation of fertility preferences and behaviours.

We could reconstruct only partial migration histories of the women. One limitation of the variables we had at hand is that we could not reconstruct full histories, compute exact age at last residential move (as the data are categorised into aggregate categories for duration of residence) or identify place of childhood residence, which would be important to determine the place of socialisation of these women. According to socialisation theory, the migrant women would remain with the fertility patterns of their places of origin, but future generations would incorporate the reproductive behaviour of the new destination (Hervitz, 1986), but with the data available, it is not possible to incorporate the type of place of childhood residence.

The total of our sample is 2746318 women, 45% from the 1970 census and the remaining 55% from the 1980 census. Of this 45%, 62% represent the SE, against 38% from the NE. As for the 1980 census, 63% are from the SE, against 37% from the NE. TABLE 2 shows the sample distribution by age, census and migratory groups, according to regions. For both NE and SE, a bit more than half of the sample comes from the 1980 census (55% for SE and 53% for NE). The percentage distribution of age groups is very similar for both regions, showing a young sample with 38% between 35 and 39 years old. In relation to migratory groups, there is a certain difference between regions. For the SE, 57% are urban non-migrants, while for the NE, most are rural non-migrants (45%), followed by urban non-migrants (36%). The unknown category refers to the really unknown plus recent migrants, which we eliminate when defining who our migrants are (who migrated more than 5 years ago).

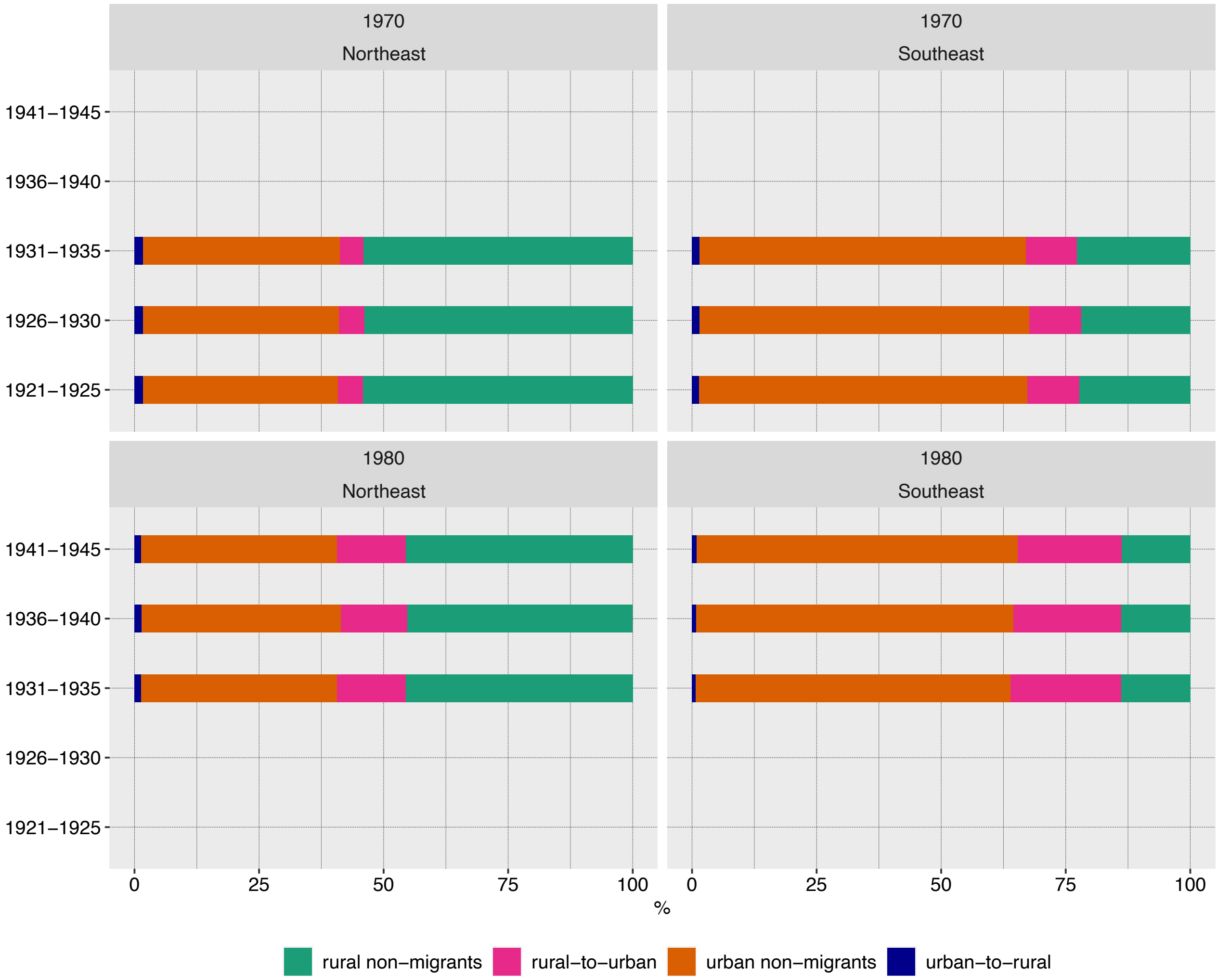
TABLE 2 - Distribution (%) of women 1921-1945 birth cohort according to migratory groups, Southeast and Northeast, 1970 and 1980

	Southeast	Northeast
census		
1970	769062 (45%)	479223 (47%)
1980	950198 (55%)	547835 (53%)
Age group		
35-39	659581 (38%)	393347 (38%)
40-44	582832 (34%)	354629 (35%)
45-49	476847 (28%)	279082 (27%)
Migration groups		
rural non-migrants	269574 (16%)	464849 (45%)
urban non-migrants	984862 (57%)	371545 (36%)
rural-to-urban migrants	250620 (15%)	86923 (8%)
urban-to-rural migrants	16981 (1%)	14181 (1%)
unkown	197223 (11%)	89560 (9%)
Total	1719260 (63%)	1027058 (37%)
N	2746318	

Sources: Authors' calculations using data from Instituto Brasileiro de Geografia e Estatística – IBGE

Figure 3 shows the distribution of the analysed cohort by this migration typology in both analysed regions. Regarding age, the two regions and the migratory groups present a similar distribution, with a larger share, almost 40%, between 35 and 39 years old and a smaller one between 45 and 49 years old, especially in the 1970 census**.** But when compare the two censuses for the Southeast, we observe a slight increase in 45-49 years and a decrease in the younger cohorts. The migration of young cohorts is important because these cohorts are more likely to have an additional child. The composition of women from birth cohort 1931-1935 that we have in both census shows how different these groups are. This may be related to reclassification of some municipalities into urban.

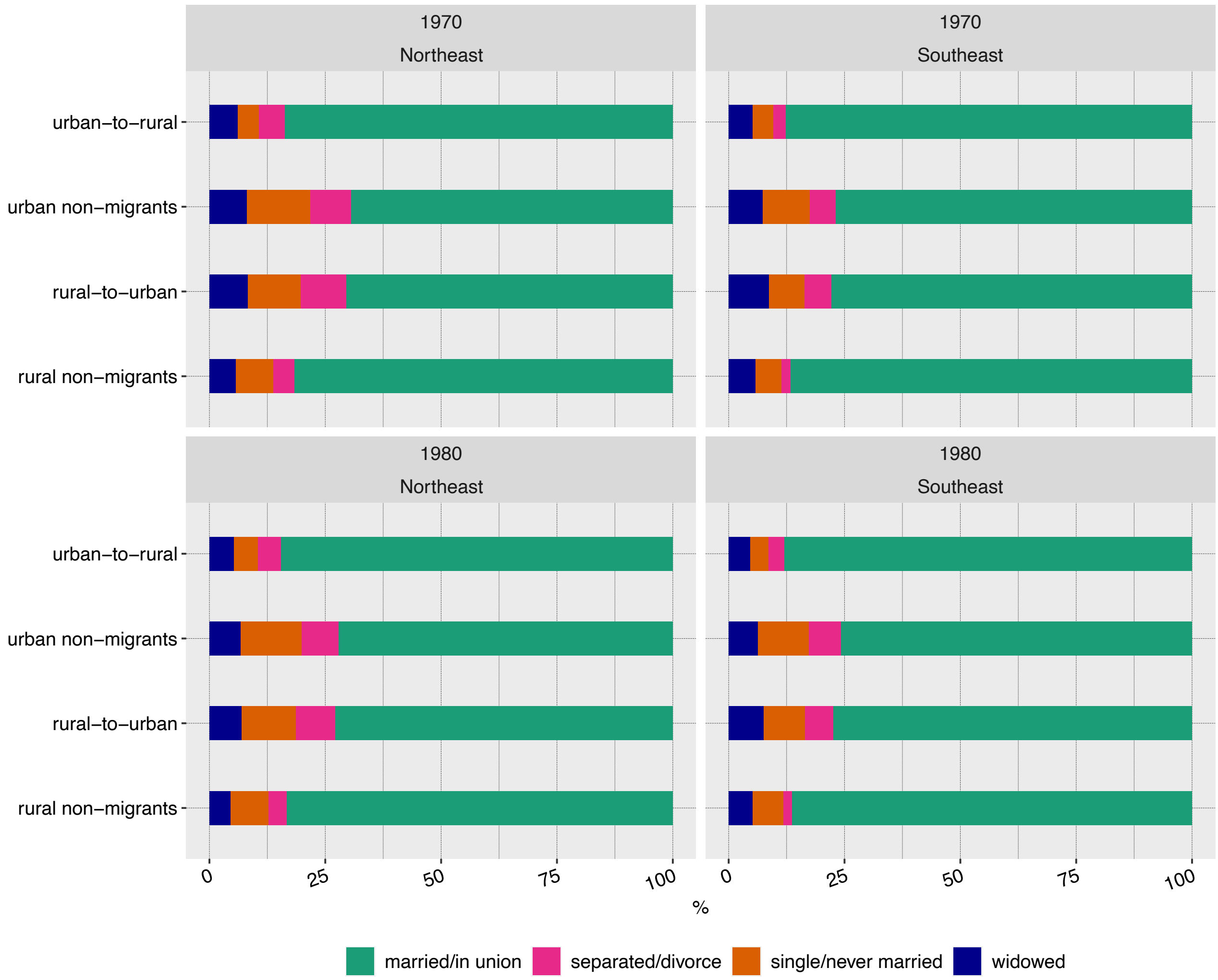
FIGURE 3 - Composition (%) of women from birth cohorts 1921-1945 according to migratory groups, Southeast and Northeast, 1970 and 1980



Source: Authors' calculations using data from Brazilian Population Censuses 1970 and 1980.Minnesota Population Center (2020)

Who are these women? Figures 4 and 5 describe these women according to marital status and educational levels. We checked these differences because these two variables could impact the decision to have children. Women married and with lower education have more probability of having more children. Regarding marital status, there is a predominance of women who are married/in union for all groups and all regions, followed by single/never married women. Looking at the chart below, it looks like married/in union women are more represented in rural areas, as in rural non-migrants and urban to rural. Urban non-migrants and rural to urban have a lower share of married and higher of single/never married for both censuses and regions. This would have implications for cohort fertility – because of the cohort tempo, that change in fertility from the timing of births in cohorts (Goldstein and Cassidy, 2014). It is expected that women with early births have more children than those who started later in childbearing.

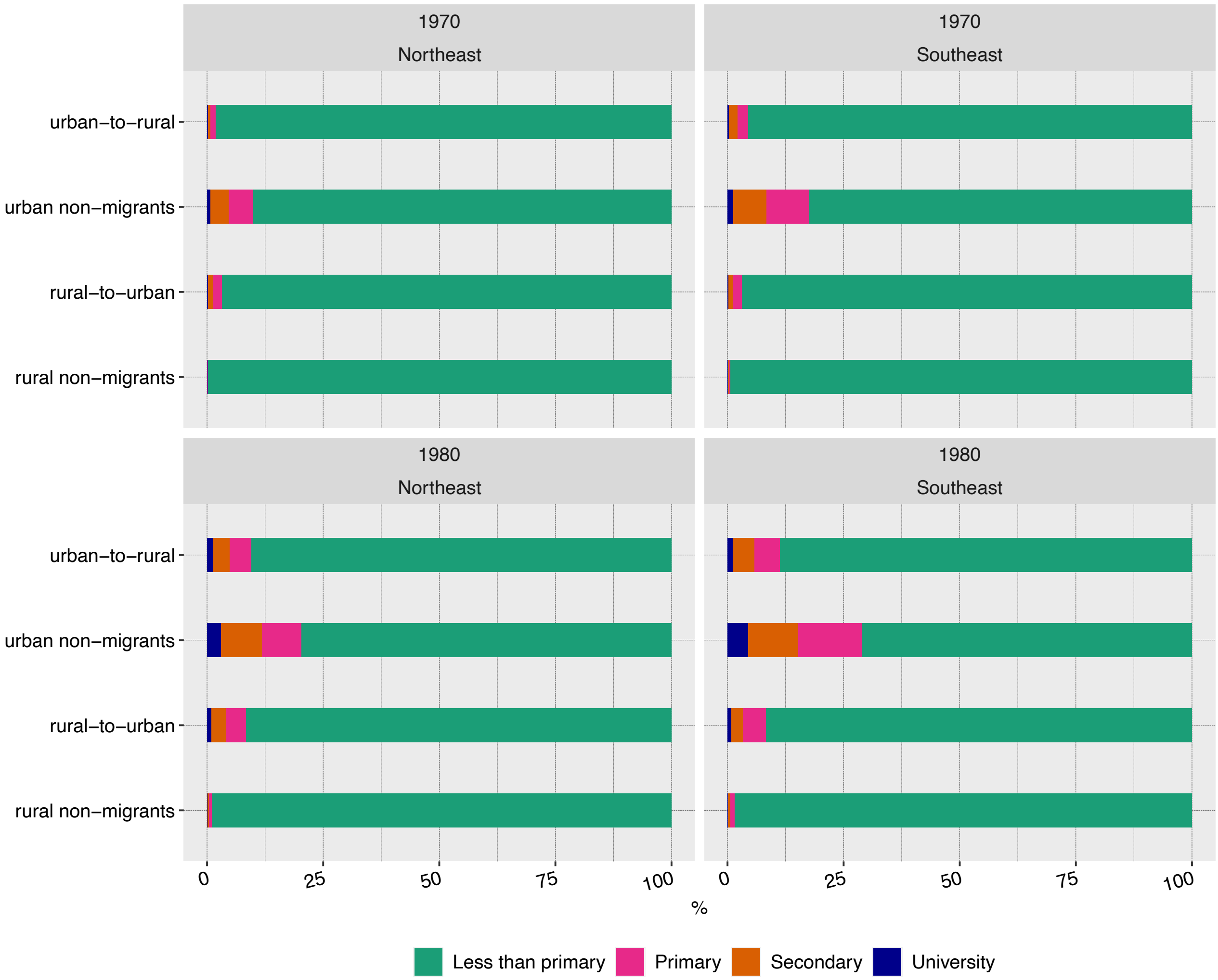
FIGURE 4 - Composition of the birth cohort 1921-1945 by marital status and according to migratory groups, Southeast and Northeast, 1970 and 1980



Source: Authors' calculations using data from Brazilian Population Censuses 1970 and 1980.Minnesota Population Center (2020)

Educational attainment among cohorts we analysed is still very low. Between 80 and 99% achieved at most primary education (6 years of school). Education can be one of the reasons for migration towards urban centres and, therefore, we would expect higher share of women with more than primary education in rural areas. As expected, we find that urban non-migrants have highest educational attainments, followed by rural to urban migrants. Furthermore, there is an educational gradient by migrant type, which can be related to the reason for migration. It is essential to highlight that the process of educational evolution had a greater prominence from 1970, however initially with the younger population (Fígoli, 2006).

FIGURE 5 - Composition of the birth cohort 1921-1945 by educational level according to migratory groups, Southeast and Northeast, 1970 and 1980



Source: Authors' calculations using data from Brazilian Population Censuses 1970 and 1980. Minnesota Population Center (2020)

3.2 Methods

3.2.1 Cohort fertility rates

The completed cohort fertility rate ($CFR_t(x)$) expresses life-time fertility of women. It is a pure quantum measure and is well suited for comparisons because, unlike total fertility rate, it is not impacted by changes in timing of childbearing. It is obtained by dividing the total number of children ever born by women born in year t up to age x by the number of women in birth cohort x born in year t:

$$CFR_t(x) = \frac{Chborn_t(x)}{w_t(x)} \tag{1}$$

Where,

- $CFR_t(x)$: Cohort Fertility Rates for cohorts of women born in year t,
- $Chborn_t(x)$: Children Ever Born to cohorts of women born in time t,
- $w_t(x)$: Total number of women from the cohort born in time t.

Because we are analysing cohort with still high fertility a non-negligible share of births occurred after age 35 or 40. Taking only fertility observed at census can distort comparison of fertility differentials among migrant groups because we can expect higher fertility, and thus higher share of births after age 35, among rural non-migrants as compared to urban non-migrants. Therefore, for cohorts younger than 40 at the census, we estimated competed fertility using the paired cohort comparison method from Brass and Juarez (1984), as in Lerch (2019):

$$PPR(35-39, t+10) = PPR(40-44, t) * \prod_{c=40-44}^{45-49} \frac{PPR(c-5,t)}{PPR(c,t-5)} \tag{2}$$

The method involves a cohort truncated approach, using parturition progression ratios (Moultrie, Sayi and Timæus, 2012; Brass-Juarez, 1983), which is the proportion of women who moved from birth order *i* that progressed to one more birth *i+1*. The method of BRASS and Juarez (1984) assumes that the fertility difference between adjacent cohorts is continuous and that there are no distortions after 30 years (Lerch, 2019).

3.2.2 Decomposition

We used decomposition to estimate the contribution of migration to fertility change. The decomposition method quantifies the effect of migration on fertility levels by decomposing the change in completed cohort fertility into migration composition and rate effect (Vaupel and Canudas-Romo, 2003).

The most frequently applied decomposition (Kitagawa, 1995) only allows to decompose the change in the rate by one characteristic. Because we are interested to decompose by more than one characteristic (migration type and education), we apply a decomposition method proposed by Lazzari, Mogi and Canudas-Romo (2021), the following mathematical formulas are used:

$$CFR\ (t) = \sum_{i=1}^{10+} \sum_{e=M1}^{M6} \frac{Chborn_i^e(t)}{W(t)} \tag{3}$$

$$CFR\ (t) = \sum_{i=1}^{10+} \sum_{e=M1}^{M6} M^e(t) F_i^e(t) \tag{4}$$

$$CFR\ (t) = \sum_{i=1}^{10+} \sum_{e=M1}^{M6} [M^e(t) F_i^e(t) + [M^e(t) F_i^e(t)] \tag{5}$$

Equation 1 was reformulated using the children born to mothers between the migratory groups *e (M1= rural non-migrants; M2= urban non-migrants; …)*, as in equation (3). This equation (3) can be decomposed into its migration composition and rate effects, as in equation (4). The partial derivative allows the decomposition of equation (4) to quantify the changes in migration composition and rate effects, equation (5). The decomposition identifies the migratory composition effect (E) and the migration-specific fertility by parity and a second analyse by education (F). The decline in cohort fertility can be explained by the drop in parity progression from the third child onwards. Thus, decomposing by parity brings another important component to explaining the decline in CFRs because it shows us the exact contribution percentage to certain effects. Thus, the method disentangles the contributions of migratory composition and fertility behaviour to changes in the cohort fertility rate among women born between 1921-1945.

We did two different decompositions. The first one was mentioned above, separating the effects of changes in cohort fertility into migration composition and parity effect (rate effect). For this, we kept the migrant groups and replaced parities with educational levels, which are no schooling, incomplete primary, complete primary, complete secondary and university. The decomposition method examines whether changes in migration groups or in educational components have had a significant impact on cohort fertility decline in the Southeast and Northeast of Brazil. As confirmed in the literature, educational attainment has an important role in the fertility decline. Thus, we expect the decomposition to quantify how much of the change is due to an intense migration between rural and urban and in the levels of education between the cohorts. Migration and education can be closely associated if education is a reason for migration to urban areas. Therefore, part of the migration effect can in fact be an educational effect. A decomposition will enable us to disentangle between the two.

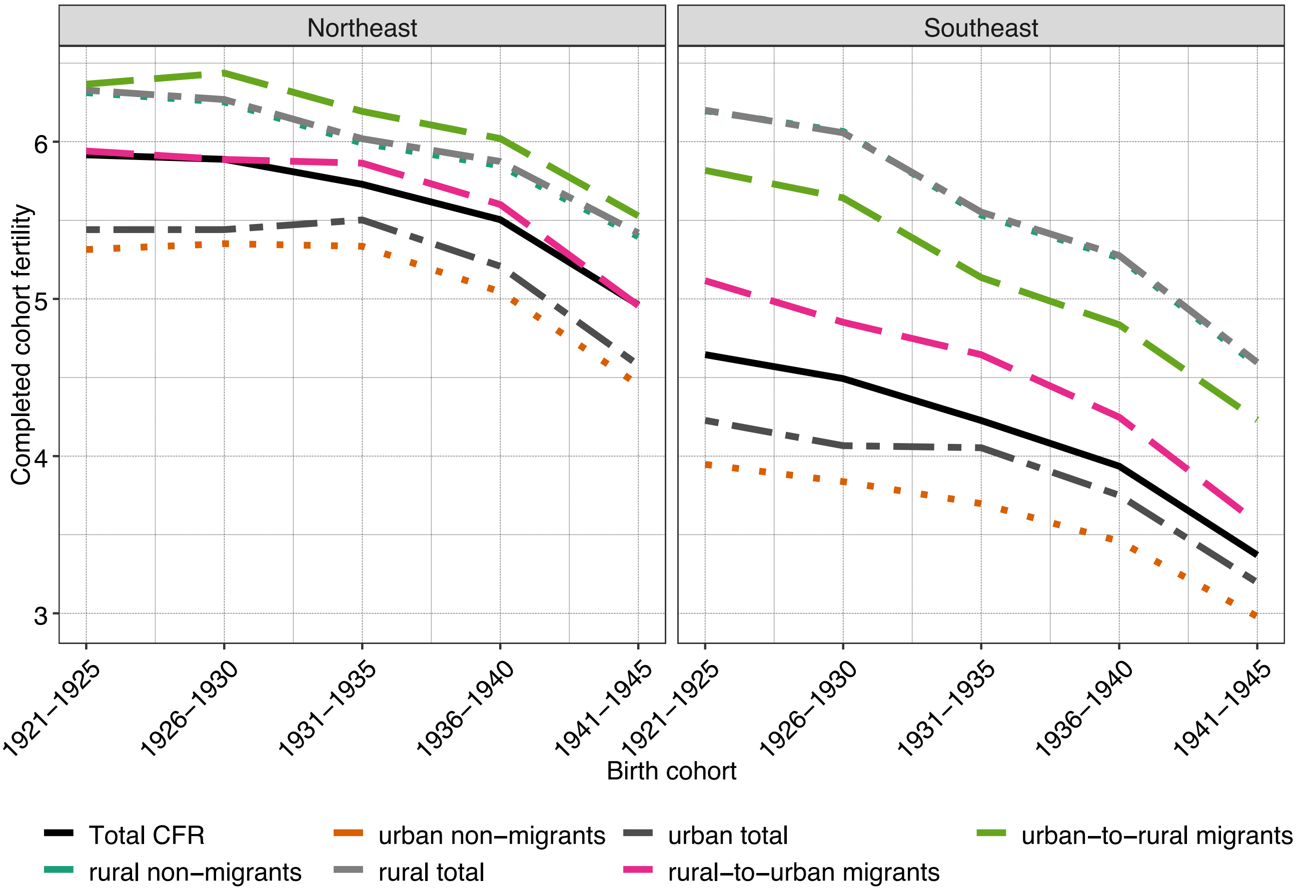
4. Results

Figure 6 shows the results for urban/rural completed fertility rates (CFRs), CFRs by migrant type within these regions and overall CFR for the whole region and birth cohort. From the overall CFR, it is clear that these rates capture only the very beginning of fertility transition in the Northeast, as CFRs for the older cohorts are close to 6, a level considered close to natural fertility with little prevalence of birth control. We can observe the start of the fertility decline only from the 1931-1935 birth cohort (when CFR declined more than 10% in comparison to previous cohort). In contrast, fertility transition had already been well progressed in the Southeast, and the CFRs for the same birth cohorts were 20% lower than in NE. The rural non-migrants have the highest CFRs. In NE, this group has similar reproductive behaviour to the urban-to-rural migrants and the level is similar to rural total (since rural non-migrants are vast majority of the rural population). For the SE, the CFRs for the urban-to-rural migrants were a bit lower than rural total but still higher than urban total. The rural-to-urban and urban-to-rural groups showed reproductive behaviour similar to that of the destination. Thus, women who migrated from rural to urban areas had fertility close to urban non-migrants, the same for the urban group for the rural group. Our results confirm that urban non-migrants CFRs were lower in Southeast that in the Northeast, below four children per woman from 1921-1925 birth cohort. This indicates that the fertility transition in this region started already among the older cohorts, which we do not capture in our analysis. In the Northeast the CFR of 4 children per women has not been reached until the last cohort studied here, born in 1941-1945. This points to about 20-year lag in the timing of fertility decline in the two regions.

SE has been already more urbanised. As expected, urban CFRs are lower than rural CFR in both regions, but the differential between the two and the levels differ remarkably between NE and SE. We find that fertility declined among non-migrants and migrants in both regions. The fertility decline was faster in the more urbanised Southeast region, where the fertility differentials between the groups narrowed but remained much more pronounced compared to the less urbanised NE. In the NE, fertility decline accelerated only from the 1936-1940 cohort, and urban and rural fertility seemed to decline at about the same pace. As in Lerch (2019), we expect that migrants have a fertility rate in-between the rural and urban non-migrants. This trend was found in both the Northeast and the Southeast, with the fertility of migrants being between rural non-migrants and urban non-migrants.

The differential between the rural non-migrants and urban non-migrants in NE was 1 child per woman for the first birth cohort, 1921-1925, then reduce to 0.6 child in 1931-1935. But from the younger cohort, 1941-1945, the differential increase to 0.94. In SE, the differential was more pronounced for the latest cohort, 1921-1925, achieved 2.25 children per woman. Even in the younger cohorts the differential was more than 1 child (1.59) between the urban non-migrants and rural non-migrants. When we compare the differentials between the urban non-migrants versus urban-to-rural and rural non-migrants versus rural-to-urban the differentials were lower, but it is still important because reached more than 1 child for the Southeast and NE for the urban non-migrants versus urban to rural group. but for the rural non-migrants versus rural to urban group the CFRs are very similar, with differentials of 0.37 for the birth cohort 1921-1925 and 0.44 for 1941-1945. While the Southeast, even for such a group, the difference remains around 1 child. For some groups, the differentials remained practically constant, mainly in the NE. While in the SE, the differentials reduced across the cohorts, especially when comparing urban non migrants with rural non-migrants (from 2.25 to 1.59). A reduction in relative differentials may indicate convergence or diffusion of new reproductive behaviours resulting from the fertility transition.

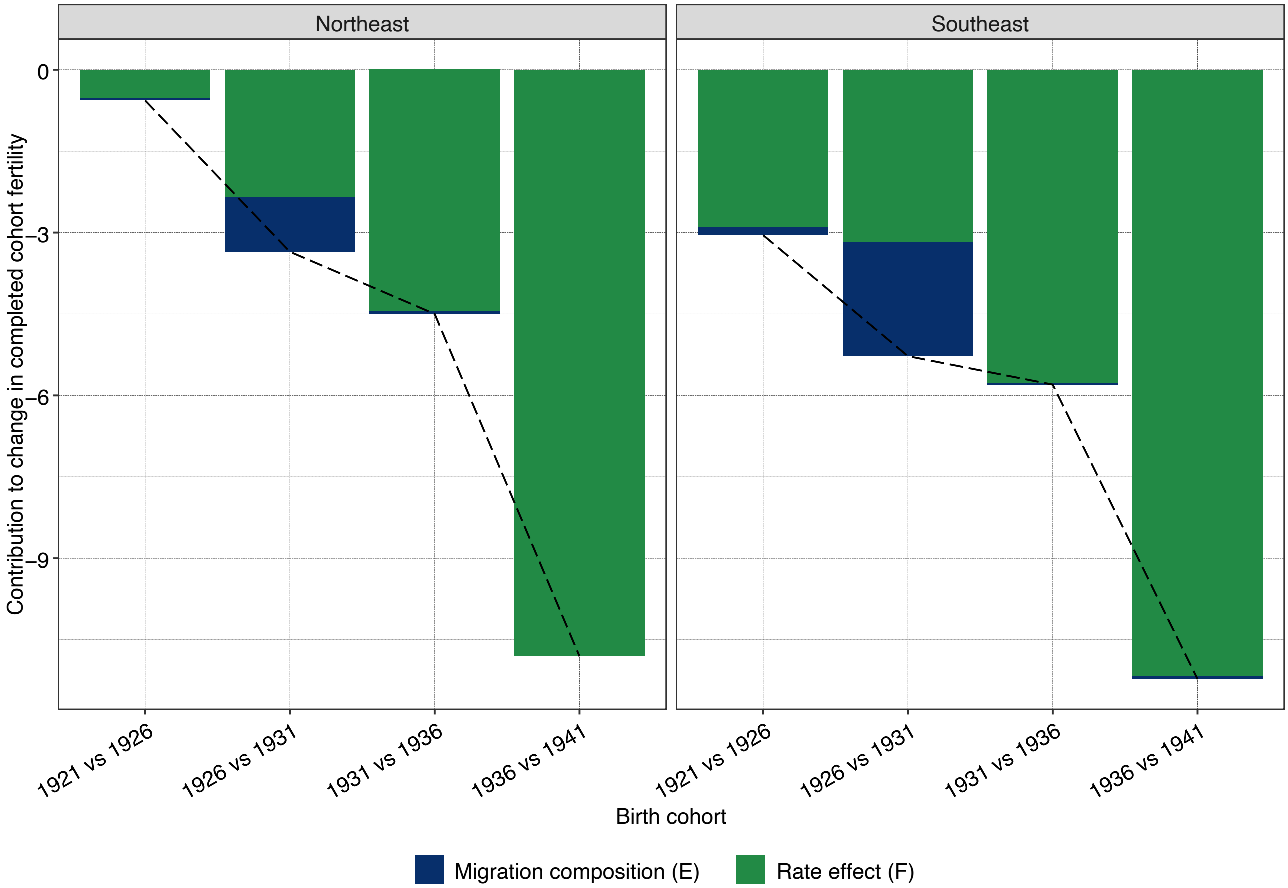
FIGURE 6 - Cohort Fertility rates from in-migrants and non-migrants, Southeast and Northeast, births cohorts 1921-1945



Source: Authors' calculations using data from Brazilian Population Censuses 1970 and 1980. Minnesota Population Center (2020)

Figure 7 shows the results of the decomposition of a change in CRFs between the birth cohorts. The effect size corresponds to the difference in CFR between the two birth cohorts. We can see that the decline was getting more pronounced in the younger birth cohorts. For instance, 1926-1930 versus 1931-1936 births cohort, the CFR declined by 0.23 child per woman in NE. 30% (-1.01 changed in standardised) of this 0.3 difference is by migration effect, and the remaining 60% of the decline is explained by other behaviour changes (the rate effect) unrelated to urban to rural migration. In the SE, the decline was 0.26 child per woman. The migration effect (E) was 40% (-2.10 change in standardised), in other words 40% of the 0.26 is explained by the migration effect. Thus, migration appears to be just the start of the change, cohorts 1926 versus 1931. When comparing the younger cohorts, the migratory effect disappears, and behavioural change is the dominant driver of fertility decline.

FIGURE 7 - Decomposition of the change over time in completed cohort fertility of women born in 1921-1945

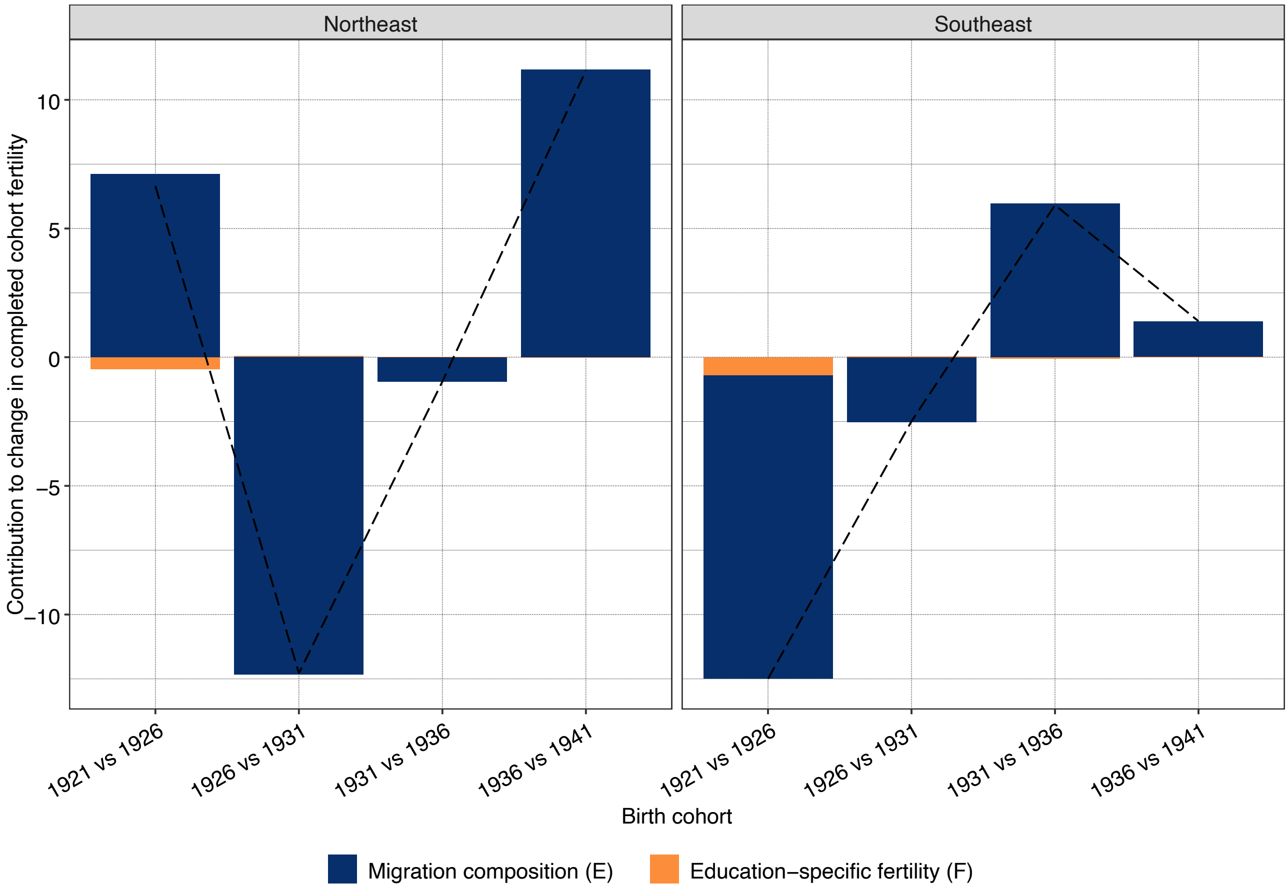


Source: Authors' calculations using data from Brazilian Population Censuses 1970 and 1980.Minnesota Population Center (2020). Notes: All values are multiplied by 100

Figure 8 illustrates the decomposition by educational attainment of the change in CFRs between the birth cohorts. In this case, we separated the effects from migration composition (E) and educational-specific fertility (F). Because education is associated with lower fertility, increasing educational attainment may have contributed to fertility decline. The education opportunities may also be a driver of rural to urban migration, therefore, we would like to disentangle these effects. As seen in the descriptive part of this study, nearly the entire sample attained less than primary education. Thus, it would be expected that there would be no or very limited educational effect because these migration groups do not differ by educational and the decline was similar among all. The educational expansion in Brazil was more pronounced in the years following the one used in this study. The decomposition shows a small education effect between the older cohorts, 1921-1925 versus 1926-1930 for both NE and SE.

The role of educational composition was marginal for both NE and SE, and the changes in fertility were attributed to migration.

FIGURE 8 - Decomposition of the change over time in completed cohort fertility of women born in 1921-1945



Source: Authors' calculations using data from Brazilian Population Censuses 1970 and 1980. Minnesota Population Center (2020). Notes: All values are multiplied by 100

5. Discussion

Previous studies showed that the fertility transition process in Brazil was faster than in developed countries. The rapid decline in fertility in Brazil was primarily marked in urban regions. It then spread to all parts and social strata, which explains the reduction of differentials across cohorts in both areas, especially after the 1931-1935 cohorts. The initial period of fertility transition was marked by an intense internal migration. With that in mind, one first hypothesis is that migration probably had some impact on the fertility transition.

Studies, like Lerch (2019a; b) confirm some effects between migration and fertility, but not looking to the two regions here analysed, the Northeast and Southeast. The main goal of this analysis was to contribute to studies on the relationship between fertility and migration. First, observing whether there are fertility differentials between migrants and non-migrants, which would answer the first research question. The results showed that, indeed, there are fertility differentials between migrant and non-migrant groups; that is, we found an indirect effect of migration on fertility, that's confirms Lerch's study. The importance of the indirect effect of migration on total fertility varies with the degree of urbanisation in the region and differences in fertility. In the case of the Northeast, a less urbanised region, the fertility differentials between the groups of migrants were smaller, while in the Southeast, urbanisation already reached lower rates at the beginning of the transition, the differentials are more pronounced, as in Lerch (2019). Several others factors, not analysed here, were very important for the transition, such as the introduction of birth control, which has been widespread since the early 1960s (Perpétuo and Wajnman, 1998; Potter, 1999), and possibly being more widespread. important than migration in this first moment of transition.

Looking at the groups of migrants, the CFRs of rural-to-urban migrants were in the middle – different to rural and urban lifetime residents. Only among the later cohort's migrant fertility declined towards the levels in the more urbanised Southeast region. This trend possible indicates a selectivity hypothesis, assuming that migrants are composed of a selected group with different characteristics from the women in the origin (Ribe and Schultz, 1980). We find an effect of rural to urban migration in the very early stages of the transition and hypothesise, by Lerch's (2019) findings for broad world regions, that the compositional effects would play a more prominent role at later transition stages when fertility declines towards two children per woman and with educational expansion towards higher education. This effect is expected to be higher in later cohorts.

However, the decomposition of rates showed that if it were not for rural/urban migration, the fertility rate would be higher in the SE for the birth cohort 1926-1930 and 1931-1935. In other words, the migratory effect seems to accelerated the initial pace of the demographic transition for these cohorts, especially in SE.

It is essential to point out the limitations of this paper which arise mainly due to data availability. The first limitation would be the changes in census questionnaire questions over the years. Although Brazil presents censuses from 1970, 1980, 1991, 2000 and 2010, we only use those from 1970 and 1980 because they have similar questions, so we do not lose comparability. Although the initial intention was to analyse whole census data time series, the differences in the way data on previous residence were collected and the fact that type of previous residence has only been collected for recent migrants, limited the usability of the more recent census data. The main limitation, however, is the absence of migration histories

– we don’t know how many moves and between what types of locations women made, at what age and we also don’t know the childhood place of residence. This information would have been very relevant to more precisely test the significance of migration for fertility outcomes and would have enabled us to test to some extend also the socialisation hypothesis. Since we don’t know the timing of migration and births, we cannot determine fertility completed before the most recent move. We have to assume that women lived around the time of the start of childbearing in the same type of residence as the one of the previous residences recorded in the census. This would be a strong assumption if most moves were very recent and if it was very common to move between different types of residences frequently during one’s lifetime.

Last but not least, this study helped us set up methodology which we can use for the analysis of fertility change in younger cohorts using data from Demographic and Health Surveys for Brazil. This data includes information of birth histories, current and childhood place of residence and can shed more light on the role of internal migration and rural to urban migration in younger cohorts and at the time when fertility transition has been more progressed and fertility was declining rapidly towards the replacement levels.

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