THE MOTHERHOOD PENALTY IN THE BRAZILIAN LABOR MARKET: AN AGE-PERIOD-COHORT ANALYSIS

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1. INTRODUCTION

This paper has the objective to investigate the presence of a motherhood penalty in the Brazilian labor market, analyzing differences in labor participation rate and hourly wages between mothers and childless women in distinct moments of life course of both groups, as well in different periods and cohorts. In order to accomplish this goals, Age, Period and Cohort (APC) models were used (Mason et al, 1973; Fienberg e Mason, 1985).

Several factors can corroborate to explain the disadvantages that mothers face in the labor market in comparison to childless women. The main disadvantages are: i) less experience accumulation due the interruptions in labor participation to take care of children; ii) decline in productivity due the difficulty to conciliate remunerated jobs with home tasks related to the children; iii) insertion in “mother friendly” jobs, which generally have flexible shifts, but tend to offer lower wages; and iv) residual factors, many times associated to discrimination in relation to mothers (Budig e England, 2001).

In Brazil there are few papers dedicated in analyzing the differences of wages and labor participation between mothers and childless women (some examples are: Pazello and Fernandes, 2004; Souza, Rios-Neto and Queiroz, 2011; Paulo, 2013; Guiginski, 2015; Souza, 2016). The differences in the present work in the relation to the papers already conducted is the focus on the age, period and cohort dimensions. We believe that this approach is relevant, once the three effects can contribute to explain the penalties faced by mothers in comparison to women without children in the labor market.

Studies conducted in other countries show that the moment in the life course – in other words, the age – in which are the women analyzed is important to explain the existence of penalty to mothers on their wages and labor market participation (Abendroth et al, 2014; Khan et al, 2014; Neumeier, Sørensen e Webber, 2018). On one hand, the more

experience in balancing motherhood and labor, plus the independence and growing of their children can contribute to the reduction of penalty in more advanced ages; on the other hand, the discontinuity in experience of mothers can difficult the insertion in job positions with higher salaries or delay their carrier progression, provoking a crescent disadvantage in relation to those women without children.

A key aspect that touches the motherhood penalty in the life course is the moment of woman's life that occurs the child birth. As an example, women that delays their motherhood probably will have higher human capital volume in the moment of the first birth. So, the penalty suffered by such women would be distinct of that experienced by women who had their children in their youth. Landivar (2008) showed to the United States that mothers inserted in occupations categorized as "professional" – with better remuneration – have experienced a higher wage penalty with precocious motherhood. The postponement of the first birth reduced the penalty in those higher wage occupations, while women in lower wages occupations show a small economic benefit from a late motherhood.

Fluctuations in the economic scenario can also interfere in the variables related to women work, and may affect differently mothers and childless women. For example, in periods of economic prosperity, mothers that have financial support of their partner can choose to offer a small number of hours to the labor market in order to dedicate more time to child care; at the same time, childless women can prefer to stay employed to ascend in their career, even having the support of their partners. Then, the period in which the motherhood penalty is analyzed can be a relevant factor to be considered.

Generational factors can also contribute to the differentials between mothers and childless women in the labor market. At first, it would be expected that the wages differential between mothers and childless women reduces in younger cohorts due smaller disparities of the productive characteristics (human capital) and lower discrimination. Nevertheless, this trend is not always observed. Avelar e Smock (2003) analyzed two young cohorts in United States of America and concluded that the wages differential between mothers and childless women remained stable, even the formers are leaving the labor market due to motherhood for a smaller period.

Hence, we understand that the APC approach is adequate to investigate the relative importance of these three effects, as will be presented later. To attend this purpose, this paper is divided in other three sections, beyond this introduction. The second section has a contextualization of the Brazilian background in relation to the women participation on the labor market and the fertility decline in the country. The third section brings a brief explanation on the data and methods used and the last two sections touch, respectively, the discussion of the results and the final considerations.

2. THE BRAZILIAN CONTEXT

The women participation in the Brazilian labor market showed a significant increase in the 1970s, with the acceleration of the industrialization and urbanization of the country, followed by the extension of the job offer. (Hoffmann and Leone, 2002; Lavinas and Nicoll, 2006). Before that, these women occupied job positions in education and health sectors, in the cases of the ones with better SES, or the paid domestic work and textile industry, in the lower social strata (Daniel, 2011). The increasing job offer in the 1970s was followed by a demand for work due the surge of new products that increased the individual standard consumption, and also an intense affirmation movement of the women space in society, corroborating to the increase of women participation in the labor market at the time (Bruschini, 1994).

The women in the 1980s kept amplifying their participation in the labor market, despite the deteriorating economic scenario caused by the recession. According to Wajnman, Queiroz e Liberato (1998), the expansion of the third sector was one of the main causes to the increase in the participation even in a unfavorable scenery. Then, the women started to have possibilities in economic activities such as commerce, administrative routines and banking services, among others. In opposition to the last period, in which the female participation expanded mostly among young women with lower education, the women in the 1980s that started in the labor market were, mostly, older than 25 years old and married (Hoffman e Leone, 2002).

The economic transformations in 1990s contributed to the increase of the unemployment rate and quality deterioration of the job positions, affecting the activity rate not only on women, but the whole population (Wajnman, Queiroz e Liberato, 1998). Although the female economically active population kept increasing, the

creation of formal job positions was not sufficient to absorb this contingent, culminating in the precariousness of female work, increase of informal activities or those that demanded a small level of instruction (Hoffmann e Leone, 2002). The female unemployment soared in a higher magnitude in comparison with the male unemployment, and both genders competed between themselves for positions in the service sector, given the deterioration of the industrial activity (Lavinas et al, 1999).

In the 2000s it was initiated a period of economic prosperity that reflected in the labor market, with reduction of the unemployment rate and increase of real income. Furthermore, this period can be categorized by the formalization and the reduction of the percentage of workers without formal jobs. This scenery culminated in the increase of the economically active population in the period for both genders, but proportionally better for the female (Oliveira e Colombi, 2014). Women with elevated educational levels obtained progresses in prestige and management positions; although, most of the female participation was still concentrated in niche activities considerate precarious, as domestic service, self-consumption or family activities. The profile of workforce kept the trend initiated in the 1980s, that is, older women, married and mothers (Bruschini, 2007).

Between the end of the 2000s and the beginning of the 2010s, the female participation in the labor market suffered a decline, and the recovery started in 2013 was not converted in the increase of occupational levels, but unemployment (Wajnman, 2016). The intensified deterioration of the economic scenario from 2015 onwards contributed to an increasing unemployment rate between women, and also informal positions.

In relation to the fertility transition in Brazil, the first evidences of reduction in the Total Fertility Rate (TFR) were observed between the Demographic Census of 1960 and 1970, when the level was reduced from 6.2 to 5.8 children per woman. In the following decades, the TFR of the country presented consecutive declines: 4.4 in 1980; 2.9 in 1991; 2.4 in 2000 and 1.9 in 2010 (IBGE, 2010).

Some phenomena demonstrated to be determinant to the onset of fertility in Brazil. One of these phenomena was the fast diffusion of contraceptive methods, mostly in lower developed region of the country and rural areas (Carvalho, Sawyer and Paiva, 1981; Merrick and Berquó, 1983; Marine, 1996). The elevated life cost during 1970s

and the intensification of industrialization in detriment of domestic production established obstacles to the maintenance of large families, mainly in the lower income strata, stimulating the contraception (Carvalho, Sawyer and Paiva, 1981; Amaral, Almeida and Gonçalves, 2015).

The increase in education and female participation in the labor market are also related to fertility decline in the country (Merrick and Berquó, 1983; Amaral, Almeida and Gonçalves, 2015). The insertion of women in the labor market had limited their availability for house chores and family care (usually imputed to women), getting more expensive the value of their time, thus, disincentivizing the motherhood. This opportunity cost would be higher to women with a higher education, given that these women tend to occupy positions with better remuneration (Simão et al., 2020).

Other phenomena related to fertility trends in Brazil are the elevation of the average age of women at their first birth and the growing number of childless women. In the Brazilian context, the fertility postponement could be perceived in the majority of Brazilian regions between 2000 and 2010, (Miranda-Ribeiro, Garcia and Faria, 2019), and it is intrinsically related to the investments in education and labor market experience (Berquó and Garcia, 2012). In relation to childlessness, the studies already conducted showed that women with lower level of education and income are in general less prone to absence of children at the end of their reproductive period in comparison to those with elevated SES (Cavenaghi e Alves, 2013; Fujiwara, 2018; Leocádio, 2019; Simão et al., 2020).

3. DATA AND METHODS

The international studies about motherhood penalty in the labor market use, mostly, longitudinal data, in which the same individuals are followed through their life course. The scarcity of this type of data in Brazil makes it impossible a traditional longitudinal analysis. Hence, it was used transversal data from the National Household Sample Survey (PNAD), performed annually by the Brazilian Institute of Geography and Statistics (IBGE). Matrices of age by period (A X P) were elaborated for the hourly wages and labor participation rates of mothers and childless women. The ages are arranged in rows, the periods in columns and the cohorts are the diagonals formed by the other two dimensions. The selected age range is between 25 and 48 years, and

the periods are between 1992 to 2015, generating matrices with dimensions 24 x 24 and 47 cohorts.

Regarding the method, it was used the approach of Mason (1973), which associates the APC perspective to econometric modeling using a linear regression, in which the dependent variable is the attribute under study - in the present work, the hourly wage and the labor participation rate of mothers and non-mothers - and the independent variables are the dimensions of age, period and cohort. An obstacle to the estimation of this regression by Ordinary Least Squares (OLS) is the linear dependence existing between the regressors, making it impossible to reverse the coefficient matrix, which in this situation does not have a full rank and, for this reason, does not admit an inverse, being a singular matrix. The solution used to deal with the identification problem of the APC model was the use of Restricted Generalized Linear Models (RGLM) in order to change the linear relationship between age, period and cohort with the application of restrictions (Fienberg and Mason, 1985).

In models whose dependent variable is the hourly wages, the estimation was performed by OLS with the dependent variable in logarithmic format, while in models in which the dependent variable is the participation rate, a Poisson model was used, in which the dependent variable is the population in the work force and the offset is working age population. It is noteworthy that, the sample used to the analysis of hourly wages differs from the one used to analyze participation rate, as can be verified in the Appendix I of this paper, that shows the number of observations in each matrix cell A x P for both variables.

Table 1 shows the different specifications estimated. In the complete models (models that have three dimensions), it was chosen to use the restricted models as proposed by Mason (1973) and Fienberg e Mason (1985), in a way that restrictions were used in each one of the components. The age restriction consisted in equal the match the effects of the last two ages of analysis (47 years old = 48 years old); the same procedure was used to the period restriction (2014 = 2015). In relation to the cohorts, it was chosen to apply the restriction in the most completed cohort, related to the women born in 1967, matching its coefficient with the second most completed cohort, of women born in 1968.

Table 1. Specifications of the estimated APC models

Specification	Explanatory variables
A	Age Only
P	Period Only
C	Birth Cohort only
AP	Age and Period
AC	Age and Birth Cohort
PC	Period and Birth Cohort
A_PC	Age, Period, and Birth Cohort, with resctriction applied to age (47 y/o = 48 y/o)
AP_C	Age, Period, and Birth Cohort, with resctriction applied to period (2014 = 2015)
APC_	Age, Period, and Birth Cohort, with resctriction applied to cohort (1967 = 1968)

Source: Own elaboration based on the results of the models.

Some noteworthy observations. The National Household Sample Survey (PNAD) was not performed in all years of the selected period; in 2000 and 2010 because of occurrence the Demographic Census, and in 1994 the research was not performed. In these cases, it was calculated the mean of the year between the prior and the following to the absent research. Furthermore, because the annual series were used for simple ages, the sample in each cell in the matrix A x P becomes small, as shown in the Appendix I. So, the presented data show many oscillations, making it necessary the use of the smoothing nonparametric method *Locally Estimated Scatterplot Smoothing* (LOESS – Cleveland e Devlin, 1988).

4. RESULTS AND DISCUSSION

Hereafter are presented the results referred to the APC models. Initially, it is analyzed in a descriptive way the variables of interest of the models – hourly wages and labor participation rate. Then, it is shown the results of the estimation performed.

4.1. Descriptive Analysis

The descriptive analysis for hourly wages / participation rate was carried out from a visual inspection of the tendencies of period and cohort. In plots that show theses tendencies, the ages are in the x axis and the variable in analysis in the y axis, while the different curves represent the periods or the birth cohorts. It was chosen to arrange

age, periods and cohorts in triannual groups in order to improve the visualization. Beyond the plots for mothers and non-mothers, it was represented the ratio of the means of each variable between the two groups of women. Thus, values lower than unity (100%) denote that the mean of the variable under analysis is lower for mothers than for childless women. Two-sample t-tests were performed in order to analyze the statistical significance of the difference between the attributes of mothers and childless women, and these differences were shown to be statistically significant for all variables, in all age groups. The test statistics are shown in Appendix II of this paper.

Before analyzing the aforementioned variables, it is presented the sample composition (Figure 1). From this figure it is observed, both for the sample of hourly wages and participation rate, that the percentage of mothers increases progressively until around 38 years of age, when the rhythm of growth reduces. This change in the composition by age reflects the migration of women from the childless group to the group of mothers through the ages, making the first group smaller and with specific characteristics, an issue considered in the following analysis.

Figure 1. Sample composition to hourly wages and labor participation rate of mothers and childless women between 25 and 48 years old, Brazil, 1992 to 2015

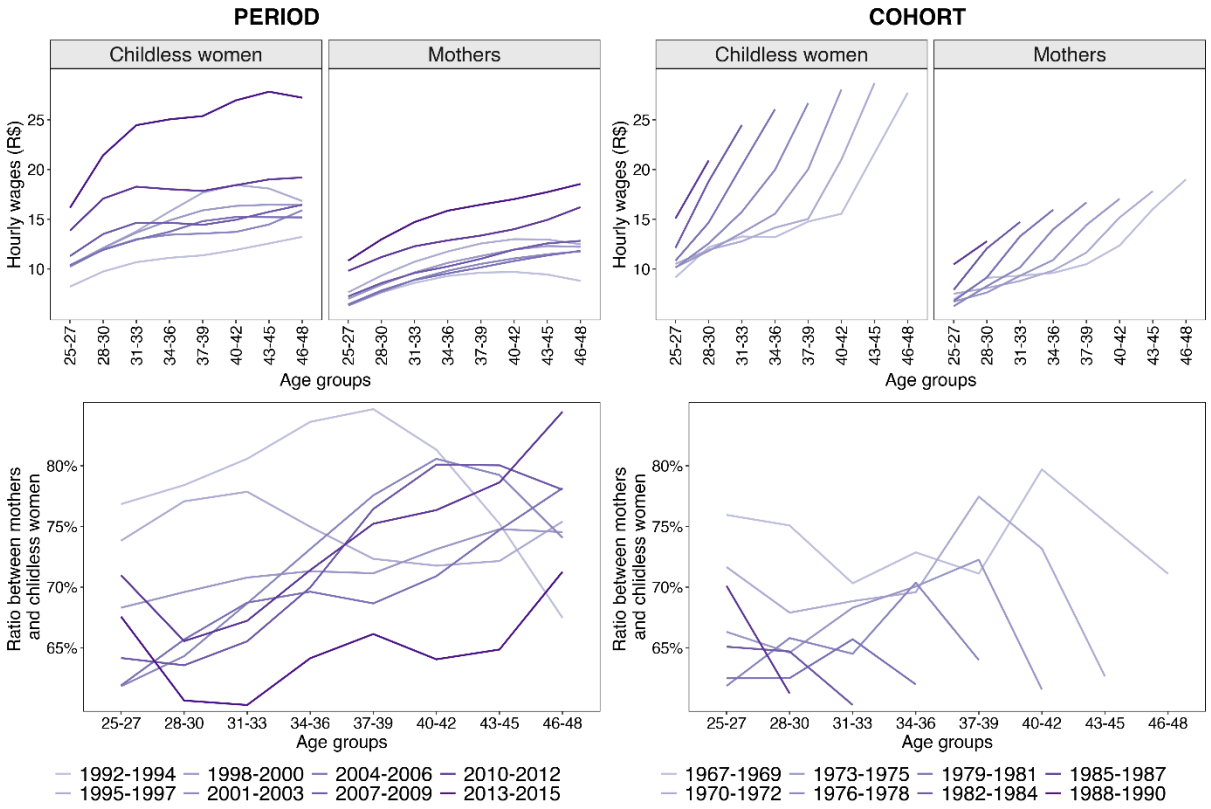
Source: PNAD microdata (1992 to 2015).

Regarding hourly wages, changes in level and pattern of the curves from mothers are overserved in Figure 2. In older periods (lighter curves), the income is relatively lower than recent periods and seem to initiate a decreasing trajectory from 40-42 years old

onwards, mostly for mothers. In the most recent periods, the curves tend to follow an increasing trend, even though with decreasing rates around 34 years old.

Changes in level can be explained by the real income increase in the last years (Oliveira e Colombi, 2014). Changes in pattern seem to reflect a cohort effect. The older women in the period plot belong to older cohorts, in which the hourly wages were smaller. Regarding the cohort plot, hourly wages show an increasing trend through the ages, reflecting the gains of experience and, consequently, gains of seniority in the labor market.

Figure 2. Hourly wages of childless women, mothers and the ratio between both over the age groups, by periods e cohorts, Brazil, 1992 to 2015



Source: PNAD microdata (1992 to 2015).

The analysis of period ratios in Figure 2 shows a motherhood penalty in all triannual groups. The visual inspection does not allow to conclude that this penalty was reduced through periods, but we observe, mainly for recent periods, a smaller penalty in older age groups. Thus, it is possible to infer in a first moment that mothers reduce their

wage disadvantage. This can reflect, for example, a catching up effect related to the acquisition of human capital (Neumeier, Sørensen e Webber, 2018).

Additionally, the analysis of the ratios reveals period peaks in cohort ratios. The most notable occurred around 2007 and 2010, and are befitting with the economic conjecture in the respective years: the first precedes an economic crisis, and the second characterizes a pungent Gross Domestic Product (GDP) (Cruz et al, 2012).

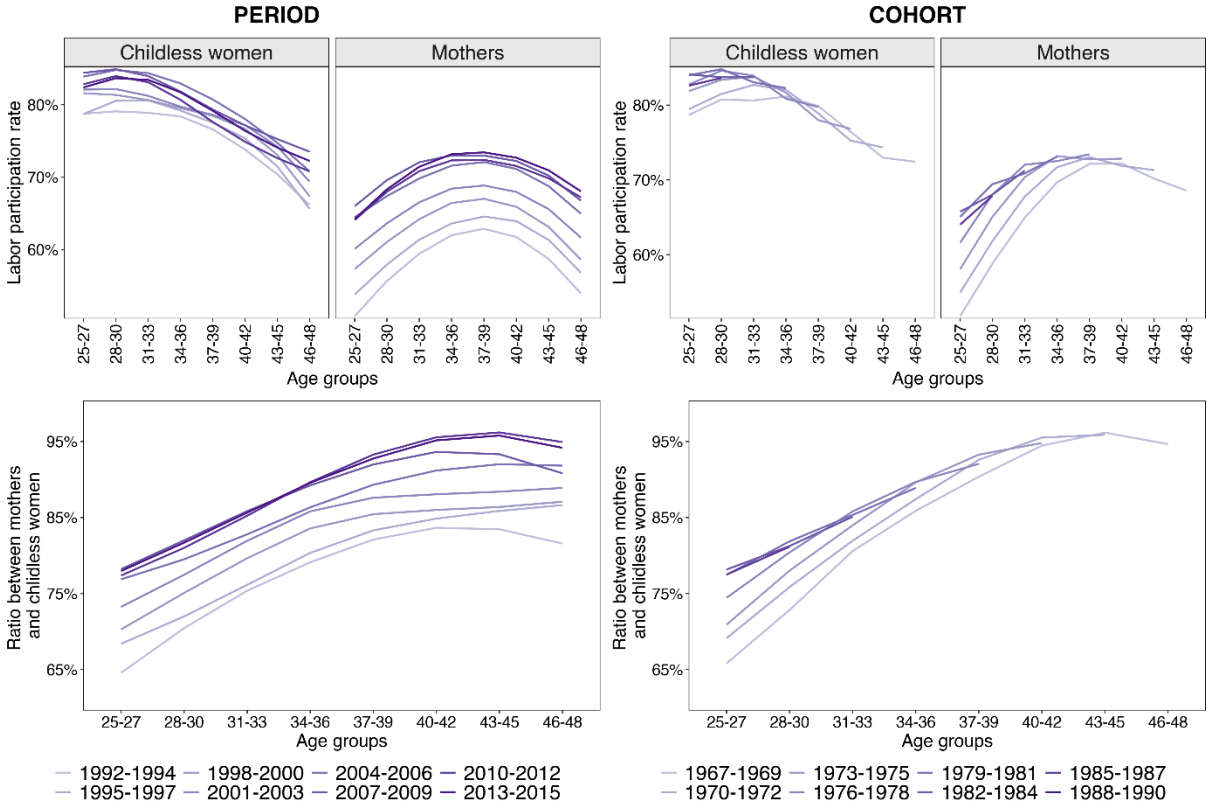
Figure 3 shows the labor participation rates of mothers and non-mothers. In opposition to the hourly wages, which showed variations in patterns between periods, the participation rates show significative changes only in level. For mothers and non-mothers, it is observed a continuous increase of the rates between the periods, befitting with the crescent female insertion in the workforce (Bruschini, 1994; Wajnman, Queiroz and Liberato, 1998; Hoffmann and Leone, 2002).

Regarding the curves pattern, Figure 3 shows remarkable differences between mothers and childless women. For mothers, it is observed that the participation rates follow a parabolic format, with elevation around 37-39 years old, when the rates start to reduce. This is an expected behavior for participation rates, with crescent insertions in the workforce up until determined age, point that initiates the increase of inactivity. For childless women, the curves show a decrease trend through almost all age interval analyzed, with the activity peak occurring around 30 years old.

Here it has to be considered the effect of selectivity and migration of women between the two women groups. It is probable that a large group of women that up to the beginning of their 30s did not have children will become mothers in the following years, when occur their activity peak. The remaining women in the childless group have a smaller participation level, making the motherhood penalty smaller with the age increase, as it is observed in the period ratio plot.

In cohort perspective, we observe low levels of participation in younger ages of older cohorts, mainly for mothers. To younger cohorts, it is verified a more elevated participation rate in the initial ages, and a discrete anticipation of the moment of higher activity in the labor market through the life course, both for mothers and childless women.

Figure 3. Labor participation rate of childless women, mothers and the ratio between both over the age groups, by periods e cohorts, Brazil, 1992 to 2015



Source: PNAD microdata (1992 to 2015).

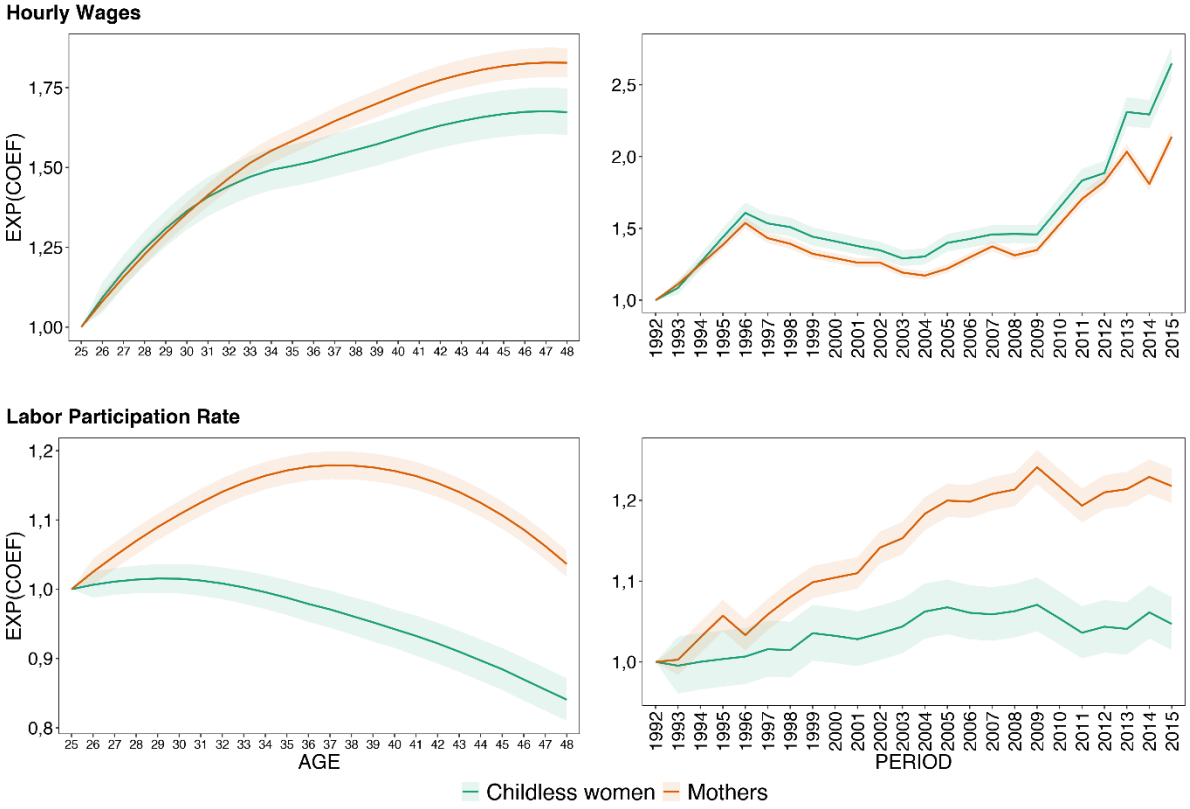
4.2. Estimation results

As showed in Table 1, several specifications for APC models were estimated. The choice of the most adequate model was done after the analysis of regression coefficients and the goodness-of-fit statistics, shown in the Appendix II of this paper. Thus, it was concluded that the specification with age and period dimensions (AP) offered the best fit to the analysis of hourly wages and labor participation rate, both for mothers and non-mothers.

Figure 4 presents the coefficients of the AP model. For hourly wages it is possible to observe an increasing effect over the life course, both for mothers and childless women. We infer that the trajectory of the curves reflects the accumulation of human capital over the ages, positively impacting the hourly wages. Up to approximately 31 years old, there is an overlap of the shaded areas around the curves, which represent the confidence intervals of the coefficients. Thereafter, the curves diverge, with income

growing faster with age to mothers. This result may indicate that they continue to obtain gains in human capital even in later stages in the life course. Regarding childless women, the rhythm of growth of age effect declines after 31 years old, probably because at this point, they are more advanced in terms of human capital.

Figure 4. Results of the APC models for hourly ages and labor participation rate of childless women and mothers, Brazil, 1992 to 2015



Source: PNAD microdata (1992 to 2015).

The behavior of age effects on the participation rate of mothers and non-mothers reflects the performance of the rates in the perspective of period. While the trajectory of the age effects for mothers is similar to a parabolic format, for the childless women there is a more precocious decrease, around 30 years old. This decline shows, once again, the issue of migration of women from the childless women to mothers' group, so those who remain apparently have lower participation.

Additionally, the greater elevation of the curve of mothers compared to childless women may reflect the greater participation gains of the former as age advances, with the growth of children and the consequent increase in availability for the work.

However, this gain in elevation occurs only up to a certain point, as, from a certain age onwards, the entry into the market to decreases, giving rise to the parabolic shape presented.

Analyzing the period dimension, no relevant differences in pattern are observed between women with and without children for hourly wages. Due to the relationship between income and the economic situation itself, there are some fluctuations in the curves of both groups analyzed, especially in 1996 and 2015. Although the curves do not reflect the behavior of income/hour itself, but rather the period effect on the hourly wages, it is observed that these periods for which there is a drop in the effect (which produce the valleys subsequent to the peaks) are of economic deterioration in Brazil.

The effects of period on the participation rate are crescent, especially for mothers. The discrete grow for childless women reflects the fact that these are in the labor market for a longer period, thus, the participation gains in the time period analyzed are small.

5. CONCLUDING REMARKS

The analysis of the APC models showed the importance of the life course – represented by the age dimension – to explain the evolution of hourly wages and the participation rate of women with and without children, together with the period effects. The cohort dimension, surprisingly, showed less relevance for the exercise in question. Cohort effects seem more important in explaining differences between men and women than between women with and without children. It is also possible that the combined age and period dimensions are already capturing cohort effects. The large changes in the economic environment in the period analyzed (including changes in inflation levels, more inclusive legislation for women and the educational transition) may have reduced the relative importance of the differentials per cohort in this period.

Another hypothesis to explain the lesser importance of cohort effects is that they are, in a way, “overshadowed” by the selectivity presented in the sample. Since pseudo-cohorts built from successive cross-sectional surveys are being analyzed, it is not possible to capture the transitions from the “childless woman” to “mother” states. Thus, as age advances, the selectivity caused by the migration of childless women to the group of mothers increases. As fertility is reduced, this migration becomes less intense,

but happens later - a result consistent with the differences (penalty) found in older ages.

In addition to the lesser relevance of cohort effects, another noteworthy result was the reduction in the participation rates of childless women according to age, once the descriptive analysis indicated that they have characteristics that may run counter to common sense. In this sense, further studies are needed in order to understand what these attributes are. By looking at the specificities that exist between different groups of women, it is hoped to better understand the challenges faced by them in each of these different contexts, so that the possibilities for reducing inequality in each of them can be discussed and evaluated.

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APPENDIX

Appendix I. Sample size to hourly wages and labor participation rate of mothers and childless women between 25 and 48 years old, Brazil, 1992 to 2015

Table A. 1. Sample size to hourly wages of mothers between 25 and 48 years old, Brazil, 1992 to 2015

A X P	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
25	549	523	574	624	579	627	629	602	676	749	832	769	899	907	891	854	788	788	728	668	652	654	633	572
26	622	606	643	679	620	602	683	658	764	869	871	847	901	1015	1028	961	935	923	820	717	754	718	710	576
27	695	668	721	773	628	762	711	722	797	871	951	942	960	992	1041	1035	1003	1023	910	796	882	783	755	659
28	758	753	752	750	750	797	753	759	854	949	983	1008	1058	1086	1083	1058	1099	1171	1016	860	911	916	902	834
29	812	793	829	865	796	816	810	817	924	1031	1035	1040	1097	1198	1163	1142	1156	1243	1167	1090	1027	971	984	822
30	872	858	910	962	873	958	910	959	1012	1064	1131	1109	1194	1207	1272	1291	1241	1341	1221	1101	1149	1161	1036	1019
31	781	832	890	947	914	978	894	930	1038	1146	1094	1176	1220	1147	1206	1324	1211	1273	1221	1168	1210	1100	1135	1004
32	922	869	973	1076	989	1013	1009	1028	1104	1179	1235	1115	1332	1270	1331	1320	1300	1399	1308	1217	1299	1257	1324	1182
33	886	933	963	993	1037	1081	1072	1055	1112	1169	1265	1270	1234	1338	1322	1356	1306	1389	1322	1255	1309	1333	1417	1225
34	849	894	910	926	964	1098	1064	1132	1170	1208	1226	1245	1336	1299	1398	1314	1386	1389	1298	1206	1280	1258	1386	1260
35	856	899	976	1052	959	1050	1131	1126	1184	1242	1286	1326	1388	1444	1429	1410	1344	1433	1343	1253	1277	1438	1409	1391
36	858	946	975	1004	999	971	1056	1073	1203	1333	1289	1240	1381	1383	1485	1322	1382	1427	1336	1244	1301	1269	1385	1317
37	824	890	969	1048	992	1119	1045	1137	1199	1261	1343	1274	1308	1442	1453	1346	1390	1433	1297	1161	1267	1294	1247	1365
38	810	959	981	1002	995	1009	1105	999	1146	1292	1418	1326	1463	1438	1498	1389	1411	1401	1312	1222	1299	1346	1359	1262
39	834	841	922	1003	975	1070	1045	1087	1151	1215	1313	1343	1464	1456	1397	1319	1443	1434	1327	1220	1273	1293	1335	1246
40	845	815	896	977	958	1069	1094	1078	1109	1139	1427	1335	1484	1496	1519	1408	1491	1559	1375	1190	1440	1395	1334	1367
41	763	694	789	883	912	915	974	942	1073	1203	1176	1265	1336	1311	1388	1386	1315	1345	1271	1196	1191	1226	1291	1163
42	763	703	777	851	893	982	954	950	1042	1134	1250	1214	1329	1375	1519	1450	1472	1418	1321	1223	1307	1279	1379	1307
43	639	729	787	845	814	859	898	965	1044	1123	1162	1206	1177	1283	1368	1335	1331	1434	1322	1209	1221	1263	1250	1364
44	612	643	698	752	744	825	873	900	969	1038	1110	1113	1210	1215	1268	1351	1365	1318	1225	1132	1206	1200	1191	1131
45	587	575	663	750	774	788	792	903	941	979	1111	1086	1142	1264	1188	1278	1323	1314	1235	1156	1185	1260	1288	1259
46	490	562	596	629	700	651	705	740	810	879	964	949	1160	1151	1249	1184	1232	1264	1219	1173	1169	1113	1155	1193
47	453	479	551	622	613	730	677	730	832	933	946	988	962	1082	1128	1141	1101	1160	1128	1096	1190	1087	1155	1119
48	439	448	515	582	578	614	623	682	749	815	880	964	967	999	1075	1025	1134	1125	1071	1016	1196	1048	1133	1064

Source: PNAD microdata (1992 to 2015).

Table A. 2. Sample size to hourly wages of childless women between 25 and 48 years old, Brazil, 1992 to 2015

A X P	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
25	584	617	653	689	632	694	684	708	758	808	804	819	894	987	1012	1028	1061	1014	986	958	871	925	891	796
26	555	546	543	539	583	550	579	638	664	689	704	752	802	876	951	914	983	895	878	861	899	810	847	758
27	492	497	521	545	505	547	507	563	577	591	676	682	704	764	800	882	856	902	826	750	807	776	816	760
28	479	469	484	499	468	443	499	490	522	554	628	581	625	646	739	718	778	842	795	748	745	733	769	678
29	388	369	397	424	377	437	422	449	455	461	498	507	532	628	595	623	674	728	718	707	688	624	631	650
30	329	345	365	384	410	407	365	391	424	456	470	522	526	528	560	579	599	673	655	636	736	712	628	607
31	274	269	291	312	330	343	359	346	352	357	399	428	459	407	467	478	496	527	560	593	548	529	586	519
32	286	259	289	318	331	338	283	345	346	347	390	377	433	433	443	430	423	457	468	479	507	543	588	526
33	216	226	254	282	276	293	279	288	306	323	315	310	357	378	381	382	363	426	439	452	440	455	494	477
34	224	200	226	251	267	256	237	282	280	277	323	329	323	288	326	399	346	362	384	405	370	388	458	443
35	209	217	232	246	201	226	227	249	255	260	288	278	292	308	318	296	351	351	331	310	370	361	404	452
36	161	169	178	186	216	193	239	243	241	239	234	238	281	290	293	293	306	284	307	329	310	332	365	343
37	156	163	175	186	192	175	168	201	215	228	230	228	221	238	228	264	268	268	276	284	274	285	298	308
38	149	146	173	199	185	180	183	182	207	232	246	221	221	254	239	240	250	222	268	313	240	277	276	285
39	117	144	145	145	165	170	171	213	207	200	200	218	216	216	216	218	228	229	226	223	244	267	218	225
40	128	108	137	165	151	152	156	192	193	194	221	214	230	222	234	242	233	271	257	242	257	249	279	275
41	109	116	118	119	123	151	131	160	155	150	175	187	190	197	204	204	209	206	212	217	215	215	240	234
42	110	97	103	108	108	133	138	157	161	164	173	164	186	175	177	205	201	188	202	215	209	199	221	220
43	97	108	114	119	115	120	121	119	140	161	154	182	153	188	192	201	193	200	201	201	188	220	189	202
44	105	93	96	99	137	110	117	122	122	122	150	155	153	162	184	188	189	211	203	195	177	171	209	183
45	71	92	95	97	88	123	111	103	123	142	137	135	146	161	127	178	166	170	177	184	186	196	203	201
46	71	79	91	102	83	92	114	125	123	121	122	109	137	143	155	138	166	161	174	186	177	162	184	186
47	64	74	76	77	101	100	88	86	95	103	119	131	122	132	139	166	158	157	171	185	178	170	181	184
48	62	62	68	74	79	80	106	91	88	84	113	135	124	115	155	142	149	156	162	168	178	192	184	166

Source: PNAD microdata (1992 to 2015).

Table A. 3. Sample size to labor participation rate of mothers between 25 and 48 years old, Brazil, 1992 to 2015

A X P	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
25	1472	1414	1447	1480	1362	1491	1492	1480	1623	1766	1771	1815	1851	1866	1844	1744	1591	1621	1484	1346	1312	1300	1227	1133
26	1558	1480	1544	1608	1515	1491	1594	1542	1709	1875	1816	1863	1877	1951	1957	1879	1768	1808	1642	1475	1440	1352	1343	1157
27	1613	1589	1652	1715	1485	1704	1504	1672	1789	1906	1968	1917	1934	1932	1961	2005	1862	1901	1719	1537	1604	1475	1437	1316
28	1797	1766	1715	1664	1692	1764	1669	1628	1809	1990	2024	2029	2024	2069	2053	2007	1939	2066	1855	1644	1603	1581	1627	1561
29	1752	1767	1806	1845	1653	1797	1722	1776	1922	2068	2032	2050	2034	2180	2118	2040	2011	2123	1997	1870	1784	1649	1692	1520
30	1865	1922	1926	1930	1883	1933	1865	1879	1979	2079	2149	2107	2196	2204	2252	2241	2090	2258	2095	1932	2011	1957	1712	1754
31	1702	1753	1805	1856	1852	1956	1828	1886	2023	2160	2016	2157	2146	2069	2139	2163	2008	2121	2056	1991	1996	1919	1809	1686
32	1846	1740	1882	2023	1961	2003	1961	1944	2091	2238	2244	2073	2282	2230	2252	2178	2106	2249	2155	2061	2136	2035	2146	1886
33	1788	1844	1846	1847	1978	2087	2019	2002	2086	2169	2254	2248	2163	2251	2173	2206	2166	2201	2104	2006	2067	2148	2156	2007
34	1693	1739	1759	1778	1844	1970	2020	2052	2137	2221	2193	2268	2242	2268	2359	2164	2238	2258	2132	2005	2020	2006	2142	2047
35	1647	1716	1826	1935	1827	1927	2028	2046	2147	2248	2253	2270	2302	2339	2310	2231	2118	2270	2126	1981	2051	2273	2155	2213
36	1661	1792	1807	1822	1828	1865	1911	2017	2157	2296	2248	2134	2279	2239	2436	2200	2189	2203	2087	1971	2012	1986	2131	2029
37	1608	1657	1761	1865	1815	2041	1865	1995	2111	2226	2260	2161	2184	2328	2302	2245	2165	2273	2096	1919	1966	2048	1922	2088
38	1582	1738	1755	1772	1789	1813	1983	1866	2047	2228	2359	2231	2395	2271	2363	2244	2213	2175	2081	1986	1985	2035	2020	2020
39	1569	1618	1703	1788	1812	1907	1787	1913	2004	2095	2224	2295	2343	2348	2322	2161	2235	2264	2099	1933	1983	1991	2015	1983
40	1623	1499	1616	1733	1782	1929	1925	1891	1994	2096	2379	2278	2441	2430	2440	2260	2332	2355	2160	1965	2222	2132	2061	2172
41	1396	1392	1482	1572	1659	1662	1747	1748	1930	2111	2024	2118	2155	2241	2230	2176	2105	2103	2037	1971	1872	1931	2058	1874
42	1448	1380	1440	1500	1633	1782	1721	1754	1870	1986	2193	2044	2176	2236	2435	2310	2284	2214	2115	2016	2043	1980	2083	1985
43	1257	1405	1462	1519	1511	1615	1639	1784	1897	2009	2007	2104	2009	2133	2237	2188	2212	2227	2067	1907	1918	1987	1966	2079
44	1253	1250	1318	1386	1442	1574	1617	1671	1764	1857	1977	1945	2003	2003	2075	2234	2143	2111	2002	1892	1908	1957	1881	1813
45	1254	1232	1323	1413	1481	1495	1560	1639	1713	1786	1921	1934	1989	2188	2021	2160	2125	2176	2045	1914	1903	2005	1976	2038
46	1062	1134	1207	1279	1450	1325	1464	1474	1581	1688	1806	1713	2008	1960	2082	1975	2012	2061	1986	1911	1915	1801	1894	1914
47	1023	1045	1148	1251	1239	1490	1443	1398	1600	1802	1774	1827	1753	1938	1944	2020	1876	1985	1949	1913	1912	1854	1802	1836
48	1001	1076	1144	1211	1293	1289	1356	1428	1524	1619	1730	1779	1815	1844	1901	1844	2033	1911	1860	1809	1951	1783	1877	1800

Source: PNAD microdata (1992 to 2015).

Table A. 4. Sample size to labor participation rate of childless women between 25 and 48 years old, Brazil, 1992 to 2015

A X P	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
25	839	929	981	1032	948	1047	1011	1078	1127	1176	1211	1263	1337	1470	1542	1488	1538	1429	1420	1411	1294	1337	1282	1244
26	828	808	796	784	859	869	867	921	969	1017	1041	1101	1108	1217	1324	1319	1381	1315	1270	1225	1240	1168	1205	1102
27	721	709	748	787	710	792	734	813	836	858	959	986	1004	1043	1105	1229	1177	1300	1185	1070	1131	1085	1116	1075
28	676	675	693	711	677	644	727	708	763	817	867	839	895	905	1006	983	1057	1131	1084	1037	1001	1041	1027	971
29	550	537	566	595	546	618	601	661	662	663	742	678	713	847	817	852	912	999	988	977	953	846	847	914
30	472	505	529	553	570	570	564	586	612	638	673	714	731	723	753	813	804	919	903	887	991	986	847	859
31	376	404	419	434	461	485	488	493	512	531	552	600	605	585	628	676	672	711	767	823	721	759	790	724
32	420	363	400	436	487	466	417	483	491	498	555	524	577	565	574	614	582	644	664	684	711	744	786	719
33	312	336	363	390	381	404	400	409	435	461	445	456	484	528	520	522	503	569	603	636	627	656	665	660
34	291	291	315	339	369	357	366	404	408	411	465	437	461	410	458	521	512	493	524	555	521	554	615	622
35	300	298	314	329	262	327	333	364	364	364	404	399	404	420	422	429	473	456	457	457	489	525	539	620
36	223	242	263	283	307	289	331	348	347	346	351	369	369	402	415	413	421	408	449	490	433	451	489	481
37	222	224	248	272	277	271	269	298	313	327	333	318	310	347	323	387	348	381	404	426	389	426	418	424
38	209	196	230	263	265	272	258	268	303	337	342	337	325	356	323	360	376	337	398	458	363	397	391	400
39	182	201	205	208	235	238	255	304	294	284	286	326	282	297	325	329	324	325	345	365	338	366	338	334
40	199	160	192	224	218	215	231	267	285	303	315	311	338	310	326	332	357	378	374	370	380	376	400	402
41	163	181	175	169	198	227	193	228	227	225	246	270	287	277	292	308	311	300	323	345	330	313	315	338
42	157	158	158	157	164	193	203	217	232	247	243	251	275	272	273	290	301	295	318	340	324	312	335	316
43	148	160	166	171	163	180	188	183	208	232	227	279	219	271	287	289	296	295	313	331	296	330	286	288
44	144	147	151	155	204	166	182	196	187	178	230	227	226	235	281	266	290	311	308	304	263	275	314	283
45	111	149	154	159	138	176	174	175	194	213	219	215	216	247	198	273	256	276	295	314	274	285	299	297
46	114	123	137	151	153	140	176	195	187	178	192	177	232	226	220	213	255	240	270	300	278	262	272	278
47	110	108	126	143	170	173	136	141	160	178	178	207	203	213	199	233	246	254	274	293	289	267	271	274
48	109	122	123	123	137	140	188	165	168	170	199	201	201	200	243	226	242	223	247	271	281	296	273	260

Source: PNAD microdata (1992 to 2015).

Appendix II. Goodness-of-fit statistics of APC models to hourly wages and labor participation rate of mothers and childless women between 25 and 48 years old, Brazil, 1992 to 2015

Table A. 5. Two-sample t-tests to hourly wages and labor participation rate of mothers and childless women between 25 and 48 years old, Brazil, 1992 to 2015

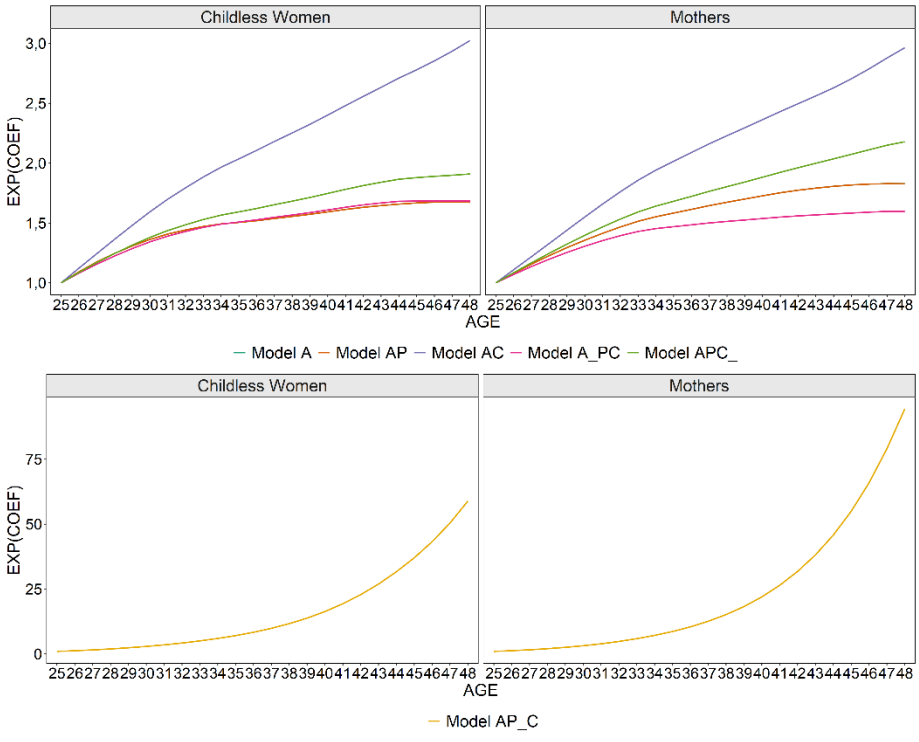
Age	Variables	
	Hourly Wages	Labor Participation Rate
25-27	-3,421	-10,257
28-30	-3,043	-9,306
31-33	*-2,799*	-8,150
34-36	*-2,724*	-7,073
37-39	*-2,666*	-6,100
40-42	*-2,519*	-5,024
43-45	*-2,443*	-4,141
46-48	*-2,435*	-3,385

Source: PNAD microdata (1992 to 2015).

Notes: Statistics in italics are significant at the 5% level and the others at the 1% level.
Tested hypotheses:

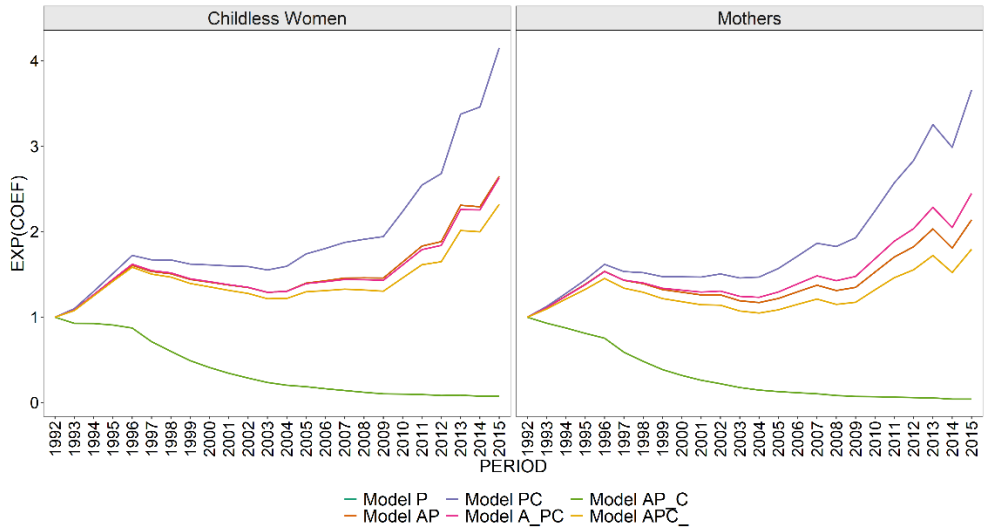
$$H_0: mean\ to\ childless\ women = mean\ to\ mothers$$
$$H_a: mean\ to\ childless\ women \neq mean\ to\ mothers$$

Figure A. 1. Age effect coefficients for hourly wages of childless women and mothers between 25 to 48 years old, Brazil, 1992 to 2015



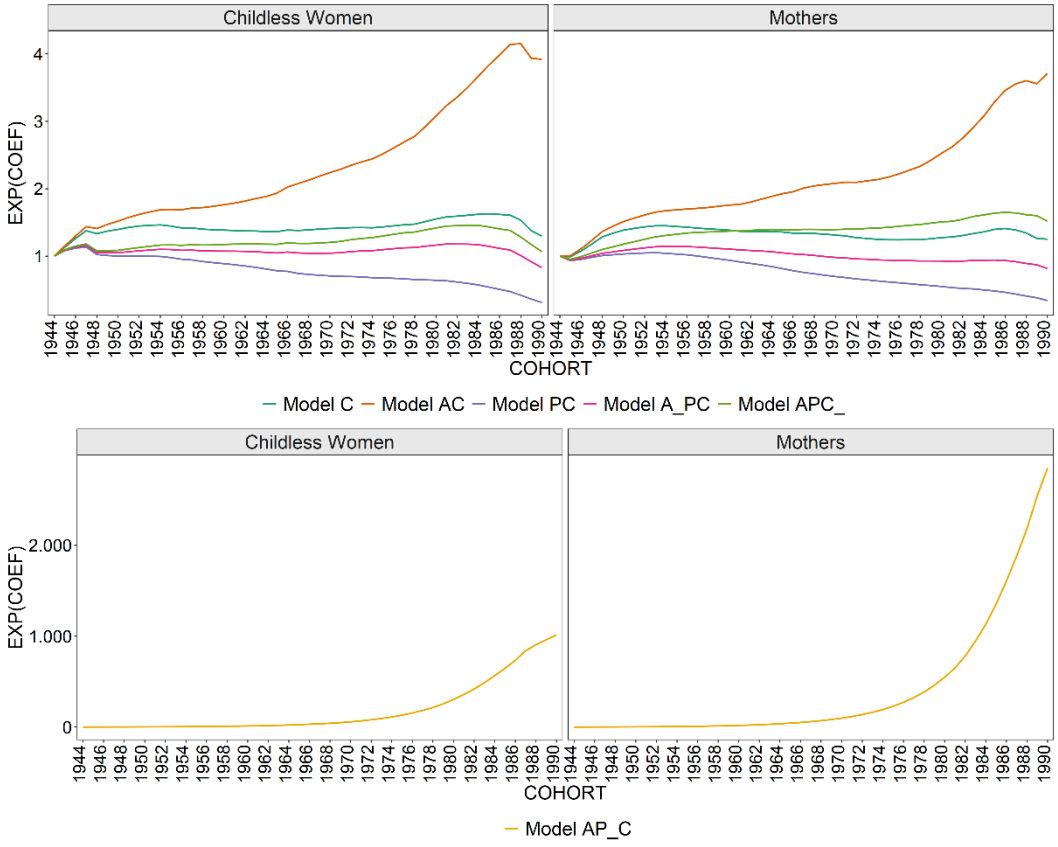
Source: PNAD microdata (1992 to 2015).

Figure A. 2. Period effect coefficients for hourly wages of childless women and mothers between 25 to 48 years old, Brazil, 1992 to 2015



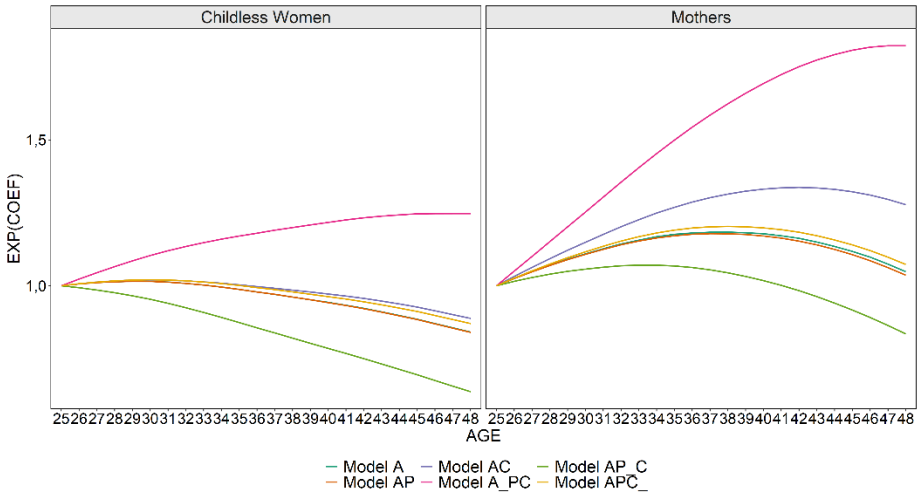
Source: PNAD microdata (1992 to 2015).

Figure A. 3. Cohort effect coefficients for hourly wages of childless women and mothers between 25 to 48 years old, Brazil, 1992 to 2015



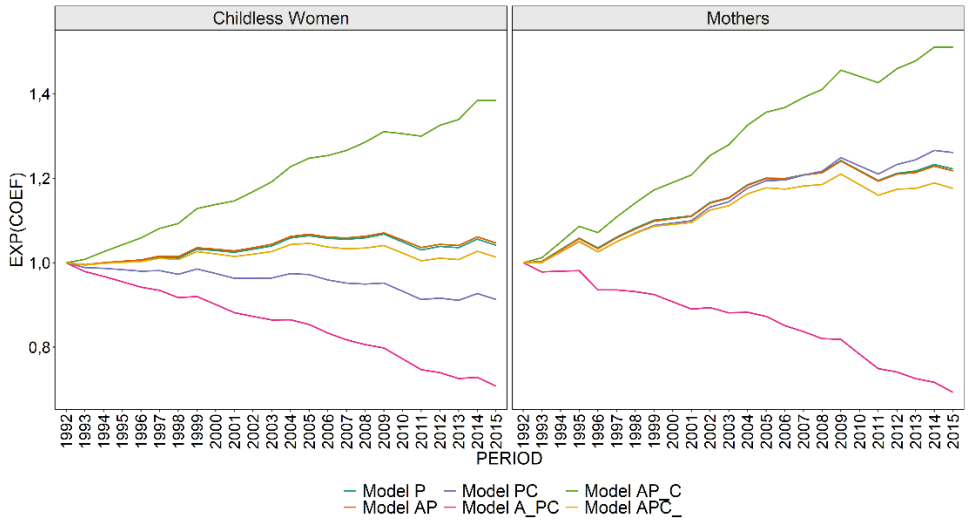
Source: PNAD microdata (1992 to 2015).

Figure A.4. Age effect coefficients for labor participation rates of childless women and mothers between 25 to 48 years old, Brazil, 1992 to 2015



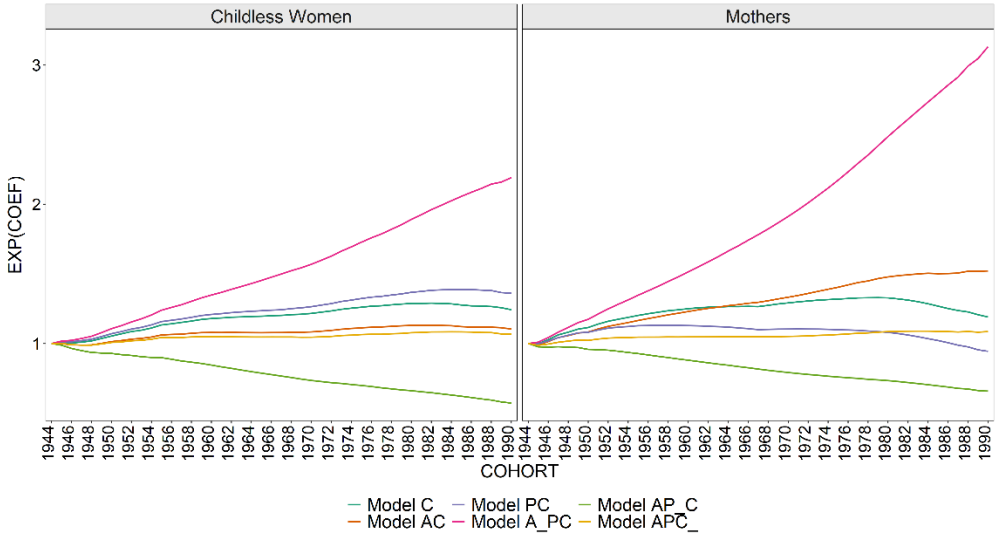
Source: PNAD microdata (1992 to 2015).

Figure A. 5. Period effect coefficients for labor participation rates of childless women and mothers between 25 to 48 years old, Brazil, 1992 to 2015



Source: PNAD microdata (1992 to 2015).

Figure A. 6. Cohort effect coefficients for labor participation rates of childless women and mothers between 25 to 48 years old, Brazil, 1992 to 2015



Source: PNAD microdata (1992 to 2015).

Table A. 6. Goodness-of-fit statistics of APC models to hourly wages of mothers between 25 to 48 years old, Brazil, 1992 to 2015

	G^2	$g.l.$	ΔG^2	$R^2(\%)$	AIC	VIF	LR	$p\text{-}value$
Modelo nulo	38,20	575	-	-	-	-	-	-
Modelo I	20,47	552	17,73	46,4%	-237,6	1,92	143,78	0,0000
Modelo P	18,76	552	19,44	50,9%	-287,7	1,92	168,85	0,0000
Modelo C	36,57	529	1,63	4,3%	142,6	13,13	-23,31	0,0000
Modelo IP	1,03	529	37,17	97,3%	-1911,1	1,92	1003,56	0,0000
Modelo IC	8,56	506	29,64	77,6%	-647,6	9,88	394,79	0,0000
Modelo PC	1,89	506	36,31	95,1%	-1518,1	9,88	830,07	0,0000
Modelo I_PC	0,34	484	37,86	99,1%	-2464,0	509,13	1325,00	-
Modelo IP_C	0,34	484	37,86	99,1%	-2464,0	522,07	1325,00	-
Modelo IPC_	0,34	484	37,86	99,1%	-2464,0	520,88	1325,00	-

Source: PNAD microdata (1992 to 2015).

Tabela A. 7. Goodness-of-fit statistics of APC models to hourly wages of childless women between 25 to 48 years old, Brazil, 1992 to 2015

	G^2	$g.l.$	ΔG^2	$R^2(\%)$	AIC	VIF	LR	$p\text{-}value$
Null model	42,38	575	-	-	-	-	-	-
Model A	31,15	552	11,22	26,5%	4,3	1,92	22,85	0,0000
Model P	14,33	552	28,04	66,2%	-442,9	1,92	246,43	0,0000
Model C	40,92	529	1,46	3,4%	207,4	13,13	-55,68	0,0000
Model AP	3,11	529	39,26	92,7%	-1276,9	1,92	686,46	0,0000
Model AC	12,49	506	29,89	70,5%	-430,3	9,88	286,15	0,0000
Model PC	4,02	506	38,36	90,5%	-1083,5	9,88	612,75	0,0000
Model A_PC	2,42	484	39,95	94,3%	-1330,4	509,13	758,21	-
Model AP_C	2,42	484	39,95	94,3%	-1330,4	522,07	758,21	-
Model APC_	2,42	484	39,95	94,3%	-1330,4	520,88	758,21	-

Source: PNAD microdata (1992 to 2015).

Table A. 8. Goodness-of-fit statistics of APC models to labor participation rate of mothers between 25 to 48 years old, Brazil, 1992 to 2015

	G^2	$g.l.$	ΔG^2	$R^2(\%)$	AIC	VIF	LR	$p\text{-}value$
Null model	4840,23	575	-	-	-	-	-	-
Model A	3243,59	552	1596,64	33,0%	8444,7	1,92	-4198,35	0,0000
Model P	1689,89	552	3150,34	65,1%	6891,0	1,92	-3421,50	0,0000
Model C	3529,76	529	1310,47	27,1%	8776,9	13,13	-4341,44	0,0000
Model AP	123,32	529	4716,92	97,5%	5370,4	1,92	-2638,21	0,0000
Model AC	447,18	506	4393,05	90,8%	5740,3	9,88	-2800,15	0,0000
Model PC	1338,99	506	3501,24	72,3%	6632,1	9,88	-3246,05	0,0000
Model A_PC	96,86	484	4743,38	98,0%	5434,0	509,13	-2624,98	-
Model AP_C	96,86	484	4743,38	98,0%	5434,0	522,07	-2624,98	-
Model APC_	96,86	484	4743,38	98,0%	5434,0	520,88	-2624,98	-

Source: PNAD microdata (1992 to 2015).

Table A. 9. Goodness-of-fit statistics of APC models to labor participation rate of childless women between 25 to 48 years old, Brazil, 1992 to 2015

	G^2	$g.l.$	ΔG^2	$R^2(\%)$	AIC	VIF	LR	$p\text{-}value$
Null model	593,06	575	-	-	-	-	-	-
Model A	129,32	552	463,74	78,2%	4536,6	1,92	-2244,29	0,0000
Model P	499,37	552	93,69	15,8%	4906,6	1,92	-2429,32	0,0000
Model C	184,83	529	408,23	68,8%	4638,1	13,13	-2272,05	0,0000
Model AP	29,57	529	563,49	95,0%	4482,8	1,92	-2194,42	0,0000
Model AC	54,13	506	538,93	90,9%	4553,4	9,88	-2206,70	0,0000
Model PC	91,08	506	501,98	84,6%	4590,3	9,88	-2225,17	0,0000
Model A_PC	20,80	484	572,26	96,5%	4564,1	509,13	-2190,03	-
Model AP_C	20,80	484	572,26	96,5%	4564,1	522,07	-2190,03	-
Model APC_	20,80	484	572,26	96,5%	4564,1	520,88	-2190,03	-

Source: PNAD microdata (1992 to 2015).