Intensity of the agricultural workload and seasonality of births in Italy (1863-2014).

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Introduction

As argued by Doblhammer et al. (1999, 5) a full understanding of the causes of births seasonal fluctuation is far from be reached: «What might the causal factors underlying the intriguing birth seasonality patterns be? Although several classes of explanations have been offered … we still don't know. It seems unlikely that one or even several obvious sources underlie a complete explanation of birth seasonality patterns. Otherwise these would have been noticed, evaluated, and formally specified long ago...» (p. 4-5).

The lack of a clear explanation of birth seasonality represents an obvious reason for being interested in the topic, however it is not the only one. In facts, a better understanding of the seasonality of births may be also useful for other ambits of demography. For instance, robust evidences produced in literature show that the month was of crucial importance for determining the probability of survival of new-borns in the demographic ancien régime and also in modern economically underdeveloped societies (Breschi e Livi Bacci, 1986, 1997; Dalla Zuanna e Rosina, 2010; Dorelièn, 2012; Muñoz-Tuduri e Garcìa-Moro, 2008).

Furthermore, we also believe that the analysis of birth seasonality could also offer indications on the role that economic activity may play in determining natural events.

In particular, the seasonality of the workload might impact the timing of both marriages and conceptions (see among others Bailey et al.,1992, Ellison et al.,2005, Pascual et al.,2002, Danubio et al., 2003, Gruppioni et al., 2005, Crisafulli et al., 2000). Simplifying the argumentation proposed by Ellison et. al (2005), the reproductions of every species, comprised humans, is a high energy demanding process for mothers. Therefore, conceptions should be concentrated in a period in which the energy balance is positive. For instance, they report that modest changes in weight, in the range of 2 kg in a month, are associated with significant changes in the production of the principal ovarian hormones, estradiol and progesterone. In other words, this energy balance mechanism implies that in those societies characterized by an unequal distribution of resources in the various periods of the year, such as agriculture based economies, births tend to be concentrated in those months in which resources are more abundant and/or energy consumption is lower. Therefore, according to this "energy balance" theory, we expect, for instance, that in the period of grain harvest, when the latter is not yet available and at the same time the workload is very intense, the energy balance of workers should be negative. Thus, this should induce a steady reduction on the number of births 9 months later.

A possible criticism to this argumentation may stem from the fact that according to both biological and demographic literature conceptions are negatively related to temperature (Seiver, 1985, 1989; Lam e Myron 1991, 1994, 1996; Lam, Myron e Riley, 1994), duration of the photoperiod (Roenneberg e Aschoff, 1990; Manfredini, 2009), light intensity (Cummings 2002, 2007, 2010, 2012). Therefore, given that harvest generally occurs in summer months and at the same time this represents the hottest and lightest period of the year, these environmental factors are determining birth seasonality and not the intensity of the workload. Therefore, one may conclude that in order to to not confusing the effect of the economic activity from that of climate (or of light intensity), one should be able to separate the role of both factors (see also Doblhammer et al 1999). However, this would require the analysis of accurate data on climatic variables which are frequently not available/reliable for historical periods. Despite of this problem of data availability, we adop an indirect way to test the energy balance theory only referring to data on monthly births and work intensity. Since, the intensity of the workload in agriculture based economy was very uneven across months, as reflected by the seasonal pattern of marriages, we expect that its effect on birth seasonality should disappear as the economy evolves from an agriculture based economy to an industrial economy.

If we are able to observe this temporal pattern in the relation between these two variables, then it is difficult to sustain that the real determinants of the relation between work intensity and birth seasonality are the confounding environmental factors.

Summing up our research questions can be formulated as follows: can work intensity affect birth seasonality? Does this hypothesized relation vanish with the decline of the workforce employed in agriculture?

To answer to these questions, we used the times series of the monthly births in each Italian regions, for the years from 1863 to 1933 and for a larger time period for Italy as a whole (1863-2014). These data come from the Volumes “Movimento dello Stato Civile”. The methodology used for the analysis is described in the next section, where also present some preliminary evidence associated to Italy as a whole are presented.

2. Data and methods

Our data sources on the monthly numbers of births are the official statistics produced formerly by the Italian Ministry of Agriculture, Industry and Commerce and later by the Italian Central Office of Statistics (ISTAT). In particular, all the statistics on the monthly numbers of marriages, births and deaths were initially collected in the volumes 'Movimenti della popolazione secondo gli atti dello stato civile' supplied until 1926 by the office of statistics of the Italian Ministry of the Agriculture, Industry and Commerce. After 1926, they were supplied by the newborn Italian central office of statistics (ISTAT). From 1953 to 1988 the name of the volumes changed in 'Annuari di statistiche demografiche' while from 1989 the information about birth was collected in ad hoc volumes. The period covered by our analysis spans from 1863 to 1933 at the regional level (due to problem of regional data availability from 1934 to 1950). For Italy as a whole, the time series span from 1863 to 2014.

To have a first idea of how seasonality has evolved over the last 150 years, we have calculated an index of birth seasonality as follows:

$$I_{i,t} = \frac{N_{i,t}}{\sum_{i=1}^{i=12} N_{i,t}} * 1200 \qquad (1)$$

Where Ni,t is number of births (excluding stillbirths) for the month i in the decade t (t = 1863-1872, 1873-1882,…, 1993-2012).[1] After having calculated this index for all the not overlapping ten years periods, we run a hierarchical cluster analysis to see how these decades are grouped together on the basis of their similarity/dissimilarity (we used Ward's method as an agglomerative algorithm and the Euclidean distance as a dissimilarity index, see Ruiu and Gonano, 2015 for details on this methods for analysing seasonality).

Our analysis suggests that we can distinguish two main models of birth seasonality: the first model characterized the Italian seasonal pattern from national unification up to the years immediately following the Second World War, while the second model prevailed from the decade 1963-72 onward. The dendrogram associated to the cluster analysis is reported in figure 1, while figure 2 represents the associated model of seasonality. The numbers reported above each cluster are named p-values and are

[1] The number of births in each month is adjusted to taking into account for the different number of days in each month.

calculated through a method proposed by Suzuki and Shimodaira (2006). The higher the p-values the stronger the cluster is supported by data.[2]

The model of seasonality for the period 1863-1962 is characterized by a peak in the winter months of January and February followed by a decline since June (the month of minimum concentration of births), after which we assist to a slow recovery up to the relative maximum of September, which is followed by a steady decline in the number of births.[3] The most recent pattern is instead characterized by two peaks in July and September and a December trough.

Figure 1: Cluster analysis

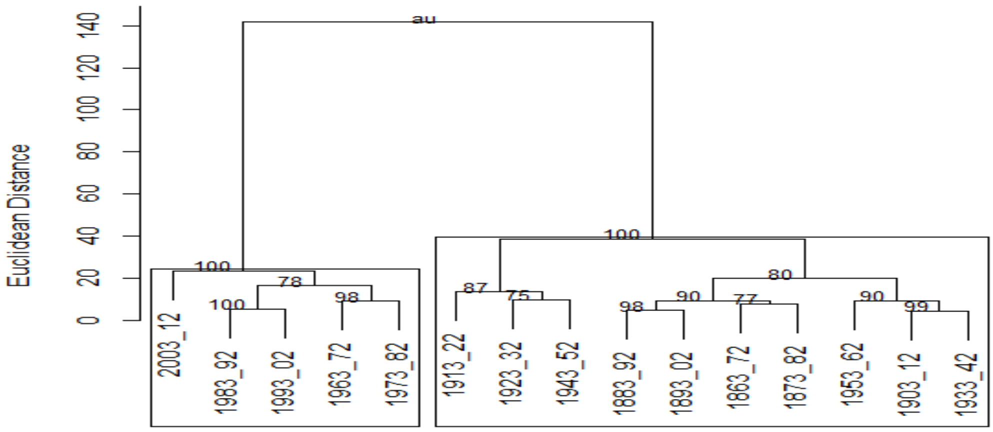
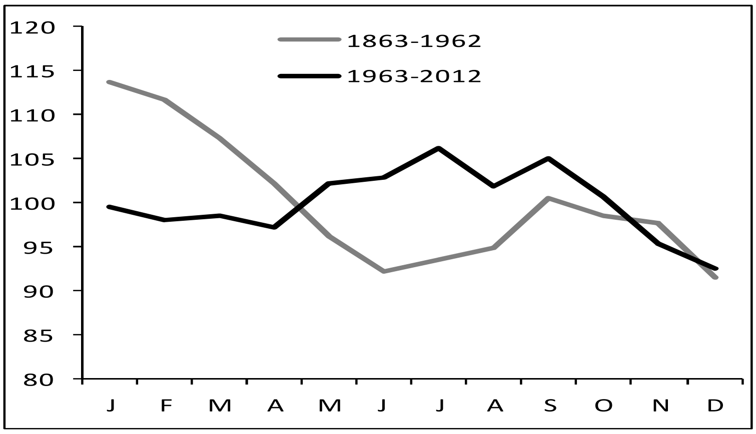


Figure 2: Models of birth seasonality, Italy 1863-2012



Note: These curves are those associated to the barycentre of each cluster

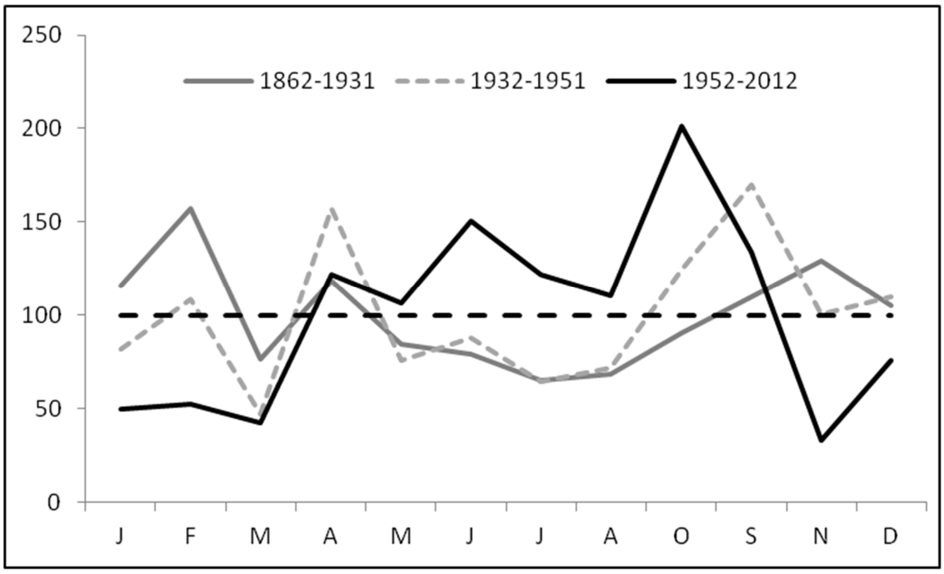
[2] In Suzuki and Shimodaira's technique thousands of bootstrap samples are generated by randomly sampling elements of the data, and bootstrap replicates of the dendrogram are obtained by repeatedly applying the cluster analysis to them. The bootstrap probability (BP) value of a cluster is the frequency that it appears in the bootstrap replicates.

[3] This model is very similar to that described by Crisafulli et al. (2000) for Southern Italy. It must be said that at the least for the first decades under investigation, the low number of births in December and the specular high number registered in January, are produced by the Italian costume to postpone the birth date of those born at the end of December with the aim of delaying for one year the call for the compulsory military service.

This first descriptive analysis seems to suggest that after the great Italian economic miracle, the timing of birth was completely transformed. However, this change cannot be automatically attributed to the change in the distribution of the workforce among economic sectors. For instance, Seiver (1985, 1989) argues that the increased possibilities of defending against extreme climatic conditions offered by technological and economic development are at the basis of the change of US birth seasonality. Thus, one may be subjected to the risk of confounding the effect of climate with that of economic progress. Thus, to take into account of this possible criticism, it is crucial to understand when the potential structural change in the relation between workload intensity and birth seasonality occurred.

How to measure work intensity? Probably, the most appropriate measure of workload intensity is a measure of the number of the hours worked in a month weighted with the proportion of the workforce employed in the primary sector. However, also in this case we need time series that are very difficult to reconstruct without arbitrary assumption on their historical evolution. For this reason, we chose to approximate the workload intensity using marriage seasonality. There exists in fact a large literature showing that agricultural work played a crucial role in determining the marriage seasonality (see among others, Dribe and Van De Putte, 2012, Van Poppel, 1995, Ruiu and Gonano, 2015, etc). In particular, the celebration of marriages was avoided in period of intense agricultural work (generally summer months in Italy), thus determining a very unequal distribution of marriages during the year. Figure 3 highlights the models of marriage seasonality resulting from the implementation of a cluster analysis similar to that described above.

Figure 3. Models of marriage seasonality, Italia 1862-2012



After the sixties of the nineteenth century we have a reversal of the model of marriage seasonality, with summer months that become the most preferred period of the year for getting married (formerly the most avoided period) while weddings in autumn and especially in winter (formerly the most preferred season) turn to be very unusual events.

Therefore, we expect, at least for the first years of the Italian Kingdom a positive correlation between the oscillations of births and the oscillations in the number of marriages occurred nine-months before, because a higher value of the latter should indicate a less burdensome workload. A possible criticism is that this correlation, especially in a Catholic country, may be in part influenced by the relation between first order births and marriages. Matsuda and Kahyo (1994) argue that seasonal variations in marriage play some role in the seasonality of first births, while other features such as environmental factors could be associated with the seasonal variations of subsequent births. However, we believe that given the high level of fertility that has characterized Italy at least for the first years of Italian Unification, the weight of first births on total births in month j should be negligible. In particular, according to Istat (1986), still in 1930 the first order births account for about the 20% on total births, while the remaining 80% was constituted by births of order greater than one. So at least for the first years of our analysis, the seasonal pattern of births on total number of births, should reflect the seasonal pattern of those births with order greater than one.

Following Manfredini (2009) we, first of all, detrended both the monthly births and the monthly number of marriage by applying a 12-term moving average:

$$y_t = Y_t / \sum_{m=t-6}^{m=t+5} Y_m$$

$$x_t = X_t / \sum_{m=t-6}^{m=t+5} X_m$$

Where Yt and Xt are respectively the number of births and the number of marriages in month t. Both Yt and Xt are corrected to take into account the different lengths of the months. In particular we have normalized the number of day in each month to 30.

Then we estimated the following regression regression:

$$log(y_t) = c_{t+} \sum_{i=feb}^{i=dec} a_{it} d_{it} + b_t log(x_{t-9}) + \varepsilon_t \qquad (2)$$

The variables d_i are month dummies. The inclusion of these dummies is necessary to avoid a spurious significant relation between marriages and births due to a similar underlying model of seasonality (for instance January and February were months with high frequency of both births and marriages).

Obviously, we are interested in establishing whether or not this relation changes in time. Therefore, we test for the presence of multiple structural breaks with unknown date in equation (2), by applying an econometric technique suggested by Bai and Perron (1998, 2003a,b). Table 1 (panel) reports the results obtained (we allow both for serial correlation in the errors and for possible change in the error distribution across the time periods individuated by the estimated breaks). As suggested by Bai and Perron (2003 a), first of all, we test the hypothesis of the presence of at least one break (not reported here), using the so called UD max test, once that the null is not rejected, then one may implement a sequential test for the presence of additional breaks. Two break dates are identified, the first occurs in 1905, the second in 1961. We have that coherently with our hypothesis before the first break, the relation between the indicator of marriage seasonality and that of birth seasonality is positively signed and statistically significant at 1% level. In terms of magnitude we have that before the first break, a 1% increase in the detrended number of marriages leads to about a 0.10% increase in the detrended index of birth seasonality.

After the first break-date, it begins a sort of period of transition between the old regime and the new one, in which the relation between the two variables becomes weaker both in terms of magnitude (a 1% increase in the index of marriages corresponds to about a 0.03% increase in birth seasonality). After the second break, we have a sign reversal in the relation between the marriages and birth. We believe that this sign reversal is likely caused by the fact that with the beginning of economic development, we are no more able to capture the seasonal pattern of workload using marriage seasonality. Indeed, as shown in figure 3, starting from the years following the World War the preferences of the spouses are more and more oriented towards months that are enjoyable from a climatic point of view (especially June and September). According to the literature, these months are also those in which the strongest depressive effects on conceptions are exerted by light intensity and temperature. Therefore, the negative sign between the two variables is probably reflecting the above mentioned confusion between the climatic determinants of birth seasonality and the seasonal pattern of marriages. In the following for simplicity of exposition we will indicate the time interval before the first estimated structural break as old regime, while the period comprised between the two breaks and the period after the last break, will be indicated as transitional regime and new regime, respectively.

It must be said also that, in the new rigme, we have also first order births are for sure increasing their weight on total births, but at the same time the increasing possibility of birth control through contraceptives is also, presumably, cancelling out the relation between first order births and marriages.

Table 1. Birth seasonality and marriage seasonality. Italy, 1870-2014*

Dependent Variable: Log(detrended birth)
Break type: Bai-Perron tests of L+1 vs. L sequentially determined breaks
Break selection: Trimming 0.20, Max. breaks 3, Sig. level 0.05
Breaks: 1905M01, 1961M12
HAC standard errors & covariance (Prewhitening with lags from SIC maxlags, Bartlett kernel, Newey-West automatic bandwidth, NW automatic lag length)
Allow heterogeneous error distributions across breaks

Variable	Coefficient	Std. Error	t-Statistic	Prob.
1870M10 - 1904M12 -- 411 obs				
LOG(DETRENDED MARRIAGE(-9))	0.096056	0.020269	4.739097	0.0000
C	0.214900	0.007134	30.12483	0.0000
Feb	0.061521	0.009921	6.200950	0.0000
Mar	0.052684	0.013235	3.980661	0.0001
Apr	0.025093	0.012101	2.073568	0.0383
May	-0.057177	0.009344	-6.119227	0.0000
Jun	-0.145797	0.009448	-15.43087	0.0000
Jul	-0.139223	0.010235	-13.60274	0.0000
Aug	-0.135153	0.008882	-15.21628	0.0000
Sep	-0.067746	0.010085	-6.717721	0.0000
Oct	-0.114303	0.013882	-8.234140	0.0000
Nov	-0.144917	0.009906	-14.62895	0.0000
Dec	-0.104667	0.031242	-3.350166	0.0008
1905M01 - 1961M11 -- 683 obs				
LOG(DETRENDED MARRIAGE(-9))	0.028112	0.008524	3.297849	0.0010
C	0.178061	0.009991	17.82236	0.0000
Feb	-0.030174	0.012312	-2.450722	0.0144
Mar	-0.080581	0.013910	-5.793056	0.0000
Apr	-0.123982	0.015610	-7.942550	0.0000
May	-0.181224	0.016914	-10.71474	0.0000
Jun	-0.222547	0.020236	-10.99778	0.0000
Jul	-0.220350	0.019825	-11.11465	0.0000
Aug	-0.207112	0.016446	-12.59373	0.0000
Sep	-0.140859	0.014158	-9.948977	0.0000
Oct	-0.147228	0.011833	-12.44257	0.0000
Nov	-0.171496	0.019213	-8.925915	0.0000
Dec	-0.237201	0.017737	-13.37326	0.0000
1961M12 - 2014M07 -- 632 obs				
LOG(DETRENDED MARRIAGE(-9))	-0.043317	0.006948	-6.234123	0.0000
C	-0.039852	0.006448	-6.180744	0.0000
Feb	-0.018168	0.007262	-2.501737	0.0125
Mar	0.000387	0.010519	0.036809	0.9706
Apr	-0.020994	0.011164	-1.880576	0.0602
May	0.028755	0.011779	2.441230	0.0147
Jun	0.057882	0.010070	5.747869	0.0000
Jul	0.077475	0.012276	6.311310	0.0000
Aug	-0.024941	0.011576	-2.154574	0.0313
Sep	0.051442	0.009344	5.505303	0.0000
Oct	-0.013747	0.010108	-1.359994	0.1740
Nov	-0.065260	0.013992	-4.664176	0.0000
Dec	-0.100396	0.007955	-12.62035	0.0000

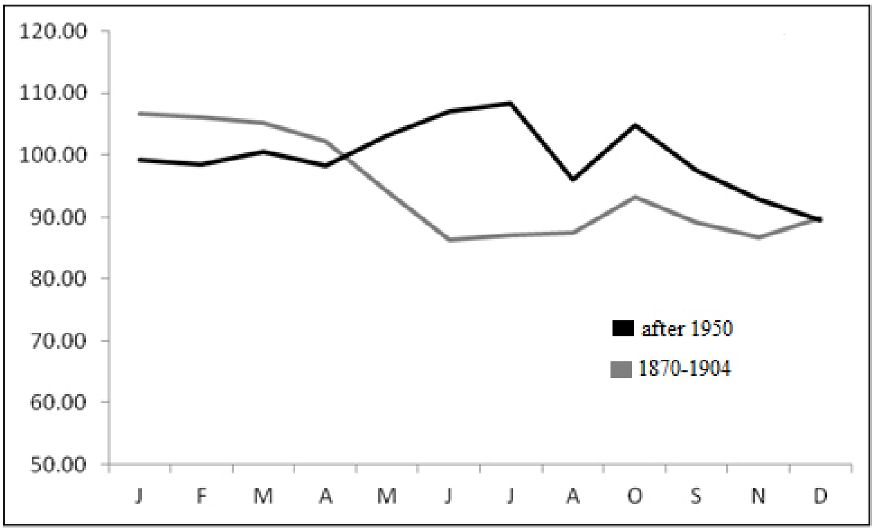
R-squared	0.713063	Mean dependent var	-0.003172
Adjusted R-squared	0.706600	S.D. dependent var	0.073383
S.E. of regression	0.039749	Akaike info criterion	-3.590119
Sum squared resid	2.665453	Schwarz criterion	-3.466893
Log likelihood	3137.273	Hannan-Quinn criter.	-3.544535
F-statistic	110.3247	Durbin-Watson stat	1.038153
Prob(F-statistic)	0.000000		

* Note: We excluded the years before 1870, because in those years the seasonal distribution of marriages was affected by the introduction of a change in the norms regarding the civil validity of religious marriages. See Breschi and Ruiu (2015) for a discussion.

Note also that, the coefficients associated to month dummies seem to radically change between the first and the third sub-period of our analysis in coherence with the descriptive evidence furnished in figure

2. In figure 4 we represent the model of seasonality resulting from the set month dummies in the first sub-period (1870-1905) and in the last sub-period (after 1961). Note that we have exponentiated the estimated coefficients reported in table 1 and, for comparative purpose with figure 2, we multiplied them for 100.

Figure 4. Models of birth seasonality estimated for Italy



3. Evidence at regional level

To give a first descriptive picture of the difference in the seasonal patterns among Italian regions, in figure 5 we plotted the seasonal indicators of marriages calculated for three not overlapping period, 1862-1885, 1886-1909, 1910-1933 for each region, while in figure 6 we replicate the same analysis for births. Regional data unavailability for the years from 1934 to 1950, forced us to focus on a shorter temporal window with respect to that considered for Italy as a whole. However, we believe that this time period should be enough to at least identify the first break. Since the estimation output associated to Italy is the result of the composition of regional effects, we expect to find regions in which the transitional regime (as defined in the previous section) started some years earlier than Italy as a whole (those in which the economic transformation has probably begun earlier) and some regions in which the transition started with some years of lag (those in which agriculture was the dominant sector of the economy for longer time).

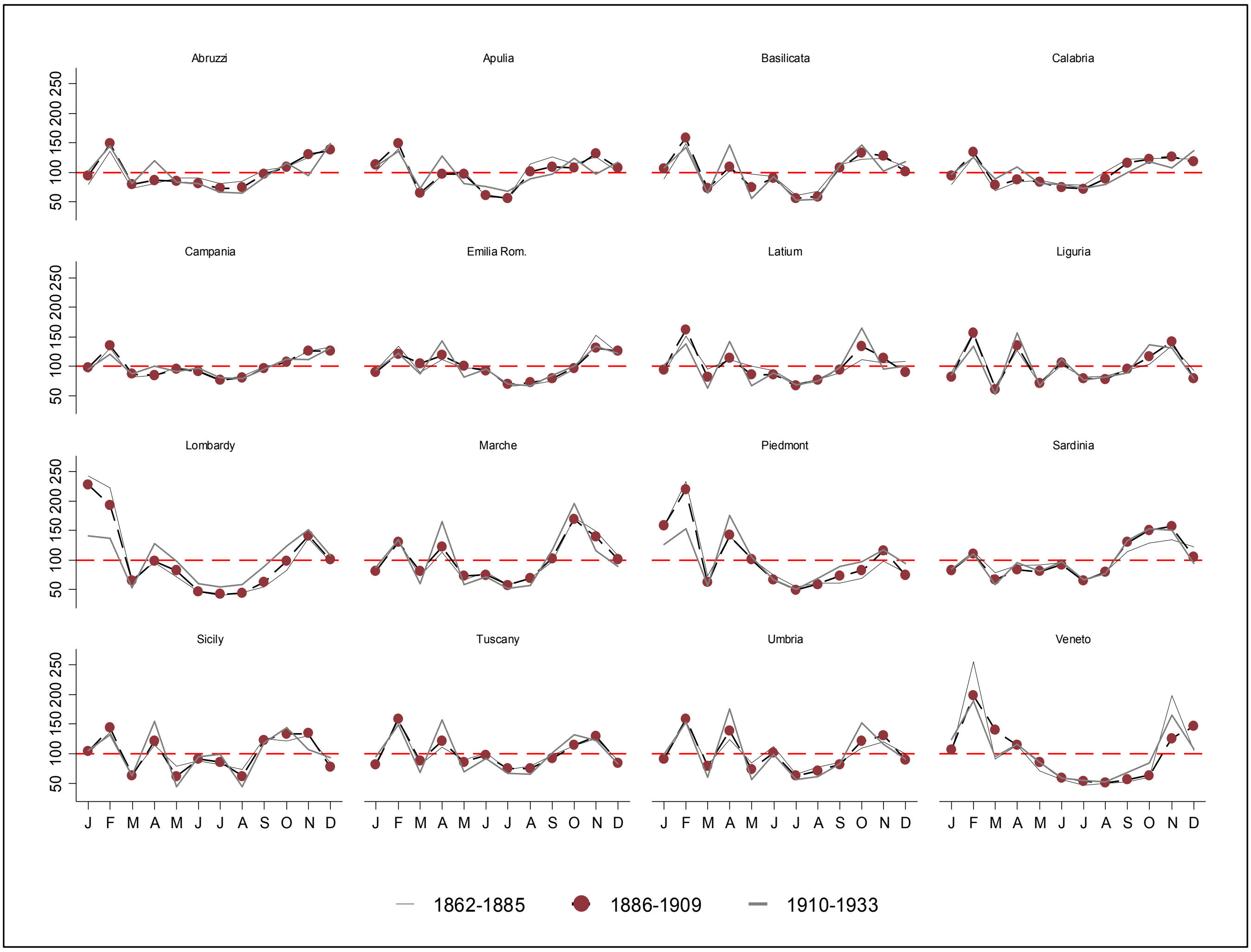
In both figure 5 and 6, the dashed horizontal line indicates the annual average, which by definition of our seasonal indicator, is normalized to 100. From figure 5 we can distinguish 3 main models of seasonality of marriages:

- Model 1A: relative maxima in late autumn and absolute maxima in winter, a decline of marriages both in the summer months and during Lent and Advent (the latter phenomenon is often remarked in demographic literature, the reader is referred to Ruiu and Breschi 2015 for a discussion). The regions characterized by this model are: Sardinia, Sicily, Basilicata, Tuscany, Liguria, Marche, Latium and Umbria.

- Model 2A: pattern of seasonality similar to model 1 from January to July, while after September, there is a stable increase in the number of marriages from August to December. Regions characterized by this model are: Campania, Calabria, Apulia, Abruzzi and Emilia Romagna.

- Model 3A: high concentration of marriage in January (Lombardy) or February (for Piedmont and Veneto), whilst among other months only November is above the annual mean. Veneto is the only region in which the index of seasonality in both March and December are well above the annual average.

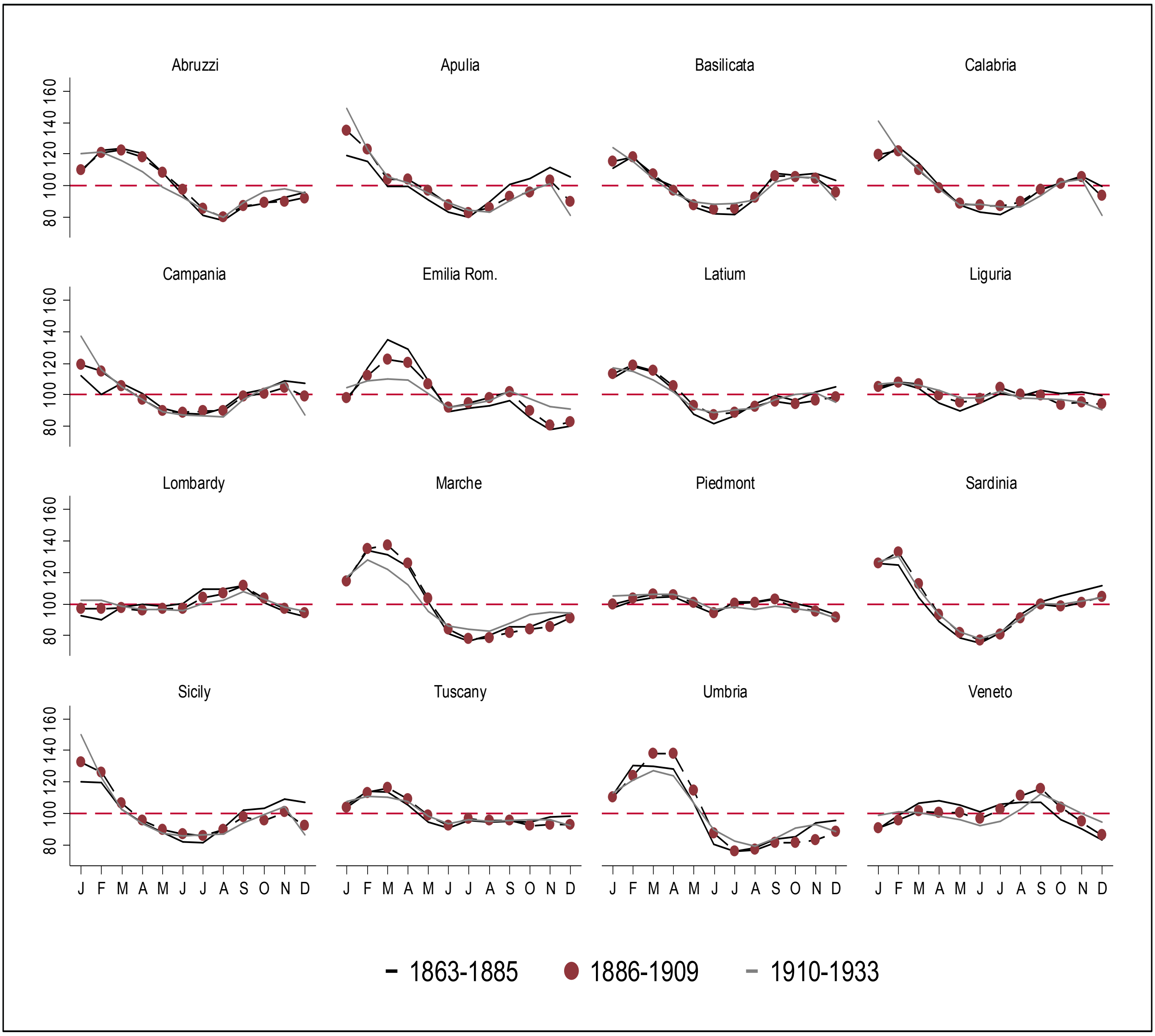
Figure 5. Seasonal pattern of marriages in Italian Regions, 1862-1933*



*For Latium data are from 1872 to 1933, because this region entered in the Italian Kingdom only after 1870.

Comparing the first period of analysis with the third period, the regions that experienced the largest change in their seasonal pattern, are, not surprisingly, the two more economically advanced, Piedmont and Lombardy.

Figure 6. Seasonal pattern of births in Italian Regions, 1863-1933



Also in regards to births (figure 6), we have a heterogeneous seasonal pattern among regions, with two main models of seasonality:

-Model 1B: The seasonality curves are characterized by peaks in one of the first three months of the year, followed by a stable decrease in the number of births since July or June (the months of minimum). After this trough, there is a moderate recovery in the number of birth since the relative maximum in November.[4] The regions characterized by this model are: Abruzzi, Apulia, Basilicata, Calabria, Campania, Sardinia, Sicily, Emilia Romagna, Latium, Marche, Tuscany, Umbria These regions belong to the Central and to the Southern part of Italy, with the exception of Emilia Romagna (Northern Italy)

-Model 2B: In this classification we include the remaining Northern regions for which the seasonal pattern is less clear. This model of seasonality is in facts characterized by less accentuated oscillations in the monthly number of births. In Piedmont and in Liguria the peak is reached in the first months of the year, while in Lombardy and Veneto is reached in September. With the exception of Liguria, in which the point of minimum is in May, the other three regions are characterized by a minimum in December.

Comparing the first and third sub-periods in which we have split the analysis, the most accentuated change in the seasonal model is in Emilia Romagna, which in the third period may be included in the model 2B (as defined above).

In general, the decline of live births after the month of March is compatible with the hypothesis that less conceptions happen in summer months when also marriages were avoided because of the intense workload. However, as observed above this may be a mere coincidence due to the fact that these also the month were temperature are high and light luminosity is intense.

To have a more formal test of our hypothesis of a relation between workload and birth seasonality at regional level, we present the results of the estimation of equation 2 for each region in Table 2. Having a shorter time interval, thus less observations, the results associated to the years around the Great War (1915-1918 for Italy) would be heavily influenced by this dramatic event. Furthermore, even if Italian soldiers were from all the regions, some parts of Veneto were occupied by Austrian military forces so making regional comparison even more difficult. Therefore, we decided to further limit the sample to the years from 1870 to 1914. We assumed a maximum number of 2 breaks in this time interval. Note that the beta coefficients reported in Table 2 are only those associated to our main variable of interest, i.e. the de-trended monthly number of marriages. We allow also the coefficients associated to month dummies to change, so in some cases we may have that in some time intervals identified by the break-dates the coefficients associated to marriages are almost equal to that of the previous period, while the

[4] A note of caution must be done before commenting the seasonal curves. Benini (1896) underlined that especially in periods in which the practice of giving birth in hospital was not diffused, a possible cause of the low number of births in December, was the Italian custom to postpone the declaration of births when children were born in the last days of the year. This was done especially for men in order to postpone their call to the compulsory military service for one year.

coefficients relative to month dummies are changing. To allow a better readability of Table 2 we do not report the latter coefficients, however they remain available upon request to the authors.

In general, we have that for almost all the regions a first break is identified during the 80s of the nineteenth century. Probably we are detecting some disturbance to the natural seasonal movement due to the Italian colonial war in Ethiopia. Thus, in our opinion, the second estimated break date is the most indicative of the possible structural change in the relation between the seasonal movement of births and seasonal movement of marriages. If our interpretation is correct than to have an idea of how the relation is changed in terms of magnitude, one has to compare the beta coefficient associated to the ante colonial war period (before 1886) and the coefficient estimated after the second break.

Table 2. Seasonality of births and seasonality of marriages, Italian regions, 1870-1914.

	Regions	Start	First Break date	Beta before first break	P-value	Beta after first break	P-value	Second Break date	Beta after second break	P-value
North	Veneto	1870 oct	1886 oct	0.011	not sign.	0.055	not sign	1895 apr	0.046	0.019
	Liguria	1870 oct	1886 nov	0.064	0.006	0.047	0.014	1895 sep	0.015	not sign
	Lombardy	1870 oct	1886 oct	0.062	0.01	0.016	not sign.	1896 jun	0.059	0.023
	Piedmont	1870 oct	1879 oct	0.043	not sign	0.043	0.038	1889 feb	0.018	0.001
	Emilia Romagna	1870 oct	1881 jul	0.106	0.003	0.109	0.003	1904 jun	0.064	0.001
Center	Tuscany	1870 oct	1886 oct	0.1	0.004	0.039	not sign.	1896 sep	0.054	0.003
	Umbria	1870 oct	1886 aug	0.08	0.022	0.089	0.09	1896 jun	0.082	0.001
	Latium	1873 apr	1886 nov	0.025	not sign	0.052	0.033	1896 nov	0.036	0.035
	Marche	1870 oct	1887 sep	0.056	0.026	0.047	not sign.	1902 oct	0.063	0.034
South	Abruzzi	1870 oct	1886 may	0.156	0.001	0.067	0.028	1897 nov	0.055	0.047
	Sardinia	1870 oct	1879 sep	0.003	not sign	0.105	0.01	1890 sep	0.101	0.002
	Campania	1870 oct	1887 dec	0.095	0.001	0.132	0.006	1902 sep	0.097	0.019
	Calabria	1870 oct	1883 jan	0.13	0.001	0.135	0.001	1898 mar	0.081	0.001
	Sicily	1870 oct	1886 oct	0.072	0.001	0.12	0.001	1902 oct	0.17	0.09
	Basilicata	1870 oct	1879 aug	0.074	0.001	0.055	0.048	1890 set	0.089	0.001
	Apulia	1870 oct	1889 dec	0.08	0.001	0.133	0.001	1900 dec	0.085	0.001

Confirming our expectation, the more economically advanced regions (Lombardy, Piedmont and Liguria) are also those where the magnitude of the relation between the two variables is lower, and where there is a further decrease after the second break-date. Among Southern regions only in Abruzzi and in Calabria we see a drop in the coefficient associated to de-trended marriage after the second break date, while in the remaining regions it remains more or less stable (and in the case of Sicily increases). Among Central regions, we have in Tuscany and in Latium the coefficient associated to marriage decreases after the second break, while in Marche and Umbria it remains more or less stable.

Note that for Tuscany, the magnitude of the coefficient is very similar to that estimated for Emilia Romagna, which is the most comparable regions in terms of economic conditions and of size of the population.

In the case of Latium, the estimation in first time interval identified by the Bai-Perron technique. Rome and the former territory of the Vatican State, entered into the Italian Kingdom only after September 1870, so in the initial phase of its constitution, the borders of this region was frequently changed, but with our data we are not able to take in account of this adjustment in the borders. The same problem is probably even more accentuated in Veneto since in the period of our study, this region included also part of Friuli.

For Sardinia and Piedmont, we are not able to find a significant relation between the two variables for the first 10 years considered in our analysis. Being two regions of the formerly Kingdom of Sardinia (the State that has moved the first political and military steps towards the national unification), a possible interpretation is that these two regions have experienced a sort of period of transition in the first years of the new Italian State.

Conclusions

The seasonal movement of live births is a phenomenon that is present in almost all the population of the World. Although many research efforts have been carried out on the topic, a full understanding of the underlying causes is far from being reached. A vast part of the literature gives attention to physical environmental characteristics, such as temperature and light intensity while less researchers have dealt themselves with the social dimension of birth seasonality. As noted by Bobak and Gjonca (2001) one has to distinguish the biological determinants of fecundability (the physiological ability to conceive) and the social determinants of fertility (the realization of the potential to reproduce). However, the two aspects cannot be easily separated. In this paper we propose to use marriage seasonality as a proxy for workload intensity in order to study the relation between the latter and fertility. The demographic literature has in facts always underlined that the seasonal movement of marriage was akin to the calendar of working activity in economies which are mainly based on the primary sector. Our hypothesis is that especially in this kind of economy, in which both the resources availability for a family and the energy consumed by the same family for the working activity, widely fluctuate from one month to another, the seasonal pattern of live births should be consequently influenced. In particular, we run a multivariate regression in which the dependent variable is a seasonal indicator of live births and the explicative variables are the 9-month lagged seasonal indicators marriages in addition to month dummies. We believe that the inclusion of this set of dummies should capture the different climatic characteristic of each months, thus allowing to interpret the coefficient associated to marriages as a partial effect which is cleaned from the effect of the environmental factors. Adopting the Bai Perron technique, we also tried to identify when the relation between work intensity, as captured by marriage seasonality, and our dependent variable started to decline. We found that in Italy, an increase in the seasonal indicator of marriages (and thus a decrease in the work intensity of the month) was associated to an increase of about 0.10% in the seasonal indicator of births since the first years of the nineteenth century. According to our estimated breakpoint, the relation between the two variables become weaker around the 1905, while after the sixty of the nineteenth century (so after the Italian economic miracle, when marriage seasonality no more incorporate information about the agricultural workload calendar) the sign of the relation is completely reversed. At the regional level we were not able to use the wide time interval used for Italy as a whole. In particular we limited our empirical exercise to the period 1870-1914. We find very reasonable differences between Northern and Southern regions. In particular, we find that magnitude of the relation between marriage and birth seasonality was lower in the more developed Northern part of the country, in which some signs of industrialization (in particular in Lombardy, Piedmont and Liguria) was yet present.

The main limitation of this work is that we are not able to separate first order births from subsequent births. This problem may undermine our ability to catch the relation between the agricultural cycle and births, if as argued by Matsuda and Kahyo (1994) the relation between the seasonal movement of the latter and that associated to marriages passes only through first order births. However, we believe that at least for the first time period used in our analysis this criticism does not apply, since the seasonality of subsequent births should dominate that associated to first births.

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