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Contraceptive trajectories and women's years of employment activity in low-income countries: combining fictive cohorts, contraceptive calendar data and sequence analysis

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Abstract

Historically, family planning (FP) programs in low-income countries (LICs) have been valued for their benefits to child and maternal health. Today, there is a focus on integrating contraceptive access into women's rights. However, measuring the impact of FP on women's economic empowerment remains challenging due to a lack of comprehensive longitudinal data. This paper aims to model the relationship between contraceptive use and women's economic empowerment using cross-sectional data, while acknowledging the limitations posed by age structure, cumulative benefits, and dynamic contraceptive behaviors. It proposes a fictive cohort approach to measure empowerment over the life course, utilizing retrospective calendar data (past 36 months) to analyze different recent contraceptive use patterns and applying sequence analysis to summarize it. Using data collected in one survey in 2020-21 in Burkina Faso, our analysis examines recent contraceptive behavior among women in union aged 20 to 44 and its association with current empowerment levels, projecting these relationships across the entire reproductive life course. Results suggest that longer durations of contraceptive use correlates with increased time spent in work and paid employment, with significant differences between non-users and long-term users. The paper also finds that consistent contraceptive use—whether through long-acting modern methods or short-term modern or traditional methods—is linked to up to 4 additional years of gainful economic activity over women's reproductive years. This suggests that, in addition to the well-documented direct health benefits of contraception, there are also significant economic advantages for consistent users. Future work should extend this approach to other countries and explore how these findings translate into economic benefits at the country level.

Keywords: Contraceptive trajectories, sequence analysis, fictive cohort, empowerment, calendar data

Introduction

In earlier times, family planning (FP) programs were advocated in low-income countries (LICs) for their positive effects on child and maternal health (Stover and Ross 2010). Today, national and international stakeholders aim to promote access to contraceptive information and services

as an integral part of women's rights (World Health Organization 2014). In this context, evidence demonstrating how FP use boosts women's overall and economic welfare would be valuable for informing future directions of FP programming. However, direct measurement of the impact of family planning on women's empowerment—economic or otherwise—remains rare. Extensive longitudinal data (within experiments or not), including several data points of both empowerment and contraceptive use, are required to assess the extent to which contraceptive use affects empowerment, and they are seldom collected. Meanwhile, the rare existing longitudinal or experimental studies indicate that the causal link between contraceptive use and female economic empowerment is far from systematic in low-income countries (Finlay 2021). These results underly the need to continue pushing to collect for (costly) complete longitudinal data, but also to imagine other ways to investigate the relationship of interest.

In the latter vein, this paper proposes to move away from the question of causality and to estimate -from cross-sectional survey data- the gains in women's empowerment, particularly economic empowerment, *associated* with contraceptive use. Many studies have shown a relationship between various dimensions of women's empowerment and contraceptive use in low-income countries (Blackstone 2017; Ang and Lai 2023; Prata et al. 2017; Ewerling 2020; Habte et al. 2023). Positing a bi-directional relationship between the two dimensions of interest, we could mirror these analyses and calculate and model the proportion of women employed (or otherwise empowered) according to their usage of contraception. However, this approach would entail several shortcomings. First, empowerment strongly increases with age; an all-ages measure of the level of empowerment as associated with contraceptive use would obscure comparisons across time, countries or subgroups, due to differences in age structure. Second, empowerment is a lifelong process, whose benefits are small when grasped on a yearly basis but cumulate in larger outcomes when measured cumulatively over the life course, at older reproductive ages. Third, contraceptive use is a behavior that women (and men) begin, switch, and stop for varying reasons. At certain ages, pregnancies and births are frequent, reducing women's need for contraception during key periods, even for those who would use contraception otherwise.

While multivariate modelling would help with the first issue (age structure), it cannot handle the cumulative nature of empowerment across the life course nor the dynamic pattern of contraception use. Moreover, results of multivariate regressions are often hard to understand and to interpret for policymakers. Such type of evidence may even elicit distrust, and they certainly do not strike the imagination as simple statistics do. Policy makers are sensitive to measure they can understand and compare across time, countries or sub-groups. For these reasons, this paper proposes to use a *fictive cohort approach* (Carstensen, 2007), and to use a simple outcome: the total number of years spent employed -or otherwise empowered- during reproductive years. Such a measure controls for the age structure and takes into account the cumulative nature of empowerment, whose level can be impressive when added across years. We propose to relate this outcome to contraceptive use, by distinguishing several pattens of contraceptive use at every age and designing varied *fictive* cohorts of women using the least / typical / most contraception as observed at every age in the population studied. Using the empowerment status observed for each group of contraceptive users at each age, we sum up the

number of years employed (or otherwise empowered) across the life course for each of the contraceptive trajectories imagined.

To render justice to the fluid nature of contraceptive use, we further propose to measure this dimension using calendar data, typically covering periods of a few years, which are available in many large demographic surveys, such as the Performance Monitoring for Action (https://www.pmadata.org/). One hurdle in using such data has been the difficulty in summarizing them: current studies use indicators such as the total duration of modern contraceptive use, which may obscure differential associations between contraception and female empowerment depending on the timing and occurrence of pregnancies in the few years preceding the survey, or types of contraceptive methods used. To summarize these calendar data, on top of total duration of contraceptive use, we thus propose to test sequence analysis. This method (Liao et al. 2022; Piccarreta and Studer 2019; Aisenbrey and Fasang 2010) allows us to distinguish different patterns of contraceptive trajectories: it considers the timing, duration, and sequences of contraceptive use within the period of observation, different types of contraceptives, as well as nonuse and pregnancy status.

In sum, we aim to produce from available cross-sectional demographic survey data an intuitive, easy-to-understand, and easily comparable life course measurement of women's empowerment gains related to various contraceptive use trajectories. We develop a method based on retrospective monthly contraceptive data collected routinely in large multi-country population surveys to summarize recent contraceptive practices observed at every age. From there, we imagine different contraceptive lifelong trajectories using a fictive cohort approach, modeled on the total fertility rate, and sum up the outcome of interest - the durations in years in different empowerment statuses - across ages and across fictive contraceptive trajectories.

II. Conceptual framework

Our modeling rests on the assumptions of a circular (bi-directional) association between contraceptive use and women's empowerment, which we describe in our conceptual framework (Figure 1). Using contraception requires a certain level of empowerment regarding family planning issues, as empowerment has been identified as a significant determinant of contraceptive use (Muluneh et al., 2021; Lassi 2024). Empowerment acts through two main routes. A first factor underlying the use of contraception is the desire to avoid pregnancy (Speizer and Calhoun 2022; Bankole and Audam, 2011): this desire is influenced by women's empowerment and other sociodemographic factors, including the number of children, level of education, and occupation (Ocalan et al., 2018). Second, women need access to FP information (Zan and Rossier, 2024) and products, along with a basic level of decision-making autonomy over FP issues, to use contraceptives effectively and act on their desires. When examining the respective impacts of household decision-making empowerment and FP empowerment on contraceptive use in a multivariate model, only the latter shows a significant relationship with contraceptive use (Zan et al., 2024). Additionally, it has also been shown that low educational attainment tends to limit women’s autonomy in FP decision-making (Jejeebhoy 1995) and their ability to use health services (Tsala Dimbuene et al 2018).

The requirement of some initial level of empowerment is especially relevant in settings where sociocultural norms grant men most of the power. For example, in Burkina Faso, only a small percentage of women can independently make decisions regarding fertility issues and healthcare (INSD, 2012). Notably, some studies demonstrate that a woman's initial level of empowerment may come from her background (family and parents). For example, a study conducted using the Egypt Labor Market Panel Survey shows that education, employment, and father's characteristics are significant determinants of empowerment measured through decision making and mobility. This same study also shows that the women's participation in marriage costs is associated with her level of both involvement in decision-making and mobility (Assaad et al., 2014). In addition, women's level of empowerment in reproductive areas may be bolstered by the dissemination of FP information that enhances women's agency (Zan and Rossier 2024).

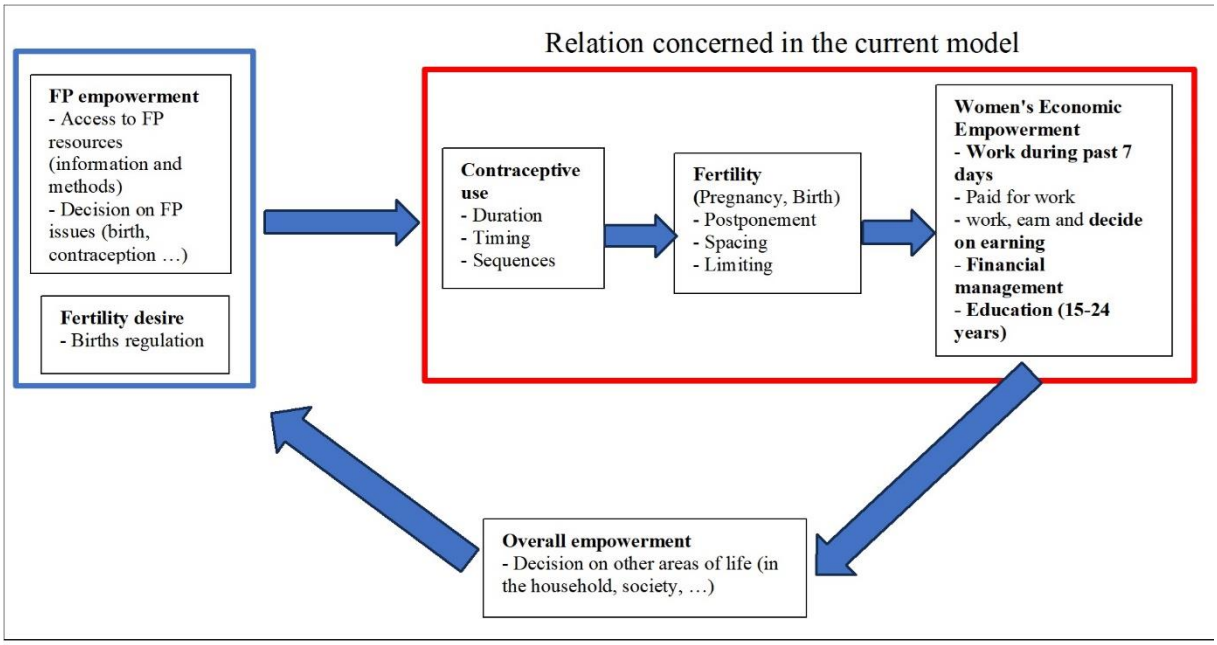
The primary purposes of contraceptive use include delaying, spacing, or preventing pregnancies. Contraceptive use results in delayed and fewer pregnancies and births, which has been shown to positively impact women's and children's health (Stover and Ross 2010; Cleland et al. 2012; Maïga et al. 2015). While the health benefits of contraception are well documented, its non-health benefits are less explored. Potentially, women who can time or reduce the number of pregnancies are more able to participate in economic activities, provided economic opportunities are available. It has been shown that the use of contraception to prevent births can reduce adolescent childbearing, allowing them to complete their education and later participate in the labor market (Finlay and Lee 2018). However, the connection between contraceptive use, fertility and labor force participation, especially in low- and middle-income countries is not so clear, partly due to the high prevalence of the informal sector (Finlay, 2021).

Empowerment is defined as a "multi-dimensional social process that helps people gain control over their own lives. It is a process that fosters power (that is, the capacity to implement) in people, for use in their own lives, their communities, and their society, by acting on issues that they define as important" (Page and Czuba, 1999, p3). Women's empowerment is about enabling women to have control over their lives, make informed choices, and participate fully in all spheres of society. Additionally, empowered women can make significant contributions to political, social, and cultural processes, leading to more inclusive and equitable societies (Dahlum et al. 2022).

Economic empowerment is also defined as "power (control over one's own life and resources) and agency (capability to originate and direct actions for given purposes)" (Fox and Romero 2017, P3). In our framework, we consider three dimensions embedded in the concept of economic empowerment. First, the ability to work, which depends on the respondent's availability to engage in economic activity and the availability of work in the setting. Second, paid work is emphasized because it involves consciously working to earn income that can be used to satisfy other needs. Third, decision-making power, especially over what is earned from work, is crucial.

When women begin to engage in economic activities and earn more revenue, their social standing starts to change as high-earning wives are seen as having high-status (Winslow-Bowe, 2006). However, women's earnings (and their higher social standing) translate in gains in

decision-making only gradually in different life areas (Klesment and Van Bavel, 2022). This change can enhance women's decision-making power within the household and increase their empowerment across various life areas. This process is in line with the most cited definition of empowerment: "women's empowerment is about the process by which those who have been denied the ability to make strategic life choices acquire such an ability'' (Kabeer, 1999). In that process women will acquire more and more ability to make strategic life choices as women's empowerment can be seen as a life-long process from childhood to adulthood, and different life areas are interconnected (Desai et al., 2022). This improvement can extend to enhanced FP empowerment, including greater decision-making authority regarding family planning and motherhood. This idea of a virtuous circle is like the relationship between women's empowerment and development (Duflo, 2012). So, our framework can be considered a virtuous circle where contraceptive use and empowerment are mutually influencing each other. However, the scope of our analysis only concerns the influence of contraceptive use on women economic empowerment.



Note: This figure is from authors own production

Figure 1: Conceptual framework

III. Presentation of the model

While much has been written on the association between female empowerment—in its various dimensions—and how women choose to plan their births and access and use contraceptives (Ang and Lai 2023; Ewerling 2020; Habte et al. 2023; Manzer 2022 ; Shah, 2021), this association still needs to be measured in the opposite direction and in a way that: a) is applicable to a large number of countries, times and groups and easy to compare b) takes into account women's entire empowerment life course in a cumulative manner, c) uses more accurate data on contraceptive use (contraceptive calendar data) than current use data, and d) is easily understandable by policymakers.

To this effect, we propose to follow fictive cohorts of women who would experience different contraceptive trajectories across their reproductive life (imagined from observed contraceptive patterns at each age) and to measure their aggregated labor market engagement outcomes (or other dimensions of empowerment). We propose using recent contraceptive calendar data available in existing large demographic surveys to document contraceptive patterns at each age. We will test whether summarizing contraceptive calendar in a more complex way using sequence analysis, notably including the occurrence of pregnancies and different types of methods, can better document the link between contraceptive use and women's economic empowerment, rather than simply using average durations of use.

III.1. Methods and data requirement

The fictive cohort model is used to measure the overall effect of recent contraceptive use on empowerment outcomes over women's life course: we will first describe this method. The application of this methodology requires variables that depict women's levels of empowerment. Since the range of empowerment dimensions is not limited, this method can be used regardless of the specific dimension of empowerment considered. Additionally, the model requires contraceptive survey data, specifically contraceptive calendar data. The contraceptive calendar data are summarized using either the duration of use or sequence patterns. The R software were used for all the analyses. We will describe these different elements in that order below.

Fictive cohort modeling

The fictive cohort model is commonly employed in demographic analyses to transform cross-sectional data (here: recent contraceptive trajectories, current empowerment status) into longitudinal data (Carstensen, 2007). This approach transposes the current level of an outcome for a specific age group to individuals of the same age followed in a cohort. In other words, it assumes that individuals in the cohort will behave at each age similarly to current individuals of the given age and maintain that behavior for one year. As an example, demographers typically consider fertility rates measured in a given year for seven age groups, ranging from ages 15-19 to 45-49, to estimate the total fertility over the entire life course of women who would experience at every age the fertility rates observed that year.

The fictive cohort model applies to quantitative outcomes that have a cumulative nature, such as the number of children or here, the duration spent in a particular status during a reference period. In our methodology, we use this model to document women's empowerment throughout their life course and to compare this synthetic empowerment indicator across different fictive groups of women, distinguished according to their contraceptive trajectories. To model durations from cross-sectional data, we assume that individuals stay in this situation for one year after the time of the survey. Thus, the outcome of the model (empowerment) can be considered as years spent in a particular (work) status during the reproductive age period for women who have followed a given contraceptive trajectory throughout their lives.

As we rely on a sample to estimate the overall number of years working (or years spent in other "empowered" statuses), we need to account for sampling uncertainty. We derive confidence intervals using the bootstrap method, treating each contraceptive pattern as a binary variable.

In a first application of the model (results in Table A3), we compute and sum the average number of years spent working (or years spent in other "empowered" statuses) by 5-year age groups, according to the duration of contraceptive use or contraceptive pattern. However, this approach has some limitations. Firstly, treating each age category as a homogeneous group (regarding the relationship between contraceptive use and work) may not accurately reflect real-world variability across single ages. Secondly, using categorical age variables requires estimating one parameter for each category minus one, whereas using a single continuous variable for age requires the estimation of only one parameter.

Therefore, in the presented model, we use a single-year linear regression with a quadratic factor to model the duration in employment. In the single-age model, the assumption of uniform empowerment outcomes is made for the women for the same age only which is more realistic that the five years assumption. In addition, to address the non-linear relationship between economic empowerment and age, we apply a quadratic transformation. Therefore, the overall difference between contraceptive patterns (for example, Pattern i = 2 or 3 versus Pattern 1) rely on a linear regression predicting women's empowerment level y_i by age a_i and contraceptive use p_i as follows.

$$y_i = \beta_0 + \beta_1 \cdot a_i + \beta_2 \cdot a_i^2 + \beta_3 \cdot p_i + \beta_4 \cdot a_i \cdot p_i + \beta_5 \cdot a_i^2 \cdot p_i + \epsilon_i$$

But how are the contraceptive Pattern p_i defined? First, one turns to the data and summarizes the contraceptive patterns as observed in a number of categories at each age. Two approaches are possible here: the categories are allowed to vary at each age (or 5 years age) groups, or they are defined on the entire sample and thus remain stable across ages. The choice of the approach depends on the empirical data, the second option being relevant in populations whose contraceptive behaviors are relatively homogenous across ages, while the first will be more appropriate if large discrepancies are observed across ages. Then, one constructs fictive cohorts depicting varying contraceptive trajectories across the life course. One option would be to examine systematically all possible trajectories by combining the observed age-specific patterns, and to affect a probability of occurrence to each trajectory. However, it seemed more relevant for policy making to construct a few -realistic and desired- trajectories: one trajectory where women would follow at every age the lowest level of contraceptive use as observed in the data, one where women would adopt at every age the most common contraceptive practices observed in the data, and one where women would adopt at each age the most extensive contraceptive coverage as observed in the data. Once the fictive trajectories are defined (that is the lifelong succession of different observed p_i in the equation above), the empowerment outcome is computed at every age for women following p_i, and then added across ages. In sum, fictive trajectories can feature either the same or varying age specific contraceptive patterns across the life course. Note that in either case, the relationship between specific contraceptive use patterns and empowerment is allowed to vary across ages.

Empowerment measures

In many studies, the economic dimension of empowerment includes labor force participation. Its measurement usually encompasses respondent occupation, if her work is paid and the comparison of her earnings to that of her partner's (Asaolu et al. 2018). In the proposed approach, several quantitative measures of economic empowerment can be used, such as whether the woman is engaged in an income-generating activity. In our model, the outcome variables are dichotomous, but the approach can be easily extended to study continuous variables.

As stated earlier, empowerment is a gradual lifelong process (Desai, 2022) and when assessed in relation to contraceptive use, is usefully measured in a cumulative manner over the entire life course, here the entire reproductive life course. That is where a cohort approach is relevant as it allows for the cumulative assessment of exposure-outcome relations (Szklo, 1998).

Ideally, to apply our fictive cohort model, we need measures of empowerment collected at two time points: at the time of the survey and in a follow-up survey one or more years later. Time spent working (or time spent in any empowered status) can then be deduced from these two data points (See results presented in Table A4, Table A5, Table A6 and Table A7). However, the model can also be applied with empowerment data collected at one point in time (at the survey). Here, we use empowerment status data collected at the time of the survey, making the model applicable with Demographic and health survey (DHS) data.

Contraceptive use measures

Demographic surveys typically ask about current contraceptive use, i.e., whether a woman is using one (or more) contraceptive methods at the time of the survey and which method(s) exactly (implant, pill, condom, withdrawal, etc.). This information is often summarized as a dichotomous variable: any modern method use versus non modern method use. Three categories are also possible: any modern method, no modern but any traditional method, or no method. However, because women's current practices can change quickly, it is difficult to assume that women will use a method consistently over one year, as our modeling would assume.

This is why we need calendar data on contraceptive use and reproductive events. Several demographic surveys also collect contraceptive calendar data. Calendar data are regularly collected in DHS surveys, retrospectively for the last five years. However, in the last phases of PMA, it was collected only for the last three years. So, in our case, we will use data on contraceptive behavior over the past three years collected in PMA Burkina Faso in 2020.

Summarizing contraceptive calendar data: durations and sequence analysis

We use two approaches to summarize recent contraceptive use. The first approach simplifies the information by aggregating all contraceptive methods (modern and traditional), summing up all periods of contraceptive use during the reference period. This measure does not account

for the number of method switches, the occurrence of pregnancies, or the timing and types of different methods used.

The second approach is an application of sequence analysis that aims to highlight regularities in the timing of contraceptive use of different types and reproductive events, their ordering, and the time spent in each situation. This approach involves three steps. First, the trajectories are coded as categorical sequences. Second, the trajectories are grouped into types using cluster analysis. Third, a distance measure is used to compare trajectories (see Studer and Ritschard, 2016, for a review). Sequence analysis is conducted in R, using the TraMineR package (Gabadinho et al., 2011; Studer, 2013).

For both approaches, we tested age-specific categories as well as categories defined for the entire sample, and then applied at each age.

IV. Illustration: Time spent in employement and contraceptive trajectories in Burkina Faso, 2020

We illustrate the proposed method through an application focusing on the relationship between patterns of contraceptive use and women's engagement in economic activities and their ability to manage their earnings in Burkina Faso. We estimate the total average years a woman spends in economic activities throughout her life course depending on her contraceptive use pattern at different ages. We apply the previously described model to three aspects of women's economic empowerment: engaging in economic activity, engaging in paid work, and engaging in paid work while managing earnings.

IV.1 Data and descriptive results

The longitudinal PMA surveys in Burkina Faso in 2019-20, 2020-21, 2021-22 focused on collecting information on contraceptive practices and services in 167 enumeration areas using a multi-stage stratified cluster design, stratified by urban or rural residence, and re-interviewing the same women three times (phases 1, 2 and 3). Between December 2019 and February 2020, 6,590 women aged 15-49 (with a 95.8% response rate) were interviewed for phase 1. Phase 2 was conducted between December 2020 and March 2021, successfully re-interviewing 5,491 eligible women. Phase 3 was conducted between December 2021 and February 2022, successfully re-interviewing 6,514 eligible women. Here, we use retrospective calendar data from survey of phase 2 and considered, as a check, longitudinal change in empowerment outcomes between phase 2 and phase 3 (Table A4-A7).

In the PMA survey, calendar data provide a detailed record of a woman's contraceptive use and reproductive events over the three years prior to the survey date. This information is collected through a calendar-based questionnaire where women provide month-by-month details about their contraceptive practices, pregnancies, births, and other relevant events. These periods are recorded into intervals of contraceptive use, non-use, types of methods used, and pregnancies. These surveys collected information on women's work status. Work status was assessed based on the last 7-day reference period.

We restricted the analysis to women who were in union, as most autonomy variables did not apply to unmarried women. Preliminary exploration indicated that women aged 15-19 were not significantly engaged in work, even if they used contraception. Additionally, due to menopause, contraception does not significantly affect pregnancies and births among women over 45 years old, thus not impacting their employment. Therefore, the analysis focuses on 2,543 women in union aged 20-44 years. This specification is important to keep in mind, as it can explain why contraceptive use patterns were found to be relatively homogenous across this age range.

Empowerment outcomes

Work status

This dimension is based on the following question: "*Aside from your own housework, have you done any work in the last seven days?*". The responses are :

- "1. Yes"
- "0. No."

Paid work status

This question concerns those who responded "YES" to the work status question. They are asked: "Are you paid in cash or kind for this work or are you not paid at all?" The responses are:

- "-99. No response"
- "1. Cash"
- "2. Cash and kind"
- "3. In-kind"
- "4. Not paid"

These responses were recoded into "Paid work" by grouping the categories 1, 2, and 3. The other two categories are considered as not being in paid work. Additionally, those working for themselves were also considered as engaged in paid work.

Paid work and earnings managing status

To capture this concept, the question asked was: "Who usually makes decisions about how your earnings will be used?". The response categories were:

- "1. Respondent"
- "2. Husband/partner"
- "3. Respondent and husband/partner"
- "96. Someone else"

We consider that a woman manages her earnings if she declares that she manages them alone or jointly with her partner.

Table 1 presents data on married women's (aged 20 to 44) work status, paid work status, and the status of managing their earnings, divided into frequencies and percentages. It shows how

the levels of these outcomes vary based on the inclusion or exclusion of payment and decision-making considerations.

Table 1. Sample distribution by empowerment outcomes variables

	Work status		Paid work status		Paid work and earnings managing status	
	Frequences	%	Frequences	%	Frequences	%
No	1636	64.3	1705	67.1	1926	75.7
Yes	907	35.7	835	32.9	617	24.3
Total	2543	100	2543	100	2543	100

Patterns of contraceptive pattern of use: durations

We first grouped women (in union, aged 20-44) based on the total duration of modern and traditional contraceptive use during the last three years, coded into three categories based on terciles. Inspection of the differences by age-groups (Table 2) shows that the same categories of duration can be used across ages in this specific sample.

The first group, with no contraceptive use at all, represents 33.2% of the sample. The second group includes women whose duration of use ranges from 1 to 21 months (32.6%), and the third group consists of women whose duration of use is 22 months or more (34.2%). Overall, we observe broadly speaking similar patterns of contraceptive use across ages, with nevertheless a trend of increased non-use instead of infrequent use among older women (35-44) and a more balanced distribution across the three categories among younger women (see Table 2).

Table 2. Sample distribution by duration of contraceptive use (modern and traditional) during the last 36 months and by age group

	None use (0 month)		1 to 21 months		22 months +		Total	
Age group	n	%	n	%	n	%	n	%
20-24	172	29,4	226	38,6	187	32,0	585	100,0
25-29	187	30,9	203	33,6	215	35,5	605	100,0
30-34	166	29,9	187	33,7	202	36,4	555	100,0
35-39	178	36,9	134	27,8	170	35,3	482	100,0
40-44	142	44,9	78	24,7	96	30,4	316	100,0
Total	845	33,2	828	32,6	870	34,2	2.543	100,0

Among married women between ages 20-24 the most common category of recent contraceptive use is "medium term use" (1 to 21 months), followed by "long term use" (22 months and above) between ages 25 and 34, and then "no use" between 35 and 44 years. A typical contraceptive trajectory for married women 20 to 44 would probably follow this pattern in Burkina Faso today. However, given the relatively large proportions of the sample in each category at each age, trajectories cumulating non-use throughout one's married life, as well as long-term (at least 22 months out of 36 months) contraceptive use throughout one's life is probably also realistic.

Link between contraceptive duration and empowerment in work

Next, we analyze the relationship between contraceptive duration and women's current work status (Table 3). Non-users exhibit the lowest levels of current employment (31.5%), paid work (29.6%), and managing earnings (20.5%). Conversely, across all empowerment outcomes considered, levels tend to increase with longer durations of contraceptive use.

Overall, we find that only current employment status is associated with contraceptive duration. However, the proportion of women engaged in paid work and managing their earnings does not significantly vary across contraceptive durations based on the Chi-square test.

Table 3. Level of empowerment outcomes by duration of contraceptive use

	Work		Paid work		Manage earnings	
	%	IC 95%	%	IC 95%	%	IC 95%
None use (0 month)	31,5	[25,2-38,6]	29,6	[23,4-36,8]	20,5	[15,8-26,3]
1 to 21 months	35,3	[29,7-41,3]	32,3	[26,7-38,3]	25,3	[20,7-30,6]
22 months +	41,0	[33,4-49,2]	37,5	[30,3-45,2]	27,7	[21,2-35,1]
Total	35.7	[30.5-41.2]	32,9	[27,9-38,3]	24,3	[20,2-28,8]
	Pearson chi2(2) = 17,1015; Design-based F(1,93, 316,39) = 3,3319 Pr = 0,039		Pearson chi2(2) = 12,0578; Design-based F(1,92, 315,30) = 2,3614 Pr = 0,098		Pearson chi2(2) = 12,4778; Design-based F(1,99, 325,68) = 2,4739 Pr = 0,086	

Patterns of contraceptive use: sequence analysis

In this alternative way of summarizing contraceptive patterns, recent use are coded using contraceptive states collected monthly in the PMA data prior to the interview. At each time point, a woman can be in one of several states: pregnancy, birth, non-use, or contraceptive use. For contraceptive users, we distinguished between long-term modern methods (mainly the implant in this population, IUDs being rare) and short-term modern methods (pill, condoms, injectables, ...), with the latter combined with traditional methods (mainly periodic abstinence in this sample). We experimented with different groupings of contraceptive methods to create more interpretable clusters. Additionally, pregnancy and birth (and other pregnancy outcomes: miscarriages) were grouped together. The number of miscarriages reported was too low to warrant a separate analysis.

Individual three years contraceptive calendars are compared using optimal matching (OM) the most used distance measure. OM measures the distance between two sequences by computing the minimum number of changes required to transform one into the other (Liao et al., 2022). Following Studer's recommendations (2013), the clustering algorithm and the number of groups were chosen to maximize the clustering quality across several cluster quality indexes while ensuring interpretability. We tested two classification methods: Ward Hierarchical clustering and Partitioning around medoid (PAM). Analysis of the quality criteria for both classifications showed that Ward Hierarchical clustering provided better results when retaining four clusters (Table A1). Therefore, we chose to use this clustering method for our analysis.

We first applied this approach one age group at a time: given the sample size, only two groups were singled out each time, which was not an improvement over simply measuring average duration of use. Observing enough consistencies in sequences across ages, we performed the clustering over the entire sample, resulting in a typology of four groups of contraceptive use trajectories. Figure 2 illustrates these four patterns using chronograms, displaying the state distributions of women classified in each type over the previous 36 months. Figure 3 presents index plots of these trajectories, where each trajectory is represented by a thin horizontal line representing individuals. While chronograms provide an easy grasp of the relative prevalence of different states over time, index plots offer a clearer description of the longitudinal dynamics of the trajectories.

The analyses identify four types of women in the sample, represented in each age group:

Cluster 1: "Non-users" (49.7% of respondents)

This group primarily consists of non-users (or quite sporadic users) throughout the 3-year observation period. A small proportion are pregnant at any time; looking at this event longitudinally, about two thirds of the women experience a pregnancy during the three years period, and a third of women, probably at low risk of pregnancy, do not experience a pregnancy (for example, those whose partners are frequently away for work or are older). A few women use long-term and short-term/traditional contraceptive methods toward the end of the observation period. This is the largest group, comprising almost half of the respondents.

Cluster 2: "Long-term users" (20.8% of respondents)

This group primarily includes women who use long-term contraceptives (i.e. implants). Here almost all women experience pregnancy along the three years, either before or after using long-term contraception. This group likely reflects highly exposed women who primarily use long-term methods for spacing pregnancies (younger ages) and possibly for limiting the number of children (older ages).

Cluster 3: "Traditional/Short-term users" (9.9% of respondents)

This group consists mainly of women using traditional methods (primarily periodic abstinence) or short-term modern contraception (such as condoms or pills or injectables). This is a relatively rare group characterized by a lower number of pregnancies (half of women do not experience pregnancy), the latter being probably women with less frequent sexual activity or lower risk of pregnancy (for example, those whose partners are frequently away for work or older) but who nevertheless protect themselves consistently.

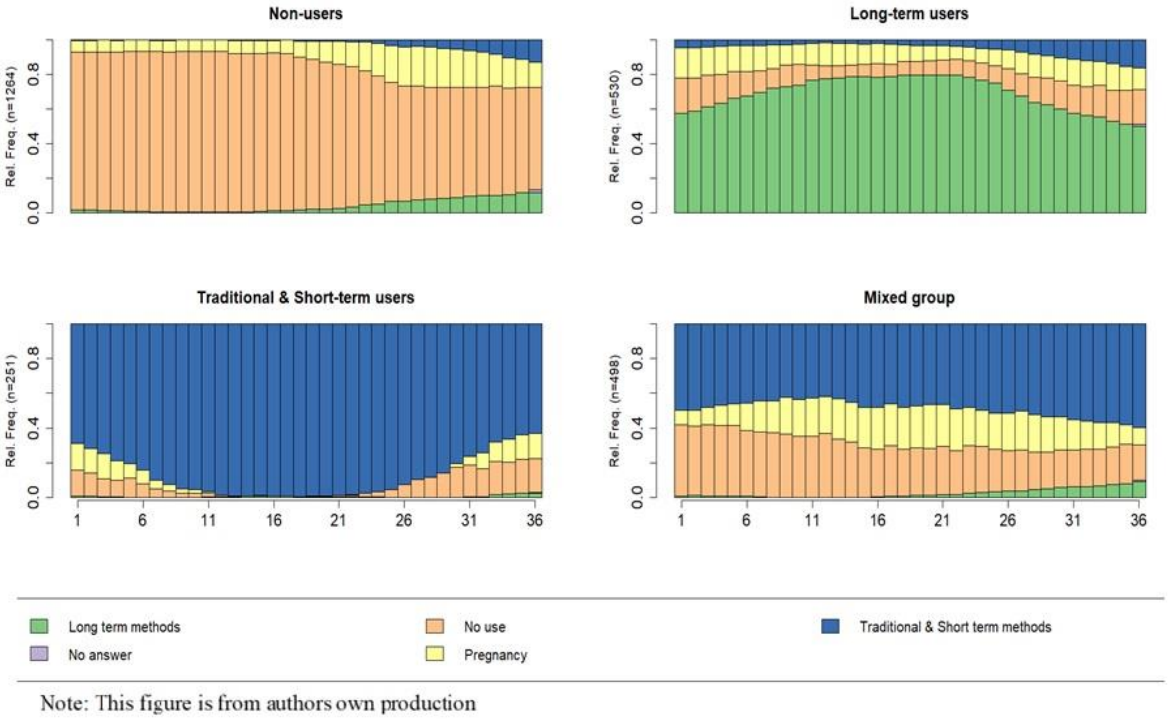
Cluster 4: "Mixed group" (19.6% of respondents)

The last type includes women who alternate between traditional / short-term modern contraceptive use and periods of non-use, in varying sequences. As indicated by the index plots, the vast majority of women in this group experience pregnancies interspersed between these contraceptive behaviors.

It is noteworthy that a significant majority of interviewed women experienced a pregnancy during the last three years, especially in clusters 2 (consist long term methods) and 4 (mix of short term/ traditional and non-use). On the other hand, pregnancies are somewhat less frequent in clusters 1 (no method) and especially in cluster 3 (about one half are pregnant during the period), indicating the presence of situations with lower pregnancy risk. Moreover, how women in each cluster combine pregnancies with contraception varies. About half of the women in the sample did not use contraception much before or after pregnancy (cluster 1), approximately 20% used long-term methods before and after pregnancy (cluster 2), another 20% switched between no method and modern short-term/traditional contraception at the time of pregnancy (cluster 4), and 10% have a consistent use of traditional/modern short-term methods between pregnancies. Note that this last group shows the longest average duration of contraceptive use (all methods); women in cluster 3, like women in cluster 2, fall in the '22 months or more' category from the duration of use classifications (see Table 4).

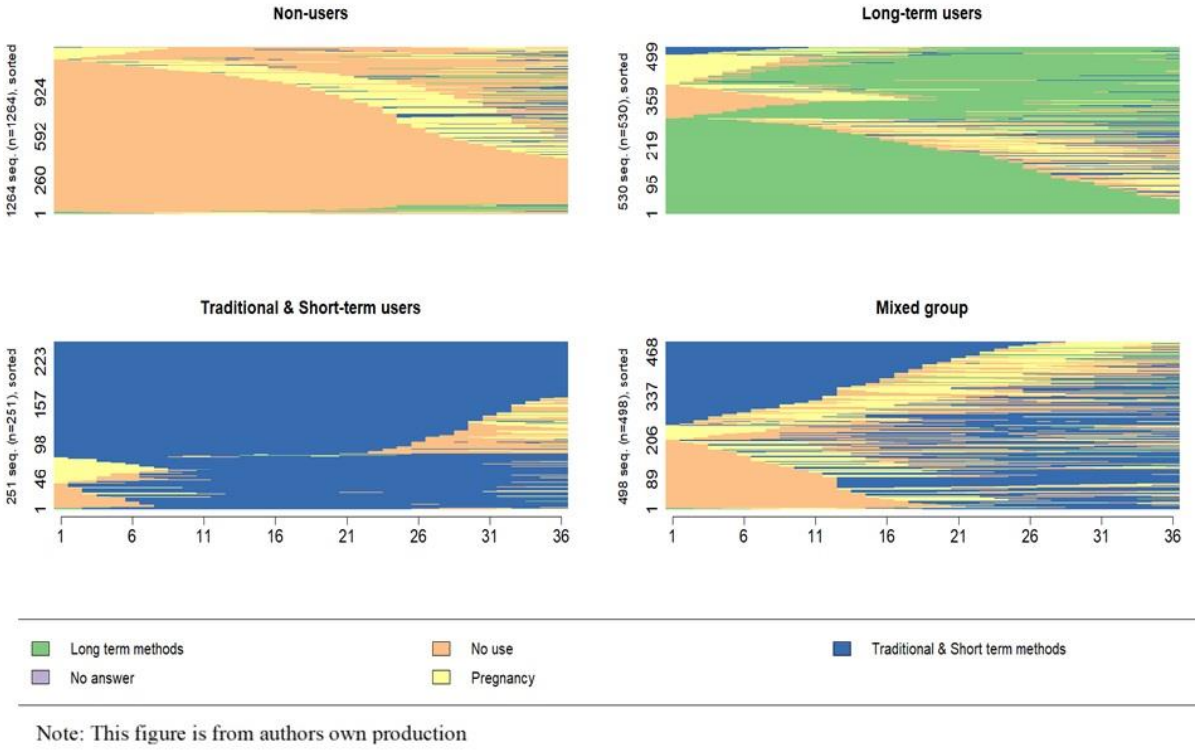
Table 4. Average duration of contraceptive use by sequence clusters

	Average duration*	IC 95%
Non-users	2.44	[2.19 ; 2.70]
Long-term users	26.90	[26.34 ; 27.46]
Traditional/Short-term users	31.78	[31.28 ; 32.28]
Mixed group	18.51	[17.94 ; 19.08]
Total	13.58	[13.08 ; 14.08]
*Duration of total use over the past 36 months		



Note: This figure is from authors own production

Figure 2. Four clusters of recent contraceptive use patterns (monthly distribution of states)



Note: This figure is from authors own production

Figure 3. Four clusters of recent contraceptive use patterns (individual sequences)

The table below demonstrates that all sequences are represented across each age group. It also illustrates some differences by age, showing a general trend of increased non-use (and non-pregnancy) among older women. Furthermore, the proportion of the mixed group (almost always a pregnancy) decreases with age, as well as the proportion of long-term method users, another very fertile group which shows an inverse U shape trend with age. Only the sustained traditional / short term methods feature a stable proportion across age groups (Table 5).

We can draw a typical fictive cohort by looking at the proportion of women in the other category apart from the non-users category. We noticed that apart from the non-users category, most of the 20-24 years women are in the mixed group and from 25 years on, the highest proportions are found in the long-term user's category. We will later compare this typical fictive cohort outcomes to the fictive cohort based on the non-users category only.

Table 5. Sample distribution by sequence cluster and by age-group

	Non-users		Long-term users		Traditional/Short-term users		Mixed group		Total	
Age group	N	%	n	%	N	%	n	%	N	%
20-24	301	51.5	108	18.5	48	8.2	128	**21.9**	585	100.0
25-29	273	45.1	137	22.6	63	10.4	132	21.8	605	100.0
30-34	251	45.2	140	25.2	55	9.9	109	19.6	555	100.0
35-39	249	51.7	95	19.7	53	11.0	85	17.6	482	100.0
40-44	190	60.1	50	15.8	32	10.1	44	13.9	316	100.0
Total	1264	49.7	530	20.8	251	9.9	498	19.6	2543	100.0

In sum, the most frequent pattern at each age in this population is the "non users" group (which entails quite often but not always a pregnancy, and only sporadic contraceptive use). A trajectory featuring non-use (as defined here) during the entire life course is thus still probably the typical pattern in this population. However, a life course contraceptive trajectory where women would alternate pregnancies and sustained long-term methods (implants) until they are 34 years and then switch to sustained traditional / short term methods and fewer pregnancies seems another realistic pattern for this population.

Link between contraceptive sequence clusters and empowerment in work

We next examine the relationship between trajectory types and women's current work status (Table 6). We observe that non-users and the mixed group (who alternate between use and non-use over the last three years) exhibit lower and similar levels of current employment (32.9% and 32.6% employed, respectively). In contrast, traditional/short-term users show the highest proportion employed (47.5%), followed by long-term users (40.9%).

Similarly, when considering engagement in paid work, non-users and the mixed group display lower and comparable levels, while traditional/short-term users demonstrate the highest engagement, followed by long-term users. Looking at women who are employed and manage their finances, non-users again show the lowest proportion (21.4%), while traditional/short-term and long-term users have the highest proportion of women engaged in paid work while managing their earnings (30.8%).

Overall, there are significant differences in levels of empowerment in work and paid employment across women with different recent contraceptive trajectories. However, the proportion of women engaged in paid work while managing their earnings does not significantly differ across contraceptive clusters based on the Chi-square test. This might be attributed to the lower proportion of women experiencing these higher forms of empowerment.

Table 6. Level of empowerment outcomes by sequence clusters

	Work		Paid work		Manage earnings	
	%	IC 95%	%	IC 95%	%	IC 95%
Non-users	32.9	[27.5-38.7]	30.3	[24.9-36.2]	21.4	[17.5-25.9]
Long-term users	40.9	[31.3-51.3]	36.5	[27.9-46.0]	27.4	[20.3-35.8]
Traditional/Short -term users	47.5	[38.2-57.0]	45.0	[36.1-54.3]	30.8	[23.3-39.6]
Mixed group	32.6	[25.9-40.1]	30.9	[24.4-38.2]	25.7	[19.5-32.9]
Total	35.7	[30.5-41.2]	32.9	[27.9-38.3]	24.2	[20.2-28.8]
	Pearson chi2(3) = 25.9215; Design-based F(2.65. 435.28) = 3.7283 Pr = 0.015		Pearson chi2(3) = 22.4839; Design-based F(2.65. 434.46) = 3.5505 Pr = 0.019		Pearson chi2(3) = 14.0497; Design-based F(2.66. 435.95) = 2.5097 Pr = 0.066	

Variations by age in the contraceptive – empowerment link

We also computed the level of work empowerment (only the first outcome, being in employment) by sub-group defined by contraceptive behavior and age group. The aim was to confirm that there are significant variations in the percentage of women employed across different age groups, and that gains linked to contraception can be small at certain ages. These were the two reasons which led us to choose a measure (the fictive cohort measurement) that controls for age and that is cumulative in nature. Table A2 demonstrates that the level of work empowerment varies significantly based on the duration of contraceptive use (or contraceptive sequence cluster), and age group.

Fictive cohorts: total gain in economic empowerment across reproductive years

The fictive cohort method is next employed to calculate the synthetic duration of time spent in specific work statuses throughout the reproductive life course for groups of women with different contraceptive usage patterns across their lives, imagined based on patterns observed at each age. It assumes that the work status measured at the time of the survey persists for one year. Initially, we aggregate the time spent in work from ages 20 to 44, both with individual age and for individual ages with quadratic correction. But, as results were similar to the 1-year age group estimate, we present only the latter (see Table A3a and Table A3b for the individual ages without quadratic correction). This method of computing averages within ages and summing them avoids bias from age structure (Hartnett, 2016) and shows the outcome as cumulated over the life course.

The total average time spent in work is compared across groups of women distinguished by their contraceptive behaviors. Notably, we contrast the (economic) empowerment gains for hypothetical women who follow a contraceptive pattern throughout their reproductive years in different patterns that are either typical or desirable.

These values are subject to sample estimation errors. To take this into account, we employ bootstrapping to derive confidence intervals. Using the same approach, we also estimate a confidence interval for the difference between contraceptive use groups. The regression model utilized is either linear or logistic, depending on the nature of the empowerment outcome variable. In this case, although the empowerment variable is dichotomous when measured in the survey, we treat it as continuous (duration in years lived under that status), thus employing a linear model.

Quadratic model with single years: durations

We first imagined three fictive cohorts of married women staying between 20 and 44 in the same duration category. We observe that those consistently using modern and traditional methods for 22 months or more out of 36 months throughout their reproductive years (from 20 to 44) are projected to significantly differ from non-users across all measured work durations (Table 7a). Women who consistently use contraceptives for a shorter period (1 to 21 months

out of 36) also tend to spend more time in all work statuses compared to non-users. Although the differences are less pronounced and not statistically significant. These findings suggest that longer use of contraception is associated with increased time spent in work, paid work, and paid work with earnings management capacities compared to non-users.

Table 7a. Three empowerment outcomes by duration of contraceptive use

	For work		**For paid work**		**For paid work and managing earning**	
	Est.	**95% CI**	**Est.**	**95% CI**	**Est.**	**95% CI**
Levels by duration of ***contraceptive***						
Cluster 1 (Non users)	8.11	[7.02 ; 9.15]	7.65	[6.59 ; 8.71]	5.36	[4.41 ; 6.29]
Cluster 2 (Users 1-21 months)	9.14	[7.86 ; 10.34]	8.37	[7.21 ; 9.58]	6.57	[5.43 ; 7.72]
Cluster 3 (Users 22 months +)	10.46	[9.26 ; 11.62]	9.60	[8.44 ; 10.73]	7.13	[6.03 ; 8.25]
Differences between duration of ***contraceptive use***						
Diff Cls2-Cls1	1.03	[-0.7 ; 2.74]	0.72	[-0.77 ; 2.27]	1.21	[-0.29 ; 2.74]
Diff Cls3-Cls1	2.35	[0.77 ; 3.94]	1.95	[0.39 ; 3.48]	1.77	[0.32 ; 3.25]
Note: The durations are based on a 25-year period; the annual average can be obtained by dividing by 25 The CI are from bootstrapping.						

Example of a typical fictive cohort

We then imagined a fictive cohort where women would follow a typical pattern of "sporadic use" (1 to 21 months), followed by "long-term use" (22 months and above) between ages 25 and 34, and then "no use" between 35 and 44 years. The level of empowerment from this typical pattern lies between the minimum and the maximum of the levels according to the three contraceptive durations (Table 7b). This typical value is even higher than the one based on the medium duration of use. Compared to the non-user's cohort, there is a gain of 1.3 of 1.8 years depending on the outcome considered.

Table 7b. Three empowerment outcomes for a typical lifelong contraceptive trajectory

	For work			For paid work			For paid work and managing earning		
Age group	Duration in months			Duration in months			Duration in months		
	0	1 to 21	22 +	0	1 to 21	22 +	0	1 to 21	22 +
20-24	1.325	**1.562**	1.365	1.283	**1.389**	1.275	0.775	**1.002**	0.811
25-29	1.334	1.575	**2.356**	1.176	1.442	**2.124**	0.748	1.174	**1.520**
30-34	1.485	2.169	**2.093**	1.394	2.073	**1.813**	1.060	1.686	**1.432**
35-39	**2.129**	1.663	2.125	2.002	**1.493**	2.046	1.499	**1.284**	1.528
40-44	**1.736**	2.055	2.647	1.711	**1.854**	2.451	1.219	**1.348**	1.974
Total average outcome based on the typical pattern	**9.876**			**9.039**			**6.672**		

Quadratic model with single years: sequences

The same analysis was then conducted using types of contraceptive trajectories instead of durations of contraceptive use. Here too we started by imagining fictive cohorts where women would stay in the same contraceptive pattern all their lives. As noted earlier, especially staying, all the way, in cluster 1 is realistic and, in fact, typical in this sample.

Table 8a shows that women who would consistently use long-acting modern contraceptives (with interruptions only for pregnancies and births), as well as women who would consistently use traditional/short-term methods from age 20 to 44 (with few births occurring), would exhibit higher economic empowerment outcomes on average compared to those who would remain non-users and in the mixed group all along, which show similar outcomes. Specifically, consistent traditional/short-term users are significantly different from non-users only when considering any type of work and paid work (but not for paid work involving earnings management). On the other hand, the differences between non-users and long-acting method users are statistically significant only for any work and paid work involving earnings management, but not for paid work alone. Although confidence intervals are quite wide across the board, these results, nevertheless, suggest a specific association between engagement in work while managing one's earnings and trajectories predominantly featuring long-acting modern methods.

Finally, across different work outcomes, there are no significant differences between women who would intermittently switch between non-use and short-term methods of contraception throughout their reproductive lives and the group of non-users. This suggests that improved economic empowerment outcomes are linked to consistent contraceptive use, whether traditional/short-term or long acting.

Table 8a: Three empowerment outcomes by contraceptive sequences cluster

	Duration spent for work		**Duration spent for paid work**		**Duration spent for paid work and managing earning**	
	Est.	**95% CI**	**Est.**	**95% CI**	**Est.**	**95% CI**
Levels by contraceptive use pattern						
Cluster 1 (Non-Users)	8.48	[7.6 ; 9.35]	7.83	[7 ; 8.69]	5.60	[4.8 ; 6.37]
Cluster 2 (Long-acting users)	10.50	[8.77 ; 12.19]	9.46	[7.87 ; 11.04]	7.34	[5.93 ; 8.73]
Cluster 3 (Tradi&short term)	11.95	[9.75 ; 14.1]	11.33	[9.25 ; 13.34]	7.60	[5.66 ; 9.62]
Cluster 4 (Mixed group)	8.22	[6.68 ; 9.76]	7.78	[6.25 ; 9.37]	6.39	[5.05 ; 7.71]
Differences between contraceptive use pattern						
Diff Cls2-Cls1	2.02	[0.09 ; 3.92]	1.62	[-0.19 ; 3.41]	1.74	[0.12 ; 3.37]
Diff Cls3-Cls1	3.47	[1.09 ; 5.82]	3.49	[1.26 ; 5.64]	2.00	[-0.08 ; 4.18]
Diff Cls4-Cls1	-0.26	[-2.02 ; 1.51]	-0.06	[-1.84 ; 1.76]	0.79	[-0.73 ; 2.32]
* The durations are based on a 25-year period; the annual average can be obtained by dividing by 25						

A trajectory where women would remain all their lives either in cluster 2 or in cluster 3 is not realistic, since cluster 2 is very fertile and cluster 3 sub-fertile. A realistic "ideal" lifelong contraceptive trajectory would thus be, in this context, one where women use sustainably long-term methods between their frequent pregnancies between 20 and 34, and then switch to consistent use of short-term methods and traditional methods and fewer pregnancies after 35.

Therefore, we consider a typical fictive cohort based on women who would follow a mixed group behavior from 20-24 and the long-term suers patterns until 44 years (Table 8b). This typical cohort give an outcome that is higher than the non-users and the mixed group categories outcomes. Compared to the non-user's cohort, there is a gain of 1.3 of 1.5 years depending on the outcome considered.

Table 8b. Three empowerment outcomes in a typical lifelong contraceptive trajectory

	For work				For paid work				For paid work and managing earning			
Age group	Patterns of contraceptive use				Patterns of contraceptive use				Patterns of contraceptive use			
	NU	LAU	TSTU	MG	NU	LAU	TSTU	MG	NU	LAU	TSTU	MG
20-24	1.61	1.59	1.15	**1.15**	1.49	1.42	1.14	**1.13**	1.00	0.97	0.56	**0.80**
25-29	1.33	**2.02**	3.06	1.65	1.17	**1.73**	2.88	1.55	0.76	**1.19**	2.16	1.31
30-34	1.61	**2.27**	2.48	2.29	1.49	**1.96**	2.34	2.20	1.17	**1.41**	1.76	2.05
35-39	2.18	**1.80**	2.75	1.39	1.99	**1.72**	2.65	1.30	1.51	**1.40**	1.84	1.10
40-44	1.82	**2.81**	3.58	1.52	1.75	**2.61**	3.46	1.35	1.19	**2.31**	2.41	0.86
Typical cohort	**10.05**				**9.15**				**7.11**			
Note : NU : Cluster 1 (Non-Users) ; LAU : Cluster 2 (Long-acting users) ; TSTU :Cluster 3 (Tradi&short term) ; MG :Cluster 4 (Mixed group)												

Discussion

This study's premise is that the extensive longitudinal data necessary to measure the effect of contraceptive use on female empowerment remain unfortunately rare. Positing that the link between the two dimensions is bi-directional, it is however possible to use cross-sectional data to assess the size of the association between the two dimensions. But computing (or modeling) percentages of women working (or being otherwise empowered) by current contraceptive use is too simplistic, because of the age-dependent, cumulative, and highly dynamic nature of the relationship between contraception and empowerment.

To overcome these hurdles, this study proposed to assess the size of the interaction of contraception with empowerment using cross-sectional survey data and a fictive cohort model. This study also proposes to observe contraceptive behavior over some time before the survey (calendar data). More specifically, we analyzed contraceptive behavior over the past 36 months, studied its association with current empowerment levels at different ages, and projected these relationships over the entire reproductive life course based on several fictive (typical or ideal) contraceptive trajectories created for policy decision-making.

The interpretation of the work empowerment outcome is straightforward, in terms of "years of life employed" (or any other "years spent empowered"). Contraceptive life course paths can be modeled to reflect both plausible and ideal trajectories, in consultation with stakeholders. This methodological approach, similar to what is done to measure the total fertility rate, is also advantageous as it mitigates bias from population age structure (Hartnett, 2016), making it suitable for comparisons. It can be applied to data from standard population surveys such as the Demographic and Health Survey. Here, we used data from a cross-sectional survey collected in Burkina Faso in 2020-21 (PMA).

The study acknowledges that empowerment can manifest in various domains, focusing here on economic dimensions. Here, we focused on three specific empowerment outcomes related to work: engagement in work over the last 7 days, engagement in paid work, and engagement in paid work with earnings management. These choices were guided by the study's scope (economic empowerment) and limited by data availability. We limited the sample to women in union aged 20-44, where contraceptive use and employment are actually linked.

We employed two methods to summarize recent (last three years) contraceptive behavior: the first approach computed the average duration of contraceptive use (modern and traditional). One first result is that it was possible to use the same categories to summarize contraceptive use (either of duration or of sequence) across ages, as each category was well represented at each age. This was an advantage, because of the relatively small sample size and the readability of the results. Moreover, uniform categories across ages are not incompatible with the idea of creating fictive cohorts alternating different patterns across ages, as we did here. The homogenous sample used (women in union aged 20-44), and the fact that many young as well as older women use both long-term methods (implants) and short-term or traditional methods in the sample at hand explains this result. Further implementations will also need to display cases where age-specific categories are more useful; this is the first limitation of the study.

Results show overall that longer durations of contraceptive use are associated with increased time spent in work, paid work, and paid work with earnings management capacities. Non-users spent the least amount of time in these activities, while those using contraceptives for over 22 months spent the most. As much as 4 years of work are to be expected when contrasting the trajectory with the most and the least use of contraception. When comparing the long duration of use trajectory with what is probably the "typical" trajectory in the country (where women first use medium duration of use, then long and then low), the gain to be expected is 1.5 years. Differences between non-users and those using contraceptives for over 22 months were generally significant across the three outcomes considered.

Sequence analysis findings suggested that consistent contraceptive use—whether long-acting methods with usually pregnancy during the period or traditional/modern short-term methods with few pregnancies—is linked to increased engagement in work and paid work. In contrast, working patterns for the mixed group (switching between non-use and short-term or traditional methods on the occasion of frequent pregnancies) closely resembled those of non-users who also usually have a pregnancy during the period.

Overall, the duration variable performed effectively due to its simplicity, yielding similar gains in working years compared to the sequence analysis approach. Moreover, applying the same

categories across all ages works well with durations; building fictive trajectories from these patterns - either assuming consistent durations across the life course or choosing a specific order of succession in durations- proved a realistic exercise.

Sequence analysis was less easy to use in this context. Notably, the sample was too small to create age-specific sequence clusters. Although the different clusters found for the entire sample were well represented at each age, constructing fictive cohorts from these building blocks was also more difficult, because fertility patterns need to be realistic as well as contraceptive patterns.

But sequence analysis had its advantages: it revealed further nuances within the "long duration" category, identifying sub-groups such as women consistently using long-acting methods between frequent and planned pregnancies, alongside those probably at lower risk of pregnancies and consistently using short-term methods, thereby achieving the lowest fertility of all groups and positive work outcomes. Moreover, the details of the sequence analysis approach underscored a stronger association between long-acting methods and higher levels of economic empowerment, specifically engagement in paid work with earnings management abilities. This last result highlights the cumulative and iterative dynamics between empowerment and in particular long term modern contraceptive use. From a programmatic perspective, all the nuances uncovered are critical. They highlight the interest of long-acting modern methods but also the challenges of promoting these methods universally, recognizing that some women may have different pregnancy prevention desires and may find consistent modern short-term or traditional methods more suitable.

On a more methodological note, the results from both the five-year group and quadratic single-year models were largely similar. However, due to the assumptions underlying the five-year group approach, greater weight was placed on the single-year approach.

One important limitation is that women and girls aged 15-19 were excluded from the analysis because most are not actively seeking employment. There are also characterized low levels of contraceptive use resulting from a low level of sexuality. But when sexually active, they tend to use contraception to continue their studies. In future applications of this model, given their significant numbers and impact on women's reproductive behaviors early in the life course for their well-being later on, it remains crucial to assess the empowerment benefits of family planning at this age stage, particularly for their propensity to pursue education.

Women over 45 years old were also excluded because they are typically no longer concerned with childbearing, and thus their contraceptive use does not significantly influence their work availability. While early contraceptive and fertility behaviors are probably often linked to empowerment outcomes after age 45, the fictional cohort model is not suited to explore such links: real cohort data remain necessary here. This is another limitation of the study.

One obvious extension of this work is to apply the method to other countries and surveys, and across different sub-groups of a national population. Patterns of contraceptive use linked to economic empowerment may vary across countries, groups and years, as well as the sizes of the effects. A large number of surveys have the contraceptive calendar, which remain largely underutilized to date. Another obvious development of this study is to translate the additional

years spent working by women in different contraceptive trajectories into amounts of revenue gained either for the women themselves or the local economy.

Conclusion

One advantage of the fictive cohort measure of the association between contraceptive use and women's economic empowerment is its applicability to all contraceptive surveys that have collected contraceptive calendar over the last few years and empowerment data collected in the survey. Furthermore, the calculations are simple, and the interpretation is straightforward. An additional time spent working can be seen as an increased personal income and greater contribution to the labor market. The study divided empowerment into specific domains, such as work, paid work, and managing earnings, based on the available data. It moves beyond typical cross-sectional measures of the association between contraceptive use and empowerment (whether bivariate or multivariate), proposing that sustained observation of contraceptive behavior and a cumulative measure of empowerment over the entire reproductive life course provide a better reflection of the relationship between the two dimensions.

Our analysis, based on data from women in union aged 20 to 44 in Burkina Faso in 2020-21, shows that trajectories involving consistent contraceptive use—whether long-acting modern methods or short-term modern or traditional methods—are associated with up to 4 more years of gainful economic activity during women's reproductive years compared to non use. This suggests that beyond the well-documented direct effects of contraception on women's and children's health, there are also economic benefits for consistent users.

In conclusion, the study underscores the age-dependent, dynamic and cumulative nature of the association between contraception and empowerment. Programmatically, it highlights the importance of boosting contraceptive use to enhance women's engagement in economic activities and thereby contribute more effectively to economic development. These programs must also include education and communication campaigns to strengthen women's contraceptive agency, because the relation is bidirectional.

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Additional tables

Table A1. List of criteria in sequence analysis

Optimal Matching (OM) sequences indicators

	PBC	HG	HGSD	ASW	ASWw	CH	R2	CHsq	R2sq	HC
cluster2	0.55	0.64	0.64	**0.41**	0.41	956.39	0.27	1666.56	0.40	**0.18**
cluster3	0.77	0.91	0.91	**0.51**	0.51	1028.93	0.45	2694.44	0.68	**0.05**
cluster4	0.75	0.91	0.91	0.44	0.44	808.64	0.49	2188.52	0.72	0.05
cluster5	0.73	0.92	0.91	0.37	0.37	686.50	0.52	1911.88	0.75	0.05
cluster6	0.73	0.93	0.93	0.39	0.39	607.84	0.55	1781.26	0.78	0.04
cluster7	0.57	0.83	0.82	0.33	0.34	613.49	0.59	1682.00	0.80	0.09
cluster8	0.58	0.87	0.86	0.33	0.33	568.27	0.61	1644.32	0.82	0.07
cluster9	0.57	0.88	0.87	0.32	0.32	533.30	0.63	1575.97	0.83	0.07
cluster10	0.57	0.88	0.87	0.32	0.33	491.94	0.64	1502.19	0.84	0.06
cluster11	0.57	0.89	0.88	0.32	0.33	460.18	0.65	1452.56	0.85	0.06
cluster12	0.56	0.90	0.89	0.32	0.32	436.95	0.66	1415.44	0.86	0.06
cluster13	0.54	0.91	0.91	0.34	0.34	425.09	0.67	1392.96	0.87	0.05
cluster14	0.51	0.91	0.91	0.34	0.35	414.41	0.68	1351.70	0.87	0.05
cluster15	0.50	0.92	0.91	0.34	0.34	402.45	0.69	1317.19	0.88	0.05

Partioning Arroud Medoids (PAM) sequences indicators

	PBC	HG	HGSD	ASW	ASWw	CH	R2	CHsq	R2sq	HC
cluster2	0.68	0.80	0.79	**0.44**	0.45	835.84	0.27	1566.44	0.41	**0.10**
cluster3	0.81	0.95	0.95	**0.54**	0.54	931.45	0.45	2620.76	0.70	**0.03**
cluster4	0.61	0.80	0.80	0.37	0.37	764.50	0.50	2110.06	0.73	0.11
cluster5	0.60	0.84	0.83	0.36	0.37	679.39	0.54	1950.95	0.77	0.09
cluster6	0.60	0.86	0.86	0.34	0.34	609.03	0.57	1819.22	0.80	0.07
cluster7	0.60	0.87	0.86	0.34	0.34	581.67	0.60	1794.24	0.82	0.07
cluster8	0.56	0.88	0.87	0.36	0.36	540.81	0.62	1706.68	0.84	0.06
cluster9	0.55	0.90	0.89	0.37	0.37	514.94	0.64	1675.90	0.85	0.05
cluster10	0.52	0.90	0.89	0.37	0.37	486.82	0.66	1586.76	0.86	0.05
cluster11	0.51	0.91	0.90	0.38	0.38	461.05	0.67	1549.27	0.87	0.05
cluster12	0.51	0.92	0.91	0.38	0.39	441.59	0.68	1511.80	0.88	0.04
cluster13	0.47	0.90	0.90	0.36	0.37	422.74	0.69	1424.83	0.88	0.05
cluster14	0.47	0.91	0.90	0.35	0.36	399.29	0.69	1351.90	0.89	0.05
cluster15	0.47	0.92	0.91	0.36	0.37	387.46	0.70	1355.03	0.89	0.05

Note: The better fit is the one with highest ASW and the lowest HC

Table A2. Level of empowerment in work by contraceptive behavior and age groups

	20-24	25-29	30-34	35-39	40-44
	% 95% CI	% 95% CI	% 95% CI	% 95% CI	% 95% CI
Duration of contraceptive use					
Non-user (0 month)	26.5 [17.2-38.4]	26.7 [17.8-37.9]	29.7 [20.9-40.4]	42.6 [32.8-53.0]	34.7 [24.8-46.2]
User of 1-21 months	31.2 [23.2-40.5]	31.5 [22.4-42.4]	43.4 [32.3-55.1]	33.3 [22.4-46.3]	41.0 [27.4-56.0]
User of 22 months +	27.3 [18.1-39.0]	47.1 [37.4-57.1]	41.9 [31.2-53.3]	42.5 [32.6-53.0]	51.0 [33.2-68.6]
Contraceptive clusters					
Non-users	29.8 [22.4-38.4]	27.4 [19.5-37.0]	30.6 [22.9-39.6]	43.2 [34.1-52.9]	36.0 [26.3-47.1]
Long-term users	33.7 [21.5-48.7]	39.2 [27.9-51.8]	45.1 [30.0-61.2]	36.8 [24.7-50.8]	54.8 [29.2-78.1]
Traditional/Short -term users	23.5 [11.0-43.5]	59.0 [39.3-76.1]	44.3 [29.6-60.0]	52.8 [32.5-72.2]	62.2 [39.4-80.6]
Mixed group	22.2 [13.9-33.5]	36.0 [26.0-47.5]	46.4 [29.9-63.8]	27.1 [16.4-41.5]	32.7 [19.5-49.5]
Total	28.5 [22.5-35.3]	34.7 [27.9-42.1]	38.5 [30.9-46.6]	39.8 [33.2-46.8]	41.1 [31.6-51.2]

Table A3a. Three empowerment outcomes by average contraceptive duration (individual years)

	Duration spent for work		**Duration spent for paid work**		**Duration spent for paid work and managing earning**	
	Est.	**95% CI**	**Est.**	**95% CI**	**Est.**	**95% CI**
Levels by duration of contraceptive use						
Cluster 1 (Non users)	8.01	[6.92 ; 9.03]	7.57	[6.52 ; 8.6]	5.30	[4.35 ; 6.22]
Cluster 2 (Users 1-21 months)	9.02	[7.75 ; 10.18]	8.22	[7.08 ; 9.4]	6.41	[5.3 ; 7.52]
Cluster 3 (Users 22 months +)	10.49	[9.3 ; 11.63]	9.59	[8.43 ; 10.71]	7.17	[6.05 ; 8.25]
Differences between duration of contraceptive use						
Diff Cls2-Cls1	1.01	[-0.7 ; 2.68]	0.66	[-0.82 ; 2.17]	1.11	[-0.36 ; 2.61]
Diff Cls3-Cls1	2.48	[0.92 ; 4.05]	2.03	[0.47 ; 3.54]	1.86	[0.41 ; 3.31]
Note: The durations are based on a 25-year period; the annual average can be obtained by dividing by 25. The CI are from bootstrapping.						

Table A3b. Three empowerment outcomes by contraceptive sequences cluster (individual years)

	Duration spent for work		**Duration spent for paid work**		**Duration spent for paid work and managing earning**	
	Est.	**95% CI**	**Est.**	**95% CI**	**Est.**	**95% CI**
Levels by contraceptive use pattern						
Cluster 1 (Non Users)	8.36	[7.48 ; 9.21]	7.72	[6.88 ; 8.57]	5.50	[4.7 ; 6.26]
Cluster 2 (Long term users)	10.48	[8.76 ; 12.14]	9.43	[7.83 ; 10.97]	7.29	[5.86 ; 8.65]
Cluster 3 (Tradi&short term)	12.09	[9.83 ; 14.22]	11.42	[9.33 ; 13.4]	7.81	[5.82 ; 9.83]
Cluster 4 (Mixed group)	8.23	[6.7 ; 9.67]	7.75	[6.26 ; 9.25]	6.43	[5.09 ; 7.69]
Differences between contraceptive use pattern						
Diff Cls2-Cls1	2.13	[0.23 ; 3.99]	1.71	[-0.1 ; 3.46]	1.80	[0.15 ; 3.4]
Diff Cls3-Cls1	3.73	[1.32 ; 6.05]	3.70	[1.45 ; 5.82]	2.31	[0.2 ; 4.49]
Diff Cls4-Cls1	-0.13	[-1.86 ; 1.56]	0.03	[-1.72 ; 1.77]	0.93	[-0.59 ; 2.41]
Note: The durations are based on a 25-year period; the annual average can be obtained by dividing by 25 The CI are from bootstrapping.						

Table A4. Three empowerment outcomes (longitudinal measure) by duration of contraceptive use

	Duration spent for work		**Duration spent for paid work**		**Duration spent for paid work and managing earning**	
	Est.	**95% CI**	**Est.**	**95% CI**	**Est.**	**95% CI**
Levels by duration of contraceptive use						
Cluster 1 (Non users)	8.01	[6.92 ; 9.03]	7.57	[6.52 ; 8.6]	5.30	[4.35 ; 6.22]
Cluster 2 (Users 1-21 months)	9.02	[7.75 ; 10.18]	8.22	[7.08 ; 9.4]	6.41	[5.3 ; 7.52]
Cluster 3 (Users 22 months +)	10.49	[9.3 ; 11.63]	9.59	[8.43 ; 10.71]	7.17	[6.05 ; 8.25]
Differences between duration of contraceptive use						

Diff Cls2-Cls1	1.01	[-.7 ; 2.68]	0.66	[-.82 ; 2.17]	1.11	[-.36 ; 2.61]
Diff Cls3-Cls1	2.48	[.92 ; 4.05]	2.03	[.47 ; 3.54]	1.86	[.41 ; 3.31]
* The durations are based on a 25-year period; the annual average can be obtained by dividing by 25						

Table A5. Three empowerment outcomes (longitudinal measure) by duration of contraceptive use (quadratic age model)

	Duration spent for work		**Duration spent for paid work**		**Duration spent for paid work and managing earning**	
	Est.	**95% CI**	**Est.**	**95% CI**	**Est.**	**95% CI**
Levels by duration of contraceptive						
Cluster 1 (Non users)	8.11	[7.02 ; 9.15]	7.65	[6.59 ; 8.71]	5.36	[4.41 ; 6.29]
Cluster 2 (Users 1-21 months)	9.14	[7.86 ; 10.34]	8.37	[7.21 ; 9.58]	6.57	[5.43 ; 7.72]
Cluster 3 (Users 22 months +)	10.46	[9.26 ; 11.62]	9.60	[8.44 ; 10.73]	7.13	[6.03 ; 8.25]
Differences between duration of contraceptive use						
Diff Cls2-Cls1	1.03	[-.7 ; 2.74]	0.72	[-.77 ; 2.27]	1.21	[-.29 ; 2.74]
Diff Cls3-Cls1	2.35	[.77 ; 3.94]	1.95	[.39 ; 3.48]	1.77	[.32 ; 3.25]
* The durations are based on a 25-year period; the annual average can be obtained by dividing by 25						

Table A6: Three empowerment outcomes (longitudinal measure) by contraceptive sequences cluster

	Duration* spent for work		**Duration spent for paid work**		**Duration spent for paid work and managing earning**	
	Est.	**95% CI**	**Est.**	**95% CI**	**Est.**	**95% CI**
Levels by contraceptive use pattern						
Cluster 1 (Non Users)	9.28	[8.53 ; 10.02]	8.66	[7.9 ; 9.37]	5.48	[4.87 ; 6.09]
Cluster 2 (Long term users)	10.62	[9.14 ; 11.97]	9.91	[8.45 ; 11.29]	7.21	[5.97 ; 8.37]
Cluster 3 (Tradi&short term)	12.78	[10.92 ; 14.44]	12.27	[10.44 ; 14.03]	7.55	[5.9 ; 9.2]
Cluster 4 (Mixed group)	8.84	[7.48 ; 10.11]	8.27	[6.95 ; 9.44]	6.24	[5.18 ; 7.28]
Differences between contraceptive use pattern						
Diff Cls2-Cls1	1.35	[-.29 ; 2.85]	1.25	[-.31 ; 2.77]	1.74	[.34 ; 3.04]
Diff Cls3-Cls1	3.50	[1.5 ; 5.31]	3.61	[1.64 ; 5.56]	2.08	[.29 ; 3.85]
Diff Cls4-Cls1	-0.44	[-2.03 ; 1.07]	-0.38	[-1.87 ; 1]	0.76	[-.44 ; 1.94]
* The durations are based on a 25-year period; the annual average can be obtained by dividing by 25						

Table A7: Three empowerment outcomes (longitudinal measure) by contraceptive sequences cluster (quadratic age model)

	Duration spent for work		**Duration spent for paid work**		**Duration spent for paid work and managing earning**	
	Est.	**95% CI**	**Est.**	**95% CI**	**Est.**	**95% CI**

Levels by contraceptive use pattern						
Cluster 1 (Non Users)	9.37	[8.62 ; 10.13]	8.74	[7.97 ; 9.47]	5.54	[4.93 ; 6.17]
Cluster 2 (Long acting users)	10.67	[9.18 ; 12.06]	9.98	[8.51 ; 11.4]	7.27	[6.03 ; 8.48]
Cluster 3 (Tradi&short term)	12.65	[10.75 ; 14.41]	12.17	[10.32 ; 13.99]	7.46	[5.77 ; 9.17]
Cluster 4 (Mixed group)	8.81	[7.44 ; 10.15]	8.28	[6.94 ; 9.51]	6.21	[5.15 ; 7.31]
Differences between contraceptive use pattern						
Diff Cls2-Cls1	1.30	[-.35 ; 2.84]	1.23	[-.33 ; 2.8]	1.74	[.33 ; 3.09]
Diff Cls3-Cls1	3.28	[1.22 ; 5.19]	3.43	[1.43 ; 5.44]	1.92	[.09 ; 3.75]
Diff Cls4-Cls1	-0.56	[-2.16 ; 1]	-0.47	[-1.96 ; .97]	0.68	[-.54 ; 1.9]
* The durations are based on a 25-year period; the annual average can be obtained by dividing by 25						