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Free Access to HAART and Pregnancy Response among HIV Patients. A Case Study from Cameroon

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Miron Tequame

Center for Research in the Economics of Development

University of Namur

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Miron Tequame[1]

Abstract

The HIV/AIDS epidemic has dramatically altered patterns of morbidity and mortality in Sub-Saharan Africa with potential consequences on fertility and population dynamics. We take advantage of a unique data-set collected in Cameroon among HIV positive patients and estimate the relationship between HAART treatment and (intended) pregnancy. HAART raises life expectancy, improves health outcomes and lowers the risk of transmission. These direct health benefits imply rational and behavioral responses in pregnancy as it allows individuals to accomplish their desired number of children. I conduct a multivariate regression based on Before-After analysis to evaluate the effect of the 2007 policy of scaling-up HAART treatment in Cameroon on intended pregnancy. With respect to women not yet on treatment, HAART increased the propensity to pregnancy after one year with the coefficient increasing over time after 2007, when treatment was rendered free of charge. The results also show that pregnancy response is highest among people who have lower number of children pre-treatment and with CD4 counts above the average at treatment initiation. This means early treatment initiation, which results in better health outcomes, enhances pregnancy with respect to women who were too sick at treatment initiation. I discuss and test the different mechanisms that driving the behavioral response in Yaoundé-Cameroon and exclude those that are less evident from the data.

Keywords:

HIV, Fertility, Risky Behavior

1. Introduction

The HIV virus has killed more than 20 million people (WHO, 2005) with 90% of them being from developing countries. Despite the large investment in research and development, this widespread disease is not curable yet. However, the emergence of Highly Active Anti-Retro-Viral Therapy (HAART or ART) allows for sensible improvement of

[1]CRED, Department of economics, University of Namur, Rempart de la Vierge, 8 B-5000 Namur, Belgium. Contact: miron.tequame@fundp.ac.be.

the quality of life of people living with HIV. By now, treatment has by far decreased morbidity and mortality both among adults and infants of people living with HIV.

Access to treatment is being available to a larger proportion of HIV positive patients. In the past, with the Bamako Initiative-1987, many developing countries aimed at charging patients fees at the point of care delivery with the objective of cost recovery policies and a way of increasing health-care funding. In sub-Saharan African countries more than half of the total health expenditures are borne by households. However, the persistence of user fees for healthcare, especially for anti-retroviral therapy, decreased adherence and treatment effectiveness. Nowadays, free access to treatment is implemented by local governments and external organization.

In Cameroon, until May 2007, patients used to pay for treatment, laboratory tests and physicians' consultations. Since 2007, the government made ART treatment free of charge for all HIV positive patients based on CD-4 measurements[2]. This has given many patients longer life expectancy and better health outcomes in a very short period. By June 2008, about 50000 patients i.e. 58% of the estimated total HIV-positive patients were benefiting from ART [3].

The literature distinguishes three direct effects of ARV therapies: it raises life expectancy (Marins et al. 2003; Goldie et al., 2006), it improves health (Koenig, Leandre, and Farmer, 2004; Laurent et al., 2002; Coetzee et al., 2004) and it lowers the risk of transmission (Porco et al., 2004; Castilla et al. 2005). Each of the three direct health benefits imply behavioral response in terms of pregnancy.

First, the increase in life expectancy might induce individuals to modify their optimal number of children. There is no general consensus on the sign and magnitude of the theoretical and empirical prediction of adult mortality on fertility. The quantity-quality model of childbearing would suggest an increase in fertility in response to a decrease in mortality risk. Less health inputs are required for rearing children so parents might also want to increase their desired number of children. However, an increase in life expectancy increases expected return to household investment in the child's human capital and hence parents might decrease fertility by substituting child quality

[2]CD-4 counts measure the patient's disease, determine the risk of opportunistic illness and are used as a guide to take decisions about when to start antiretroviral therapy.

[3]Ministère de la Santé Publique and Comité National de Lutte contre le VIH/Sida du Cameroun. Vers l'accès universel au traitement et à la prise en charge du VIH/Sida chez les adultes et les enfants au Cameroun [in French]. Yaounde: Ministère de la Santé Publique and Comité National de Lutte contre le VIH/Sida du Cameroun; 2008.

for quantity. Second, the direct health improvement due to ART implies more fecundity (ART restores menstrual disorder and reduces vaginal infections). Everything else being equal, treatment increases the probability of being pregnant after treatment. Moreover, women also gain their full functional capacity and are less susceptible to other opportunistic diseases. With treatment, women also become more active risky sexual behavior and un-intended pregnancies. Several papers in economics have underlined a positive impact of treatment on risky sexual behavior: Lakdawalla et al. (2004) among HIV positive individuals in the US; Mechoulan (2004) among homosexuals in San Francisco; Goldstein et al. (2007) in rural Kenya.

Third, the impact of ART in reducing viral load and hence infectivity of individuals might imply altruistic behavior. HIV positive women might delay births after treatment initiation in order to protect their partners from HIV infection.

In conclusion, all the above three channels induce behavioral change in pregnancies. We take advantage of a data-set collected in the Central Hospital of Yaoundé and use the staggered timing of patient's date of treatment initiation between 2003-2010 to estimate the impact of treatment on pregnancy. We first implement a Diff-in-Diff approach in a moving-window set-up and further enrich our analysis by using panel data where we control for individual and time fixed effects. We also allow for individual specific trends. The major difficulty in the Diff-in-Diff analysis involves separating out pre-existing trends from the dynamic response to treatment. We hence extend our analysis by including a differential trend between the pre and the post treatment period.

Our results suggest that HAART increased propensity to pregnancy among HIV positive women by 15 percentage points on average. These increase is heterogeneous by year of treatment initiation: the coefficient is increasing in the magnitude for individuals who start treatment in recent years with a big jump being characterized in 2007. This is inline with the literature in epidemiology suggesting that treatment increases pregnancy among women living with HIV/AIDS. We also find that treatment effect is heterogeneous by the number of children born before treatment initiation. Women starting treatment with zero number of children before treatment initiation are the most affected. Given the total fertility rate for a woman living in Yaounde is 3, we show that the effect of treatment is such that it does not increase the total fertility rate.

We also find that initial CD-4 matters for pregnancy response; women who start treatment with CD-4 above the average are the most likely to be pregnant after treatment initiation.

We test and show that the above results are not driven only by the direct health

effect of treatment related to fecundity and risky sexual behavior. First, our results hold if we exclude individuals who start treatment for reasons related to menstrual disorder; second, we show that our coefficient is time dependent suggesting that the fee-free ticket of treatment had an important role in fertility decision; third, treatment is most effective among the sub-population of individuals with zero number of children before treatment initiation. These results provide evidence in support of a need for a broader interpretation of the behavioral response of pregnancy that is not solely driven by health benefits.

To our knowledge, up-to-date nobody has analyzed the impact of ART treatment on pregnancy in the economic literature. In epidemiology, Myer et al. (2010) found that ART doubles the chances of becoming pregnant among HIV-infected women in sub-Saharan Africa. In their analysis, one third of women who initiated ART experienced pregnancy within 4 years after their initiation. However, the behavioral mechanisms that may underlie this association have not been further investigated by the authors for lack of information. In the same line, other papers in epidemiology have underlined that ART restores fertility among HIV patients with fertility desire changing over time (see for example Blair et al. (2004) and Massad et al. (2004)). Among the few longitudinal studies on fertility preferences, Homsy et al. (2009) report that pregnancy significantly increased over follow-up. However, even though fertility intentions increased over time, they were much lower with respect to the pregnancies encountered among couples.

Our analysis proceeds as follows: we present the data in Section 2 and the empirical strategy in Section 3. In Section 4, we presents the results and in Section 5 and 6 we test the heterogeneity of our parameter by sub-population. We discuss the limitations of a our strategy in Section 7 and conclude in Section 8.

2. Data

The Day-Hospital at the Central Hospital of Yaoundé has been active since 1998. It is a public structure, one of the biggest and the first to provide ART on a large scale. It offers several services among which: Voluntary Counseling and Testing, Sexually Transmitted Diseases Counseling, Dermatitis, Psychological Support, Social Assistance and General Counseling for people living with HIV. Patients monitor their CD4 count and viral load every 6 months if they are not yet eligible for treatment. Once eligible, they are put on treatment by the Committee of the hospital and they renew their medical prescription every three months for their ART treatment.

We retrospectively identify each pregnancy with birth recalling and construct a panel data-set which varies between 2003-2010 where for each pregnancy we are able to identify if the individual wanted to be pregnant at that moment.

We use the conventional measure of intended/unintended pregnancy from the standard DHS surveys[4]. Throughout our analysis, we do not emphasize the difference between the two as the conclusion and interpretation of our results equally hold for both. We hence present the result on intended pregnancies in the appendix.

Almost all women in the data-set are aware of the program on mother–to-child transmission and therefore of the possibility that an HIV positive woman can give birth to a healthy child. We find no statistical difference in knowledge about all the risks of vertical transmission between women who are on treatment and those who are not yet on treatment. ART reduces child mortality among both groups of HIV positive women. The main reasons for HIV testing are Ame-norrhea, Zona, Diarrhea or Fever. In Table .1, we provide descriptive statistics by treatment year in terms of age, education and pregnancy pre-post treatment.

Patients differ a lot in terms of HIV detection and treatment initiation. About 135 patients were not yet on treatment by 2010, while the rest had recently been put on treatment or had been on treatment from 1 to 5 years. Few patients had been on treatment for more than 5 years.

The average number of births per treatment status increases over time as shown in Figure.1. Women on treatment have lower number of births with respect to patients who are not yet on treatment and there is a catch-up after 2007 where ART programs have been implemented in Cameroon. This also holds for intended and unintended births. A more detailed descriptive statistics is provided in Table .2. The number of individuals who are detected HIV positive or who start treatment increases over the years.

Independently from marital status, partner's HIV status is unknown to the patient in the majority of the cases. However, about 75% of the patients desired a child within the next two years maximum while only 20% responded not to desire any and the

[4]A potential drawback of this variable is measurement error as it is based on ex-post rationalization of individual's desire for fertility. They are limited in their utility because they are based on the assumption that all women have fully formed intentions at the time of conception. The bias may arise from several factors like gender of the child, education of the mother, marital status, partner's intentions and etc. Intended or unintended pregnancies can be both intended/unintended as such or combined with timed and mistimed. A more complete analysis on measures of fertility preferences can be found in Pritchett (1994).

remaining want a child in a delayed period. In the majority of the cases, among the reasons reported for not wanting a child was marital status or lack of a partner.

3. Empirical Strategy

Treatment initiation is influenced by an interaction of the condition of a person's CD-4 count and a random shock. Assignment to treatment is resulting from either eligibility based on CD-4 counts (disease progression to AIDS) or critical health status (co-infection with other diseases like Tuberculosis or Hepatitis). CD4 counts are unlikely to be directly self-monitored by patients but it results from unobserved individual characteristics or observables like living standards and hence individuals self-sort in the assignment mechanism.

Our empirical approach exploits time variation of treatment and pregnancy of individuals. The main objective is to measure the change in fertility associated with treatment initiation while controlling for unobserved individual and time fixed effects. For each time period *'t'* of an individual, we define the treatment variable as 0 if the individual is not on treatment and 1 if else. We consider the lagged value of this variable because we assume a child conceived after treatment initiation is likely to be born the year after.

Our first empirical approach is based on the so called *moving window*[5] where we consider two treatment periods. We are comparing the average probability of giving birth in period *'t+1'* with respect to period *'t'* for an individual beginning treatment in period *'t'*. The choice of these two time periods is motivated by biological considerations. Usually patients react to ART after at least one year of treatment; if they conceive a child in the same year they started treatment, they would give birth the year after treatment initiation. The control group for individuals treated in period 't' are those who start treatment two year later[6]. The *moving window* implies replacement of controls and treated in the database. Some individuals are considered controls or treated at different points in time. However, patients are not present more than twice

[5]This method has been applied in labor economics by Monteiro, (2004) in estimating the effect of privatization on wages in Portugal. It has first been used in Kluve *et al.* (1999). A good advantage of the moving window is the short period of analysis pre-post which avoids auto-correlation in the error terms and allows to control for baseline characteristics that are time invariant.

[6]We also replicate our results by considering pre-post period as time *'t-1'* with respect to *'t+1'* and results do not change. The reason why we focus on on *'t'* rather than on *'t-1'* is to avoid loss of observations. Moreover, when we take patients who enter treatment in *'t+2'* as controls for those treated in *'t'*, we risk of comparing treatment groups with non-comparable control groups. The control groups might be physically better off than the treated three years before treatment initiation.

in the database: as controls and treated. We restrict our controls to individuals who start treatment in t+2 such that treated and controls are as comparable as possible.

We consider total and intended pregnancies. Upon the constructed data-set, we use a simple difference-in-differences approach extended by adding a vector of individual characteristics, in order to control for differences in observable attributes between groups at baseline. We estimate a regression of the form:

$$outcome_{it} = \beta_0 + \beta_1 ART_i + \beta_2 Post + \beta_3 ART_i * Post + \pi_k \mathbf{X}_{it} + \tau_t + \varepsilon_{it} \qquad (1)$$

where outcomes are pregnancy and intended pregnancy in a given year; ART is a treatment dummy if the individual 'i' started treatment in year t; Post is the post-treatment period, *i.e. a 't+1'* dummy constructed from the moving window. Finally, τ_t represent year dummies and $\mathbf{X}_{it}$ is a set of observable characteristics like age, education and baseline pregnancy.

The moving-window analysis does not allow us to control for different trends in the treatment and control groups[7]. With this purpose we base our analysis on panel data-set and we extend the study such that the treatment effect is identified from its variation within the individuals over time over a larger window. We also control for year fixed effects and individual specific trend that vary across individuals and represents a flexible way to control for heterogeneous pregnancy behavior. Finally, we allow the trend to depend on treatment initiation: in addition to shifting the level of outcome, treatment may also affect the trend. Ultimately our estimated equation based on the Linear Probability model is as follows:

$$outcome_{it} = \theta_i + \tau_t + \theta_i t + \beta_1 ART_{it-1} + \beta_2 ART_{it-1} * t + \beta_{3k} \mathbf{X}_{it} + \varepsilon_{it} \qquad (2)$$

4. Impact of Treatment on Pregnancy

Results from the Moving-Window

Table .4 shows results from the estimation of treatment on total and intended pregnancy based on Equamtion 1. One year of treatment is likely to increase the probability of childbearing on average by 6.36 percentage points with respect to women who will start treatment 2 years later. Very similar patterns with slightly higher coefficients are observed in column 2 and 4 for the intentionally conceived children *i.e.* 7.3 percentage

[7]It is based on the Diff-in-Diff approach which assumes parallel trend between the two groups.

points. We find a positive effect of treatment on the likelyhood of pregnancy after one year.

We decompose the average effect of treatment on childbearing over the different years based on treatment initiation to look at the heterogeneity of the parameter. In Table .5, we show how the magnitude and sign of one year treatment effect varies across patients depending on the year of treatment initiation. Even though parametres are imprecise in the first columns of Table .5 due to few observations, similar patterns are observed in panel data analysis in the following sub-section. This is intuitive as we are comparing individuals with different unobservables due to different psychological and social costs of infection. Each column represents a sub-sample of the moving-window in Table .4. Interestingly, women who started treatment in earlier years were less likely to bear a child after one year of treatment[8]. This can be explained by the evolution in the social and psychological cost of infection over the years. With increasing number of individuals infected over the years, social and psychological cost due to stigma, self-exclusion and trauma of infection are decreasing, allowing patient's childbearing.

Results from Individual Specific Slopes depending on Treatment Initiation

In this paragraph we exploit information on a larger window with respect to the diff-in-diff. In Table .6 we run different types of regressions on all the sample, including women who are not yet on treatment by 2010. In Column 1 we show results from a simple regression for ease of comparison while in Column 2 we control for fixed effects to capture unobserved heterogeneity at individual level that do not vary over time. The coefficient on treatment is quite sensitive to the propensity of childbearing of individuals that is constant over time. In Column 3 , we add year fixed effects and show that we obtain comparable results as in the moving window. Individual and year fixed effects explain a good part of the variability in pregnancy. We assume that they are constant over time for individuals or else they are changing over time uniformly across all individuals. The optimal analysis would have been to consider an interaction of individual and time fixed effects which is not feasible.

In Column 4, we allow for individual specific trends that capture unobserved factors influencing pregnancy at individual level to have a linear trend and allow this trend to vary across individuals. The coefficient have almost doubled: at least one year of

[8]It is likely that our results are driven by insufficient number of observations for inference. However, as we will illustrate later on, we find very similar patterns when using panel data-set.

treatment increases an individual's propensity to be pregnant by 15 percentage points and this specification allows individuals to have their own trend which can be increasing or decreasing depending on the health status and age.

A 15 percentage point increase in pregnancy due to at least one year of treatment is relatively a very big impact and not only in absolute terms. Compared to the mean pregnancy rate of 0.14 in the sample, a coefficient of 15 percentage points increase corresponds to approximately a 107% increase in the pregnancy rates i.e. treatment has more than doubled the chance of pregnancy among HIV positive women, a very similar result found in epidemiology.

There is a possibility that the unobservables exhibit a more complex dynamic behavior than just a linear trend. We relax this assumption by separating out pre-existing trends from the dynamic response of a policy shock. In first place, we allow the trend to vary pre-post 2007 policy. We investigate how treatment effect varies pre-post free access to treatment. In Column 5, we show that women who are on treatment after 2007 are more likely to increase the average propensity of childbearing by 19.5 percentage points. This result is the average positive effect of the Cameroonian 2007 policy on free access to treatment on all treated women.

In Column 6 we decompose the policy effect year by year as in Table .5. The coefficients are slightly higher and the patterns are very similar. As in the above regressions, the coefficient of treatment effect on pregnancy increases over time with respect to the baseline. This is intuitive as HIV infection is increasingly perceived as a chronic disease allowing individuals to conduct normal lives including childbearing.

There is a positive effect of treatment on pregnancy and it is heterogeneous by year of treatment.

5. Treatment Effect by the Number of Children Before treatment Initiation

Information on pre-treatment number of children enables us to understand if treatment has an effect on the total fertility rate of women living in Yaounde. We estimate our coefficients by interacting treatment with pre-treatment number of children and results are shown in Table .7.

The coefficient estimates plotted in Table .7 show that treatment affects pregnancy among women who had no children before treatment and hence below the average fertility rate of Yaounde (that is 3 from DHS 2004). Treatment increases the pregnancy propensity by about 12 percentage points among women without children before treat-

ment initiation. It then decreases with additional number of children until acquiring a negative effect for women who had four or above children before treatment initiation.

This finding is consistent with the idea that treatment does not increase total fertility rate in the population. In fact, women who had already reached the local average fertility rate are not affected by treatment. This suggests that treatment allows women to reach their desired number of children but this does not lead to an increase in the latter. We do not compare HIV patients with non-HIV patients in the population and thus cannot conclude if treatment increases desired number of children and fertility. However, our regressions from Equation 1 would suggest that HIV positive women on treatment have lower number of children before treatment and increases just after treatment initiation. This leads to conclude that HIV positive women delay birth after treatment initiation.

6. Treatment Effect by the level of CD-4 at Treatment Initiation

The literature in epidemiology states that there is no optimal time for treatment initiation. If there are no other co-infections the WHO recommends to start treatment with CD-4 below 200 cells/μl in 2010. From 2010, the threshold is increased to 350 cells/μl because there has been evidence that "hit hard and early" strategy increases survival. In line with these strategy, recent evidences also support even earlier initiation of treatment - before CD4 count drops below 350 cells/μl .

We test the hypothesis if response to pregnancy depends on the initial level of CD-4 when treatment initiating i.e. if patients who start treatment earlier are those who are more likely to be pregnant.

In Table .8, we show that the effect of treatment on pregnancy is heterogeneous by the level of CD-4 at treatment initiation. Women who start treatment earlier with CD-4 count above the average have higher propensity. The effect of CD-4 holds especially for total pregnancy. Total pregnancy includes unintended pregnancy and this might suggest that the heterogeneous effect is mainly driven by unintended pregnancy and hence risky sexual behavior. However, we do not emphasize this channel as we do not have enough data on unintended pregnancy.

7. Threats to Internal Validity

Attrition

An important concern with our results is that we do not account for women who

might have died of AIDS at any point in time between 2003-2010 and who were treated in the Day Hospital of Yaounde. The death of some patients at any point in the window can be due to socio-economic characteristics affecting both fertility decisions and screening and monitoring of CD4 counts .

We verify our results on a smaller window by taking time period between 2008-2010. Data on women who start treatment after 2008 is a good representative of the population of women who were on treatment in the Central Hospital of Yaounde as they were tracked by phone from the hospital registry. Attrition due to death or dropout is less likely to occur in this small window of 2008-2010. In Table .9 and Column 1, we show that the above results hold and the effect is also similar in terms of magnitude. We use three time periods to control for individual specific trends.

Endogeneity

We check if our results are not driven by omitted correlates of treatment and pregnancy. There are time variant shocks that affect contemporaneously treatment initiation and pregnancy that are not captured by individual fixed effects or individual specific trends.

We exploit the exogeneity of the Cameroonian policy on free scaling-up of treatment. We restrict the sample to individuals who started treatment on and before 2007 and as such individuals are comparable and they are all on treatment. Once we control for secular trend and other individual characteristics, the coefficient on pre-post 2007 should not have an effect on pregnancy. In Column 2 of Table .9, we show that the effect of treatment depends on the 2007 policy. This means that the increase in pregnancy is mainly driven by free access of ART and is not confounded with other unobservables related to health status of the individuals.

Reverse causality could also confound the estimates and results in Table .8 would suggest self selection of healthy individuals. The relationship between treatment and pregnancy could be a result of planned pregnancy and treatment initiation. For example, if individuals plan to have a child, they can better monitor their CD-4 count and self-select themselves to treatment for pregnancy related decisions. We show that our results hold when we restrict the sample to individuals who started treatment in the same year they were detected HIV positive. We restrict the sample to individuals who were not able to monitor their CD-4 count and hence self-select themselves to treatment as they were not aware of their status. The results depicted in Column 3 of Table .9 shows that our previous results are not altered. This also rule out the case if individuals anticipate the 2007 policy and decide to be pregnant before treatment initiation.

8. Concluding Remarks and Discussion

This paper examines fertility responses to a change in availability of ART, a treatment which provides enormous mortality benefits to HIV positive women in the Central Hospital of Yaounde-Cameroon. We use a first hand data collected in the day hospital on birth history, health status of the child and other socio-economic variables on HIV positive women. We used the staggered timing of treatment initiation on fertility response between 2003-2010 to model pregnancy response by taking into account different types of heterogeneity: time variant and time invariant. We further exploit the 2007 policy on free access to treatment as a quasi-experiment on pregnancy rate.

Our estimates suggest that ART increases the likelihood of patients to be pregnant at least after one year of treatment. Our best specification indicates that, over the window of 2003-2010, on average treatment is associated with an increase in the propensity to pregnancy by 0.15, which is a huge effect both in absolute and relative terms. An average effect of 15 percentage points corresponds to doubling the pregnancy rate among women living with HIV in our sample over the window of analysis. This result is very similar to other finding in epidemiology.

The effect of treatment on pregnancy is time dependent. Decomposing the average effect year by year, the effect is driven by the availability of ART thanks to the Cameroonian Government's policy of 2007. Since 2007, treatment is free of charge and this has affected pregnancy response among women living with HIV. With respect to individuals who are on treatment at least for one year in 2004, treatment increases pregnancy response up to 22.4 percentage points among women who are on treatment at least for one year by and after 2007. This coefficient increases over time suggesting a long term effect of treatment on pregnancy.

The effect of treatment is heterogeneous by pre-treatment number of children: pregnancy response is driven by women who had zero number of children before treatment initiation while we find non significant or negative response among women who start treatment with a positive number of children born before treatment. The total fertility rate for women living in Yaounde was 3.2 in the 2004 DHS survey. Women who started treatment with children above 3 have a negative coefficient suggesting that treatment does not increase births unconditionally but it restores fertility in woman to (partially) reach the desired fertility rate.

In our study, treatment increased pregnancy among women who had higher initial CD-4 count. Possible explanations lie in the fact that women starting treatment with

higher CD-4 have better health outcomes and are more fecund. As such, after the 2007 policy, they had more incentives for Voluntary Counseling and Testing (VCT) and better monitoring their CD-4 because treatment is freely available. Unfortunately, the data is not extensive to investigate all these possible mechanisms.

We test and exclude behavioral response due to lower viral load and altruistic behavior of individuals who delay birth in order not to infect own partner. In our sample only 35% of women were aware of the fact that HAART reduces viral load and our coefficient is not heterogeneous by this knowledge suggesting that altruism is not among the channels explaining treatment effect on pregnancy.

We conclude that there is behavioral response beyond the immediate impact on health status that is based on several evidences: *first*, our coefficient is increasing over time with a jump being characterized in 2007 when treatment was liberalized and this suggests a time dependent effect correlated with increasing access to treatment; *second,* the treatment effect is significant only for a sub-population of individuals with zero number of children before treatment initiation suggesting that the most affected women are those whose total number of children is below the average*; third*, our results are consistent when we exclude women who got tested or started treatment for reasons related to amenorrhea or menstrual disorder; *fourth*, when we restrict our sample to individuals who were already on treatment before 2007 and we evaluate the 2007 policy as an exogenous increase in access to treatment and we find very similar result.In Figure .2 we show the average number of births per year of 67 individuals who were already on treatment by 2006. The average number of children born from these treated women is increasing over time with the big jump being characterized after the 2007 policy. The difference is statistically significant and these individuals are comparable in terms of health, years of infection, treatment and socio-economic characteristics which were all subject to similar social and economic costs of infection. This result demonstrates that there is more than just the health benefit and VCT.

There is also a role played by longer life expectancy which can induce individuals to invest in children. Individual's choices depend on their perceived life expectancy and they update their expectation by observing objective measures of present health outcomes. The initial psychological cost of learning own infection is perceived as reduced life expectancy because there is uncertainty in the efficacy of ART. In fact, in the Central Hospital of Yaounde, we collected information on subjective perception of future life expectancy among people living with HIV. The question was asked in the following way: "HAART treatment lengthens life expectancy for several years: Accord-

ing to you, is it from 15-20 years or more, 10-15, 5-10? or "I don't know?". There is a statistical difference between women who were on treatment and those who did not yet start treatment. A higher percentage of women on treatment chose the option *"15-20" or more* while a higher percentage of women who did not yet start treatment revealed higher uncertainty by choosing the option *"I don't know"*. In the same line, women on treatment were more likely to respond that treatment is a chronic disease which people can leave with like other diseases while those not yet on treatment choose the option "*I don't know*". Even though women on treatment knew more people who were HIV positive and treated with HAART, there is no statistical difference across the two groups on knowledge about PMTCT. More details are provided in Table .3.

ART adherence and efficacy is threatened by other factors like good nutrition, viral mutation or co-infections with other chronic diseases. From a research based on interviews of individuals receiving ART through a government-supported program in southeastern Nigeria: "*With treatment, the life projects of marriage and childbearing are again possible. For unmarried young adults and for older adults perhaps widowed by AIDS, once the shock of an HIV diagnosis is reduced and the positive effects of ART are experienced, finding a marriage partner becomes among the most pressing issues they face*" (Smith *et al.* 2007). In Nigeria, HIV positive women program their marriage and childbearing once they perceive the effect of ART treatment. We hence conclude that the effect of treatment on pregnancy is mainly driven by the free *access/availability* of ART i.e total abolition of economic cost which is perceived as long-term availability.

The epidemiological implication of treatment availability and pregnancy in terms of HIV incidence is not the object of this study. However, an important implication of our analysis is the behavioral response of treatment on intended or unintended pregnancy which is reflected on unsafe sex . Even though pregnancy implies unprotected sex and consequently is a factor of HIV transmission, treatment reduces viral load and hence the probability of infecting own partner. If treatment adherence is well developed among patients, the probability of HIV infection is dramatically reduced: both horizontally and vertically. The fact that pregnancy response is higher among women who start treatment with CD-4 higher than the average might suggest that pregnancy occurs among women with lower initial viral load. In terms of policy implication, as treatment increases the propensity of intended pregnancy as well, a more comprehensive approach that includes family-planning is urgently needed with treatment availability.

A concern about our analysis might be the possibility of heterogeneous impact of treatment by marital status. Marriage patterns differ a lot from the time of registra-

tion at the hospital to the date of interview in 2010. Our study does not address issues related to bargaining power among couples and how partners influence pregnancy related decisions on women living with HIV/AIDS. So intra-household bargaining might be explaining our results depending on marital status of the women interviewed and awareness of their partner on their seropositivity. In Figure .3, we show how unawareness on partner's status prevails in married and cohabiting couples and it suggests that partners are unlikely to be aware of their HIV status. Another important characteristic of the women interviewed is that they live in the capital city or near-by with a good percentage of them having completed secondary school. This characteristic alleviates issues related to gender gap and intra-household fertility decisions. Hence, the intended pregnancies declared and observed by the patients are likely to be reliable in measuring their own willingness.

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Figure .1: Birth Trends: Total, Intended and Unintended

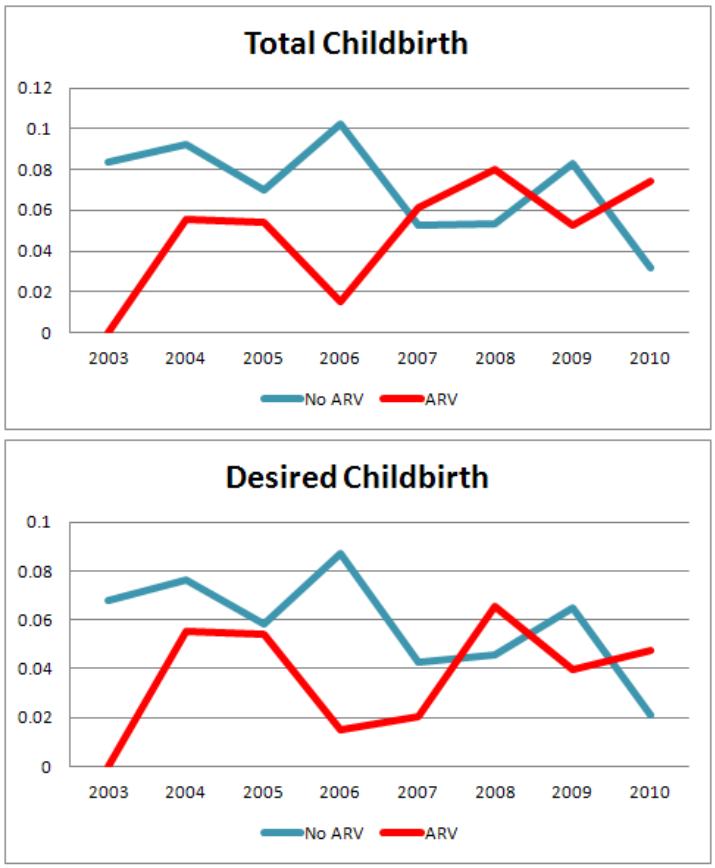

Figure .2: Individuals on Treatment Before 2006

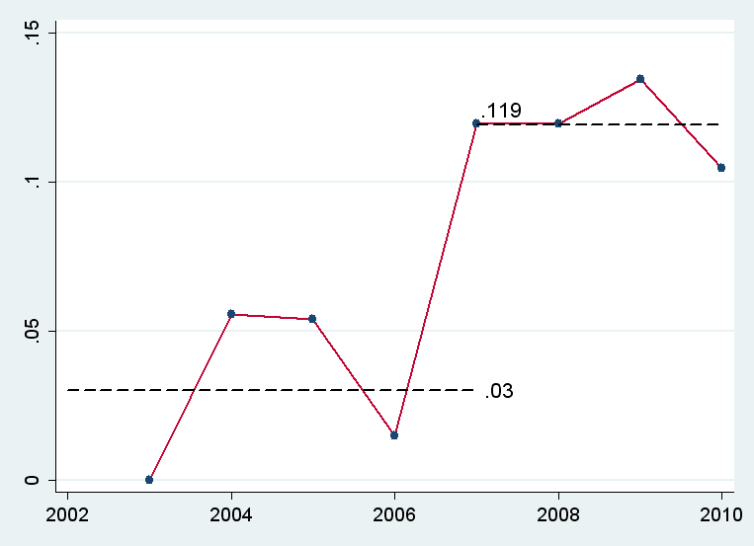

Figure .3: Knowledge of Women on their Partner's Status

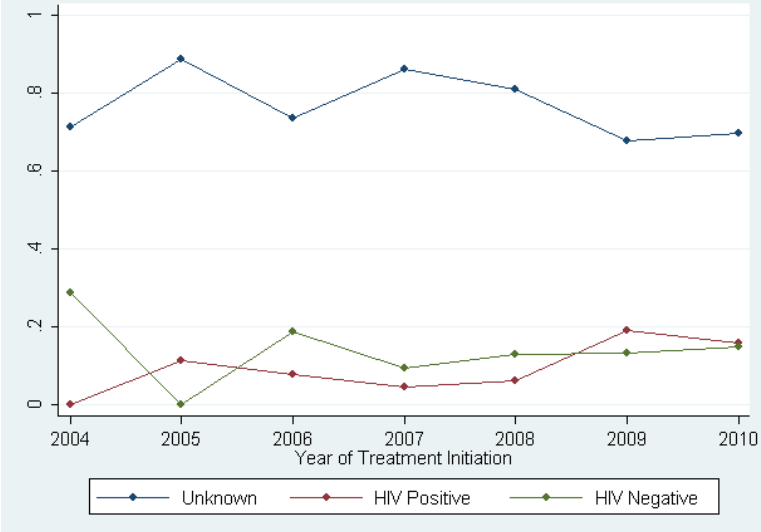

Table .1: Descriptive Statistics by Treatment Year

Year of Treatment	Age		Education		Fertility		Children before Treatment		Children after Treatment	
	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs
2000	**37.00**	**2**	**8.00**	**2**	**2.50**	**2**	**2.00**	**2**	**0.50**	**2**
	1.41	*74*	*2.83*	*16*	*0.71*	*5*	*1.41*	*4*	*0.71*	*1*
2001	**37.00**	**1**	**14.00**	**1**	**3.00**	**1**	**0.00**	**1**	**2.00**	**1**
	.	*37*	.	*14*	.	*3*	.	*0*	.	*2*
2002	**35.00**	**2**	**12.00**	**2**	**1.50**	**2**	**1.00**	**2**	**1.00**	**2**
	7.07	*70*	*1.41*	*24*	*0.71*	*3*	*0.00*	*2*	*1.41*	*2*
2003	**36.60**	**5**	**11.80**	**5**	**2.40**	**5**	**2.25**	**4**	**0.40**	**5**
	2.61	*183*	*1.64*	*59*	*2.30*	*12*	*0.96*	*9*	*0.89*	*2*
2004	**34.25**	**8**	**10.88**	**8**	**2.75**	**8**	**2.29**	**7**	**1.13**	**8**
	3.11	*274*	*3.23*	*87*	*1.91*	*22*	*1.60*	*16*	*0.99*	*9*
2005	**33.89**	**19**	**10.84**	**19**	**2.05**	**19**	**1.78**	**18**	**0.37**	**19**
	3.57	*644*	*3.06*	*206*	*1.27*	*39*	*1.17*	*32*	*0.76*	*7*
2006	**33.30**	**30**	**11.03**	**29**	**1.90**	**30**	**1.72**	**25**	**0.53**	**30**
	4.47	*999*	*3.44*	*320*	*1.47*	*57*	*1.31*	*43*	*0.68*	*16*
2007	**32.58**	**31**	**11.23**	**30**	**1.42**	**31**	**1.64**	**22**	**0.35**	**31**
	3.98	*1010*	*3.70*	*337*	*1.15*	*44*	*0.85*	*36*	*0.55*	*11*
2008	**32.08**	**39**	**9.84**	**37**	**1.90**	**39**	**2.00**	**32**	**0.36**	**39**
	4.91	*1251*	*3.06*	*364*	*1.47*	*74*	*1.19*	*64*	*0.63*	*14*
2009	**32.46**	**89**	**10.49**	**85**	**1.53**	**89**	**1.83**	**70**	**0.13**	**89**
	4.52	*2889*	*2.95*	*892*	*1.37*	*136*	*1.23*	*128*	*0.38*	*12*
2010	**31.65**	**69**	**11.35**	**66**	**1.81**	**69**	**2.19**	**57**	**0.00**	**69**
	5.34	*2184*	*3.42*	*749*	*1.54*	*125*	*1.42*	*125*	*0.00*	*0*
Total	**32.59**	**295**	**10.80**	**284**	**1.76**	**295**	**1.91**	**240**	**0.26**	**295**
	4.66	*9615*	*3.21*	*3068*	*1.44*	*520*	*1.25*	*459*	*0.56*	*76*
Not on Treatment	**30.16**	**95**	**10.70**	**92**	**1.78**	**95**	**1.77**	**95**	***0.00***	***0***
	4.95	2865	3.73	984	1.40	169	1.37	168	*0.00*	*0*

Table .2: Descriptive Statistics of Pregnancy by Year

Year	Pregnancy		Interrupted Pregnancy		Birth		Intended Birth		Unintended Birth	
	Mean	Sum/Obs.	Mean	Sum/Obs.	Mean	Sum/Obs.	Mean	Sum/Obs.	Mean	Sum/Obs.
2003	**0.11**	**42**	**0.03**	**10**	**0.08**	**32**	**0.07**	**26**	**0.02**	**6**
	0.32	*394*	*0.16*	*394*	*0.27*	*394*	*0.25*	*394*	*0.12*	*394*
2004	**0.13**	**50**	**0.04**	**14**	**0.09**	**36**	**0.08**	**30**	**0.02**	**6**
	0.34	*397*	*0.18*	*397*	*0.29*	*397*	*0.26*	*397*	*0.12*	*397*
2005	**0.11**	**45**	**0.05**	**18**	**0.07**	**27**	**0.06**	**23**	**0.01**	**4**
	0.32	*396*	*0.21*	*396*	*0.25*	*396*	*0.23*	*396*	*0.10*	*396*
2006	**0.11**	**45**	**0.03**	**10**	**0.09**	**35**	**0.08**	**30**	**0.02**	**6**
	0.32	*399*	*0.16*	*399*	*0.28*	*399*	*0.26*	*399*	*0.12*	*399*
2007	**0.10**	**41**	**0.05**	**19**	**0.05**	**22**	**0.04**	**15**	**0.02**	**7**
	0.32	*402*	*0.22*	*402*	*0.23*	*402*	*0.19*	*402*	*0.13*	*402*
2008	**0.10**	**40**	**0.04**	**15**	**0.06**	**25**	**0.05**	**21**	**0.01**	**5**
	0.32	*400*	*0.20*	*400*	*0.24*	*400*	*0.22*	*400*	*0.11*	*400*
2009	**0.12**	**46**	**0.05**	**20**	**0.07**	**26**	**0.05**	**20**	**0.02**	**6**
	0.33	*396*	*0.23*	*396*	*0.25*	*396*	*0.22*	*396*	*0.12*	*396*
2010	**0.09**	**35**	**0.02**	**9**	**0.07**	**26**	**0.04**	**17**	**0.02**	**9**
	0.31	*390*	*0.17*	*390*	*0.26*	*390*	*0.22*	*390*	*0.15*	*390*
Total	**0.11**	**344**	**0.04**	**115**	**0.07**	**229**	**0.06**	**182**	**0.02**	**49**

In the first column we show the mean and standard error for each type of pregnancy. In the second column, we show the number of children born and the number of women who were analyzed in that specific year. As the sample is restricted to women between the age of 15-40, the sample size varies year by year depending on the number of women who are part of the age group.

Table .3: Mean Comparison between Treated and Non-Treated on Perception of HIV/AIDS

	Mean					Observations	
Variable	Non Treated	Treated	Difference		P-Value	Non Treated	Treated
Good Knowledge of PMTCT	0.644	0.620	-0.024		0.336	101	292
Knows Someone With AIDS	0.530	0.735	0.204	***	1.000	100	290
Life expectancy 15-20	0.610	0.736	0.126	***	0.992	100	292
Certain about future Life Expectancy	0.700	0.788	0.088	**	0.963	100	292
Perceive AIDS as a chronic Disease	0.812	0.877	0.065	*	0.947	101	292
Certain about AIDS Chronic/not Chronic	0.891	0.949	0.058	**	0.977	101	292

*** p<0.01, ** p<0.05, * p<0.1. The Variables: "Certain about future Life Expectancy" and "Certain about AIDS Chronic/not Chronic" are complement to the answer "I don't know". Women on treatment are less likely to take the option "I don't know" on their future life expectancy and whether AIDS is a chronic disease.

Table .4: Coefficients from DIFFinDIFF based on the Moving Window: Birth in t+1 with respect to t

	(1)	(2)	(3)	(4)
Dependent Variable	Pregnancy	Intended Pregnancy	Pregnqncy	Intended Pregnancy
POST	0.0132	-0.0132	0.0219	-0.00834
	(0.0224)	(0.0197)	(0.0247)	(0.0217)
ART	-0.0759***	-0.0693***	-0.0676***	-0.0636***
	(0.0152)	(0.0146)	(0.0187)	(0.0174)
POST*ART	**0.0852*** **	**0.0870*** **	**0.0636* **	**0.0730** **
	(0.0294)	**(0.0259)**	**(0.0344)**	**(0.0304)**
AGE			0.0244	0.0290**
			(0.0152)	(0.0118)
AGE SQ			-0.000508**	-0.000529***
			(0.000256)	(0.000203)
LAGGED CHILD			-0.0484***	-0.0405***
			(0.0169)	(0.0134)
EDUCATION			-0.00616***	-0.00381**
			(0.00232)	(0.00189)
YEAR FE			YES	YES
Constant	0.0759***	0.0693***	-0.120	-0.264
	(0.0152)	(0.0146)	(0.217)	(0.162)
Observations	1,095	1,095	1,024	1,024
R-squared	0.022	0.016	0.045	0.030

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
The dependent variables in the first and third columns are total number of pregnancy while in column two and four we refer to intended pregnancy

Table .5: Dynamic of the Coefficients by Year of Treatment Initiation

	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
Intended Birth	**-0.147**	**-0.0333**	**0.144***	**0.129***	**0.0979***	**0.206*****
	(0.0954)	(0.0593)	(0.0768)	(0.0677)	(0.0544)	(0.0514)
Controls	YES	YES	YES	YES	YES	YES
Obs	86	100	152	244	226	444
Rsq	0.121	0.036	0.072	0.049	0.026	0.069

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Note: Each column is a restricted sample of women who start treatment in different years with the restricted pre-post periods i.e. it is a decomposition of the moving window. This tables shows how patients who enter treatment in different years are affected differently by the treatment. Each regression include the same controls specified in the main model of moving window.

Table .6: Coefficients Estimates of Treatment on Pregnancy

LPM	Dependent Variable: Pregnancy					
	(1)	(2)	(3)	(4)	(5)	(6)
ART	0.0166	0.0359**	*0.0826****	*0.159****	-0.0111	-0.0404
	(0.0141)	(0.0161)	(0.0195)	*(0.0274)*	(0.0159)	(0.0259)
POLICY					0.00353	
					(0.0340)	
POLICY*ART					*0.195****	
					(0.0368)	
ART*2005						0.0756
						(0.0542)
ART*2006						0.0110
						(0.0406)
ART*2007						*0.224****
						(0.0859)
ART*2008						*0.265****
						(0.0923)
ART*2009						*0.174***
						(0.0814)
ART*2010						*0.255****
						(0.0535)
IND FE		YES	YES	YES	YES	YES
YEAR FE			YES	YES		YES
IND SPEC TR				YES	YES	YES
LINEAR TREND					YES	
Constant	0.102***	0.0985***	0.106***	-0.0689***	0.0332	0.0179
	(0.00636)	(0.00304)	(0.0143)	(0.0224)	(0.0236)	(0.0222)
Observations	3,174	3,174	3,174	2,780	2,780	2,780
R-squared	0.000	0.002	0.008	0.010	0.010	0.012
Number of id		407	407	405	405	405

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

In Column 1 we report results from a simple regression model while in Column 2, Column 3 and Column 4, we respectively control for individual fixed effects, year fixed effects and individual specific trends. In Column 5 and Column 6, we allow the trend to vary by treatment status. In Column 6, we evaluate the 2007 policy while in the last column we evaluate the policy year by year.

Table .7: Coefficient Estimates by Number of Pre-Treatment Children

Dependent Variable	Pregnancy	
	(1)	(2)
ART	0.0826***	0.120***
	(0.0195)	(0.0272)
ART*One Child.		-0.0465
		(0.0350)
ART*Two Child.		-0.0510
		(0.0402)
ART*Three Child.		0.0197
		(0.0775)
ART*Four Child.		-0.0847
		(0.117)
ART*Five Child.		-0.276**
		(0.115)
ART*Six Child.		-0.280***
		(0.0411)
ART*Seven Child.		-0.340***
		(0.0285)
Constant	0.106***	0.106***
	(0.0143)	(0.0143)
Observations	3,174	3,161
R-squared	0.008	0.010
Number of id	407	405

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table .8: Random Individual Specific Trend dependent on Initial CD-4

	(1)	(2)	(3)	(4)
VARIABLES	Pregnancy		Intended Pregnancy	
ART	0.159***	0.201***	0.109***	0.139***
	(0.0274)	(0.0401)	(0.0223)	(0.0339)
(CD4<144)*ART		-0.0874*		-0.0637
		(0.0500)		(0.0401)
YEAR FE	YES	YES	YES	YES
Constant	-0.0689***	-0.0699***	-0.0475**	-0.0482***
	(0.0224)	(0.0223)	(0.0184)	(0.0184)
Observations	2,780	2,780	2,780	2,780
R-squared	0.010	0.011	0.009	0.010
Number of id	405	405	405	405

Robust standard errors in parentheses and clustered at individual level. *** p<0.01, ** p<0.05, * p<0.1. The variable CD4<144 takes the value 1 if CD4 is below the average. Same result holds if we take the median of CD4 rather than the average. We test the hypothesis on total pregnancy and intended pregnancy.

Table .9: Sensitivity analysis: Attrition, Selection and Omitted Variables

	(1)	(2)	(3)
Dependent Variable		Pregnancy	
ART	0.226***	0.00834	0.171***
	(0.0447)	(0.0278)	(0.0362)
ART*2007 Policy		0.178*	
		(0.0919)	
2007 Policy		0.0239	
		(0.0738)	
Trend		-0.00702	
		(0.0168)	
YEAR FE	YES		YES
CLASSE AGE	YES		YES
Constant	-0.0824	0.00296	-0.0523
	(0.103)	(0.0492)	(0.0799)
Observations	1,186	684	2,034
R-squared	0.032	0.017	0.012
Number of id	400	98	297

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

In Column 1, we show the effect of treatment on the restricted sample between 2008-2010 in order to avoid bias due to attrition. In Column 2, we show results on the restricted sample of individuals who started treatment before 2007 and we evaluate the impact of the policy as an exogenous variation. In Column 3, we restrict the sample to individuals who started treatment in the same year they discovered their status. As such, we avoid the problem of self-selection.

Appendix

Coefficients Estimates of Treatment on Intended Pregnancy

LPM	Dependent Variable: Intended Pregnancy					
	(1)	(2)	(3)	(4)	(5)	(6)
ART	0.00320	0.00983	0.0407**	0.109***	-0.000675	-0.0356
	(0.0118)	(0.0146)	(0.0170)	(0.0223)	(0.0149)	(0.0229)
POLICY					-0.0179	
					(0.0283)	
POLICY*ART					0.123***	
					(0.0319)	
ART*2005						0.103**
						(0.0495)
ART*2006						0.0112
						(0.0350)
ART*2007						0.125**
						(0.0488)
ART*2008						0.204**
						(0.0845)
ART*2009						0.131*
						(0.0672)
ART*2010						0.185***
						(0.0466)
IND FE		YES	YES	YES	YES	YES
YEAR FE			YES	YES		YES
IND SPEC TR				YES	YES	YES
LINEAR TREND					YES	
Constant	0.0687***	0.0675***	0.0740***	-0.0475**	0.0103	0.0179
	(0.00526)	(0.00274)	(0.0126)	(0.0184)	(0.0194)	(0.0195)
Observations	3,174	3,174	3,174	2,780	2,780	2,780
R-squared	0.000	0.000	0.006	0.009	0.006	0.011
Number of id		407	407	405	405	405

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

In Column 1 we report results from a simple regression model while in Column 2, Column 3 and Column 4, we respectively control for individual fixed effects, year fixed effects and individual specific trends. In Column 5 and Column 6, we allow the trend to vary by treatment status. In Column 6, we evaluate the 2007 policy while in the last column we evaluate the policy year by year.