# Medication of Postpartum Depression and Maternal Outcomes: Evidence from Geographic Variation in Dutch Prescribing*

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**Abstract:** We use data on over 420,000 first-time Dutch mothers to examine the effects of postpartum antidepressant use. Dutch general practitioners (GPs) must be available for house calls. We therefore instrument a woman's receipt of antidepressants postpartum with local practitioners' propensity to prescribe antidepressants to women 46 to 65. Ordinary least squares suggests negative effects of postpartum antidepressants but this is due to selection into treatment. Instrumental variables estimates indicate that the marginal treated patient is likely to continue taking antidepressants long term and is less likely to be employed in the year after birth, with little evidence of other effects.

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## I. Introduction

Postpartum depression (PPD) is defined as a major depression that begins within four weeks of giving birth (Miller 2002). It is estimated to affect one in nine postpartum women (Office on Women's Health 2019). Because of its association with negative outcomes, including self-harming behaviors (Moses-Kolko and Hipwell 2016; Bodnar-Deren et al. 2016), improving treatment for postpartum depression is viewed as an urgent priority. Treatment with antidepressant drugs has been described as the mainstay of treatment for postpartum depression (Miller 2002). However, a Cochrane review (Molyneaux et al. 2014) found that studies of postpartum antidepressant use suffered from small samples, high attrition, and unrepresentative participation (caused, for example, by the exclusion of the most severely depressed women from experimental studies). The review also flagged short follow-up periods as a problem because little information is available about medium- and longer-term outcomes. Hence, their review called for further research into the efficacy of antidepressant treatment.

This study uses Dutch administrative data covering a sample of over 420,000 first births between 2008 and 2016 to estimate the effects of postpartum antidepressant use on outcomes in the three years following childbirth. By using comprehensive administrative data, we solve many of the problems of the previous literature. We have large samples, a three-year follow-up, virtually no attrition, and a sample consisting of all first births rather than a selected sample of new mothers. We are also able to focus on a range of outcomes that are important to a woman's economic wellbeing, including employment, earnings, the stability of domestic partnerships, and the probability of receiving psychological treatment for a more-severe mental illness.

Because antidepressant use is not random, we follow several recent papers (e.g., Chorniy and Kitashima 2016; Dalsgaard, Nielsen, and Simonsen 2014; Currie and MacLeod 2017, 2020;

Cuddy and Currie 2020) that use measures of doctors' propensities to prescribe antidepressants. Specifically, we instrument a woman's receipt of antidepressants using the propensity of local doctors (defined as those in the new mother's 4-digit postal code) to prescribe antidepressants to women aged 46 to 65.

This instrument takes advantage of several institutional features of the Dutch health care system. First, in the Netherlands, general practitioners (GPs) are the gatekeepers to mental health care and prescribe most antidepressants. Second, GPs must be available to make house calls to their patients and can decline to serve patients living more than 15 minutes away. Consequently, as a practical matter, the prescribing practices of doctors in the local area affect the prescribing environment to which a woman is exposed. We show that, conditional on other features of the postal code and on area-level fixed effects, this instrument is not related to individual-level characteristics of the mothers. Moreover, because the instrument is constructed using women aged 46 to 65, the attitudes of new mothers themselves toward antidepressant use should not have a direct effect on this measure of prescribing propensity.

We find that ordinary least squares (OLS) estimates of the effects of postpartum antidepressant treatment suggest that it has pervasive negative effects on all the outcomes considered. Women prescribed antidepressants postpartum are more likely to be taking antidepressants up to three years later, more likely to be treated by a specialist for a more severe psychiatric disorder, less likely to have any positive earnings, less likely to live with the child's father, and less likely to have another baby within three years.

In contrast, instrumental variable estimates suggest that these negative estimated OLS effects are largely driven by selection into antidepressant use. Controlling for this selection, we still find that women who were prescribed postpartum antidepressants because they live in a high-prescribing area are more likely to be using them long term. These effects are mainly concentrated among women in the top quartile of the pre-pregnancy income distribution.

We also find negative effects of postpartum antidepressant use on the probability that a woman is employed (i.e., has positive income) in the first calendar year after birth. These effects are accounted for mainly by women in the lower quartiles of the income distribution. We find no statistically significant effects on the other outcomes.

The instrumental variables estimates focus on women who are moved into treatment status solely because they happen to live in areas where practitioners are more likely to prescribe antidepressants. The fact that these women derive little benefit in terms of measurable outcomes and may suffer some harm raises the question of whether antidepressants are being overprescribed in these areas. Long-term use of antidepressants has side effects including significant weight gain, sexual problems, emotional numbness, a higher risk of new cardiovascular events, and even a higher risk of death (Bet et al. 2013; Maslej et al. 2017). Hence, long-term antidepressant use is justified only if it actually improves outcomes. Similarly, loss of employment is costly.

The rest of the paper is laid out as follows. Section II provides additional background information. Section III gives an overview of our empirical approach. Section IV describes the data, and Section V shows the results. A discussion and conclusion follow.

## II. Background

This section provides a very brief overview of some of the research on postpartum depression as well as the unique institutional features of the Netherlands that enable our study.

### *A. Prior Literature about the Effects of PPD*

Many studies have argued that PPD interferes with a mother's ability to bond with her baby, which leads to negative effects on early child development (Slomian et al. 2019; Moore Simas et al. 2019; Netsi, Pearson and Murray 2018). Some studies also suggest that PPD is associated with increased stress, anxiety, and depression among partners (Moore Simas et al. 2019) and more conflict in the home (Burke 2003). Other studies emphasize links with suicidal ideation and self-harm (Moses-Kolko and Hipwell 2016; Bodnar-Deren et al. 2016). PPD has also been linked to inadequate housing, food insecurity, and economic distress among mothers and children, though it is not entirely clear whether it is a cause or an effect of these outcomes (Curtis et al. 2014; Garg et al. 2014; Corman et al. 2016; Noonan, Corman, and Reichman 2016; Williams and Cheadle 2015).

However, very few studies have examined the longer-term impacts of postpartum depression on mothers themselves. Vliegen, Casalin, and Luyten (2014) review longitudinal studies of the course of the disease and find that while most women eventually recover from PPD, it is a significant risk factor for subsequent mental illness. Given that depression accounts for large numbers of working days lost in industrial economies and that chronic depression can lead to withdrawal from the labor market, it is possible that PPD has long-term negative labor market outcomes. In one of the only previous studies to examine the effects of PPD on the return to work, Dagher, Hofferth, and Lee (2014) find that PPD has no statistically significant effect, but this may be because they have a relatively small sample size.

Postpartum depression could also affect women's longer-term economic status through effects on family formation given the previous results suggesting increased conflict in the home. Because single mothers are much more likely to suffer from low household income than partnered mothers, PPD could undermine financial security by making it less likely that a new mother would stay partnered.

This summary highlights the lack of attention to the medium- and longer-term effects of PPD and treatment for PPD on women themselves. This paper aims to begin to fill this gap in the literature.

### *B. Institutional Features of Dutch Health Insurance and Maternity Care*

In the Netherlands, the 2006 Health Insurance Act created a unified system in which all residents are required to purchase health insurance with a predefined set of "basic" benefits from private insurers. Insurance companies can compete by offering these basic benefits at different prices (i.e., there is managed competition). Each year, the Ministry of Health updates the set of basic benefits. These benefits cover medical care by general practitioners, midwives, and specialists, as well as dental care and pharmaceuticals. Out-of-pocket costs are low. A mandatory deductible was introduced in 2008,[1] but some services, like GP and maternity care, are excluded from this deductible.[2] Healthcare subsidies are available for low-income individuals to help cover the costs of health insurance as well as the deductible. Therefore, anyone who needs treatment for PPD can access it at low cost.

The GP serves as a gatekeeper for specialist care, including mental health care (Van Dijk et al. 2013). GPs treat patients with mild mental health problems themselves and can refer more serious cases to specialists.[3] One recent report found that out of 879 individuals who visited a GP for depressive symptoms, 78 percent of individuals received a referral to another health professional, such as a therapist, and 41 percent were prescribed medication (MIND 2019). Most

[1] The mandatory deductible was introduced in 2008 and increased from 150 euros in 2008 to 385 euros in 2020.
[2] The deductible is applicable for specialized mental health care. Hence, access to specialized mental health care may be more restricted for lower-income individuals despite available healthcare subsidies. For this reason, we also present results splitting the sample by household income.
[3] A reform was introduced in 2014 that made it harder for patients to get a referral from a GP for specialized mental health care. As a result, more patients with mental health problems were treated by their GP.

antidepressant prescribing is done by GPs: in 2004, GPs were responsible for 79.6 percent of the antidepressants prescribed in the Netherlands (SFK 2005), while in 2019, they accounted for 65 percent of *new* prescriptions for antidepressants (SFK 2020). A further 29 percent were prescribed by specialists (mostly psychiatrists and neurologists) and 6 percent by other doctors such addiction specialists and geriatricians (SFK 2020).

As in the United States, any doctor can prescribe antidepressants and most antidepressants are covered by basic insurance.[4] Over our sample period (2006 to 2018) 5.7 percent of the Dutch population used antidepressants. The rate was higher among prime-aged women (15 to 45) at 6.0 percent, and it was even higher for women aged 46 to 65 at 11.2 percent.[5] These numbers are lower than for the United States where 13.2 percent of all adults, 17.7 percent of women, and 24.3 percent of women over 60 used antidepressants over the 2015 to 2018 time period (Brody and Gu 2020).

In the Netherlands there are guidelines that cover the treatment of depression during and after pregnancy. This study focuses on the treatment of postpartum depression, defined as depression that occurs within the ten months following the pregnancy. The Dutch guidelines acknowledge that antidepressant use *during* pregnancy involves possible tradeoffs between benefits to the mother and possible harms to both the mother and the fetus, but conclude that antidepressants, and in particular SSRIs, should not necessarily be discouraged during pregnancy (NVOG 2012; Molenaar 2018).[6] As we will show however, many Dutch women avoid taking antidepressants during pregnancy and even discontinue them during pregnancy perhaps for fear of potential harm to the fetus.

[4] In some cases, only the generic version of the antidepressant is covered by basic insurance.
[5] Authors' calculations based on microdata from Statistics Netherlands. Usage of antidepressants corresponds to any prescription for antidepressants (prescription in ATC-4 category N06A) in a year, and we average the usage by group over the years 2006 to 2018 to get to these numbers.
[6] For example, O'Connor et al. (2016) provide a review of the literature that reports higher rates of miscarriage, seizures, and preeclampsia in women taking antidepressants.

With regards to postpartum depression, the guidelines of the Dutch Association of General Practitioners (NHG 2019) state that it is important to diagnose and treat it. The guidelines state that while psychotherapy is an effective treatment for postpartum depression, doctors can opt to prescribe antidepressants as well. The guidelines do not discourage the prescription of antidepressants for women who are breastfeeding, nor do they suggest that women who are on antidepressants should not breastfeed.[7] It is important to note that even though midwives and possibly pediatricians can help to identify the first signs of potential postpartum depression in women, new mothers must go to their GP to receive treatment.[8]

Dutch women are entitled to six weeks of pregnancy leave and at least ten weeks of maternity leave. Pregnancy leave lasts until the day of giving birth and can start six to four weeks before the woman's due date. After giving birth, women are entitled to at least ten weeks of maternity leave (more if the baby was born early so that mother did not use all of her pregnancy leave). Maternity benefits are equal to 100% of daily wages. Employers continue to pay the woman's salary during her pregnancy and maternity leave and then request reimbursement of the benefits from the social insurance administration.[9] The main implication of these policies for our analysis is that if a woman is willing and able to return to work after giving birth, we expect her to return within the year.



[7] There is little evidence on the effects on antidepressants during lactation on infants, and there is no evidence for severe negative consequences (NVOG 2012; NHG 2019).

[8] The midwife is the key actor for maternity care during pregnancy and in the postpartum period in the Netherlands. However, the midwife refers the mother to her GP in the case of postpartum depression (KNOV 2018). Midwives are not allowed to prescribe antidepressants (Schippers 2014). Obstetricians play a limited role in the Dutch context. If complications arise during their pregnancy, women can be referred to an obstetrician (Amelink-Verburg and Buitendijk 2010). However, even in this case the mother is cared for by the midwife and her GP in the postpartum period, so the obstetrician is unlikely to prescribe antidepressants.

[9] If a woman is not able to return to work after maternity leave ends because of an illness due to her pregnancy, she is entitled to receive sickness benefits equal to 100% of daily wages for a maximum of 104 weeks. If an individual is still sick after two years, they will transition into the fund for long-term illness (WIA).

In summary, there are few barriers to a woman receiving an antidepressant for postpartum depression if her doctor thinks it is warranted. Guidelines would support such prescribing and public insurance would pay for it. If women return to work after childbirth, they should be observed to do so after a relatively short period of paid maternity leave.

## III. Empirical Strategy

Our goal is to assess the effects of taking antidepressant drugs for postpartum depression sometime in the 10 months after giving birth on a woman's future well-being measured using the broad range of outcomes available in Dutch administrative data. The main difficulty is that there are likely to be unobserved (to the researcher) attributes of women that are correlated both with their propensity to be prescribed antidepressants and with their future outcomes.

To try to identify a causal effect of antidepressant use, we focus on a group of women who are delivering for the first time and who were not taking antidepressants in the 10 to 24 months prior to the delivery. Women who were taking antidepressants prior to the pregnancy may be continuously depressed rather than suffering from postpartum depression. Women delivering for the first time have—by construction—never suffered from postpartum depression before. We focus on this group because previous postpartum depression is a risk factor for experiencing another episode of postpartum depression and might influence subsequent outcomes.[10]

In this sample of first-time mothers who were not being medicated for depression prior to pregnancy, it is still possible that unobserved attributes correlate both with the propensity to use antidepressants after the birth and with future outcomes. Hence, we instrument the woman's own

[10] Moreover, **Figure A1** shows that a woman's propensity to take antidepressants in the months surrounding childbirth is higher for higher-parity births in the raw data (see Panel a). This pattern remains even after controlling for maternal age at birth (see Panel b).

postpartum antidepressant use with a 4-digit postal code–level average of doctors' propensities to provide new prescriptions of antidepressants to women aged 46 to 65 in the year before the woman gives birth. This measure is described in more detail below.

Measures of a doctor's propensity to prescribe have been widely used as instruments for a patient's probability of receiving medications (c.f., Chorniy and Kitashima 2016; Dalsgaard, Nielsen, and Simonsen 2014). However, these studies still raise the question of how a patient ended up being matched with a particular provider. To deal with this difficulty, some researchers have turned to area-level measures of the propensity to prescribe. The logic behind using area-level measures is that in areas with high levels of prescribing, individuals are more likely to end up seeing a high-prescribing provider (Currie and MacLeod 2017, 2020; Cuddy and Currie 2020). This work builds on the large literature demonstrating the importance of geographical variations in treatment patterns (e.g. Chandra and Staiger 2007; Finkelstein, Gentzkow, and Williams 2015; Fisher et al., 2003a,b; Cutler et al. 2019). A limitation of much of this literature is that in most jurisdictions, it is possible that patients could travel to see a provider who better matches their treatment preferences.

We also make use of an area-level measure of the propensity to prescribe. However, in our case, patients are unlikely to travel very far to find a provider because of an institutional feature of the Dutch health care system: in the Netherlands, GPs are required to be able to make house calls and can decline to take patients who live more than fifteen minutes from their office location (Ministerie voor Volksgezondheid, Welzijn en Sport 2005). We show empirically that a woman's probability of being prescribed postpartum antidepressants is strongly related to the average propensity of physicians in her postal code to prescribe antidepressants to women aged 46 to 65.

Postal code boundaries are generally within 15 minutes' driving distance of postal code centroids, so we can infer that many patients do see GPs in the same postal code.[11]

We focus on new prescriptions of antidepressants to women aged 46 to 65 in the year prior to the birth in an effort to capture local providers' general attitudes toward the prescribing of antidepressants to women. Note that our data do not allow us to see who prescribed the antidepressants, but we know that the GPs are the largest prescriber of antidepressants in the Netherlands. We show below that areas where doctors write more new prescriptions for older women are areas in which new mothers are also more likely to receive prescriptions. Given that the instrument is a strong predictor of a woman's receiving a postpartum prescription for antidepressants, the additional condition necessary for it to be a valid instrument is that the fraction of women aged 46 to 65 in the neighborhood who are newly prescribed antidepressants has no independent impact on the outcomes of women aged 15 to 45 once their own postpartum antidepressant use and other control variables are accounted for. While this assumption is inherently untestable, we show that our instrument passes a "balance" test as described further below.

We include the following individual-level controls: maternal and paternal age at birth (in seven groups, < 20, 20 to 25, 25 to 30, 30 to 35, 35 to 40, >40, and missing for fathers); maternal and paternal migration background (Dutch background or not); an indicator for multiple births; maternal and paternal mean income; and maternal and paternal labor force participation in the two

[11] We calculated the distance between all postal codes with at least one GP practice over the 2009–2016 time period to the closest postal code that also had at least one GP practice over the 2009–2016 time period (with distance measured from the centroids). The 99th percentile is 7.23 kilometers. Assuming an average driving speed of 30 kilometers an hour, a person could cover 7.5 kilometers in 15 minutes. Hence, postal code boundaries likely fall within a 15-minute distance buffer zone around a GP practice.

years preceding the birth. We also include an indicator for whether the parents are living together in the year before the birth.

In addition, we include the following postal code level controls: the percent of inhabitants with a Dutch background, the percent of one-parent households, the percent of welfare recipients; the percent of low-income households, and five indicators for the "urbanicity" of the postal code. We also include a control variable for the total population in the child's year of birth, and controls for mean income and mean labor force participation for men and women between the ages of 15 and 45 in the year before the child's birth.

Finally, we include "municipality" and year of birth fixed effects. In the Netherlands the concept of a municipality is closer to the U.S. idea of a county than to a city. The entire country is divided into municipalities that generally include a city, village, or town as well as its surrounding area.[12] Each municipality is further divided into postal codes. One could reasonably think of the municipality as corresponding to the local labor market and transportation network. We divide the four largest cities (Amsterdam, Rotterdam, The Hague, and Utrecht) into districts to account for possible regional differences within cities. Our sample is comprised of 2,001 postal codes that belong to 481 different areas (municipalities plus districts). We cluster standard errors at the area level.

Hence, the first-stage equation is:

$$AD_{izjt} = \alpha_j + \beta_1 GP\_prop_{zjt} + \beta_2 X_{izjt} + \beta_3 Zip_{zjt} + \varphi_t + \varepsilon_{izjt} \tag{1}$$

[12] The boundaries of municipalities can change over time, generally because smaller municipalities merge into larger units. We take this into account by matching the postal codes to the 2016 municipality boundaries.

where $AD_{izjt}$ denotes antidepressant use by individual *i*, in postal code *z*, in municipality *j*, in year *t*; $GP\_prop_{zjt}$ denotes the propensity of doctors to prescribe antidepressants in the postal code, that is, new prescriptions to women aged 46 to 65; $X_{izjt}$ is a vector of individual-level attributes; $Zip_{zjt}$ is a vector of postal code–level attributes; $\varphi_t$ is a vector of year fixed effects for the year of birth of the child, $\alpha_j$ is a vector of area fixed effects; and $\varepsilon_{izjt}$ is an error term. Standard errors are clustered at the area level.

Denoting the predicted probability of antidepressant use from the first stage as $PredAD_{zjt}$, the second stage takes the form:

$$(2) \qquad Y_{izjt} = \delta_j + \gamma_1 PredAD_{zjt} + \gamma_2 X_{izjt} + \gamma_3 Zip_{zjt} + \theta_t + \varepsilon_{izjt}$$

where $Y_{izjt}$ is one of several maternal outcomes described further below.

As we show below, areas where doctors are more likely to prescribe antidepressants to women aged 46 to 65 tend to be relatively poorer areas, with higher fractions of low-income individuals. Therefore, to better distinguish between the effects of income and the effects of prescription propensities, we also estimate separate models for relatively high-income individuals (the top 25 percent of the pre-pregnancy family income distribution) and other individuals. This split also helps us to deal with the possible consequences of deductibles for specialized mental health treatment, which may impact low-income individuals more than higher income individuals.

To check the validity of our instrument we also estimate a specification in which we focus on individuals living in areas with three or fewer GP practices. On average, the women in our sample have access to 2.9 GP practices in their postal code between 2009 and 2016. We show that the instrument has a stronger first stage in areas with less choice of health providers, as one would expect.

Also, an area-level measure of prescribing intensity could also be related to the prescription of other medications that could affect the outcomes of mothers after birth. That is, the estimated effects might reflect other prescribing that is correlated with antidepressant prescribing. To investigate this possibility, we tried using our instrument to predict the usage of antibiotics and the use of opioids in the calendar year after childbirth. We show that the first stage is absent in these models, which is reassuring.

## IV. The Data

We use administrative data from Statistics Netherlands, which covers the universe of individuals born or living in the Netherlands after 1995.[13] This section offers further information about the construction of the instrument, the sample of births, the linkage of antidepressant prescriptions to births, and the outcomes we examine.

### *A. Building the Instrument*

We use geographic variation in prescribing as an instrument for antidepressant usage in the months after giving birth. We focus on postal codes as the geographic unit of analysis because GPs must be available to make house calls to their patients and can decline to serve patients living more than 15 minutes away. Empirically, we also see that the prescribing propensity of GPs in the woman's postal code is strongly predictive of her probability of being prescribed.

To construct the instrument, we start by assigning individuals to a 4-digit postal code of residence in each year of the sample. In some cases, an individual may have had more than one address during a calendar year, in which case we use the longest spell as their main address. We

[13] The administrative data from Statistics Netherlands is available at a remote-access facility after signing a confidentiality agreement.

combine the address data with information on all the prescriptions that an individual received from a pharmacy and that were covered by basic insurance. This file has information about whether the individual received at least one prescription for an antidepressant (ATC-4 code: N06A) in a given calendar year. To zero in on postpartum antidepressant use, we also make use of an additional file compiled for us by Statistics Netherlands that has information about the *months* when each antidepressant prescription was received.

To reliably construct area-level prescribing patterns, we focus on 4-digit postal codes that have inhabitants in every year between 2006 and 2018.[14] We focus on postal codes that have at least one GP practice in all years. The data on the locations of GP practices over 2009–2016 were obtained from Nivel (Netherlands Institute for Health Services Research). In postal codes without a GP practice, people are obviously allowed to see a GP elsewhere, and we do not know their GP's location. Postal codes without GP practices account for 18.76 percent of the person-year observations. There are 2,001 postal codes with a GP practice in all years. These postal codes have a mean population of 7,039 ($10^{th}$ percentile 1,978; median 6,612; $90^{th}$ percentile 12,587).

The area-level prescribing measure is constructed by focusing on new antidepressant prescribing to women aged 46 to 65. We focus on new patients as their experience is more likely to reflect actual current prescribing practices in the postal code rather than capturing people who are taking antidepressants that were perhaps initially prescribed elsewhere. New patients are defined as individuals who did not receive a prescription the year before. Given that the data start in 2006, our measure of new patients can be determined for 2007 to 2018.[15] Using an instrument

[14] We drop 74 postal codes that do not have inhabitants in all years, which results in a loss of 0.12 percent of all person-year observations.

[15] We need to observe an individual in all years to be able to reliably determine whether she is a new antidepressant patient. In practice, we observe 94.4% of women between the ages of 46 to 65 in all years from 2006 to 2018. Some individuals move abroad for one or more years, which means that they are not observed in every year. The measure

based on prescribing to the mothers in our sample (women aged 15 to 45) could raise concerns about reverse causality as the mothers themselves could be asking their doctors for antidepressants; therefore, we focus on women aged 46 to 65. The instrument reflects the proportion of women aged 46 to 65 in each postal code who are new antidepressant patients. The mean value of the instrument at the municipality-year level is 0.020 (which implies that in the mean municipality-year, 20 out of every 1,000 women aged 46 to 65 are using antidepressants). The 10$^{th}$ percentile is 0.011, and the 90$^{th}$ percentile is 0.030.

**Figure 1** shows the variation in the instrument in 2009 and in 2016. There is a great deal of variation within small geographical areas and even within municipalities (municipal boundaries are indicated in black). Note that by excluding the smallest postal codes, we have greatly reduced the amount of variation that is due to small sample sizes. The figure also shows that prescribing intensity has tended to increase over time.

**Table 1** shows the correlation between the instrument (newly prescribed women aged 46 to 65) with a measure of newly prescribed women aged 15 to 45, and with other characteristics of postal codes. Prescribing of antidepressants to women aged 46 to 65 is positively related to prescribing to women aged 15 to 45 (0.3849). The table also shows that prescribing intensity is higher in postal codes with larger populations, lower shares with a Dutch background, larger shares of low-income households, and larger shares of welfare recipients. These characteristics of postal codes are all controlled for in our models, as discussed above.



of new antidepressant patients based on all women aged 46 to 65 who are ever observed, and women aged 46 to 65 whom we observe for all thirteen years have a correlation coefficient of 0.996.

### *4.2 The Sample of Births*

To create the sample of mothers we start with the registry of persons (GBAPERSOONTAB) and use the parent–child register (KINDOUDERTAB) to match children to parents. The variables that are known for all births include parity, whether it is a multiple birth, spacing between siblings, parental age at birth, and parental migration background. The sample is restricted to first births that occurred between January 2008 and before July 2016 (N = 688,343) so that antidepressant use in the 24 months prior to birth and the 30 months after birth can be identified. Births to mothers younger than 15 and older than 45 are dropped (N = 846).

Mothers are assigned to 4-digit postal codes based on the first postal code observed for them in the 24 months prior to giving birth. The house call rule that we exploit is only applicable to new patients at GP practices. The rules allow individuals to move and still stay with their previous GP. We try to take this "stickiness" into account by taking the first postal code that is observed for the woman in the 24 months prior to giving birth. The instrument is measured for this location in the year prior to the childbirth.

The sample is restricted to mothers who were born in the Netherlands whose postal code is observed in the 24 months prior to the birth and whose postal codes are inhabited and have at least one GP practice over the 2009–2016 period.[16] These restrictions leave 468,056 observations. For multiple births, we keep one observation per mother (N = 460,138) because the focus here is on mothers rather than children. Finally, 2.6 percent of mothers are not observed in the income data in the two calendar years before childbirth, the calendar year of childbirth, and the three

[16] We drop 2,478 observations because the postal code is not observed in the 24 months prior to the birth. Restricting to mothers who live in continuously inhabited postal codes with at least one GP practice over the entire period results in a loss of 17.69 percent of births (121,184), leaving 563,835 births. The sample is further restricted to births to mothers who were born in the Netherlands because prescription drug usage and labor market outcomes are more likely to be observed over the complete time period in this sample.

calendar years after childbirth. These mothers are dropped as these women may not have lived in the Netherlands in all years.[17] The final sample consists of 448,226 births.

### *C. Usage of Antidepressants Relative to Childbirth*

To determine the usage of antidepressants relative to childbirth, and particularly after birth, Statistics Netherlands compiled a special prescription drug file for us. This file includes information about all antidepressant prescriptions dispensed at retail pharmacies (ATC-4 category N06A) for 2006 to 2018. The data has a panel structure where t = 0 reflects the birth month of the child. It is then possible to see whether the mother had at least one dispensed prescription for antidepressants in the 24 months before or the 30 months after the birth. The mean number of days between filled prescriptions for antidepressants is 32 days,[18] which implies that antidepressant scripts are usually renewed every three to four weeks.

Women who took antidepressants prior to pregnancy can be distinguished from those who did not. Women who were not taking any antidepressants in the 10 to 24 months preceding childbirth (95.4 percent) are referred to as "never takers"; "ever takers" are women who were dispensed at least one script for antidepressants in this before-birth period (3.1 percent); and "always takers" are women who were dispensed a script for antidepressants in at least seven of the fifteen months before the likely conception (1.5 percent).

**Figure 2a** shows antidepressant usage relative to childbirth for these three groups. The figure shows that antidepressant usage is quite constant in the months prior to the likely conception date (shown by the first vertical red line). It declines when the woman finds out that she is pregnant

[17] If someone was in the Netherlands but did not have income, they would still be entered in this file as a zero-income person.
[18] The median is 23 days. The 10th percentile is seven days (indicating weekly pick-up of antidepressants), and the 90th percentile is 87 days (which would refer to a three-month supply).

(two to three months after the likely conception date) and remains at a lower level throughout the pregnancy. This dip suggests that many women go off antidepressants during pregnancy. The proportion of women receiving antidepressants increases again after childbirth. Usage is highest among always takers, somewhat lower for ever takers, and appears very low for never takers. However, this is partly a matter of scale. **Figure 2b** zooms in on women who did not take antidepressants prior to the likely conception month. In this group, take up rises slightly during pregnancy and then increases sharply after the birth.

This study focuses on these never takers to ensure that we are looking at a comparable group of women when it comes to antidepressant use after pregnancy. This restriction yields a final sample of 427,475 observations. The main treatment measure of postpartum antidepressant use refers to whether the mother received at least one antidepressant script in the 1 to 10 months after giving birth. Of the women in the final sample, 2.5 percent were treated.

**Figure 3a** shows a plot of antidepressant use similar to **Figure 2b** except that women are broken into terciles based on the value of the instrument (local prescribing intensity to women aged 46 to 65 in the year before birth). The figure shows that antidepressant use after childbirth is highest for mothers in the highest tercile (i.e., in areas with a lot of antidepressant prescribing to older women) and is lower for women in the middle and lowest terciles.

These patterns could reflect differences in the types of women who live in the three areas. To rule out this hypothesis, antidepressant use was residualized by controlling for the wide range of individual-level background and postal code-level characteristics discussed above. This residualized antidepressant use is shown in **Figure 3b**. Although the differences between terciles become smaller, they show a very similar pattern. Therefore, these figures suggest that the instrument does predict mothers' antidepressant use after childbirth.

Although **Figure 3** shows that the instrument is predictive, it cannot show that the instrument is valid in the sense that it affects outcomes only through its effects on prescribing for postpartum depression. To further probe this question, **Figure 4** shows a balance check. **Figure 4** demonstrates that once characteristics of postal codes and area-level fixed effects are accounted for, the individual-level characteristics of the mothers in our sample do not predict the instrument.

### *D. Maternal Outcomes*

These data make it possible to ask whether antidepressant use in the 1 to 10 months after birth affects several important maternal outcomes. The first set of outcomes concern subsequent mental health treatment. The main measures here are: antidepressant use 11 to 20 and 21 to 30 months after birth, and spells of specialized mental health care (GGZDBCTRAJECTENBUS) at 1 to 10 months, 11 to 20 months, and 21 to 30 months after the birth. Given that sample births occurred between 2008 and 2016 and the data in this file are available from 2011 to 2016, this outcome is not available for every birth in the sample so the sample size is smaller (maximum number of observations is 254,489) for these outcomes.

The labor market outcomes of the parents come from the Dutch tax authority and are in the personal income files (IPI and INPATAB). These files include a measure of primary annual income, which contains everyone’s gross annual income from employment (including payments received for work done outside the scope of the contract and imputed values for the private use of a car). The files also include a measure of annual income for self-employed individuals. The values of personal primary income for mothers and fathers are calculated for the three years after the birth of the first child, and the measure is corrected for inflation.[19] It is also possible to create a measure for positive income in any year—an individual is assumed to be out of the labor force if income is zero.[20]

To examine effects on family formation, indicators were created by using the address file to see whether children lived with their parents or in the same municipality as their parents in the years after childbirth. It is also possible to ask how antidepressant use influenced subsequent fertility by focusing on the probability of giving birth within 24 months or within 30 months after the first birth.

**Table A1** presents means of all the variables including outcomes, area-level controls, and individual-level controls. Column 1 shows the overall means, while the remaining columns break up the means by terciles of the instrument. The table shows that areas that are in the top tercile of prescribing to women aged 46 to 65 also have more prescribing to new mothers postpartum as well as 11 to 20 months and 21 to 30 months after birth. Women in high-prescribing areas are also more likely to be receiving specialized psychiatric treatment during these time periods. Women in high-prescribing areas are less likely to have a second birth within 30 months and are less likely to have positive income in the three years after birth. Fathers are also less likely have positive income and both mothers and fathers have lower incomes after the birth in the high-prescribing areas. It is also less likely that fathers and children are living at the same address or in the same municipality in the years after the birth.

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[19] Some individuals have incomes less than zero. This is caused by individuals who are self-employed and for whom income is often equal to the profits made by their company (this applies to less than 1 percent of observations). We set these negative values to zero.

[20] Fathers' income in all these years is observed for 94 percent of births, so in the Appendix, where we examine fathers' income as an outcome, the sample size is slightly lower. Information on income is missing if individuals did not report income to the tax authorities each year. Most of these individuals were likely absent from the Netherlands in that year because even zero-income people in the Netherlands report to the tax authorities. Also, for some individuals who receive income from abroad but live in the Netherlands, income is unknown if they do not have to pay Dutch taxes.

However, the individual-level and area-level controls presented in the rest of the table indicate that women in high-prescribing areas are systematically more disadvantaged along every dimension. For example, they are more likely to have children at a young age and less likely to have a Dutch background. Mothers and fathers are also less likely to work and have lower incomes in the two years prior to the birth. The areas they live in also have these characteristics. Therefore, the apparently negative outcomes following postpartum antidepressant prescribing could reflect selection: women who receive prescriptions because they live in high-prescribing areas may be disadvantaged in ways that would themselves predict more negative outcomes.

## V. Results

The first row of **Table 2** shows OLS estimates of the relationship between postpartum antidepressant use, future antidepressant use, and future receipt of specialized mental health care. The estimates all suggest that postpartum antidepressant use has large effects. For example, women who were taking antidepressants in the 1 to 10 months after birth have a 39-percentage-point higher probability of taking them 21 to 30 months after the birth. The first-stage regression is shown in the first column of **Table 2**. The instrument is strongly statistically significant, suggesting that a one standard deviation change in the instrument (0.007)[21] would be associated with a 5.5 percent increase ((0.007 x 0.197)/0.025) in the probability that a new mother receives postpartum antidepressants.

The first-stage F-statistics are larger than ten and thus conform to the rule-of-thumb for ruling out weak instruments. However, recently there have been discussions about the validity of this rule-of-thumb, as inference based on t-ratios may prove unreliable in the case of weak

[21] The mean value of the instrument in our sample is 0.022, with a standard deviation of 0.007.

instruments (e.g., Andrews, Stock, and Sun, 2019; Lee et al. 2021). For this reason, we also report Anderson–Rubin (AR) confidence sets that are robust to weak instruments for just-identified models with a single instrument as recommended by Andrews, Stock, and Sun (2019).[22]

The instrumental variable estimates shown in **Panel A2** of **Table 2** indicate slightly larger effects of postpartum antidepressant use on future antidepressant use—the probability that a mother is still taking antidepressants 11 to 20 months after the birth rises by 60.9 percentage points, and the probability that the mother is still taking them 21 to 30 months after the birth rises by 68.7 percentage points. This estimate implies that a one standard deviation increase in the instrument leads to long-term use of antidepressants that is 3.8 percent higher in the 21 to 30 months after birth (0.687 x 0.055). However, the effects on future use of specialized mental health care are no longer statistically significant.

The remainder of **Table 2** breaks the sample into the top quartile by pre-pregnancy family income (calculated as the sum of paternal and maternal income over the two calendar years prior to the birth year) and the remaining 75 percent. The first stage is stronger in the top quartile than in the rest of the sample as evidenced by both the size of the estimated coefficient and the first-stage F-statistic. For women in the top quartile of the pre-pregnancy income distribution, a one standard deviation increase in the instrument leads to a 18.0 percent increase ((0.007 x 0.334)/0.013) in the probability of receiving antidepressants in the 1 to 10 months after childbirth.

[22] We calculate these Anderson–Rubin (AR) confidence bounds using the Stata implementation by Sun (2018). Lee et al. (2021) suggest an alternative method (the tF method) for correcting the standard errors. However, their power calculations show that the AR method has more power for the range of significant point estimates that we estimate. Keane and Neal (2022) compare conventional t-test critical values with those derived by the AR test and the tF test. They conclude: "The tF test has low power in general, and very little power to detect true negative effects when the OLS bias is positive" (Appendix C, page 48). Overall, their paper concludes: "Thus, we advise using the AR test even if the first-stage F is in the thousands" (page 39).

The instrumental variable estimates of the effects of postpartum antidepressant use on future antidepressant use are quite similar in terms of the point estimates, but the effects of a one standard deviation increase in the instrument on long-term use of antidepressants are about three times larger because of the more predictive first stage. However, the instrumental variables estimate of the effect of postpartum antidepressant on specialized mental health care after birth is still not statistically significant for either group. Because high-income individuals are presumably less affected by deductibles on these services, these results suggest that there really is little effect of postpartum antidepressant use on the use of these services.

**Table 3** shows the estimated effects on maternal labor force outcomes. The OLS estimates suggest that postpartum antidepressant use is strongly associated with reductions in the probability of labor force participation and in lower earnings conditional on being employed. For example, by three calendar years after the birth, the probability of having positive personal income has dropped by 10 percentage points (on a baseline of 90 percent employed), while earnings conditional on employment are down 20 percent. However, when we turn to the instrumental variables estimates, these effects are not statistically significant, except in the first full calendar year after birth. The split by income shows that the negative effects on employment income in the first year are driven by the bottom 75% of the sample and are not observed in the top quartile of the income distribution. Possibly, high-income women with PPD are better able to negotiate accommodations with their employers. In sum, while there is evidence of a short-term effect, there is little evidence that postpartum antidepressant use hurts longer-term maternal employment outcomes.

**Table 4** explores the effects of postpartum antidepressant use on family structure. The OLS estimates suggest that maternal postpartum antidepressant use has modest negative effects on the probability that the father lives at the same address or in the same municipality as the child. There also appears to be a negative effect on the probability of a second birth within 30 months. However, once again, when we instrument for individual postpartum antidepressant use, most of these effects become statistically insignificant, and the effect on whether the father is living with the child generally turn positive. We find no evidence that the effects are different by pre-pregnancy household income levels.

**Tables A2** and **A3** show some additional outcomes: the effects of maternal postpartum antidepressant use on father's employment outcomes and the effects on whether the mother lives with the child. In all cases, the OLS estimates suggest negative impacts, and the IV estimates are statistically insignificant.

In **Table A4** we report additional estimates focusing only on mothers with a Dutch background (about 87 percent of our sample). For the heterogeneity and robustness analyses that follow, the reported coefficients are those for which the IV-estimates are significantly different from zero in the main set of results: that is, subsequent antidepressant usage and whether the mother has positive income after childbirth. The first-stage results are somewhat stronger in the sample of Dutch mothers: a one standard deviation increase in the instrument leads to a 5.8 percent higher probability that the mother uses antidepressants in the 10 months after birth. Also, the IV coefficient on antidepressant use 11–20 months after birth is slightly larger as compared to the baseline estimates.

In the remaining panels of **Table A4**, the sample is split by maternal age at first birth. Panel B focuses on women above the median age (29.4 or older), and Panel C focuses on women of below-median age at birth. The OLS estimates on subsequent antidepressant use are stronger for older mothers as compared to younger mothers. However, this appears to be explained by selection into antidepressant use: the IV-estimates for subsequent antidepressant use are not statistically significant in the sample of older women. The estimated effect of postpartum antidepressant use is large and statistically significant in the sample of younger women. This result suggests that particularly for young women, it may be difficult to stop taking antidepressants after starting to take them postpartum.

Moreover, younger women who take antidepressants are significantly less likely to work in the first calendar year after giving birth, which is about 2.3 times larger than the baseline estimate. However, there are no statistically significant effects in the two to three years after birth, so the impact on employment outcomes for this group appears only in the first year.

So far, we have focused on the sample of women who can be followed for three years after childbirth. It is possible, for a smaller sample of women, to follow outcomes up to five years after birth.[23] **Table A5** shows that in the full sample, the effect of using post-partum antidepressants on future antidepressant use fades out after three years. However, there is considerable heterogeneity by pre-pregnancy household income. Women in the top quartile of pre-birth household income who use antidepressants post-partum are more likely to continue using them up to five years afterwards, whereas women in the lower parts of the household income distribution have significant effects only in the first year. In this smaller sample, we also find that women who use antidepressants postpartum are less likely to have positive income in the year after birth, just as in our baseline estimates. Once again, there are no significant labor supply effects among women in higher-income households, but there is a negative and significant effect on labor supply for women in lower-income households in the calendar year after childbirth. There were no statistically

[23] Births in 2016 are excluded from this five-year analysis because we cannot yet follow the mothers for five years. Given that data on monthly antidepressant use is not available to us after 2018, we focus on antidepressant use in the one to five calendar years after childbirth in these analyses.

significant effects of postpartum antidepressant use on other maternal outcomes in this smaller sample. These results are available on request.

**Table 5** presents some additional robustness checks. The first panels focus on areas with three or fewer GP practices. In these areas, a mother is likely to be more constrained in her choice of provider, so the instrument may be more predictive.[24] Table 5 shows the first stage and two outcomes: subsequent antidepressant usage and whether the mother has any positive income. As predicted, the first-stage results and the estimated effects on subsequent antidepressant use are larger in these 1,548 postal codes than in the full sample. The effect on maternal employment, however, is not statistically significant, even in the first year after the birth (unlike in **Table 3**).

We have also estimated models that split this subsample (results available on request). In these models, the effects of postpartum antidepressant use on future antidepressant use are statistically significant for both women in the top quartile of income and in the lower quartiles, but the effects on employment in the first year after birth are not significant for either group.

Panel B of **Table 5** shows the results when focusing on more rural areas. Individuals in these areas have access to 1.9 GP practices on average; thus, GP choice may be even more restricted than when focusing on areas with three or fewer GP practices. Accordingly, the first stage for this subsample is even more predictive than in Panel A. The estimated effects on subsequent antidepressant use are also larger in this subsample. However, no significant effects on positive income in the calendar years after childbirth are found. The models were also estimated focusing on only the most urban areas, but the first stage is not predictive in this subsample (results available on request).

[24] The mothers in our sample have an average of 2.9 GP practices in their postal codes over the 2009 to 2016 period.

The third panel of **Table 5** provides a robustness check including both first and second births, which yields a larger sample of more than 760,000 births. The estimates from this larger sample are similar to the baseline estimates, confirming that women who are prescribed antidepressants because they live in a high-prescribing area are more likely to be using them up to three years after the birth and are less likely to be employed in the calendar year after birth.[25]

We have also estimated models interacting the postal code–level controls with linear time trends and with year of childbirth fixed effects to allow the effects of local-area variables to change over time. **Table A6a** shows that the point estimates are very similar when adding interactions between the area-level controls and linear time trends. The main change is that postpartum depression use now predicts antidepressant use in both higher- and lower-income samples. **Table A6b** shows what happens when the area-level controls are interacted with year of childbirth fixed effects. The estimates are again very similar to our baseline results, although the effect on employment (having positive income) in the year after childbirth becomes insignificant.

Finally, it is possible that our measure of prescribing intensity reflects not only a higher propensity to prescribe antidepressants, but also a higher propensity to prescribe other drugs that could affect a mother's outcomes. **Table A7** shows first-stage regressions of post-partum opioid use and antibiotic use on the measure of antidepressant prescribing propensities. We chose to examine opioids, because opioid use is thought to have potentially profound effects on an individual's labor market outcomes. Moreover, while opioids are prescribed at lower levels in the Netherlands than in the United States, prescription rates are increasing and are of concern (Ho 2019). We chose to examine antibiotics because they are very frequently prescribed (31.1 percent of mothers received a prescription in the year after birth) and infection is a common complication

[25] The estimate is not statistically significant using conventional t-inference but is significant using the AR confidence interval.

of pregnancy. **Table A7** shows that neither type of prescribing is significantly related to the local propensity to prescribe antidepressants.

## VI. Discussion and Conclusions

Women treated with antidepressants postpartum have different outcomes than other new mothers in many respects. In OLS regressions they are estimated to be more likely to remain on antidepressants after several years and are more likely to be treated by specialists for acute mental health problems. They are also less likely to return to work and earn less money conditional on working. Their children are less likely to be living with their fathers or even to be living in the same municipality as their fathers. Finally, these mothers are less likely to have a second birth within 30 months of a first birth.

Taken at face value, these estimates might suggest that treating new mothers with antidepressants has very negative effects on their future outcomes. However, clearly, most people treated with antidepressants are depressed and that is predictive of negative outcomes. What is needed is an examination of similar women who are treated differently with respect to being prescribed antidepressants. The instrumental variables strategy proposed here builds on the growing literature showing that similar people who live in different places often receive different treatments because of the propensities of local providers to prefer one treatment or another (Fisher et al. 2003a,b; Chandra and Staiger 2007; Finkelstein, Gentzkow, and Williams 2015; Currie and MacLeod 2017, 2020; Cutler et al. 2019; Cuddy and Currie 2020).

The instrumental variables estimates focus on women who receive antidepressants because they live in a high-prescribing area, but who would not have received them if they lived in a low-prescribing area. This group can be considered marginal for antidepressant treatment—some providers would advocate it while others would not.

In this group of women, postpartum antidepressant treatment is shown to increase the probability that a woman is taking antidepressants up to five years later. This effect is concentrated among women who were in the top quartile of the family income distribution before the birth. This observation is consistent with a growing literature showing that it can be very difficult for patients to stop taking antidepressants, with some patients experiencing extended withdrawal symptoms that may mimic relapse into depression (Davies and Read 2019). Because antidepressants do have side effects (such as weight gain and increases in blood sugar), long-term use is not costless. Postpartum antidepressant treatment also predicts that a woman will be less likely to work in the year following the birth. This effect is concentrated in the lower quartiles of the income distribution. Losing a year of employment is also costly, though we do not find effects on future employment probabilities or wages.

Hence, the instrumental variables estimates still suggest that postpartum antidepressant use has negative effects on these marginal women, but the effects are much attenuated relative to those seen in OLS models.

It is important to note that these IV estimates cannot be used to infer anything about the effects of prescribing on patients who are so severely depressed that they would likely be treated with antidepressants in any neighborhood. However, our estimates can shed light on the question of whether doctors should be more or less likely to prescribe to the marginal patient (i.e., someone for whom the decision could go either way).

Our work contributes to a small but growing literature about the effects of treating the marginal patient. Bos, Hertzberg, and Liberman (2021) argue that the marginal young male patient diagnosed with a mental illness in Sweden is harmed by being diagnosed with that illness. In a different context, Alalouf, Miller, and Wherry (2019) find that the marginal diabetes patient spends more money and obtains more treatment but is not in measurably better health six years after a diagnosis. Persson, Qiu, and Rossin-Slater (2021) find that marginal diagnoses also have spillovers onto other family members, increasing *their* probability of being diagnosed with an illness.

Finally, our work adds to the small literature about the effects of treatment for PPD on the women themselves. As discussed above and reflected in our OLS estimates, PPD is associated with a wide range of negative outcomes including future mental illness, lower wages, detachment from the labor force, and family instability. These associations suggest that effective treatment for PPD should improve outcomes. In the set of women who may be considered borderline for treatment, we find no evidence that treatment with antidepressants produces a benefit. While much more research on this topic is necessary, our results suggest that treatment with antidepressants should be reserved for more serious cases.

It is difficult to extrapolate these results to other health care settings, such as the United States. Given that a much higher fraction of U.S. women is treated for postpartum depression, it seems likely that the marginal U.S. woman treated is even less likely to see a benefit and that stricter guidelines for the prescription of antidepressant drugs could be beneficial.

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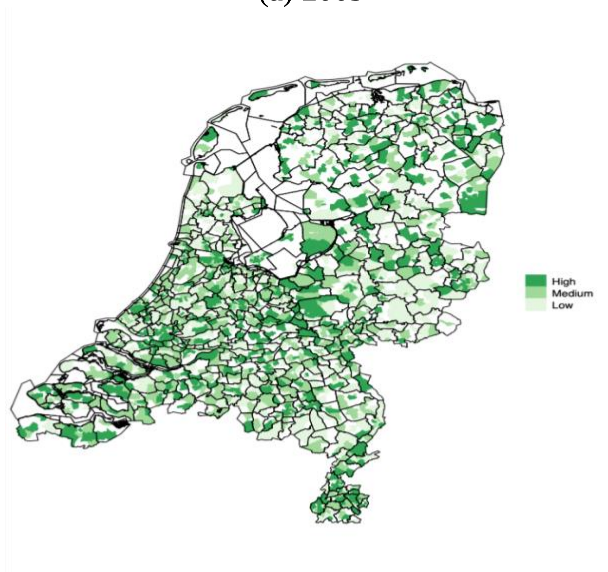
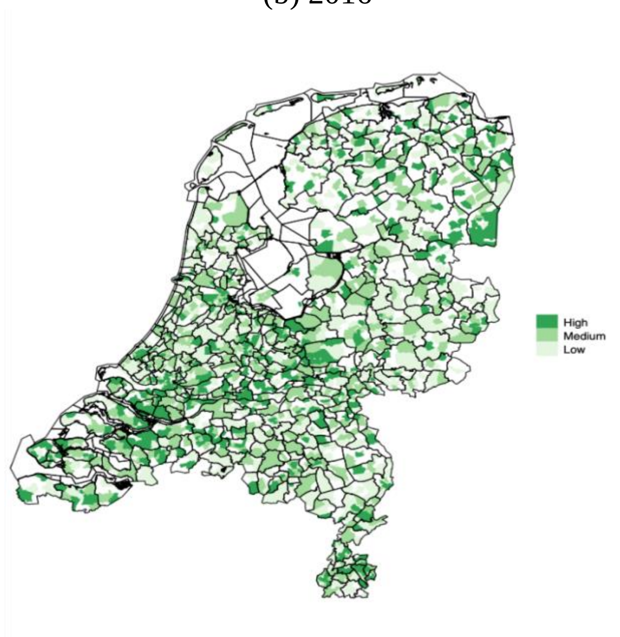
**Figure 1** *Geographic Variation in New Uses of Antidepressants for Women Aged 46-65, per 1000, the Netherlands, 2009 and 2016*

(a) 2009



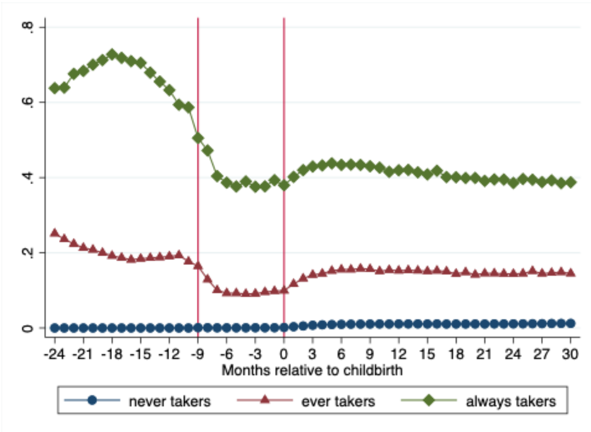

(b) 2016



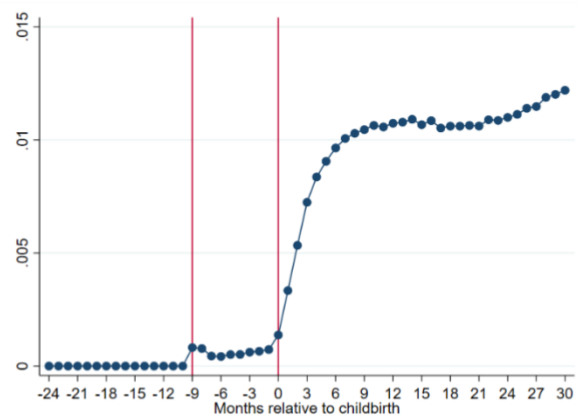

Notes: The maps plot the number of new antidepressant patients among women aged 46–65 in each 4-digit postal code (2,001) that has inhabitants in all years 2006 to 2018 and that has at least one GP practice in all years 2009–2016. Prescribing measure plotted for 2009 and 2016 and postal codes are split in terciles of this measure of prescribing intensity. The black lines on the maps show the 2016 municipality boundaries.

**Figure 2** *Antidepressant Usage Relative to Childbirth*

(a) By antidepressant use before birth



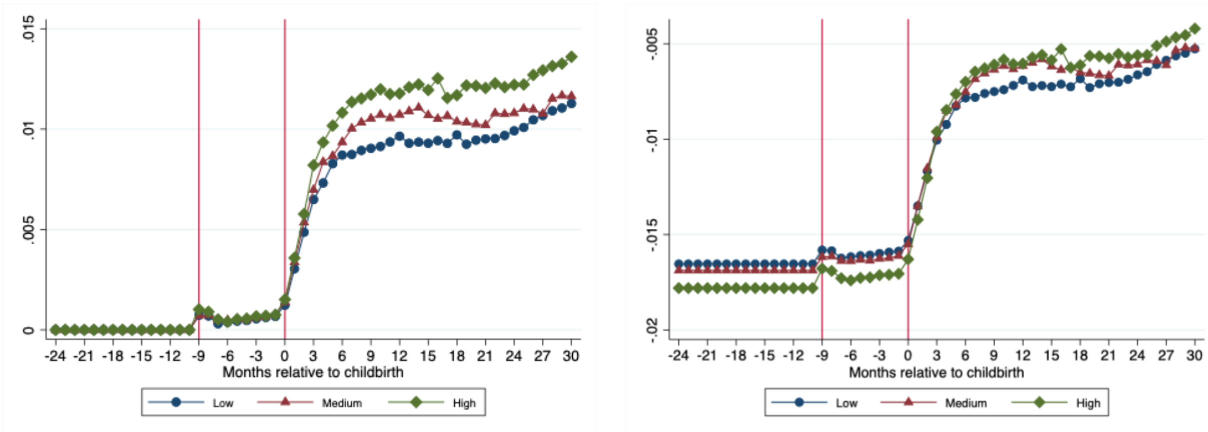

(b) No use before birth




Notes: Panel (a) is based on the sample of first births (N = 448,226) and splits the sample into no use before birth (no prescriptions in the 10–24 months prior to childbirth), "ever takers" (those with at least one prescription in the 10–24 months prior to childbirth, and "always takers" (those with prescriptions in more than 50% of the 10–24 months prior to childbirth). Panel (b) focuses on those with no use before birth (N = 427,475).

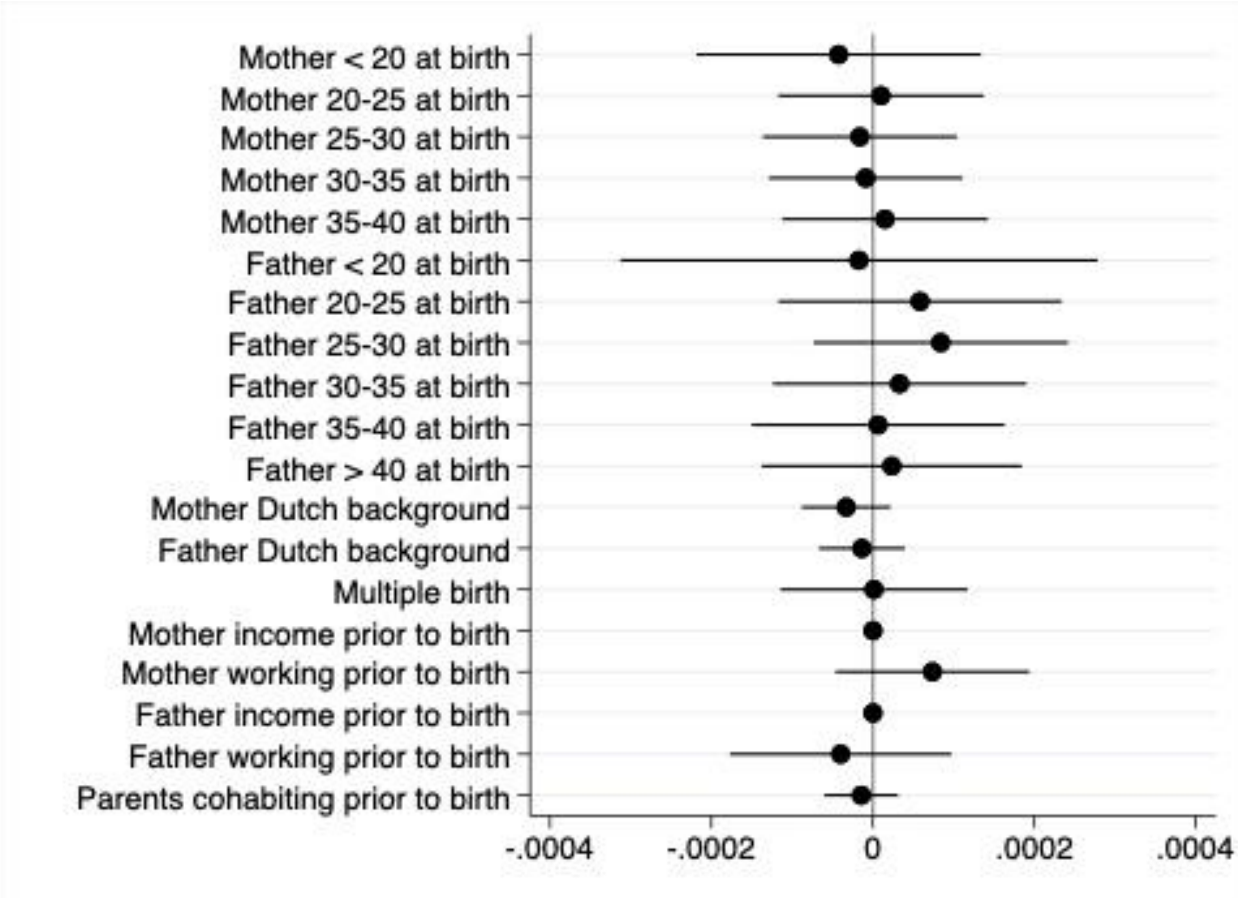
**Figure 3** *Antidepressant Usage by Area-Level Prescribing Intensity*

(a) Raw data (b) Residualized data




Notes: Panel (a) reports the proportion of individuals dispensing a script for antidepressants at a pharmacy in each month relative to childbirth for first births and never users (N = 427,475). It splits the sample into three groups depending on terciles of the instrument—new antidepressant patients in the woman's postal code of residence in the year prior to giving birth (our instrument). Panel (b) plots residualized antidepressant use after controlling for the wide range of individual-level characteristics and postal code–level characteristics as mentioned in the empirical strategy.

**Figure 4** *Balance Check: Do Individual Characteristics Predict the Instrument?*




Notes: This figure plots the coefficients and 95 percent confidence intervals from a balance check in which we regress the value of the instrument for everyone (N = 427,475) on their individual-level characteristics (plotted), and include year of birth fixed effects, the 4 digit postal code level controls, and (481) area-level fixed effects. Standard errors are clustered at the area level.

**Table 1** *Correlates of Instrument With Postal Code Characteristics, 2016*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| (1) New female patients aged 46–65 | 1.0000 | | | | | | |
| (2) New female patients aged 15–45 | 0.3849 | 1.0000 | | | | | |
| (3) % population Dutch | -0.3532 | -0.1347 | 1.0000 | | | | |
| (4) % low income HHs | 0.4023 | 0.3175 | -0.6113 | 1.0000 | | | |
| (5) % welfare recipients | 0.4206 | 0.3990 | -0.6020 | 0.8207 | 1.0000 | | |
| (6) Number of GP practices | 0.0873 | 0.0310 | -0.3076 | 0.2461 | 0.1821 | 1.0000 | |
| (7) Total population | 0.1457 | 0.0386 | -0.4584 | 0.2372 | 0.2335 | 0.5878 | 1.0000 |

Notes: The measures of new antidepressant patients and total population at the 4-digit postal code level are calculated by the authors, and the measures for 2016 are used to calculate the correlations. The postal code characteristics (apart from mean number of GP practices) come from Statistics Netherlands (in Dutch: *Kerncijfers per postcode*) and are shown for 2016. The mean number of GP practices in each postal code is calculated over the 2009–2016 period using data obtained from NIVEL – Netherlands Institute for Health Services Research.

**Table 2** *First Stage, Subsequent Antidepressant Use and Future Specialized Mental Health Care*

| | Antidepressant use | | | Specialized mental health care | | |
|---|---|---|---|---|---|---|
| | Mo 1 to 10 | Mo 11 to 20 | Mo 21 to 30 | Mo 1 to 10 | Mo 11 to 20 | Mo 21 to 30 |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **Panel A1: OLS** | | | | | | |
| AD 1–10 mo after birth | | 0.573** | 0.390** | 0.401** | 0.363** | 0.279** |
| | | (0.005) | (0.005) | (0.008) | (0.008) | (0.008) |
| **Panel A2: 2SLS** | | | | | | |
| New patients aged 46–65 | 0.197** | | | | | |
| | (0.050) | | | | | |
| AD 1–10 mo. after birth | | 0.609** | 0.687** | 0.064 | -0.005 | 0.193 |
| | | (0.218) | (0.248) | (0.332) | (0.342) | (0.401) |
| Weak IV 95% AR confidence set | | [0.111; 1.063] | [0.221; 1.299] | [-0.692; 0.689] | [-0.919; 0.637] | [-0.800; 1.107] |
| Mean outcome | 0.025 | 0.028 | 0.030 | 0.045 | 0.044 | 0.043 |
| F-statistic 1st stage | 15.23 | 15.23 | 15.23 | 16.28 | 13.23 | 10.74 |
| Observations | 427,475 | 427,475 | 427,475 | 254,489 | 214,617 | 174,249 |
| **Panel B1: OLS Top 25% income** | | | | | | |
| AD 1–10 mo. after birth | | 0.612** | 0.421** | 0.438** | 0.348** | 0.250** |
| | | (0.013) | (0.013) | (0.017) | (0.018) | (0.018) |
| **Panel B2: 2SLS Top 25% income** | | | | | | |
| New patients aged 46–65 | 0.334** | | | | | |
| | (0.071) | | | | | |
| AD 1–10 mo. after birth | | 0.612** | 0.560* | 0.095 | 0.245 | 0.661 |
| | | (0.164) | (0.221) | (0.405) | (0.422) | (0.406) |
| Weak IV 95% AR confidence set | | [0.272; 0.953] | [0.145; 1.018] | [-0.908; 0.937] | [-1.051; 1.123] | [-0.022; 1.825] |
| Mean outcome | 0.013 | 0.014 | 0.016 | 0.028 | 0.026 | 0.026 |
| F-statistic 1st stage | 21.88 | 21.88 | 21.88 | 11.86 | 8.33 | 12.68 |
| Observations | 106,868 | 106,868 | 106,868 | 72,432 | 59,442 | 46,670 |
| **Panel C1: OLS Bottom 75% income** | | | | | | |
| AD 1–0 mo. after birth | | 0.566** | 0.385** | 0.393** | 0.365** | 0.283** |
| | | (0.006) | (0.006) | (0.008) | (0.009) | (0.009) |
| **Panel C2: 2SLS Bottom 75% income** | | | | | | |
| New patients aged 46–65 | 0.162** | | | | | |
| | (0.060) | | | | | |
| AD 1–10 mo. after birth | | 0.646 | 0.750* | 0.063 | -0.088 | -0.039 |
| | | (0.334) | (0.371) | (0.472) | (0.459) | (0.612) |
| Weak IV 95% AR confidence set | | [-0.314; 1.540] | [0.052; 2.256] | [-1.291; 1.137] | [-1.680 0.867] | [-4.703; 1.475] |
| Mean outcome | 0.029 | 0.033 | 0.035 | 0.051 | 0.050 | 0.049 |
| F-statistic 1st stage | 7.16 | 7.16 | 7.16 | 8.23 | 7.42 | 4.74 |
| Observations | 320,607 | 320,607 | 320,607 | 182,057 | 155,175 | 127,579 |

Notes: Panels B and C split the sample by household income (mean of the sum of maternal and paternal income in the two years prior to first birth). The antidepressant use dummies for month 1 to 10, 11 to 20, and 21 to 30 are equal to one if the woman was dispensed at least one script for antidepressants in these months. Specialized mental health care is a dummy variable for receipt of such care in the 1 to 10, 11 to 20, or 21 to 30 months after giving birth. All specifications contain area-level fixed effects, year of birth fixed effects, individual controls, and postal code–level controls. Robust standard errors are clustered at the area level and are shown in parentheses. ** $p < 0.01$, * $p < 0.05$.

**Table 3** *Labor Market Outcomes for Mothers After Birth*

| | Positive income | | | Log earnings | | |
|---|---|---|---|---|---|---|
| | Y1 | Y2 | Y3 | Y1 | Y2 | Y3 |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **Panel A1: OLS** | | | | | | |
| AD 1–10 mo, after birth | -0.092** | -0.101** | -0.104** | -0.141** | -0.159** | -0.205** |
| | (0.004) | (0.004) | (0.004) | (0.012) | (0.011) | (0.011) |
| **Panel A2: 2SLS** | | | | | | |
| AD 1–10 mo. after birth | -0.821* | -0.089 | -0.021 | 1.042 | 0.305 | -0.416 |
| | (0.406) | (0.420) | (0.405) | (1.213) | (1.331) | (1.329) |
| Weak IV 95% AR confidence set | [-1.907; -0.137] | [-0.962; 0.868] | [-0.862; 0.901] | [-1.238; 4.283] | [-2.462; 3.337] | [-3.179; 2.347] |
| Mean outcome | 0.910 | 0.905 | 0.900 | €30,590 | €31,947 | €33,457 |
| F-statistic 1st stage | 15.23 | 15.23 | 15.23 | 13.09 | 13.72 | 16.93 |
| Observations | 427,475 | 427,475 | 427,475 | 386,973 | 384,930 | 382,611 |
| **Panel B1: OLS Top 25% income** | | | | | | |
| AD 1–10 mo. after birth | -0.028** | -0.034** | -0.045** | -0.063** | -0.094** | -0.146** |
| | (0.006) | (0.007) | (0.008) | (0.022) | (0.019) | (0.023) |
| **Panel B2: 2SLS Top 25% income** | | | | | | |
| AD 1–10 mo. after birth | -0.179 | 0.329 | 0.021 | 0.172 | -0.388 | 0.687 |
| | (0.269) | (0.321) | (0.303) | (1.062) | (1.213) | (1.554) |
| Weak IV 95% AR confidence set | [-0.791; 0.327] | [-0.276; 0.997] | [-0.609; 0.591] | [-1.825; 2.591] | [-2.910; 2.374] | [-2.236; 4.533] |
| Mean outcome | 0.978 | 0.972 | 0.968 | €48,670 | €50,504 | €52,673 |
| F-statistic 1$^{st}$ stage | 21.88 | 21.88 | 21.88 | 18.89 | 16.39 | 14.11 |
| Observations | 106,868 | 106,868 | 106,868 | 104,146 | 103,464 | 102,926 |
| **Panel C1: OLS Bottom 75% income** | | | | | | |
| AD 1–10 mo. after birth | -0.096** | -0.106** | -0.107** | -0.131** | -0.151** | -0.195** |
| | (0.004) | (0.004) | (0.004) | (0.012) | (0.013) | (0.013) |
| **Panel C2: 2SLS Bottom 75% income** | | | | | | |
| AD 1–10 mo. after birth | -1.331* | -0.473 | -0.196 | 0.229 | -0.321 | -1.921 |
| | (0.665) | (0.599) | (0.599) | (1.837) | (1.845) | (1.774) |
| Weak IV 95% AR confidence set | [-4.557; -0.344] | [-2.428; 0.890] | [-1.915; 1.403] | [-5.773; 6.594] | [-6.348; 4.245] | [-7.363; 1.415] |
| Mean outcome | 0.887 | 0.883 | 0.878 | €23,933 | €25,125 | €26,385 |
| F-statistic 1$^{st}$ stage | 7.16 | 7.16 | 7.16 | 5.64 | 6.84 | 9.71 |
| Observations | 320,607 | 320,607 | 320,607 | 282,827 | 281,466 | 279,685 |

Notes: Panels B and C split the sample by household income (mean of the sum of maternal and paternal income in the two years prior to first birth). Positive income is a dummy variable and indicates that an individual had income greater than zero in the full calendar years after the birth year (Y1–Y3). Log earnings conditional on employment (after an inflation correction) is also reported for the three years after the birth year (Y1–Y3). All specifications include area-level fixed effects, year of birth fixed effects, individual controls, and postal code–level controls. Robust standard errors are clustered at the area level and are shown in parentheses. ** $p < 0.01$, * $p < 0.05$.

**Table 4** *Family Formation*

| | Father lives at same address | | | Father lives in same muni | | | 2nd birth |
|---|---|---|---|---|---|---|---|
| | Y1 | Y2 | Y3 | Y1 | Y2 | Y3 | <30 mo |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| **Panel A1: OLS** | | | | | | | |
| AD 1–10 mo. after birth | -0.019** | -0.033** | -0.042** | -0.011** | -0.018** | -0.021** | -0.137** |
| | (0.003) | (0.003) | (0.003) | (0.002) | (0.002) | (0.003) | (0.004) |
| **Panel A2: 2SLS** | | | | | | | |
| AD 1–10 mo. after birth | 0.148 | 0.309 | 0.512 | 0.201 | 0.086 | 0.174 | -0.256 |
| | (0.307) | (0.351) | (0.382) | (0.270) | (0.270) | (0.305) | (0.752) |
| Weak IV 95% AR confidence set | [-0.428; 0.907] | [-0.351; 1.246] | [-0.131; 1.608] | [-0.308; 0.869] | [-0.475; 0.702] | [-0.400; 0.930] | [-1.819; 1.456] |
| Mean outcome | 0.906 | 0.896 | 0.884 | 0.934 | 0.928 | 0.922 | 0.393 |
| F-statistic 1st stage | 15.23 | 15.23 | 15.23 | 15.23 | 15.23 | 15.23 | 15.23 |
| Observations | 427,475 | 427,475 | 427,475 | 427,475 | 427,475 | 427,475 | 427,475 |
| **Panel B1: OLS Top 25% income** | | | | | | | |
| AD 1–10 mo. after birth | -0.014** | -0.025** | -0.036** | -0.003 | -0.012* | -0.019** | -0.205** |
| | (0.005) | (0.006) | (0.007) | (0.004) | (0.005) | (0.005) | (0.012) |
| **Panel B2: 2SLS Top 25% income** | | | | | | | |
| AD 1–10 mo. after birth | 0.205 | 0.094 | 0.331 | 0.443 | 0.151 | 0.383 | -1.143 |
| | (0.293) | (0.270) | (0.321) | (0.257) | (0.218) | (0.255) | (0.926) |
| Weak IV 95% AR confidence set | [-0.346; 0.871] | [-0.468; 0.656] | [-0.273; 1.063] | [0.010; 1.079] | [-0.258; 0.647] | [-0.045; 1.013] | [-3.435; 0.415] |
| Mean outcome | 0.969 | 0.969 | 0.964 | 0.982 | 0.981 | 0.979 | 0.477 |
| F-statistic 1st stage | 21.88 | 21.88 | 21.88 | 21.88 | 21.88 | 21.88 | 21.88 |
| Observations | 106,868 | 106,868 | 106,868 | 106,868 | 106,868 | 106,868 | 106,868 |
| **Panel C1: OLS Bottom 75% income** | | | | | | | |
| AD 1–10 mo. after birth | -0.018** | -0.032** | -0.041** | -0.011** | -0.018** | -0.019** | -0.123** |
| | (0.003) | (0.004) | (0.004) | (0.003) | (0.003) | (0.003) | (0.005) |
| **Panel C2: 2SLS Bottom 75% income** | | | | | | | |
| AD 1–10 mo. after birth | -0.022 | 0.252 | 0.405 | -0.023 | -0.064 | -0.090 | -0.108 |
| | (0.444) | (0.527) | (0.562) | (0.391) | (0.411) | (0.457) | (1.036) |
| Weak IV 95% AR confidence set | [-1.209; 1.252] | [-0.843; 2.181] | [-0.652; 2.797] | [-1.068; 1.100] | [-1.244; 1.035] | [-1.401; 1.131] | [-2.671; 3.274] |
| Mean outcome | 0.884 | 0.872 | 0.857 | 0.918 | 0.911 | 0.903 | 0.365 |
| F-statistic 1st stage | 7.16 | 7.16 | 7.16 | 7.16 | 7.16 | 7.16 | 7.16 |
| Observations | 320,607 | 320,607 | 320,607 | 320,607 | 320,607 | 320,607 | 320,607 |

Notes: Panels B and C split the sample by household income (mean of the sum of maternal and paternal income in the two years prior to the first birth). In the first three columns the outcome variable is equal to one when the father and the child live at the same address. In columns 4 to 6 the outcome variable is equal to one if the father and child live in the same municipality. Column 7 is a dummy variable that is equal to one if the mother had a second child within 30 months. All specifications include area-level fixed effects, year of birth fixed effects, individual controls, and postal code–level controls. Robust standard errors are clustered at the area level and shown in in parentheses. ** $p < 0.01$, * $p < 0.05$.

**Table 5** *Robustness Results: First Stage, Antidepressant Use and Mother's Labor Market Outcomes*

| | Antidepressant use | | | Mother Positive Income | | |
|---|---|---|---|---|---|---|
| | Mo. 1–10 | Mo. 11–20 | Mo. 21–30 | Y1 | Y2 | Y3 |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **Panel A1: OLS – Postal codes with 3 or fewer GP practices** | | | | | | |
| AD 1–10 mo. after birth | | 0.577** | 0.388** | -0.090** | -0.098** | -0.101** |
| | | (0.006) | (0.006) | (0.005) | (0.005) | (0.005) |
| **Panel A2: 2SLS – Postal codes with 3 or fewer GP practices** | | | | | | |
| New patients aged 46–65 | 0.265** | | | | | |
| | (0.059) | | | | | |
| AD 1–10 mos after birth | | 0.694** | 0.712** | -0.501 | 0.122 | 0.204 |
| | | (0.192) | (0.216) | (0.325) | (0.364) | (0.351) |
| Weak IV 95% AR confidence set | | [0.296; 1.093] | [0.306; 1.247] | [-1.241; 0.110] | [-0.563; 0.950] | [-0.457; 1.003] |
| Mean outcome | 0.025 | 0.028 | 0.030 | 0.911 | 0.907 | 0.901 |
| F-statistic 1st stage | 20.29 | 20.29 | 20.29 | 20.29 | 20.29 | 20.29 |
| Observations | 275,160 | 275,160 | 275,160 | 275,160 | 275,160 | 275,160 |
| **Panel B1: OLS – Rural areas** | | | | | | |
| AD 1–10 mo. after birth | | 0.565** | 0.381** | -0.067** | -0.073** | -0.089** |
| | | (0.010) | (0.009) | (0.007) | (0.007) | (0.007) |
| **Panel B2: 2SLS – Rural areas** | | | | | | |
| New patients aged 46–65 | 0.314** | | | | | |
| | (0.087) | | | | | |
| AD 1–10 mo. after birth | | 0.776** | 1.025** | -0.712 | -0.791 | -0.711 |
| | | (0.231) | (0.300) | (0.419) | (0.479) | (0.458) |
| Weak IV 95% AR confidence set | | [0.343; 1.393] | [0.520; 1.945] | [-2.000; -0.007] | [-2.262; 0.016] | [-2.115; 0.059] |
| Mean outcome | 0.024 | 0.027 | 0.029 | 0.927 | 0.922 | 0.915 |
| F-statistic 1$^{st}$ stage | 13.12 | 13.12 | 13.12 | 13.12 | 13.12 | 13.12 |
| Observations | 110,809 | 110,809 | 110,809 | 110,809 | 110,809 | 110,809 |
| **Panel C1: OLS – First and second births** | | | | | | |
| | | 0.576** | 0.404** | -0.082** | -0.092** | -0.098** |
| | | (0.004) | (0.004) | (0.003) | (0.003) | (0.003) |
| **Panel C2: 2SLS – First and second births** | | | | | | |
| New patients aged 46–65 | 0.165** | | | | | |
| | (0.036) | | | | | |
| AD 1–10 mo. after birth | | 0.577** | 0.686** | -0.713 | -0.169 | -0.210 |
| | | (0.188) | (0.239) | (0.376) | (0.365) | (0.351) |
| Weak IV 95% AR confidence set | | [0.187; 0.967] | [0.236; 1.230] | [-1.643; -0.006] | [-0.927; 0.589] | [-0.940; 0.450] |
| Mean outcome | 0.025 | 0.029 | 0.033 | 0.901 | 0.898 | 0.893 |
| F-statistic 1$^{st}$ stage | 20.95 | 20.95 | 20.95 | 20.95 | 20.95 | 20.95 |
| Observations | 768,740 | 768,740 | 768,740 | 768,740 | 768,740 | 768,740 |

Notes: Panel A focuses on 1,548 postal codes with three or fewer GP practices. Panel B focuses on rural areas (urbanicity categories four and five). Panel C includes both first and second births. The antidepressant use dummies for month 1 to 10, 11 to 20, and 21 to 30 are one if the woman was dispensed at least one antidepressant script in these months. Positive income is a dummy and indicates that an individual had income greater than zero in the full calendar years after birth (Y1–Y3). All specifications include area-level (municipality) fixed effects, individual controls. and postal code–level controls. Robust standard errors are clustered at the area level and shown in parentheses. ** $p < 0.01$, * $p < 0.05$.