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ABSTRACT

The Intergenerational Transmission of Opioid Dependence: Evidence from Administrative Data*

To address the opioid crisis, it is crucial to understand its origins. We provide evidence for the intergenerational transmission of opioid dependence. Our analysis is based on administrative data covering the universe of Austrian births from 1984 to 1990. We consider prescription opioids and have a close proxy for addiction to illicit opioids. We find that, if at least one parent is using illicit opioids, the likelihood of the child using increases from 1.1 to 6.1%. For prescription opioids, we observe an increase from 4.6 to 7.7%. Both associations are stable and do not change when controlling for environmental variables.

JEL Classification: I12, I14, I18, J62

Keywords: opioids, prescription opioids, illicit opioids, heroin, addiction, drug abuse, intergenerational transmission, intergenerational correlation

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I. Introduction

Opioid dependence, misuse, and overdoses are serious public health problems faced by many countries. Particularly in the United States (US) and in Canada the use of opioids has surged since the late 1990s. This trend is observed for both illicit opioids, such as heroin or fentanyl, and prescription opioids. Today, both countries are in the midst of a devastating opioid epidemic.[1] Some observers are worried that this epidemic could turn into a worldwide pandemic.[2] In Europe, overdose deaths have recently began to increase again too. Especially the emergence of potent synthetic opioids is alarming (EMCDDA 2017). To address this crisis, it is crucial to understand the origins of opioid dependence.

Opioid dependence not only has a negative impact on the addict, but harms entire families. Children are particularly vulnerable. The incidence of neonatal abstinence syndrome, a condition that occurs if babies are exposed to opioids in utero, has increased almost 4-fold between 2004 and 2013 (Tolia et al. 2015). These babies experience severe withdrawal symptoms up to six months after birth (McQueen & Murphy-Oikonen 2016) and are more likely to have adverse outcomes in later life (Maguire et al. 2016). Children exposed to parental opioid dependence postnatally face obstacles as well. They are more likely to grow up in an unstable environment with economic and emotional challenges, such as secrecy, loss, conflict, violence, and fear (Nunes et al. 2000). These childhood experiences are associated with severe limitations in economic and social functioning in later life. These factors may increase the likelihood of children's own substance abuse. Thus, the family is potentially an important factor in explaining opioid addiction.

This presumption is in line with a vast literature on substance abuse which concludes that addiction is often transmitted from parents to children. However, very little is known about the case of opioids. We fill this gap by providing credible estimates of the intergenerational transmission of opioid dependence. We use administrative data from Austria, which combines several useful features. First, while Austria does not experience a opioid crisis comparable to the US, opioid use is very high. Austria ranks fourth in per capita opioid prescriptions among OECD countries (see Appendix Figure A.1). Second, we can track the vast majority of opioid users in statutory health insurance data and do not have to rely on survey measures. Third, we are not only able to identify the users of prescription opioids, but we can also observe former and current users of illicit opioids, such as heroin. As in most other European countries, heroin addicts are institutionalized in opioid substitution therapy. The state-of-the-art treatment replaces

[1] In 2018, the *Centers for Disease Control and Prevention* recorded 67,367 drug overdose deaths in the US, 69 percent of which are due to opioids (Wilson 2020). At their peak in 2017, opioid overdose deaths were six times higher than in 1999, and have overtaken homicides, suicides, and vehicle accidents as the leading cause of death among Americans below the age of 50 (CDC 2017). Initially, opioid abuse was concentrated in low-income urban areas. Over time, the socio-demographic structure of the epidemic has changed, and opioid addiction has shifted to more affluent suburban and rural areas with primarily white populations (Cicero et al. 2014). Estimates for the total economic burden of prescription opioid abuse alone range up to $78.5 billion per year, including the costs of healthcare and addiction treatment, lost productivity and taxes, as well as law enforcement expenses (Florence et al. 2016).

[2] See, for example, https://news.un.org/en/story/2019/06/1041341 (accessed June 16, 2020).

fast-acting street opioids with slow-acting ones, such as methadone. The primary objective of substitution therapy is harm reduction, by providing patients with stable doses of these drugs. In Austria, substitution is an outpatient therapy fully funded by statutory health insurance, hence the vast majority of heroin users join the program eventually to secure a constant supply of opioids. This provides us with a close proxy for (past) heroin addiction. Fourth, we are able to link licit and illicit opioids use across generations. Fifth, extensive information on the family environment allows us to test the degree to which the intergenerational transmission of opioid dependence is correlated with these and other known determinants of opioid addiction.

We find that the intergenerational transmission of using illicit opioids is 0.057. This suggests that, if at least one parent is addicted, the likelihood of the child being addicted increases from 1.1 percent to 6.8 percent. For prescription opioids, the intergenerational transmission is slightly lower. It amounts to an increase from 4.6 percent to 7.4 percent. Both associations are precisely estimated (p-value < 0.001) and remarkably robust to controlling for socioeconomic background and economic conditions. While we are not able to quantify the relative contribution of nature (inherited genes) and nurture (upbringing), we can show that the intergenerational link is not correlated with observable characteristics of the child's environment inside and outside the family. The inclusion of detailed covariates (such as child's birth weight or mother's education) does not alter these estimates.

Our results contribute to the literature in two main ways. *First* and foremost, we provide credible estimates of the intergenerational transmission of opioid dependence, with separate estimates for heroin and prescription opioids. While it is widely acknowledged in the literature on substance abuse that problems with addiction tend to run in families,[3] very little is known about the case of opioids. A plausible explanation for this gap in the literature is the high data requirements. One not only needs to observe the consumption of prescription opioids or illicit opioids on an individual level, but also the ability to link this information across generations. The existing literature largely relies on small samples of addicts surveyed on their family background.[4] To our knowledge, the only exception is Log et al. (2013), who use the Norwegian Prescription Database covering the period 2004 to 2009 to obtain a sample of almost 100,000 Norwegian adolescents and their mothers. They find an association between maternal use of prescribed opioids and the repeated use in their adolescent children.[5] We are not aware of a large-scale study on the intergenerational correlation in heroin use.

Second, since there is a close link between opioid dependence and mental health disorders

[3]The existing literature covers the intergenerational transmission of alcohol abuse (Kendler et al. 2015, Schmidt & Tauchmann 2011, Walters 2002), smoking (Göhlmann et al. 2010, Leonardi-Bee et al. 2011, Mays et al. 2014, Melchior et al. 2010), and cannabis use (Henry & Augustyn 2017, Roettger et al. 2011).

[4]We are aware of the following studies Ellinwood et al. (1966), Hill et al. (1977), Maddux & Desmond (1989), O'Donnell (1969), Pohlisch (1933). All of these studies exploit data from small-scale surveys of opioid-dependent respondents (family history method). The number of respondents varies between 33 and 266. Inference on the intergenerational correlation is based on a comparison of the lifetime prevalence of opioid dependence among the respondents' parents with lifetime prevalence of the general population. In all studies, the former prevalence markedly exceeded the latter, suggesting a positive intergenerational correlation in opioid dependence.

[5]Additionally, de Vaan & Stuart (2019) study correlations in prescription opioid use between spouses.

(e.g., Davis et al. 2017, Halbert et al. 2016, Sullivan et al. 2006), our study also speaks to the larger literature on the intergenerational transmission of health behavior (Thompson 2014) and mental health (Johnston et al. 2013). There is also a close connection to the intergenerational transmission of crime (Lindquist & Hjalmarsson 2012, Williams & Sickles 2002) and incarceration (Bhuller et al. 2018, Dobbie et al. 2018). Finally, to the extent that intergenerational transmission of opioid dependence is a hindrance to socioeconomic success, our results also speak to the broad literature on intergenerational mobility (Bowles & Gintis 2002).

Third, our results contribute to burgeoning literature on the opioid crisis. One strand of this literature, closely related to our study, discusses the causes of the US opioid crisis. There is an ongoing debate over the relative importance of different factors. Methodologically, these studies relate geographic variation in opioid usage across US counties to potential drivers, mainly economic conditions and the supply of opioids. Most of these studies quantify opioid usage by prescription rates and thus refer to the consumption of licit pain relievers. Other studies approximate opioid usage by drug mortality rates. So far, the literature has not reached consensus. Case & Deaton (2017) attribute the surge in overdose deaths to worsening economic conditions and refer to the so-called *deaths of despair hypothesis*. In contrast, Currie et al. (2018), Finkelstein et al. (2018), Hollingsworth et al. (2017), Ruhm (2018), and Schnell & Currie (2018) find little evidence for a causal impact of economic conditions and stress the importance of the availability of opioids. A second strand in this literature evaluates policies that target the opioid crisis or the harm thereof. The majority of these policies are supply-side measures outside the family sphere. So far, there is evidence on the impact of prescription drug monitoring laws (Buchmueller & Carey 2018, Gihleba et al. forthcoming, Grecu et al. 2019) and abuse-deterrent drug formulations (Alpert et al. 2018, Evans et al. 2019). Demand-side interventions, such as syringe exchange programs (Packham 2019), have received relatively less attention.

The reminder of the paper is organized as follows. Section II summarizes describes the institutional setting with a focus on the substitution therapy in Austria. Section III describes our data source and the definition of our estimation sample. Section IV presents our estimation model. Section V discuss our estimates of the intergenerational transmission and shows how they change due to inclusion of covariates. The final Section VII concludes the paper.

II. Institutional setting

Opioid dependence is a complex health condition that requires long-term treatment and medical care. The first-line treatment recommended by the *World Health Organization* is medication-assisted substitution therapy (WHO 2009). In substitution programs, patients are prescribed specific opioids, such as buprenorphine, methadone, or morphine, which mimic the effects of heroin but are sufficiently long-acting to avoid the cycles of intoxication and withdrawal. Programs have been shown to be effective in terms of substantially reducing illicit opiate use, HIV risk behaviors, death from overdose, criminal activity, and financial and other stresses on drug users and their families (Lawrinson et al. 2008). Although long-term abstinence can be achieved and is

sometimes desired, most patients are maintained on stable doses over time.

In Austria, methadone has been used since the early 20th century. It had been prescribed as an ultima ratio for long-term addicts who had failed multiple withdrawal attempts in rehabilitation centers. Substitution therapy in its current form was established in 1998, when policy makers recognized it as being equally effective as abstinence treatment. The barrier to enter substitution therapy is low. Austria has a Bismarckian welfare system, which provides almost universal access to high-quality healthcare.[6] Thus, every patient can enter substitution therapy for free. In principal, every patient who produces a positive urine screening on opioids will be admitted to the program. For patients under the age of 20, or when the patient declares to have taken opioids for less than two years, the prescribing GP has to consult with a psychiatrist to obtain a second opinion.

Treatment is primarily delivered by general practitioners. Some specialized outpatient services and hospital departments offer substitution therapy as well. The most commonly used substitutions drugs are methadone and buprenorphine. Methadone is dispensed as a fluid diluted with sugar and syrup, which makes it impossible to inject. Buprenorphine is a partial opioid antagonist, which does not produce euphoria and is therefore hardly abused by addicts.[7] Patients receive their substitution drug prescriptions for a duration of either 28 or 30 days (depending on the drug). Short-term prescriptions are only allowed in emergencies and for a maximum of three days (e.g., to bridge the gap until a patient enters long-term substitution). The physician has to specify the prescription drug, the mode of dispension (e.g., how methadone is diluted), and the first and last day of the prescription. Every prescription then has to be countersigned by the regional public health officer (PHO) before it can be dispensed daily and under supervision at a pharmacy.

To minimize abuse, substitution prescriptions are only valid after the physician attaches a vignette that contains a unique identification number. Those vignettes are recorded in an online system to which GPs, PHOs, and pharmacies have access to. This ensures that prescriptions cannot be forged and that patients can only obtain one prescription at a time. Substitution patients are also subject to close scrutiny. PHOs require regular urine drug screenings to test the intake of the substitution drug as well as other illicit substances, in particular benzodiazepines. Additionally, PHOs regularly addicts' arms for injection marks, and have to approve changes in dosage and medication. If addicts fail multiple tests they may loose take-home rights, be put on a different medication, or — in rare cases — be expelled from the program entirely.

Since its introduction, the number of opioid users in substitution treatment has increased steadily. Official estimates suggest that 53 percent of opioid users were in treatment in 2019 (Horvath et al. 2019). However, this is likely only a lower bound of the true in-treatment rate among opioid addicts. First, there is no reliable data on the number of opioid users in Austria, which makes it difficult to compute the denominator of the substitution prevalence rate with

[6]Patients hold mandatory health insurance administered through 9 *Regional Health Insurance Funds* ("Gebietskrankenkassen"), which cover private employees and their dependents, and 16 social security institutions that provide health insurance for specific occupational groups such as farmers, civil servants, and self-employed persons.

[7]If patients have an intolerance to these two medications, extended-release morphine can be prescribed. The downside of morphine as substitution drug is that it can be dissolved and injected.

statistical certainty. Second, the denominator is based on an estimate of the number of all opioid addicts, not just regular ones. Third, the number represents a snapshot in time. A study from 2011 found that 30 percent of patients currently in treatment had been on a stable dose for at least 12 months, the rest had multiple temporary interruptions (Weigl & Busch 2013). If, despite these interruptions, at a given time as much as 55.3 percent of users are in substitution treatment, the lifetime prevalence is likely significantly higher. By observing addicts between 1998–2015, it is likely that we capture most of them at least once in our data.

Opioid prescriptions for pain are very similarly regulated as substitution prescriptions. They require special narcotic scripts, attached with vignettes that contain a unique running number. Thereby, every prescription is documented in an online monitoring system. Pain prescriptions are, however, subject to certain maximum amounts of the drug (e.g., 2 g morphine or 0.2 g oxycodone per patient). If the patient requires successive prescriptions for long-term treatment, PHO approval becomes a necessity, and every single prescription has to be countersigned before it can be dispensed at the pharmacy. Weak opioids, such as codeine or tramadol, are not subject to specific provisions in case they are prescribed only once.

III. Data and sample definition

Our empirical analysis is based on linked data from several administrative registers. Most importantly, we have access to the database of the *Upper Austrian Health Insurance Fund* (henceforth UAHIF). This is a statutory health insurance provider that covers the population of all private-sector workers and non-employed residents in the province of Upper Austria.[8] This database includes detailed information on inpatient and outpatient healthcare expenditures. It also provides information on all prescribed medical drugs. These are coded using the *Anatomical Therapeutic Chemical Classification System* (ATC). This allows us to distinguish between opioids used in substitution therapy and those used to treat pain. Substances that are used in either therapy, however, carry a different ATC code depending on their purpose.[9] Below we use the term "prescription opioids" to refer to opioids used in pain therapy. In particular, these are all drugs in ATC categories N01AH and N02A that require a prescription in Austria.

We examine children who are born between 1984 and 1990. This choice of birth cohorts allows us to observe children between 14 and 27 years of age (see Figure 1).[10] After linking these

[8]Upper Austria is one of nine provinces in Austria and comprises about one sixth of the Austrian population and work force. The more than 1 million insurants represent approximately 75 percent of the Upper Austrian population. The remaining 25 percent are civil servants, self-employed and distinct occupational groups, such as farmers or public teachers (see footnote 6)

[9]Morphine, for example, is administered both in substitution therapy and in pain treatment. The morphine preparations in ATC category N07BC *("drugs used in opioid dependence")* are only approved for substitution therapy, since they come only in dosages that would be far too high for most regular pain patients. The share of prescribed substitution drugs is as follows: buprenorphine (24.9 percent), morphine (49.7 percent), methadone (25.4 percent), naltrexone (0.1 percent).

[10]We choose 1984 as the first cohort because we lack socioeconomic information in the birth register prior to that year. In a robustness check below, we extend the window to 1980–1990, with a restricted set of covariates, which leads to similar conclusions.

children to their parents, we obtain an estimation sample comprising 81,307 child-parent pairs.[11] Among these children, about 1.1 percent had been in substitution therapy at some point in time. Their average age at onset is 22 years and less than 0.2 percent had started substitution therapy before the beginning of the sample period (i.e., are left censored). Since it is presumably rare that children started *and* ended opioid abuse before the age of 14, we are confident that our data allow us to capture children's lifetime prevalence in illicit opioid use.

The median birth years of mothers and fathers are 1961 and 1959, respectively. Thus, for the median mother, we observe opioid usage starting from the 37$^{\text{th}}$ birthday. The addiction prevalence rates among parents are comparably lower. They amount to 0.3 percent for mothers and 0.5 percent for fathers. This generational gap can be explained a difference in the lifetime prevalence of heroin across birth cohorts. This is consistent with Giordano et al. (2014), who find that Swedes born in the 1980s and 1990s have significantly higher hospitalization rates for drug abuse than those born in the 1960s and 1970s. Alternatively, it could reflect measurement error. It is possible that parents had been in substitution therapy before we observe them in our sample (in 1998), but have not participated anymore thereafter. While this timing certainly does not represent a typical pattern, it is worth noting that the resulting measurement error would lead to an attenuation bias.[12] Thus, we would obtain smaller, more conservative intergenerational associations in heroin dependence.

The incidence of prescription opioid use is lower for children (4.6 percent) than for their parents (mothers: 20.4 percent, fathers: 17.7 percent). An important factor in explaining this difference across generations is certainly age. For children we therefore cannot claim to measure lifetime prevalence in prescription opioid use. For our main analysis, we define parental opioid use as either the mother or the father being in substitution therapy or being prescribed prescription opioids. According to these definitions, we observe a parental life time prevalence of heroin use of 0.6 percent and of prescription opioids use of 33.3 percent.

IV. Methodology

To examine the intergenerational link in opioid use in family j, we relate the child's opioid use, a_j^c, to their parents' opioid use, a_j^p,

$$a_j^c = \alpha \cdot a_j^p + \boldsymbol{\beta}^c \mathbf{b}_j^c + \boldsymbol{\beta}^p \mathbf{b}_j^p + \boldsymbol{\gamma} \mathbf{e}_j + \eta_j, \tag{1}$$

where the superscripts c and p denote children and parents, respectively. We run separate regressions for illicit opioids and prescription opioid use. For both measures, the parameter of primary interest is α, which captures the intergenerational transmission of opioid dependence. This reflects the genetic transmission of parental characteristics ('nature'), the environment a

[11] Naturally, we can only include family child-parent pairs in which both are insured with the UAHIF.

[12] Compliant patients typically remain in substitution therapy for long periods of time. Non-compliant patients who drop-out of substitution therapy (e.g., due to heroin consumption) typically return at some later point in time. The share of left-censored observations is 14.6 and 8.8 percent among mothers and fathers, respectively.

child is growing in ('nurture'), or a combination of both. While the distinction between these two channels is important, a separation from nature and nurture is beyond the scope of this paper. However, we present different specifications below where we control for a wide-range of socioeconomic and environmental factors.[13] We distinguish between three sets of controls; the child's conditions at birth and socioeconomics, $\mathbf{b}_j^c$, the mother's socioeconomic characteristics, $\mathbf{b}_j^p$, and environmental factors outside the family $\mathbf{e}_j$.

V. Results

Our estimation results are summarized in Figure 2. Full estimation output is listed in Tables 1 (illicit opioids) and 2 (prescription opioids). We find clear evidence of an intergenerational transmission of opioid use. Our unconditional estimate for illicit opioid abuse of 0.06 indicates that a heroin user's child is 6.0 percentage points more likely to use heroin her/himself compared to the child of non-using parents. Put differently, if at least one parent is using heroin, the likelihood of the child being addicted increases from 1.1 percent to 6.1 percent. The equivalent intergenerational transmission estimate for prescription opioids is about half and amounts to 0.03. Thus, if at least one parent uses prescription opioids, the likelihood of the child using increases from 4.6 percent to 7.7 percent. Both coefficients are precisely estimated (p-value < 0.001) and remarkably stable when introducing socioeconomic covariates.

To compare our estimate to the existing literature, it is useful to compute odds ratios. Using a logit model, we obtain odds ratios of 5.78 for illicit opioids and 1.78 for prescription opioids. This is well within the range of intergenerational correlations reported for other drugs. For example, Henry & Augustyn (2017) find an intergenerational odds ratio for cannabis use of 9.70, but their confidence interval $(3.00, 31.34)$ encompasses our estimate for illicit opioids. The intergenerational transmission of licit drug abuse appears to be less strong. Kendler et al. (2015) find an odds ratio of 1.46 for the effect of parental alcohol use disorder on children being diagnosed with the same. Leonardi-Bee et al. (2011), in a meta-study, find a similar odds ratio for smoking at 1.72. This is very close to our estimate for the intergenerational transmission of licit opioids. Using a composite measure of substance abuse (including both licit and illicit drugs), Thornberry et al. (2006) report an intergenerational odds ratio of 2.1, which is again in the neighborhood of our estimates.

While we do not aim to quantify the relative contribution from nature (inherited genes) and nurture (upbringing), it is still instructive to examine how the intergenerational transmission of opioid abuse is affected when including different types of covariates. We distinguish between three broad categories. First, we include information on the child's condition at birth, controlling for sex, birth weight, birth length, legitimacy status, and place of residence. Second, we introduce

[13] The medical literature identifies a range of biological and social risk factors associated with opioid addiction. A recent meta analysis identifies previous substance use, the presence of any mental health diagnosis, younger age, and being male as the strongest predictors of opioid abuse (Cragg et al. 2019). Furthermore, specific genetic and epigenetic factors associated with brain reward pathways and impulsivity are linked to addiction vulnerability (Wiss 2019).

measures for the mother's socioeconomic status at the time of birth. In particular, we control for the mother's age, religious denomination, educational attainment, and occupation. Third, we account for environmental factors outside the family. Here we aim to capture (or at least proxy) for the quality of the neighborhood and the local supply of opioids. To capture the local economic situation, we control for the share of population in employment. To approximate the local supply of opioids we use two variables: the number of GPs in the district providing substitution therapy, and the ethnic composition of the municipality. The rationale for the former is that there is a correlation between the number of GPs offering opioid substitution therapy and the number of opioid users in a community. The ethnic composition is relevant because heroin (and other illicit drugs) arrive primarily through the Balkan route in Austria, hence in communities with a high share of Balkan people, exposure to heroin may tend to be higher, ceteris paribus. The inclusion of this large set of covariates does not alter the estimated intergenerational transmission of opioid usage at all. A comparison of the bars in Figure 2 shows that this intriguing finding holds for both illicit and prescription opioids.[14] In the following we discuss signs and magnitudes of selected control variable coefficients.

Child birth conditions and socioeconomics Better birth conditions are associated with a lower probability of being opioid addicted, but become insignificant once environmental conditions controlled for (column 4). We see this effect only for illicit opioids, for prescription opioids birth conditions are not significant. Children born in wedlock are significantly less likely to be addicted to illicit opioids and to take prescription opioids. Sex is only relevant for the former but not the latter.

Mother socioeconomics Mother socioeconomics have large effects on child addiction, even in the full model controlling for a variety of other determinants. For example, the mother's age at birth is negatively correlated with the probability children become addicted, but this effect is small (for illicit opioids, we see a 0.4 percentage point reduction for every 10 years of age). Children of Catholic mothers have the smallest probability of becoming addicted, children of Muslims the highest. Furthermore, children of blue collar workers are more likely to become addicted, while better education is a protective factor.

Environmental conditions While our proxy for opioid supply, the density of substituting GPs in the district, is insignificant, we find that neighborhood quality is important. The former is surprising, but perhaps a result of the other variables in this category picking up most of the variation in opioid supply. We see that, the higher employment in the community, the lower the child's chance to get addicted. The share of Former Yugoslavs has a massive impact on the chance of becoming addicted. The coefficient suggests a 9.6 percentage point increase ($p < 0.001$) if the share doubles from an average 3.5 percent. As we alluded to before, this is most likely the case because most heroin comes through the Balkan route from Afghanistan to Austria. Former Yugoslavs are simply more likely to have access to heroin, and in communities where they settle, exposure to opioids may on average be slightly higher.

[14] Detailed estimation output is available in columns (2) to (4) of Table 1 and 2.

VI. Alternative specifications

In Panel (a) of Figure 3, we present results for the intergenerational transmission of illicit opioids based on two alternative definitions of treatment. First, a child is considered treated if the mother has ever been in substitution therapy (see filled bars). These estimations are based on a sample of 74,909 mother-child pairs, comprising 225 substituted mothers and 844 substituted children. Second, a child is considered treated if the father has ever been in substitution therapy (see hollow bars). These estimations are based on a sample of 60,649 father-child pairs, comprising 301 substituted fathers and 578 substituted children. Panel (b) depicts equivalent results for prescription opioids. Here the mother-child pairs (filled bars) contain 16,345 mothers and 3,583 children with at least one prescription. The father-child pairs (hollow bars) contain 14,364 fathers and 2,698 children. Details are provided in the notes to Figure 3. Across outcomes and specifications we find significant estimates of intergenerational transmission of opioid dependence. Point estimates are consistently larger for the treatments based on mothers. Estimates for illicit opioids differ by a factor of almost two. However, 95 percent confidence intervals are overlapping. Estimates for prescription opioids differ by a factor of about 1.7.

Finally, we show that our estimation results do not depend on the specific cohorts of children chosen. In our baseline estimates, we focus on children born between 1984 and 1990. This allows us to observe children in their adolescence and early adulthood (i.e., between the age of 14 to 27). Appendix Figure A.2 replicates our estimation for children born between 1980 and 1990. This results in a larger sample size, but prevents us from observing children younger than 18. Additionally, we do not have information on mothers' education and job at birth, because these variables are not available in the birth register prior to 1984. Estimates for this sample are practically similar to our baseline estimates.

VII. Conclusions

Our goal in this paper is to provide credible estimates of the intergenerational transmission of opioid usage. Using administrative data sources from Austria, we show that the usage of heroin and prescription opioids are both strongly transmitted within families. We do not aim to quantify the relative contribution from nature (inherited genes) and nurture (upbringing), nor do we attempt to isolate specific causal mechanism accounting for the transmission of opioid addiction across generations. We see our contribution in setting the stage for important future work. The next step for research is to unpack the mechanisms by which parents' addiction affects their children's experiences with opioids.

VIII. Bibliography

Alpert, A., Powell, D. & Pacula, R. L. (2018), 'Supply-Side Drug Policy in the Presence of Substitutes: Evidence from the Introduction of Abuse-Deterrent Opioids', *American Economic Journal: Economic Policy* **10**(4), 1–35.

Bhuller, M., Dahl, G. B., Loken, K. V. & Mogstad, M. (2018), 'Intergenerational Effects of Incarceration', *AEA Papers and Proceedings* **108**, 234–240.

Bowles, S. & Gintis, H. (2002), 'The Inheritance of Inequality', *Journal of Economic Perspective* **16**(3), 3–30.

Buchmueller, T. C. & Carey, C. (2018), 'The Effect of Prescription Drug Monitoring Programs on Opioid Utilization in Medicare', *American Economic Journal: Economic Policy* **10**(1), 77–112.

Case, A. & Deaton, A. (2017), 'Mortality and Morbidity in the 21st Century', *Brookings Papers on Economic Activity* **2017**(1), 397–476.

CDC (2017), National Vital Statistics System, Leading Causes of Death, Official Statistics, Centers for Disease Control and Prevention, US Department of Health and Human Services.

Cicero, T. J., Ellis, M. S., Surratt, H. L. & Kurtz, S. P. (2014), 'The Changing Face of Heroin Use in the United States: A Retrospective Analysis of the Past 50 Years', *JAMA Psychiatry* **71**(7), 821–826.

Cragg, A., Hau, J. P., Woo, S. A., Kitchen, S. A., Liu, C., Doyle-Waters, M. M. & Hohl, C. M. (2019), 'Risk Factors for Misuse of Prescribed Opioids: A Systematic Review and Meta-Analysis', *Annals of Emergency Medicine* **74**(5), 634–646.

Currie, J., Jin, J. Y. & Schnell, M. (2018), U.S. Employment and Opioids: Is There a Connection?, Working Paper 24440, National Bureau of Economic Research, Cambridge, MA.

Davis, M. A., Lin, L. A., Liu, H. & Sites, B. D. (2017), 'Prescription Opioid Use among Adults with Mental Health Disorders in the United States', *Journal of the American Board of Family Medicine* **30**(4), 407–417.

de Vaan, M. & Stuart, T. (2019), 'Does Intra-household Contagion Cause an Increase in Prescription Opioid Use?', *American Sociological Review* .

Dobbie, W., Grönqvist, H., Niknami, S., Palme, M. & Priks, M. (2018), The Intergenerational Effects of Parental Incarceration, NBER Working Paper 24186, National Bureau of Economic Research.

Ellinwood, E. H., Smith, W. G. & Vaillant, G. E. (1966), 'Narcotic Addiction in Males and Females: A Comparison', *International Journal of the Addictions* **1**(2), 33–45.

EMCDDA (2017), *European Drug Report 2017: Trends and Developments*, European Monitoring Centre for Drugs and Drug Addiction, Luxembourg.

Evans, W. N., Lieber, E. M. J. & Power, P. (2019), 'How the Reformulation of OxyContin Ignited the Heroin Epidemic', *Review of Economics and Statistics* **101**(1), 1–15.

Finkelstein, A., Gentzkow, M. & Williams, H. (2018), What Drives Prescription Opioid Abuse? Evidence from Migration, Working Paper 18-028, Stanford Institute for Economic Policy Research, Stanford, CA.

Florence, C. S., Zhou, C., Luo, F. & Xu, L. (2016), 'The Economic Burden of Prescription Opioid Overdose, Abuse, and Dependence in the United States, 2013', *Medical Care* **54**(10), 901.

Gihleba, R., Giuntella, O. & Zhang, N. (forthcoming), 'Prescription Drug Monitoring Programs and Neonatal Outcomes', *Regional Science and Urban Economics* .

Giordano, G. N., Ohlsson, H., Kendler, K. S., Winkleby, M. A., Sundquist, K. & Sundquist, J. (2014), 'Age, Period and Cohort Trends in Drug Abuse Hospitalizations within the Total Swedish Population (1975–2010)', *Drug and Alcohol Dependence* **134**, 355–361.

Göhlmann, S., Schmidt, C. M. & Tauchmann, H. (2010), 'Smoking Initiation in Germany: The Role of Intergenerational Transmission', *Health Economics* **19**(2), 227–242.

Grecu, A. M., Dave, D. M. & Saffer, H. (2019), 'Mandatory Access Prescription Drug Monitoring Programs and Prescription Drug Abuse', *Journal of Policy Analysis and Management* **38**(1), 181–209.

Halbert, B. T., Davis, R. B. & Wee, C. C. (2016), 'Disproportionate Longer-Term Opioid Use among US Adults with Mood Disorders', *Pain* **157**(11), 2452–2457.

Henry, K. L. & Augustyn, M. B. (2017), 'Intergenerational Continuity in Cannabis Use: The Role of Parent's Early Onset and Lifetime Disorder on Child's Early Onset', *Journal of Adolescent Health* **60**, 87–92.

Hill, S. Y., Cloninger, C. R. & Aye, F. R. (1977), 'Independent Familial Transmission of Alcoholism and Opiate Abuse', *Alcoholism: Clinical and Experimental Research* **1**(4), 335–342.

Hollingsworth, A., Ruhm, C. J. & Simon, K. (2017), 'Macroeconomic Conditions and Opioid Abuse', *Journal of Health Economics* **56**, 222–223.

Horvath, I., Anzenberger, J., Busch, M., Schmutterer, I., Tanios, A. & Weigl, M. (2019), *Bericht zur Drogensituation 2019*, Gesundheit Österreich, Wien.

Johnston, D. W., Schurer, S. & Shields, M. A. (2013), 'Exploring the Intergenerational Persistence of Mental Health: Evidence from Three Generations', *Journal of Health Economics* **32**, 1077–1089.

Kendler, K. S., Ji, J., Edwards, A. C., Ohlsson, H., Sundquist, J. & Sundquist, K. (2015), 'An Extended Swedish National Adoption Study of Alcohol Use Disorder', *Archives of General Psychiatry* **72**(3), 211–218.

Lawrinson, P., Ali, R., Buavirat, A., Chiamwongpaet, S., Dvoryak, S., Habrat, B., Jie, S., Mardiati, R., Mokri, A., Moskalewicz, J., Newcombe, D., Poznyak, V., Subata, E., Uchtenhagen, A., Utami, D. S., Vial, R. & Zhao, C. (2008), 'Key Findings from the WHO Collaborative Study on Substitution Therapy for Opioid Dependence and HIV/AIDS', *Addiction* **103**(9), 1484–1492.

Leonardi-Bee, J., Jere, M. L. & Britton, J. (2011), 'Exposure to Parental and Sibling Smoking and the Risk of Smoking Uptake in Childhood and Adolescence: A Systematic Review and Meta-Analysis', *Thorax* **66**(10), 847–855.

Lindquist, M. J. & Hjalmarsson, R. (2012), 'Like Godfather, Like Son: Exploring the Intergenerational Nature of Crime', *Journal of Human Resources* **47**(2).

Log, T., Skurtveit, S., Selmer, R., Tverdal, A., Furu, K. & Hartz, I. (2013), 'The Association between Prescribed Opioid Use for Mothers and Children: A Record-linkage Study', *European Journal of Clinical Pharmacology* **69**, 111–118.

Maddux, J. F. & Desmond, D. P. (1989), 'Family and Environment in the Choice of Opioid Dependence or Alcoholism', *American Journal of Drug and Alcohol Abuse* **15**(2), 117–134.

Maguire, D. J., Taylor, S., Armstrong, K., Shaffer-Hudkins, E., Germain, A. M., Brooks, S. S., Cline, G. J. & Clark, L. (2016), 'Long-Term Outcomes of Infants with Neonatal Abstinence Syndrome', *Neonatal Network* **35**(5), 277–286.

Mays, D., Gilman, S. E., Rende, R., Luta, G., Tercyak, K. P. & Niaura, R. S. (2014), 'Parental Smoking Exposure and Adolescent Smoking Trajectories', *Pediatrics* **133**(6), 983–991.

McQueen, K. & Murphy-Oikonen, J. (2016), 'Neonatal Abstinence Syndrome', *The New England Journal of Medicine* **375**(25), 2468–2479.

Melchior, M., Chastang, J.-F., Mackinnon, D., Galéra, C. & Fombonne, E. (2010), 'The Intergenerational Transmission of Tobacco Smoking – The Role of Parents' Long-term Smoking Trajectories', *Drug and Alcohol Dependence* **107**, 257–260.

Nunes, E. V., Weissman, M. M., Goldstein, R., McAvay, G., Beckford, C., Seracini, A., Verdeli, H. & Wickramaratne, P. (2000), 'Psychiatric Disorders and Impairment in the Children of Opiate Addicts: Prevalances and Distribution by Ethnicity', *American Journal on Addictions* **9**(232–241).

O'Donnell, J. A. (1969), Narcotic Addicts in Kentucky, Public Health Service Publication 1881, U.S. Department of Health, Education and Welfare, Chevy Chase, Maryland.

Packham, A. (2019), Are Syringe Exchange Programs Helpful or Harmful? New Evidence in the Wake of the Opioid Epidemic, Working Paper 26111, National Bureau of Economic Research.

Pohlisch, K. (1933), Soziale und persönliche Bedingungen des chronischen Alcoholismus, *in* 'Sammlung Psychiatrischer und Neurologischer Einzeldarstellungen', G. Thieme Verlag, Leipzig.

Roettger, M. E., Swisher, R. R., Kuhl, D. C. & Chavez, J. (2011), 'Paternal Incarceration and Trajectories of Marijuana and Other Illegal Drug Use from Adolescence into Young Adulthood: Evidence from Longitudinal Panels of Males and Females in the United States', *Addiction* **106**, 121–132.

Ruhm, C. J. (2018), Deaths of Despair or Drug Problems?, Working Paper 24188, National Bureau of Economic Research, Cambridge, MA.

Schmidt, C. M. & Tauchmann, H. (2011), 'Heterogeneity in the Intergenerational Transmission of Alcohol Consumption: A Quantile Regression Approach', *Journal of Health Economics* **30**, 33–42.

Schnell, M. & Currie, J. (2018), 'Addressing the Opioid Epidemic: Is there a Role for Physician Education?', *American Journal of Health Economics* **4**(3), 383–410.

Sullivan, M. D., Edlund, M. J., Zhang, L., Unützer, J. & Wells, K. B. (2006), 'Association Between Mental Health Disorders, Problem Drug Use, and Regular Prescription Opioid Use', *Archives of Internal Medicine* **166**(19), 2087–2093.

Thompson, O. (2014), 'Genetic Mechanisms in the Intergenerational Transmission of Health', *Journal of Health Economics* **35**, 132–146.

Thornberry, T. P., Krohn, M. D. & Freeman-Gallant, A. (2006), 'Intergenerational Roots of Early Onset Substance Use', *Journal of Drug Issues* **36**(1), 1–28.

Tolia, V. N., Patrick, S. W., Bennett, M. M., Murthy, K., Sousa, J., Smith, P. B., Clark, R. H. & Spitzer, A. R. (2015), 'Increasing Incidence of the Neonatal Abstinence Syndrome in U.S. Neonatal ICUs', *New England Journal of Medicine* **372**(22), 2118–2126.

Walters, G. D. (2002), 'The Heritability of Alcohol Abuse and Dependence: A Meta-analysis of Behavior Genetic Research', *The American Journal of Drug and Alcohol Abuse* **28**(3), 557–584.

Weigl, M. & Busch, M. (2013), *Substitutionsbehandlung Opioidabhängiger Personen*, Gesundheit Österreich, Wien.

WHO (2009), *Guidelines for the Psychosocially Assisted Pharmacological Treatment of Opioid Dependence*, World Health Organization, International Narcotics Control Board, United Nations Office on Drugs and Crime, Geneva.

Williams, J. & Sickles, R. (2002), 'An Analysis of the Crime as Work Model: Evidence from the

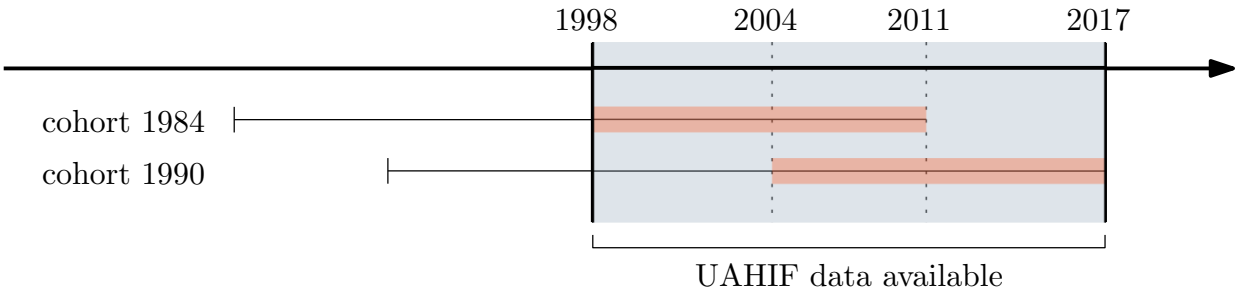
1958 Philadelphia Birth Cohort Study', *Journal of Human Resources* **37**(3), 479–509.

Wilson, N. (2020), 'Drug and Opioid-Involved Overdose Deaths — United States, 2017–2018', *Morbidity and Mortality Weekly Report* **69**.

Wiss, D. A. (2019), 'A Biopsychosocial Overview of the Opioid Crisis: Considering Nutrition and Gastrointestinal Health', *Frontiers in Public Health* **7**, 193.

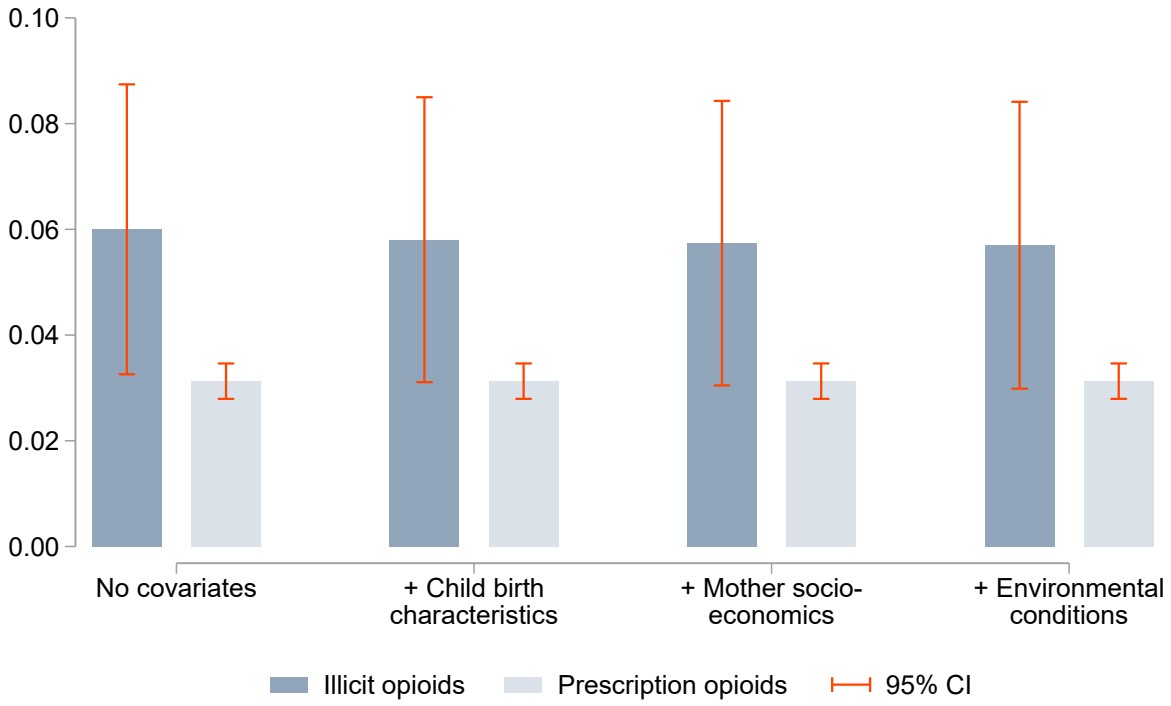
A. Figures and tables

Figure 1 — Birth cohorts in study and data availability



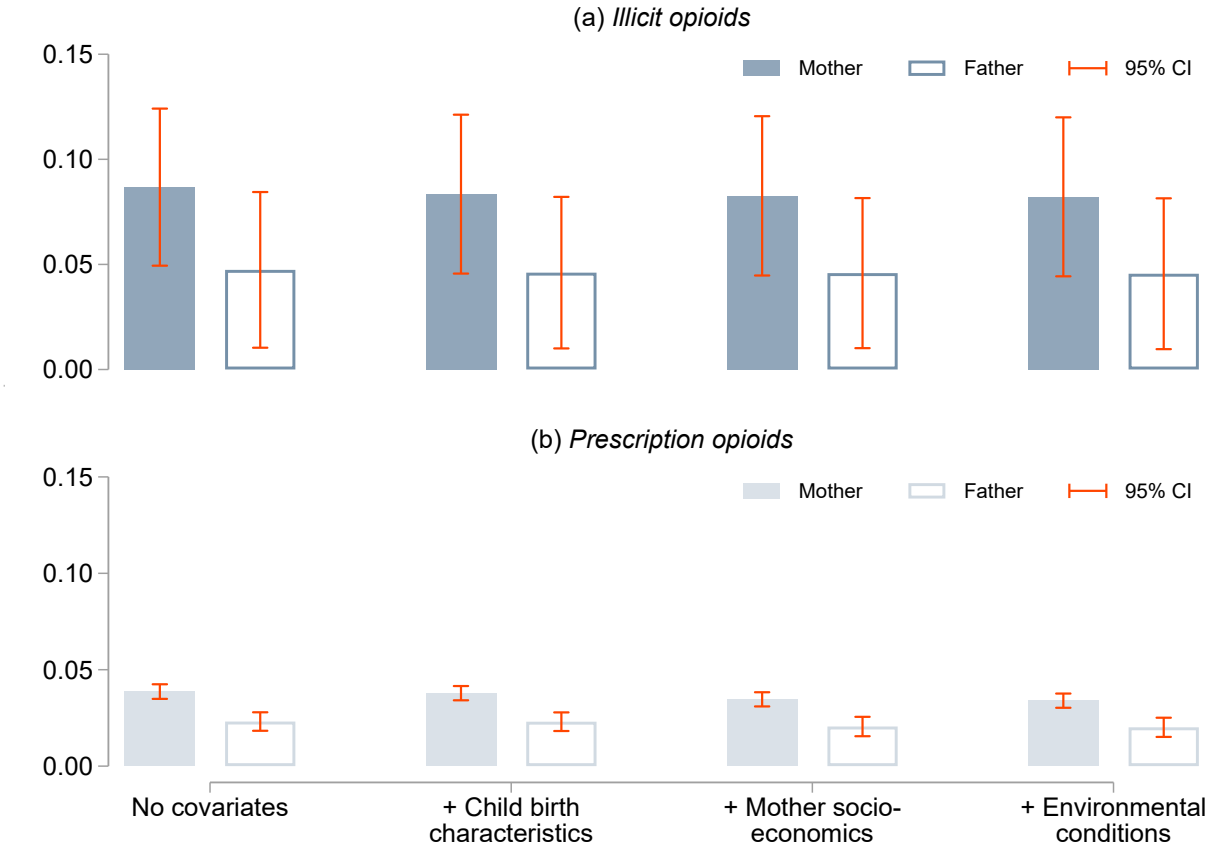
Notes: This figure illustrates the birth cohorts in study and data availability. UAHIF records are available between 1998 and 2017, this is the blue shaded area. We consider the cohorts 1984–1990, where we observe each child from age 14 to 27. For example, a child born in 1984 is 14 in 1998 and 27 in 2011. A child born in 1990 is 14 in 2004 and 27 in 2017. Our results are robust to choosing different cohorts; in Figure A.2, we extend the window to children born between 1980 and 1990, which leads to very similar conclusions as in our baseline.

Figure 2 — The intergenerational transmission of opioid dependence



Notes: This graph plots the intergenerational transmission estimates for illicit opioids and prescription opioids with varying covariates. Dependence to illicit opioids is approximated with participation in substitution therapy. Prescription opioids comprise all drugs in ATC categories N01AH and N02A. Children are considered treated if either the father or the mother have ever been using illicit opioids and prescription opioids, respectively. The bars represent OLS estimates and 95% confidence intervals based on municipality-level clustered and heteroskedasticity-robust standard errors are indicated by the purple lines. The covariate included are listed in Table 1.

FIGURE 3 — The intergenerational transmission of opioid dependence: Effect of mothers vs. fathers



Notes: This graph plots the intergenerational transmission estimates for illicit opioids (Panel a) and prescription opioids (Panel b) with varying covariates. Dependence to illicit opioids is approximated by participation in substitution therapy. We present results based on two treatment definitions. First, a child is considered treated if her/his mother has ever been in substitution therapy (filled bars). These estimations are based on a sample of 74,909 mother-child pairs, containing 225 substituted mothers and 844 substituted children. Second, a child is considered treated if her/his father has ever been in substitution therapy (hollow bars). These estimations are based on a sample of 60,649 father-child pairs, which comprises 301 substituted fathers and 578 substituted children. Prescription opioids comprise all drugs in ATC categories N01AH and N02A. Here the mother-child pairs (filled bars) contain 16,345 mothers and 3,583 children with at least one prescription. The father-child pairs (hollow bars) contain 14,364 fathers and 2,698 children. The covariates included are listed in Table 1. The bars represent OLS estimates and 95% confidence intervals based on municipality-level clustered and heteroskedasticity-robust standard errors are indicated by the orange lines.

TABLE 1 — The intergenerational transmission of opioid dependence: Illicit opioids

	(1)	(2)	(3)	(4)	(5)
Mother or father have been in opioid substitution	0.060***	0.058***	0.057***	0.057***	
	(0.014)	(0.014)	(0.014)	(0.014)	
Child birth conditions and socioeconomics					
Birth weight below 2,500 grams		-0.004*	-0.003*	-0.003	-0.003
		(0.002)	(0.002)	(0.002)	(0.002)
ln(length at birth)		-0.010	-0.006	-0.002	-0.003
		(0.009)	(0.008)	(0.008)	(0.008)
Female		-0.008***	-0.008***	-0.008***	-0.008***
		(0.001)	(0.001)	(0.001)	(0.001)
Born in wedlock		-0.008***	-0.007***	-0.006***	-0.006***
		(0.001)	(0.001)	(0.001)	(0.001)
Urban region		0.011**	0.011**	0.002	0.003
		(0.005)	(0.005)	(0.004)	(0.004)
Mother socioeconomics					
Age at birth (years / 10)			-0.004***	-0.004***	-0.004***
			(0.001)	(0.001)	(0.001)
Religion [baseline: catholic]					
Protestant			0.005***	0.003*	0.003*
			(0.002)	(0.002)	(0.002)
Muslim			0.024***	0.021***	0.021***
			(0.006)	(0.006)	(0.006)
Other			0.008***	0.006***	0.007***
			(0.002)	(0.002)	(0.002)
Job [baseline: white collar worker]					
Entrepreneur or freelancer			-0.002	-0.001	-0.001
			(0.002)	(0.002)	(0.002)
Housewive			-0.002	-0.001	-0.001
			(0.001)	(0.001)	(0.001)
Blue collar worker			0.005***	0.005***	0.005***
			(0.001)	(0.001)	(0.001)
Education [baseline: compulsory education]					
Apprenticeship training			-0.001	-0.002	-0.002
			(0.001)	(0.001)	(0.001)
High school (without A-levels)			-0.002*	-0.002**	-0.002***
			(0.001)	(0.001)	(0.001)
High school			-0.005***	-0.006***	-0.006***
			(0.002)	(0.001)	(0.001)
Vocational school			-0.006***	-0.007***	-0.007***
			(0.001)	(0.001)	(0.001)
University			-0.004	-0.005*	-0.006*
			(0.003)	(0.003)	(0.003)
Environmental conditions at age 14[a]					
No. of substituting GPs in district per 1,000 population				0.009	0.009
				(0.006)	(0.006)
Share of population employed				-0.059*	-0.059*
				(0.031)	(0.031)
Ethnic composition of municipality					
Share of Former Yugoslavs				0.169***	0.170***
				(0.027)	(0.027)
Share of Turks				0.046	0.047
				(0.051)	(0.051)
Share of Germans				-0.039	-0.040
				(0.026)	(0.026)
Share of other immigrants				-0.087	-0.081
				(0.092)	(0.090)
F-statistic	18.4	20.7	13.7	15.9	14.9
Adjusted R^2	0.002	0.007	0.009	0.011	0.009
Number of observations	81,307	81,307	81,307	81,307	81,307
Number of children substituted	869	869	869	869	869
Number of parents substituted	512	512	512	512	512

Notes: This table presents regression results for the determinants of a child being in the opioid substitution therapy before the age of 27. The sample is based on the universe of children born between 1984 and 1990. Municipality-level clustered standard errors given in parentheses, stars indicate statistical significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[a] Variables capturing the environmental condition are measured at the municipality level. The only exception is GP density, which is measured on the district level.

TABLE 2 — The intergenerational transmission opioid dependence: Prescription opioids

	(1)	(2)	(3)	(4)	(5)
Mother or father have used prescription opioid	0.031***	0.031***	0.028***	0.028***	
	(0.002)	(0.002)	(0.002)	(0.002)	
Child birth conditions and socioeconomics					
Birth weight below 2,500 grams		-0.007	-0.006	-0.006	-0.006
		(0.004)	(0.004)	(0.004)	(0.004)
ln(length at birth)		-0.032	-0.024	-0.020	-0.025
		(0.021)	(0.021)	(0.021)	(0.021)
Female		0.002	0.002	0.002	0.002
		(0.001)	(0.001)	(0.001)	(0.001)
Born in wedlock		-0.012***	-0.009***	-0.008***	-0.007***
		(0.002)	(0.002)	(0.002)	(0.002)
Urban region		0.014***	0.015***	0.002	0.002
		(0.004)	(0.003)	(0.005)	(0.005)
Mother socioeconomics					
Age at birth (years / 10)			-0.006***	-0.006***	-0.004**
			(0.002)	(0.002)	(0.002)
Religion [baseline: catholic]					
Protestant			0.003	0.000	0.001
			(0.004)	(0.004)	(0.004)
Muslim			0.026***	0.022***	0.028***
			(0.007)	(0.007)	(0.007)
Other			0.015**	0.013**	0.014**
			(0.007)	(0.006)	(0.006)
Job [baseline: white collar worker]					
Entrepreneur or freelancer			0.008	0.009	0.008
			(0.006)	(0.006)	(0.006)
Housewive			-0.006*	-0.004	-0.007**
			(0.003)	(0.003)	(0.003)
Blue collar worker			0.007***	0.007***	0.008***
			(0.002)	(0.002)	(0.002)
Education [baseline: compulsory education]					
Apprenticeship training			-0.005***	-0.006***	-0.008***
			(0.002)	(0.002)	(0.002)
High school (without A-levels)			-0.010***	-0.011***	-0.015***
			(0.002)	(0.002)	(0.002)
High school			-0.015***	-0.016***	-0.021***
			(0.003)	(0.003)	(0.003)
Vocational school			-0.022***	-0.023***	-0.029***
			(0.003)	(0.003)	(0.004)
University			-0.016***	-0.018***	-0.023***
			(0.006)	(0.006)	(0.006)
Environmental conditions at age 14[a]					
No. of substituting GPs in district per 1,000 population				0.011	0.012
				(0.015)	(0.016)
Share of population employed				-0.111***	-0.110**
				(0.042)	(0.043)
Ethnic composition of municipality					
Share of Former Yugoslavs				0.210***	0.228***
				(0.043)	(0.044)
Share of Turks				0.079	0.091
				(0.071)	(0.073)
Share of Germans				-0.089	-0.104*
				(0.060)	(0.062)
Share of other immigrants				-0.039	-0.015
				(0.119)	(0.124)
F-statistic	335.4	64.9	31.3	33.7	25.3
Adjusted R^2	0.005	0.006	0.008	0.009	0.005
Number of observations	81,307	81,307	81,307	81,307	81,307
Number of children taking pain drugs	3,770	3,770	3,770	3,770	3,770
Number of parents taking pain drugs	27,053	27,053	27,053	27,053	27,053

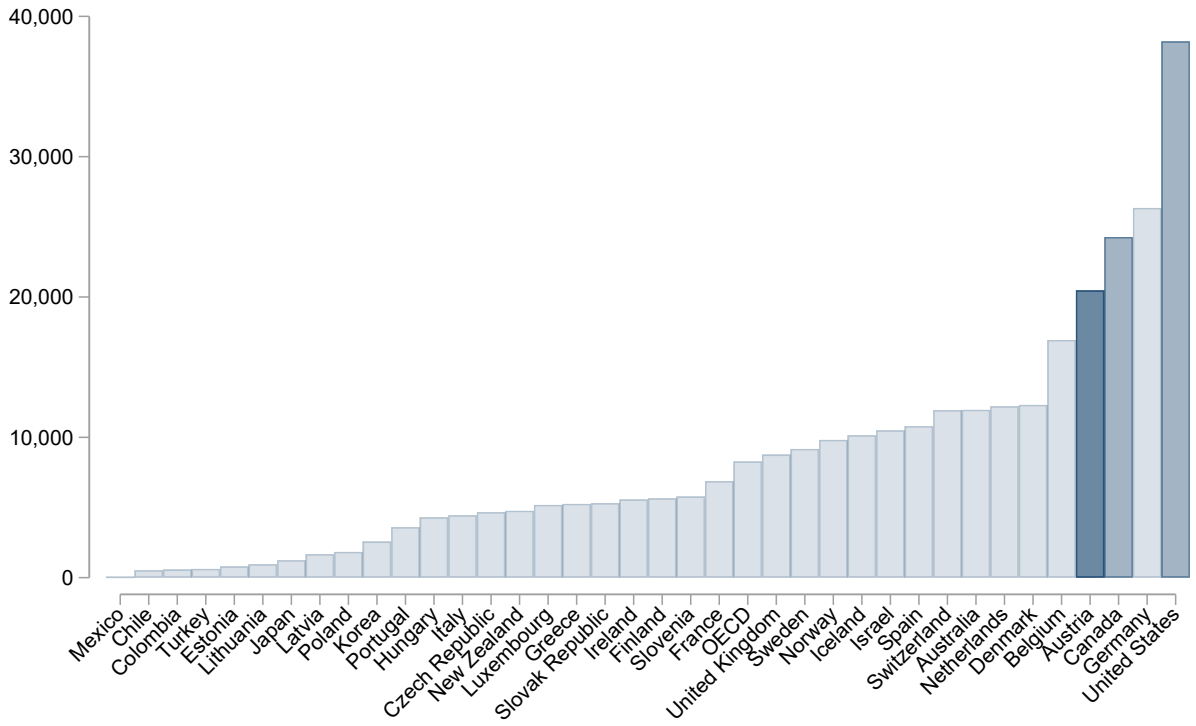
Notes: This table presents regression results for the determinants of a child using prescription opioids before the age of 27. The sample is based on the universe of children born between 1984 and 1990. Municipality-level clustered standard errors given in parentheses, stars indicate statistical significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[a] Variables capturing the environmental condition are measured at the municipality level. The only exception is GP density, which is measured on the district level.

A. Web Appendix

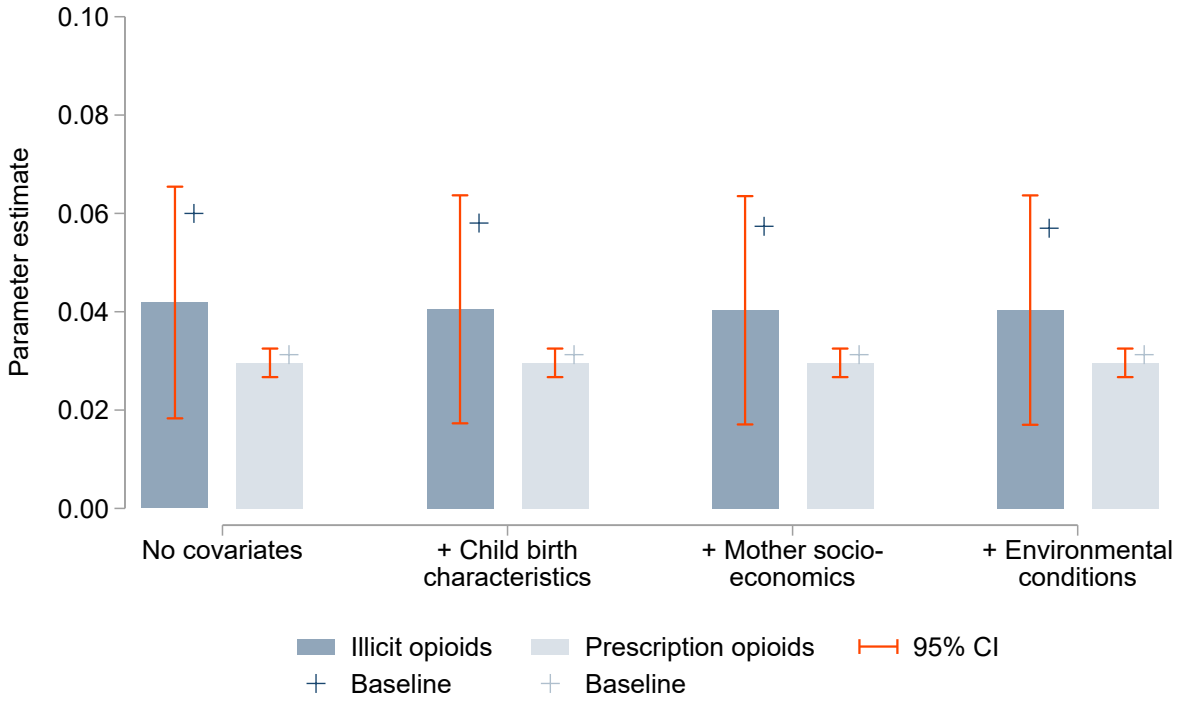
This Web Appendix contains additional tables and figures for the paper "*The Intergenerational Transmission of Opioid Dependence: Evidence from Administrative Data*" by Alexander Ahammer and Martin Halla.

Figure A.1 — Per capita opioid prescriptions among OECD member countries



Notes: Average availability of analgesic opioids in OECD countries 2014–2016 in defined daily doses for statistical purposes per million inhabitants per day. The data are retrieved from www.oecd.org/els/health-systems/opioids.htm, accessed on June 16, 2020.

FIGURE A.2 — Intergenerational transmission of opioid dependence, extended sample 1980–1990



Notes: This graph replicates the regressions in Figure 1 on a sample that also includes children born between 1980 and 1983. For these cohorts we do not have information on mothers' education and job, we therefore do not control for these variables when we introduce mother socioeconomics. The bars represent OLS estimates and 95% confidence intervals based on municipality-level clustered and heteroskedasticity-robust standard errors are indicated by the purple lines. The covariate included are listed in Table 1.

TABLE A.1 — Sample characteristics, cohorts 1984–1990.

	Full sample			Illicit opioids[a]			Prescription opioids[b]		
	n	Mean	Std. dev.	*n*	Mean	Std. dev.	*n*	Mean	Std. dev.
Substitution status									
Child is substituted between age 14 and 27	81,307	0.011	(0.10)	512	0.070	(0.26)			
Mother is substituted between 1998 and 2017	74,909	0.003	(0.05)	490	0.459	(0.50)			
Father is substituted between 1998 and 2017	60,649	0.005	(0.07)	418	0.720	(0.45)			
Either mother or father is substituted	81,307	0.006	(0.08)	512	1.000	(0.00)			
Average age at onset of substitution therapy									
Child	940	22.230	(3.36)	38	21.406	(3.47)			
Mother	225	41.948	(7.13)	225	41.948	(7.13)			
Father	301	44.727	(6.71)	301	44.727	(6.71)			
Opioid prescription status									
Child takes opioids between age 14 and 27	81,307	0.046	(0.21)				27,053	0.067	(0.25)
Mother takes opioids between 1998 and 2017	81,307	0.204	(0.40)				27,053	0.613	(0.49)
Father takes opioids between 1998 and 2017	81,307	0.177	(0.38)				27,053	0.532	(0.50)
Either mother or father takes opioids	81,307	0.333	(0.47)				27,053	1.000	(0.00)
Average age of first opioid prescription									
Child	4,709	23.367	(4.38)				2,287	23.324	(4.44)
Mother	16,571	46.365	(7.56)				16,571	46.365	(7.56)
Father	14,401	49.625	(8.24)				14,401	49.625	(8.24)
N	81,307			512			27,053		

Notes: Number of observations for substitution status differs because we assign zeros only when children, mothers, and fathers are insured (children: at age 27; mothers and fathers: at one point between 1998 and 2017). For 'either mother or father is substituted,' we assign zeros if either the mother or the father is insured. Age at onset is calculated for all observations that are substituted between 1998 and 2017, which includes also children that were older than 27 at onset of substitution.

[a] Parents are classified as having had prior opioid abuse.

[a] Parents were prescribed at least one opioid analgesic between 1998–2017.