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Illicit Drugs and the Decline of the Middle Class*

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Abstract

Empirical evidence for the U.S. suggests that the consumption of intoxicants increases in association with the socio-economic deprivation of the middle-class. To explore the underlying mechanisms, we set up a task-based labor market model with endogenous mental health status and a health care system. The decline of tasks that were historically performed by the middle class and the associated decline in relative wages and socio-economic status increases the share of mentally ill middle class workers. Mentally ill workers can mitigate their hardships by the intake of illicit drugs or by consuming health goods. We argue that explaining the drug epidemic of the U.S. middle class requires an interaction of socio-economic decline and falling opioid prices. One factor in isolation is typically insufficient. Our analysis also points to a central role of the health care system. In our model, extending mental health care could motivate the mentally ill to abstain from illicit drug consumption.

Key words: Socio-economic deprivation; Intoxicants; Health insurance; Mental health; Middle class.

JEL classification: I10; H51.

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1 Introduction

Middle-aged, white non-Hispanic men and women in the United States with a high school degree or less have experienced two adverse, secular trends. First, deteriorating labor market opportunities, associated with outsourcing and automation of tasks performed by medium-skilled workers and the polarization of wages (e.g. Autor and Acemoglu, 2011; Autor et al., 2013, 2014). Second, markedly increasing abuse of illicit drugs like opioids, associated with "[s]elf-reported declines in health, mental health, and ability to conduct activities of daily living, and increases in chronic pain and inability to work, as well as clinically measured deteriorations in liver function" (Case and Deaton, 2015).

Case and Deaton (2015, 2017) hypothesize a strong relationship between rising consumption of intoxicants and the adverse labor market implications of automation and globalization. They argue that the relative deprivation of the middle class has resulted in stress-inducing social status losses and despair that is associated with higher incidence of mental illness like depression, bipolar disorder or anxiety disorder.[1] Mental illness, in turn, is known as a causal factor for illicit drug dependency and abuse disorder (Swendsen et al., 2010). The Case-Deaton hypothesis is thus consistent with a large literature on "social causation", highlighting the role of perceived inequity and social comparisons on mental illness and drug abuse (e.g. Kessler, 1979; Wilkinson, 1997; Stansfeld et al., 1998; Power et al., 2002; Aneshensel, 2009; Reiss, 2013; Pickett and Wilkinson, 2015). One reason for declining socio-economic status may be the loss of tasks in production that were historically performed by the middle class through increased outsourcing and automation. In support of this line of reasoning, Colantone et al. (2015) have documented a large and highly significant impact of import competition on mental distress with British data for the period 2001-2007.

In light of this suggestive evidence it may seem surprising that, for the specific case of the U.S. opioid epidemic, Ruhm (2018) does not find robust evidence that the local economic environment is significantly related to the consumption of intoxicants. Instead he suggests that improved availability and falling prices of illicit drugs are largely responsible

[1] Alarmingly, the consumption of antidepressants among middle-aged men and women in the U.S. has doubled between 1999-2012 (Kantor et al., 2015).

for the epidemic. His findings, however, do not exclude an important role of a changing economic environment that has disproportionately affected the U.S. middle class, since socio-economic deprivation may interact with falling opioid prices in determining illicit drug consumption.

These considerations are the starting point of our analysis. In order to capture the potential mechanisms we set up a model that allows us to examine the isolated and interaction effects of reductions in demand for medium-skilled intensive tasks and changes in illicit drug prices on mental health problems, mental health expenditure, and consumption of intoxicants, conditional on the health system. We also examine the role of health care coverage and the extent of health insurance. In the U.S., low-skilled workers typically have access to Medicaid if privately uninsured, which is less typical for middle income earners who experienced socio-economic deprivation. Thus, particularly the uninsured middle class could be inclined to abuse opioids as a substitute for health expenditure. We therefore also investigate the skill-specific differences in mental health status, mental health expenditure, consumption of intoxicants, and welfare between insured and uninsured workers.

The supply-side features a version of the task-based labor market model by Acemoglu and Autor (2011). The model explains declining relative wages of medium-skilled workers that we view as indicative of socio-economic deprivation of the middle class. The main innovation of the paper is on the household side, where we formalize the notion of Case and Deaton (2015, 2017). As socio-economic deprivation causes stress, the incidence of mental illness becomes more likely for the middle class and the average severeness of mental illness may increase. We allow consumption of intoxicants to mitigate adverse utility effects of mental illness as a substitute for health spending. The health system captures both private insurance and tax-financed health care for the poor and uninsured (Medicaid).

Our results suggests that the drug epidemic among the U.S. middle class requires the interaction between socio-economic deprivation and falling opioid prices. We demonstrate via counterfactual analysis that relative deprivation in isolation does not suffice, except in the case where it causes also greater severeness of mental illness among the mentally ill. Hence, our theory reconciles the "despair hypothesis" of Case and Deaton (2015, 2017) with the "price hypothesis" of Ruhm (2018). Falling opiod prices alone cannot explain rising opioid consumption of the middle class. By contrast, falling opioid prices alone can explain the increasing opioid consumption among workers with low but over time increasing wages.

Moreover, our analysis points to a central role of the U.S. health care system for explaining the increased drug abuse. The model predicts that, when hit by mental illness, privately uninsured workers spend more on intoxicants and less on health than insured workers with the same skill level. We also show that middle class workers without private health insurance would benefit from public health care coverage in an environment where illicit drug prices are declining over time and that low-skilled workers would benefit from a more generous Medicaid system.

Our results are consistent with empirical evidence. Jones et al. (2015) show that past year heroine abuse is highly correlated with not having access to Medicaid or other health insurance and that it is also highly correlated with past year opioid pain reliever (and other psychotherapeutic) nonmedical use. Finkelstein et al. (2012) evaluate the effects of a randomized lottery for the provision of Medicaid insurance in Oregon in the year 2008, which chose 10,000 lower-income people. Only one year after implementation, lottery winners showed significantly increased health status and happiness. For instance, those with insurance were about 10 percent less likely to report a diagnosis of depression. A later study found that, two years after implementation, Medicaid access reduced the fraction of depressed individuals by 9 percentage points, or 30 percent (Baicker et al., 2013). More recently, Curie et al. (2018, Tab. 3) compare changes in deaths of despair between 1990 and 2010 in the U.S. with France. In the age group 25-44, there was an increase by 42 and 106 percent for U.S. males and females, respectively, while decreasing by 17 and 35 percent in France. In the age group 45-64, deaths of despair increased by 59 and 96 percent for U.S. males and females, respectively, but decreased by 20 and 26 percent in France. The authors attribute such dramatically different experiences to a universal health care system in France that is very different to the one in the U.S. They conclude that the health system is important for the health effects of rising earnings inequality. Our analysis complements these empirical studies with counterfactual experiments that account for the substitutability between health spending and drug abuse at the individual level and with a quantitative analysis of U.S. health care reforms. The calibrated model deepens the understanding of underlying mechanisms that could be exploited in future empirical research.

The paper is structured as follows. Section 2 presents the theoretical model, which is algebraically analyzed in section 3. Section 4 calibrates the model. Section 5 quantifies important results from the equilibrium analysis for the status quo Medicaid system and performs counterfactual analysis to gauge the role of falling illicit drug prices and socio-economic deprivation of the middle class for illicit drug consumption, mental health care expenditure, and welfare of the mentally ill. Section 6 examines how illicit drug consumption and mental health expenditure would change if Medicaid were extended. Section 7 discusses the results by assuming that socio-economic deprivation does not only affect the probability of developing mental illness but also its average intensity for those becoming ill. The last section concludes.

2 The Model

We focus on middle-aged individuals living in non-overlapping generations. The model links endogenous wage polarization, mental health status, and consumption of intoxicants, conditional on the evolution of illicit drug prices and the mental health care system. Time is discrete and indexed by t.

2.1 Production Technology and Tasks

There is a homogenous final good with price normalized to unity. It is produced under perfect competition according to

$$Y_t = (A_t H_t^Y)^\beta (X_t)^{1-\beta}, \tag{1}$$

$\beta \in (0,1)$, where H^Y is high-skilled labor input, A is a productivity parameter that measures the efficiency of high-skilled labor, and X is a composite intermediate input.[2]

[2] We occasionally omit the time index for notational simplicity provided there is no potential confusion from referring to different time periods.

For the composite input, we employ the task-based approach of Acemoglu and Autor (2011). Its level of production depends symmetrically on input of a unit mass of tasks, indexed by $j \in [0,1]$ with quantity $x(j)$ of task j, according to the constant-returns to scale technology

$$X_t = \exp\left(\int_0^1 \log x_t(j)\mathrm{d}j\right). \tag{2}$$

Any task j may be produced by low-skilled and medium skilled labor, $l(j)$ and $m(j)$, respectively, that are perfectly substitutable,[3] i.e.

$$x_t(j) = \alpha_t^L(j)l_t(j) + \alpha_t^M(j)m_t(j), \tag{3}$$

with $\alpha^L(j) > 0$ and $\alpha^M(j) > 0$. We assume that, for all j and t, $\omega_t(j) \equiv \alpha_t^M(j)/\alpha_t^L(j)$ is a continuously differentiable and strictly increasing function. As argued in Acemoglu and Autor (2011), in this case there exists an endogenous threshold level $J_t \in (0,1)$ that separates the task space into those performed by low-skilled and those performed by medium-skilled workers according to their comparative advantage. That is, $l(j) > 0$ and $m(j) = 0$ for all $j < J$ whereas $l(j) = 0$ for all $j \geq J$.

The extent of outsourcing or automation of middle class jobs up to time t can be captured by the size of subset $\mathcal{D}_t \subset [J_t, 1)$ removed out of the set of tasks initially performed by medium-skilled workers, i.e. $\mathcal{D}_0 = \varnothing$. We denote by $\Delta_t \equiv |\mathcal{D}_t|$ the measure of this set in t (i.e. $\Delta_0 = 0$). The set of tasks performed by medium-skilled workers thus reads as $\mathcal{Z} \equiv [J,1)\backslash\mathcal{D}$ and has measure $|\mathcal{Z}| = 1 - J - \Delta$. The representative final good producer purchases any task $j \in \mathcal{D}_t$ at (exogenous) price $\bar{p}_t$ either from outside the economy ("outsourcing") or at the competitive price that equals the rate of transformation between the final good and the respective tasks ("automation").

Denote by w_t^L, w_t^M and w_t^H the wage rate per unit of low-skilled, medium-skilled and high-skilled labor in period t, respectively. As will become apparent in Section 3, the equilibrium relative wage rates of medium-skilled workers compared to both other skill groups, w^M/w^L and w^M/w^H, are declining with Δ ("wage polarization").

[3]In contrast to Acemoglu and Autor (2011), high-skilled labor is only imperfectly substitutable to medium- and low-skilled labor, according to (1)-(3).

2.2 Individuals

Individuals live and work one period in non-overlapping generations. In each period a new cohort of size one is born. There are three sets of workers denoted by $\mathcal{L}$, $\mathcal{M}$ and $\mathcal{H}$ with possibly time-varying sizes $L \equiv |\mathcal{L}|$, $M \equiv |\mathcal{M}|$ and $H \equiv |\mathcal{H}|$, capturing the sets of workers with low, medium and high education, respectively. Each individual inelastically supplies one unit of labor. Thus, population sizes equal the total supply of the respective type of labor. For simplicity, we abstract from educational choice. There are no frictions in the labor market.

We now formalize the notion of Case and Deaton (2015, 2017) that socio-economic deprivation associated with automation and outsourcing leads to mental illness associated with despair and investigate under which circumstances it can explain the rising abuse of intoxicants. More precisely, the stress level associated with negative deviations (i.e. losses) from earnings aspirations causes mental illness, conditional on the education level. The notion is supported by evidence showing that lower socio-economic status leads to a higher probability of mental illness (see Reiss, 2013, and Pickett and Wilkinson, 2015, for surveys). Swendsen et al. (2010) argue that, in turn, mental illness causes illicit drug abuse.

We assume that aspirations come from the previous period's earnings relative to social comparison groups. Low-skilled workers compare themselves with medium-skilled workers, medium-skilled workers compare themselves with both low-skilled and high-skilled workers, and high-skilled workers compare themselves with medium-skilled workers. As will become apparent, only medium-skilled workers lose relative to their social comparison group such that

$$\frac{w_{t-1}^M}{w_{t-1}^L} \geq \frac{w_t^M}{w_t^L}, \; \frac{w_{t-1}^M}{w_{t-1}^H} \geq \frac{w_t^M}{w_t^H}, \tag{4}$$

irrespective of the evolution of (high-skilled) labor efficiency A_t. If (4) holds (the scenario we exclusively focus on), the probability that individual i becomes mentally ill in period

t is given by[4]

$$\lambda_t(i) = \begin{cases} \lambda^L \text{ for } i \in \mathcal{L}_t, \\ \lambda^M \cdot G\left(\frac{w_{t-1}^M}{w_{t-1}^L} - \frac{w_t^M}{w_t^L}, \frac{w_{t-1}^M}{w_{t-1}^H} - \frac{w_t^M}{w_t^H}\right) \text{ for } i \in \mathcal{M}_t, \\ \lambda^H \text{ for } i \in \mathcal{H}_t. \end{cases} \tag{5}$$

The first derivatives of function G are positive and $G(0,0) = 1$. Hence, a decline of relative wage rates of medium skilled workers compared to the previous period increases the likelihood to become mentally ill. From (5), we obtain the skill group-specific fraction of mentally ill individuals as a function of the distribution of wages in the previous and current period.

The severity of mental illness an individual i suffers from is denoted by $n(i)$. We allow for heterogeneity of the severity of mental illness such that, on average, mental illness may be more severe if the probability to become mentally ill is higher. This links the extensive and intensive margin of mental illness and illicit drug abuse. Formally, let $f(n;\lambda)$ denote the p.d.f. of n conditional on λ with support $\mathcal{N}(\lambda) \subset (0,1)$ and assume that expected value of n, $\bar{n}(\lambda) \equiv \int_{\mathcal{N}(\lambda)} nf(n;\lambda)\mathrm{d}n$, is non-decreasing in λ. Clinically, psychiastrists distinguish between mild and severe depression. In our context, $\bar{n}'(\lambda) > 0$ captures that stress caused by socio-economic deprivation raises the relative frequency of severe depression. In fact, empirical evidence suggests that occupation status, job strain, and job insecurity are a strong predictors of mental well-being scores and severity of depression (Stansfeld et al., 1998; Power et al., 2002).

The effective mental health status of individual i is denoted by $S(i)$. It depends negatively on the severity of mental illness an individual suffers from, $n(i)$, and is non-decreasing in his/her consumption level of health goods and services targeted to treat mental illness, $h(i)$, according to

$$S_t(i) = \begin{cases} 1 - n_t(i) + \kappa h_t(i)^{\theta_t} \text{ if } h_t(i) < \left(\frac{n_t(i)}{\kappa}\right)^{\frac{1}{\theta_t}} \equiv \bar{h}(n_t(i);\kappa,\theta_t), \\ 1 \text{ otherwise,} \end{cases} \tag{6}$$

[4]We allow the probability to become mentally ill to vary across education groups (SAMHSA, 2016) and calibrate the model accordingly. SAMHSA (2016) reports the fraction of individuals who suffered from a depressed state for at least two weeks in a given year.

where $\kappa > 0$ measures the (time-invariant) effectiveness of the health input and $\theta \in (0, 1]$ measures the (possibly time-variant) extent of decreasing returns in the health technology. The maximally effective health input, $\bar{h}$, achieves full recovery.

In addition to consuming a standard numeraire good, individuals may abuse intoxicants like opioids (e.g. heroine, fentanyl, tramadol). One unit of such drug can be bought at exogenous and possibly time-variant (world market) price q_t in period t. Let $c(i)$ and $d(i)$ denote consumption levels of the numeraire good and illicit drugs of individual i, respectively. Welfare of individual i in period t is represented by the utility function

$$U_t(i) = u(c_t(i), d_t(i), S_t(i)) \text{ with } u(c, d, S) \equiv \frac{S \cdot c^{\gamma} - \bar{u}}{(1 + d)^{\delta}}, \tag{7}$$

where $0 < \gamma \leq 1$, $0 < \delta < 1$, and $\bar{u}$ is an arbitrary constant. Property $u_{cS} > 0$ captures that a decline in health status S reduces the marginal utility of consumption, in line with evidence by Finkelstein et al. (2013). The innovation of modeling preferences as in (7) lies in the potential motivation of mentally ill persons to consume intoxicants. Illicit drug consumption is not beneficial when the numerator of function u is positive, i.e. $u_d < 0$. In this case, individuals would choose $d = 0$. If $\bar{u} > 0$, however, utility turns negative if health status, S, and the numeraire good consumption level, c, are sufficiently low such that $S \cdot c^{\gamma} < \bar{u}$. In this case, $u_d > 0$ and an individual may demand intoxicant drugs to dampen the pain or negative feelings associated with poor mental health and/or low consumption.[5] Properties $u_{cd} < 0$ and $u_{dS} < 0$ mean that higher consumption c or better health status S reduce the benefit from consuming intoxicants, respectively.

Ill individuals face two interesting trade-offs. First, they could reduce numeraire good consumption (c) to raise health good consumption (h) and thus improve mental health status (S). However, this may not help to prevent negative utility if an individual is poor to begin with and/or is severely affected by mental illness (i.e. has a high n). In this case, second, a mentally ill individual faces the trade-off to raise h or to consume intoxicants (d) for mitigating negative utility. The health system potentially affects both trade-offs

[5] We abstract from the impact of intoxicants on non-mental health status. Implicitly, we assume that individuals do not take into account such impact in their decision how much intoxicants to consume. Boundedly rational behavior of this sort appears plausible in a context of mental illness.

and is introduced next.

2.3 Health System

We focus on the part of the health insurance system that pays to a certain degree for the costs to treat mental illness. In the U.S., private health insurance is typically provided by employers. Empirical evidence strongly suggests that most workers do not choose or understand their health care plan with respect to coverage of costs of mental illness (e.g. Garnick, 1993; Meredith, 2001). Thus, we assume that mental health care plans are exogenous.

A fraction μ^L, μ^M, μ^H of the low-skilled, medium-skilled and high-skilled workforce has no private health insurance, respectively, $\mu^L > \mu^M > \mu^H \geq 0$. The uninsured low-skilled labor force receives a subsidy rate $\underline{s} \in (0, 1)$ for mental health costs, which in the U.S. may be thought of as Medicaid. Privately insured workers have a common health care subsidy rate, $\bar{s} > \underline{s}$, i.e. $1 - \bar{s}$ is the copayment rate. Privately uninsured medium- and high-income earners are not eligible for Medicaid, thus having a copayment rate of 100 percent.

The simple health system in our model captures in a stylized way the U.S. health system, in which private health insurance coexists with tax-financed Medicaid on behalf of poor, uninsured individuals. To simplify and focus on isolated effects, we neglect that some uninsured, non-poor are eligible for Medicaid and some uninsured poor are not.

Also for simplicity, all insured workers have the same proportional health care contribution rate, $\bar{\tau} \in (0, 1)$, i.e. absolute premia levels are rising with income to capture that higher income workers generally have more generous health care plans if insured. Health care plans typically come in a package that includes treatment for mental illness that we assume, however, not to be different across individuals. Privately insured health costs are financed in a pay-as-you-go fashion (i.e. the health care subsidy budget is balanced each period). For Medicaid, there is a separate budget. It is financed by general income taxes levied at rate $\underline{\tau}$ on medium and high-skilled workers,[6] whereas the low-skilled do not pay taxes for financing Medicaid. This captures a progressive tax system.

[6]The expenditure share of Medicaid in total government spending from all sources was 28.2 percent in 2012, see https://www.macpac.gov/subtopic/medicaids-share-of-state-budgets/.

The gross price of the health good in period t, r_t, is exogenously given by the world market and possibly time-variant. Because different types of individuals face different subsidy rates in the health system, the effective health good prices differ according to income class and insurance status.

3 Equilibrium Analysis

In order to isolate mechanisms, we start by taking contribution rates and copayment rates for private and public health care as given before introducing the finance constraints of the health system in the numerical analysis.

3.1 Households' Decisions

Denote by $y(i)$ the disposable income of individual i (net wage income after income-specific contributions to the health system) and by $R(i)$ the individual-specific health good price (copayment). With price q of intoxicants, the budget constraint of individual i in t reads as

$$c_t(i) \leq y_t(i) - q_t \cdot d_t(i) - R_t(i) \cdot h_t(i). \tag{8}$$

We will focus on interior solutions for the health input. According to (6), (7) and (8), neglecting constraint $0 \leq h \leq \bar{h}$, and assuming that (8) holds with equality, we can define the objective function of an individual with disposable income y, severity of mental illness n, and health good price R as

$$\tilde{u}(h, d; y, n, R, q, \kappa) \equiv \frac{\left(1 - n + \kappa h^{\theta}\right)(y - qd - Rh)^{\gamma} - \bar{u}}{(1 + d)^{\delta}}, \tag{9}$$

according to (7). The optimization problem of such an individual thus reads as

$$\max_{(h,d)} \tilde{u}(h, d; y, n, R, q, \kappa) \text{ s.t. } d \geq 0. \tag{10}$$

The optimal choices of health input, h, and illicit drug consumption, d, are denoted by h^* and d^*, respectively. Possibly, some individuals may not have (had) access to intoxicants or choose to abstain from them. The optimal health input conditional on that the individual is *not* taking intoxicants ($d = 0$) is denoted by $\hat{h}^*$. An interior solution for $\hat{h}^*$ is given by first-order condition $\tilde{u}_h(\hat{h}^*, 0; \cdot) = 0$. If the resulting utility is non-negative, $\tilde{u}(\hat{h}^*, 0; \cdot) \geq 0$, then it is also optimal not to consume intoxicant drugs, $d^* = 0$. We can show the following.

Proposition 1. *(i) If disposable income (y) is sufficiently high or if $\bar{u} \leq 0$, it is not optimal to consume illicit drugs, $d^* = 0$. (ii) An interior optimal health input in this case, $\hat{h}^*$, is increasing in disposable income, y, increasing in the severity of mental illness, n, increasing in the effectiveness of the health input, κ, and decreasing in the net health good price, R.*

Proof. See Appendix A. ■

Part (i) of Proposition 1 is very intuitive. Illicit drug consumption makes an individual worse off if the numerator in objective function (9) is positive, which is the case if disposable income is sufficiently high. In this case, an individual abstains from consuming intoxicants. However, if utility becomes negative, illicit drug consumption helps individuals to mitigate consequences from mental illness if low income neither allows them to afford sufficient health care treatment nor high enough a level of numeraire good consumption. Notably, although negative utility $\tilde{u}(\hat{h}^*, 0; \cdot) < 0$ is necessary, it will turn out not being sufficient for an interior solution, $d^* > 0$.

The comparative-static results in part (ii) of Proposition 1 (given that $d = 0$) are also easy to understand. Health good consumption is a normal good, i.e. it is increasing with disposable income, y. Moreover, marginal utility from numeraire good consumption is reduced by a greater severity of mental illness, n, inducing an increase in $\hat{h}^*$. Finally, an increase in the effectiveness of health care, κ, and a decrease in the health good price R (i.e. a lower copayment rate, $1 - s$) induces individuals to tilt the trade-off between health and material consumption towards health expenditure.

In the case of an interior solution for both choice variables, $0 < h^* < \bar{h}$ and $d^* > 0$, the following comparative-static results hold.

Proposition 2. *In an interior solution (h^*, d^*) of optimization problem (10):*

(i) An increase in disposable income (y) raises health spending, h^*, and, for $\gamma = 1$, lowers illicit drug consumption, d^*;

(ii) An increase in the severity of mental illness (n) raises d^*;

(iii) An increase in both the price of intoxicants (q) and in the effectiveness of health expenditure (κ) raises h^*while lowering d^*;

(iv) If $\gamma = 1$, then an increase in the net health good price (R) lowers h^* while raising d^*.

Proof. See Appendix A. ■

Again, because health status is a normal good, health good consumption, h^*, is increasing in disposable income, y. Part (i) of Proposition 2 says that, for $\gamma = 1$, the illicit drug is an inferior good that presumes "negative utility" associated with mental illness and low income (Proposition 1). According to part (ii) of Proposition 2, greater severity of mental illness induces individuals to mitigate the hardships of their lives by raising illicit drug consumption, d^*. An increase in drug price, q, reduces d^* and induces individuals to raise h^* instead. Similarly, according to part (iii) of Proposition 2, medical progress that raises the effectiveness of health care induces individuals to substitute away from illicit drugs towards health expenditure. In the case where $\gamma < 1$, the impacts of a higher price of health goods (R) on h^* and d^* are ambiguous. The reason is that an increase in R may not reduce health input, h^*, because individuals may respond by lowering their illicit drug intake which increases their budget for other goods. Such outcome does not arise though in the case where $\gamma = 1$, according to part (iv) of Proposition 2.

3.2 Firms' Decisions

Denote by P_t the price of the composite input and $p_t(j)$ the price of task j in t. The representative firm in the final good sector solves profit maximization problem

$$\max_{\{y_t(j)\}_{j\in[0,1]}} (A_t H_t^Y)^\beta (X_t)^{1-\beta} - w_t^H H_t^Y - P_t X_t. \tag{11}$$

Using equilibrium condition $H^Y = H$, associated first-order conditions imply

$$w_t^H = \beta(A_t)^\beta \left(\frac{X_t}{H_t}\right)^{1-\beta}, \tag{12}$$

$$P_t = (1-\beta)\left(\frac{A_t H_t}{X_t}\right)^\beta. \tag{13}$$

Using the production function of the composite input (2), the representative firm producing X solves profit maximization problem

$$\max_{\{x_t(j)\}_{j\in[0,1]}} \left\{ P_t \exp\left(\int_0^1 \log x_t(j)\mathrm{d}j\right) - \int_0^1 p_t(j)x_t(j)\mathrm{d}j \right\}. \tag{14}$$

First-order conditions are given by $p(j) = PX/x(j)$, $j \in [0,1]$. Thus, we have

$$\int_0^1 \log p_t(j)\mathrm{d}j = \log P_t + \underbrace{\log X_t - \int_0^1 \log x_t(j)\mathrm{d}j}_{=0} = \log P_t, \tag{15}$$

where the latter follows from (2). Wage rates are given by the value of their marginal products. According to task production function (3),

$$w_t^L = p_t(j)\alpha_t^L(j) \text{ for any } j < J_t, \tag{16}$$

$$w_t^M = p_t(j)\alpha_t^M(j) \text{ for any } j \in \mathcal{Z}_t. \tag{17}$$

Using next that $p(j)x(j) = p(j')x(j') = PX$ for any $j, j' \in [0,1]$ and again making use of (3) yields

$$p_t(j)\alpha_t^L(j)l_t(j) = p_t(j')\alpha_t^L(j')l_t(j') \text{ for any } j, j' < J_t. \tag{18}$$

Substituting (16) in (18) implies that $l(j) = l(j') > 0$ for any $j, j' < J$. Also using $l(j) = 0$ for any $j \geq J$, labor market clearing condition $\int_0^1 l(j)\mathrm{d}j = L$ for the low-skilled implies

$$l_t(j) = \frac{L_t}{J_t} \text{ for any } j < J_t. \tag{19}$$

Similarly, for the medium-skilled, $m(j) = m(j') > 0$ for any $j, j' \in \mathcal{Z}$ and $m(j) = 0$ for any $j \notin [J, 1]$. With a loss of middle class jobs of size Δ, we find

$$m_t(j) = \frac{M_t}{1 - \Delta_t - J_t} \text{ for any } j \in \mathcal{Z}_t. \tag{20}$$

Combing first-order conditions $p(j)x(j) = PX$ for all j with (3) also implies

$$p_t(j)\alpha_t^L(j)l_t(j) = p_t(j')\alpha_t^M(j')m_t(j') \text{ for } j < J_t \text{ and } j' \in \mathcal{Z}_t. \tag{21}$$

Using (16), (17), (19), (20) and (21), we find

$$w_t^L \frac{L_t}{J_t} = w_t^M \frac{M_t}{1 - \Delta_t - J_t}. \tag{22}$$

At the threshold level J_t, the unit costs of producing with low-skilled and medium-skilled labor must be the same, i.e. equilibrium condition

$$\frac{w_t^L}{\alpha_t^L(J_t)} = \frac{w_t^M}{\alpha_t^M(J_t)} \tag{23}$$

must hold. Combining (22) and (23) and assuming an interior solution, J_t is then implicitly given by

$$\frac{1 - \Delta_t - J_t}{J_t} \frac{L_t}{M_t} = \omega_t(J_t) \left[= \frac{\alpha_t^M(J_t)}{\alpha_t^L(J_t)} \right]. \tag{24}$$

Proposition 3. *Equilibrium threshold value J_t (that separates tasks performed by low-skilled and medium-skilled workers) is decreasing in both the loss of tasks of middle class workers, Δ_t, and relative supply of medium to low skills, M_t/L_t. We have $\partial J_t/\partial \Delta_t \in (-1, 0)$.*

Proof. Apply the implicit function theorem to (24) and recall that $\alpha_t^M(j)/\alpha_t^L(j)$ is increasing in j; thus, $\omega_t'(j) > 0$. ■

Proposition 3 shows that outsourcing forces medium-skilled workers to perform tasks formerly executed by low-skilled workers. If Δ increases, then both groups are left with a lower task range. The effects on relative wage rates of the two groups are to the disadvantage of medium-skilled workers whose jobs have been outsourced, as shown next (with superscript (*) denoting equilibrium levels).

Proposition 4. *In equilibrium, the relative wage rate of medium- to low-skilled workers is given by*

$$\frac{w_t^{M*}}{w_t^{L*}} = \omega_t(J_t). \tag{25}$$

w_t^{M*}/w_t^{L*} *is decreasing in both* Δ_t *and* M_t/L_t*, and independent of* A_t*.*

Proof. The comparative static results of Proposition 4 follow from the comparative static results from Proposition 3. ■

We turn next to the relative wage rate of medium- to high-skilled workers.

Proposition 5. *The equilibrium (log) relative wage rate of medium- to high-skilled workers is given by*

$$\log\left(\frac{w_t^{M*}}{w_t^{H*}}\right) = \log\left(\frac{1-\beta}{\beta}\right) - \log\left(\frac{M_t}{H_t}\right) + \log\left(1 - \Delta_t - J_t\right). \tag{26}$$

w_t^{M*}/w_t^{H*} *is decreasing in* Δ_t*,* L_t/M_t *and* M_t/H_t*, and independent of* A_t*.*

Proof. See Appendix A. ■

Proposition 5 shows that outsourcing or automation worsens the earnings position of medium-skilled workers also relative to high-skilled workers, causing wage polarization. Moreover, according to (25) and (26), the relative wage rate of medium-skilled labor to both other skill groups does not depend on the efficiency parameter of high-skilled labor, A. This is in stark contrast to Acemoglu and Autor (2011), who assumed that high-skilled labor can be perfectly substituted by labor with lower skill. High-skilled labor saving technological progress thus does not affect the probability of medium-skilled workers to become mentally ill, according to (5) and Proposition 4 and 5.

3.3 Outsourcing, Mental Health, and Illicit Drug Consumption

Putting things together, we arrive at the following result.

Corollary 1. *Outsourcing or automation of tasks formerly performed by medium-skilled workers (increase in* Δ*) (i) raises the fraction of mentally ill middle class workers and (ii) leads to an increase in illicit drug consumption in the middle class. (iii) If* $\bar{n}'(\lambda) >$

0, then an increase in Δ also raises the average severity of mental illness among mentally ill middle class workers. (iv) High-skilled labor saving technological progress (increase in A) does neither affect the fraction of mentally ill middle class workers nor the average severity of their mental illness.

Proof. Part (i) of Corollary 1 follows in view of (5) from the results that an increase in Δ lowers both w^{M*}/w^{L*} (Proposition 4) and w^{M*}/w^{H*} (Proposition 5). Part (ii) of Corollary 1 follows from its part (i) and, in the case where $\bar{n}'(\lambda) > 0$, also from parts (ii) of Proposition 1 and 2. Part (iii) of Corollary 1 follows from part (i) of Corollary 1. Part (iv) of Corollary 1 is implied by (5) and the neutrality of relative wages of medium-skilled workers with respect to A, according to Proposition 4 and 5. ■

4 Calibration

We calibrate the model to examine both levels and changes over time of mental health care expenditure, drug consumption, and welfare of the different subgroups, taking into account the health care budget constraints.[7] The calibration of the production side, particularly the extent of outsourcing, Δ, matches the changes in the earnings distribution over time, whereas an increase in productivity parameter A captures unbiased wage growth (Proposition 4 and 5). The household side and health instruments are calibrated to match, *inter alia*, the expenditure share on mental illness by taking into account that the price of intoxicants, q, has markedly fallen in the last decades. We then perform counterfactual analysis, assuming that q has remained constant over time and that socio-economic deprivation has not taken place. We finally investigate the implications of extending Medicaid.

4.1 Supply Side

We specify $\alpha^M(j) = 1$ and $\alpha^L(j) = B/j$ to be time-invariant, $j \in [0, 1]$, where $B > 0$ is a productivity parameter. We consider the time period 1979 (roughly the starting date of steady increases in the college-premium) to 2007 (the onset of the financial crisis). The

[7] The derivations of the budget constraints for tax-financed Medicaid and contribution-financed subsidies for private health insurance are relegated to Appendix B.

length between t and $t+1$ is roughly 10 calendar years.

We use data from BLS (2017) on the educational attainment of the civilian workforce to determine relative group sizes. We associate low-skilled workers with those having less education than a high school degree, medium-skilled workers as either high school graduates or workers with some college (without degree), and high-skilled workers as those with a bachelor degree or more. From 1979 to 2007 the fraction of the low-skilled population, L, declined from 0.20 to 0.09 and the high-skilled population share, H, increased from 0.22 to 0.33. The size of the middle class, M, increased from 0.57 to 0.6 in 1990 and then declined to 0.57 in 2007; in other words, it stayed roughly constant.

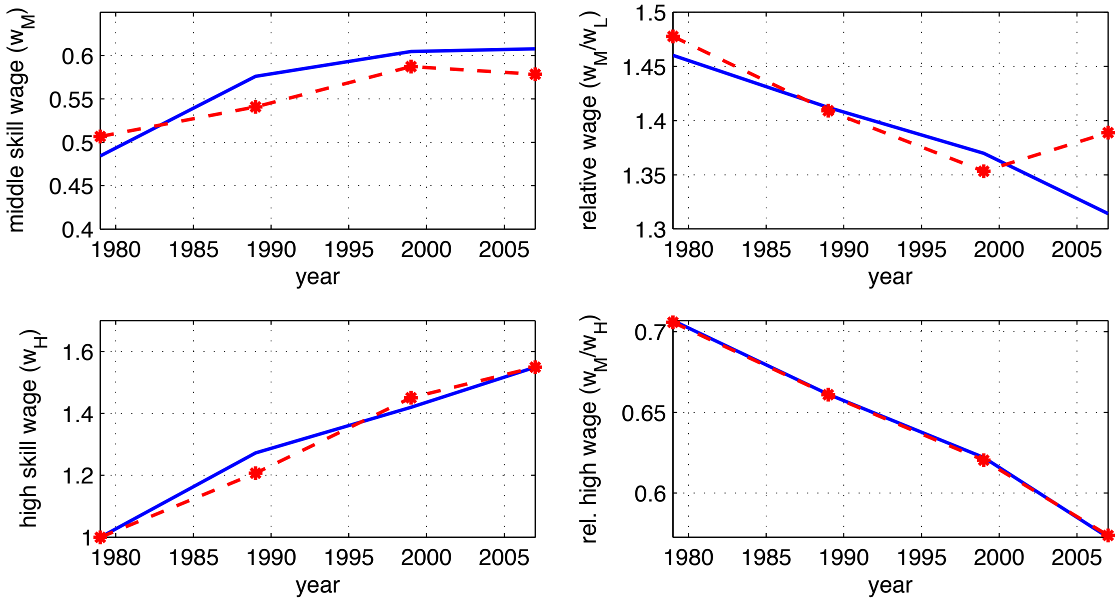
We follow Acemoglu and Autor (2011) and associate "Professional, Managerial, Technical Jobs" with tasks performed by high-skilled workers, "Clerical, Sales, Production, and Operators" with tasks performed by middle class workers, and Service jobs with tasks performed by low-skilled workers. From their Table 3b we compute the time series of the relative wages, w_M/w_L and w_M/w_H, from 1979 to 2007.

We estimate the output elasticity of high-skilled labor (β), the parameter capturing productivity of medium-skilled workers (B), the high-skilled labor efficiency parameter in 1979 (A_{1979}) and the mass of rationed middle class jobs in 1979 (Δ_{1979}), such that we match the 1979 levels w^H_{1979}, w^M_{1979}/w^L_{1979}, w^M_{1979}/w^H_{1979}, and w^M_{1979}. We estimate a constant trend growth rate of A_t such that we match the growth rate of high-skilled wages w^H_t. Finally, we estimate the evolution of the extent of outsourcing, Δ_t, such that we match the empirical w^M_t/w^H_t time series exactly. This leads to the estimates $\beta = 0.3$, $B = 0.04$, $\Delta_{1979} = 0.43$, $\Delta_{1989} = 0.465$, $\Delta_{1999} = 0.495$, $\Delta_{2007} = 0.533$. The implied annual growth rate of A_t is 5.4 percent, corresponding to an annual growth rate in the wage rate of high-skilled labor of 2.0 percent. Results are shown in Figure 1. The model predictions (solid lines) match the observed time series (dashed-crossed lines) reasonably well.

4.2 Household Side and Health Instruments

For the calibration of household income, we feed in the wages of the three different classes from the production side. Since 1979 is our first year with wage data, we look at outcomes from year 1989 onwards (to have a period to compare wages with). The final year is

Figure 1: Fit of calibrated model with earnings data.



Note: Solid lines display model earnings; dashed lines display data for the years 1979, 1989, 1999, 2007 (Acemoglu and Autor, 2011; BLS, 2017).

2007 (with wage comparison to year 1999). We also start by assuming that all mentally ill individuals face the same severity of mental illness irrespective of their skill-specific probability to become ill − an assumption that is relaxed later on. We set $n(i) = 0.5$ for all i as an intermediate value for the benchmark run. We also set $\gamma = 0.7$ (determining the marginal utility of numeraire consumption) and the utility constant to $\bar{u} = 14$. These values imply that, at any year, utility is positive for non-depressed individuals and that utility turns negative for depressed low- and middle-income individuals if they receive no anti-depression therapy (i.e. for $h = 0$). This means that we set up a scenario of "despair", as motivated by Case and Deaton (2015, 2017), in which depression among the middle class is partly caused by lost social status. In this setup, the rich consume no drugs, capturing the notion that there is no despair motive that drives their drug consumption.[8]

Empirical evidence suggests a mental health-education gradient, such that $\lambda^H \leq \lambda^M <$

[8]As the rich do not experience negative utility, they do not consume intoxicants in our model. The rich (like other individuals) may consume drugs for fun and recreational purpose − a motive that is not captured in our model.

λ^L (SAMHSA, 2016). However, even if $\lambda^M < \lambda^L$, the fraction of mentally ill individuals may become higher in the medium-skilled group than among the low-skilled when relative wages of the medium-skilled decline, according to (4) and (5). We calibrate an aggregate share of 7 percent of depressed Americans (SAMHSA, 2016). We assume that without socio-economic deprivation of the middle-class, medium-skilled workers would have the same prevalence of depression as high-skilled workers but given their socio-economic deprivation from (roughly) 1979 onwards they have the same prevalence as the low-skilled in year 1989. This leads to the "estimates" $\lambda^L = 0.085$, $\lambda^M = \lambda^H = 0.05$. Function G, capturing the impact of social comparisons of medium-skilled workers on the prevalence of depression, is parameterized as

$$G = 1 + \chi \left[\psi \left(\frac{w_{t-1}^M}{w_{t-1}^L} - \frac{w_t^M}{w_t^L} \right) + (1-\psi) \left(\frac{w_{t-1}^M}{w_{t-1}^H} - \frac{w_t^M}{w_t^H} \right) \right], \tag{27}$$

$\chi > 0$, $0 < \psi < 1$. We assume that the middle class is mainly socially upward oriented, $\psi = 0.1$, and calibrate $\chi = 15$ to induce an equal fraction (8.5 percent) of mentally ill workers among the poor and the middle class in 1989 as response to relative wage changes between 1979 and 1989 (Figure 1). The length between $t-1$ and t is 10 years except for the last period where it is 8 years (recall that the empirical series in Figure 1 displays data for years 1979, 1989, 1999 and 2007).

We set the (gross) price of the health good to $r = 1$ for year 1979 and let it grow similarly to the wage rate of high skilled labor, w^H. The evolution of the price of intoxicants in the observation period depends, of course, on the considered type of drug. In the benchmark run we conceptualize q as the heroin price. We set $q = 1$ in the initial year 1989 and assume in line with data from the United Nations Office on Drugs and Crime that q has declined to 76 percent of its initial value in 1999 and to 51 percent of its initial value in 2007 (see The Economist, 2009). We will contrast the benchmark results with the scenario where drug prices stayed constant.

We assume that the following group shares are not covered by private insurance: 80 percent of the poor ($\mu^L = 0.8$), 50 percent of the middle class ($\mu^M = 0.5$), and 20 percent of the rich ($\mu^H = 0.2$). Compared to MEPS (2000) data these values are too high but the MEPS data includes also children and the elderly. The age-specific data, on the other hand, is not stratified by income group. The most accurate way would be to obtain the shares by hand from the micro data on which the MEPS survey is based. Here, we rely on KFF (2013). There, we see that 20 percent of the non-elderly poor are privately insured (justifying $\mu^L = 0.8$), 48 percent are insured by Medicaid, and 32 percent are uninsured. Thus, we set the health care subsidy for the uninsured poor to $\underline{s} = 48/(48 + 32) = 0.6$.

We choose preference parameter $\delta = 0.4$ such that, when mentally ill, poor individuals spend about 30 percent of their income on intoxicants and middle class individuals spend about 10 percent.[9] The value of κ controls how much mental health is repaired by the treatment. We set $\kappa = 0.15$ such that in the benchmark scenario up to 70 percent of mental health is restored by therapy.

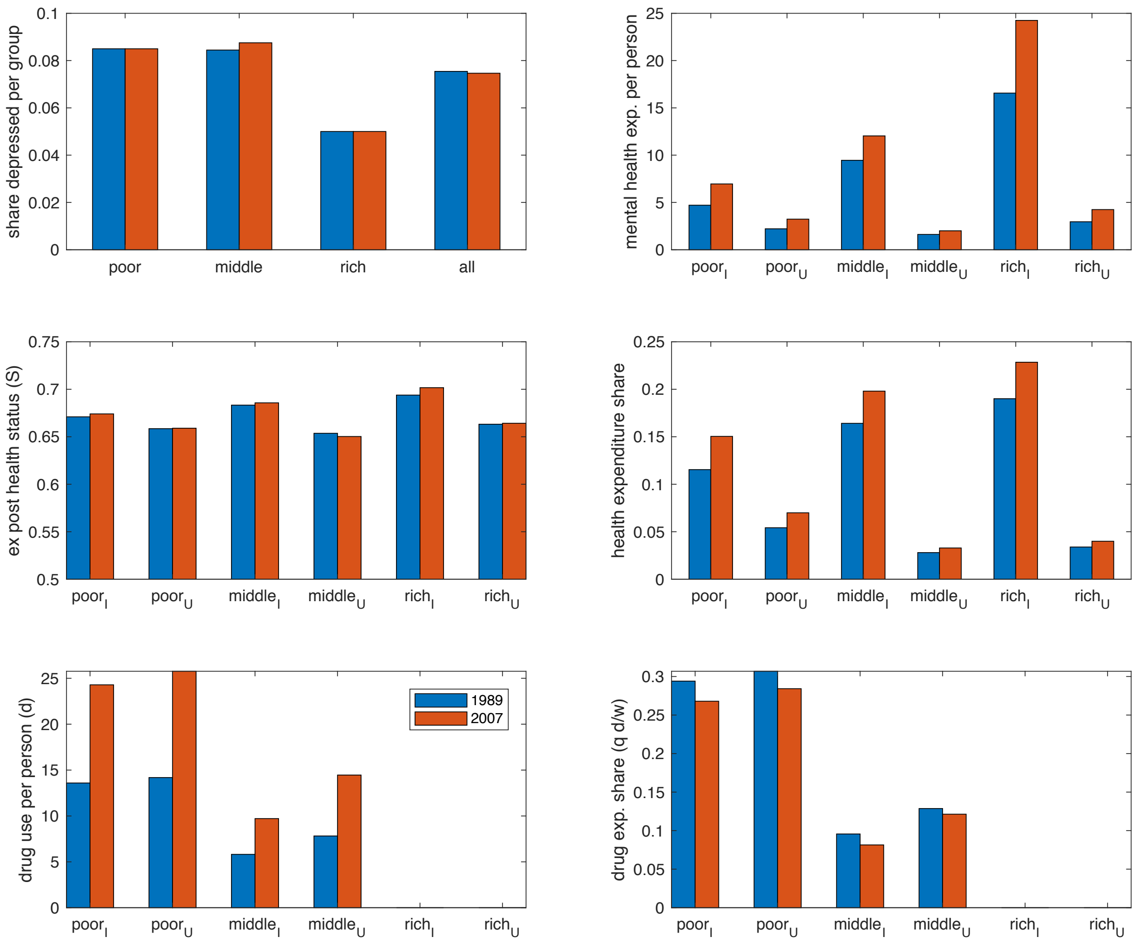
For the basic run we set the private health care subsidy to $\bar{s} = 0.8$, roughly matching the median out-of pocket share of health expenditure of about 17 percent (Machlin and Carper, 2014). About 6 percent of all health expenditure is spent on mental health with little variation over time (SAMSHA, 2016, Exhibit 3). Taken together with the information of a health expenditure share in GDP of about 12.5 percent in 1989 and 16.0 percent in 2007, we infer a mental health expenditure share of 0.0075 in 1989 and of 0.0096 in 2007. We adjust θ, $\bar{\tau}$, and $\underline{\tau}$ such that the empirical mental health expenditure shares are matched and the budget constraints for Medicaid and the private insurer are balanced. This leads to the estimates $\theta = 0.1$, $\underline{\tau} = 0.00021$ and $\bar{\tau} = 0.0093$ for the year 1989 and $\theta = 0.119$, $\underline{\tau} = 0.00018$ and $\bar{\tau} = 0.0109$ for the year 2007. Thus, the anyway very low tax rate for financing treatment of the insured poor declines somewhat over time while the private health insurance premium slightly increases. Notice that these numbers apply to mental health and not to total health expenditure.

[9] These expenditure shares are meant to capture expenditure for a "drug mix". If the consumed drug were solely heroine, the implied expenditure would be nearly 100 percent for the poor and about 25 percent for the middle class (Kilmer et al., 2014). If the drug were solely marijuana the implied expenditure shares would be about 8 percent for the poor and 2 percent for the middle class (Brown, 2017).

5 Numerical Results 1: Time Trends

5.1 Benchmark Case

Figure 2: Outcomes for the calibrated model (benchmark case), 1989 vs. 2007



Note: Referring to the mentally ill, subscript I refers to the respective income group with private insurance, subscript U refers to those without private insurance.

Figure 2 shows the results for the benchmark scenario, in which q is decreasing over time from 1989 onwards and the middle class experiences socio-economic deprivation as displayed in Figure 1.

We compare outcomes for the income groups (poor, middle, rich) by private health insurance status (uninsured, insured) in 1989 and 2007. The uninsured poor have access to Medicaid, in contrast to the other groups.

5.1.1 Mental Health Status and Health Expenditure

According to the upper left panel of Figure 2, the fraction of mentally ill middle income earners is somewhat higher in the later year. This is the response to status loss under falling relative wages over time (Figure 1), as formalized in (5). All other panels show outcomes for workers having developed mental illness. We see an income gradient in mental health expenditure (including subsidies) for the privately insured (subscript I) in absolute terms (upper right panel) and as a fraction of gross income (middle right panel). For the privately uninsured (subscript U), health expenditure of the mentally ill is U-shaped in income due to the public subsidy (Medicaid) on health expenditure. Strikingly, insurance status creates large differences in the health expenditure shares. Particularly the uninsured middle class spends comparatively little on mental health treatment.

Table 1 provides numbers. In the low income class, the uninsured spend about half on mental health compared to the insured in 1989 and 2007 ($h_t^{L,U}/h_t^{L,I} - 1 \approx -0.53$). The gap is much higher in the middle income class where the uninsured have 83 percent lower health spending than the insured in both years.

From Figure 2, we see the income gradient for the insured and the U-shape for the uninsured also in terms of *ex post* (i.e. after treatment) mental health (middle left panel). Like the U-shape with respect to health expenditure, the latter is of course to some degree imposed by the assumption that no middle income earner is eligible for Medicaid whereas in the data there are some beneficiaries (see KFF 2013). We see also that for insured middle income earners, *ex post* mental health (middle left panel) improves over time although *ex ante* mental health (upper left panel) deteriorates. By contrast, *ex post* mental health status of uninsured middle income earners, declines mildly over time. The reason is that socio-economic deprivation induces a substitution away from health spending towards drug consumption and this substitution is stronger for the uninsured. Notably, the outcome is special to the middle class. For the poor and rich, mental health improves irrespective of insurances status and the improvement is more pronounced for the insured.

Table 1 reports the percentage changes of mental health expenditure over time of

Table 1: Mental Health, Consumption of Intoxicants and Welfare, 1989-2007

	case 1 bench	case 2 const price	case 3 const status	case 4 const status const price	case 5 var n	case 6 var n const price
$\Delta\log(rh^{L,I})$	47.66	51.03	71.04	74.41	66.13	70.27
$\Delta\log(rh^{L,U})$	46.22	49.57	69.68	73.00	65.08	69.28
$\Delta\log(rh^{M,I})$	27.27	29.24	55.23	55.23	38.61	40.82
$\Delta\log(rh^{M,U})$	23.77	25.71	58.13	58.13	33.70	35.98
$\Delta\log(rh^{H,I})$	46.40	46.40	46.40	46.40	57.75	57.75
$\Delta\log(rh^{H,U})$	43.48	43.48	43.48	43.48	54.08	54.08
$\Delta\log d^{L,I}$	78.66	-14.02	50.23	-28.98	66.08	-20.38
$\Delta\log d^{L,U}$	81.63	-12.24	55.06	-26.22	71.75	-17.15
$\Delta\log d^{M,I}$	66.97	-28.34	-100.00	-100.00	230.74	51.34
$\Delta\log d^{M,U}$	84.89	-15.52	-100.00	-100.00	222.71	53.76
$h^{L,U}_{1989}/h^{L,I}_{1989}-1$	-53.04	-53.04	-53.02	-53.02	-52.50	-52.50
$h^{M,U}_{1989}/h^{M,I}_{1989}-1$	-82.90	-82.90	-82.85	-82.85	-81.95	-81.95
$d^{L,U}_{1989}/d^{L,I}_{1989}-1$	4.34	4.34	4.61	4.61	6.41	6.41
$d^{M,U}_{1989}/d^{M,I}_{1989}-1$	34.51	34.51	60.44	60.44	58.36	58.36
$h^{L,U}_{2007}/h^{L,I}_{2007}-1$	-53.50	-53.50	-53.39	-53.40	-52.80	-52.78
$h^{M,U}_{2007}/h^{M,I}_{2007}-1$	-83.37	-83.37	-82.53	-82.53	-82.59	-82.57
$d^{L,U}_{2007}/d^{L,I}_{2007}-1$	6.07	6.50	7.98	8.68	10.04	10.72
$d^{M,U}_{2007}/d^{M,I}_{2007}-1$	48.95	58.56	–	–	54.52	60.89
$\xi^{L,I}_{1989}$	2.95	2.95	3.02	3.02	13.87	13.87
$\xi^{L,U}_{1989}$	3.13	3.13	3.19	3.19	15.19	15.19
$\xi^{M,I}_{1989}$	2.80	2.80	2.52	2.52	8.92	6.92
$\xi^{M,U}_{1989}$	3.30	3.30	3.05	3.05	9.04	9.04
$\Delta\xi^{L,I}$	0.62	0.19	0.65	0.08	1.19	-2.46
$\Delta\xi^{L,U}$	0.73	0.24	0.77	0.14	1.73	-2.39
$\Delta\xi^{M,I}$	0.40	-0.18	-0.75	-0.75	5.29	2.27
$\Delta\xi^{M,U}$	0.71	-0.05	-1.15	-1.15	8.32	3.98

Upper part: the first index identifies the class (L low income, M middle, H high); the second index identifies the insurance status (I insured, U uninsured). All changes in percent relative to 1987 levels. Middle part: relative health care and drug consumption of uninsured vs. insured individuals by skill group and year. All changes in percent. Lower part: welfare and welfare changes in consumption equivalents. $\xi^{i,j}$ is the factor by which consumption of a depressed individual of group i,j need to increase to obtain the utility of a healthy individual of the same group, both evaluated in the base year (1989). $\Delta\xi^{i,j}$ is the change of the consumption equivalent from 1987 to 2007.

different types and the skill-specific health expenditure levels of uninsured relative to insured individuals in each group. Column (1) of Table 1 refers to the baseline calibration (case 1). For instance, $\Delta\log(rh^{M,U})$ is the percentage change in mental health expenditure of an uninsured medium-skilled worker between 1989 and 2007. Because of income growth (driven by the constant growth rate of high-skilled labor efficiency A), all mentally ill spend more on health over time. Uninsured middle class workers have the lowest health expenditure increase (24 percent), but only slightly less than the insured middle class. The poor and the rich have higher expenditure increases (43-48 percent) than the middle class thanks to their higher wage growth.

5.1.2 Drug Consumption

The model predicts an income gradient in illicit drug consumption. Per mentally ill person, the poor spend more on drugs in both years (lower left panel of Figure 2). Consistent with the evidence by Case and Deaton (2015, 2017), the model predicts that the *increase* in drug consumption is highest for the uninsured middle class. It increases by $\Delta\log d^{M,U} = 85\%$ from 1989 to 2007 (and by 67 percent for the insured middle class), according to column (1) in Table 1. The privately uninsured poor come second with an increase by 82 percent (and 79 percent for the insured). These results correspond well this with the actual increase of 62 percent for the poor and 77 percent for middle income earners (CDC, 2015). However, we should not stress the comparison too much since the CDC reports prevalence while our model, strictly speaking, produces mostly increases in the intensity of drug use.

Because of income growth, the drug expenditure share for the poor and the middle class is somewhat decreasing over time but remains substantial also for the later year (lower right panel of Figure 2). A particularly interesting outcome is that uninsured middle income workers spend significantly more than the insured and their relative spending $d^{M,U}/d^{M,I}$ is higher for the later year. According to column (1) in Table 1, in the year 2007 an uninsured middle income earner spends 49 percent more on drugs than an insured one (34.5 percent in 1989). The drug expenditure share is higher for the poor but, in contrast to the middle class, there is little difference between the insured and uninsured ($d^{L,U}$ is just 6 percent higher than $d^{L,I}$ in both years). Again, this reflects that the uninsured poor are eligible for Medicaid, whereas the lack of health insurance may be an important cause of drug consumption for mentally ill middle class workers.

5.1.3 Welfare

In the lower part of Table 1 we report the implied welfare level and welfare change for within-group comparisons of mentally ill versus healthy people. Welfare is measured in consumption equivalents. For instance, we denote by $\xi_{1989}^{M,U}$ the factor by which numeraire good consumption of a mentally ill medium-skilled worker without health insurance needs to increase to obtain the utility of a healthy individual of the same group, both evaluated in the base year (1989).

In 1989, consumption of an uninsured, middle class individual would need to rise by factor 3.3 to compensate for mentall illness, which is slightly higher than for the other non-rich. $\Delta\xi^{M,U}$ is the change of the consumption equivalent from 1989 to 2007 for the same type of worker, which increased by 0.71 in the considered time period. We see that, for all non-rich groups, the welfare distance between mentally ill and healthy individuals got larger over time, with a larger increase for uninsured individuals.[10]

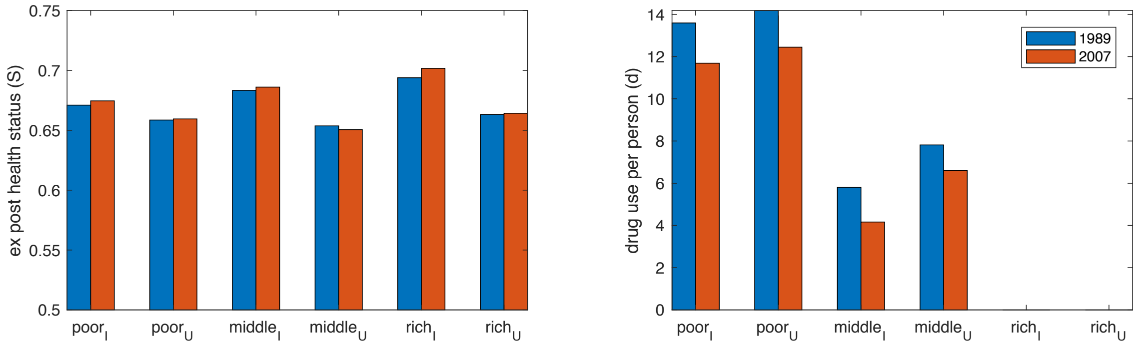
5.2 Constant Drug Price

In a second case we investigate the impact of the price reduction of drugs by switching to the constant drug price scenario ($q = 1$ instead of q declining over time). Results are reported in column (2) of Table 1.

The main difference of case 2 to the benchmark case 1 lies in the type-specific consumption of intoxicants for both comparison years, visualized in the panel on the right-hand side of Figure 3. We see that the increase in drug consumption at the intensive margin in the benchmark case for the period 1989-2007 was entirely motivated by the price decline. Comparing Figure 2 and 3 suggests that, if drug prices stayed constant, drug consumption at the intensive margin would have declined for poor and middle class individuals. After-treatment mental health status of uninsured middle class people, however, is still

[10]Our analysis abstracts from the impact of illicit drug consumption on non-mental health status and addiction − issues that would require a considerably more complicated framework. Our results thus are likely to underestimate welfare changes over time.

Figure 3: Mental health status and consumption of intoxicants with time-invariant drug price q, 1989 vs. 2007



somewhat lower in the later year (as shown in the left-hand side panel of Figure 3), despite increasing health expenditure (as reported in column (2) of Table 1).

From columns (1) and (2) of Table 1 we also see that the increase over time of the welfare distance to healthy individuals (in terms of consumption equivalent) is smaller for the poor than in the benchmark case and actually reverses slightly for the middle class. This means that welfare of mentally ill middle class individuals would have improved mildly over time, compared to their healthy group counterparts, if drug prices stayed constant.

5.3 No Socio-Economic Deprivation

We next counterfactually abolish socio-economic deprivation by assuming that wages of low- and medium-skilled workers grow at the same rate as high-skilled wages. In case 3, we assume in addition that drug prices are declining, like in case 1. Results are shown in column (3) of Table 1. Interestingly, we see that despite falling drug prices the middle class lowers drug consumption over time to zero. Income of the middle class is now increasing sufficiently fast that medical treatment becomes the exclusive way of dealing with mental illness even for the uninsured. As a result, the welfare wedge between healthy and unhealthy middle class individuals declines substantially over time.

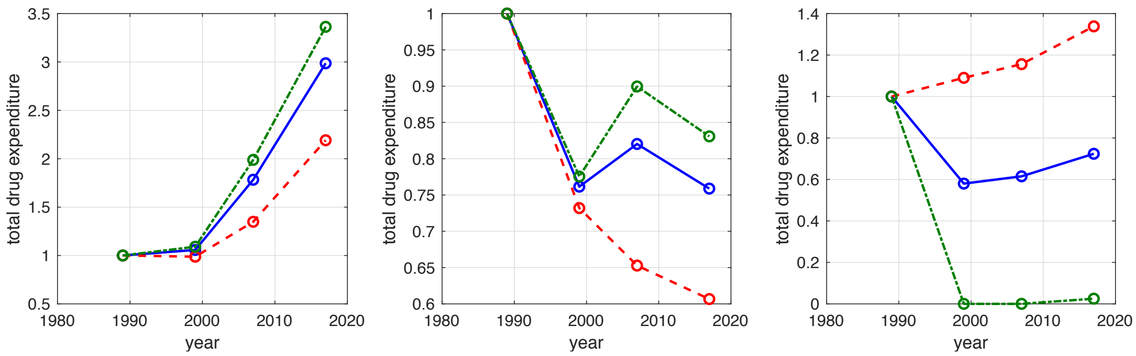
With constant drug prices (case 4), according to column (4) of Table 1, like in case 2, also the low-skilled reduce their drug consumption over time albeit, in contrast to the middle class, not fully. The welfare difference to the healthy counterparts basically remains unchanged.

Comparing the results to benchmark case 1, cases 3 and 4 suggest that both falling drug prices and economic deprivation are necessary to elicit increasing drug consumption of the middle class. It is thus the interaction between both forces that matter, reconciling the "despair hypothesis" with the evidence from Ruhm (2018) that relative deprivation alone cannot explain rising drug consumption.

5.4 Aggregate Drug Consumption

We next look at the evolution of aggregate drug consumption in cases 1-3, for the different skill groups and the total population. In order to compare with more recent data we also extrapolate trends for another period, i.e. from 2007 to 2017. For that purpose we interpolate nonlinearly the past trends from 1979 to 2007 for wages and prices for health care and drugs.

Figure 4: Total Drug Consumption 1989–2017



Blue (solid) lines: total drug consumption; red (dashed) lines: total drug consumption of the poor; green (dash-dotted) lines: total drug consumption of the middle class. All values relative to drug consumption in 1989. Values for 2017 extrapolated from past trends of wages and prices. Left panel: benchmark run (case 1); middle panel: constant drug price (case 2); right panel: constant status (case 3).

Results are shown in Figure 4. To derive percentage changes, the values for 1989 are normalized to unity. Blue lines reflect aggregate drug consumption of the total population, relative to its 1989 value. Red lines show aggregate drug consumption of the poor relative to the year 1989, and green lines show aggregate drug consumption of the middle class relative to the year 1989. The panel on the left hand side shows the benchmark scenario (case 1). We see that drug consumption is predicted to increase further from 2007 to 2017 where it reaches a level that is three times higher than the 1989 value. The increase is steepest for the middle class (albeit starting from a lower level compared to the low-skilled, according to Figure 2).

In the middle panel we see aggregate drug expenditures when the drug price stays constant (case 2). We see that drug consumption of the poor falls during the observation period and is predicted to fall further. The steep fall until 2007 also reflects the decline in the supply of low-skilled labor. The group of medium-skilled stayed roughly constant and the combination of falling relative but rising absolute wage rates generates a non-monotonic time paths of drug consumption, with the 2017 level being at 83 percent of the 1989 level. Total drug consumption falls to about three quarters of the initial level.

The panel on the right-hand side of Figure 4 shows the counterfactual result if there is no socio-economic deprivation ("constant status") but the drug price is decreasing (case 3). Then, aggregate drug consumption increases for the poor despite falling group size and is predicted to rise further after 2007. For the middle class, illicit drug consumption falls to virtually zero. As a result, aggregate drug consumption in the total population is falling until 1999 and then only mildly rising to about three quarters of the 1989 value.

We can thus conclude, again, that explaining the sharp increase of aggregate drug consumption as observed in the U.S., requires both falling drug prices and relative deprivation of the middle class.

6 Numerical Results 2: Effects of Medicaid Reform

The key feature of our analysis is that illicit drug consumption is a potential substitute for mental health care for those hit by mental illness. Consequently, in particular the uninsured consume more drugs over time under the conditions highlighted in the previous section. This points to a potentially important role of the Medicaid system to which we turn now.

Table 2: Health Expenditure, Drug Consumption, and Welfare 2007

	constant n			variable n		
	case 1	ext MDCD	gen MDCD	case 5	ext MDCD	gen MDCD
$rh^{L,I}$	6.96	6.96	6.96	8.95	8.92	8.92
$rh^{L,U}$	3.24	3.24	5.52	4.23	4.23	7.15
$rh^{M,I}$	12.04	12.01	12.01	15.78	15.67	15.67
$rh^{M,U}$	2.00	5.62	9.54	2.75	7.51	12.57
$d^{L,I}$	24.28	24.28	24.28	25.53	25.62	25.62
$d^{L,U}$	25.76	25.76	24.49	28.10	28.10	25.98
$d^{M,I}$	9.70	9.79	9.79	15.33	15.59	15.59
$d^{M,U}$	14.45	11.48	9.82	23.70	18.61	15.95
$\xi^{L,I}$	3.57	3.55	3.54	15.06	15.10	15.06
$\xi^{L,U}$	3.86	3.86	3.68	16.93	16.93	15.47
$\xi^{M,I}$	3.20	3.21	3.20	12.22	12.35	12.32
$\xi^{M,U}$	4.01	3.53	3.26	17.37	14.20	12.63

The first index identifies the class (L low income, M middle, H high); the second index identifies the insurance status (I insured, U uninsured). All numbers in absolute values for the year 2007; $\xi^{i,j}$ is the factor by which consumption of a depressed individual of group i, j need to increase to obtain the utility of a healthy individual of the same group, both evaluated in the year 2007. The extended Medicaid system is denoted by ext MDCD and the more generous Medicaid system is denoted by gen MDCD; see text for details.

Column (1) of Table 2 shows for the year 2007 the health expenditure and drug use choices of the mentally ill for the benchmark, also displayed in Figure 2 (upper right panel and lower left panel, respectively). Column (2) of Table 2 displays the behavior and relative welfare of mentally ill workers when public health care (Medicaid) is extended to the privately uninsured middle class at the same subsidy rate as the poor, $\underline{s} = 0.6$ (scenario "ext MDCD"). All else is kept the same as in the benchmark, except the tax rates that we adjust accordingly. We see that this reform would increase mental health expenditure, as intended. Importantly, drug consumption of the targeted middle class workers decreases by about one fifth ($100 - \frac{11.48}{14.45} = 0.206$) to a level closer to that of privately insured middle class workers.

The bottom of Table 2 also displays welfare comparisons to the healthy group counterparts for 2007. Again comparing column (2) with column (1), we see that the reform also reduces the welfare difference of mentally ill, uninsured middle class workers to their healthy counterparts. The poor are not affected, as they do not pay for Medicaid.

Column (3) of Table 2 reports results of a generous Medicaid system ("gen MDCD") that raises the health care subsidy rate from 60 to 75 percent for both the privately uninsured middle class and the poor. As expected, mentally ill low- and middle income workers now spend more on mental health care and less on drugs. They also achieve higher welfare relative to healthy persons.

Overall, the results point to unambiguously positive effects of health care subsidies on health spending and negative effects on drug consumption. As the insured are only marginally affected by Medicaid reforms (via tax rate adjustments only), the difference between privately insured and uninsured types within income groups declines in a pronounced way.

7 Discussion: Intensity of Mental Illness

In the numerical analysis so far, we assumed that the average severity of mental illness, $n(i)$, is unrelated to the probability to become ill, $\lambda(i)$. Here we relax this assumption. Part (iii) of Corollary 1 suggests that socio-economic deprivation of middle class workers that is associated with a higher probability to become mentally ill could then raise drug consumption over time also at the intensive margin even for given drug price q. To illustrate this point, we now assume that $n(i) = \bar{n}(\lambda(i))$ with $\bar{n}'(\lambda) > 0$.

To allow for skill-specific severity of mental illness, let us specify $\bar{n}(\lambda) = 10\lambda$, i.e. $\bar{n}(\lambda^L) = 0.85$ (as $\lambda^L = 0.085$) and $\bar{n}(\lambda^H) = \bar{n}(\lambda^M) = 0.5$ (as $\lambda^H = \lambda^M = 0.05$). In order to make the scenario comparable with the previous cases we adjust preference parameter $\gamma = 0.88$ (instead of 0.7) such that the uninsured poor continue to spend about 30 percent of their income on drugs and the rich still abstain from drug consumption. In order to match the empirical mental health expenditure shares and fulfil the health care budget constraints we also adjust $\theta = 0.075$, $\underline{\tau} = 0.00024$ and $\bar{\tau} = 0.0086$ for the year 1989 and $\theta = 0.095$, $\underline{\tau} = 0.00023$ and $\bar{\tau} = 0.0104$ for the year 2007.

Column (5) of Table 1 shows that for a declining drug price over time, mentally ill middle class workers now increase drug consumption more drastically (case 5), compared to the benchmark case 1. As expected, according to column (6) of Table 1, drug consumption now increases over time also for constant prices (case 6) $-$ although to a lesser degree.[11]

[11]The magnitudes should not be taken at face value, as function $\bar{n}(\lambda)$ is not calibrated based on real data. Here we just want to illustrate qualitatively what happens if $\bar{n}(\lambda)$ is an increasing function.

The percentage increases are of similar magnitude for insured and uninsured workers. As we saw for the falling drug price scenario in Figure 2, however, the uninsured have higher levels to start with. For the low-skilled, the changes in drug consumption over time in cases 5 and 6 are similar in magnitude to cases 1 and 2, respectively.

Due to the recalibration of preference parameter γ in cases 5 and 6 compared to cases 1-4, welfare differences between mentally ill and healthy individuals are now higher. Changes in drug consumption over time lead to the welfare changes displayed at the bottom of Table 1. According to columns (5) and (6), the consumption equivalent that would compensate middle class workers for mental illness almost doubles over time for the uninsured under falling drug prices (case 5) and substantially increases even for constant drug prices (case 6). It significantly rises also for the insured. By contrast, mentally ill low-skilled workers experience a relatively small welfare decline relative to the healthy when drug prices decline and, as for case 2, they experience a welfare improvement when drug prices stay constant.

We finally present the results of reforming Medicare for the "variable n" scenario. Column (4) of Table 2 displays the choices and welfare levels for the year 2007 in case 5 (falling drug prices). Extending Medicaid to the uninsured middle class induces the targeted group to substitute away from drugs towards health spending, associated with higher welfare relative to the healthy group counterpart (column (5) of Table 2). Further substitution is induced by making Medicare more generous (column (6) of Table 2), not only for the middle class but also for the privately uninsured poor.

In sum, with skill-specific severity of mental illness, falling drug prices are not anymore required to explain rising drug consumption of the middle class, relative deprivation is sufficient. All other conclusions remain qualitatively the same as in sections 5 and 6.

8 Conclusion

We have examined the hypothesis of Case and Deaton (2015, 2017) that increased consumption of intoxicants of the middle class is rooted in labor market developments. We have proposed a framework in which (i) conditional on their income, mentally ill workers may consume intoxicants to mitigate negative utility as a substitute for mental health care and (ii) outsourcing or automation causes socio-economic deprivation of the middle class that results in higher incidence and possibly an increased severity of mental illness in that group.

Most importantly, our analysis suggests that in absence of an increased average severity of mental illness, a higher incidence caused by relative deprivation can explain the drug epidemic in the U.S. middle class only in interaction with falling drug prices. We thus reconcile the evidence by Ruhm (2018) who does not find that changes in the economic environment caused increasing drug consumption, in contrast to a changing drug environment. In fact, we find that both conditions have to be met as regards the middle class. However, the U.S. drug epidemic is also visible among low-skilled workers who have experienced in the last few decades rising earnings both in absolute terms and relative to the middle class. Our analysis suggests that for this group increased drug consumption can be entirely led back to falling opioid prices. If opioid prices stayed constant, their welfare would have improved relative to their healthy counterparts, whereas our model suggests that their relative welfare decreases when drug prices decline over time.

We also demonstrated that, theoretically, the Case-Deaton hypothesis alone would suffice to explain the U.S. drug epidemic in the middle class if the average severity of mental illness has risen among the mentally ill. Whether or not this is so is an empirical question.

A main (and novel) feature of our framework is the simultaneous choice and substitutability between illicit drug consumption and mental health expenditure, with important implications for public health care like tax-financed Medicaid in the U.S. We have argued that the lack of Medicaid access of the socio-economically deprived and uninsured middle class contributes to their high consumption of intoxicants. The lack of insurance is also responsible for large welfare gap between the mentally ill and the healthy. In addition, Also mentally ill workers with low skills and access to Medicaid would decrease drug consumption and would experience higher welfare under a more generous public health care system. These results strongly suggests that tax-financed public health care should be (and should have been) extended for mentally ill non-rich persons in order to fight the U.S. drug epidemic. The analysis also contributes to understanding why European countries with a more generous public health care system avoided the same dismal experience, as documented by Haan, Hammerschmid and Schmieder (2018) for Germany.

Our analysis is a first attempt to investigate under which circumstances the consumption of intoxicants is related to despair of the U.S. middle class, by investigating a wider range of contributing factors. We provided a rationale for the observation that some individuals address mental illness in a seemingly unconstructive way, i.e. to dampen their negative feelings from poor health and declining status by abusing drugs. As a caveat, the presented one period non-overlapping generations framework does not capture the consequences of drug abuse. Future research may extend the framework featuring a life-cycle perspective of decisions and possibly boundedly rational behavior. Such a framework could take into account that drug addiction triggers further health problems and reduces productivity, features that are surely important but beyond the scope of our analysis.

Appendix

A. Proofs

Proof of Proposition 1: According to (9), we have

$$\tilde{u}_h(h,d;y,n,R,q,\kappa) = \frac{\kappa R(y-qd-Rh)^{\gamma-1}}{(1+d)^{\delta}}\left(\frac{\theta h^{\theta-1}(y-qd)}{R} - \frac{(1-n)\gamma}{\kappa} - (\gamma+\theta)h^{\theta}\right), \tag{28}$$

$$\tilde{u}_d(h,d;y,n,R,q,\kappa) = -\frac{\frac{\gamma q(1-n+\kappa h^{\theta})(1+d)}{(y-qd-Rh)^{1-\gamma}} + \delta\cdot\overbrace{\left[(1-n+\kappa h^{\theta})(y-qd-Rh)^{\gamma}-\bar{u}\right]}^{=\tilde{u}(h,d;y,n,R,\kappa)(1+d)^{\delta}}}{(1+d)^{\delta+1}}, \tag{29}$$

$$\tilde{u}_y(h,d;y,n,R,q,\kappa) = \frac{\gamma(1-n+\kappa h^{\theta})(y-qd-Rh)^{\gamma-1}}{(1+d)^{\delta}} > 0. \tag{30}$$

$$\tilde{u}_n(h,d;y,n,R,q,\kappa) = -\frac{(y-qd-Rh)^{\gamma}}{(1+d)^{\delta}} < 0. \tag{31}$$

First, according to (29), $\bar{u} \leq 0$ implies that $\tilde{u}_d < 0$. Thus, in this case, there is a corner solution for consumption of intoxicants, $d^* = 0$. Conditional on $d = 0$, $\hat{h}^* \equiv \hat{h}(y,n,R,\kappa)$ as given by first-order condition $\tilde{u}_h(\hat{h}^*,0;\cdot) = 0$ is an interior solution for health input, since $\tilde{u}_{hh}(\hat{h}^*,0;\cdot) < 0$, according to (28). Also according to (28),

$$0 = \frac{\theta(\hat{h}^*)^{\theta-1}y}{R} - \frac{(1-n)\gamma}{\kappa} - (\gamma+\theta)(\hat{h}^*)^{\theta}. \tag{32}$$

Comparative-static results in part (ii) follow by applying the implicit function theorem to (32).

Finally, to show that $d^* = 0$ when y is sufficiently high even when $\bar{u} > 0$, define

$$\begin{aligned} g(y) &\equiv \tilde{u}_d(\hat{h}(y,\cdot),0;y,\cdot) && (33)\\ &= -\gamma q(1-n+\kappa\hat{h}(y,\cdot)^{\theta})\left[y - R\hat{h}(y,\cdot)\right]^{\gamma-1} - \delta\tilde{u}(\hat{h}(y,\cdot),0;y,\cdot), && (34) \end{aligned}$$

according to (29), and note that $d^* = 0$ if $g(y) < 0$. Part (ii) is proven by showing that partial derivative $g'(y) < 0$. According to (32), (34) and $\tilde{u}_h(\hat{h}^*,0;\cdot) = 0$ (envelope theorem),

$$g'(y) = -\gamma q \hat{h}_y(y,\cdot)\left(\frac{\kappa\theta(\hat{h}^*)^{\theta-1}\left[y - R\hat{h}^*\right] + (1-\gamma)\left[1-n+\kappa(\hat{h}^*)^{\theta}\right]}{(y-R\hat{h}^*)^{2-\gamma}}\right) - \delta\tilde{u}_y(\hat{h}^*,0;\cdot) < 0, \tag{35}$$

as partial derivatives $\hat{h}_y(y,\cdot) > 0$, according to Proposition 1, and $\tilde{u}_y(\hat{h}^*,0;\cdot) > 0$, according to (30), respectively. This concludes the proof. ■

Proof of Proposition 2: Define $c^* \equiv y - qd^* - Rh^*$ as the equilibrium numeraire good consumption level in an interior optimum where $h^* > 0$ and $d^* > 0$. Applying the envelope theorem, (28) implies

$$\tilde{u}_{hh}(h^*,d^*;\cdot) = -\frac{\kappa\theta\left[(1-\theta)(y-qd^*) + (\gamma+\theta)Rh^*\right]}{(1+d^*)^{\delta}(c^*)^{1-\gamma}(h^*)^{2-\theta}} < 0, \tag{36}$$

$$\tilde{u}_{hd}(h^*,d^*;\cdot) = -\frac{\kappa\theta q}{(1+d^*)^{\delta}(c^*)^{1-\gamma}(h^*)^{1-\theta}} < 0, \tag{37}$$

$$\tilde{u}_{hy}(h^*,d^*;\cdot) = \frac{\kappa\theta}{(1+d^*)^{\delta}(c^*)^{1-\gamma}(h^*)^{1-\theta}} > 0, \tag{38}$$

$$\tilde{u}_{hn}(h^*,d^*;\cdot) = \frac{\gamma R}{(1+d^*)^{\delta}(c^*)^{1-\gamma}} > 0, \tag{39}$$

$$\tilde{u}_{hq}(h^*,d^*;\cdot) = -\frac{\kappa\theta d^*}{(1+d^*)^{\delta}(c^*)^{1-\gamma}(h^*)^{1-\theta}} < 0, \tag{40}$$

$$\tilde{u}_{h\kappa}(h^*,d^*;\cdot) = \frac{(1-n)\gamma R}{(c^*)^{1-\gamma}(1+d^*)^{\delta}\kappa} > 0, \tag{41}$$

$$\tilde{u}_{hR}(h^*,d^*;\cdot) = -\frac{\kappa\theta(y-qd^*)}{(1+d^*)^{\delta}(c^*)^{1-\gamma}(h^*)^{1-\theta}R} < 0. \tag{42}$$

Also define $S^* \equiv 1-n+\kappa(h^*)^{\theta}$. According to (29), when $d^* > 0$ and thus $\tilde{u}_d(h^*,d^*;\cdot) = 0$ we have $S^*\cdot(c^*)^{\gamma} < \bar{u}$ and

$$1 + d^* = -\frac{\delta(c^*)^{1-\gamma}}{\gamma q\mu^*}\underbrace{\left[S^*\cdot(c^*)^{\gamma} - \bar{u}\right]}_{<0} > 1. \tag{43}$$

Moreover, using the envelope theorem which implies that (43) holds, we also obtain from

(29) that

$$\tilde{u}_{dd}(h^*, d^*; \cdot) = -\frac{\gamma q \mu^* \left[(1-\gamma)q(1+d^*) + (1-\delta)c^*\right]}{(1+d^*)^{\delta+1}(c^*)^{2-\gamma}} < 0, \tag{44}$$

by recalling that $\gamma \leq 1$ and $\delta < 1$. Furthermore, (29) implies

$$\tilde{u}_{dy}(h^*, d^*; \cdot) = \frac{q(1-\gamma)(1+d^*) - \delta c^*}{(c^*)^{2-\gamma}(1+d^*)^{\delta+1}} \gamma \mu^*. \tag{45}$$

Inserting (43) into (45), we find

$$\tilde{u}_{dy}(h^*, d^*; \cdot) = -\frac{\delta}{(1+d^*)^{\delta+1} c^*} (\gamma \bar{u} + \underbrace{S^* \cdot (c^*)^\gamma - \bar{u}}_{<0}). \tag{46}$$

Thus, $\tilde{u}_{dy}(h^*, d^*; \cdot) < 0$ for $\gamma = 1$, whereas $\tilde{u}_{dy}(h^*, d^*; \cdot) \geq 0$ is possible for $\gamma < 1$. Using (31), we also derive

$$\tilde{u}_{dn}(h^*, d^*; \cdot) = \frac{\gamma q(1+d^*) + \delta c^*}{(1+d^*)^{\delta+1}(c^*)^{1-\gamma}} > 0. \tag{47}$$

Moreover, according to (29),

$$\tilde{u}_{dq}(h^*, d^*; \cdot) = -\frac{(1+d^*)c^* + (1+d^*)q(1-\gamma)d^* + \delta c^*}{(1+d^*)^{\delta+1}(c^*)^{2-\gamma}} \gamma \mu^* < 0, \tag{48}$$

$$\tilde{u}_{d\kappa}(h^*, d^*; \cdot) = -\frac{\gamma q(1+d^*) + \delta c^*}{(c^*)^{1-\gamma}(1+d^*)^{\delta+1}} (h^*)^\theta < 0, \tag{49}$$

$$\tilde{u}_{dR}(h^*, d^*; \cdot) = \gamma h^* S^* \frac{\delta c^* - q(1-\gamma)(1+d^*)}{(c^*)^{2-\gamma}(1+d^*)^{\delta+1}}. \tag{50}$$

Inserting (43) into (50), we obtain

$$\tilde{u}_{dR}(h^*, d^*; \cdot) = \frac{\delta h^*}{(1+d^*)^{\delta+1} c^*} (\gamma \bar{u} + \underbrace{S^* \cdot (c^*)^\gamma - \bar{u}}_{<0}). \tag{51}$$

Thus, $\tilde{u}_{dR}(h^*, d^*; \cdot) > 0$ for $\gamma = 1$, whereas $\tilde{u}_{dy}(h^*, d^*; \cdot) \leq 0$ is possible for $\gamma < 1$.

At an interior solution, $[\tilde{u}_{hh}\tilde{u}_{dd} - (\tilde{u}_{hd})^2]_{(h^*,d^*)} > 0$. According to (36), (44) and (37), this implies

$$\frac{\left[(1-\theta)(y - qd^*) + (\gamma+\theta)Rh^*\right]\left[(1-\gamma)q(1+d^*) + (1-\delta)c^*\right]\gamma\mu^*}{(h^*)^\theta} > \kappa\theta q(1+d^*)c^*. \tag{52}$$

Applying Cramer's rule, we have

$$sgn\left(\frac{\partial h^*}{\partial y}\right) = -sgn\left(\tilde{u}_{hy}\tilde{u}_{dd} - \tilde{u}_{dy}\tilde{u}_{dh}\right)\big|_{(h^*,d^*)} = sgn\left(c^*\right) > 0, \tag{53}$$

where we used (38), (37), (44) and (45) for the latter equation. Similarly, according to (40), (37), (44) and (48), we have

$$sgn\left(\frac{\partial h^*}{\partial q}\right) = -sgn\left(\tilde{u}_{hq}\tilde{u}_{dd} - \tilde{u}_{dq}\tilde{u}_{dh}\right)\big|_{(h^*,d^*)} = sgn\left(\delta d^* + 1 + \delta\right) > 0. \tag{54}$$

According to (41), (37), (44) and (49), we also obtain

$$sgn\left(\frac{\partial h^*}{\partial \kappa}\right) = -sgn\left(\underset{>0}{\tilde{u}_{h\kappa}}\underset{<0}{\tilde{u}_{dd}} - \underset{<0}{\tilde{u}_{d\kappa}}\underset{<0}{\tilde{u}_{hd}}\right)\Bigg|_{(h^*,d^*)} > 0. \tag{55}$$

Similarly, with (42), (37), (44) and (50),

$$sgn\left(\frac{\partial h^*}{\partial R}\right) = -sgn\left(\underset{<0}{\tilde{u}_{hR}}\underset{<0}{\tilde{u}_{dd}} - \underset{>0 \text{ if } \gamma=1}{\tilde{u}_{dR}}\underset{<0}{\tilde{u}_{hd}}\right)\Bigg|_{(h^*,d^*)} < 0 \text{ if } \gamma = 1. \tag{56}$$

Next, using (36), (37), (38) and (45) yields

$$sgn\left(\frac{\partial d^*}{\partial y}\right) = -sgn\left(\underset{<0}{\tilde{u}_{hh}}\underset{<0 \text{ if } \gamma=1}{\tilde{u}_{dy}} - \underset{>0}{\tilde{u}_{hy}}\underset{<0}{\tilde{u}_{dh}}\right)\Bigg|_{(h^*,d^*)} < 0 \text{ if } \gamma = 1. \tag{57}$$

According to (36), (37), (39) and (47), we have

$$\begin{aligned} sgn\left(\frac{\partial d^*}{\partial n}\right) &= -sgn\left(\tilde{u}_{hh}\tilde{u}_{dn} - \tilde{u}_{hn}\tilde{u}_{dh}\right)\big|_{(h^*,d^*)} \\ &= sgn\left(\left[(1-\theta)c^* + (1+\gamma)Rh^*\right]\delta c^* + \right. \\ &\quad \left. (1-\theta)\gamma q c^*(1+d^*) + \gamma^2 q(1+d^*)Rh^*\right), \end{aligned} \tag{58}$$

which is positive. We also find from (36), (37), (40) and (48) that

$$
\begin{aligned}
sgn\left(\frac{\partial d^*}{\partial q}\right) &= -sgn\left(\tilde{u}_{hh}\tilde{u}_{dq} - \tilde{u}_{hq}\tilde{u}_{dh}\right)\big|_{(h^*,d^*)} \\
&= -sgn\Big(-\kappa\theta q(1+d^*)c^*d^* + \\
&= \frac{\gamma\mu^*\left[(1-\theta)(y-qd^*)+(\gamma+\theta)Rh^*\right]\left[(1+d^*)c^*+(1-\gamma)q(1+d^*)d^*+\delta c^*\right]}{(h^*)^\theta}\Big) \qquad (59)
\end{aligned}
$$

which is negative, according to concavity condition (52).

Similarly, using (36), (37), (41) and (49) implies

$$
sgn\left(\frac{\partial d^*}{\partial \kappa}\right) = -sgn\left(\underset{<0}{\tilde{u}_{hh}}\underset{<0}{\tilde{u}_{d\kappa}} - \underset{>0}{\tilde{u}_{h\kappa}}\underset{<0}{\tilde{u}_{dh}}\right)\Bigg|_{(h^*,d^*)} < 0. \tag{60}
$$

Finally, from (36), (37), (42) and (50) we find that

$$
sgn\left(\frac{\partial d^*}{\partial R}\right) = -sgn\left(\underset{<0}{\tilde{u}_{hh}}\ \underset{>0 \text{ if } \gamma=1}{\tilde{u}_{dR}} - \underset{<0}{\tilde{u}_{hR}}\underset{<0}{\tilde{u}_{dh}}\right)\Bigg|_{(h^*,d^*)} > 0 \text{ if } \gamma = 1. \tag{61}
$$

This concludes the proof. ■

Proof of Proposition 5: First, we consider the output level and the price of the composite input. Using (3) in (2) we have

$$
\log X_t = \int_0^{J_t} \log\left(\alpha_t^L(j) l_t(j)\right) \mathrm{d}j + \int_{j\in\mathcal{D}_t} \log x_t(j)\mathrm{d}j + \int_{j\in\mathcal{Z}_t} \log\left(\alpha_t^M(j) m_t(j)\right) \mathrm{d}j. \tag{62}
$$

For the tasks produced outside the economy, output reads as

$$
x_t(j) = \frac{P_t X_t}{\bar{p}_t} \text{ for any } j \in \mathcal{D}_t. \tag{63}
$$

Substituting (19), (20) and (63) into (62), the (log of the) composite input is given by

$$
\log X_t = \int_0^{J_t} \log\left(\frac{\alpha_t^L(j)L_t}{J_t}\right)\mathrm{d}j + \Delta_t\left(\log\left(\frac{P_t}{\bar{p}_t}\right) + \log X_t\right) + \int_{j\in\mathcal{Z}_t} \log\left(\frac{\alpha_t^M(j)M_t}{1-\Delta_t-J_t}\right)\mathrm{d}j. \tag{64}
$$

Substituting $P_t = (1-\beta)\left(A_t H/X_t\right)^\beta$ from (13) into (64) and solving for $\log X_t$ implies

$$\log X_t = \frac{\Delta_t \log\left(\frac{(1-\beta)(A_t H_t)^\beta}{\bar{p}_t}\right) + J_t \log\left(\frac{L_t}{J_t}\right) + (1-\Delta_t - J_t)\log\left(\frac{M_t}{1-\Delta_t-J_t}\right) + \log Q_t}{1-(1-\beta)\Delta_t}, \tag{65}$$

$$\log Q_t \equiv \int_0^{J_t} \log \alpha_t^L(j)\mathrm{d}j + \int_{j\in\mathcal{Z}_t} \log \alpha_t^M(j)\mathrm{d}j. \tag{66}$$

Next, use (16), (17) and $p(j) = \bar{p}_t$ for any $j \in \mathcal{D}_t$ in (15) to obtain

$$\log P_t = \int_0^{J_t} \log\left(\frac{w_t^L}{\alpha_t^L(j)}\right)\mathrm{d}j + \Delta_t \log \bar{p}_t + \int_{j\in\mathcal{Z}_t} \log\left(\frac{w_t^M}{\alpha_t^M(j)}\right)\mathrm{d}j. \tag{67}$$

Using the definition of $\log Q$ in (66) and inserting (13) and $w_t^M = w_t^L \omega_t(J_t)$ from (23) into (67) leads to

$$\log\left[\frac{(1-\beta)\left(A_t H_t\right)^\beta Q_t}{(\bar{p}_t)^{\Delta_t}}\right] = (1-\Delta_t)\log w_t^L + (1-\Delta_t-J_t)\log\omega_t(J_t) + \beta\log X_t. \tag{68}$$

Substituting (65) into (68) and solving for $\log w_t^L$ yields equilibrium value

$$\begin{aligned}\log w_t^{L*} = {} & \frac{(1-\beta)\log\left(\frac{Q_t}{(\bar{p}_t)^{\Delta_t}}\right) + \log\left[(1-\beta)\left(A_t H_t\right)^\beta\right]}{1-(1-\beta)\Delta_t} - \left(1-\frac{J_t}{1-\Delta_t}\right)\log\omega_t(J_t) - \\ & \frac{\beta}{1-(1-\beta)\Delta_t}\left[\frac{J_t}{1-\Delta_t}\log\left(\frac{L_t}{J_t}\right) + \left(1-\frac{J_t}{1-\Delta_t}\right)\log\left(\frac{M_t}{1-\Delta_t-J_t}\right)\right]\end{aligned} \tag{69}$$

Inserting (69) into $\log w_t^M = \log w_t^L + \log\omega_t(J_t)$ then implies equilibrium value

$$\begin{aligned}\log w_t^{M*} = {} & \frac{(1-\beta)\log\left(\frac{Q_t}{(\bar{p}_t)^{\Delta_t}}\right) + \log\left[(1-\beta)\left(A_t H\right)^\beta\right]}{1-(1-\beta)\Delta_t} + \frac{J_t}{1-\Delta_t}\log\omega_t(J_t) - \\ & \frac{\beta}{1-(1-\beta)\Delta_t}\left[\frac{J_t}{1-\Delta_t}\log\left(\frac{L}{J_t}\right) + \left(1-\frac{J_t}{1-\Delta_t}\right)\log\left(\frac{M}{1-\Delta_t-J_t}\right)\right]\end{aligned} \tag{70}$$

Now substitute (65) into (12) to find equilibrium value

$$\begin{aligned}\log w_t^{H*} &= \log\left[\beta(A_t)^\beta\right] + \frac{(1-\beta)\Delta_t}{1-(1-\beta)\Delta_t}\log\left((1-\beta)\left(A_t H_t\right)^\beta\right) + \\ &\frac{(1-\beta)J_t}{1-(1-\beta)\Delta_t}\log\left(\frac{L_t}{J_t}\right) + \frac{(1-\beta)(1-\Delta_t-J_t)}{1-(1-\beta)\Delta_t}\log\left(\frac{M_t}{1-\Delta_t-J_t}\right) + \\ &\frac{1-\beta}{1-(1-\beta)\Delta_t}\log\left(\frac{Q_t}{(\bar{p}_t)^{\Delta_t}}\right) - (1-\beta)\log H_t. \end{aligned} \quad (71)$$

Subtracting the right-hand side of (71) from the right-hand side of (70) implies

$$\begin{aligned}\log\left(\frac{w_t^M}{w_t^H}\right)^* &= (1-\beta)\log H_t - \log\left[\beta(A_t)^\beta\right] + \log\left[(1-\beta)\left(A_t H_t\right)^\beta\right] + \frac{J_t}{1-\Delta_t}\log \omega_t(J_t) - \\ &\frac{J_t}{1-\Delta_t}\log\left(\frac{L_t}{J_t}\right) - \left(1-\frac{J_t}{1-\Delta_t}\right)\log\left(\frac{M_t}{1-\Delta_t-J_t}\right). \end{aligned} \quad (72)$$

According to (24), we have

$$\frac{J_t}{1-\Delta_t} = \frac{1}{\frac{M}{L}\omega_t(J_t)+1} \Longleftrightarrow 1-\Delta_t-J_t = \omega_t(J_t)J_t\frac{M_t}{L_t}. \quad (73)$$

Using (73), we then find

$$\frac{J_t}{1-\Delta_t}\log\left(\frac{L_t}{J_t}\right)+\left(1-\frac{J_t}{1-\Delta_t}\right)\log\left(\frac{M_t}{1-\Delta_t-J_t}\right) = \log\left(\frac{L_t}{J_t}\right)-\frac{\frac{M_t}{L_t}\omega_t(J_t)}{\frac{M_t}{L_t}\omega_t(J_t)+1}\log\omega_t(J_t). \quad (74)$$

Also note from (24) that

$$\log\omega_t(J_t) - \log\left(\frac{L_t}{J_t}\right) = \log\left(\frac{1-\Delta_t-J_t}{M_t}\right) \quad (75)$$

Substituting (74) into (72) and using (75) confirms (26). For the comparative-static result regarding a change in Δ_t, use the result $\partial J_t/\partial\Delta_t \in (-1,0)$ from Proposition 3. The effect of an increase in M_t/H_t follows from (26) by noticing from (25) that J_t can be written as function of L_t/M_t and is independent of M_t/H_t. This concludes the proof. ■

B. Health Care Budget Constraints

Under the health system introduced in section 2, disposable income of an individual i

reads as

$$y_t(i) = \begin{cases} (1-\bar{\tau}_t)w_t^L \text{ for } i \in \mathcal{L}_t \text{ if insured,} \\ w_t^L \text{ for } i \in \mathcal{L}_t \text{ if not insured,} \\ (1-\bar{\tau}_t-\underline{\tau}_t)w_t^M \text{ for } i \in \mathcal{M}_t \text{ if insured,} \\ (1-\underline{\tau}_t)w_t^M \text{ for } i \in \mathcal{M}_t \text{ if not insured,} \\ (1-\bar{\tau}_t-\underline{\tau}_t)w_t^H \text{ for } i \in \mathcal{H}_t \text{ if insured,} \\ (1-\underline{\tau}_t)w_t^H \text{ for } i \in \mathcal{H}_t \text{ if not insured.} \end{cases} \tag{76}$$

We denote the (world market) price per unit of health input by r. In the baseline case where only the uninsured poor receive Medicaid, the individual price of the health input $h(i)$ is

$$R_t(i) = \begin{cases} (1-\bar{s}_t)r_t \text{ if insured,} \\ (1-\underline{s}_t)r_t \text{ for } i \in \mathcal{L}_t \text{ if not insured,} \\ r_t \text{ for } i \in \{\mathcal{M}_t, \mathcal{H}_t\} \text{ if not insured.} \end{cases} \tag{77}$$

Let $h^*(y, R, \cdot)$ be the optimal health expenditure given disposable income, y, and the net price of the health good, R. We focus on the case where all ill individuals have the same extent of mental illness.

According to (76) and (77), the balanced budget condition for tax-financed Medicaid equates revenue and expenditure according to

$$\underline{\tau}_t \cdot \left[M_t w_t^M + H_t w_t^H\right] = \underline{s}_t \mu_t^L L_t h^*(w_t^L, (1-\underline{s}_t)r_t, \cdot). \tag{78}$$

Under conditions (4), according to (5), (76) and (77), the budget constraint for contribution-financed health insurance that equates subsidies of health expenditures and health care contributions read as

$$\begin{aligned} & \bar{\tau}_t \cdot \left[(1-\mu_t^L)L_t w_t^L + (1-\mu_t^M)M_t w_t^M + (1-\mu_t^H)H_t w_t^M\right] \\ = \; & r_t \cdot \left[s_t^L(1-\mu_t^L)L_t h^*((1-\bar{\tau}_t)w_t^L, (1-s_t^L)r_t, \cdot) + \right. \\ & s_t^M(1-\mu_t^M)L_t \sum_{n \in \mathcal{N}} h^*((1-\bar{\tau}_t-\underline{\tau}_t)w_t^M, (1-s_t^L)r_t, \cdot) + \\ & \left. s_t^H(1-\mu_t^H)H_t h^*((1-\bar{\tau}_t-\underline{\tau}_t)w_t^H, (1-s_t^H)r_t, \cdot)\right]. \end{aligned} \tag{79}$$

In the case where also the uninsured middle class has access to Medicaid, $R(i) = (1-\underline{s})r$ rather than $R(i) = r$ for $i \in \mathcal{M}_t$ and (78) modifies to

$$\underline{\tau}_t \cdot \left[M_t w_t^M + H_t w_t^H\right] = \underline{s}_t \left[\mu_t^L L_t h^*(w_t^L, (1-\underline{s}_t)r_t, \cdot) + \mu_t^M M_t h^*(w_t^M, (1-\underline{s}_t)r_t, \cdot)\right]. \quad (80)$$

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