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ABSTRACT

Illicit Drugs and the Decline of the Middle Class*

Empirical evidence for the U.S. suggests that illicit consumption of opioids increases in association with 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 socio-economic status increases the share of mentally distressed middle class workers. Mentally distressed workers can mitigate their hardships by the intake of illicit drugs or by consuming health goods. We argue that explaining the rise in illicit drug use among the U.S. middle class requires an interaction of socio-economic decline and falling opioid prices, i.e. one factor in isolation is insufficient. Our analysis also points to a central role of the health care system. Extending mental health care could motivate the mentally distressed to abstain from illicit drug consumption.

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1. Introduction

Middle-aged, white non-Hispanic men and women in the United States without college degree 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 (2017, 2020) associate the rising non-medical use of drugs and 'deaths of despair' within the non-college educated population with a long process of cumulative disadvantage that originates from labor market conditions, particularly for the lower middle class. For instance, from 2002 to 2013, heroin consumption increased by 77% among individuals with household income between $ 20,000 and $ 50,000 and it increased relatively by more than among individuals with less or more household income (CDC, 2015).

The goal of this paper is to shed light on the mechanisms that link relative deprivation of the middle class caused by changing labor market conditions to rising illicit drug consumption in absolute terms and relative to other groups. We develop a framework in which relative deprivation increases the probability of mental distress and individuals can respond by consuming intoxicants or seeking health treatment.[1] The argument is based on social status loss for the middle class, particularly caused by a blurring divide between the middle class and the lower class. Tailoring the task-based labor market model by Acemoglu and Autor (2011) to our research focus, we capture a loss of tasks in production that were historically performed by the middle class through increased outsourcing and automation. The labor market outcomes are declining relative wages compared to both low-skilled and high-skilled workers and a shift of the task space for the middle class towards tasks previously performed by low-skilled workers. We ask whether such relative deprivation of the middle class alone can explain the changing pattern of illicit drug consumption and which role changes in street prices for illicit drugs like heroin and opioid pain relievers (OPRs) could play.

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[1]We focus on mental distress as the channel that may link relative deprivation and illicit drug consumption. Mental distress includes depression and other mood disorders influenced by environmental circumstances such as stress. Mental illness also comprises schizophrenia and bipolar disorder, which are thought to be largely genetic and thus not relevant for our line of reasoning.

Our framework captures that relative deprivation of the middle class causes a loss of social status for the middle class that makes the incidence of mental distress more likely. In turn, mental distress is known as a causal factor for illicit drug dependency and abuse disorder (Swendsen et al., 2010; Grant et al., 2004; Solomon, 2015). The causal chain is consistent with the "despair hypothesis" of Case and Deaton (2017, 2020). A related but different issue is how overprescription and declining out-of-pocket ratios for prescribed OPRs may have contributed to the opioid epidemic (e.g. Kodolny et al., 2015; Zhou et al., 2016).[2] Here, we focus on mental distress (despair) as the motivation for the nonmedical (i.e. illicit) use of opioids and notice that OPRs are *not prescribed* for these kind of illnesses. However, mental distress and pain share some biological pathways and neurotransmitters such that mental distress is likely to be also relieved by OPR use (Bair et al., 2003; Verdu et al., 2008). This fact may make the illicit and non-medical use of OPRs attractive as a form of self-treatment of mental distress, in particular when missing health insurance constrains the medial treatment of mental distress.[3]

Despite the evidence that support the "despair hypothesis" of Case and Deaton (2017, 2020), there remains the question about possible contributing factors and group-specific effects that are in line with more differentiated empirical patterns. In this regard it is interesting that Ruhm (2019) does not find robust evidence that the local economic environment is significantly related to the recent epidemic in the use of OPRs (CDC, 2017). Instead he suggests that it is largely caused by improved availability and falling prices of illicit drugs. His findings, however, do not exclude an important role of a changing economic environment that has disproportionately affected the U.S. middle class. In fact, socio-economic status may *interact* with falling opioid prices in determining illicit drug consumption and mildly rising wage income can be experienced in conjunction with relative deprivation of the middle class (as in our calibrated model).

Our results suggest that the drug epidemic among the U.S. middle class requires the interaction between socio-economic deprivation and falling opioid prices. We demonstrate via

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[2]In order to evaluate to which extent relative deprivation (despair) and falling drug prices can explain the opioid epidemic we ignore the issue of unintentional addiction of pain patients due to wrong believes about the addictive power of prescribed OPRs. How bounded rationality of pain patients affects addiction to prescription drugs and illicit drug use is in detail explored in Strulik (2021).

[3]Alpert et al. (2018) show that the introduction of abuse-deterrent OxyContin in 2010, which makes is difficult to crush or dissolve the pills and thus avoids fast release of the active ingredient known as particularly promoting addiction, is largely responsible for the subsequent heroin epidemic in the U.S. This suggests that OxyContin and heroin are highly substitutable. In any case, the relevant price of OPRs in our context is not the prescription price but the street price which, in terms of morphine equivalents, exceeds the price of heroin by about factor ten (Gupta, 2016).

counterfactual analysis that relative deprivation in isolation does not suffice. Hence, our theory reconciles a refined view of the "despair hypothesis" of Case and Deaton (2017, 2020) with the "price hypothesis" of Ruhm (2019). Falling opioid prices alone can explain the increasing opioid consumption among workers with low but over time increasing wages. For the middle class, however, falling prices and falling social status are both necessary in order to motivate increasing consumption of illicit drugs. The reason is that despite their status loss they earn relatively more than the low-skilled, which makes illicit drug consumption in case of mental distress less attractive compared to health spending, all other things being equal.

Our modeling device that consumption of intoxicants could mitigate adverse utility effects of mental distress as a substitute for health spending also generates a critical role of the health care system that we analyze in some detail. In the U.S., low-skilled workers typically have access to Medicaid if privately uninsured, which is less typical for middle income earners. Thus, particularly the uninsured middle class could become more inclined to abuse illicit drugs. This reasoning motivates us to also investigate the skill-specific differences in mental health status, mental health expenditure, consumption of intoxicants, and welfare between insured and uninsured workers. The model predicts that, when hit by mental distress, privately uninsured workers spend more on intoxicants and less on health than insured workers with the same skill level. We show that deprived 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.

Two broad strands of literature support the mechanisms highlighted in our research. First, ample evidence suggests an influence of perceived inequity and social comparisons on stress and health in general and on mental distress in particular (e.g. Marmot, 2004, 2005; Kessler, 1979; Wilkinson, 1997; Stansfeld et al., 1998; Power et al., 2002; Aneshensel, 2009; Reiss, 2013; Pickett and Wilkinson, 2015). In our model we follow the conventional economic reasoning and implement status concerns by relative income comparisons. However, we also consider, perhaps for the first time in health economic theory, the insight from biology and medical science that status concerns affect health and behavior beyond income comparisons through the position in social rankings (Sapolsky, 2004; Sapolsky and Marmot, 2014). We employ the task-based model of Acemoglu and Autor (2011) and implement the idea that traditional middle class tasks are eliminated through import competition and automation. As a result, middle class

workers, on average, move down in the ranking of tasks and perform some of the tasks that were formerly performed by low class workers. The loss of relative income and relative position in the hierarchy of tasks causes occupational stress, which, for some workers leads to mental distress and depression. In support of this line of reasoning, Colantone et al. (2019) document a large and highly significant impact of import competition on mental distress with British data for the period 2001–2007. Similarly, Pierce and Schott (2020) find that U.S. counties more exposed to trade liberalization exhibit higher declines in manufacturing employment and higher rates of suicide and related causes of death. Charles et al. (2019) find that manufacturing decline in the U.S. in the 2000s had large and persistent negative effects on local labor markets and is related to rising local opioid use and deaths. Abeliansky and Beulmann (2019) observe that an increase in robot intensity of German firms is associated with a large decline in average mental health of workers.

Second, regarding the role of the health care system for illicit drug consumption, Jones et al. (2015) show that past year heroin abuse is highly correlated with not having access to Medicaid or other health insurance and that it is also highly correlated with past year nonmedical use of OPR and other psychotherapeutic drugs. 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, those having received 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, Currie et al. (2020, 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., a view also advanced more recently by Case and Deaton (2020). In a similar vein, Degenhardt et. al. (2019) show that opiod consumption levels are much lower in France than in the U.S. Nevertheless, Natali et. al. (2020) show in a careful causal analysis that also in France socioeconomic conditions (regional poverty and share of middle-aged individuals) affect opioid

retail sales. Our analysis complements these empirical studies with counterfactual experiments and 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 distressed. We also investigate how illicit drug consumption and mental health expenditure would change if Medicaid were extended. Section 6 extends the model in two directions: first, individuals take into account longer run consequences of illicit drug consumption like addiction; second, well-being is affected by socio-economic deprivation beyond the channels of possibly reduced consumption possibilities and mental distress risk. The last section concludes.

2. The Model

We focus on middle-aged individuals living in non-overlapping generations. Goods and labor markets are perfectly competitive. The model endogenizes wage polarization and a shift in the composition of tasks performed by low-skilled and medium-skilled workers and links those labor market developments to mental health status and the consumption of intoxicants. We show how the effects depend 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 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.[4]

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

The production level of the composite input depends symmetrically on input of a unit mass of tasks, indexed by $j \in [0,1]$, according to constant-returns-to-scale technology

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

where $x(j)$ is the input of of task j. Any task j may be produced by low-skilled and medium skilled labor, $l(j)$ and $m(j)$, respectively. These two types of labor are perfectly substitutable in task production, 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 $j \geq J$. Notably, we differ from the task-based approach of Acemoglu and Autor (2011) in assuming that in the economy high-skilled labor is only imperfectly substitutable to medium- and low-skilled labor, according to (1) and (2). This may add some realism. More importantly, our modification of their approach allows us to focus on the task composition between medium-skilled and low-skilled labor.

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").

2.2. **Individuals.** 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 intertemporal considerations of individuals like savings, educational choice and longer-run health consequences of illicit drug abuse. All of these issues would be worthwhile to consider in future research with more elaborated modeling of boundedly rational behavior. Our goal is rather to focus on some recent cohorts of workers that have been exposed to changing labor market conditions and drug environment. The assumption of short-sightedness allows us to focus on the static trade-off individuals face between mitigating mental distress by non-medical use of intoxicants and health goods.

We now formalize the notion that the relative deprivation of the middle class that is associated with social status loss leads to a higher probability of mental distress. We assume that the group-specific probability to become mentally distressed are affected by a decline in earnings relative to social comparison groups and by the task space performed. In particular, we capture that an occupational shift towards tasks characterized by a high comparative advantage for the low-skilled creates occupational stress for the middle class. That a perceived decline of the social position may lead to mental distress is consistent with a large array of evidence outlined in Section 1 (see Reiss, 2013, and Pickett and Wilkinson, 2015, for surveys). Moreover, it is well established in the literature that social competition can endogenously generate a concern for relative income. For instance, Corneo and Gruener (2000) show that the middle class is particularly concerned of distancing themselves from the lower class in terms of net earnings to increase the likelihood of a favorable match in the marriage market. We capture this notion by assuming that also declining relative wages to comparison groups may lead to a higher probability of mental distress, in addition to shifts in the task composition.

We measure social status losses as deviation from some reference level formed at period 0. Regarding occupation-related social status, note that the mean task performed by low-skilled and medium-skilled workers for threshold task level J_t separating the task spaces for the two groups is $\frac{J_t}{2}$ and $\frac{1+J_t}{2}$, respectively, i.e. the deviation of the mean tasks in period t from the reference point is given by $\frac{J_t - J_0}{2}$ for both of these groups. With respect to the relative position in the earnings distribution, define $W_{t,0}^{M,L} \equiv \frac{w_0^M}{w_0^L} - \frac{w_t^M}{w_t^L}$ as the deviation in period t of the relative wage

of medium-skilled workers to low-skilled workers to relative wage aspirations formed in period 0 (e.g. coming from the parent generation) and analogously for other relative wage deviations. In the calibrated model, period 0 is the year 1979, after which the data point towards wage polarization in the U.S. (Acemoglu and Autor, 2011).

We assume that 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. Formalizing these notions, the probability that individual i becomes mentally distressed in period t is given by:

$$
\lambda_t(i) = \begin{cases} \bar{\lambda}^L + \nu \frac{J_0 - J_t}{2} + \chi W_{t,0}^{L,M} \equiv \lambda_t^L & \text{for } i \in \mathcal{L}_t, \\ \bar{\lambda}^M + \nu \frac{J_0 - J_t}{2} + \chi W_{t,0}^{M,L} + \chi W_{t,0}^{M,H} \equiv \lambda_t^M & \text{for } i \in \mathcal{M}_t, \\ \bar{\lambda}^H + \chi W_{t,0}^{H,M} \equiv \lambda_t^H & \text{for } i \in \mathcal{H}_t, \end{cases} \tag{4}
$$

where $\bar{\lambda}^L$, $\bar{\lambda}^M$, $\bar{\lambda}^H$ are the incidences of mental distress for the three education classes in period 0, $\nu > 0$ measures the sensitivity of the incidence of mental distress to occupational shifts, and $\chi > 0$ measures the impact of wage shifts relative to the neighboring education group.

From (4), we obtain the skill group-specific fraction of mentally distressed individuals as a function of the distribution of wages and the skill-specific task space. As will become apparent, only medium-skilled workers lose over time in terms of earnings relatively to those they socially compare with. Specifically, wage polarization ($W_{t,0}^{M,L} > 0$, $W_{t,0}^{M,H} > 0$) jointly with an enlargement of the task space towards jobs previously performed by low-skilled workers ($J_t < J_0$) unambiguously increases the likelihood for the middle class to become mentally distressed. By contrast, for the low-skilled, a smaller task space jointly with a rising wage rate relative to medium-skilled workers ($W_{t,0}^{L,M} < 0$) has an ambiguous effect on the probability to become mentally distressed.

The effective mental health status of individual i is denoted by $S(i)$. It is normalized to one for healthy individuals and is non-decreasing in his/her consumption level of health goods and services targeted to treat mental distress, $h(i)$, according to

$$
S_t(i) = \begin{cases} \underline{S} + \kappa h_t(i)^{\theta_t} & \text{if } h_t(i) < \left(\frac{1-\underline{S}}{\kappa}\right)^{\frac{1}{\theta_t}} \equiv \bar{h}(\underline{S}; \kappa, \theta_t) \text{ for } i \in \Lambda_t, \\ 1 & \text{otherwise,} \end{cases} \tag{5}
$$

where Λ_t is the set of mentally distressed individuals in period t, $\underline{S} \in (0, 1)$ is a minimum health level, $\kappa > 0$ 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. heroin, 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

$$U_t(i) = u(c_t(i), d_t(i), S_t(i)) \text{ with } u(c, d, S) \equiv \frac{S \cdot c^\gamma - \bar{u}}{(1 + d)^\delta}, \tag{6}$$

where $0 < \gamma \leq 1$, $0 < \delta < 1$, and $\bar{u}$ is an arbitrary constant. The utility function implies $u_{cS} > 0$, capturing 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 (6) lies in the potential motivation of mentally distressed 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 $d = 0$. However, in the case where $\bar{u} > 0$, utility turns negative ($S \cdot c^\gamma < \bar{u}$) if health status, S, and the numeraire good consumption level, c, are sufficiently low. In this case, $u_d > 0$ such that an individual may demand intoxicant drugs to mitigate their hardships associated with poor mental health and/or low consumption. The utility function also implies $u_{cd} < 0$ and $u_{dS} < 0$ which means that both higher consumption c and better health status S reduce the benefit from consuming intoxicants, respectively.

Mentally distressed individuals face two 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 and/or has a low health status to begin with (i.e. has a low $\underline{S}$). In this case, second, a mentally distressed individual also faces the trade-off to raise h or to consume intoxicants (d). The health system potentially affects both trade-offs 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 distress. 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 distress (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 to treat mental distress, $\mu^L > \mu^M > \mu^H \geq 0$. 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 their 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, suppose that 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 distress 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,[5] whereas the low-skilled do not pay taxes for financing Medicaid. This captures a progressive tax system.

The gross price of the health good consumption, h is denoted by r. It is exogenously given 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.

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[5]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/.

3.1. **Households' Decisions.** In our model, only mentally distressed individuals make choices. 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 (co-payment).[6] With price q of intoxicants, the budget constraint of individual i in period t reads as

$$c_t(i) \leq y_t(i) - q_t \cdot d_t(i) - R_t(i) \cdot h_t(i). \tag{7}$$

We will focus on interior solutions for the health input. According to (5), (6) and (7), neglecting constraint $0 \leq h \leq \bar{h}$, and assuming that (7) holds with equality, we can define the objective function of an individual with disposable income y, and health good price R as

$$\tilde{u}(h, d; y, \underline{S}, R, q, \kappa, \bar{u}) \equiv \frac{\left(\underline{S} + \kappa h^\theta\right)(y - qd - Rh)^\gamma - \bar{u}}{(1+d)^\delta}, \tag{8}$$

according to (6). The optimization problem of such an individual thus reads as

$$\max_{(h,d)} \tilde{u}(h, d; y, \underline{S}, R, q, \kappa, \bar{u}) \text{ s.t. } d \geq 0. \tag{9}$$

The optimal choices of health input, h, and illicit drug consumption, d, are denoted by h^* and d^*, respectively. 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 obtain the following results.

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 effectiveness of the health input, κ, decreasing in the net health good price, R, and decreasing in the minimum health level, $\underline{S}$.*

Proof. See Appendix A. $\square$

Part (i) of Proposition 1 is very intuitive. Illicit drug consumption makes an individual worse off if the numerator in objective function (8) is positive, which is the case if disposable income is sufficiently high. In this case, an individual abstains from consuming intoxicants. However,

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[6]The copayment is proportional to the gross price r and depends on the health care system; see Appendix B for details).

if utility becomes negative, illicit drug consumption helps individuals to mitigate consequences from mental distress if low income does not allow them to afford sufficient health care treatment.

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, an increase in the effectiveness of health care, κ, and a decrease in the health good price R (i.e. a lower copayment rate, $1 - s$) induce individuals to tilt the trade-off between health and material consumption towards health expenditure. Finally, marginal utility from numeraire good consumption is raised by a higher minimum health status, $\underline{S}$, such that a lower health input, $\hat{h}^*$, is optimal.

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 (9):*

(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 price of intoxicants (q) lowers d^*;

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

(iv) An increase in the effectiveness of health expenditure (κ) raises h^* while lowering d^*;

(v) An increase in the minimum health status ($\underline{S}$) lowers d^*.

(vi) An increase in $\bar{u}$ 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 also says that, for $\gamma = 1$, the illicit drug is unambiguously an inferior good, provided that $d^* > 0$. According to part (ii), a decrease in the drug price, q, unambiguously raises its consumption, d^*.[7] Part (iii) says that, for $\gamma = 1$, a higher price of health goods (R) unambiguously induces a substitution away from health good consumption towards illicit drugs. The response to the price change may not be unambiguous in the case of declining marginal utility of numeraire good consumption ($\gamma < 1$). Intuitively, the income effect of an increase in R could lead to lower illicit drug intake, in turn leaving

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[7]In Appendix A, it is also shown that individuals reduce h^* in response to a decrease in q, i.e. the substitution effect dominates the income effect for our specification of the utility function.

a higher budget for other purposes. According to part (iv), medical progress that raises the effectiveness of health care, κ, induces individuals to substitute away from illicit drugs towards health expenditure. Part (v) says that a lower level of mental distress to begin with, $\underline{S}$, induces individuals to mitigate the hardships of their lives by raising illicit drug consumption, d^*. Finally, an increase in $\bar{u}$ raises the marginal benefit from consuming illicit drugs. According to part (vi), for $d^* > 0$ (requiring $\bar{u} > 0$), individuals thus substitute from health spending to drugs.

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. According to (1), the representative firm in the final good sector solves profit maximization problem

$$\max_{\{y_t(j)\}_{j\in[0,1]}} (A_t H_t^Y)^\beta (X_t)^{1-\beta} - w_t^H H_t^Y - P_t X_t. \tag{10}$$

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

$$w_t^H = \beta(A_t)^\beta \left(\frac{X_t}{H_t}\right)^{1-\beta}, \tag{11}$$

$$P_t = (1-\beta)\left(\frac{A_t H_t}{X_t}\right)^\beta. \tag{12}$$

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

$$\max_{\{x_t(j)\}_{j\in[0,1]}} \left\{ P_t \exp\left(\int_0^1 \log x_t(j)\mathrm{d}j\right) - \int_0^1 p_t(j) x_t(j)\mathrm{d}j \right\}. \tag{13}$$

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

$$\int_0^1 \log p_t(j)\mathrm{d}j = \log P_t + \underbrace{\log X_t - \int_0^1 \log x_t(j)\mathrm{d}j}_{=0} = \log P_t, \tag{14}$$

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

$$w_t^L = p_t(j)\alpha_t^L(j) \text{ for any } j < J_t, \tag{15}$$

$$w_t^M = p_t(j)\alpha_t^M(j) \text{ for any } j \in \mathcal{Z}_t. \tag{16}$$

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

$$p_t(j)\alpha_t^L(j)l_t(j) = p_t(j')\alpha_t^L(j')l_t(j') \text{ for any } j, j' < J_t. \tag{17}$$

Substituting (15) in (17) 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

$$l_t(j) = \frac{L_t}{J_t} \text{ for any } j < J_t. \tag{18}$$

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

$$m_t(j) = \frac{M_t}{1 - \Delta_t - J_t} \text{ for any } j \in \mathcal{Z}_t. \tag{19}$$

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

$$p_t(j)\alpha_t^L(j)l_t(j) = p_t(j')\alpha_t^M(j')m_t(j') \text{ for } j < J_t \text{ and } j' \in \mathcal{Z}_t. \tag{20}$$

Using (15), (16), (18), (19) and (20), we find

$$w_t^L \frac{L_t}{J_t} = w_t^M \frac{M_t}{1 - \Delta_t - J_t}. \tag{21}$$

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

$$\frac{w_t^L}{\alpha_t^L(J_t)} = \frac{w_t^M}{\alpha_t^M(J_t)} \tag{22}$$

must hold. Combining (21) and (22) and assuming an interior solution, J_t is then implicitly given by

$$\frac{1 - \Delta_t - J_t}{J_t} \frac{L_t}{M_t} = \omega_t(J_t) \left[= \frac{\alpha_t^M(J_t)}{\alpha_t^L(J_t)} \right]. \tag{23}$$

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 (23) and recall that $\alpha_t^M(j)/\alpha_t^L(j)$ is increasing in j; thus, $\omega_t'(j) > 0$. $\qquad\square$

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*

$$\frac{w_t^{M*}}{w_t^{L*}} = \omega_t(J_t). \tag{24}$$

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

Proof. Eq. (24) follows from (22). The comparative static results of Proposition 4 follow from the comparative static results of Proposition 3. $\square$

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*

$$\log\left(\frac{w_t^{M*}}{w_t^{H*}}\right) = \log\left(\frac{1-\beta}{\beta}\right) - \log\left(\frac{M_t}{H_t}\right) + \log\left(1 - \Delta_t - J_t\right). \tag{25}$$

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. $\square$

Proposition 4 and 5 imply that outsourcing or automation causes wage polarization. Moreover, according to (24) and (25), the relative wage rate of medium-skilled labor to both other skill groups does not depend on the efficiency of high-skilled labor, A.

3.3. **Outsourcing, Mental Health, and Illicit Drug Consumption.** Putting things together, we arrive at the following conclusions.

Corollary 1. *(i) Outsourcing or automation of tasks formerly performed by medium-skilled workers (increase in Δ) raises the fraction of mentally distressed middle class workers whereas the effect on the lower class is ambiguous. (ii) An increase in Δ may lead to an increase in illicit drug consumption of the middle class, unless they have sufficiently high income. The effect on the lower class is ambiguous. (iii) A lower price of illicit drugs fosters illicit drug consumption.*

(iv) High-skilled labor saving technological progress (increase in A) does not affect the fraction of mentally distressed middle class workers.

Proof. Part (i) follows from (4) and the results that an increase in Δ_t lowers J_t, w_t^{M*}/w_t^{L*} and w_t^{M*}/w_t^{H*}, i.e. $J_t < J_0$ (Proposition 3), $W_{t,0}^{M,L} > 0$, $W_{t,0}^{L,M} < 0$ (Proposition 4), and $W_{t,0}^{M,H} > 0$ (Proposition 5). Part (ii) of Corollary 1 follows from part (i) of Corollary 1 and part (i) of Proposition 1, as mentally distressed workers may experience negative utility and start consuming illicit drugs unless income is sufficiently high. Part (iii) follows from part (ii) of Proposition 2. Part (iv) is implied by (4) and the results that neither threshold task J nor relative wages of medium-skilled workers are affected by a change in A (Propositions 3-5). $\square$

4. Calibration

We calibrate the model to examine both levels and changes over time of mental health care expenditure, illicit drug consumption, and welfare of the different subgroups, taking into account the health care budget constraints.[8] 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 (Propositions 4 and 5). The household side and health instruments are calibrated to match, *inter alia*, the health expenditure share on mental distress. For the calibration we feed in that the price of intoxicants, q, has markedly fallen in the last decades.

In order to investigate various channels in isolation, we 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 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
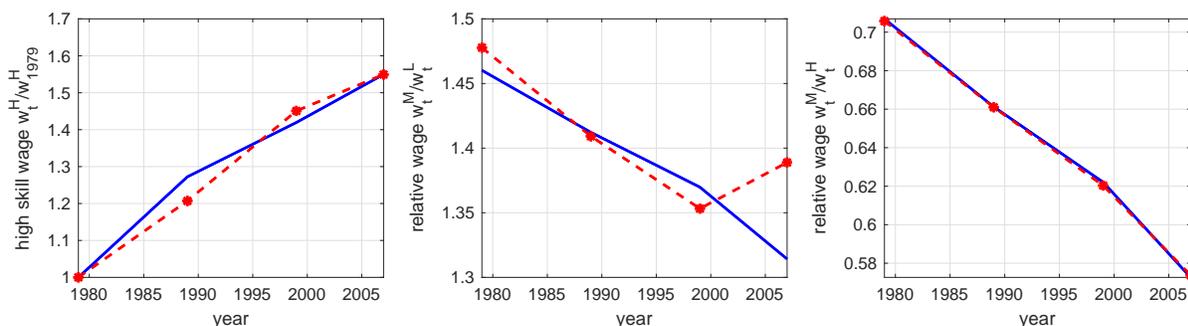
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[8]The derivations of the budget constraints for tax-financed Medicaid and contribution-financed subsidies for private health insurance are relegated to Appendix B.

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) and the mass of rationed middle class jobs in 1979 (Δ_{1979}), such that we match the relative wage between medium-skilled and high-skilled workers in 1979, w^M_{1979}/w^H_{1979}, and fit the level and trend of the w^M_t/w^L_t time series. 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.

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).

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. We set $\underline{S} = 0.5$ for the minimum mental health status, $\gamma = 0.7$ (determining the marginal utility of numeraire consumption) and the utility constant to $\bar{u} = 13$. 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 (2017, 2020), 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.[9] We acknowledge that there exists parameter uncertainty in the specification of the utility function. We try to accommodate this problem by an extensive sensitivity analysis that shows the robustness of our main result (of relative deprivation and falling drug prices being jointly necessary for middle class drug consumption to increase) against parameter variation of the utility function (see Appendix C).

On average, mental health improves with socio-economic status. SAMHSA (2018, Table 10.2B) reports prevalence of any mental illness for three income groups (below 100%, 100-200%, above 200% of average income), which we associate with our low-, middle-, and high education groups. Close to the end of our simulation scenario, for the year 2008, prevalence of mental illness is by factor 2.0 higher for the poor than for the rich and by factor 1.6 higher for the middle class than for the rich. For the calibration, we consider mental distress as the prevalence of depression. At least until recently, there is no trend discernible for the prevalence of depression among American adults (SAMSHA, 2017; GBD, 2019). In our calibration we target the prevalence of a major depressive episode in the past year, which is on average 6.7 percent (SAMSHA, 2017). Since low-skilled individuals may loose or gain in social status, depending on whether income comparisons or task comparisons are more important, we assume for our benchmark scenario that there is no trend in mental distress among the low-skilled. We later show that the results are rather insensitive to this assumption. Altogether we have five conditions, $\lambda^L/\lambda^H = 2.0$ and $\lambda^M/\lambda^H = 1.6$ in 2007, an average λ in the population of 6.7 percent, and no trend in prevalence of depression among the low-skilled and within the total population. These calibration targets

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[9]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.

lead to a solution $\bar{\lambda}^L = 0.091$, $\bar{\lambda}^M = 0.060$, $\bar{\lambda}^H = 0.057$, and $\chi = 0.06$, $\nu = 1.33$.[10] At these parameter values, positive and negative influences of social status balance each other for the low-skilled and declining mental distress among the high-skilled compensates for increasing mental illness among the low skilled. Notice that the dimensions of relative income and relative rank differ. On average, the calibrated χ and ν imply that the influence of income comparisons on mental illness is about 2.3 times higher than the influence of task comparisons.

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. As discussed in the introduction, opioid pain relievers are not prescribed to treat mental distress. Heroin is a close substitute to OPR and their street price exceeds the street price of heroin by about factor 10 (Gupta, 2016; Alpert et al. 2018). Our income-constrained individuals will thus prefer heroin over non-medical OPR use as form of self-treatment of mental distress. 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 the illicit drug price 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 also includes 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 distressed, poor individuals spend about 30 percent of their income on intoxicants and middle class individuals spend about

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[10]There is also a trivial solution, namely $\bar{\lambda}^L = 0.093$, $\bar{\lambda}^M = 0.075$, $\bar{\lambda}^H = 0.047$, and $\chi = \nu = 0$. Obviously, this solution is of little interest for our study since it implies that mental distress is unaffected by changing socioeconomic status.

10 percent.[11] 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. Appendix C provides a sensitivity analysis with respect to these parameters.

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, 2017, Exhibit 3). Taken together with the information of the health expenditure share in GDP (from OECD, 2019), we infer a mental health expenditure share of 0.0064 in 1989, 0.0074 in 1999, and 0.0089 in 2007. We adjust the values of $(\theta, \underline{\tau}, \bar{\tau})$ such that the empirical mental health expenditure shares are matched and the budget constraints for Medicaid (with tax rate $\underline{\tau}$) and the private insurer (with contribution rate $\bar{\tau}$) are balanced. This leads to the estimates $(0.093, 2.0 \cdot 10^{-4}, 0.0076)$ for the year 1989, $(0.105, 1.8 \cdot 10^{-4}, 0.0085)$ for the 1999, and $(0.131, 2.0 \cdot 10^{-4}, 0.010)$ for 2007. Thus, the anyway very low tax rate for financing treatment of the uninsured poor is roughly constant whereas the private health insurance premium slightly increases over time. Notice that these numbers apply to mental health and not to total health expenditure.
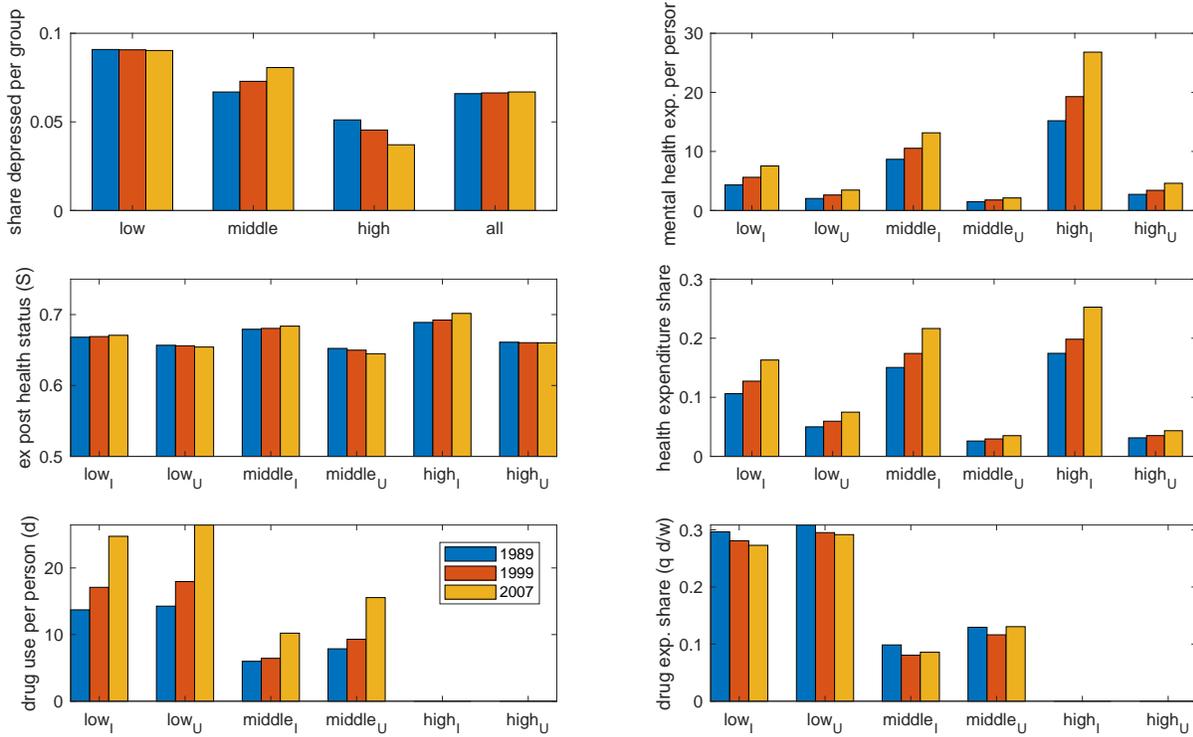
5. Numerical Results 1: Time Trends

5.1. **Benchmark Case.** Figure 2 shows the results for the benchmark scenario, in which q is decreasing over time and the middle class experiences socio-economic deprivation caused by outsourcing and automation (calibrated increase in Δ). We report the numerical outcomes by education group (low, middle, high) and by private health insurance status, indicated by index U for uninsured and I for insured.

5.1.1. *Mental Health Status and Health Expenditure.* According to the upper left panel of Figure 2, the fraction of mentally distressed middle class workers increases steadily from 6.0 percent in the base year 1979 to 8.1 percent in 2007. This is the response to status loss due to wage polarization (Figure 1) and the average lower rank of tasks performed (Proposition 3), as formalized in (4) and predicted by part (i) of Corollary 1. All other panels show outcomes for those workers who developed mental distress. We see an income gradient in mental health expenditure

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[11]These expenditure shares are meant to capture expenditure for a "drug mix". If the consumed drug were solely heroin, 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).

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

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

(including subsidies) for the privately insured in absolute terms (upper right panel) and as a fraction of gross income (middle right panel). For the privately uninsured, health expenditure of the mentally distress is U-shaped in income due to the public subsidy (Medicaid) on health expenditure that is exclusively available to uninsured lower class workers. Strikingly, the 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, where column (1) refers to the baseline calibration (case 1). In the low income class, the uninsured spend about half on mental health compared to the insured in 1989 ($h_{1989}^{L,U}/h_{1989}^{L,I} - 1 \approx -0.53$) and 2007. The gap is much higher in the middle class where the uninsured have 83 percent lower health spending than the insured in both years.

From Figure 2, we see the monotonic income gradient for the insured and the U-shaped gradient 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 class worker is eligible for Medicaid whereas

in the data there are some beneficiaries (see KFF 2013). We see also that for the insured middle class, *ex post* mental health (middle left panel) improves over time. By contrast, *ex post* mental health status of the uninsured middle class declines 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.

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 only task comparison
$\Delta \log(rh^{L,I})$	74.13	78.17	102.48	106.51	74.13
$\Delta \log(rh^{L,U})$	69.74	73.70	97.80	101.76	69.74
$\Delta \log(rh^{M,I})$	51.72	54.10	86.67	86.67	51.71
$\Delta \log(rh^{M,U})$	42.35	44.63	84.91	84.91	42.35
$\Delta \log(rh^{H,I})$	76.43	76.43	76.43	76.43	76.43
$\Delta \log(rh^{H,U})$	68.69	68.69	68.69	68.69	68.69
$\Delta \log d^{L,I}$	80.50	-13.04	52.43	-27.80	80.50
$\Delta \log d^{L,U}$	85.37	-10.29	59.38	-23.97	85.37
$\Delta \log d^{M,I}$	70.52	-26.09	-100.00	-100.00	70.54
$\Delta \log d^{M,U}$	97.69	-8.88	-100.00	-100.00	97.70
$h_{1989}^{L,U}/h_{1989}^{L,I} - 1$	-52.93	-52.93	-52.90	-52.90	-52.93
$h_{1989}^{M,U}/h_{1989}^{M,I} - 1$	-82.74	-82.74	-82.70	-82.70	-82.74
$d_{1989}^{L,U}/d_{1989}^{L,I} - 1$	4.04	4.04	4.30	4.30	4.04
$d_{1989}^{M,U}/d_{1989}^{M,I} - 1$	31.34	31.34	53.79	53.79	31.34
$h_{2007}^{L,U}/h_{2007}^{L,I} - 1$	-54.11	-54.11	-53.99	-53.99	-54.11
$h_{2007}^{M,U}/h_{2007}^{M,I} - 1$	-83.81	-83.80	-82.86	-82.86	-83.81
$d_{2007}^{L,U}/d_{2007}^{L,I} - 1$	6.85	7.33	9.06	9.84	6.85
$d_{2007}^{M,U}/d_{2007}^{M,I} - 1$	52.27	61.91	–	–	52.26
$\xi_{1989}^{L,I}$	2.98	2.98	3.03	3.03	2.97
$\xi_{1989}^{L,U}$	3.15	3.15	3.21	3.21	3.15
$\xi_{1989}^{M,I}$	2.85	2.85	2.56	2.56	2.84
$\xi_{1989}^{M,U}$	3.31	3.31	3.06	3.06	3.31
$\Delta\xi^{L,I}$	0.67	0.23	0.70	0.12	0.65
$\Delta\xi^{L,U}$	0.83	0.32	0.87	0.22	0.83
$\Delta\xi^{M,I}$	0.44	-0.15	-0.78	-0.78	0.43
$\Delta\xi^{M,U}$	0.89	0.08	-1.14	-1.14	0.89

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 1989 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 needs 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 1989 to 2007.

Table 1 reports the percentage changes of mental health expenditure over time of different types and the skill-specific health expenditure levels of uninsured relative to insured individuals in each group. 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 distressed spend more on health over time. According to column (1) of Table 1, the health expenditure increase is lowest for the uninsured middle class (42 percent), next to the insured middle class (52 percent). The poor and the rich have higher expenditure increases (69 to 76 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 distressed 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 $\Delta \log d^{M,U} = 98$ percent from 1989 to 2007 (and by 71 percent for the insured middle class), according to column (1) in Table 1. The privately uninsured poor come second with an increase by 85 percent (and 80 percent for the insured). In relative terms, these results correspond well this with the actual increase in heroin consumption 2002–2013, 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 covers a different time period and reports prevalence while our model considers the intensity of drug use of the group-specific representative agent.

Because of income growth, the drug expenditure share for the poor is somewhat decreasing over time while it is mildly U-shaped for the middle class (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 1989 an uninsured middle income earner spends 31 percent more on drugs than an insured one and in 2007 the difference rises to 52 percent. In contrast to the middle class, there is little difference between the insured and uninsured among poor drug users, $d^{L,U}$ is just 4 to 7 percent higher than $d^{L,I}$. 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 distressed middle class workers.
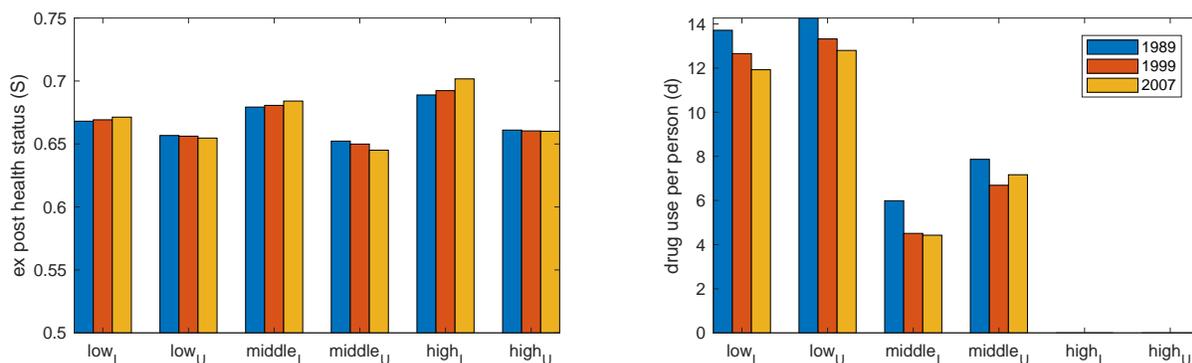
5.1.3. *Welfare.* In the lower part of Table 1 we report the implied welfare level and welfare change for within-group comparisons of mentally distressed versus healthy people. Welfare is measured in consumption equivalents. For instance, we denote by $\xi_{1989}^{M,U}$ the factor by which numeraire good consumption of a mentally distressed middle class 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 mental distress, which is slightly higher than for the other non-rich individuals. $\Delta \xi^{M,U}$ is the change of the consumption equivalent from 1989 to 2007 for the same type of worker, which increased by 0.89 in the considered time period. We see that, for all non-rich groups, the welfare distance between mentally distressed and healthy individuals got larger over time, with a larger increase for uninsured individuals.[12]

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 and in Figure 3.

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

The main difference of case 2 to the benchmark case 1 lies in the type-specific consumption of intoxicants for both comparison years. Figure 3 shows that, if drug prices stayed constant, drug consumption would have declined from 1989 to 2007 for all individuals. Thus, the increase in drug consumption that we found in the benchmark case for the period 1989-2007 requires drug prices to decline. The mental health status observed after treatment of uninsured individuals, however, is still 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).

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[12]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.

In addition, from columns (1) and (2) of Table 1 we see that the increase over time of the welfare distance to healthy individuals (in terms of consumption equivalent) is considerably smaller for the lower class than in the benchmark case and even close to zero actually for the middle class (even reversing sign for the insured middle income earners). This means that welfare of mentally distressed middle class individuals would not have declined, 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 and that the performance of tasks is irrelevant for status concerns ($\nu = 0$). We keep the assumption of the benchmark case 1 that drug prices are declining. Results are shown in column (3) of Table 1 (case 3). Interestingly, we see that despite falling drug prices the middle class stops using drugs (drug consumption declines by 100%). Apparently, income of the middle class has increased sufficiently such that medical treatment becomes the exclusive way of dealing with mental distress even for the uninsured middle class workers. As a result, the welfare wedge between healthy and unhealthy middle class individuals declines substantially over time.

Finally, case 4 combines cases 2 and 3 by considering constant drug prices jointly with the absence of social deprivation of the middle class and counterfactually higher wage growth also for the poor. Results are shown in column (4) of Table 1 (case 4). Now, also low-skilled workers are predicted to reduce their drug consumption over time (as in case 2) albeit, in contrast to the middle class, not fully. The welfare difference to the healthy counterparts basically remains unchanged.
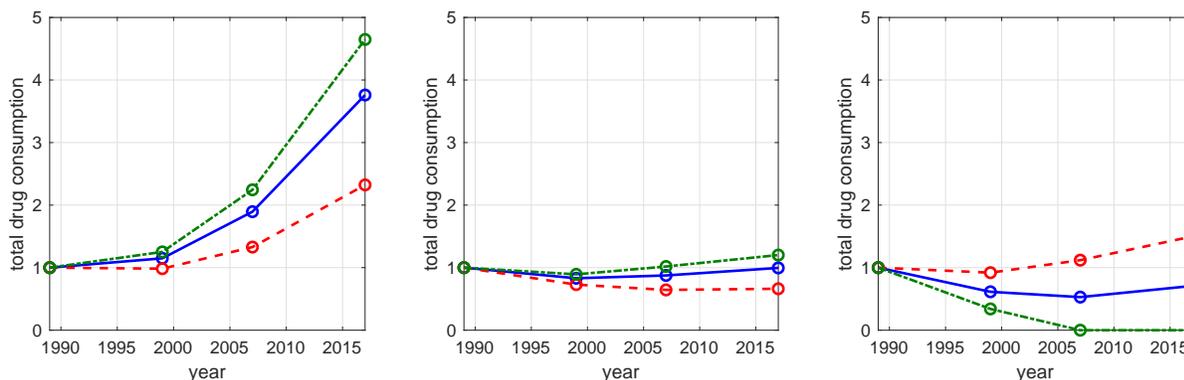
Comparing the results to benchmark case 1, cases 2 to 4 suggest that both falling drug prices and economic deprivation are necessary to elicit increasing drug consumption of the middle class. It is thus the interaction between both forces that matter, reconciling the "despair hypothesis" with the evidence from Ruhm (2019) that relative deprivation alone cannot explain rising drug consumption.

5.4. **Only Rank Comparisons.** Finally, we show robustness of results with respect to the source of status concerns. For that purpose, we assume that status concerns are uniquely determined by task performance, setting $\chi = 0$. Assuming that the benchmark erosion of middle class status is now solely explained by the on average lower rank of tasks (lower position

in the hierarchy) requires to recalibrate $\nu = 6.7$. Naturally, we need to give up the assumptions of no trend of mental distress for the low-skill and for the total population. With the new parameters, prevalence of mental distress among the low-skilled increases to 11 percent and aggregate prevalence increases to 7.5 percent. The results reported in Table 1 (case 5), deviate insignificantly from the benchmark results (case 1). The reason is that Table 1 considers within-group comparisons, which remain largely unaffected by changing prevalence of mental distress. Similarly, robustness of results is obtained when the benchmark erosion of middle class status is solely explained by wage comparison (implying mildly declining trends for mental distress among the low-skilled and on the aggregate). We thus conclude that the results are robust against different assumptions on the driver of status concerns.

5.5. **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, tasks, 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 3.7 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. Drug consumption of the middle class stays roughly constant until 2007 and then rises mildly, i.e. the combination of declining status and rising absolute wage rates generates a non-monotonic time paths of drug consumption. Total drug consumption follows a shallow U-shaped pattern and reaches about its value from 1989 again in 2007.

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, thanks to counterfactually rising wages that induce middle class workers to treat mental distress with health inputs rather than consuming illicit drugs. 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.

5.6. **Effects of Medicaid Reform.** A key feature of our analysis is that illicit drug consumption is a potential substitute for mental health care for those hit by mental distress. 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.

Column (1) of Table 2 shows for the year 2007 the health expenditure and drug use choices of the mentally distressed for the benchmark case, 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 distressed workers when public health care (Medicaid) is extended to the privately uninsured middle class at the same subsidy rate as for the poor, $\underline{s} = 0.6$ (scenario "ext

	case 1	ext MDCD	gen MDCD
$rh^{L,I}$	5.62	5.62	5.62
$rh^{L,U}$	2.63	2.63	4.45
$rh^{M,I}$	10.54	10.54	10.54
$rh^{M,U}$	1.79	4.95	8.35
$d^{L,I}$	17.09	17.09	17.09
$d^{L,U}$	17.96	17.96	17.25
$d^{M,I}$	6.44	6.44	6.44
$d^{M,U}$	9.29	7.49	6.51
$\xi^{L,I}$	3.27	3.26	3.25
$\xi^{L,U}$	3.49	3.49	3.35
$\xi^{M,I}$	2.92	2.91	2.90
$\xi^{M,U}$	3.53	3.16	2.95

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.

MDCD"). All else is kept the same as in the benchmark case, except the tax rates that we adjust accordingly. We see that the health care reform would increase mental health expenditure of the targeted group, as intended. The mentally distressed, privately uninsured middle class workers would increase their health spending by factor 2.7. Importantly, their drug consumption would decrease by about 20 percent ($100 - \frac{7.49}{9.29} = 0.193$) to a level closer to that of privately insured middle class workers.

The bottom of Table 2 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 distressed, 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 (again adjusting tax rates accordingly). Now, in addition to mentally distressed middle income workers, also the low income counterparts spend more on mental health care and less on drugs. Moreover, both groups reduce the welfare gap relative to healthy persons. The insured are only marginally affected by Medicaid reforms (via tax rate adjustments only).

Overall, the results point to unambiguously positive effects of health care subsidies on health spending and negative effects on drug consumption.

6. EXTENSIONS

6.1. **Longer-run Consequences of Illicit Drug Consumption.** Our model explains why individuals may deliberately consume illicit drugs to cope with mental distress. So far, however, we have implicitly assumed that the choice ignores potentially detrimental longer run effects like cravings from addiction. The economic literature on addiction assumes that consumption of a certain good leads to an accumulation of a stock (consumption capital), which enters the utility function (Becker and Murphy, 1988; Dockner and Feichtinger, 1993). Thus, past consumption potentially affects future consumption. Further extensions of this literature considered effects of addiction on health and longevity (Strulik, 2018) and painkiller addiction that motivates the transition into illicit drug use (Strulik, 2020). The available addiction literature, however, focusses on drug consumption of an individual. Here, we do not venture into uncharted terrain and attempt to integrate addiction into a macroeconomic model with heterogenous agents. Instead, we capture harmful longer run effects like addiction in "reduced-form" by an alleviated risk of adverse utility consequences of drug consumption.

Specifically, we assume that adverse effects become more likely if drug consumption is higher. Suppose that utility component $\bar{u}$ worsens from $\bar{u}_0 > 0$ to $\bar{u}_1 > \bar{u}_0$ with probability $\Phi(d(i))$ that is increasing in drug intake $d(i)$ of individual i. We specify $\Phi(d) = \phi \cdot d$ for $d \leq 1/\phi$ and $\Phi = 1$ otherwise, $\phi > 0$. Focussing on interior solutions, individual i thus maximizes in period t expected utility

$$V_t(i) \equiv \phi d_t(i) \frac{S_t(i)c_t(i)^\gamma - \bar{u}_1}{(1 + d_t(i))^\delta} + (1 - \phi d_t(i)) \frac{S_t(i)c_t(i)^\gamma - \bar{u}_0}{(1 + d_t(i))^\delta} \tag{26}$$

s.t. (5) and (7). We can show the following:

Proposition 6. *In the extended model capturing the risk of longer run consequences of illicit drug consumption (addiction),*

(i) part (ii) of Proposition 1 and parts (i)-(v) of Proposition 2 still hold;

(ii) an exogenous increase in the probability of addiction (increase in ϕ) or in the utility loss from addiction ($\Delta\bar{u} \equiv \bar{u}_1 - \bar{u}_0$) raises health input, h^*, and lowers drug intake, d^*.

Proof. See Appendix A. □

Proposition 6 reveals that all relevant analytical results on individual behavior carry over to the extended model. Moreover, intuitively, a higher utility risk from illicit drug consumption or more severe potential consequences lead to a substitution away from drugs towards health spending.

The calibration of the extended model is constrained by the fact that there exists no literature on addiction probabilities for the use of illicit drugs. The meta-study of Vowles et al. (2015) reviews the literature on addiction to prescription opioids of opioid users who had been on their prescriptions for at least 90 days. It was found that the average share of opioid users who become addicted is around 10 percent. Although the addictive ingredient of prescription opioids is the same as for heroin (i.e. morphine), this estimate is likely a lower bound in the context of illicit drug use in mental distress. We therefore also consider higher addiction probabilities of 20 percent and 40 percent. We keep the value $\bar{u} = 13$ from the basic model for $\bar{u}_0$ and set $\bar{u}_1$ such that drug-using middle-class workers without private health insurance experience a decline of their already negative utility by factor 2 if they become addicted. If results turn out to be robust against such a drastic impact of addiction on utility, they will be robust for any smaller utility effect as well (for $\bar{u}_1 \to \bar{u}_0$ the solution converges to the solution of the basic model).

As explained above, a positive probability of addiction reduces the propensity to use drugs. We thus need to make drug use more attractive for a different reason in order to match the same share of drug using individuals as in the benchmark model without addiction and to make the predictions of the two models comparable. For that, we adjust δ such that drugs become more powerful in mental stress reduction. Specifically we set ϕ and δ such that the average addiction probability of those who take drugs in 2007 is, alternatively, 10, 20, and 40 percent and such that the model predicts about the same initial distribution of drug use among social groups as the benchmark model. This leads to (ϕ, δ) estimates of $(0.008, 0.41)$; $(0.019, 0.43)$; and $(0.043, 0.49)$ for addiction probabilities of 10, 20, and 40 percent.

Results are shown in Table 3. To facilitate comparison, case 1 reiterates the result from the benchmark model without addiction (from Table 1). Cases A.1–A.3 show results for low, medium, and high probability of addiction. We find that the probability of addiction dampens the increase of drug use and amplifies the increase in health expenditure. All qualitative results, however, carry over from the benchmark model. Specifically, we continue to find that (i) the increase in health expenditure is lowest for uninsured middle class workers, (ii) the increase

in drug consumption is highest for uninsured middle-class workers, (iii) uninsured middle class workers spend significantly more on drugs than insured middle class workers (about 50% more irrespective of the addiction probability), (iv) the difference in drug consumption between insured and uninsured low-skilled workers is small, (v) the welfare difference between mentally distressed workers and non-distressed workers is highest for the uninsured middle class, (vi) the welfare distance between mentally distressed and non-distressed individuals increases over time with the largest increase for the uninsured middle-class workers.

TABLE 3. Mental Health, Consumption of Intoxicants and Welfare, 1989-2007: Addiction

addiction	case 1 no	case A.1 low	case A.2 medium	case A.3 high	case A.4 medium const price	case A.5 medium const status
$\Delta \log(rh^{L,I})$	74.13	78.54	82.87	90.65	77.36	108.33
$\Delta \log(rh^{L,U})$	69.74	74.58	79.26	87.37	73.10	104.50
$\Delta \log(rh^{M,I})$	51.72	52.82	53.73	55.12	53.58	84.48
$\Delta \log(rh^{M,U})$	42.35	44.30	45.88	47.92	44.46	81.86
$\Delta \log(rh^{H,I})$	76.43	76.43	76.43	76.43	76.43	76.43
$\Delta \log(rh^{H,U})$	68.69	68.69	68.69	68.69	68.69	68.69
$\Delta \log d^{L,I}$	80.50	66.44	52.37	34.02	-14.61	25.37
$\Delta \log d^{L,U}$	85.37	70.77	56.15	37.19	-11.97	30.81
$\Delta \log d^{M,I}$	70.52	54.71	39.58	19.99	-27.81	-100.00
$\Delta \log d^{M,U}$	97.69	79.56	62.51	40.99	-10.07	-100.00
$h^{L,U}_{1989}/h^{L,I}_{1989} - 1$	-52.93	-52.86	-52.81	-52.78	-52.81	-52.78
$h^{M,U}_{1989}/h^{M,I}_{1989} - 1$	-82.74	-82.69	-82.65	-82.64	-82.65	-82.61
$d^{L,U}_{1989}/d^{L,I}_{1989} - 1$	4.04	3.99	3.90	3.68	3.90	4.16
$d^{M,U}_{1989}/d^{M,I}_{1989} - 1$	31.34	31.69	32.00	32.24	32.00	57.20
$h^{L,U}_{2007}/h^{L,I}_{2007} - 1$	-54.11	-53.91	-53.74	-53.59	-53.94	-53.65
$h^{M,U}_{2007}/h^{M,I}_{2007} - 1$	-83.81	-83.65	-83.54	-83.44	-83.68	-82.86
$d^{L,U}_{2007}/d^{L,I}_{2007} - 1$	6.85	6.70	6.49	6.13	7.11	8.68
$d^{M,U}_{2007}/d^{M,I}_{2007} - 1$	52.27	52.84	53.68	55.38	64.43	–
$\xi^{L,I}_{1989}$	2.98	2.91	2.88	2.97	2.88	2.96
$\xi^{L,U}_{1989}$	3.15	3.08	3.05	3.15	3.05	3.12
$\xi^{M,I}_{1989}$	2.85	2.81	2.81	2.97	2.81	2.50
$\xi^{M,U}_{1989}$	3.31	3.26	3.27	3.50	3.27	3.00
$\Delta\xi^{L,I}$	0.67	0.55	0.47	0.49	0.26	0.51
$\Delta\xi^{L,U}$	0.83	0.67	0.58	0.50	0.35	0.65
$\Delta\xi^{M,I}$	0.44	0.34	0.26	0.17	-0.16	-0.73
$\Delta\xi^{M,U}$	0.89	0.73	0.61	0.54	0.07	-1.08

Calibrated addiction probabilities: low 10%, medium 20%, high 40%. Case 1 re-iterates case 1 from Table 1. 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 1989 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 needs 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 1989 to 2007.

We next replicate the counterfactual analyses from Sections 5.2 and 5.3. For that, we focus on the case of medium addiction. Results for low and high addiction are similar. Case A.4 shows results for a constant drug price. Qualitatively, we obtain the same conclusions as for the benchmark model. Specifically, for constant drug price (i) all groups would have reduced their drug consumption, (ii) the distance of welfare between mentally distressed and healthy individuals would have increased by less than with falling drug prices and welfare changes would have been close to zero for mentally-distressed middle-class workers. Case A.5 shows results for constant status. As for the benchmark model we observe that (i) middle-class workers would have quit using drugs despite declining drug prices and (ii) the welfare-distance between mentally distressed and healthy middle-class workers declines over time. We thus conclude that falling drug prices and declining status remain to be jointly necessary to explain rising drug consumption of the middle class.

Our reduced-form approach avoids to model addiction as a dynamic process. This short cut appears to be justified since the period length of the model is ten years such that addiction – if it occurs – is likely to develop fully within one period. While future research may attempt a full dynamic analysis with multiple periods of drug consumption, it is perhaps useful to speculate on potential results. For that, suppose again that present drug intake raises utility component $\bar{u}$ with some positive probability and that this is in turn affects future drug consumption and thus $\bar{u}$ in the future. That is, $\bar{u}$ would become a state variable, which enters the utility function negatively, unlike consumption capital in Becker and Murphy (1988) and similar to the conceptualization of pain in Strulik (2021). Then, part (vi) of Proposition 2 would still hold and suggest a positive feedback effect on drug consumption that unambiguously leads to rising drug consumption along with an increasing $\bar{u}$ over time. Addiction would thus gradually and monotonously increase from one period to the next. However, there would be no scope for cyclical drug consumption because a cyclical consumption pattern would require a second state variable (see Dockner and Feichtinger, 1993; Levy and Faria, 2008).[13]
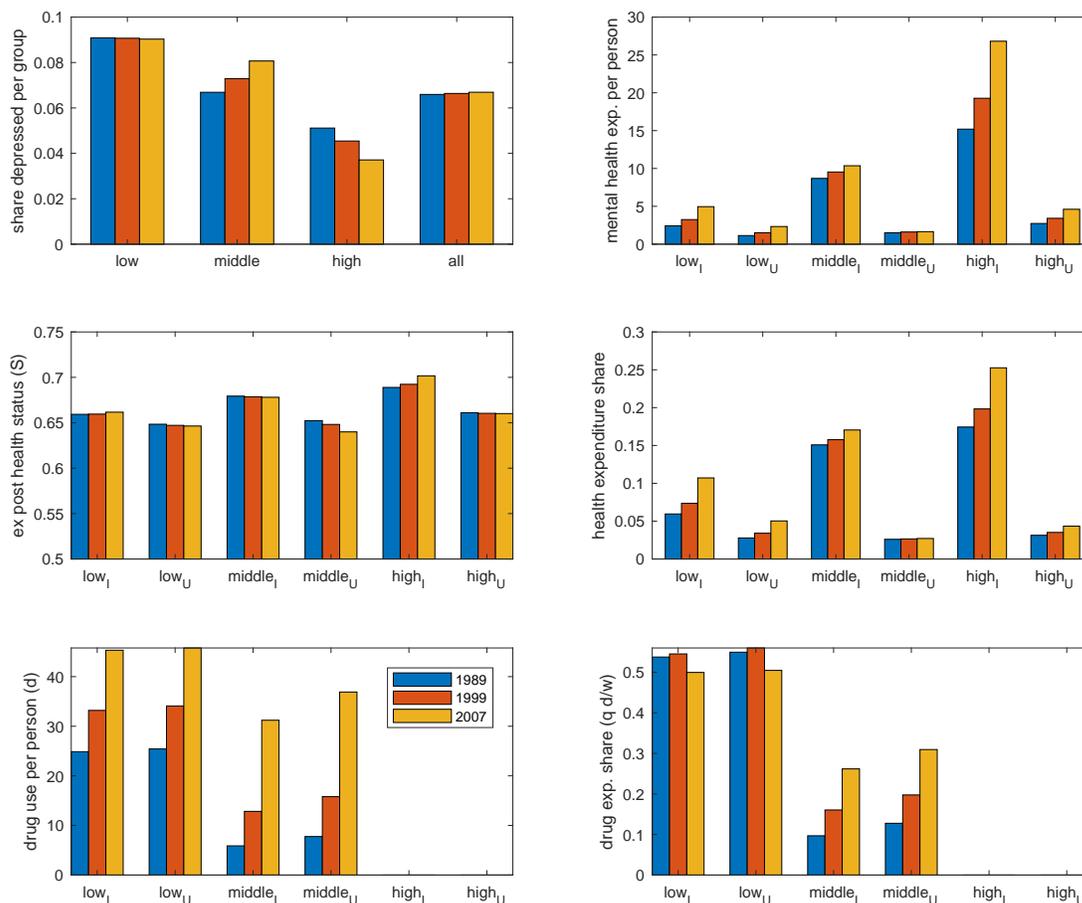
6.2. **Socio-economic Deprivation and Well-being: An Additional Channel.** Socio-economic deprivation may affect utility beyond the channels of possibly reduced consumption

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[13]In an interesting approach with scope for cyclical consumption, Levy and Faria (2008) model the feedback loop between depression and drug consumption that improves well-being in the short-run but positively affects the depressive state. Their analysis points to an important role of the time preference rate for cyclical drug consumption.

possibilities and mental distress. For instance, social status loss may be painful even without health effects.

A natural way to capture such additional, negative effects on well-being is by linking social status loss to utility component $\bar{u}$ (for simplicity, ignoring the risk of addiction). Suppose that $\bar{u}$ is determined by the same labor market outcomes as the probability of mental distress. For the sake of concreteness, we specify a time- and individual specific component $\bar{u}_t(i) = \bar{\mathfrak{u}} \cdot \lambda_t(i)$, $\bar{\mathfrak{u}} > 0$, in utility function (6). As so far we assumed $\bar{u} = 13$ and matched an average λ (fraction of mentally distressed individuals in the whole population) in 2007 of 6.7 percent, we calibrate $\bar{\mathfrak{u}} = 13/0.067 = 194$. All other parameter values are set as for the benchmark case 1. Results are shown in Figure 5, which can be compared to Figure 2. As expected from part (vi) of Proposition 2, we see that for deprived and mentally distressed middle-income earners the increase in illicit

FIGURE 5. Outcomes for the calibrated model with direct effects of status loss on utility, 1989 vs. 2007

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

33

drug consumption over time is steeper compared to Figure 2, particularly for the uninsured. Moreover, the gap in drug use between middle and low-income earners becomes smaller. In other words, the substitution away from mental health expenditure towards illicit drug consumption becomes more pronounced for those affected the most by labor market effects of outsourcing and automation.

7. Conclusion

We have examined the hypothesis 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 distressed workers may consume intoxicants to mitigate negative utility as a substitute for mental health care and (ii) outsourcing and automation causes socio-economic deprivation of the middle class that results in higher incidence of mental distress in that group.

Most importantly, our analysis suggests that a higher incidence of mental distress caused by relative deprivation can explain the drug epidemic in the U.S. middle class only in interaction with falling drug prices. We thus provide an empirically supported, theoretical foundation of Case and Deaton's (2017, 2020) despair hypothesis and reconcile it with the supply side evidence compiled by Ruhm (2019). We find that, if opioid prices stayed constant, welfare of mentally distressed middle class workers would not have declined relative to their healthy counterparts. By contrast, relative welfare particularly decreases for mentally distressed medium-skilled workers without health insurance when drug prices decline over time. We also account for the fact that 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.

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 and causes a large welfare gap between the mentally distressed and the healthy. In addition, also mentally distressed workers with low levels of

education and access to Medicaid would decrease drug consumption and would experience higher welfare under a more generous public health care system. In terms of policy conclusions, the first best policy would be to remedy the labor market causes of the deprivation of the middle class. However, the erosion of middle-class tasks through automation and outsourcing seems to be hard to address by policy in an open market economy. In this case, an active health system helps to curb the health consequences of the decline of the middle class. Specifically, our results strongly suggests that tax-financed public health care should be (and should have been) extended for mentally distressed non-rich persons in order to fight the U.S. drug epidemic. The analysis also contributes to the understanding why European countries with a more generous public health care system avoided the dismal experience of the U.S., as documented by Haan et al. (2019) for the case of Germany.

Appendix A: Proofs

Proof of Proposition 1: According to (8), we have

$$\tilde{u}_h(h, d; y, \underline{S}, R, q, \kappa, \bar{u}) = \frac{\kappa R(y - qd - Rh)^{\gamma-1}}{(1+d)^\delta} \left(\frac{\theta h^{\theta-1}(y - qd)}{R} - \frac{\underline{S}\gamma}{\kappa} - (\gamma + \theta)h^\theta \right), \quad (27)$$

$$\tilde{u}_d(h, d; y, \underline{S}, R, q, \kappa, \bar{u}) = -\frac{\frac{\gamma q(\underline{S} + \kappa h^\theta)(1+d)}{(y - qd - Rh)^{1-\gamma}} + \delta \left[(\underline{S} + \kappa h^\theta)(y - qd - Rh)^\gamma - \bar{u} \right]}{(1+d)^{\delta+1}}, \quad (28)$$

$$\tilde{u}_y(h, d; y, \underline{S}, R, q, \kappa, \bar{u}) = \frac{\gamma(\underline{S} + \kappa h^\theta)(y - qd - Rh)^{\gamma-1}}{(1+d)^\delta} > 0. \quad (29)$$

$$\tilde{u}_{\underline{S}}(h, d; y, \underline{S}, R, q, \kappa, \bar{u}) = \frac{(y - qd - Rh)^\gamma}{(1+d)^\delta} > 0. \quad (30)$$

First, according to (28), $\bar{u} \leq 0$ implies that $\tilde{u}_d < 0$. Thus, in this case, there is a corner solution for consumption of intoxicants, $d^* = 0$. Conditional on $d = 0$, $\hat{h}^* \equiv \hat{h}(y, \underline{S}, R, \kappa)$ 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 (27). Also according to (27),

$$0 = \frac{\theta(\hat{h}^*)^{\theta-1}y}{R} - \frac{\underline{S}\gamma}{\kappa} - (\gamma + \theta)(\hat{h}^*)^\theta. \quad (31)$$

Comparative-static results in part (ii) follow by applying the implicit function theorem to (31).

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

$$g(y) \equiv \tilde{u}_d(\hat{h}(y, \cdot), 0; y, \cdot) \quad (32)$$

$$= -\gamma q(\underline{S} + \kappa \hat{h}(y, \cdot)^\theta) \left[y - R\hat{h}(y, \cdot)\right]^{\gamma-1} - \delta \tilde{u}(\hat{h}(y, \cdot), 0; y, \cdot), \tag{33}$$

according to (28), and note that $d^* = 0$ if $g(y) < 0$. The result is proven by noting that $\lim_{y \to \infty} \tilde{u}(h, 0; y, \cdot) = \infty$ and confirming that partial derivative $g'(y) < 0$. According to (31), (33) and $\tilde{u}_h(\hat{h}^*, 0; \cdot) = 0$ (envelope theorem),

$$g'(y) = -\gamma q \hat{h}_y(y, \cdot) \left(\frac{\kappa \theta (\hat{h}^*)^{\theta-1} \left[y - R\hat{h}^*\right] + (1 - \gamma) \left[\underline{S} + \kappa(\hat{h}^*)^\theta\right]}{(y - R\hat{h}^*)^{2-\gamma}} \right) - \delta \tilde{u}_y(\hat{h}^*, 0; y, \cdot) < 0, \tag{34}$$

as partial derivatives $\hat{h}_y(y, \cdot) > 0$ (part (ii) of Proposition 1), and $\tilde{u}_y(\hat{h}^*, 0; y, \cdot) > 0$, according to (29), 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, (27) implies

$$\tilde{u}_{hh}(h^*, d^*; \cdot) = -\frac{\kappa \theta \left[(1 - \theta)(y - qd^*) + (\gamma + \theta)Rh^*\right]}{(1 + d^*)^\delta (c^*)^{1-\gamma}(h^*)^{2-\theta}} < 0, \tag{35}$$

$$\tilde{u}_{hd}(h^*, d^*; \cdot) = -\frac{\kappa \theta q}{(1 + d^*)^\delta (c^*)^{1-\gamma}(h^*)^{1-\theta}} < 0, \tag{36}$$

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

$$\tilde{u}_{h\underline{S}}(h^*, d^*; \cdot) = -\frac{\gamma R}{(1 + d^*)^\delta (c^*)^{1-\gamma}} < 0, \tag{38}$$

$$\tilde{u}_{hq}(h^*, d^*; \cdot) = -\frac{\kappa \theta d^*}{(1 + d^*)^\delta (c^*)^{1-\gamma}(h^*)^{1-\theta}} < 0, \tag{39}$$

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

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

$$\tilde{u}_{h\bar{u}}(h^*, d^*; \cdot) = 0. \tag{42}$$

Now define $S^* \equiv \underline{S} + \kappa(h^*)^\theta$. Using the envelope theorem which implies that $\tilde{u}_d(h^*, d^*; \cdot) = 0$ when $d^* > 0$ holds, we also obtain from (28) that

$$\tilde{u}_{dd}(h^*, d^*; \cdot) = -\frac{\gamma q S^* \left[(1 - \gamma)q(1 + d^*) + (1 - \delta)c^*\right]}{(1 + d^*)^{\delta+1}(c^*)^{2-\gamma}} < 0, \tag{43}$$

by recalling that $\gamma \leq 1$ and $\delta < 1$. Furthermore, (28) implies

$$\tilde{u}_{dy}(h^*, d^*; \cdot) = \frac{q(1-\gamma)(1+d^*) - \delta c^*}{(c^*)^{2-\gamma}(1+d^*)^{\delta+1}} \gamma S^*. \tag{44}$$

Thus, $\tilde{u}_{dy}(h^*, d^*; \cdot) < 0$ for $\gamma = 1$. Using (30), we also derive

$$\tilde{u}_{d\underline{S}}(h^*, d^*; \cdot) = -\frac{\gamma q(1+d^*) + \delta c^*}{(1+d^*)^{\delta+1}(c^*)^{1-\gamma}} < 0. \tag{45}$$

Moreover, according to (28),

$$\tilde{u}_{dq}(h^*, d^*; \cdot) = -\frac{(1+d^*)c^* + (1+d^*)q(1-\gamma)d^* + \delta c^*}{(1+d^*)^{\delta+1}(c^*)^{2-\gamma}} \gamma S^* < 0, \tag{46}$$

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

$$\tilde{u}_{d\bar{u}}(h^*, d^*; \cdot) > 0, \tag{48}$$

$$\tilde{u}_{dR}(h^*, d^*; \cdot) = \gamma h^* S^* \frac{\delta c^* - q(1-\gamma)(1+d^*)}{(c^*)^{2-\gamma}(1+d^*)^{\delta+1}}. \tag{49}$$

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

At an interior solution, $\left[\tilde{u}_{hh}\tilde{u}_{dd} - (\tilde{u}_{hd})^2\right]_{(h^*, d^*)} > 0$, which is equivalent to

$$\frac{[(1-\theta)(y - qd^*) + (\gamma + \theta)Rh^*][(1-\gamma)q(1+d^*) + (1-\delta)c^*]\gamma\mu^*}{(h^*)^\theta} > \kappa\theta q(1+d^*)c^*, \tag{50}$$

according to (35), (36) and (43). We start with comparative-static results regarding optimal health input, h^*. Applying Cramer's rule, we have

$$sgn\left(\frac{\partial h^*}{\partial y}\right) = -sgn\left(\tilde{u}_{hy}\tilde{u}_{dd} - \tilde{u}_{dy}\tilde{u}_{dh}\right)|_{(h^*, d^*)}. \tag{51}$$

Substituting (37), (36), (43) and (44) into (51) we can easily show that $\tilde{u}_{hy}\tilde{u}_{dd}|_{(h^*, d^*)} < \tilde{u}_{dy}\tilde{u}_{dh}|_{(h^*, d^*)}$, thus confirming $\partial h^*/\partial y > 0$. Similarly,

$$sgn\left(\frac{\partial h^*}{\partial q}\right) = -sgn\left(\tilde{u}_{hq}\tilde{u}_{dd} - \tilde{u}_{dq}\tilde{u}_{dh}\right)|_{(h^*, d^*)}. \tag{52}$$

Substituting (39), (36), (43) and (46) into (52), it is easy to show that $\tilde{u}_{hq}\tilde{u}_{dd}|_{(h^*, d^*)} < \tilde{u}_{dq}\tilde{u}_{dh}|_{(h^*, d^*)}$, thus confirming $\partial h^*/\partial q > 0$. According to (40), (36), (43) and (47), we also obtain

$$sgn\left(\frac{\partial h^*}{\partial \kappa}\right) = -sgn\left(\underset{>0}{\tilde{u}_{h\kappa}}\underset{<0}{\tilde{u}_{dd}} - \underset{<0}{\tilde{u}_{d\kappa}}\underset{<0}{\tilde{u}_{hd}}\right)\Bigg|_{(h^*, d^*)} > 0. \tag{53}$$

37

Similarly, with (41), (36), (43) and (49),

$$sgn\left(\frac{\partial h^*}{\partial R}\right) = -sgn\left(\underset{<0}{\tilde{u}_{hR}}\underset{<0}{\tilde{u}_{dd}} - \underset{>0 \text{ if } \gamma=1}{\tilde{u}_{dR}}\underset{<0}{\tilde{u}_{hd}}\right)\Bigg|_{(h^*,d^*)} < 0 \text{ if } \gamma = 1. \tag{54}$$

Using $\tilde{u}_{h\bar{u}} = 0$, we obtain

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

We next come to comparative-static results regarding illicit drug consumption, d^*. Using (35), (36), (37) and (44) yields

$$sgn\left(\frac{\partial d^*}{\partial y}\right) = -sgn\left(\underset{<0}{\tilde{u}_{hh}}\underset{<0 \text{ if } \gamma=1}{\tilde{u}_{dy}} - \underset{>0}{\tilde{u}_{hy}}\underset{<0}{\tilde{u}_{dh}}\right)\Bigg|_{(h^*,d^*)} < 0 \text{ if } \gamma = 1. \tag{56}$$

Moreover, we have

$$sgn\left(\frac{\partial d^*}{\partial \underline{S}}\right) = -sgn\left(\tilde{u}_{hh}\tilde{u}_{d\underline{S}} - \tilde{u}_{h\underline{S}}\tilde{u}_{dh}\right)\big|_{(h^*,d^*)}. \tag{57}$$

Substituting (35), (36), (38) and (45) into (57), it is easy to show that $\left(\tilde{u}_{hh}\tilde{u}_{d\underline{S}}\right)\big|_{(h^*,d^*)} > \left(\tilde{u}_{h\underline{S}}\tilde{u}_{dh}\right)\big|_{(h^*,d^*)}$, thus confirming $\partial d^*/\partial \underline{S} < 0$. We also find from (35), (36), (39) and (46) that

$$sgn\left(\frac{\partial d^*}{\partial q}\right) = -sgn\left(\tilde{u}_{hh}\tilde{u}_{dq} - \tilde{u}_{hq}\tilde{u}_{dh}\right)\big|_{(h^*,d^*)} \tag{58}$$

$$= -sgn\left(-\kappa\theta q(1+d^*)c^*d^* + \right. \tag{59}$$

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

which is negative, according to concavity condition (50). Next, using (35), (36), (40) and (47) implies

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

From (35), (36), (41) and (49) we also find that

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

Finally, using $\tilde{u}_{h\bar{u}} = 0$, we obtain

$$sgn\left(\frac{\partial d^*}{\partial \bar{u}}\right) = -sgn\left(\underset{<0}{\tilde{u}_{hh}}\underset{>0}{\tilde{u}_{d\bar{u}}}\right)\Bigg|_{(h^*,d^*)} > 0. \tag{62}$$

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

$$\log X_t = \int_0^{J_t} \log\left(\alpha_t^L(j)l_t(j)\right) \mathrm{d}j + \int_{j\in\mathcal{D}_t} \log x_t(j)\mathrm{d}j + \int_{j\in\mathcal{Z}_t} \log\left(\alpha_t^M(j)m_t(j)\right) \mathrm{d}j. \qquad (63)$$

For the tasks produced outside the economy, output reads as

$$x_t(j) = \frac{P_t X_t}{\bar{p}_t} \text{ for any } j \in \mathcal{D}_t. \qquad (64)$$

Substituting (18), (19) and (64) into (63), the (log of the) composite input is given by

$$\log X_t = \int_0^{J_t} \log\left(\frac{\alpha_t^L(j)L_t}{J_t}\right) \mathrm{d}j + \Delta_t\left(\log\left(\frac{P_t}{\bar{p}_t}\right) + \log X_t\right) + \int_{j\in\mathcal{Z}_t} \log\left(\frac{\alpha_t^M(j)M_t}{1 - \Delta_t - J_t}\right) \mathrm{d}j. \ (65)$$

Substituting $P_t = (1 - \beta)\left(A_t H/X_t\right)^\beta$ from (12) into (65) and solving for $\log X_t$ implies

$$\log X_t \quad = \quad \frac{\Delta_t \log\left(\frac{(1-\beta)(A_t H_t)^\beta}{\bar{p}_t}\right) + J_t \log\left(\frac{L_t}{J_t}\right) + (1 - \Delta_t - J_t)\log\left(\frac{M_t}{1-\Delta_t-J_t}\right) + \log Q_t}{1 - (1 - \beta)\Delta_t}, (66)$$

$$\log Q_t \quad \equiv \quad \int_0^{J_t} \log\alpha_t^L(j)\mathrm{d}j + \int_{j\in\mathcal{Z}_t} \log\alpha_t^M(j)\mathrm{d}j. \qquad (67)$$

Next, use (15), (16) and $p(j) = \bar{p}_t$ for any $j \in \mathcal{D}_t$ in (14) to obtain

$$\log P_t = \int_0^{J_t} \log\left(\frac{w_t^L}{\alpha_t^L(j)}\right) \mathrm{d}j + \Delta_t \log\bar{p}_t + \int_{j\in\mathcal{Z}_t} \log\left(\frac{w_t^M}{\alpha_t^M(j)}\right) \mathrm{d}j. \qquad (68)$$

Using the definition of $\log Q$ in (67) and inserting (12) and $w_t^M = w_t^L\omega_t(J_t)$ from (22) into (68) leads to

$$\log\left[\frac{(1 - \beta)\left(A_t H_t\right)^\beta Q_t}{(\bar{p}_t)^{\Delta_t}}\right] = (1 - \Delta_t)\log w_t^L + (1 - \Delta_t - J_t)\log\omega_t(J_t) + \beta\log X_t. \qquad (69)$$

Substituting (66) into (69) and solving for $\log w_t^L$ yields equilibrium value

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

$$\frac{\beta}{1 - (1 - \beta)\Delta_t}\left[\frac{J_t}{1 - \Delta_t}\log\left(\frac{L_t}{J_t}\right) + \left(1 - \frac{J_t}{1 - \Delta_t}\right)\log\left(\frac{M_t}{1 - \Delta_t - J_t}\right)\right]. \quad (70)$$

Inserting (70) into $\log w_t^M = \log w_t^L + \log\omega_t(J_t)$ then implies equilibrium value

$$\log w_t^{M*} \quad = \quad \frac{(1 - \beta)\log\left(\frac{Q_t}{(\bar{p}_t)^{\Delta_t}}\right) + \log\left[(1 - \beta)\left(A_t H\right)^\beta\right]}{1 - (1 - \beta)\Delta_t} + \frac{J_t}{1 - \Delta_t}\log\omega_t(J_t) -$$

$$\frac{\beta}{1-(1-\beta)\Delta_t}\left[\frac{J_t}{1-\Delta_t}\log\left(\frac{L}{J_t}\right)+\left(1-\frac{J_t}{1-\Delta_t}\right)\log\left(\frac{M}{1-\Delta_t-J_t}\right)\right]. \quad (71)$$

Now substitute (66) into (11) to find equilibrium value

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

Subtracting the right-hand side of (72) from the right-hand side of (71) implies

$$
\begin{aligned}
\log\left(\frac{w_t^{M*}}{w_t^{H*}}\right) \;=\;& (1-\beta)\log H_t-\log\left[\beta(A_t)^\beta\right]+\log\left[(1-\beta)\left(A_tH_t\right)^\beta\right]+\frac{J_t}{1-\Delta_t}\log\omega_t(J_t)-\\
& \frac{J_t}{1-\Delta_t}\log\left(\frac{L_t}{J_t}\right)-\left(1-\frac{J_t}{1-\Delta_t}\right)\log\left(\frac{M_t}{1-\Delta_t-J_t}\right). \quad (73)
\end{aligned}
$$

According to (23), we have

$$\frac{J_t}{1-\Delta_t}=\frac{1}{\frac{M}{L}\omega_t(J_t)+1}\iff 1-\Delta_t-J_t=\omega_t(J_t)J_t\frac{M_t}{L_t}. \quad (74)$$

Using (74), we then find

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

Also note from (23) that

$$\log\omega_t(J_t)-\log\left(\frac{L_t}{J_t}\right)=\log\left(\frac{1-\Delta_t-J_t}{M_t}\right) \quad (76)$$

Substituting (75) into (73) and using (76) confirms (25). 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 (25) by noticing from (24) 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. ∎

Proof of Proposition 6: According to (26), dropping indices and using both $S=\underline{S}+\kappa h^\theta$ and $c=y-qd-Rh$, according to (5) and (7), the optimization problem of an individual can

be written as

$$\max_{h \geq 0, 0 \leq d \leq 1/\phi} \tilde{V}(h,d;y,\underline{S},R,q,\kappa,\phi,\bar{u}_0,\bar{u}_1) \equiv \phi d\tilde{u}(h,d;y,\underline{S},R,q,\kappa,\bar{u}_1) +$$

$$(1-\phi d)\tilde{u}(h,d;y,\underline{S},R,q,\kappa,\bar{u}_0), \qquad (77)$$

where we used the definition of $\tilde{u}$ in (8). According to (8) and (77), we have $\tilde{V}_h(h,d;\cdot) = \tilde{u}_h(h,d;\cdot)$, with $\tilde{u}_h$ as given in (27). Thus, in a corner solution in which an individual abstains from consuming intoxicants, $d^* = 0$, the optimal health input $\hat{h}^*$ is still given by first-order condition $\tilde{u}_h(\hat{h}^*,0;\cdot) = 0$, implying that part (ii) of Proposition 1 continues to hold.

We now confirm that the results of Proposition 2, which deals with the case where $d^* > 0$, continue to hold. First, note that $\tilde{V}_h(h,d;\cdot) = \tilde{u}_h(h,d;\cdot)$ implies

$$\tilde{V}_{hz}(h^*,d^*;\cdot) = \tilde{u}_{hz}(h^*,d^*;\cdot) \text{ for } z \in \{h,d,y,\underline{S},R,q,\kappa\} \qquad (78)$$

as given by (35)-(41). Moreover, $\tilde{V}_{h\phi}(h,d;\cdot) = 0$. We also obtain from (77) that

$$\tilde{V}_d(h,d;\cdot) = \phi d\tilde{u}_d(h,d;\cdot,\bar{u}_1) + (1-\phi d)\tilde{u}_d(h,d;\cdot,\bar{u}_0) + \phi[\tilde{u}(h,d;\cdot,\bar{u}_1) - \tilde{u}(h,d;\cdot,\bar{u}_0)], \qquad (79)$$

where $\tilde{u}_d(h,d;\cdot,\bar{u})$ is given by (28). Now note from (8) that

$$\tilde{u}(h,d;\cdot,\bar{u}_1) - \tilde{u}(h,d;\cdot,\bar{u}_0) = -\frac{\bar{u}_1 - \bar{u}_0}{(1+d)^\delta} \qquad (80)$$

and from (28) that

$$\tilde{u}_d(h,d;\cdot,\bar{u}_1) - \tilde{u}_d(h,d;\cdot,\bar{u}_0) = \frac{\delta(\bar{u}_1 - \bar{u}_0)}{(1+d)^{\delta+1}}. \qquad (81)$$

Using (80) and (81) in (79) yields

$$\tilde{V}_d(h,d;\cdot) = \underbrace{-\frac{\frac{\gamma q(S+\kappa h^\theta)(1+d)}{(y-qd-Rh)^{1-\gamma}} + \delta\left[(\underline{S}+\kappa h^\theta)(y-qd-Rh)^\gamma - \bar{u}_0\right]}{(1+d)^{\delta+1}}}_{=\tilde{u}_d(h,d;\cdot,\bar{u}_0)} - \frac{\phi(\bar{u}_1 - \bar{u}_0)[1+d(1-\delta)]}{(1+d)^{\delta+1}}. \qquad (82)$$

Using $\bar{u}_1 - \bar{u}_0 > 0$ and $\delta < 1$, we have $V_{d\phi}(h,d;\cdot) < 0$; moreover, (82) implies

$$\tilde{V}_{dz}(h^*,d^*;\cdot) = \tilde{u}_{dz}(h^*,d^*;\cdot) \text{ for } z \in \{h,y,\bar{S},R,q,\kappa\} \qquad (83)$$

with $\tilde{u}_{dz}$ as given in the proof of Proposition 2. However, generally, $\tilde{V}_{dd}(h^*,d^*;\cdot) \neq \tilde{u}_{dd}(h^*,d^*;\cdot)$, except for the special cases $\phi = 0$ or $\bar{u}_1 = \bar{u}_0$ that bring us back to the baseline model. According

to (82), in a interior solution where $\tilde{V}_d(h^*, d^*; \cdot) = 0$, we have

$$\tilde{u}_d(h^*, d^*; \cdot, \bar{u}_0) = \phi(\bar{u}_1 - \bar{u}_0)\frac{1 + d^*(1 - \delta)}{(1 + d^*)^{\delta+1}}. \tag{84}$$

According to (82) and (84), we obtain

$$\tilde{V}_{dd}(h^*, d^*; \cdot) = \tilde{u}_{dd}(h^*, d^*; \cdot) - \frac{\phi(\bar{u}_1 - \bar{u}_0)(1 - \delta)}{(1 + d)^{\delta+1}} < \tilde{u}_{dd}(h^*, d^*; \cdot), \tag{85}$$

where $\tilde{u}_{dd}(h^*, d^*; \cdot) < 0$ is given by (43) and the inequality in (85) follows from $\delta < 1$ and $\bar{u}_1 > \bar{u}_0$. Because of this inequality, (78) and $\tilde{u}_{hh}(h^*, d^*; \cdot) < 0$, if $\left[\tilde{u}_{hh}\tilde{u}_{dd} - (\tilde{u}_{hd})^2\right]_{(h^*,d^*)} > 0$ (as implied by condition (50)) then also $\left[\tilde{V}_{hh}\tilde{V}_{dd} - (\tilde{V}_{hd})^2\right]_{(h^*,d^*)} > 0$ holds.

We now come to comparative-static results. According to (78), (83) and (56)–(61), parts (i)-(v) of Proposition 2 still hold regarding illicit drug consumption, d^*. Regarding health input h^*, note from Cramer's rule that

$$sgn\left(\frac{\partial h^*}{\partial z}\right) = -sgn\left(\tilde{V}_{hz}\tilde{V}_{dd} - \tilde{V}_{dz}\tilde{V}_{hd}\right)\Big|_{(h^*,d^*)} \quad \text{for } z \in \{y, R, q, \kappa\}. \tag{86}$$

Using $\tilde{V}_{dd}(h^*, d^*; \cdot) < \tilde{u}_{dd}(h^*, d^*; \cdot)$, according to (85), $\tilde{u}_{hy}(h^*, d^*; \cdot) > 0$, according to (37), as well as (78) and (83) implies that $\tilde{V}_{hy}\tilde{V}_{dd}\Big|_{(h^*,d^*)} < \tilde{V}_{dy}\tilde{V}_{dh}\Big|_{(h^*,d^*)}$ when $\tilde{u}_{hy}\tilde{u}_{dd}|_{(h^*,d^*)} < \tilde{u}_{dy}\tilde{u}_{dh}|_{(h^*,d^*)}$, which holds according to (51) and part (i) of Proposition 2. This confirms that $\partial h^*/\partial y > 0$ remains valid. Similarly, recall $\tilde{u}_{h\kappa}(h^*, d^*; \cdot) > 0$, according to (40). Thus, $\tilde{V}_{h\kappa}\tilde{V}_{dd}\Big|_{(h^*,d^*)} < \tilde{V}_{d\kappa}\tilde{V}_{dh}\Big|_{(h^*,d^*)}$ when $\tilde{u}_{h\kappa}\tilde{u}_{dd}|_{(h^*,d^*)} < \tilde{u}_{d\kappa}\tilde{u}_{dh}|_{(h^*,d^*)}$, which holds according to (53). This confirms that $\partial h^*/\partial \kappa > 0$ still holds. Next, note that $\tilde{u}_{hR}(h^*, d^*; \cdot) < 0$, according to (41). Thus, $\tilde{V}_{hR}\tilde{V}_{dd}\Big|_{(h^*,d^*)} > \tilde{V}_{dR}\tilde{V}_{dh}\Big|_{(h^*,d^*)}$ when $\tilde{u}_{hR}\tilde{u}_{dd}|_{(h^*,d^*)} > \tilde{u}_{dR}\tilde{u}_{dh}|_{(h^*,d^*)}$, which holds for $\gamma = 1$ according to (54). This confirms that also $\partial h^*/\partial R < 0$ still holds, concluding the proof of part (i) of Proposition 6. Regarding part (ii), note that

$$sgn\left(\frac{\partial h^*}{\partial \phi}\right) = -sgn\left(\underset{=0}{\tilde{V}_{h\phi}}\underset{<0}{\tilde{V}_{dd}} - \underset{<0}{\tilde{V}_{d\phi}}\underset{<0}{\tilde{V}_{hd}}\right)\Big|_{(h^*,d^*)} > 0, \tag{87}$$

$$sgn\left(\frac{\partial d^*}{\partial \phi}\right) = -sgn\left(\underset{<0}{\tilde{V}_{hh}}\underset{<0}{\tilde{V}_{d\phi}} - \underset{=0}{\tilde{V}_{h\phi}}\underset{<0}{\tilde{V}_{dh}}\right)\Big|_{(h^*,d^*)} < 0. \tag{88}$$

Using that $\tilde{u}_{h\bar{u}} = \tilde{V}_{h\bar{u}} = 0$ and that $\tilde{V}_d$ is decreasing in $\Delta\bar{u} = \bar{u}_1 - \bar{u}_0$, according to (82), we can analogously confirm the comparative-static results regarding $\Delta\bar{u}$. This concludes the proof. ∎

42

Appendix B: Health Care Budget Constraints

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

$$
y_t(i) = \begin{cases}
(1 - \bar{\tau}_t)w_t^L & \text{for } i \in \mathcal{L}_t \text{ if } i \text{ is insured,} \\
w_t^L & \text{for } i \in \mathcal{L}_t \text{ if not insured,} \\
(1 - \bar{\tau}_t - \underline{\tau}_t)w_t^M & \text{for } i \in \mathcal{M}_t \text{ if insured,} \\
(1 - \underline{\tau}_t)w_t^M & \text{for } i \in \mathcal{M}_t \text{ if } i \text{ is not insured,} \\
(1 - \bar{\tau}_t - \underline{\tau}_t)w_t^H & \text{for } i \in \mathcal{H}_t \text{ if insured,} \\
(1 - \underline{\tau}_t)w_t^H & \text{for } i \in \mathcal{H}_t \text{ if not insured.}
\end{cases}
\tag{89}
$$

Recall that 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

$$
R_t(i) = \begin{cases}
(1 - \bar{s}_t)r_t & \text{if insured,} \\
(1 - \underline{s}_t)r_t & \text{for } i \in \mathcal{L}_t \text{ if not insured,} \\
r_t & \text{for } i \in \{\mathcal{M}_t, \mathcal{H}_t\} \text{ if not insured.}
\end{cases}
\tag{90}
$$

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 distressed individuals have the same
extent of mental illness.

According to (89) and (90), the balanced budget condition for tax-financed Medicaid equates
revenue and expenditure according to

$$
\underline{\tau}_t \cdot \left[M_t w_t^M + H_t w_t^H \right] = \underline{s}_t \mu_t^L L_t h^*(w_t^L, (1 - \underline{s}_t)r_t, \cdot),
\tag{91}
$$

while the budget constraint for contribution-financed health insurance that equates subsidies of
health expenditures and health care contributions reads as

$$
\begin{aligned}
&\bar{\tau}_t \cdot \left[(1 - \mu_t^L)L_t w_t^L + (1 - \mu_t^M)M_t w_t^M + (1 - \mu_t^H)H_t w_t^M \right] \\
&= r_t \cdot \bar{s} \cdot \left[(1 - \mu_t^L)L_t h^*((1 - \bar{\tau}_t)w_t^L, (1 - \bar{s})r_t, \cdot) + \right. \\
&\qquad (1 - \mu_t^M)M_t h^*((1 - \bar{\tau}_t - \underline{\tau}_t)w_t^M, (1 - \bar{s})r_t, \cdot) + \\
&\qquad \left. (1 - \mu_t^H)H_t h^*((1 - \bar{\tau}_t - \underline{\tau}_t)w_t^H, (1 - \bar{s})r_t, \cdot) \right].
\end{aligned}
\tag{92}
$$

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 (91) modifies to
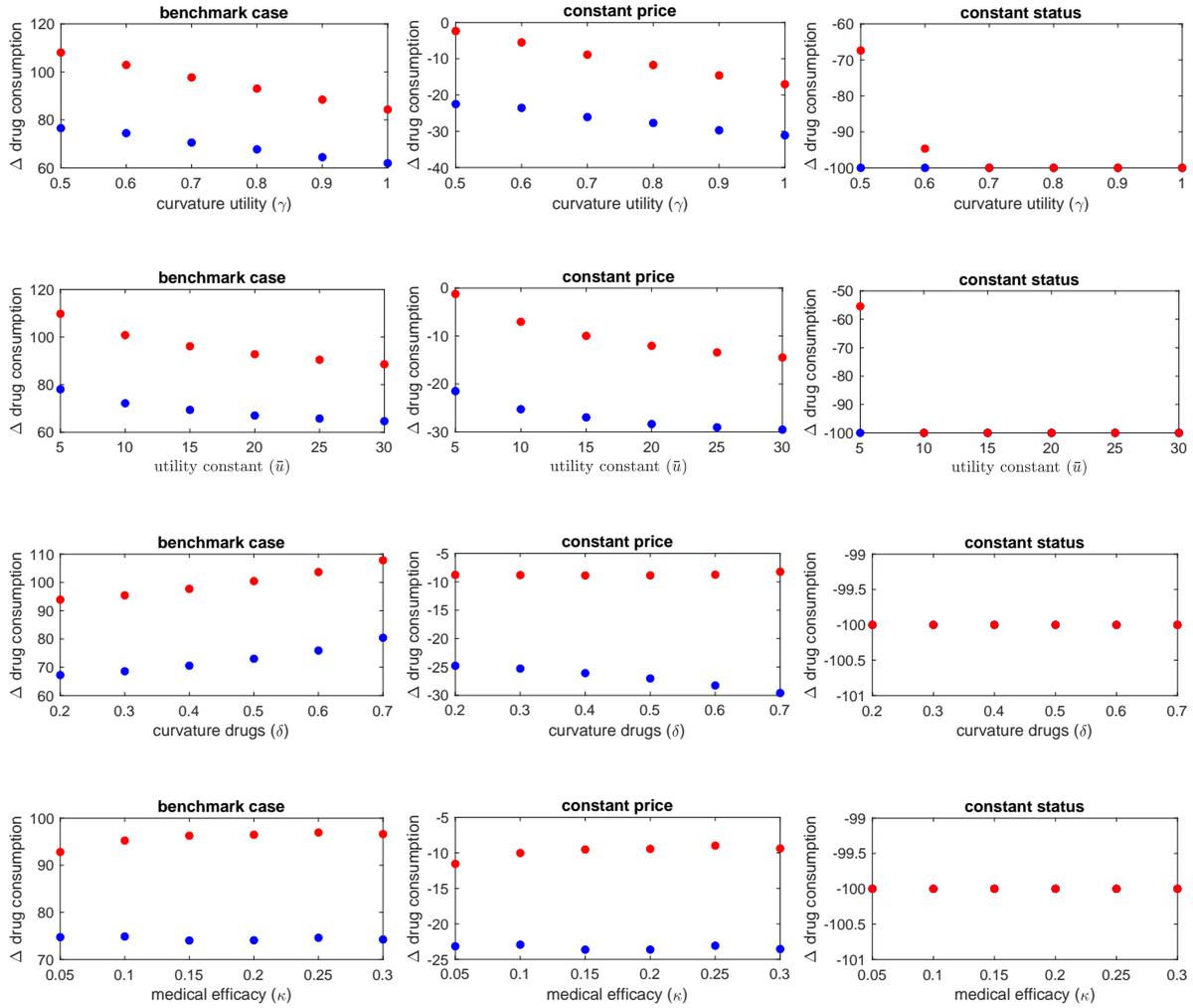
$$\underline{\tau}_t \cdot \left[M_t w_t^M + H_t w_t^H \right] = \underline{s}_t \left[\mu_t^L L_t h^*(w_t^L, (1 - \underline{s}_t)r_t, \cdot) + \mu_t^M M_t h^*(w_t^M, (1 - \underline{s}_t)r_t, \cdot) \right]. \qquad (93)$$

Appendix C: Sensitivity Analysis

A sensitivity check of all the model's dimensions would easily cover dozens of pages. In the sake of brevity we focus on the sensitivity of our main result, namely that both relative deprivation and declining drug prices are necessary in order to motivate increasing drug consumption of the middle class. One-by-one we consider alternative values of the preference parameters and recalibrate the other parameters of the model such that we match the same targeted outcomes and such that the *initial* consumption of mental health goods and drugs by the middle class is the same as in the benchmark case. We then report the change of drug consumption of mentally-distressed middle class workers predicted for the period 1989 to 2007.

The first row of panels in Figure A.1 shows results for alternative values of the curvature parameter of the utility function γ from 0.5 (square root) to 1.0 (linear). Red dots indicate the change in drug consumption of uninsured middle class workers ($\Delta \log d^{M,U}$) and blue dots indicate the change in drug consumption of insured middle class workers ($\Delta \log d^{M,I}$). In the left panel we see that, for the benchmark case (of relative deprivation and declining prices), drug consumption is predicted to increase for all values of γ. The middle panel shows that drug consumption declines if prices were constant (case 2) and the right panel shows that drug consumption declines if there is no relative deprivation (case 3). In this case, drug consumption declines by 100 percent for insured and uninsured middle class workers such that the blue dots lie invisibly behind the red dots. The subsequent rows in Figure A.1 repeat this exercise for the constant in the utility function $\bar{u}$, for the degree of declining returns from drug consumption δ, for the minimum health level $\underline{S}$, and for the parameter measuring the efficacy of medical treatment of mental distress κ. We see that the main result of joint necessity of falling drug prices and relative deprivation is robust against these alternative specifications of the utility function.

Figure A.1: Sensitivity Analysis

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