Pain *

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Abstract

Painkilling drugs produce a good called relief which reduces the fixed level of bad (pain) the individual is endowed with. These drugs have the side-effect of reducing the utility the individual gets from consuming goods. This means that the shadow price of relief counts not only the cost of drugs and their ability to reduce pain, but also the undesired reduction in pleasure from consuming goods. The tradeoff between goods and relief is non-linear and convex even for painkilling drugs that have a linear effect on pain. Small increases in pain may push the individual to a corner where painkilling drugs dominate his life. This seeming dependence on the drug has nothing to do with addiction or habit formation, but is a consequence of how consumption of these drugs changes the shadow prices of goods and relief. *Keywords: Pain, addiction, drugs, household production J.E.L.* classification: I10, D13

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1. Introduction

This paper attempts to model pain. The purpose of modeling pain is to understand why some people consume painkilling drugs, why others resist consuming these drugs, and why some painkillers lead their users to dependence while others return their users to work and pleasure. Painkillers reduce the level of pain, but they may also interfere with one's ability to enjoy goods. Someone who consumes a high level of goods may find that painkillers remove much from the enjoyment of life. Those with higher incomes or those who have managed to pull a great deal of pleasure from their consumption of goods, might avoid painkillers and may display what appears to be a greater tolerance for pain. I suggest that tolerance for pain may have less to do with a stoic disposition than with an economic calculation of the tradeoffs between relief from pain and the loss of pleasure that comes from the overall numbing effect of painkillers. Those with higher incomes may appear more resistant to pain than those with lower incomes, but that is only because those with higher incomes cannot "afford" to buy relief from pain.

Viewing pain relief as a purchase whose cost depends on one's level of income says something about who will become addicted to painkillers. A central feature of painkilling drugs is that some individuals have a tendency to allow these drugs to dominate their lives. Some researchers, notably Becker and Stigler (1977), and Boyer (1983) have sought to explain this domination by arguing that individuals learn by doing and that some drugs have the special feature that learning by doing gets easier as more drug is consumed. Those who invest in such learning by doing may become addicted to the drug and may find it costly to stop consuming the drug. Typically, the addiction literature has depended on complicated dynamic formulations of consumer choice to make its point. The present paper is a complementary explanation of the major forces that drive consumers to use drugs in what may appear an addictive manner. Dependence in the present paper's model is not learned. It is an instantaneous response to the way painkillers decrease in cost as more of them are consumed. The consumer can be driven to a corner, where drug consumption dominates his life, because the more of a drug one consumes, the less this drug costs in terms of foregone enjoyment of goods. Painkillers impose a progressive "tax" on consumption of goods. As more painkillers are consumed the tax rises and makes the cost of painkillers looks smaller

relative to the cost of consuming one unit of a final good. The poor have a strong tendency to be driven to dependence because they have little enjoyment from other goods to lose and so their painkilling tax is low.

These results depend on the nature of the pain in question. Medical researchers have long known that the same drug used to treat two different kinds of pain can either lead to dependence or help the pain victim lead a fruitful life. The addiction literature is silent on this point. My approach of directly modeling pain allows me to address this point in a manner which the addiction literature has not been able to address. I propose two types pain "technologies." These technologies correspond to the medical notions of chronic and acute pain. I show that in the case of chronic pain, a painkiller can lead to addiction, whereas in acute pain, the painkiller does not lead to addiction.

The purpose of this paper is not to diminish the importance of the habit formation literature but rather to provide a methodological complement which might help answer why the same painkiller such as morphine can in some cases lead to dependence and in other cases can help the individual lead a fruitful existence. What motivated me to ask this question was my concern that the addiction literature is disconnected from the distinction between good and bad addiction. Becker and Stigler (1977) tried to address the point by suggesting that good addictions are those which increase pleasure over time from use of the addictive substance. They pointed to piano playing or reading as examples. Yet is not clear that the pleasure of heroin users from the use of heroin does not also rise over time. If it did, then according to Becker and Stigler this would count as a good addiction. Classical literature dating back to the Odyssey and the tale of the lotus eaters disapproves of drug addictions for a more straightforward reason: the addict loses interest in natural sensations, becomes a dullard in conversation, and forgets obligations to friends and family. It is this approach to drugs that will allow me to explain why the same drug may lead to dependence or may contribute to the quality of life, depending on the type of pain in question. I view the contribution of this paper as mainly a methodological one, which points out that there are insights to paying greater attention to pain and painkilling "technologies" than the literature on the subject has recognized.

2. Chronic pain

Modeling pain calls for some knowledge of medical researches into the topic. According to physicians pain comes in two broad categories: acute and chronic. In a major survey of the literature on the pharmaceutical management of pain Zagari et al. (1996) explain that "acute pain is caused by known stimuli, is short-lived, and ends with healing of tissue injury...chronic pain continues after the healing of injured tissue and has been arbitrarily defined as lasting longer than 6 months." Zagari et al. go on to subdivide chronic pain into malignant and non-malignant forms. Non- malignant chronic pain is the most prevalent and the least easy to attribute to a particular cause. In discussing this variety of chronic pain Shug and Large (1993) write "Many musculoskeletal pains, some headaches, and neuropathic pains fall into this latter category. Sometimes no cause can be discovered and speculation runs rife as to whether the patient is depressed, hysterical, malingering or has a low pain threshold." In spite of these problems of classification, Shug and Large go on to explain that in the past 20 years medical researchers have begun to think of chronic pain as a disease syndrome in its own right.

How can an economist make these loose definitions operational? Any precise definition commits the economist to a view of pain that will contradict what some medical researchers believe to be chronic or acute pain. The precise definitions of chronic and acute pain I present will not please everyone, but are based on what a broad reading of the literature reveals are central features of each pain. Acute pain blots out the ability to sense other stimuli. It is a signal that interferes with all other signals. Chronic pain is a sensation which, though unpleasant, allows the individual to receive and process information on other, possibly pleasant incoming stimuli. These definitions can help to account for the manner in the same drug, taken to treat two different forms of pain, may lead in one case to debilitating addiction and in another case to an improvement of the patient's function. For example, opioides such as morphine help the victim of acute pain or malignant chronic pain (which in the view of pain I will develop is just a longer-term form of acute pain) to block stimuli which prevent him from functioning in society. In spite of large doses of the drug which may be administered, addiction from this judicious use of the painkiller is almost unheard of. When opioides are administered for chronic non-malignant pain, they blunt the sufferer's

appreciation of his surroundings and impair his function in the world. In practice, users of the drug tend to develop what appears to be a dependence. Why addiction should develop in one case of pain and not in another is a problem with which the addiction literature in economics has not grappled. In the present paper I show that drawing a distinction between the two types of pain can explain much about who take painkillers, what sorts of painkillers they take, and why what appears to be habit formation may be nothing of the sort.

2.1 Demand for chronic pain killers

Consider the following utility function

$$U = U(G, B) \tag{1}$$

Here G is a good which gives positive utility and which the consumer may vary through his budget. The term B is a bad which reduces utility. The consumer does not consume B willingly, so B can be considered a parameter in his choices, not a variable. I call this chronic pain because B does not interfere directly with enjoyment of the good G. In section 3 I suggest acute pain differs from chronic pain in that by blocking the ability to process information on goods, acute pain diminishes the amount of good consumption the sufferer can sense. I show that this crucial distinction can explain why painkillers may be abused by chronic pain sufferers and not by acute pain sufferers. This distinction between chronic and acute pain may appear artificial. Chronic pain can degrade enjoyment of the good through cross-effects between G and B in the utility function. Does this not mean that chronic and acute pain are really the same? To see why the answer is no, we have to look at how painkillers work. This will show that cross-partial effects in utility between the good and pain are not what distinguishes the effects of acute and chronic pain on the demand for painkillers.

Painkillers may enter the utility function by either subtracting a fixed quantity from the level of pain, or a multiplicative quantity. I have chosen a multiplicative painkiller effect mainly because it minimizes the structure needed to impose on the model in order to get meaningful results. A subtractive painkiller would raise the question of "how much do I subtract?"

Suppose that the painkiller K enters a "production function" α in the following manner $\alpha = \alpha(K)$ and that $\alpha(K)$ produces pain relief as follows:

$$U = U[\underbrace{G(1-\alpha)}_{final\ good\ Z}, B - \underbrace{\alpha B}_{relief\ R}] \tag{2}$$

In the above utility function, final good consumption Z increases utility, and the bad experienced $B(1-\alpha)$ reduces utility. This means that as relief αB increases, utility increases. Painkillers could be a drug, alcohol, time invested in hypnosis, acupuncture. These painkillers reduce the level of bad by $\alpha(K)B$ which I call the level of relief R. Utility rises with relief. The problem with painkillers is that they reduce the enjoyment of the good by $\alpha(K)G$ so that final consumption is $Z = (1-\alpha)G$. The term α is a general numbing that follows the consumption of a painkiller. This general numbing is what distinguishes the consumption of painkillers from the consumption of standard goods. Relief cannot be consumed without reducing the enjoyment of the good G. Relief imposes a "numbing tax" on the consumption G. It is this jointness between relief and good consumption that generates the insights of the present paper.

Not all painkilling drugs of course impose a painkilling tax. A perfect painkiller is one that reduces pain without interfering with the enjoyment of goods. For certain forms of acute pain, such as the pain from cancer, opioides such as morphine and Demerol seem to approach this definition of perfection. They do not impair normal functioning, but are extremely effective at limiting the torment of cancer, burns, or back injuries. More chronic forms of pain such as nausea react best to anti-emetics such as cannabis. Cannabis is a less than perfect painkiller because it has the unwanted side effect of clouding the mind and draining its user of initiative and energy. The less easily defined chronic afflictions of depression, lassitude and despair, or general body aches physicians do not understand but adorn with names such as neurofibromyalgia, may be treated with the neuroleptic drugs Prozac, Valium, and with stimulants such as amphetamines. As Shug and Large (1993) explain, the drawback of using such drugs in these cases is that they impair the patient's ability to function in society. Sufferers of chronic pain syndrome tend to be overmedicated, and experience disruptions in work, sleep, family duties, and social activities. Causality is hard to pin down, but it is difficult to discount that painkillers diminish the chronic pain

sufferer's contacts with outside reality. The same observations apply once we descend to the world of illegal drugs such as heroin and cocaine.

The reader may wonder why I need to complicate the analysis of drugs by introducing them into the utility function as a utility-enhancing reduction in pain. Why not simply enter drugs as a good that gives a high? To do so would introduce a level of generality into the analysis of painkillers that would be next to meaningless. To get sharp predictions about drug use it is necessary to model the technology of painkilling. Assumptions about this technology should be based on some notions of the medical properties of painkillers.

There are several ways to see how painkilling technology influences decisions about how much painkiller to use. We could model how painkilling technology affects the the utility function in (G, K) space, or we could try to "pull" the technology of painkilling out of the of the utility function and model how painkilling technology affects the budget equation in (Z, R) space. The choice of which approach to take is often a rhetorical one and depends on which aspects of individual decision-making, constraints or preferences, a researcher wishes to emphasize. I will use the second strategy of melding painkilling technology with the budget equation. This, as Deaton and Muellbauer (1980) explain, is the research agenda of the household-production technology movement in economics. I follow this agenda mainly because it highlights the technological aspects of painkilling and because it emphasizes the central intuition of this paper: that those with higher incomes cannot afford to buy painkillers.

The shortest route to understanding who will consume painkillers is to get an idea of the shadow prices of relief and final good consumption π_R and π_Z. These shadow prices can be deduced from examining the marginal rate of substitution between relief and final goods when the consumer chooses intermediate inputs into utility, G and K, to maximize utility. If the consumer maximizes the following Langrangean with respect to G and K:

$$L = U = U[\underbrace{G(1-\alpha)}_{final\ \ good\ \ Z}, B - \underbrace{\alpha B}_{relief\ \ R}] + \lambda(Y - P_G G - P_K K) \tag{3}$$

the first order conditions are

$$\frac{\partial L}{\partial G} = \frac{\partial U}{\partial Z}(1-\alpha) - \lambda P_G = 0 \tag{4}$$

$$\frac{\partial L}{\partial K} = -\alpha' G\frac{\partial U}{\partial Z} + \alpha' B\frac{\partial U}{\partial R} - \lambda P_K = 0 \tag{5}$$

These can be rearranged to show that to maximize utility a consumer sets the marginal rates of substitution between relief and final good consumption equal to the following quantity

$$MRS_{R,Z} = \frac{P_K}{P_G}\frac{1-\alpha}{\alpha' B} + \frac{G}{B} \tag{6}$$

This means that the right hand side of the above equation has the interpretation of the ratio of the shadow price of relief to the shadow price of final good consumption: π_R/π_Z. This is a precise, but not very intuitive way of getting at the shadow price. Consider an alternate formulation of these shadow prices which will show clearly why those with higher incomes cannot afford painkillers.

Since $Z = (1-\alpha)G$ it is easy to see that drug consumption imposes a "tax" of α per unit of G. The tax is progressive in the amount of painkiller K taken. In order to consume a full unit of Z the consumer must spend $P_G/(1-\alpha)$. What about the shadow price of a unit of relief π_R? The shadow price of a unit of relief counts the cost of the painkilling drug K which the market prices at P_K. The true price of relief is not simply the amount spent to buy the painkiller K but also the amount of consumption of the good that evaporates in the haze of the painkiller's action. The price of painkilling can be broken into two parts. The first part of the cost is simply the direct price of buying one unit of relief R. This price is $P_K dK/dR$ where P_K is the price of a unit of painkiller, and dK/dR is the amount by which K must change to produce an additional unit of R. For example, if a unit of painkiller produces ten units of relief, then one tenth of a unit of painkiller increases relief by one unit and the cost of a unit of relief is $P_K/10$. Put differently, the amount K needed to produce a unit of R is the inverse of the marginal product of K on painkilling $1/MP_K$ (note that $MP_K = Bd\alpha/dK$). The second part of the cost of painkilling comes from the value of the lost consumption of the good G. An extra unit of relief comes from raising K by $1/MP_K$. This means the value of final consumption that evaporates with the consumption of one unit of relief R is:

$$\underbrace{\frac{P_G}{1-\alpha}}_{shadow\ price\ Z}\ \underbrace{G\frac{d\alpha}{dK}\frac{dK}{dR}}_{loss\ of\ Z} = \frac{P_G}{1-\alpha}G\frac{d\alpha}{dK}\frac{1}{B\frac{d\alpha}{dK}} \tag{7}$$

$$= \frac{P_G}{1-\alpha}\frac{G}{B} \tag{8}$$

In sum, the marginal shadow price of a unit of relief π_R is

$$\pi_R = P_K \frac{1}{B\frac{d\alpha}{dK}} + \frac{P_G}{1-\alpha}\frac{G}{B} \tag{9}$$

And the marginal shadow price of relief relative to final good consumption is

$$\frac{\pi_R}{\pi_Z} = \frac{P_K}{P_G}\frac{1-\alpha}{\alpha' B} + \frac{G}{B} \tag{10}$$

Which is exactly the same as derived in equation (6). I refer to the marginal shadow price because this price is not constant at all levels of relief. The price depends on the level of good consumed G. As one spends more on painkillers there is less money to buy goods. The fewer goods one consumes the less a unit of painkillers costs. Consuming few goods means that there is little consumption to be lost from the numbing effects of painkilling. Here are the traces of a vicious circle. The more relief one consumes, the cheaper this relief will be. Among those at risk of being trapped in the vicious circle I have sketched above are those with lower incomes. Their costs of consuming painkillers are lower than those of individuals with higher incomes because lower income people consume fewer goods G than those with higher incomes consume, so they have a head-start over rich consumers along the vicious circle.

There is the same sort of pressure here to go to a corner in my model as one finds in Becker and Tomes' (1976) model of the tradeoff between child quantity and quality. They saw parent utility as being a function of the number of children multiplied by the quality of these children. The greater the quality per child, the cheaper was the cost of an extra child because that child came with extra benefits per dollar of upkeep spent on him or her. A corner, where consuming painkilling drugs is the major pastime could be equated with addiction. My model differs from those of Becker and Murphy (1988) and Suranovic et al. (1999) in that I do not rely on their assumptions of habit formation and the complicated dynamics this brings to modeling. My model brings individuals to corners simply because the price of relief falls as more of it is consumed. While I use a degree of freedom less than the above authors by not using dynamic analysis, I add my own degree of freedom by specifying a painkilling technology.

To see the convexity in the tradeoff between relief R and final good consumption Z consider the consumer's budget constraint illustrating the tradeoff between painkillers K and

the raw good G before it is diminished by the numbing effects of painkillers: $Y = P_K K + P_G G$ where Y is income. The trick is to convert this into an equation relating relief R to final consumption of the good Z. This will allow us to see the tradeoff between relief and final good consumption. First we must isolate G and K in terms of R and Z note that

$$Z = (1-\alpha)G \Rightarrow \tag{11}$$

$$G = \frac{Z}{1-\alpha} \tag{12}$$

and

$$R = \alpha(K)B \Rightarrow \tag{13}$$

$$K = \alpha^{-1}\left(\frac{R}{B}\right) \tag{14}$$

To get a budget equation that we can graph we need to specify a functional form for the equation $\alpha(K)$ that relates the amount of painkiller K taken to the fraction of pain killed. I will use $\alpha = K/K_{sat}$, where K_{sat} is a saturation level of the drug. If the consumer takes more than K_{sat} of the drug he loses all his pain and also all awareness of his consumption of the good G. The equation for α is linear in K and does not introduce non-linearities in the budget equation that would distract from the convexity I am trying to illustrate. After substituting $\alpha(K)$ into both the expressions for G and K above it is easy to show that

$$Y = \frac{P_K K_{sat}}{B} R + \frac{P_G B}{B-R} Z \tag{15}$$

The above equation shows that there is a nonlinear tradeoff between relief R and final good consumption Z. Note that the coefficients attached to R and Z are not their shadow prices, as would be the case if prices did not vary with consumption of the goods to which they refer. The shadow prices have to be deduced from the slope of the budget line. The non-linear tradeoff between R and Z has nothing to do with the painkilling technology summarized in $\alpha(K)$ because I have expressly restricted this technology to be linear.

Isolating Z in terms of R can bring out the nature of the budgetary tradeoff between these two quantities. It is easy to show from the above budget equation that

$$Z = \frac{P_K K_{sat}}{P_G B^2} R^2 - \frac{Y + P_K K_{sat}}{P_G B} R + \frac{Y}{P_G} \tag{16}$$

Figure 1 graphs this budget line for the case where $P_G = 1,\ P_K = 2,\ B = 100,\ K_{sat} = 500,$ and income Y is either \$1000 or \$2000. I have calibrated these numbers so that the consumer with an income of \$1000 exhausts all his income when he consumes the saturation level of relief of 500. Consumers with income greater than \$1000 will be able to consume up to the saturation level of relief and find that they still have income left over. But is no point in using this income on good consumption, because at the saturation level of relief no benefit is derived from consuming G. This waste of income is a further manifestation of the high cost of pain relief to the rich. Figure 1 shows nicely the curvature of the budget line. The lesson is that as the consumption of relief rises, less and less final good Z needs to be given up to get an extra unit of relief R. What is not entirely clear from Figure 1 is the effect that income has on the shadow price of relief relative to final good consumption. This effect becomes clearer by examining the negative of the derivative of Z with respect to R. This would give the shadow price of R relative to Z :

$$-\frac{dZ}{dR} = \frac{\pi_R}{\pi_Z} \tag{17}$$

$$= \frac{Y + P_K K_{sat}}{P_G B} - \frac{2P_K K_{sat}}{P_G B^2} R \tag{18}$$

Figure 2 maps this shadow price for varying levels of relief R and for two levels of income (\$1000, \$2000). The figure shows what was already illustrated in Figure 1: that no matter what the income level, as more relief is consumed, its shadow price relative to the shadow price of final good consumption falls. Figure 2 also shows that higher income people have a higher shadow price of relief than lower income people. What is the final prediction about the effect of income on the consumption of pain relief? No conclusive statements can be made. Having more income pushes the budget line out and allows the individual to consume more of both the final good and the painkiller. What is novel in the analysis, and could reverse what would seem the obvious positive effect of income on relief consumption, is that the shadow price of relief falls as income falls. A change in income *has a relative price effect*. The relative price effect grows with income.

Income not only determines how much a person will indulge in painkillers, it also determines how demand for painkillers changes when the native level of pain B rises. It is simple to glean from the utility that a rise in pain B must lead to an increase in the

consumption K of painkillers. Recall that

$$U = U[\underbrace{G(1-\alpha)}_{final\ good\ Z}, B - \underbrace{\alpha B}_{relief\ R}] \tag{19}$$

A rise in B is similar to reducing the individual's overall level of relief. Whenever someone with a diminishing marginal rate of substitution between two goods has part of a good removed, the best strategy for reoptimizing utility calls for the individual to bring consumption of that good up somewhat, and to lower consumption of the other good. Yet consumption of the good that suffered an initial fall does not rise back to its old levels. If this individual did not pursue this strategy it would mean he had not been optimizing in the first place. In the case of a rise in B, the individual consumes more K than before, but does not bring his net pain level back to what it was before the rise in B.

The rich will tend to reach less ardently for painkillers when pain rises than the poor reach for painkillers. The price of a unit of relief is larger for the rich than it is for the poor, for reasons explained earlier in this section. This means that the strategy of a rich individual for reoptimizing utility after a rise in pain will call for the use of less painkiller in relation to income than for a poor individual. This does not mean that the rich individual uses less painkiller overall, but rather that his or her elasticity of demand for painkiller in response to a rise in pain B is lower than for the poor.

3. Acute Pain

In the previous section, I treated chronic pain as a pain that does not remove directly from enjoyment of other goods G but that enters separately into the utility function as a bad B. I suggested that in contrast, acute pain directly reduces appreciation for consumption of the good. What I have in mind is this. Consider a utility function of the form

$$U[G \times (1 - f(B))] \tag{20}$$

Here, unlike in the case of chronic pain, there is only one argument to the utility function. The argument is the consumption of goods G diminished by a pain factor f which itself increases with the amount of pain B. Acute pain is like a radio signal jamming the pleasant signals the consumer gets from goods G. The 19^{th} century philospher of pessimism, Athur

Schopenhauer, in a prescient view of pain, might have been describing acute pain when he wrote "all that opposes, frustrates, and resists our will, that is to say all that is unpleasant and painful, impresses itself instantly, and with great clarity. Just as we are conscious not of the healthiness of our whole body but only of the little place where the shoe pinches, so we think not of the totality of our successful activities but of some insignificant trifle or other which continues to vex us (1970, p.41)."

The reader may wonder why bother with such distinctions between chronic and acute pain. Cannot chronic pain also reduce appreciation for the good G through cross- effects in the utility function? The answer is that, in principle, yes, a utility function could be chosen with cross effects between pain and the good that mimics the features of the above utility function of acute pain. But this mimicking utility function would not show the same effects on behaviour once a painkilling drug was introduced, because the drug works through different channels in the two functions. In the acute pain utility function there are none of the forces that pushed the consumer towards a corner in the case of chronic pain. To see this consider how a painkiller would work in the above function. The painkiller would reduce, as in the case of chronic pain direct enjoyment of the good G so that G is diminished to $G(1-\alpha)$, and as before the painkiller would reduce pain B to $B(1-\alpha)$. This would give utility level

$$U[G(1-\alpha)\times(1-f(B(1-\alpha)))] \tag{21}$$

What is immediately apparent from the above utility function is that a painkiller K with a linear effect on pain such as I have modeled in the present paper, can never bring the consumer to corners in the case of acute pain, as it could in the case of chronic pain. In the case of chronic pain a rise in the painkiller diminished the amount of good G available for consumption. This lowered the numbing tax paid for each unit of painkiller taken, or, put differently, more painkiller meant that consumers had fewer goods available to lose in the haze which the painkiller brings on. So each additional unit of painkiller consumed reduced the price of relief. In the case of acute pain a painkiller acts to lower the numbing tax. This action has two parts. First the painkiller reduces the direct effect of pain $f(B)$. The painkiller raises the numbing factor α but this effect must be more than compensated by the fall in the direct effect of pain $f(B)$. I say "must" because otherwise there would be no

point in taking a painkiller. So acute painkillers must directly raise appreciation for G. It was by diminishing appreciation for G that chronic painkillers led to a diminishing shadow cost of relief. This diminished appreciation is not present in the case of acute painkillers, so that the consumer's problem contains none of the non-convexities present in the case of chronic pain. Perhaps this explains why there is much less tendency for people in a state of acute pain to abuse of painkillers and develop a dependence than there is a tendency for chronic pain victims to become dependent. But the main point to retain from the analysis of chronic pain is that income does not carry with it a price effect. In the case of acute pain, high income people are likelier to consume painkillers heavily than they were in the case of chronic pain. In fact, in the case of acute pain, painkillers have to be a normal good. There is really only one good in the case of acute painkillers and that is final consumption of the good G after pain has taken its toll and painkillers have reduced the toll that pain takes. If income rises it can be used only in two complementary ways to raise utility. Either the individual consumers more of the good G, or consumes more, or combines an increase of painkiller and good. There are no negative cross effects in the utility function that could lead painkillers to be an inferior good.

4. Empirical Implications

The last decade has seen a rising interest among health economists in the link between income and the use of alcohol and drugs. Many of these studies found a positive link between drug use and income. Kaestner (1994) found a 17% "wage premium" for marijuana use. Gill and Michaels (1992) found premiums of 19% for hard drug users. French and Zarkin (1995) found a U-shaped relation between income and alcohol use. Zarkin et al. (1998) found that income and alcohol use were positively related. In contrast, Buchmueller and Zuvekas (1998) using data which more accurately measures drug use than previous data, found that among young workers there is a weak tendency for problematic drug use to be linked with lower income. Among prime-aged workers the tendency is much stronger. Buchmueller and Zuvekas were at a loss to explain their results and suggested, without support, that drug use may only hit wages with a lag because it may take drugs a long time to have a detrimental effect on their users. The insights of the present paper suggest a different interpretation.

Young workers and prime age workers may suffer from different types of pain. If prime age workers are more susceptible to chronic pain than are young workers, we may find that the poor among prime age workers are heavy users of painkillers. This might explain the greater negative relationship among prime age workers between drug use and income. What may also contribute to finding a negative relation between drug use and income is that among prime age workers, those with high levels of native pain B are the poorest among the group. In a survey of chronic pain, Stimmel (1983) found that patients at chronic pain clinics "tend to be married and unsuccessful in their marriages, to come from large families, to be engaged in unskilled or semiskilled work, and to seek many additional consultations. They emphasized bodily complaints in general and had an increased history of painful illness in the past." Buchmueller and Zuvekas did not introduce any variables that could proxy for an individual's native pain level. It is possible that the omitted pain variable biases the results in a way that suggests a spurious negative relation between income and drug use.

These conjectures are not meant as critiques of previous studies, but rather I make these conjectures to show that the distinction between types of pain, and native pain levels that individuals suffer could have a place in empirical work.

5. Conclusion

The present paper has suggested that drug dependence can be modeled not as a dynamic phenomenon of habit formation, but rather as a static phenomenon of immediate pain reduction. Depending on the type of pain in question, chronic or acute, I find that drugs can lead to dependence or may enhance a person's life. In the case of chronic pain drug use can lead to dependence because as more is consumed of the painkiller its costs fall. Costs fall because the more money the individual spends on the painkiller, the less money he has available for other goods. Since part of the cost of the painkiller is that it robs the individual of his or her enjoyment of these other goods, the fewer other goods are consumed, the lower is the "numbing tax" imposed by chronic painkillers. This is what leads to a fall in the unit costs of relief from pain as more relief is consumed and this falling cost is what may lead users to corners of their budget constraint. Being at a corner would be similar to the dependence arrived at through complicated dynamic formulations in the habit formation literature. In

the case of acute pain I showed that painkillers cannot create a dependence because of the manner in which acute pain enters the utility function.

I admit that the technical definitions of chronic and acute pain I have given may be disputed, and to some readers may appear artificial. Is not pain just pain? My goal has been to demonstrate that pain may reduce enjoyment of life in different manners. The drugs one takes and how one takes them will depend on the type of pain. While the question of pain has traditionally been a medical one, I hope to have demonstrated that economics may bring some insights into the forces driving people to the use of painkillers.

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Figure 1: Budget lines in final good, re
individual with income of $1000, and indiv
$2000

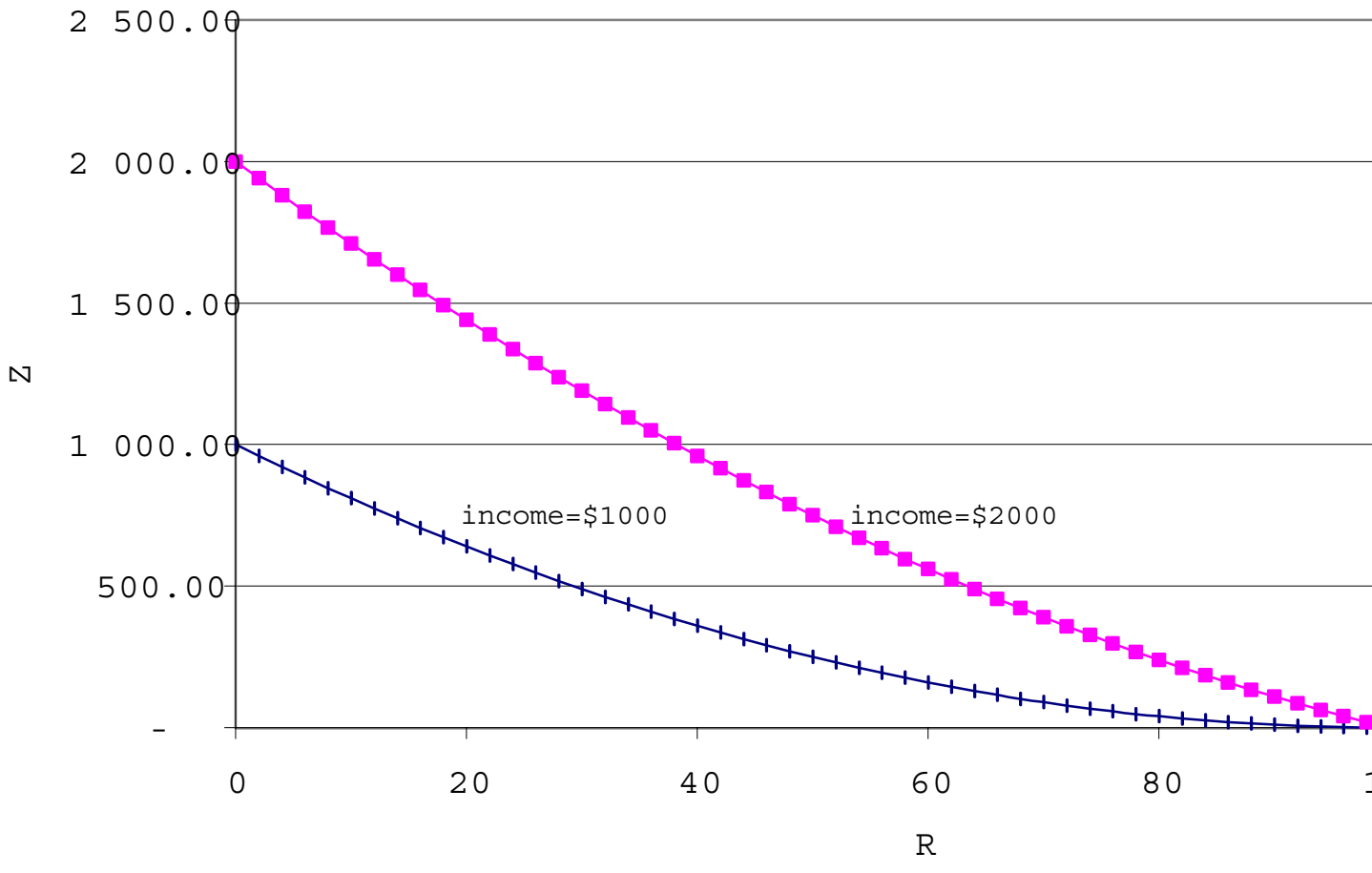

Figure 2: Shadow price of relief r
good consumption for income levels $1