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ASSESSING CONSUMER GAINS FROM A DRUG PRICE CONTROL POLICY IN THE U.S.

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ABSTRACT

This paper uses national data for the period 1960 to 2000 to estimate an aggregate private consumer demand for pharmaceuticals in the U.S. The estimated demand curve is then used to simulate the value of consumer surplus gains from a drug price control regime that holds drug price increases to the same rate of growth as the general consumer price level over the time period from 1981 to 2000. Based upon a 7 percent real interest rate, we find that the future value of consumer surplus gains from this hypothetical policy would have been $319 billion at the end of 2000. According to a recent study, that same drug price control regime would have led to 198 fewer new drugs being brought to the U.S. market over this period. Therefore, we approximate that the average social opportunity cost per drug developed during this period to be approximately $1.6 billion. Recent research on the value of pharmaceuticals suggests that the social benefits of a new drug may be far greater than this estimated social opportunity cost.

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I. INTRODUCTION

The public debate over prescription drug prices in the U.S. is one of the most contentious in the history of healthcare politics. The commonly held perception that U.S. drug prices are "too high" has been fueled by the fact that real drug prices in the U.S. have been rising steadily, and at a rate faster than that of the general consumer price index for over two decades. As a result, the pharmaceutical industry has come under intense criticism, with both politicians and special interests groups calling for new legislation that will make pharmaceuticals more affordable, either through legalized reimportation from price-regulated markets such as Canada and the European Union, or more directly through government imposed price controls.

While these calls for legislative action are not new, the U.S. does appear to be, for the first time, very close to a major policy change regarding U.S. drug prices.[1] The U.S. government may, like all other industrialized governments around the world, soon begin regulating drug prices[2]. In addition to several reimportation bills currently on the Senate floor, proposed amendments to the recently passed Medicare Modernization Act of 2003 also exist that will allow the U.S. government to negotiate *directly* with drug manufacturers for Medicare prescription drug purchases (the MMA currently has a non-interference clause), which will amount to approximately 60 percent of all U.S. drug purchases (Vernon, Santerre, and Giaccotto, 2004).

[1] Approximately 10 years ago the Clinton Administration's Health Security Act had provisions for directly controlling drug prices. In addition, the drug industry has been under the political microscope since the 1960s (Scherer, 2004)

[2] There are numerous theoretical reasons why reimportation may not generate the desired prescription drug cost savings that the advocates of this and related policies expect. See, for example, the paper by Kanavos et al. (2004). If this occurs, direct price regulation will have to follow to procure the cost savings that such reimportation policies were intended to achieve.

While regulated drug prices in the U.S. will undoubtedly improve the public's access to today's medicines, and thus generate both cost savings and improved public health, it will simultaneously reduce firms' incentives to invest in pharmaceutical R&D because of lower levels of pharmaceutical profitability. Less investment in pharmaceutical R&D will have a negative effect on the rate of future pharmaceutical innovation. Recent research has documented the considerable benefits of pharmaceutical innovation in terms of improved U.S. longevity (Lichtenberg 2002; Miller and Frech, 2002) as well as the sensitivity of R&D investment to real pharmaceutical prices (Giaccotto, Santerre, and Vernon, 2003, 2005) and profits (Vernon, 2004a). Thus, in addition to the short-run benefits associated with lower, regulated drug prices, there will also be long-run costs. This is precisely the tradeoff the U.S. patent system tries to balance by awarding limited-term patents to new drug products.

Even though a policy of regulated drug prices in the U.S. involves a tradeoff between short-run benefits and long run costs, the former outcome often receives more attention in policy debates (Scherer, 2004). Interestingly, however, efforts to quantify these short-run benefits from a rigorous economic perspective are nonexistent. Therefore, in the current paper, we attempt to do just that. We also compare our findings with the results from an earlier study—one that employed the same data and modeling techniques, but which measured the economic costs of the same U.S. price control policy—in terms of reduced levels of pharmaceutical innovation. Thus, we are able to weigh the benefits of pharmaceutical price controls (in terms of consumer surplus gains) against the costs (measured in terms of forgone drug discoveries). While these studies are retrospective in nature (out of necessity), and consider only one type of U.S. price

control policy (one that requires pharmaceutical prices grow no faster than the CPI), the price control policy simulated is, nevertheless, similar to an actual policy enacted in 1992 for drugs purchased by the government for the Veterans Administration (VA) health system. Moreover, and for the first time, a formal cost-benefit analysis of a particular type of drug price control is possible, and this may offer new insights.

Our paper proceeds as follows. In Section II we develop an empirical model of the aggregate consumer demand for pharmaceuticals in the United States. We also outline our empirical strategy and describe the data. Section III reports and discusses our empirical estimates. In Section IV we simulate the consumer surplus gains from a hypothetical price control policy in the U.S.: one that limits the growth rate of pharmaceutical prices to that of the CPI from 1981-2000. We then assess the net benefit of this policy by comparing the gains of consumer surplus to some fairly plausible estimates of the value of the R&D (and drugs) that would be lost had the policy been enacted. Section V provides a summary and offers some conclusions.

II. CONCEPTUAL AND EMPIRICAL MODELS OF THE AGGREGATE CONSUMER DEMAND FOR PHARMACEUTICAL PRODUCTS

We begin by assuming a one-period model in which a representative consumer, given her exogenous tastes and preferences, T, derives utility from consuming the units of "health services", H, that flow from her health capital, and some composite good, X. Stated mathematically:

$$U = U(H, X; T). \qquad (1)$$

We also make the following standard assumptions about the individual's utility function:

$$\frac{\partial U}{\partial H} > 0; \qquad \frac{\partial U}{\partial X} > 0; \qquad \frac{\partial^2 U}{\partial H^2} < 0; \qquad \frac{\partial^2 U}{\partial X^2} < 0; \qquad \frac{\partial^2 U}{\partial H \partial X} > 0. \tag{2}$$

That is, utility is assumed to increase at a decreasing rate with respect to both health services and the composite good. We further assume that health services are produced with various combinations of prescription drugs, Q (e.g., dosages), and medical services, M (such as office visits or inpatient days), conditioned on the representative consumer's initial endowment of health capital, H_0. Thus, for ease of exposition, we ignore a set of other healthcare "goods" and "bads" such as exercise, diet, alcohol and tobacco use, etc. and the consumer's time involved in producing these healthcare activities.[3] A production function for units of health services can thus be written as follows:

$$H = H(Q, M; H_0), \tag{3}$$

where H is assumed to be concave with respect to both Q and M.

Substituting equation (3) into equation (1), allows utility to be expressed in terms of the production function for health services and the composite good. It is assumed that expenditures on the two inputs that produce health services, and spending on the composite good, fully exhaust the consumer's income. The consumer's optimization problem is therefore to select the amounts of prescription drugs, medical services, and the composite good that maximize her utility subject to the constraints of income, Y, and the

[3] For instance, Miller and Frech (2002) examine empirically the effect of pharmaceuticals, medical care, and various lifestyle factors on measures of the quality and quantity of life using a sample of OECD countries. Among other results, they find that pharmaceutical consumption extends and improves life.

out-of-pocket prices for drugs, P_O, medical services, P_M, and the composite good, P_X. Stated more formally we have:[4]

$$\text{MAX } U = U\left[H(Q,M;H_0),X;T\right] \quad \text{Subject to: } QP_O + MP_M + XP_X = Y. \tag{4}$$

Using the method of Lagrange Multipliers to find the solution to this constrained optimization problem generates the familiar first-order conditions. Using the first-order conditions, we can solve for the marginal rate of substitution between drugs and the composite good. This yields:

$$\left[\frac{\partial U}{\partial H}\cdot\frac{\partial H}{\partial Q}\right]\left[\frac{\partial U}{\partial X}\right]^{-1} = \frac{P_O}{P_X}. \tag{5}$$

The first partial derivative in the left-most bracket captures the marginal utility of good health while the second reflects the marginal productivity of drugs on good health. Equation (5) implies that, in equilibrium, the representative consumer equates the marginal benefit of the last drug consumed with its marginal cost, as reflected by the relative out-of-pocket price of an additional drug.

For purposes later in the paper, it is important to consider here that the marginal benefit of an additional drug dosage is influenced by both the value that the consumer places on being in a state of good health and the marginal product of an additional drug on good health. As a result, the actual price paid for an additional drug in the marketplace captures the consumer's willingness to pay for a small reduction in the probability of dying and/or a marginal improvement in her quality of life. This notion becomes particularly important when we use the inverse demand curve to estimate the consumer

[4] For simplicity, it is assumed that the decision to purchase pharmaceutical and medical expense insurance coverage has already been made.

surplus from a drug price control regime. That is, consumer surplus, the area under the inverse demand curve, captures the value of life and the marginal contribution of an additional drug to good health.

Defining *X* as the numeraire, it also follows from the utility maximization process that the representative consumer's quantity demanded of prescription drugs can be derived as a function of the relative out-of-pocket drug price, relative out-of-pocket medical price, and her real income. Expressed generally, the demand function takes the following form:

$$Q = Q\left(\frac{P_O}{P_X}, \frac{P_M}{P_X}, \frac{Y}{P_X}; T, H_0\right). \tag{6}$$

Lastly, for purposes of empirical estimation, it is assumed that the representative consumer's demand for prescription drugs takes the following specific log-log form:

$$\ln(Q) = \beta_0 + \beta_1 \ln\left(\frac{P_O}{P_X}\right) + \beta_2 \ln\left(\frac{P_M}{P_X}\right) + \beta_3 \ln\left(\frac{Y}{P_X}\right). \tag{7}$$

Therefore, the coefficients in equation (7) may be interpreted as elasticities. According to the law of demand, the quantity demanded of prescription drugs should be inversely related to its relative out-of pocket market price ($\beta_1 < 0$). The relationship between the quantity demanded of prescription drugs and the relative out-of-pocket price for medical services depends on whether pharmaceuticals and medical services are substitutes ($\beta_2 > 0$) or complements ($\beta_2 < 0$). Finally, if prescription drugs can be classified a normal good, real income will have a direct impact on the quantity demanded of

prescription drugs ($\beta_3 > 0$). Obviously, an inverse relation holds if prescription drugs are inferior goods.

Time series data for the variables in equation (7) were obtained on-line either at the Center for Medicare and Medicaid Services, the Bureau of Labor Statistics, or the Bureau of Economic Analysis for the period 1960-2000. The quantity of drugs consumed by the average consumer is measured by real drug expenditures per capita. Dividing nominal drug expenditures by the pharmaceutical consumer price index and by the population produces a measure of real drug expenditures per capita.[5]

The out-of-pocket price of drugs is calculated in the following manner:

$$P_0 = cP . \qquad (8)$$

Thus, the out-of-pocket price is determined by multiplying the consumer's out-of-pocket share, *c*, by the pharmaceutical consumer price index, *P*, our measure of market price. The expression in equation (8) is then divided by the general consumer price index, P_X, to derive a real or relative out-of-pocket price of drugs for each year.

As noted by some researchers, consumer price indices are not measured without error because substitution effects and quality changes over time are not fully incorporated (e.g., Hausman, 2003). Several authors have also pointed out the biases that previously existed in pharmaceutical price indices because of (1); the undersampling of new drugs, (2); the failure to treat generic drugs as lower-priced substitutes for branded drugs rather than new drugs, and (3); the use of list instead of transaction prices (Berndt, Griliches,

[5] Note that real pharmaceutical expenditures per capita capture purchases of both existing and new drugs but a demand curve assumes a standardized product. Technical change over time obviously changes the mix of old and new drugs and thus might present a problem when estimating long-run elasticities. However, variables are first differenced in our multiple regression model. Thus, we are estimating short-run elasticities and technical change therefore presents less of a problem.

and Rosett, 1993; Scherer, 1993). Nevertheless, the pharmaceutical price index represents the best available time series indicator of drug price swings in the U.S. (Beginning in 1995, the Bureau of Labor Statistics has taken steps to correct some of these biases in the pharmaceutical price index.) Moreover, since we are examining changes in the ratio of the pharmaceutical and general CPI measures over time, some of the substitution and quality bias in the numerator and denominator may tend to cancel out. In addition, average year-to-year parameter estimates are obtained in the multiple regression analysis. These short-run estimates may avoid some of this bias because sufficient time does not pass for substitution effects and quality changes to fully work themselves out. It should be kept in mind, however, that any remaining measurement error biases the parameter estimates towards zero if the rest of the model is properly specified.

Similarly, the out-of-pocket real price of medical care is obtained by multiplying the ratio of the medical care consumer price index and the general price index by the percent of medical care expenditures that were out-of-pocket expenses. Real income is measured by real GDP per capita. Before presenting our multiple regression results, we first discuss how the dependent variable and the two out-of-pocket prices in equation (7) changed over time. This information is provided in Exhibit 1. Notice that real drug expenditures per capita increased rapidly from 1960 to 1975, continued to increase but at a diminishing rate from 1976 to 1994, and then began increasing at an increasing rate once again from 1995 to 2000. It may not be coincidental, but instead reflective of the law of demand, that out-of-pocket real prescription drug prices inversely mirrored these movements in per capita real drug expenditures during this time period. For instance, the out-of-pocket real price of drugs declined rapidly from 1960 to 1975 and from 1993 to

2000, the two time periods when real drug expenditures per capita were rising quickly. Attention should also be drawn to the fact that the out-of-pocket real price for medical services generally declined over the entire time period, but at a relatively slow rate.

III. EMPIRICAL RESULTS

A high degree of serial correlation necessitated first differencing of the data (after taking logarithms). First differencing of the data seems particularly appropriate because diagnostic tests revealed the presence of unit roots in several of the time series data (i.e., real drug spending per capita and real GDP per capita) before they were first differenced. Unit roots can result in spurious correlations among variables. We also included in our empirical model a lagged measure of real drug expenditures per capita as an additional independent variable (after first differencing). The lagged measure was included to control to for unobserved demand factors like tastes and preferences, T, and the initial endowment of health, H_0, as specified in equation (6). Estimation of the first-differenced model by ordinary least squares produced the coefficient estimates and corresponding t-statistics reported in the second column of Exhibit 2[6,7] We note that the adjusted R^2 of

[6] Mathematically, the intercept term in equation (7) falls out after first differencing of the variables. Statistically, an intercept term proved to be no different from zero.

[7] As noted in the text, a one-period lagged value of Q (in logs) was also included in the specification to control for changing tastes and preferences. Because a lagged value of the dependent variable is specified on the right hand side of the equation, the typical Durbin Watson statistic cannot be used to detect serial correlation. We remind the reader, however, that our specification contains first differences of the variables and not levels so we report the Durbin Watson statistic. We also experimented with other diagnostic tests such as the Q-statistic and Durbin's alternative test (Maddala, 1992). These tests failed to detect the presence of serial correlation.

0.58 is quite high for this type of time-series model (i.e., models using first-differenced data).[8]

As anticipated, the estimated own-price elasticity of demand is negative and statistically significant. Our relatively price-inelastic estimate of –0.48 suggests that a 10 percent decrease (increase) in the real out-of-pocket price of prescription drugs increases (decreases) the quantity demanded of prescription drugs by about 4.8 percent, *ceteris paribus*. This estimate is very close to Coulson and Stuart's (1995) estimate of –0.34 and also falls within previous estimates ranging from –0.06 to –0.64 as noted by these authors. Earlier research focused on the demand for pharmaceuticals by elderly individuals. Our own-price elasticity is most likely higher because it captures the demand of the representative consumer, rather than the representative elderly individual. Because of their relatively more depreciated health capital, elderly individuals are likely to face fewer health-related choices than the general population, and thus may possess less price-elastic demands for pharmaceuticals.

The positive and statistically significant cross-price elasticity estimate suggests that medical care and prescription drugs are substitute products. For example, based upon our cross-price elasticity estimate of 0.56, a 10 percent increase in the price of medical care is associated with a 5.6 percent increase in the quantity of prescription drugs demanded. The direct relation between the price of medical care and the quantity of prescription drugs demanded suggests that decision-makers have some ability to

[8] The specification of equation (7) assumes that the market price of drugs, which helps to make up the out-of-pocket real price of drugs, is independent of the amount of existing drugs produced. An assumption of independence or constant returns to scale in production is not unreasonable, particularly in the short run. For example, Schwartzman (1976) finds no evidence to support economies in manufacturing pharmaceuticals. While the market price of pharmaceuticals may be independent of consumption at a point in time, market price may change over time given varying supply conditions, allowing us to identify a demand curve for pharmaceuticals.

substitute one good for the other in the production of good health when relative price changes. This finding is consistent with Lichtenberg's (1996) research, which found that increased expenditures on pharmaceuticals leads to reduced expenditures on hospitalizations, ambulatory care, and physician services.

The income elasticity estimate is also positive and statistically significant, indicating that pharmaceutical products can, on average, be treated as normal goods. The income elasticity is fairly sizable suggesting that a 10 percent increase in real income per capita produces a 5.1 percentage increase in the quantity of drugs demanded. Studies tend to suggest that health care is a normal good (Santerre and Neun, 2004). The estimated coefficient on the lagged measure of real pharmaceutical spending per capita is positive and statistically different from zero. This coefficient estimate can be used in conjunction with the short-run estimates to calculate long-run elasticity estimates.[9] According to the calculations, the long run own-price, cross-price, and income elasticities are –0.89, 1.03, and 0.94 respectively.

Although predominately influenced by private demand (because public health insurance for pharmaceuticals was largely absent on an outpatient basis during the sample period), public financing may also influence real drug expenditures per capita, the dependent variable in equation (7). During the time period under investigation, the government paid for drugs administered to inpatients if they were covered by one of the various public health insurance programs. The government also paid for prescription drugs for outpatient care under the Veterans Administration and Medicaid programs.

[9] For example, the long run price elasticity estimate is calculated by dividing the short run elasticity by one minus the coefficient estimate on the lagged dependent variable. The other long-run estimates are determined in a similar fashion.

Reimbursement for pharmaceutical is fairly restrictive under the latter two programs, but the programs do provide some of the population with financial access to pharmaceuticals. In any case, a control variable should be included in the multiple regression equation for the percentage of pharmaceutical expenditures paid by government. The ratio of government expenditures on pharmaceutical to total pharmaceutical expenditures ranged from a little under 3 percent in 1960 to slightly under 22 percent in 2000.

Inclusion of this additional independent variable (after taking first differences in logarithms), results in the multiple regression findings reported in the third column of Exhibit 2. Notice that the multiple regression findings remain virtually the same as those reported in column 2, and the coefficient estimate on the public financing variable is not statistically different from zero. Public financing may have had no independent impact on pharmaceutical consumption because of its relatively low percentage over time, at least until very recently, or because our public financing variable captures a host of widely diverse government reimbursement schemes.

IV. SIMULATING CONSUMER GAINS FROM A DRUG PRICE CONTROL REGIME

We use the multiple regression results in column 2 of Exhibit 2 to estimate the future value of the consumer surplus from a drug price control policy that holds drug price increases to the same rate of growth as the general price level over the period from the beginning of 1981 through the end of 2000. To measure the consumer surplus for each year, we estimate the area under the inverse demand curve over the range between actual real drug expenditures for that year and the real drug expenditures that would result from a lower controlled price.

We pick the years between 1981 and 2000 to conduct the experiment because real drug prices increased throughout that period, as depicted in Exhibit 1. Moreover, in a recent study, Giaccotto, Santerre, and Vernon (2003, 2005) used that same period to estimate the number of new drugs that would have been lost from the same drug price control regime. These authors assumed Congress enacted a law in 1980 requiring pharmaceutical prices in the U.S. to grow no faster than the general price level. This approach mirrors one of the actual mandates in the Veteran's Health Care Act of 1992: namely, that drug prices paid by federal agencies cannot grow at a rate faster than the urban consumer price index. Thus, while our experiment is couched within a hypothetical and historical context, it will nevertheless reflect an actual approach employed by the Federal Government to control pharmaceutical prices (albeit on a relatively small scale). By combining the results from these two studies, some insight may be gained into the *net* consumer benefits arising from a drug price control system that holds the rate of growth of drug prices to the same rate of growth as the overall CPI.

Retrieving the elasticities from the multiple regression results in Exhibit 2, we can express a representative consumer's constant elasticity of demand curve for drugs as the following:

$$Q = A\left(\frac{P_O}{P_X}\right)^{-0.483}\left(\frac{P_M}{P_X}\right)^{0.560}\left(\frac{Y}{P_X}\right)^{0.512} Q_{t-1}^{0.456} \tag{9}$$

Or more simply, we can write:

$$Q = K\left(\frac{P_O}{P_X}\right)^{-0.483} \tag{10}$$

and define,

$$K = A\left(\frac{P_M}{P_X}\right)^{0.560}\left(\frac{Y}{P_X}\right)^{0.512} Q_{t-1}^{0.456} \qquad (11)$$

It follows that *K*, the amount of drug consumption that results from all factors other than the real out-of-pocket price, can be determined by dividing *Q*, real pharmaceutical expenditures per capita, by $P_O^{-0.483}$ for each year between 1981 and 2000. *K* changes over time in response to adjustments in the relative out-of-pocket price for medical care, real income and the lagged measure of the dependent variable.

To estimate the consumer surplus associated with the representative consumer's additional drug purchases under our price ceiling program, we have to invert equation (10) and solve for the market price of pharmaceutical products by employing the expression for the out-of-pocket price depicted by equation (8), which gives:

$$P = \frac{P_x}{c}\left(\frac{K}{Q}\right)^{\frac{1}{0.483}} \qquad (12)$$

Using standard integration techniques, the area under the inverse demand curve can be measured over the range between the actual real drug expenditures observed and the real drug expenditures that would have resulted from a price control regime that held the rate of growth in pharmaceutical prices to that of the general consumer price index. For the purposes of our simulation, the price control policy holds the ratio of the market price of pharmaceutical goods to all other goods at the same level observed in 1980 (but not necessarily the relative out-of-pocket price because c, the out-of-pocket share, changes over time).

Some disagreement exists in the literature regarding the appropriate measure of consumer surplus when health care is involved because of the presence of third-party

payers. Health economists typically argue that the uninsured demand curve when people are healthy should be used to estimate consumer surplus to remove the distortion caused by moral hazard. Nyman (2003) insists on the insured demand curve when people are ill because insurance provides access to health care that many could not otherwise afford and because the amount of utility received from medical care depends on health status. Because our demand equation is specified on a per capita basis, it reflects the aggregated demands of the insured (both partially and fully) and the uninsured as well as the sick and the healthy (zero consumption). Thus, following Nyman, the resulting estimate of consumer surplus may be biased downward because it implicitly incorporates the demands of the uninsured and healthy. On the other hand, the estimate of consumer surplus may be biased upward because it incorporates the inefficiencies of moral hazard through c, the out-of-pocket fraction. To remove the potential inefficiencies caused by moral hazard, estimates for consumer surplus are also reported assuming that c = 1. However, we are unable to correct for the possible lower bound nature of the consumer surplus estimate because of the inclusion of the healthy and uninsured into the demand specification.

Theory suggests that willingness to pay should be measured by the compensated demand curve because a price change also typically triggers an income effect. However in this particular case the income effect is very tiny because of both a small drug expenditure share (about 1 percent on average for the sample) and an income elasticity of demand less than one. Applying the Slutsky equation, the uncompensated and compensated price elasticities of demands differ by only .005 (i.e., -0.483 versus –0.478).

Given this minor discrepancy, we measure consumer surplus with the uncompensated demand curve.

The results of the consumer surplus simulation are shown in Exhibit 3 assuming an insured demand based upon the actual figures for the out-of-pocket fraction in each period. The second column shows the consumer surplus resulting from the drug price ceiling for the representative consumer during each of the years. Notice how individual consumer surplus increases throughout the period as actual drug prices continue to increase relative to the controlled drug prices.

By multiplying the total population in the U.S. by the representative consumer's surplus figures, *aggregate* consumer surplus can be derived. Aggregate consumer surplus for each of the years is shown in column 3. Assuming no interest and compounding of earnings, these yearly figures are summed, and result in a total of $206 billion by the end of 2000. Finally, the fourth column lists the future value of the aggregate consumer surplus that would have been earned over 20 years at a 7 percent real rate of return. Over the last few decades, the average rate of return in the stock market has exceeded general price inflation by about 7 percent. According to the figure shown at the bottom of column 4, the total future value of the aggregate consumer surplus would equal roughly $319 billion if the entire savings from the drug price control regime were invested at a 7 percent annual real rate of return. The future value of the consumer surplus for the uninsured demand (found by setting c equal to 1) amounts to $149 billion. For purposes of comparison, we also report in Exhibit 4 the future value of the consumer surplus for the insured and uninsured demands at different rates of return.[10]

[10] Over the 1980 to 2000 period, the rate of return in the stock market averaged roughly 17 percent and the general price inflation rate averaged 4 percent.

Over this same time period, Giaccotto, Santerre, and Vernon (2003, 2005) estimated that this same price control regimen would have caused firms to reduce pharmaceutical R&D expenditures (in $2000) by between $264.5 and $293.1 billion, because of lower profit expectations and possibly reduced levels of internal funds (which are the primary source of R&D finance)[11]. This reduced investment in R&D would have led to approximately 38 percent fewer new drugs being brought to market in the global economy. If this 38 percent figure is applied to the total number of new chemical entities approved for marketing during this period in the U.S., we can use our simulation results to calculate the average social opportunity cost per new drug.

During the period from 1980 to 2000, 520 new chemical entities were approved for marketing in the U.S.[12] This figure suggests that 198 drugs would have been "lost" if the assumed price control regime was imposed. Dividing the $319 billion consumer surplus gains from price controls over the period from 1980-2000 by the number of new drugs "lost" due to price controls, we estimate that, on average, consumers (in the aggregate) gave up $1.6 billion in consumer surplus per new drug developed.

This raises the question of whether or not the benefit of a new drug brought to market during this period was greater than or less than $1.6 billion. If the former is the case, then the fact that price controls were not imposed (in the manner we describe and model) was, on net, good for the U.S. If, however, the latter is the case, then not imposing price controls had a net social cost for Americans. While recent research has documented the significant benefits associated with medical and pharmaceutical research,

[11] The latter would be the case if capital market imperfections imparted a cost advantage to internal funds over external debt and equity (see Vernon, 2004a).
[12] Federal Drug Administration at http://www.FDA.gov.

and even suggested that U.S. may be currently underinvesting in R&D (Murphy and Topel, 2003), very few studies have documented the value (in dollar terms) of new drugs or pharmaceutical R&D. A notable exception is the econometric study by Lichtenberg (2002). In his study, which covered a similar time period in the U.S. (1960-1997), he approximated that, on average, every $1,345 spent on pharmaceutical R&D "produced" an additional U.S. life year.

While speculative, we can use this average productivity measure of R&D to compare the benefits of price controls (as modeled in this study) and the costs in terms of "lost" R&D and drugs[13]. To do this we divide Giaccotto and colleague's estimated range of forgone capitalized pharmaceutical R&D, by $1,345 and multiply this by $100,000, which is one measure of the value of a U.S. life year (Cutler and McClellan, 2001). Of course, both higher and lower estimates exist. When this first approximation of the cost of price controls is compared with the $319 billion gain in consumer surplus, the resulting cost-benefit ratio ranges from about 62 to 68. This suggests that, from a social welfare perspective, price controls would have done much more harm than good.

V. CONCLUSION

Rising drug prices have captured the attention of the media, various public interest groups, and politicians. Some have pointed to price controls as a way of reining in what are perceived by many to be "runaway" drug prices. But as economists have known for centuries, price controls simply represent "bad economics". Economic theory suggests that price controls often create shortages, reduce quality, lead to price discrimination, and

[13] See the papers by Vernon, Santerre, and Giaccotto (2004), and Vernon (2004b) for a discussion of the caveats involved.

can harm incentives for innovation. The only benefit to price controls is that some individuals gain, at the expense of others, through an increase in their consumer surplus as a result of the lower controlled prices.

In this paper, we estimate the consumer surplus, or benefit, resulting from a hypothetical price control regime in the U.S. To accomplish this objective, we use national data from 1960 to 2000 to estimate the aggregate private demand for pharmaceuticals. Based upon our empirical results, the demand for pharmaceuticals is shown to be inversely related to its own-price and directly related to the both medical prices and real income. Moreover, the empirical estimation generates elasticity estimates with plausible magnitudes that are in general agreement with previous research findings.

We then use the estimated demand curve to simulate the consumer surplus gains associated with an assumed price control policy that holds the increase in pharmaceutical prices to the rate of growth of the general consumer price index. Giaccotto, Santerre, and Vernon (2003, 2005) have conducted this same experiment, and found that this same price control regime would have reduced the number of new drug innovations by about 38 percent. For the nation as a whole, we estimate that the future value of the consumer surplus from the assumed price control regime would equal approximately $319 billion in 2000. On a per drug basis, we estimate that the social opportunity cost of not imposing this price control policy was approximately $1.6 billion. However, when compared to the estimated benefits of the additional pharmaceutical R&D that was undertaken because these hypothetical price controls were not implemented, these costs appear to be very small. Given our results, and those reported in prior research, society may be better off discovering more efficient ways than price controls to improve access to existing drugs.

Exhibit 1:

Real Drug Expenditures per capita, Out-of-Pocket Real Price of Drugs and Out-of-Pocket Real Price of Medical Care Over Time in the U.S.

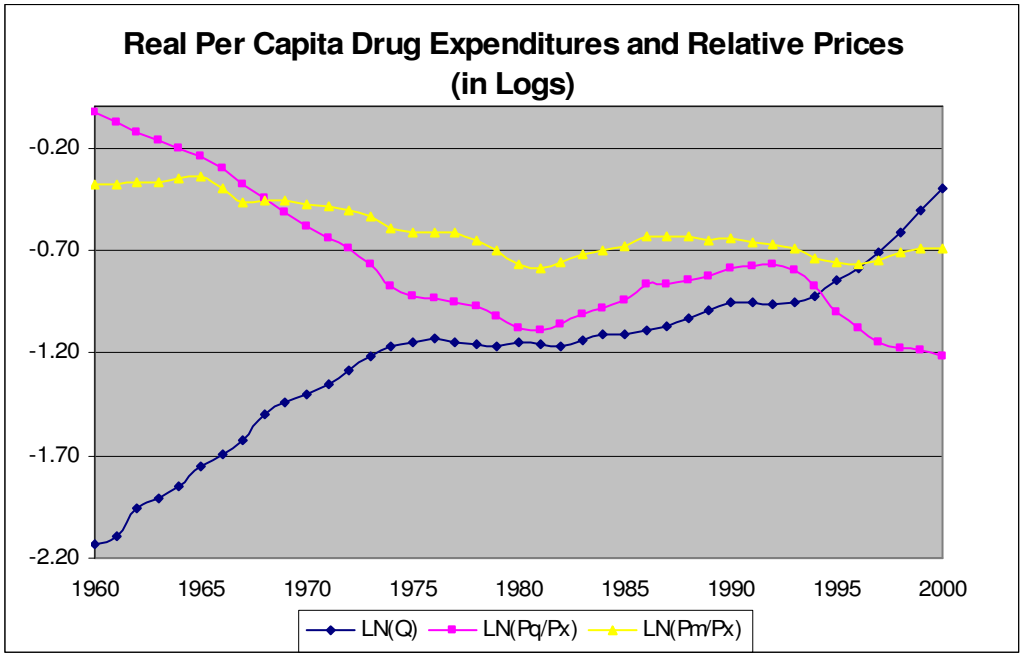

Exhibit 2:

Multiple Regression Results (dependent variable is the first difference of the log of real pharmaceutical expenditures per capita)

Variable	Basic Results	Extended Results
Log of out-of-pocket real price of drugs (P_Q/P_X)	-0.483 (3.73)	-0.469 (3.51)
Log of out-of-pocket real price of medical care (P_M/P_X)	0.560 (3.04)	0.506 (2.38)
Log of real GDP per capita (Y/P_X)	0.512 (2.99)	0.528 (3.00)
One-year lagged measure of real pharmaceutical expenditures per capita	0.456 (4.06)	0.492 (3.70)
Log of percent of total pharmaceutical expenditures paid by government		-0.039 (0.52)
Adjusted R^2	0.584	0.575
Durbin Watson Statistic	1.81	1.84
Observations	39	39

Exhibit 3:

Determination of the Aggregate Consumer Surplus
From a Drug Price Control Regime

Year	Money value of the consumer surplus from one individual	Money Value of Aggregate Consumer Surplus (i.e., the second column times population)	Future value of consumer surplus (invested at 7 percent until the end of the year 2000)
1981	$0.26	$60,472,360	$234,008,952
1982	$1.84	$426,554,876	$1,542,647,455
1983	$4.57	$1,069,482,312	$3,614,777,785
1984	$6.96	$1,642,217,474	$5,187,461,537
1985	$9.88	$2,350,009,621	$6,937,613,212
1986	$13.63	$3,271,366,127	$9,025,802,326
1987	$16.80	$4,071,236,379	$10,497,822,037
1988	$20.79	$5,082,849,457	$12,248,879,350
1989	$25.37	$6,260,541,229	$14,099,938,298
1990	$31.74	$7,918,736,937	$16,667,768,902
1991	$38.55	$9,722,865,584	$19,126,348,231
1992	$43.93	$11,201,883,372	$20,594,205,681
1993	$46.79	$12,061,384,335	$20,723,703,874
1994	$50.03	$13,021,977,945	$20,910,450,971
1995	$54.36	$14,286,584,751	$21,440,311,361
1996	$59.89	$15,881,839,547	$22,275,101,543
1997	$67.23	$18,003,459,448	$23,598,862,810
1998	$79.11	$21,375,526,811	$26,185,939,492
1999	$97.97	$26,716,982,518	$30,588,273,285
2000	$115.32	$31,747,355,082	$33,969,669,938
TOTAL		**$206,173,326,166**	**$319,469,587,040**

Exhibit 4

Future Value of the Consumer Surplus for Various Rates of Return and Insured versus Uninsured Demands

Real Rate of Return	Uninsured Demand	Insured Demand
5%	$128 Billion	$280 Billion
9%	$174 Billion	$366 Billion
13%	$241 Billion	$488 Billion

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