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Ashley C. Craig
University of Michigan, ashcraig@umich.edu
James R. Hines Jr.
University of Michigan Law School, jrhines@umich.edu

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TAXES AS PANDEMIC CONTROLS

Ashley C. Craig and James R. Hines Jr.

Tax policy can play important roles in limiting the spread of communicable disease and in managing the economic fallout of a pandemic. Taxes on business activities that bring workers or customers into close contact with each other offer efficient alternatives to broad regulatory measures, such as shutdowns, that have been effective but enormously costly. Corrective taxation also helps raise the revenue required to cover elevated government expenditure during a pandemic. Moreover, the restricted consumer choice that accompanies a pandemic reduces the welfare cost of raising tax revenue from higher-income taxpayers, making it a good time for deficit closure. Current U.S. tax measures serve some of these functions, but additional measures could further limit the spread of disease while also addressing government budget deficits.

I. INTRODUCTION

In the dramatic months of early 2020, the United States and many other countries abruptly shut down their economies in efforts to prevent widespread contagion and disease due to the SARS-CoV-2 virus. The monetary cost of these economic shutdowns was enormous, as the world adopted various drastic expedients in order to gain time to allow health care systems and the organization of workplaces and public spaces to adjust to the new reality.

The experience of early 2020 prompts consideration of methods that might be used to limit the spread of disease in economies that are operating more or less normally. This paper evaluates the function that routine tax policy serves in limiting the spread of contagious diseases, and how tax policy might be designed to play more active and efficient roles in controlling the externality generated by activities that spread such diseases.

In crisis situations, it is natural to turn to administrative restrictions based on levels of potentially harmful activity, and that is what much of the world did in early 2020.[1]

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[1]   These measures are studied by Lin and Meissner (2020) for the United States. A summary has also been compiled by Keystone Strategy: https://www.keystonestrategy.com/coronavirus-covid19-intervention-dataset-model/.

Ashley C. Craig: Department of Economics, University of Michigan, Ann Arbor, MI, USA (ash@ashleycraig.com)

James R. Hines Jr.: Department of Economics, University of Michigan, Ann Arbor, MI, USA (jrhines@umich.edu)

In anything other than a severe crisis, however, the potential economic benefits of tax-based externality control are apparent. Tax incentives can be designed to serve many if not all of the same functions as regulatory restrictions and to do so more efficiently in many cases.[2] Prior to the appearance of the SARS-CoV-2 virus, climate change was the global problem capturing much of the world's attention. While there is considerable controversy over the most efficient method of addressing climate change, many thoughtful observers prefer carbon taxes to regulatory alternatives because carbon taxes afford degrees of flexibility and adjustment to heterogeneous situations that administrative rules often lack.[3] The features that make carbon taxes cost-effective methods of reducing carbon emissions similarly have the potential to make appropriately designed taxes efficient methods of contagion control.

Disease externalities differ from climate change externalities in many respects, most notably in that many individuals whose actions might put others at risk also thereby put themselves at risk. Whereas the harm that an individual does to herself by contributing to global warming may be vanishingly small, the same is not true of reckless behavior in the face of community disease spread. Corrective actions on the part of governments can expand on self-interest on the part of individuals and firms to help avoid some of the more adverse potential consequences.[4]

Efficient government policy measures that limit the spread of disease can include taxes that impose marginal costs on externality-generating activities such as employment in close quarters. Existing personal and corporate income taxes, social insurance systems, and other tax policies serve some of these externality-correcting functions, albeit rather indirectly and crudely. Existing taxes can readily be modified to address disease externalities more directly, though a truly first best externality correction would require a thorough overhaul of the tax system that addresses both supply and demand of externality-generating activities. By contrast, simply shutting down an economy is a very inefficient method of controlling the spread of disease.

In practice, any system is unlikely to be able to tailor taxes and regulations to control externalities perfectly — and the controls themselves can distort resource allocation. As a result, restoring a semblance of efficiency requires that additional corrective measures accompany externality controls. One example is that efforts to control the actions of firms can entail taxes or penalties that discourage firm operations and, therefore, inefficiently

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[2] A growing literature studies optimal policy responses to SARS-CoV-2 with a focus on administrative restrictions. Examples include Alvarez, Argente, and Lippi (2020), Atkeson (2020), Bodenstein, Corsetti, and Guerrieri (2020), Chari, Kirpalani, and Phelan (2020), Farboodi, Jarosch, and Shimer (2020), Glover et al. (2020), Guerrieri et al. (2020), Jones, Philippon, and Venkateswaran (2020), Moser and Yared (2020), and Rampini (2020). In some cases, consumption taxation is used as a proxy for quantitative containment measures (Eichenbaum, Rebelo, and Trabandt, 2020; Krueger, Uhlig, and Xie, 2020).

[3] There is a large literature, prompted by Weitzman (1974), on the choice between price and quantity instruments to control externalities. This includes Laffont (1977), Spence (1977), and Newell and Pizer (2003).

[4] The externalities involved in disease transmission were extensively studied well before the SARS-CoV-2 pandemic. See, for example, Goldman and Lightwood (2002) and Gersovitz and Hammer (2004).

reduce economic activity. An efficient system of externality-controlling taxes, therefore, may need to include subsidies or other devices to encourage employment and output.

Governments must balance their budgets over time, though not necessarily every year; in periods of economic emergency, governments commonly run large budget deficits. There remains the question of the extent to which government budget deficits are warranted at different times. During a pandemic, portions of the population can experience severe hardship and require resource transfers to maintain even minimum levels of welfare, while other parts of the population and economy, though underperforming relative to normal conditions, are nonetheless capable of funding these transfers. In such circumstances, it is far from clear that large, or even any, government deficits are warranted since the cost of extracting taxes from the part of the economy capable of paying them may be lower during a pandemic than in the future.

Sections II and III of the paper analyze the use of taxes to support efficient control of externalities, with Section II focusing on individual taxes and Section III exploring taxes on firms. Section IV of the paper considers the implications of disease-driven economic upheaval for government budget deficits. Section V identifies the extent to which existing U.S. taxes and social insurance programs address the externalities created by disease spread. Section VI provides the conclusion.

II. EFFICIENT AND INEFFICIENT EXTERNALITY CONTROL

One of the characteristics of disease externality is that individuals who transmit the disease also are at risk of experiencing severe outcomes themselves. Suppose that the expected utility of individual i can be represented as

(1) $u_i(c_i,\ L_i,\Delta_i(L_i,d_i,e_i))$,

in which c_i is consumption; L_i is labor supply; and Δ_i is the probability of catching the disease, itself a function of labor supply. In this specification, individuals control their own exposure to disease by adjusting their labor supplies. In addition to labor supply, the probability of catching the disease is also a function of the safety of an individual's workplace environment, denoted e_i, and the extent of disease in individual i's proximity but outside the workplace (e.g., at grocery stores or other necessary activities), denoted d_i. The utility specification in Equation (1) takes nonwork disease exposure, d_i, to be exogenous, a restriction that is relaxed in Section II.C.

Individuals choose labor supply mindful of the budget constraint

(2) $c_i \leq w_i L_i + m_i - T(w_i L_i, m_i)$,

in which w_i is individual i's pretax wage, m_i is her nonlabor income and other resources (not all of which may be taxable), and $T(w_i L_i,\ m_i)$ is the tax obligation associated with these levels of labor and nonlabor income. Denoting labor income by $y_i = w_i L_i$, the

first-order condition corresponding to positive labor supply that maximizes Equation (1) subject to Expression (2) is

$$(3) \quad w_i \left(1 - \frac{\partial T(y_i, m_i)}{\partial y_i} \right) = -\frac{\partial u_i / \partial L_i}{\partial u_i / \partial c_i} + \frac{\partial u_i / \partial \Delta_i}{\partial u_i / \partial c_i} \frac{\partial \Delta_i}{\partial L_i}.$$

The first term on the right side of Equation (3) is standard in labor supply: in the absence of any additional costs or restrictions, a worker chooses labor supply to equate the after-tax wage with the cost of foregone leisure, normalized by the marginal utility of consumption. The second term on the right side of Equation (3) reflects the expected health cost associated with an additional hour of labor supply, as it is the product of the normalized cost of illness and the extent to which an additional unit of labor supply increases the probability of becoming infected. While strictly speaking the derivation of Equation (3) applies only to individuals who can choose to supply any amount of labor, even those facing inflexible job schedules will make discontinuous choices of whether to work based on the same trade-offs between the benefits of compensation and the costs of foregone leisure plus the risk of disease.

Labor supply decisions corresponding to Equation (3) are extremely unlikely to maximize social welfare, since individuals disregard their own effects on others. The specification in Equation (3) calls attention to two such spillover effects that are notable by their absence: an individual's labor supply affects aggregate tax collection and it affects the likelihood that others will catch the disease. These spillovers work in opposite directions: the tax externality implies that labor supply will be too low, whereas the disease externality implies that labor supply will be too high.

A. Improving Efficiency

Greater labor supply on the part of individual i increases the chance that nearby others catch the disease by affecting the extent of disease in their areas. The aggregate welfare effect of an additional unit of i's labor supply is given by

$$(4) \quad \sum_{j \neq i} \frac{\partial u_j}{\partial \Delta_j} \left(\frac{\partial \Delta_j}{\partial d_j} \frac{\partial d_j}{\partial L_i} + \frac{\partial \Delta_j}{\partial e_j} \frac{\partial e_j}{\partial L_i} \right).$$

Since $\partial u_j / \partial \Delta_j < 0$, and the parenthetical term is positive, Expression (4) is negative, the government can support efficient labor supply by imposing a marginal tax equal in magnitude to Expression (4); this causes i to exactly internalize the impact of her labor supply on the probability that others catch the disease. The first-order condition (Equation (3)) includes an income tax at marginal rate $\partial T(y_i, m_i)/\partial y_i$, but only by chance would this marginal tax rate equal the value of Expression (4). Furthermore, any existing income tax may have been designed to achieve other aims such as redistribution. In that case, the disease externality provides a motive to raise the marginal tax rate further.[5]

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[5] If labor supply is the only activity that generates the externality, the correction for this can simply be added to the component of the tax that serves other purposes such as redistribution (Sandmo, 1975; Kopczuk, 2003).

When setting such a corrective tax, the external impact of individual i's labor supply is evaluated at its equilibrium level. This introduces an interaction between the potential cost of an individual's own exposure and the external cost from exposing others. An individual's own risk of exposure likely reduces their desired labor supply during a pandemic, thus partially mitigating the externality without government intervention. While this does not change the formula describing the externality correction as represented in Expression (4), this voluntary labor supply reduction changes the magnitude of the implied externality-correcting tax. For example, if an individual's workplace is already less crowded because many colleagues choose to work less or work from home, the externality is diminished compared to what it would have been if they were all commuting to work, and the externality-correcting tax rate is correspondingly lower.

Since income taxes are functions of income rather than amounts of labor, a flat or progressive income tax would be poorly targeted from the standpoint of discouraging aggregate labor supply during a pandemic. Instead, the fact that higher earners supply less labor per dollar of income suggests that the increase in optimal marginal tax rates is smaller at higher incomes. It also suggests that increasing the generosity of unemployment insurance could be a better-targeted policy, since it crowds out labor supply specifically at lower incomes (Ganong, Noel, and Vavra, 2020). Of course, this does not take into account differences in the occupations of people with higher and lower incomes or externalities from the consumption activities they engage in with the income they earn.

B. The Shutdown Alternative

One regulatory alternative to tax adjustments is to shut down the economy entirely, in which case $L_i = 0$, $\forall i$. Under these circumstances, individual i's utility is given by $u_i(e_i, 0, \Delta_i(0, d_i, e_i))$. It is clear in this scenario that a worker's chance of contracting the disease is unaffected by their employer's level of workplace protection, e_i, since no one works. But someone who does not work might nonetheless catch the disease, as there can be unavoidable exposure while engaged in everyday activities such as shopping. Community disease proclivity, d_i, can therefore affect Δ_i even though labor supply is zero.

As an instructive benchmark, it is useful to start by considering a stark example in which the only way for an individual to catch the disease is through workplace exposure. Under these circumstances, Δ_i is independent of d_i if $L_i = 0$: greater community disease prevalence has no effect on the likelihood that an individual will contract the disease if they do not work. Effectively, the individual is immunized by staying at home. Under this assumption, if only one person in the economy worked, there would be no externality associated with their labor supply since there would be no one else at work to infect. A tax correction based on Expression (4) would therefore be zero, because the value of Expression (4) is zero. This does not imply that there is no role for government intervention. Indeed, price-based externality correction measures can improve welfare even here. But a complete shutdown in this example is inefficient, because it imposes externality control even to the point at which the externality disappears.

An interesting aspect of this scenario is that a complete shutdown produces an outcome that is Pareto inferior even to the very inefficient alternative of no government

action at all.[6] Start with individual utility, which is given by Equation (1). Maximizing Equation (1), individual i chooses labor supply L_i^*. Similarly, the equilibrium levels of workplace protection and community disease proclivity in the absence of government intervention are e_i^* and d_i^*, respectively. Since zero labor supply is always an option, every individual must weakly prefer to supply L_i^* so that $u_i(c_i, L_i^*, \Delta_i(L_i^*, d_i^*, e_i^*)) \geq u_i(c_i, 0, \Delta_i(0, d_i^*, e_i^*))$. Finally, since utility is independent of d_i and e_i when $L_i = 0$, it follows that $u_i(c_i, L_i^*, \Delta_i(L_i^*, d_i^*, e_i^*)) \geq u_i(c_i, 0, \Delta_i(0, d_i, e_i))$ for any d_i and e_i. Consequently, forcing everyone to have zero labor supply cannot make anyone better off and, as a general matter, will make some worse off. This strong conclusion holds regardless of the values individuals place on personal infection risk, their risk aversion, or the value of a statistical life. Intuitively, the reason why this result obtains is that there are only two types of workers in this example: (1) those who would not have supplied labor anyway, who are thus indifferent to the shutdown; and (2) those who would have supplied labor despite the risk of catching the disease, who are now weakly worse off because they are prevented from doing so.

To be clear, this conclusion relies not only on individual rationality but also on the assumption that individuals are entirely unaffected by community disease prevalence (d_i) if they do not supply any labor. The latter is overly strong, since individuals are exposed to disease through their consumption, health care, and receipt of support in rest homes and other venues, and are in other ways unable to protect themselves fully from disease exposure simply by not working for pay. Furthermore, even the most complete economic shutdown is not fully complete, as essential workers continue to provide services. Incorporating these realities removes the very strong Pareto-inferiority property of economic shutdowns, because even individuals who are themselves isolated then benefit from others reducing their labor supplies. But the example highlights the potential disadvantages of sustaining blunt quantitative restrictions as a solution to a disease externality.

C. Application to Other Economic Activities

While the model in this section treats an individual's nonwork activities as though they are exogenous from the standpoint of externality control, the model's implications apply in straightforward fashion to broader formulations that treat consumption activities explicitly. It is clearly possible, indeed easy, to catch and transmit disease while shopping for goods or consuming services. Since consumers prefer to avoid getting sick, sellers of goods and services have incentives to modify their operations to reduce the risks that their customers face, in return for which they can charge higher prices. As in the workplace environment, the induced incentive for disease mitigation is limited by the external nature of a portion of the costs. Since customers do not bear the full costs of their actions, in that they do not internalize the costs they impose on unrelated

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[6] This argument draws on the work of Brito, Sheshinski, and Intriligator (1991), which analyzes the welfare consequences of compulsory vaccinations.

parties via their own disease transmission, the incentives facing firms from which they purchase goods and services will not support efficient outcomes, leaving scope for efficiency-enhancing taxes or regulations. In principle, these taxes and regulations could be tailored to reflect the risks of different activities.

III. EMPLOYER TAXES

The externality identified in Section II arises because individuals choose labor supply without regard to their own effects on the welfares of others. The analysis takes as fixed any efforts on the part of employers to control contagion in their workplaces. However, the government can influence these employer control efforts, perhaps only very imperfectly, with either taxes or regulations. This section considers the design of efficient firm incentives and how they interact with other policies that might accompany them. A technical elaboration of the model, and derivation of results, is available in Appendix A.

Consider an economy with competitive firms. Each has a decreasing-returns production function $q(L, K)$, in which L is the firm's labor input and K its capital input. Economic profits, π, are given by

(5) $\pi = (1-\tau)\{q(L,K) - [w + (1-\alpha)x]L\} - \rho K - \alpha xL,$

in which τ is the profit tax rate and ρ the (nondeductible) opportunity cost of capital invested.[7] The firm spends x per worker to limit the spread of disease in the workplace, the benefit of which (to the firm) is that its employees are willing to work for a lower wage in a safer workplace. A fraction α of expenditures on x is nondeductible, being in the nature of capital expenditures on new equipment and reconfiguring buildings; the remaining fraction $(1 - \alpha)$ constitutes business expenses that can be immediately deducted from taxable income.

Workers care about their total payoffs per hour worked, $w + f(x)$, with $f'(x) > 0$ reflecting that workers value both their monetary wages and firms' mitigation efforts (x). The labor market affords a firm the opportunity to hire as many workers as it needs, providing that total worker payoff per hour equals or exceeds a fixed outside option, w_0. Assuming that the marginal benefit to expenditure on mitigation is positive but diminishing, there is a unique privately optimal level of mitigation by each firm, x^*, and a corresponding wage demanded by workers, $w = w_0 - f(x^*)$. In addition, there is a negative health externality due to community disease transmission. The magnitude of this aggregate health externality, $h(L, x)$, increases with employment, L, and declines with firm per-worker mitigation efforts, x.

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[7] This specification of the tax treatment of capital expenditures ignores the availability of depreciation allowances. This is for simplicity; inclusion of depreciation allowances does not change the implications of the model.

The sole purpose of the profit tax in this example is to correct for the health external-ity from SARS-CoV-2.[8] The optimal level of the tax is given by

$$(6) \quad \frac{\tau}{1-\tau} = \frac{\dfrac{\partial h(L,x)}{\partial L} \varepsilon_L L + \dfrac{\partial h(L,x)}{\partial x} \varepsilon_x x}{\rho \varepsilon_K K + \alpha \varepsilon_{xL} xL},$$

in which $\varepsilon_L \equiv \dfrac{dL}{d(1-\tau)} \dfrac{(1-\tau)}{L}$ is the firm's elasticity of demand for labor with respect to

the after-tax rate; ε_K and ε_x are analogous elasticities of demand for capital expenditures and per-worker mitigation efforts, respectively; and ε_{xL} is the elasticity of total mitiga-tion spending, xL, with respect to the after-tax rate.

Profit taxation (or subsidization) can help correct for the negative externality from employment and the positive externality from mitigation. Whether profits are optimally taxed or subsidized depends on how labor supply and mitigation respond. Higher tax rates may exacerbate the externality by reducing per-worker spending on mitigation ($\varepsilon_x > 0$). Thus, a profit subsidy is warranted if labor demand does not respond ($\varepsilon_L = 0$). But higher taxes presumably reduce total employment, since the reduced scale of firm operations is likely to depress labor demand more than labor-capital substitution increases it. If this labor demand response is large enough to outweigh the distortion of spending on mitigation, Equation (6) suggests that a profit tax is optimal.

The need for profit taxation is reduced to the extent that employment is directly taxed or firm mitigation efforts directly subsidized. For example, consider an extreme case in which (1) an employment tax is set optimally to internalize the health externality from labor supply and (2) firm mitigation efforts are optimally subsidized (or enforced via regulation). In this case, there is no net wedge between the marginal benefits and costs of labor supply and disease mitigation by firms. No profit tax is then warranted for the purpose of externality correction. Corrective policy such as that described by Equation (6) is beneficial only to the extent that other, more direct, methods of externality control are unavailable or too costly to use.

In practice, firms are also encouraged to take steps to mitigate the spread of the disease by the threat that they will be penalized if their workers contract it. This has motivated proposals for a liability shield for businesses (Cowen and Mitchell, 2020). While a liability shield would be counterproductive from the point of view of external-ity correction, these proposals do highlight an important point: the threat of penalties causes even the most responsible business owners to be fearful of reopening. For this reason, measures such as profit or wage subsidization could be warranted to encourage employment and economic activity.

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[8] If there are other motives for profit taxation, this externality correction should be weighed together with these other concerns, just as was the case for the labor tax discussed above.

IV. NOW AND THEN

The financial costs of the Covid-19 pandemic are immense, affecting all parts of the economy, including the government. The economic contraction associated with the pandemic significantly reduces tax revenues while greatly increasing desired government spending (Congressional Budget Office, 2020). The resulting government budget imbalance raises the question of the extent to which governments should borrow to finance rising spending. The analysis above suggests that certain taxes help correct for health externalities during the pandemic and, therefore, should be set higher than otherwise. While these higher taxes would also help balance the government budget, actually closing the budget shortfalls would require much more aggressive action if the economy and potential tax revenue remain depressed due to the actual and feared effects of the virus.

Large government deficits have the effect of reallocating consumption from the future to the present, whereas deficit closure does the opposite.[9] The benefit of transferring consumption from the future to the present depends on how the pandemic affects the relative values of consumption, and therefore income, at different times. Expressing aggregate welfare as $\bar{u}(c, L, \Delta)$, and taking individuals to be at interior solutions with respect to consumption, the value of an additional dollar of aggregate income is $\frac{1}{\hat{p}} \frac{\partial \bar{u}(c,L,\Delta)}{\partial c}$, in which $\hat{p}$ is the aggregate consumer price index and marginal consumption is divided equally among all s individuals in society:

$$(7) \quad \frac{\partial \bar{u}(c,L,\Delta)}{\partial c} = \frac{1}{s} \sum_{i=1}^{s} \frac{\partial u_i(c_i, L_i, \Delta_i)}{\partial c_i}.$$

Importantly, the optimal timing of aggregate consumption is distinct from the desirability of redistribution, which can be achieved by cross-sectional redistribution of resources. It is clear that segments of society that are hardest hit by the health and economic fallout from the pandemic require significant financial support in the form of various types of transfers. From the standpoint of government finance, however, the key question is how the value of marginal consumption has changed for those higher-income taxpayers who would effectively pay any tax increases used to reduce deficits.

An important feature of a pandemic environment is that the availability of some consumption goods becomes severely limited. For example, high-risk activities, such as exercising in gyms and travel for leisure, are greatly restricted or banned altogether. Similarly, many stores stock out of goods, such as freezers and luxury food items, and still other goods remain available but at much higher than usual cost. Moreover, the net benefit of partaking in a wide variety of activities involving other people is reduced due to health risks that cannot be eliminated.

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[9] This presumes the absence of complete Ricardian equivalence of the form described by Barro (1974).

Disease-induced disruption of this kind reduces the marginal value of consumption. The reason is simple and robust: the potential benefits of spending increase with the available options, so restricting these options reduces the per-dollar value of expenditures. This feature is an implication of basic consumer theory, but it is nonetheless useful to see it in an example.[10] Suppose that aggregate utility is additively separable in consumption and other components and is given by

$$(8) \quad \bar{u}(c,L,\Delta) = \left(\sum_{j=1}^{N} q_j^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} + \bar{u}^*(L,\Delta),$$

in which q_j is aggregate consumption of commodity j and $\sigma > 1$ is a parameter of the utility function that reflects consumer love of variety. Consumers choose among N different commodities, the units of which are normalized so that the price of each one is p.

The marginal benefit of a dollar of income in this example is $\dfrac{1}{p} \dfrac{\partial \bar{u}(c,L,\Delta)}{\partial c}$, with

$$(9) \quad \frac{\partial \bar{u}(c,L,\Delta)}{\partial c} = N^{\frac{1}{\sigma-1}}.$$

Since $\sigma > 1$, the right side of Equation (9) is increasing in N, which implies that the utility produced by an extra dollar of consumption uniformly increases as more goods become available. Furthermore, the marginal utility of income decreases as goods become more expensive. The effect of N on the marginal utility of consumption reflects that individuals have the option of maintaining the same basket of consumption goods as more become available, but they prefer instead to consume some of any newly available good, which in turn raises the value of each dollar of spending. The opposite is true when goods cease to be available.

This logic suggests one reason why it may be beneficial for governments to limit their budget deficits during pandemics: among upper-income taxpayers, restrictions on consumption reduce the welfare costs of meeting heavier tax obligations. This, of course, should be weighed jointly with many other concerns, such as the need for greater health expenditures and income support programs for those at greatest economic risk. Furthermore, the timing of government taxation and expenditure may play an important role in macroeconomic stabilization. These considerations are important but so too is the benefit of raising tax revenue in the least costly way, given that governments must pay their bills eventually.

V. TAXES TO THE RESCUE

The U.S. tax system creates strong behavioral incentives. This was true prior to the advent of Covid-19 and remains so during the course of widespread transmission of the disease. As it happens, many of the incentives created by the U.S. tax system discourage activities that are responsible for disease transmission. Most obviously, an income

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[10] This example, and the associated "love of variety" result, derives from Dixit and Stiglitz (1977). See Appendix B for technical details.

tax discourages the production of income, and since income is commonly produced in settings that facilitate disease transmission, the tax system in this way rather coincidentally reduces the potential for the spread of disease. Similarly, consumption taxes discourage consumption activities, which may also contribute to disease transmission. These situational benefits reduce the net social cost of taxation and suggest that higher taxes — presumably adopted on a temporary basis with expiring provisions — might be warranted simply on the basis of externality control.

Table 1 identifies several of the U.S. federal tax provisions that most significantly affect disease transmission. The top left column lists provisions that affect labor supply, starting with the individual income tax and federal social insurance taxes. These measures

Table 1

Federal Tax Measures and Their Behavioral Incentives

Labor Supply Incentives	Density Incentives
Personal income tax	Absence of income tax cost of living adjustment for urban areas
Social insurance taxes	Opportunity Zones
Social Security retirement incentives	Cap on state/local tax deductions
Unemployment insurance	College tuition credits and 529 plans
Mandatory taxable pension distributions	Exclusion of employer-paid transportation fringe benefits
Earned Income Tax Credit	Exclusion of employer-provided onsite gym benefits
Fringe benefit exclusions	Favorable treatment of owner-occupied housing
Excise taxes	Home office deduction
Labor Demand Incentives	**Health Incentives**
Corporate income tax	Medical expense deduction
Taxation of pass-through business income	Exclusion of employer-provided medical insurance
Expensing and accelerated depreciation of equipment expenditures	Credit for providing paid family and medical leave
Work Opportunity Tax Credit	Exclusion of military health benefits
	ACA premium subsidies
	Health savings accounts

Note: The table identifies existing U.S. federal tax provisions that create incentives for behavior that affects disease transmission and treatment.

reduce marginal returns to working, thereby reducing labor supply notwithstanding their partially offsetting income effects. Federal excise taxes have similar effects on labor supply, albeit of smaller magnitude, by reducing the purchasing power of labor earnings. The retirement incentives created by Old Age, Survivors, and Disability Insurance have the effect of reducing labor supply by a portion of the population that is particularly vulnerable to disease transmission. Unemployment insurance taxes and benefits likewise discourage labor supply, as do mandatory 401(k), 403(b), and IRA distributions that push elderly recipients into higher marginal income tax rate brackets. The Earned Income Tax Credit increases labor force participation, but it has an ambiguous effect on total hours of labor supply, increasing labor supply by recipients with lower taxable incomes and reducing labor supply by recipients with higher incomes. And there are federal tax provisions, such as the exclusion from taxable income of certain employer-provided fringe benefits, including health insurance, pension contributions, and on-site and miscellaneous fringe benefits, which effectively reduce the taxation of marginal income and thereby stimulate greater labor supply.

The federal tax provisions noted in the lower left panel of Table 1 have the effect of generally reducing labor demand on the part of firms. The corporate income tax and the pass-through taxation of the incomes of partnerships, LLCs, subchapter S corporations, proprietorships, and other business forms discourage business investment and growth, and thereby reduce their demand for labor. Table 1 identifies partially offsetting federal tax provisions, including the rapid depreciation (and in some cases immediate expensing) of equipment expenditures and the Work Opportunity Tax Credit, that encourage equipment investment and the hiring of certain categories of workers. But the net effect of federal tax provisions on labor demand, as on labor supply, is to discourage employment. This aspect of federal taxation, long thought to be an inefficient distortion, may have an externality-correcting function in the presence of disease transmission.

The top right panel of Table 1 lists federal tax measures that affect population density and thereby influence the spread of disease. The first is the absence of cost of living adjustments in the income tax, which effectively discourages location and employment in high-cost, high-wage dense urban areas by pushing residents into higher marginal income tax rate brackets. While the absence of cost of living adjustment in the federal income tax is not explicitly location based, the benefits of federal opportunity zones are, though the net effect on density is a function of the extent to which states designate urban and rural areas as being eligible for opportunity zone benefits. The cap on the availability of state and local tax deductions discourages location (and labor supply) in high-tax states and cities, which tend to be more densely populated than other parts of the country. Favorable tax treatment of college expenses through tuition tax credits and 529 plans encourages college attendance, with all of its accompanying student density. The exclusion under the federal income tax of the benefits of employer-provided van pools and public transportation fringe benefits encourages commuting methods that may contribute to the spread of disease, but the exclusion of employer-provided parking for individual cars has the opposite effect. Similarly, the effect of the exclusion from taxable income of the benefits of employer-provided onsite gyms may depend on what the alternative is to an employer gym.

Federal excise taxes influence not only labor supply but also other aspects of behavior that affect the rate of disease transmission. For example, the federal gasoline tax discourages commuting by automobile, thereby encouraging the use of public transportation (though given its very low rate compared to other countries, the U.S. gas tax is notable mostly by its absence). And to the extent that alcohol is an important component of social gatherings at bars, events, and private parties, alcohol taxes discourage these opportunities for disease transmission.

Certain federal tax provisions famously encourage owner-occupied housing, including the availability of home mortgage interest deductions and the exclusion of most capital gains on sales of primary residences. While these provisions apply to condominiums as well as stand-alone housing, they generally have the effect of encouraging low-density living arrangements. Similarly, the (limited) availability of home-office deductions not only encourages private home ownership but also discourages workplace attendance, and the associated proximity to others.

The bottom right panel of Table 1 lists federal tax provisions that facilitate access to health care that may limit the spread and severity of disease. The first is the tax deduction for medical expenses exceeding an adjusted gross income threshold, and the second is the federal tax exclusion of the benefits of employer-provided medical insurance. Together these provisions encourage employers to offer medical insurance as a fringe benefit of employment and make it feasible for patients to afford medical treatments. The federal government also offers employers tax credits for providing paid family and medical leave, which encourages the provision of such leave and thereby reduces the likelihood of disease transmission by employees who feel unwell but who might otherwise face strong financial pressures to continue to go to work. Active duty and retired military personnel receive medical benefits that are excluded from taxable income, and lower-income taxpayers are eligible for tax credits equal to portions of their premiums for medical insurance purchased through the health insurance marketplace created by the Affordable Care Act (ACA). These provisions encourage greater availability and take-up of medical treatment by portions of the population that might not otherwise have these options. And the availability of health savings accounts reduces the after-tax cost of providing a form of self-insurance for future medical spending needs.

The picture that emerges from this thumbnail survey of federal tax provisions is one of a system that prods the economy generally in the direction of efficient resource allocation in the presence of communicable disease. To be sure, the incentives created by federal taxes are not finely tuned to the problem at hand, nor do they point uniformly in the direction of discouraging workplace and other population density that is most associated with disease transmission. But it is noteworthy that a tax system designed largely without regard to the potential for viral infection nonetheless has the effect of modifying the behavior of individuals and businesses in ways that generally work against the spread of disease. This consideration argues in favor of temporary tax increases while the danger of community infection remains, and it highlights the idea that any tax reductions adopted on other grounds are apt to encourage risky behavior. While this survey focuses on federal taxes, state and local taxes create similar incentives and might be more finely honed to local

disease conditions. Indeed, the case for higher taxes is perhaps even stronger for state and local governments, which face enormous budgetary pressures from spending demands and revenue declines and are less capable of borrowing than is the federal government.

Many of the economic measures introduced by governments at the beginning of the pandemic helped further limit labor supply and consumption in large groups. Supplementary unemployment insurance made it unnecessary for many to work during that time, especially those with lower incomes. Lump sum payments to households likely also reduced labor supply. Bans on specific activities reduced contagion in crowded environments. Business loan schemes and wage supports, conditional on job guarantees, allowed individuals and businesses to temporarily halt operations with reduced fear that doing so would negatively impact their future economic prospects. However, many of these policies are designed to be short lived. Some propose that at their expiration they be replaced with measures designed to stimulate hiring and economic activity, such as payroll subsidies. The logic of this paper suggests that some caution is warranted until the pandemic subsides, since such changes would push in the wrong direction from the point of view of limiting spread of the disease.

VI. CONCLUSION

The emergence of a deadly and previously unknown communicable disease demands swift administrative action on the part of governments. Once the immediate crisis passes, it is prudent to consider the most cost-effective means of addressing the lingering problems created by a pandemic. Tax policies can be used to create flexible incentives for individuals and businesses and, for that reason, are routinely deployed to control environmental and other externalities. They can be similarly used to control the spread of disease. Furthermore, taxes raise revenue that governments need to finance health expenditures and transfers to those hardest hit by the economic fallout of a pandemic. U.S. tax policy already takes steps in this direction, but with purposeful design, it could do much more to address some of the challenges created by widespread transmission of the SARS-CoV-2 virus. It is undoubtedly difficult to forge political compromises over new tax policies during the outbreak of a major disease, but the alternatives to thoughtful tax policy are typically much less efficient and less likely to address the nation's problems in a comprehensive and sustainable way.

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DISCLOSURE

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APPENDIX A: EMPLOYER TAXES—TECHNICAL DETAILS

The economic profits of a representative firm are given by

(A1) $\pi = (1-\tau)\{q(L,K)-[w+(1-\alpha)x]L\}-\rho K-\alpha xL.$

With a utilitarian social welfare function, total social welfare in this model (W) is simply the sum of firm profits, the externality, and tax revenue:

(A2) $W = \pi + h(L,x) + \dfrac{\tau}{1-\tau}(\pi+\rho K+\alpha xL).$

An increase in the after-tax rate has the following effect on this objective:

(A3) $\dfrac{dW}{d(1-\tau)} = \dfrac{\partial h(L,x)}{\partial L}\dfrac{dL}{d(1-\tau)}+\dfrac{\partial h(L,x)}{\partial x}\dfrac{dx}{d(1-\tau)}+\tau\dfrac{\partial Q}{\partial K}\dfrac{dK}{d(1-\tau)}$

$\qquad +\tau\left[\dfrac{\partial Q}{\partial L}-(w+(1-\alpha)x)\right]\dfrac{dL}{d(1-\tau)}+\tau[f'(x)-(1-\alpha)]\dfrac{dx}{d(1-\tau)}L.$

Next, the firm's first-order conditions for capital, labor, and disease mitigation are

(A4) $\dfrac{\partial Q}{\partial L} = w+(1-\alpha)x+\dfrac{\alpha}{(1-\tau)}x$

(A5) $\dfrac{\partial Q}{\partial K} = \dfrac{\rho}{(1-\tau)}$

(A6) $f'(x) = 1-\alpha+\dfrac{\alpha}{(1-\tau)}.$

Finally, if the tax is set optimally, there can be no effect on welfare when it is changed slightly. The equation for the optimal tax, therefore, is obtained by setting $\dfrac{dW}{d(1-\tau)}=0$ and then substituting in the three firm first-order conditions. Doing so yields

(A7) $\dfrac{\partial h(L,x)}{\partial L}\dfrac{dL}{d(1-\tau)}+\dfrac{\partial h(L,x)}{\partial x}\dfrac{dx}{d(1-\tau)}+\tau\left[\dfrac{\rho}{(1-\tau)}\dfrac{dK}{d(1-\tau)}+\dfrac{\alpha}{(1-\tau)}\dfrac{d(xL)}{d(1-\tau)}\right]=0 \,.$

Rearranging this condition produces the optimal tax formula presented in Equation (6).

APPENDIX B: NOW AND THEN—TECHNICAL DETAILS

Suppose the economy is comprised of individuals with utility functions of the following form:

(B1) $u(c_i,L_i,\Delta_i) = \left(\displaystyle\sum_{j=1}^{N} q_j^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}+u^*(L_i,\Delta_i)\,.$

For any given level of income, Y, the consumer chooses a consumption bundle by solving the following problem:

(B2) $\max \left(\displaystyle\sum_{j=1}^{N} q_j^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} , s.t. \displaystyle\sum_{j=1}^{N} pq_j \leq Y$.

This yields the following demand function for each good:

(B3) $q_j^{\frac{-1}{\sigma}} \left(\displaystyle\sum_{j=1}^{N} q_j^{\frac{\sigma-1}{\sigma}} \right)^{\frac{-1}{\sigma-1}} = \lambda p$,

where λ is the multiplier on the individual's budget constraint.

Since all prices are identical, individuals consume the same amount of each good and their indirect consumption subutility function is

(B4) $v(Y,p,N) = N^{\frac{1}{\sigma-1}} \left(\dfrac{Y}{p} \right)$.

Differentiating the right side of Equation (B4) with respect to Y yields the individual's marginal utility of income. Since this is identical across individuals, aggregation produces Equation (9).