THE COUNTERCYCLICAL BENEFITS OF REGULATORY COSTS

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Abstract

Legal academics, journalists, and senior executive branch officials alike have assumed that the economic costs of regulatory requirements go up in severe recessions that drive interest rates to zero. But this is not correct; the aggregate costs of regulatory requirements decrease, not increase, during severe economic contractions that push interest rates to the zero lower bound (i.e., a liquidity trap). While this prediction arises in conventional macroeconomic models and is empirically supported in the econometrics literature, surprisingly no scholarship has noted this fact. This paper remedies this oversight by analyzing the effect of regulations in the now-standard New Keynesian model of the business cycle. But it also argues that scholars and policymakers have likely missed the countercyclical benefits of regulatory costs because of informal, *ad hoc* macroeconomic assumptions embedded in regulatory analysis. Accordingly, formally integrating business-cycle macroeconomic dynamics into benefit-cost analyses would lead to better regulatory analysis and decisionmaking.

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We thank Yair Listokin, Michael Love, Christina Romer, David Romer, and participants at the 5th Conference on Law & Macroeconomics for helpful comments and suggestions.

1. Introduction

In September of 2011, the Obama administration reversed course and rejected one of its most anticipated regulations: tightening atmospheric ozone standards for the first time since 1997 (Sunstein 2011).[1] While the Environmental Protection Agency had calculated that this regulation would save thousands of lives and generate over a billion dollars in net benefits each year,[2] imposing higher regulatory costs on firms during the worst economic downturn since the Great Depression made policymakers nervous. The letter formalizing the decision explicitly stated a need to "minimize regulatory costs and burdens, particularly in this economically challenging time," (Sunstein 2011) and President Obama's statement on the matter claimed that his decision aimed at "reducing regulatory burdens and regulatory uncertainty, particularly as our economy continues to recover" from recession (Obama 2011).

This claim, that the sluggish economic recovery following the 2008 financial crisis was particularly costly time to implement additional regulations, was treated as obviously true by both the academic and popular press. *The Economist* went furthest, arguing that "cost-benefit analysis" should formally consider "the stage of the business cycle" in future regulatory reviews (The Economist 2011). Scholarship such as Masur and Posner (2017) argued that since a regulation is a "kind of tax," regulations should ideally be weakened in recessions and strengthened in recoveries like ordinary forms of fiscal and monetary policy.

[1] A similar update to ozone standards would eventually be proposed and finalized four years later (Environmental Protection Agency 2015).

[2] Specifically, the regulation was predicted to prevent 1,500-4,300 deaths, 6,600 hospital and emergency room visits, 170,000 lost days of work and 600,000 lost days of school due to illness annually; these were only partial estimates, likely undercounting the benefits. Monetizing these benefits, and subtracting the estimated costs of the regulation, produced a median estimate of $1.4 billion (in 2006 dollars) in annual net benefits, when discounting at the 7% rate (net benefits were even higher when discounting at a 3% rate) (Environmental Protection Agency 2011).

This paper aims to correct a critical blind spot of these arguments: the aggregate costs of regulation are lower, not higher, in a recession that pushes interest rates to the zero lower bound (i.e., a liquidity trap), as occurred in the long recovery following the 2008 financial crisis. In fact, under certain conditions, additional regulatory costs may even hasten an economic recovery and reduce the pain—as well as the long-term economic scars[3]—of deep recessions. Thus, given that the benefits of most regulations (e.g., those stemming from less ozone) do not vary much over the business cycle, the fact that the costs decline during such recessions implies that there is *more* reason, not *less* reason, to impose stringent regulations in a liquidity trap.

All of this is the straightforward result of analysis using conventional, textbook macroeconomic models, old and new, that incorporate liquidity traps in the form of a zero lower bound on nominal interest rates. We show that the aggregate costs of regulation are smaller at the zero lower bound both in traditional "Old Keynesian" models of aggregate demand and in the so-called "New Keynesian" dynamic stochastic general equilibrium (DSGE) models now widely used by central banks. Key to this result is not that contractionary supply shocks (like those caused by regulations) are necessarily expansionary, but rather that regulations—by raising prices and hence expected inflation—help relax the zero lower bound constraint on nominal interest rates that keeps real interest rates inefficiently high. This benefit of regulation is absent away from the zero lower bound, which informs this paper's claim that regulation is less costly in such recessions specifically.

If macroeconomics is to productively inform regulatory decisionmaking—and it should—formal, mainstream macroeconomic models must replace the informal macroeconomics

[3] The long-term negative effects of recessions are referred to as "hysteresis" effects in the macroeconomic literature. For more detail, see Yagan (2019); Blanchard (2018); Ball (2014); Delong and Summers (2012); Ball (2009). Regarding hysteresis following pandemics specifically, see Jordà, Singh and Taylor (2022).

embodied in the Obama administration's statements and previous scholarship. Indeed, when macroeconomic forces and a focus on recovery from recessions were last at the center of regulatory decisionmaking—in the depths of the Great Depression and the early New Deal—efforts to increase prices through the National Industrial Recovery Act formed a core part of the Roosevelt administration's successful effort to stimulate the economy.[4] Though such efforts were derided by some economists for decades, recent work has revealed how such measures, by breaking the connection between insufficient aggregate demand and future disinflation, likely contributed to stimulating a deeply depressed economy (Eggertsson 2012).

Certainly, the zero lower bound often does not bind. However, the Great Depression, Great Recession, and the early phase of the COVID-19 recession of 2020 all pushed nominal interest rates to the zero lower bound.[5] And given indications of persistently low real interest rates (i.e., "secular stagnation"), there is reason to believe that understanding the relationship between regulatory costs and an economy in a liquidity trap is growing more relevant by the year; shortfalls in aggregate demand will put advanced economies at elevated risk of liquidity traps for the foreseeable future, due to the reduced power of monetary policy (Eggertsson, Mehrotra and Robbins 2019; Rachel and Summers 2019; Andrade et al. 2019). On the other hand, in 2022, the Russian invasion of Ukraine spiked oil prices after the United States had escaped the liquidity trap.[6] This paper confirms that in such a scenario (a negative shock to aggregate supply in ordinary times) regulatory requirements do not exhibit declining economic costs. Yet as the U.S. economy becomes less dependent on fossil fuels, their importance as a

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[4] See the National Industrial Recovery Act of 1933 (NIRA); before NIRA could expire in June of 1935, the Supreme Court struck down Title I of the Act in Schechter Poultry Corp. v. United States.

[5] For the Great Depression and Great Recession, see Eggertsson and Egiev (2019); for the Covid recession, see Guerrieri et al. (2022).

[6] Oil prices rose more than 60% from the beginning of January 2022 through June 2022 (FRED 2022). Well before the vast majority of this increase, or certainty about the coming Russian invasion of Ukraine (or its effect on commodity prices), the Federal Reserve had announced plans to begin rate hikes (Schneider and Saphir 2022).

potential source of negative aggregate supply shocks continues to decline (Blanchard and Riggi 2013).

Narrowly, this paper establishes that regulatory costs decline at the zero lower bound. The most closely related literature studies the general-equilibrium impacts of environmental regulation, specifically using a DSGE framework which rarely considers nominal rigidities, unlike this paper, which develops a model based upon Eggertsson (2011); see Annicchiarico and Di Dio (2015) for an exception and discussion. Relative to those authors, we abstract from regulatory benefits and focus on the costs of regulations as a kind of tax following Masur and Posner (2017), highlighting how these costs decline at the zero lower bound. Like Masur and Posner (2017) and Dominioni and Faure (2022), we consider the ways in which imposing regulatory costs on firms interacts with the business cycle, but unlike those authors, we use formal models that imply that regulatory costs decline at the zero lower bound. More broadly, this paper points towards the need for the still-nascent law and macroeconomics literature (Listokin 2012; Liscow 2016; Listokin 2017; Hayashi and Murphy 2017; Listokin 2019) to move away from informal analysis and toward use of formal models and engagement with empirics at the center of recent advances in the field of macroeconomics.[7]

The remainder of this paper consists of four additional sections. Section 2 lays out the traditional, simple Keynesian model of aggregate supply and aggregate demand; summarizes the intuitive argument that regulatory requirements do additional harm during a recession; and, in light of the simple Keynesian model, explains why the intuitive argument is wrong specifically in a liquidity trap. It does all of this using simple figures intended for a less-technical legal audience. Section 3, of potentially greater interest for those with a more technical background in

[7] An exception to the usual lack of formality in law and macroeconomic analysis can be found in Listokin (2019).

macroeconomics, develops this paper's analysis of regulatory costs in liquidity traps, demonstrating that in the benchmark, micro-founded New Keynesian DSGE model the costs of regulatory requirements still decline (and can even, in some circumstances, become beneficial) in a liquidity trap. Section 4 checks that the empirics match this model's predictions, showing that evidence from the recent Great Recession, as well as the Great Depression, is consistent with there being a countercyclical decrease in the aggregate economic costs of imposing stricter regulatory requirements in a liquidity trap. It also supports the theoretical prediction that the same relationship does not obtain when the economy is not in a liquidity trap. Section 5 concludes by noting the difficulties of accounting for the business-cycle dynamics of regulations within traditional benefit-cost analyses, and the importance of doing so.

2. The Intuitive Argument, and What it Gets Wrong

2.1 Aggregate Supply and Aggregate Demand: the Basics of Business-cycle Macroeconomics

Before developing a more complicated, micro-founded New Keynesian model in Section 3, this Section reviews a simple textbook model of the macroeconomy, the Keynesian AD-AS (aggregate demand—aggregate supply) model.[8] The AD-AS model's name reflects two key relationships between inflation (π) and output (Y). Consider a simple closed economy with no government spending where output is composed of consumption and investment. Consumption increases as a function of output: people consume more when they earn more income, and output is equal to aggregate income. Investment decreases as a function of real interest rates (r): firms

[8] A similar exposition can be found in Mishkin (2017).

invest less when financing investments is more costly. Accordingly, we can use Figure 1 to trace out an investment-savings relationship for output as real interest rates vary:

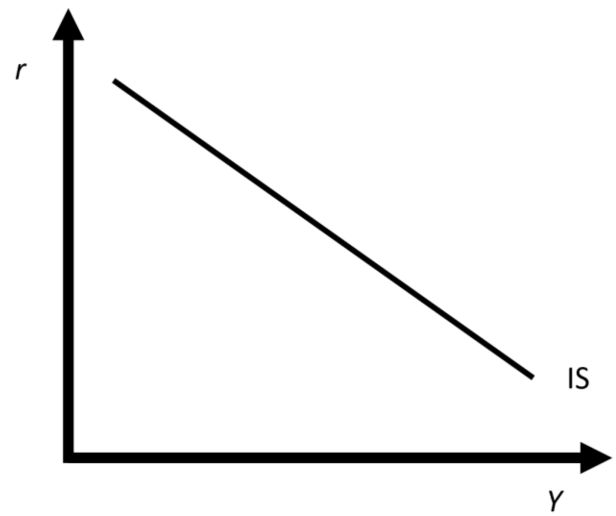

Figure 1

This is the traditional "Investment-Savings" (IS) diagram developed by Hicks (1937).

To derive the rest of the AD curve requires relating the real interest rate to inflation. First note that the real interest rate is defined as the nominal interest rate less *expected* inflation, π^e:

$$r = i - \pi^e$$

Thus, to determine how the real interest rate responds to inflation requires determining how both the nominal interest rate and expected inflation respond to inflation. A common simplifying assumption is that expected inflation is "adaptive," so that expected inflation equals current inflation ($\pi^e = \pi$).[9]

For nominal interest rates *i*, note that the central bank (which controls *i*) always moves interest rates to ensure that real interest rates fall whenever inflation falls and vice versa (to avoid

[9] This is not an unreasonable assumption; historically, current and expected inflation move together (Hazell et al. 2022).

inflationary or deflationary spirals). Thus, lower inflation ordinarily leads to lower real interest rates (and vice versa). But at the zero lower bound (ZLB), i.e., when some shock is large enough to push the economy to $i = 0$, the relationship between inflation and real interest rates reverses. The nominal interest rate is now stuck at zero, so further deflation—which reduces π^e—now *raises* the real interest rate. While the central bank would like to further reduce the nominal interest rate, it cannot at the ZLB. That is why an economy at the ZLB is referred to as being in a "liquidity trap": the central bank cannot escape the ZLB by increasing the money supply (liquidity)—it is trapped. This implies the following relationship for *r* and π plotted in Figure 2:

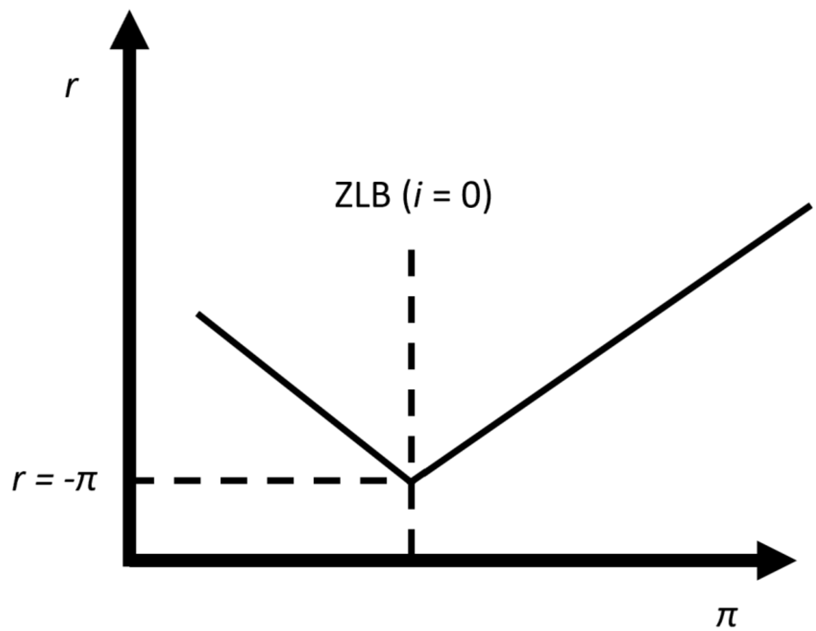

Figure 2

Decreased inflation implies decreased real interest rates and increased output—up until the point the economy hits the ZLB, when nominal interest rates are at zero. Then, further deflation implies *higher* real interest rates, and lower output. Thus, the AD curve has a kink in it because of the ZLB, as seen in Figure 3:

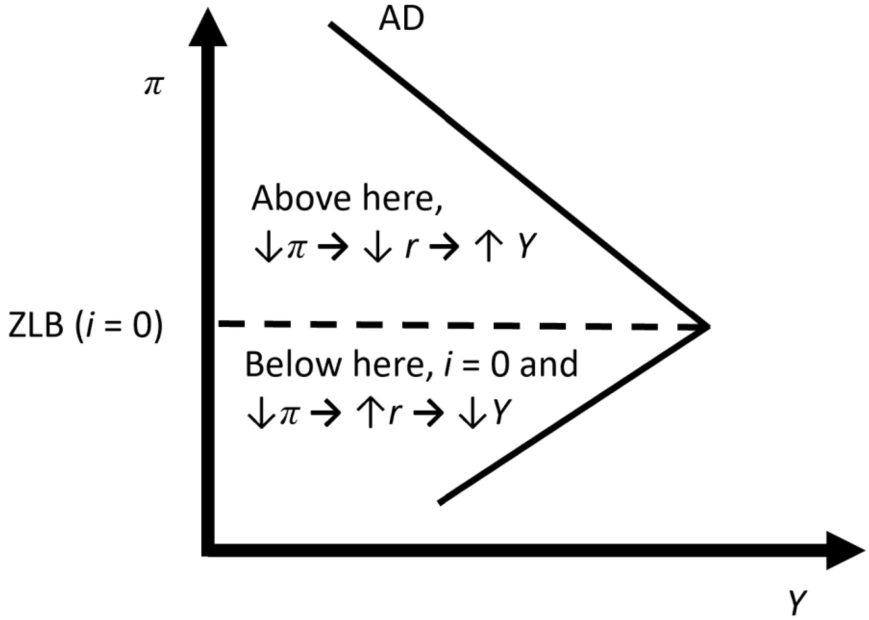

Figure 3

This change in the relationship between inflation and real interest rates at the ZLB is key—both in this model and the more sophisticated model presented in Section 3—in changing the relationship between inflationary shocks (such as changes in regulation) and output.

Now all that remains is to motivate the aggregate supply (AS) relationship between output and inflation. To begin analyzing the supply side of the economy, assume that nominal wages are somewhat "sticky" so that as inflation rises, real wages fall, causing firms to want to employ more labor and increase output. However, at some point, all workers are employed doing their highest-productivity work, and output cannot rise any more (the economy is supply-constrained). In normal times, AS intersects AD where the AD curve is downward sloping. But as seen in Figure 4, when a shock to aggregate demand pushes the economy into a liquidity trap, key dynamics change, with profound implications for the costs of regulatory requirements:

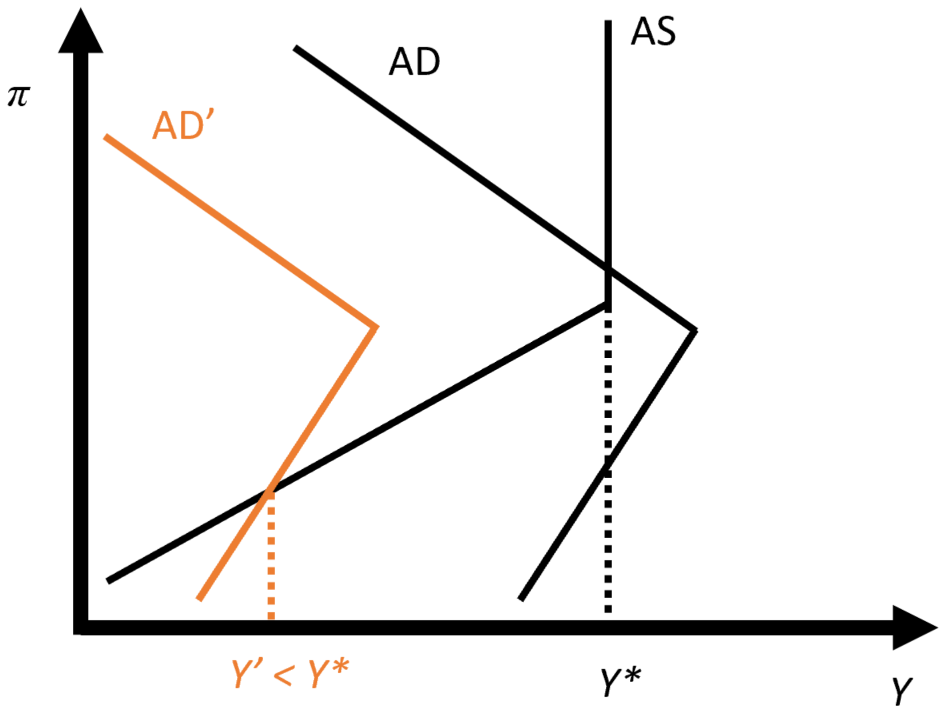

Figure 4

But before turning to a discussion of the counter-intuitive dynamics of this Keynesian model in Section 2.3, Section 2.2 first explores the intuitive argument for why imposing regulatory burdens would seem to be more costly during a recession.

2.2 The Intuitive Argument

Masur and Posner (2017) develop the intuitive argument that regulations are more costly when the economy is in a deeper recession, which others, such as Dominioni and Faure (2022), have followed. They start by reasoning that when the government “cuts taxes, it increases the take-home pay of workers, who (in theory) spend some of the additional money on goods and services.” In turn, “providers of those goods and services are then able to spend the additional money they have earned on other goods and services,” which creates a multiplier effect on economic output in excess of the quantity of taxes cut during. Empirically, they note that leading studies have indeed found large multipliers on tax cuts in some circumstances.

Masur and Posner reason that “[r]egulations are similar to taxes,” yet note that “[n]ot all taxes are equally useful for fiscal stimulus” when cut, and that “regulations similarly vary in ways that make some of them more appropriate for stimulus than others.” Primarily, Masur and Posner argue that regulations are specifically “like corporate taxes, and suspending regulations should stimulate economic activity just as would a cut in the corporate tax rate.” In their view, suspending a regulation saves a firm its variable costs associated with the regulation; however, Masur and Posner note that the stimulative effect of the cut depends on “how the firm uses the money that it saves.” If the savings are simply reinvested, “the regulatory cut will not serve as a stimulus”; if they are returned to shareholders, “the stimulus is likely to be limited or nil because shareholders are typically wealthy and unlikely to spend much of their savings.” However, they note, if “the firm buys inputs,” this will have a stimulative effect, although they state that “it may be doubtful that a firm will expand production in the middle of a recession.” Accordingly, Masur and Posner follow Yair Listokin in qualifying their claim by noting that regulations are more stimulative if they require firms to make capital expenditures, increasing aggregate demand.

2.3 What the Intuitive Argument Gets Wrong

To understand the role of regulations, it is helpful to analogize them to taxes, as Masur and Posner do. But Masur and Posner analogize regulations to a corporate tax, which is inapt. Corporate taxes are levied on the net profits of corporations; regulations ordinarily make certain types of capital or other variable inputs more expensive to use (in Masur and Posner’s example, requiring a factory to reduce more pollution by running a "scrubber" more often) or require more labor to be hired to produce the same amount of output (for example, in capping the number of hours truck drivers can be on the road each day or week). In this way, most regulations are better thought of as akin to taxes on specific kinds of labor or capital.[10] But this correction is only a minor point. More importantly, in a liquidity trap, cutting back regulations that function like a kind of tax on firms—whether on labor, capital, or corporate profits—has counterintuitive results.

As shown in Section 2.1, in a liquidity trap, monetary policy can stimulate aggregate demand (AD) no further, no matter how much the central bank increases the money supply. In that context, consider suspending a regulation that falls on capital, the primary case that Masur and Posner focus on. Cutting taxes on a kind of capital would show up in our AD-AS model as the AS curve shifting out (to the right). The shift in aggregate supply causes aggregate supply to intersect with aggregate demand at a lower level of inflation. Ordinarily, this would also mean a higher level of output, but when the economy falls into a liquidity trap (AS intersects AD below the kink in the AD curve) lower inflation raises the real interest rate, lowering output.[11] Thus, suspending regulations and thereby reducing the cost of capital in a liquidity trap lowers output and lowers incomes—all because aggregate supply increased. The reasoning is similar when considering the suspension of a regulation that increases the cost of labor for firms, which also shows up in this model as the AS curve shifting out (to the right), with the same result: inflation and output decline. In fact, if we consider a regulation that falls on firms in the same manner as

[10] Both Masur and Posner—as well as Listokin—correctly note that regulations requiring firms to buy goods or services that they would not otherwise purchase increase aggregate demand, and therefore increase output at the ZLB. Such regulations are often better modeled as imposing a fixed cost or lump-sum tax; others are best modeled as a hybrid of a fixed cost (or lump-sum tax) and variable costs (or tax on labor or capital inputs) and would therefore affect both aggregate demand and aggregate supply. Section 3 briefly discusses the case of regulations that impose such fixed costs.

[11] In the diagrams from Section 2.1, this is the part of the AD curve below the kink.

the corporate tax, as Masur and Posner claim, the same result appears.[12] Yet again, the AS curve shifts out, and output falls, as seen in Figure 5.

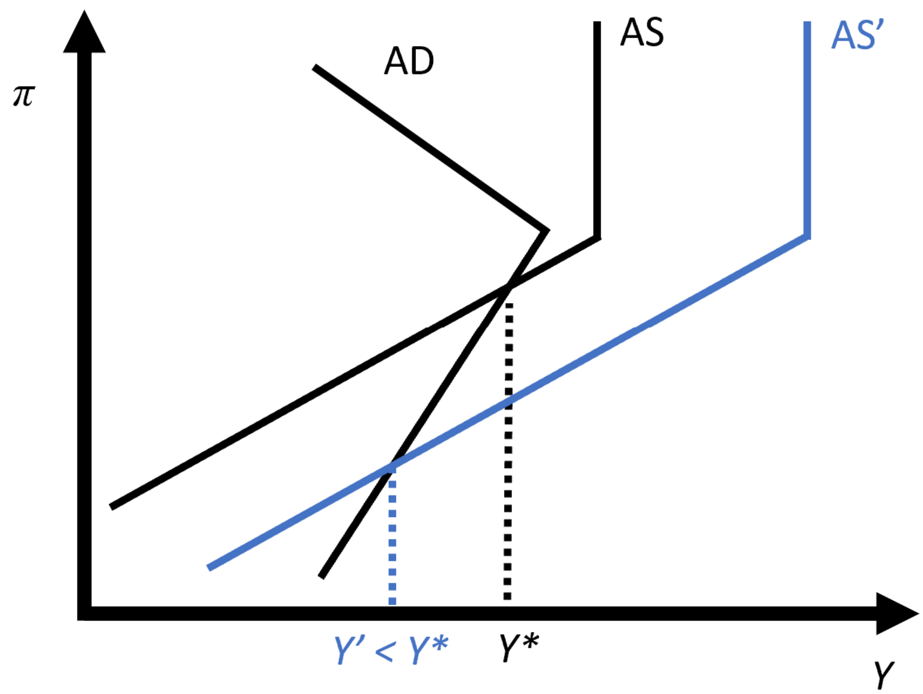

Figure 5

These results come out of a simple, traditional Keynesian AD-AS model. One might be suspicious that the results are the product of some flaw in the classic AD-AS model, or the simplifying assumption of "adaptive" inflation expectations. But the same result emerges, in richer form, from the benchmark, micro-founded New Keynesian model which does not assume adaptive inflation expectations.

3. A Model of the Countercyclical Benefits of Regulatory Costs

[12] For an explanation of this in a more formal model, see Section 3.

This Section develops a model based upon Eggertsson (2011), a nonlinear model environment, which augments the textbook three-equation New Keynesian DSGE model (Galí 2015; Woodford 2003) with two different kinds of government spending and three different taxes. We are most interested in the payroll tax, τ_t^w, which imposes a cost to the firm to hiring labor. This tax can equivalently be thought of as a regulatory requirement that increases labor costs for firms. Reducing the payroll tax, or relaxing such regulatory requirements, is analogous to lowering the price of variable inputs, which results in lower prices and ultimately lower inflation. As we will show, at the ZLB, this is contractionary; the social planner prefers a higher τ_t^w until the economy escapes the liquidity trap.

Households maximize a utility function given by

$$E_t \sum_{T=t}^{\infty} \beta^{T-t} \left[u(C_T) - \int_0^1 v\big(l_T(j)\big) dj \right]$$

where β is the discount factor, C_t aggregates consumption at time *t* over a continuum of differentiated goods using a Dixit-Stiglitz function, $l_t(j)$ is the quantity of type-*j* labor supplied at time *t*, u is a concave function of the utility of consumption, and v is an increasing convex function of the disutility of labor relative to leisure. The household budget constraint is given by

$$P_t C_t + B_t \leq (1 + i_{t-1}) B_{t-1} + (1 - \tau_t^P) \int_0^1 Z_t(i) di + (1 - \tau_t^w) \int_0^1 W_t(j) l_t(j) dj$$

where B_t are one-period riskless bonds (which we can assume are the only assets that are traded, for simplicity and without loss of generality), i_t is the nominal interest rate on bonds traded at time *t*, P_t is a price index at time *t* taking Dixit-Stiglitz functional form, $Z_t(i)$ is the profits of firm *i* at time *t* (which are distributed to households in a lump sum), $W_t(j)$ is the wage earned by type-*j* workers at time *t*. There are two types of taxes in this model: a payroll tax, τ_t^w, and a tax on firms' profits, τ_t^P. These taxes are equivalent to different types of regulatory requirements, and we will refer to them as such going forward. Note that the model assumes that these taxes (i.e., the cost of the regulatory requirements) decay over time.[13]

Households take prices and wages as fixed, and maximize utility subject to the following first-order conditions:

$$u_c(C_t) = (1 + i_t)\beta E_t u_c(C_{t+1}) \frac{P_t}{P_{t+1}}$$

$$(1 - \tau_t^w) \frac{W_t(j)}{P_t} = \frac{v_l\big(l_t(j)\big)}{u_c(C_t)}$$

$$\lim_{T\to\infty} E_t \frac{B_T}{P_T} u_c(C_t) = 0$$

where u_c is the marginal utility of consumption, and v_l is the marginal disutility of labor.

Each goods-producer produces a different good, *i*, and producers are monopolistically competitive. There are many goods in each of the infinite number of industries, *j*, and goods in each industry are produced with industry-specific labor. Firms all change their prices at the same time in each industry, with Calvo pricing; each industry has an equal probability, $0 < \alpha < 1$, of not updating its prices in each period. Any firm that updates its price at time *t* sets the same new optimal price, p_t^*. For simplicity, each good is produced with just one input, labor, with a common production function for each *i* producer

$$y_t(i) = l_t(i)$$

[13] This is a reasonable assumption in the context of regulatory requirements for at least five reasons. First, most regulations are structured to require up-front investments by firms that provide long-term benefits. Second, learning-by-doing tends to allow firms to find less costly ways to comply with regulatory requirements (Argote and Epple 1990). Third, learning-by-doing is enhanced by technological innovation that reduces the costs of most inputs over time. Fourth, and relatedly, technological obsolescence tends to reduce the relevance of regulatory requirements to productive processes over time (Frankel 1955). A regulation that increased costs on producing CD-ROMs likely has little relevance to Spotify's costs today. Fifth, firms will attach a reasonable probability to the prospect that regulations will be modified or rescinded by a future administration, or by a future statute, particularly if the political party in power flips in Washington.

where, as a reminder, $l_t(i)$ is industry-specific (*j*) labor hired by firm *i*. The demand for good *i* takes the form

$$y_t(i) = Y_t \left(\frac{p_t(i)}{P_t} \right)^{-\theta}$$

where Y_t, aggregate output, is defined by $Y_t \equiv C_t + G_t$, and θ is the elasticity of substitution between different *i*-goods. Profits for each firm *i* (which produces good *i*) in industry *j* is described by

$$Z_t(i) = p_t(i) Y_t \left(\frac{p_t(i)}{P_t} \right)^{-\theta} - W_t(j) Y_t \left(\frac{p_t(i)}{P_t} \right)^{-\theta}$$

Firms set prices by choosing p_t^* to maximize

$$\max_{p_t^*} E_t \left\{ \sum_{T=t}^{\infty} (\alpha\beta)^{T-t} \lambda_T (1 - \tau_T^P) \left[p_t^* Y_t \left(\frac{p_t^*}{P_t} \right)^{-\theta} - W_T(j) Y_T \left(\frac{p_t^*}{P_t} \right)^{-\theta} \right] \right\}$$

where λ_t is the marginal utility of nominal income for the household at time *t*.

This yields the following first-order condition:

$$E_t \left\{ \begin{array}{l} \displaystyle\sum_{T=t}^{\infty} (\alpha\beta)^{T-t} \frac{u_c(C_T)}{P_T} (1 - \tau_T^P) \left(\frac{p_t^*}{P_T} \right)^{-\theta-1} \times \\ \displaystyle Y_T \left[\frac{p_t^*}{P_T} - \frac{\theta}{\theta - 1} \frac{1}{(1 - \tau_T^W)} \frac{v_l \left(Y_T \left(\frac{p_t^*}{P_t} \right)^{-\theta} \right)}{u_c(C_T)} \right] \end{array} \right\} = 0$$

The price index is specified as

$$P_t = \left[(1 - \alpha)(p_t^*)^{1-\theta} + \alpha P_{t-1}^{1-\theta} \right]^{\frac{1}{(1-\theta)}}$$

Let y_t be the deviation of output from its long-run value at time *t*, so that positive values of y_t denote expansions or booms, and negative values denote recessions. Similarly, let π_t be the deviation of inflation from its long-run value (which, for simplicity and without loss of generality, we will assume to be zero[14]). Accordingly, equilibrium can be well-approximated in a two equation New Keynesian AD-AS model, with AD

$$y_t = -\sigma(i_t - \pi_{t+1} - r_t^e) + y_{t+1}$$

and AS

$$\pi_t = \kappa y_t + \kappa\psi\chi^w + \beta\pi_{t+1}$$

where $\sigma, \kappa, \psi,$ and χ^w are positive constants.[15] The variable r_t^e goes by many names: it is most often referred to as the “natural” (but sometimes “efficient,” “neutral,” “Wicksellian,” or “market-clearing”) real rate of interest; it is also known as r-star (r^*) in other notations (Bernanke 2017).

The AD equation shows that, in this model, current output is increasing in expected future output (y_{t+1}) and decreasing in the distance of the real interest rate (the nominal interest rate, i_t, minus expected inflation, π_t) from the natural real rate of interest, r_t^e. The AS equation shows that, in this model, current inflation depends on current demand, y_t, variable labor costs due to regulations, τ_t^w, and expected future inflation, π_{t+1}. This equation is also known as the “New Keynesian Phillips Curve” because it relates output and inflation in a manner similar to the traditional Phillips Curve (Phillips 1958; Phelps 1967).

Finally, the model is closed by specifying the central bank’s behavior. We choose a slightly different functional form for the central bank policy rule than Eggertsson (2011), instead using:

$$i_t = \phi\pi_{t+1} + r_t^e$$

[14] The Federal Reserve in fact has a flexible average inflation target of 2% (Federal Open Market Committee 2022).
[15] For details on the interpretation of these constants, see Eggertsson (2011).

with $\phi > 1$, which ensures that in the long run the unique equilibrium of this economy does not feature runaway inflation.[16] Note, however, that the central bank's policy rule is constrained to be above zero: $i_t \geq 0$. Accordingly, the central bank's policy rule is specified by

$$i_t = \max\{\phi\pi_{t+1} + r_t^e, 0\}$$

This is the complete model without capital; we will return to the role of capital later.

Even in this more complex model, we can again see that the ZLB constraint causes similar problems. If the market-clearing interest rate r_t^e falls below the negative one times inflation ($-\pi_t$)—zero, in this model—due to, e.g., a financial crisis (Cúrdia and Woodford 2010), the central bank will not be able to match it with the policy rate i_t, and a recession will ensue. As noted previously, this situation describes the 1930s, the "Great Recession" of 2008, and also the recent COVID crisis in its initial phase. In each case, a massive shock caused demand for current consumption to fall relative to output, pushing prices and interest rates down (less consumption implies more saving, which drives the "market clearing" interest rate lower). The Federal Reserve tried in each case to boost current demand by lowering interest rates to the market-clearing level, but failed, as it was constrained by the ZLB.

To see these dynamics at play, consider a three-period model where the market clearing rate $r_0^e < 0$ and $r_1^e = r_2^e = r^e$, the long-run value of r. To keep things simple, suppose that it is known that the shock to aggregate demand will only last one period, and that by $t = 2$ the economy will be back in steady-state with $y_2 = \pi_2 = 0$ and $i_2 = r_2^e = r^e$. What should the government do today, in $t = 0$, about new regulatory burdens that are planned to be in place in $t = 1$, that is, $\tau_1^w - \tau_0^w > 0$?[17]

[16] This difference is purely for tractability.
[17] Current regulations, τ_0^w only affect current inflation, so given our monetary policy rule current regulations do not directly impact current output, y_0; moreover, we may think that—in practice—current regulation is "already in place" and too burdensome to change in real time based on economic developments.

Given our simplifying assumptions, current output, y_0, boils down to

$$y_0 = -\sigma(\max\{\phi\kappa\psi\chi^w\tau_1^w + r_0^e, 0\} - r_0^e) + \sigma\kappa\psi\chi^w\tau_1^w$$

Now consider two cases. When the ZLB binds, i.e.,

$$\phi\kappa\psi\chi^w\tau_1^w + r_0^e < 0$$

then the previous expression for current output becomes:

$$y_0 = \sigma r_0^e + \sigma\kappa\psi\chi^w\tau_1^w$$

To put this result in plain English, at the zero lower bound, there is a recession (since, above, we specified $r_0^e < 0$) *unless* τ_1^w is sufficiently high! New regulatory burdens that increase labor costs are *expansionary* in this model when the ZLB binds.[18] This expression shows that, in this model, increasing regulatory burdens raises current output (y_0) because the inflation it causes helps to "relax" the ZLB constraint: higher inflation reduces the real interest rate, which has expansionary effects.

These benefits of high inflation are absent in "normal times," when the ZLB does not bind. To see this, imagine the government went overboard imposing new regulatory burdens, for no reason other than to raise the price level. It is easy to see, by examining the first equation in the previous paragraph, that increasing τ_1^w only increases y_0 until the government causes enough inflation to escape the ZLB, i.e., when

$$\phi\kappa\psi\chi^w\tau_1^w + r_0^e = 0$$

At that point, additional regulations will decrease output:

$$y_0 = \sigma(1-\phi)\kappa\psi\chi^w\tau_1^w$$

because $\phi > 1$ entails that $\sigma(1-\phi)\kappa\psi\chi^w\tau_1^w < 0$. This should be intuitive: in normal times, the model's dynamics reflect the fact that more stringent regulations raise the cost of labor for firms

[18] Or, alternatively, raising payroll taxes.

and result in lower wages and higher inflation, which the Federal Reserve responds to by raising interest rates and curbing demand in order to reduce inflation. Contrast this with the situation at the ZLB, where interest rates are already sub-optimally high, so the Federal Reserve does not raise interest rates in response to higher inflation.

Now let us consider an economy in which each firm uses both capital and labor as inputs in the Cobb-Douglas production function

$$y_t(i) = K_t(i)^{\gamma} l_t(i)^{1-\gamma}$$

where $K_t(i)$ is firm-*i*-specific capital at time *t*, and γ is the capital output elasticity. Assume that investment increases the firm's capital stock in $t + 1$ ($K_{t+1}(i)$) by the following relationship:

$$I_t(i) = \varphi \left[\frac{K_{t+1}(i)}{K_t(i)}, \xi_t\right] K_t(i)$$

where $I_t(i)$ is firm-*i*-specific investment at time *t*, ξ_t is an adjustment shock, and the function φ satisfies certain conditions allowing for determinacy.[19] Eggertsson (2011) shows that, in reasonable parameterizations, a cut to the corporate tax rate (τ_t^P)—which had previously dropped out of the model without capital—now reduces output at the ZLB.[20] While, as previously noted, corporate taxes are a dubious proxy for regulatory burdens (and vice versa), in this model, the sign of the relationship between corporate taxes and output at the ZLB is the opposite of that implied by Masur & Posner's analysis.

Finally, consider the case where regulation takes the form of a one-time mandated purchase of a *fixed* quantity of goods or services (a new scrubber, a one-time inspection, etc.). It is not hard to show that this is isomorphic to tax-and-spend fiscal policy where the government finances the purchase of output with a lump-sum tax on households. This is expansionary in the

[19] For a list of these conditions, see Eggertsson (2011).
[20] The sign of the relationship between τ_t^w and output is unaffected (Eggertsson 2011).

model, and more so at the ZLB when the added inflation caused by the shock does not induce the central bank to raise real interest rates; see Eggertsson (2011) for a thorough discussion of the effects of government spending at the ZLB in this model.

The prediction of the model that increased regulatory burdens literally raise output at the ZLB does not obtain in all extensions of the New Keynesian model.[21] However, the central insight will persist in any reasonable model: in a liquidity trap, any inflation caused by regulations is a benefit; outside of a liquidity trap, higher-than-target inflation is a problem. Thus, the costs of regulation in a liquidity trap are lower than in normal times, even if such regulation is not literally expansionary. This implies that, in a liquidity trap, policymakers should not seek to delay the timing of regulations that they would have otherwise gone forward with. Indeed, there may be a case for policymakers to promulgate regulations that would have been narrowly net-costly in other times, because doing so in a liquidity trap would have reflationary benefits. But whether policymakers should issue such (narrowly) net-costly regulations in a liquidity trap will depend on whether the strong theoretical prediction of this model holds: does the empirical data truly support the prediction that imposing regulatory burdens *increases* output at the ZLB?

4. Do the Empirics Support the Theory?

The model in Section 3 is a bog-standard New Keynesian DSGE model, which are widely used in macroeconomic analyses and reflect plausible microeconomic foundations. Yet the counter-intuitive implication that imposing the same regulatory requirement has lower

[21] *See, e.g.*, Liu, Huang, and Lai (2022) (showing that, under certain additional modeling assumptions, this result may no longer hold); but see Section 4 on empirical evidence supporting this surprising result.

costs—and may even be stimulative—while the economy is in a liquidity trap, has led some to question whether these models accurately describe reality. Two recent articles have questioned the standard New Keynesian DSGE model on this basis. Wieland (2019) analyzed Japanese data following the 2011 earthquake, as well as the global economic response to positive shocks to the price of oil, and found that that both were contractionary, not expansionary. Unfortunately, Wieland's analysis was limited by the scope and frequency of the data: Japanese GDP was only available on a quarterly basis, and data used in the oil shock analysis was no more frequent than monthly. Garin, Lester, and Sims (2019) analyzed utilization-adjusted TFP data, similarly finding that positive supply shocks from productivity were stimulative in a liquidity trap. But yet again, small sample sizes and low frequency data reduced the power of their analysis.

To overcome the data limitations in these papers, and investigate whether the benchmark New Keynesian DSGE models are indeed flawed, some economists have recently turned to high-frequency financial market data.[22] Most persuasively, Datta et al. (2021) find that during the period that the federal funds rate was zero, after 2008—i.e., while the economy was in a liquidity trap—stock prices were positively correlated with oil prices. Prior to this, the correlation between oil prices and equities was slightly negative, exactly as would be implied by theory. This is entirely consistent with the New Keynesian DSGE model outlined in Section 3, under which a positive shock to oil prices would cause expected inflation to rise, lowering the real interest rate and stimulating the economy while in a liquidity trap (and accordingly, raising stock prices).

One might think that Wieland's and Datta et al.'s findings can be reconciled: equities respond positively to oil shocks, but GDP declines. For example, it could be the case that

[22] High frequencies also help ensure that the shocks are more likely to be unanticipated, relative to data at monthly or quarterly frequencies (Nakamura and Steinsson 2018).

diminished consumption from high marginal propensity-to-consume individuals bearing the brunt of higher oil prices outweighs any reflationary effect on GDP, but that the higher stock prices of oil companies outweigh the lower stock prices of sellers of consumer goods when looking at average equity prices. But the data do not support this attempt to reconcile Wieland with Datta et al.: when equities are separated by industries, consumer durables also flip from having a small (but significant) negative relationship with oil prices in the pre-zero-lower-bound period to a large (and significant) positive relationship with oil prices in the zero-lower-bound period. Indeed, equity prices in every single industrial sector—consumer nondurables, manufacturing, business equipment, telecommunications, etc.—exhibit this changing relationship. For additional support, Datta et al. also find that surprises in the data releases of core PPI (the producer price index, excluding food and energy) were negatively correlated with equity returns during the pre-zero-lower-bound period, but positively correlated with equity returns during the post-zero lower bound period. Similarly, Gourio and Ngo (2020) find that during the period where the ZLB is binding, stock returns flip from being negatively correlated with inflation to being positively correlated with inflation.

The higher equity prices observed by Datta et al. as well as Gourio and Ngo could arise, however, not from increases in firms' expected cash flows, but solely from lower real interest rates. That is, the increase in equity prices could solely result from the effect of oil shocks (or inflation surprises) on higher inflation, lower real rates, and therefore a reduction in the discount rate applied to firms' future real cash flows (which could be flat, or even decline slightly). This is a strong assumption.[23] Even if it were the case, however, it would still provide evidence of the

[23] One that could, in principle, be tested empirically, using publicly available data on firms' expected future cash flows, the average pass-through of oil shocks to a decline in real rates, and the average change in equity prices following the oil shock.

primary claim of this paper—that the costs of regulation decline in a liquidity trap—as it would be evidence that cost shocks have offsetting reflationary benefits by lowering real interest rates during ZLB episodes, even if those reflationary benefits are not greater than the cost harms (the strong theoretical prediction of the model).

Focusing specifically on regulations, consider Mohommad (2021)'s analysis of environmental policies. Examining data from 31 countries and the OECD environmental policy stringency (EPS) index, Mohammad finds that tightening the stringency of environmental policies—and correspondingly, increasing costs on firms—has a positive effect on employment when the output gap (an estimate of how far GDP is from its potential) is very large. But as the output gap declines (actual GDP rises relative to potential GDP), the effect on employment falls and eventually becomes negative. Mohommad investigates the mechanism by which increasing EPS increases employment by considering the effect of tighter EPS on inflation. The analysis reveals that, controlling for other variables, tighter EPS has a positive effect on inflation. This lends more support to the New Keynesian DSGE model's prediction that increasing regulatory costs boosts output and employment in a liquidity trap by spurring expected inflation, thereby causing the real interest rate to decline.[24]

Accordingly, multiple lines of evidence—from financial market correlations and analysis of environmental policies across many countries—support the counterintuitive result that regulatory costs are smaller, and might even be an economic boon, in the depths of a liquidity trap. We can also look to analysis of the Great Depression. Eggertsson (2012) finds that New Deal policies that boosted prices—essentially constituting an increase in firms' markups—can

[24] It also supports the secondary claim of this paper: in an economy that is not at the ZLB, increased regulatory costs both lower output directly and spur inflation, leading monetary policy to tighten, and output and employment to fall further.

explain much of the recovery in output and inflation from 1933 to 1937. Following the New Deal, these policies were much derided, but at the time they were explicitly advocated for on the basis that they would halt deflation and increase consumption—the exact mechanism discussed above.

5. The Necessity and Difficulty of Integrating Business-cycle Effects in Benefit-Cost Analysis

The most effective way to ensure that the macroeconomic effects of regulations are adequately and consistently analyzed would be to do so as an ordinary part of regulatory review. For "economically significant" regulations—those with over $100 million of benefits, costs, or transfers in any year—Executive Order 12866 requires that the agency conduct a monetized benefit-cost analysis (Clinton 1993). Pursuant to Executive Order 12866, EPA estimated the net benefits of its 2011 ozone regulation in accordance with OMB's best practices for benefit-cost analyses, as established in OMB Circular A-4 (Environmental Protection Agency 2011). With the Biden administration's effort to modernize regulatory review currently underway (Biden 2021), there is a greater potential for improvements in the federal government's approach to benefit-cost analysis than there has been since 2003, when Circular A-4 was promulgated by OIRA. But accounting for the macroeconomic effects of regulations in a regulatory impact analysis will not be easy. Indeed, previous difficulties integrating the costs of unemployment in benefit-cost analysis demonstrate the enormous hurdles to institutionalizing such effects in benefit-cost analysis.[25]

One difficulty is that mainstream macroeconomists naturally concern themselves with understanding the aggregate behavior of the economy. Since regulatory benefits and costs are usually small and difficult to identify—relative to, e.g., changes in tax policy or government spending induced by war or recessions—their aggregate effects over the business cycle have received little attention in the macroeconomics literature. However, the effect of the business cycle on regulations has received attention: as noted in the Introduction, policymakers are concerned with the state of the business cycle when weighing the merits of regulations. This suggests that policymakers should be interested in the predictions that state-of-the-art macroeconomic models make regarding aggregate responses to regulatory choices.

While the results of this paper rely on simple pedagogical models that can be analyzed "by hand" with just pen-and-paper, nothing prevents federal agencies from borrowing more sophisticated models meant for the quantitative analysis of optimal tax policy and government spending over the business cycle to inform benefit-cost analysis. As a starting point, one can simply proceed as we have in this paper, following Masur and Posner in observing that a regulation is often similar to a particular kind of tax.[26] Having mapped a regulation in question

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[25] Traditionally, benefit-cost analysis excludes consideration of the unemployment effects of regulations because it assumes the economy is at full employment, and thus, unemployed workers can obtain new jobs with similar salaries with relative ease after being laid off (Furman 2017). This is a simplifying assumption, but it is straightforwardly the case that if spells of unemployment are almost always brief and new jobs provide roughly similar wages to eliminated ones—as should be the case in an economy operating at full employment—the costs of unemployment should be quite small (relative to other costs in the analysis of most economically significant regulations). Nevertheless, Masur and Posner argued a decade ago that benefit-cost analysis should consider the effects of unemployment (Masur and Posner 2012). In response to their work, OIRA solicited public comment on methodologies for estimating employment effects in benefit-cost analysis (Office of Management and Budget 2013). However, "the comments received were not particularly helpful," and as a result, the costs of unemployment remain ordinarily unmonetized in federal agencies' regulatory impact analyses (Furman 2017).

[26] Masur and Posner followed in a long tradition in this respect. For one early treatment see, e.g., Averch and Johnson (1962); for a more recent treatment see, e.g., Fullerton and Heutel (2010).

into a particular tax, a model can easily make predictions about the effects of the regulation on aggregate output using more sophisticated versions of the DSGE model presented in Section 3 that are already widely used in government. Indeed, Congress's Joint Committee on Taxation (Staff of the Joint Committee on Taxation 2018) and the Federal Reserve System (Board of Governors of the Federal Reserve System 2017) already incorporate such DSGE models when evaluating the impact of changes in fiscal and monetary policy, respectively, and there is growing use of DSGE models in national agencies and international bodies around the world (Yagihashi 2020).

These suggestions are only a starting point; higher GDP is not itself a benefit, so any model would need to determine the willingness-to-pay or dollar-denominated welfare effects of a given regulatory change in order to serve as an input to benefit-cost analysis. In addition, it would be ideal if in future work mainstream DSGE models are tailored to fit the needs of particular regulators. Doing so is most likely to be worth the additional analytic work when proposed regulatory changes are large. In that vein, the Environmental Protection Agency's ongoing efforts to develop a large-scale computable general equilibrium model, SAGE, to evaluate the long-run costs and benefits of environmental regulation represents an important advance in this area (Marten, Schreiber and Wolverton 2021). However, despite SAGE's many features, it is not designed to capture business cycle dynamics and abstracts from the possibility of being at the ZLB. Thus, scope remains for further developing models to inform regulatory decisions over the course of the business cycle which, as this paper emphasizes, materially increases the net benefits of regulation at the ZLB. Given the long-run trend towards lower real interest rates, discussed previously, such models are unfortunately likely be needed sooner rather than later.

6. Conclusion

When faced with a recession that plunges the economy into a liquidity trap, the first-best solution is for Congress to use fiscal policy to overcome the shortfall in aggregate demand. But as was observed in the slow, grinding recovery from the Great Recession, sometimes fiscal policy falls short of what is needed to pull the economy out of a liquidity trap. And when the legislative branch fails, the executive branch must rely on its existing authorities to minimize unnecessary suffering.

In such a situation, the executive branch should hunt for regulatory policies that cause firms and individuals to spend, which can substitute for a lack of sufficient government expenditures. The executive branch may want to develop regulations that transfer resources from low marginal-propensity-to-consume individuals to high marginal-propensity-to-consume individuals, which likewise will have stimulative effects. But beyond such cases, there will be tough political decisions—like the ones that the Obama administration faced in 2011—about whether to move forward on important regulatory priorities that address environmental, health, safety, or other concerns. This paper has shown that, at a minimum, periods at the zero lower bound are no time for delaying beneficial regulatory action. On the contrary, it is in these dire economic circumstances that policymakers should be made aware that the costs of imposing regulatory requirements have fallen, and that the case for action has only grown stronger.

References

Andrade, Philippe, Hervé Le Bihan, Jordi Galí, and Julien Matheron. 2019. "The Optimal Inflation Target and the Natural Rate of Interest." *Brookings Papers on Economic Activity* 173-230.

Annicchiarico, Barbara, and Fabio Di Dio. 2015. "Environmental Policy and Macroeconomic Dynamics in a New Keynesian Model." *Journal of Environmental Economics and Management* 1-21.

Argote, Linda, and Dennis Epple. 1990. "Learning Curves in Manufacturing." *Science* 920-924.

Averch, Harvey, and Leland L. Johnson. 1962. "Behavior of the Firm Under Regulatory Constraint." *The American Economic Review* 1052-1069.

Ball, Laurence. 2009. "Hysteresis in Unemployment." In *Understanding Inflation and the Implications for Monetary Policy: A Phillips Curve Retrospective*, by Jeff Fuhrer, Yolanda K. Kodzycki, Jane Sneedon Little and Giovanni P. Olivei, 361-382.

Ball, Laurence. 2014. "Long-Term Damage from the Great Recession in OECD Countries." *European Journal of Economics and Economic Policies: Intervention* 149-160.

Bernanke, Ben S. 2017. "The Mayekawa Lecture: Some Reflections on Japanese Monetary Policy." *Institute for Monetary and Economic Studies, Bank of Japan* 23-38.

Biden, Joe. 2021. *Modernizing Regulatory Review.* January 20. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/modernizing-regulatory-review/.

Blanchard, Olivier J., and Marianna Riggi. 2013. "Why Are the 2000s So Different from the 1970s? A Structural Interpretation of Changes in the Macroeconomic Effects of Oil Prices." *Journal of the European Economic Association* 1032-1052.

Blanchard, Olivier. 2018. "Should We Reject the Natural Rate Hypothesis?" *Journal of Economic Perspectives* 97-120.

Board of Governors of the Federal Reserve System. 2017. *Estimated Dynamic Optimization (EDO) Model.* March 16. https://www.federalreserve.gov/econres/edo-models-about.htm.

Clinton, Bill. 1993. "Executive Order 12866." *Federal Register.* October 4.

Cúrdia, Vasco, and Michael Woodford. 2010. "Credit Spreads and Monetary Policy." *Journal of Money, Credit and Banking, Supplement 1* 3-35.

Datta, Deepa D., Benjamin K. Johannsen, Hannah Kwon, and Robert J. Vigfusson. 2021. "Oil, Equities, and the Zero Lower Bound." *American Economics Journal: Macroeconomics* 214-253.

Delong, J. Bradford, and Lawrence H. Summers. 2012. "Fiscal Policy in a Depressed Economy." *Brookings Papers on Economic Activity* 223-274.

Dominioni, Goran, and Michael Faure. 2022. "Environmental Policy in Good and Bad Times: The Countercyclical Effects of Carbon Taxes and Cap-and-Trade." *Journal of Environmental Law* 269-286.

Eggertsson, Gauti B. 2012. "Was the New Deal Contractionary?" *American Economic Review* 524-555.

Eggertsson, Gauti B. 2011. "What Fiscal Policy Is Effective at Zero Interest Rates?" *NBER Macroeconomics Annual* 59-112.

Eggertsson, Gauti B., and Sergey K. Egiev. 2019. "Fundamental Driven Liquidity Traps: A Unified Theory of the Great Depression and the Great Recession." *Working Paper*.

Eggertsson, Gauti B., Neil R. Mehrotra, and Jacob A. Robbins. 2019. "A Model of Secular Stagnation: Theory and Quantitative Evaluation." *American Economic Journal: Macroeconomics* 1-48.

Environmental Protection Agency. 2015. *National Ambient Air Quality Standards for Ozone.* October 26.

Environmental Protection Agency. 2011. "Regulatory Impact Analysis: Final National Ambient Air Quality Standard for Ozone."

Federal Open Market Committee. 2022. *Statement on Longer-Run Goals and Monetary Policy Strategy*. January 25. https://www.federalreserve.gov/monetarypolicy/files/FOMC_LongerRunGoals.pdf.

Frankel, Marvin. 1955. "Obsolescence and Technological Change in a Maturing Economy." *American Economic Review* 296-319.

FRED. 2022. *Crude Oil Prices: West Texas Intermediate (WTI) – Cushing, Oklahoma.* https://fred.stlouisfed.org/graph/?g=RwYl.

Fullerton, Don, and Don Heutel. 2010. "The General Equilibrium Incidence of Environmental Mandates." *American Economic Jounral: Economic Policy* 64-89.

Furman, Jason. 2017. "How Lawyers Can Help Macroeconomists in the Wake of Three Major Challenges." *Yale Journal on Regulation* 709-742.

Galí, Jordi. 2015. *Monetary Policy, Inflation, and the Business CYcle: An Introduction to the New Keynesian Framework and Its Applications.*

Garin, Julio, Robert Lester, and Eric Sims. 2019. "Are Supply Shocks Contractionary at the ZLB? Evidence from Utilization-Adjusted TFP Data." *The Review of Economics and Statistics* 160-175.

Gourio, François, and Phuong Ngo. 2020. "Risk Premia at the ZLB: A Macroeconomic Interpreatation." *Federal Reserve Bank of Chicago Working Paper.*

Guerrieri, Veronica, Guido Lorenzoni, Ludwig Straub, and Ivan Werning. 2022. "Macroeconomic Implications of COVID-19; Can Negative Supply Shocks Cause Demand Shortages?" *American Economic Review* 1437-1474.

Hayashi, Andrew, and Daniel P. Murphy. 2017. "Savings Policy and the Paradox of Thrift." *Yale Journal on Regulation* 743-790.

Hazell, Jonathan, Juan Herreño, Emi Nakamura, and Jón Steinsson. 2022. "The Slope of the Phillips Curve: Evidence from U.S. States." *The Quarterly Journal of Economics* 1299-1344.

Hicks, J. R. 1937. "Mr. Keynes and the "Classics"; A Suggested Interpretation." *Econometrica* 147-159.

Jordà, Òscar, Sanjay R. Singh, and Alan M. Taylor. 2022. "Longer-Run Economic Consequences of Pandemics." *Review of Economics and Statistics* 166-175.

Liscow, Zachary D. 2016. "Counter-Cyclical Bankruptcy Law: An Efficiency Argument for Employment-Preserving Bankruptcy Rules." *Columbia Law Review* 1461-1501.

Listokin, Yair. 2019. "A Theoretical Framework for Law and Macroeconomics." *American Law and Economics Review* 46-80.

Listokin, Yair. 2012. "Equity, Efficiency, and Stability: The Importance of Macroeconomics for Evaluating Income Tax Policy." *Yale Journal on Regulation* 45-89.

Listokin, Yair. 2017. "Law and Macroeconomics: The Law and Economics of Recessions." *Yale Journal on Regulation* 791-856.

Liu, Shih-fu, Wei-chi Huang, and Ching-chong Lai. 2022. "The Paradox of Toil at the Zero Lower Bound in a TANK Model." *European Economic Review* 1-25.

Marten, Alex, Andrew Schreiber, and Ann Wolverton. 2021. *SAGE Model Documentation (2.0.1).* Environmental Protection Agency.

Masur, Jonathan S., and Eric A. Posner. 2012. "Regulation, Unemployment, and Cost-Benefit Analysis." *Virginia Law Review* 579-634.

Masur, Jonathan S., and Eric A. Posner. 2017. "Should Regulation Be Countercyclical?" *Yale Journal on Regulation* 857-893.

Mishkin, Frederic S. 2017. *Macroeconomics: Policy and Practice.*

Mohommad, Adil. 2021. "Employment Effects of Environmental Policies – Evidence from Firm-Level Data." *IMF Working Paper.*

Nakamura, Emi, and Jón Steinsson. 2018. "High-Frequency Identification of Monetary Non-Neutrality: The Information Effect." *The Quarterly Journal of Economics* 1283-1330.

Obama, Barack. 2011. *Statement by the President on the Ozone National Ambient Air Quality Standards.* September 2. https://obamawhitehouse.archives.gov/the-press-office/2011/09/02/statement-president-ozone-national-ambient-air-quality-standards.

Office of Management and Budget. 2013. "2012 Report to Congress on the Benefits and Costs of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities."

Phelps, Edmund S. 1967. "Phillips Curves, Expectations of Inflation and Optimal Unemployment Over Time." *Economica* 254-281.

Phillips, A. W. 1958. "The Relationship Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957." *Economica* 283-299.

Rachel, Lukasz, and Lawrence H. Summers. 2019. "On Secular Stagnation in the Industrialized World." *Brookings Papers on Economic Activity* 1-54.

Schneider, Howard, and Ann Saphir. 2022. "Fed Likely to Hike Rates in March as Powell Vows Sustained Inflation Fight." *Reuters*, January 26.

Staff of the Joint Committee on Taxation. 2018. "Overview of the Joint Committee Macroeconomic Modeling."

Sunstein, Cass R. 2011. "Administrator, Office of Information and Regulatory Affairs." *Letter to Lisa P. Jackson, Administrator, Environmental Protection Agency.* September 2.

The Economist. 2011. *Clause and Effect.* October 29. https://www.economist.com/finance-and-economics/2011/10/29/clause-and-effect.

Wieland, Johannes F. 2019. "Are Negative Supply Shocks Expansionary at the Zero Lower Bound?" *Journal of Political Economy* 973-1007.

Woodford, Michael. 2003. *Interest and Prices: Foundations of a Theory of Monetary Policy.*

Yagan, Danny. 2019. "Employment Hysteresis from the Great Recession." *Journal of Political Economy* 2505-2558.

Yagihashi, Takeshi. 2020. "DSGE Models Used by Policymakers: A Survey." *Policy Research Institute, Ministry of Finance, Japan, PRI Discussion Paper Series.*