3-5-2013

Social Costs of Jobs Lost Due to Environmental Regulations

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Upjohn Institute working paper ; 13-193

Citation

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March 5, 2013

ABSTRACT

This paper estimates the social costs of job loss due to environmental regulation. Per job lost, potential social costs of job loss are high, plausibly over $100,000 in present value costs (2012 dollars) per permanently lost job. However, these social costs will typically be far less than the earnings associated with lost jobs, because labor markets and workers adjust, increased leisure has some value, and employers benefit from wage reductions. A plausible range for social costs is 8–32 percent of the associated earnings of the lost jobs. Social costs will be higher for older workers, high-wage jobs, and in high unemployment conditions. Under plausible estimates of job loss for most environmental regulations, the social costs of job loss will typically be less than 10 percent of other measured social costs of regulations. Therefore, adding in job loss is unlikely to tip many regulatory benefit-cost analyses.

INTRODUCTION

The loss of jobs due to environmental regulation often looms large in political debate. Jobs are important to voters, but benefit-cost analysis of environmental regulations has not reached a consensus on the social costs of job loss.

This paper estimates a plausible range of dollar values for the social costs of job losses. I also estimate percentage effects of job losses on overall social costs of regulations.

I conclude that social costs are large per job lost. Per lost job, social costs probably exceed, in present value terms, over $80,000. However, social costs of job losses are much less than these lost jobs' earnings. I estimate that social costs of job loss are at most 32 percent of the associated earnings loss. Furthermore, a fairly wide range of social costs per job lost are plausible: from 8 to 32 percent of the associated earnings loss. Finally, social costs of job loss may be greater for older workers and higher-wage jobs, or in higher unemployment conditions.

Despite the large social costs of job loss, the effect of job loss on overall costs of regulations is rarely a large percentage. For most regulations, even if regulatory-induced job loss is permanent, social costs of job loss are less than 10 percent of overall social costs. More realistically, regulatory-induced job loss will lead to some offsetting job creation, due to shifts in demand and capital. Because this offsetting job creation provides benefits, net social costs of these jobs shifts will be further reduced.

Regulation's effect on jobs is a hot political issue, especially in an era of high unemployment. For example, in arguing in December of 2010 against increased regulation of industrial boiler emission of hazardous air pollutants, the American Forest and Paper Association claimed that the regulation might cost 40,000–60,000 jobs. Losing that many jobs is a strong

argument when the unemployment rate is 9.4 percent, as it was when AFPA made its press release. Job loss is likely to be a strong argument for some time. The U.S. economy is currently 11 million jobs short of restoring the employment to population ratio prior to the Great Recession (Greenstone and Looney 2012). Environmental regulations will be considered in a high unemployment political situation for many years to come.

Job loss has been used to argue against increased regulation. Representative Fred Upton, chairman of the House Energy and Commerce Committee, has argued that "at a time of near double-digit unemployment, the Environmental Protection Agency (EPA) should stand down altogether from any action that will further hamstring our fragile economy" (Institute for Policy Integrity 2012).

The importance of job loss to the public naturally leads to the demand that job effects be incorporated in benefit-cost analyses of regulations. In the past, this normally has not been done. As pointed out by Masur and Posner (2012, p. 581), "agencies have long reported the predicted unemployment effects of regulations and have in some cases declined to choose certain regulatory options because the unemployment effects were too high. But they do not incorporate the unemployment costs into cost-benefit analysis, which is the standard basis for evaluating regulations, so it is not clear what role unemployment plays in their evaluation of proposed regulations."

One rationale for not incorporating jobs in benefit-cost analysis is to assume that the economy is at "full employment." The full employment assumption leads to the following argument for benefit-cost analysis to exclude costs of job loss: "In an economy or region experiencing full employment, economists typically assume that the opportunity cost of a worker's labor is equal to the wages he or she earns. The rationale is that the wages earned are

approximately equal to the value of the worker's output at an alternative job" (EPA 2011a, p. 15). That is, at full employment, any worker has the option of instantly moving to an equally productive job, or enjoying leisure of the same monetary value. Therefore, any "job loss" that occurs in the short run due to regulation merely moves us from one full employment equilibrium to another full employment equilibrium, where everyone can get a job at the prevailing wage. The adjustment to the job loss is costless.

A more realistic model recognizes that the economy often has considerable involuntary unemployment, but even so, a pragmatic defense for excluding job effects from benefit-cost analysis is that the social costs of job loss are uncertain. I argue in a previous paper that "involuntary unemployment makes benefit-cost analysis more difficult" (Bartik 2012). Economists have not reached a clear consensus on how to estimate the job effects of policies in labor markets with involuntary unemployment, and how to measure the social value of such job effects (Bartik 2012). The economic research literature offers diverse approaches to measuring and valuing job effects that are difficult to carry out and rely on arbitrary assumptions.

Although incorporating job effects may not be standard in benefit-cost analysis, this exclusion makes no sense to the public. As economist Paul Courant at the University of Michigan has pointed out, the public does not view jobs the way that most economists do. "Economists view labor as a cost . . . Mayors, undergraduates, presidents, union officials, and (other?) folks in bars *say* that they view labor (or, at least, jobs) as benefits" (Courant 1994, p. 875). As Courant muses, there does seem to be "something special about jobs" to the public.

How to respond to public concerns about job loss? One argument is that environmental regulations may also create jobs. As research by Morgenstern, Pizer, and Shih (2002) has pointed out, regulation may cause added jobs in pollution control, either in regulated firms or their

suppliers. In addition, general equilibrium adjustments, macroeconomic adjustments, or policy may cause lost jobs in the regulated sector to be offset by job gains elsewhere in the national economy. I will briefly consider possible offsets in the present paper. However, this topic will be explored in more detail in other research for this project by Richard Morgenstern and his colleagues, and by Robert Shimer and Richard Rogerson. This new research is unlikely to change the following reality: accurately estimating the job effects of regulation is challenging.

But suppose we know the job effects of regulation. There remains the issue of what social value to put on these job effects. The agnostic stance is to consider an extremely broad range of possibilities. For example, EPA's recent handbook on benefit-cost analysis of land cleanup argues that "because there is no consensus in the literature about the average opportunity cost of labor under long-term unemployment, analysts are encouraged to consider multiple values between zero and the new wage rate to demonstrate a range of possible outcomes" (EPA 2011a, p. 16). While it is nice to consider a broad range of social values of job effects, it would be even nicer if this range could be narrowed.

The next section of the paper considers models of regulations' job effects and their social costs. I then use these models to provide estimates of social costs per lost job. I narrow the range of social costs, but the variance is still considerable. Following that section, I consider how these social costs affect benefit-cost analyses of environmental regulations. Some have argued that if costs of job loss were included in benefit-cost analysis, "many regulations would need to be revised and made less stringent" (Masur and Posner 2012, p. 583). I do not find such large effects of job loss on regulatory analysis. The conclusion suggests better policy directions for concerns about jobs. I also consider possibilities for future research.

MODELS OF REGULATORY JOB EFFECTS AND THEIR COSTS

Background on Issues in Measuring Social Costs of Job Effects of Regulations

Environmental regulation may cause a variety of job effects. Some effects are job losses and some effects are job gains. One issue is how to measure the job losses and gains; a second is how to measure the social value of whatever reallocation of labor is estimated or assumed.

The main topic of this paper is the social costs of some given reallocation of jobs. But before considering this, let's briefly consider what job reallocations might occur because of a pollution control regulation. Table 1 provides a summary.

The most obvious direct effect is that environmental regulation may increase regulated businesses' costs, and thereby reduce these industries' labor demand. But as Morgenstern, Pizer, and Shih (2002) have emphasized, the regulations may also increase demand for labor to be used in pollution control activities, both in the regulated industry and in companies that supply pollution control equipment or services. In addition, these direct labor demand effects will be accompanied by multiplier effects. For example, job losses in regulated industries will reduce demand for labor in suppliers to those industries or in businesses that produce goods or services for workers in the regulated industries. Similar multiplier effects, in the other direction, occur for job gains in pollution control.

Effects in regulated industry may also lead to general equilibrium or macro effects, which may affect labor demand in other industries. The consumer demand and capital supply that would otherwise have gone to the regulated industries are likely to go in part to other industries. This leads to some offsetting labor demand increases in other industries. These may be augmented due to Fed policies or other macro policies that seek to offset the reduced labor demand in the regulated industries.

Effects on regulated industries may also lead to general equilibrium effects on aggregate labor supply. As pointed out by Hazilla and Kopp (1990), increased consumer prices may lower real wages, which may reduce aggregate labor supply.

Amenity and health benefits of regulation may also affect labor demand or supply. Amenities may have substitution or complementary relationships with various goods and services or with leisure, which may affect demand for goods and services or the supply of labor. Health benefits of regulation may affect the quantity or quality of labor supply.

Conventional benefit-cost analysis would focus on the direct costs of the pollution control regulations in compliance costs, versus the direct benefits of the regulations in health benefits and improved amenities. All the various general equilibrium adjustments would be ignored, in the belief that in competitive markets, all these spillover effects represent optimal adjustment as prices change due to the regulation. Among the adjustments that are ignored are any job effects due to shifts in labor demand or supply.

My focus in this paper is on the value of job changes due to labor demand effects. Labor demand decreases may increase involuntary unemployment or underemployment. Labor demand increases may reduce involuntary unemployment or underemployment. Increases in involuntary unemployment or underemployment have social costs, and reductions in involuntary unemployment or underemployment have social benefits. In contrast, labor supply shifts involve voluntary changes in workers' choices, which do not imply the same social costs from shifts in involuntary unemployment or underemployment.[1]

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[1]For example, in a model with fixed wages, and excess labor supply, shifts in labor supply do not affect the number of jobs, so there are no job creation or destruction effects. From other perspectives, there may be good reason to exclude labor supply effects. First, it is not implausible to assume that aggregate labor supply does not vary much with the real wage. Second, we do not have good estimates of the labor market effects of labor supply shocks, whereas we do have such models for labor demand shocks, as will be discussed later in this paper.

When analyzing labor demand effects, we have to consider both the obvious direct job effects and overall labor market effects. For example, there are direct job effects on workers displaced by regulation from polluting industries, but this negative labor demand shock also has broader effects on all workers. As displaced workers search for other jobs, they will compete with other workers in the labor market, which will tend to reduce other workers' employment rates and wage rates.

In benefit-cost analysis, social costs of labor demand shocks can be ignored from an economic efficiency perspective if the regulations move us instantly from one full-employment equilibrium to another full-employment equilibrium. In that case, all workers who want to be employed at the prevailing wage will always be employed in both the old and new equilibrium, and in the transition between the two equilibria. Even if there is still some temporary or permanent net job loss, the full employment assumption means that these additional nonemployed workers choose to be out of work. The regulatory induced net drop in labor demand reduces employment by slightly reducing the wage rate. This slight reduction in the wage rate induces some workers to drop out of the labor force. The value of their increased leisure time (time at nonpaid work), because it was voluntarily chosen by workers, must be in between the old and new wage rate, and thereby quite close to either wage rate. (Gains to leisure is labor economics jargon for any value to workers of whatever they do with their time while unemployed, including child care, work around the house, or education or job training, as well as other activities that may be more popularly called leisure, such as TV watching and socializing.) The reduction in the wage rate is a loss to workers, but an equal gain to firms. Therefore, there is no social cost even if there is regulatory-induced net job loss. The additional nonemployed

workers will gain leisure (nonpaid work time) that they value at the wage rate, and firms' gains

from reduced wages will perfectly offset worker losses.

But in an economy with involuntary unemployment, there may be social costs from

regulatory-induced job loss. In a model with involuntary unemployment, many workers who are

unemployed may place a value on their leisure time that is well below the market wage. (This

would be impossible in a full employment equilibrium, as then all such workers could get a job.)

As a result, many workers who end up being displaced from employment by the regulation, for at

least some significant time period, may end up unemployed, with leisure that they value at

considerably less than the market wage. How much less? That's hard to say. One could even

argue that the value of involuntary leisure is negative. Negative leisure values may occur if

involuntary unemployment has stigma effects, or if it leads to the loss of job skills, future

reputation with employers, and the worker's self-confidence. There is considerable research

literature that involuntary unemployment has negative effects on life satisfaction that exceed the

earnings lost (Helliwell and Huang 2011; Tella, MacCulloch, and Oswald 2001). Research also

shows that unemployment harms physical and mental health (Frey and Stutzer 2002). Finally, as

I will explore in more detail later, being displaced from a job has large long-run effects in

reducing future earnings (e.g., Davis and von Wachter 2011).

Furthermore, if jobs are in short-supply for willing and able workers, then many workers

may be capable of being more productive than their current jobs allow. As a result, when

workers are displaced from their original jobs into lower-paying jobs, they may be less

productive in their new jobs than they are capable of being. In other words, they experience

involuntary underemployment. (In a market where all labor markets clear, this would be

impossible, as the worker's true productivity potential would always be realized by some

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alternative job. But in models with involuntary underemployment, these higher-wage and higher-productivity jobs are rationed so that not all qualified workers can access such jobs.) The loss in wages from their new to their old jobs may represent a genuine loss of productivity to the economy. In contrast, in full employment models, this loss of wages is simply a gain to employers. The loss of wages is either due to shifts in the market clearing wage, or the workers losing "rents" due to union-imposed or government-imposed wages that are artificially above the market-clearing level. In either case, the loss of wages is exactly matched by a gain to employers.

How much do firms gain when workers are downgraded to lower-wage occupations? That's hard to say. The productivity of a firm-worker match depends on both the job and worker. There is not much empirical literature that allows us to precisely quantify the relative contribution of the job and the worker to productivity.

Overcoming Confusions in Valuing Workers' Time

The research literature on social costs of jobs, when there is involuntary unemployment, is confusing and reaches contradictory conclusions. I review the literature in Bartik (2012). A key source of confusion is that the research literature uses different concepts of the opportunity cost of workers' time, their "reservation wage," or the lowest wage at which they would be indifferent between taking a paid job and being engaged in leisure. These different concepts of reservation wages are both correct, but from different perspectives.

The older perspective on the reservation wage is that it represents the value of the worker's time while unemployed (Haveman and Farrow 2011; Haveman and Krutilla 1967; Mishan and Quah 2007). This value may incorporate how much the worker values their leisure time activities, as well as any stigma effects of unemployment. Because stigma values may be

negative and large, such "leisure value" reservation wages may be well below the market wage. The value of leisure may even be negative. These leisure values of time really shouldn't be viewed as true reservation wages. They are only reservation wages when compared with the option of never working again, which is typically not the option facing the worker.

The newer perspective on the reservation wage is that it represents an option value of the worker's time while unemployed, given the likely future job opportunities the worker faces (Mortensen 1986; Shimer and Werning 2007). In searching the labor market, an unemployed worker will set a reservation wage as the lowest wage at which she will accept a job offer. This reservation wage will depend in part on what future job offers she expects to get, not just on the value of leisure time. It can be shown that if market wages increase by x per hour, this reservation wage will increase by about the same x per hour (Mortensen 1986, p. 864). In addition, because reservation wages, when viewed as option prices that govern job search, are so tied to market wages, they tend to be close to market wages. The empirical literature suggests that such "job search" reservation wages, as a ratio to the worker's previous market wage, average 105 percent (Jones 1989), 107 percent (Feldstein and Poterba 1984), and 99 percent (Krueger and Mueller 2011). These ratios to previous market wages are high even if there is high unemployment that is plausibly involuntary; for example, the Krueger and Mueller study was carried out when the unemployment rate was in double digits in their study area (New Jersey).

The older perspective on the reservation wage is applicable from an ex post perspective on valuing some labor demand change, whereas the new perspective on the reservation wage is applicable from an ex ante perspective on valuing some labor market change. Consider some labor demand shock that changes the availability of jobs in a labor market. After the fact, we can compare the earnings and leisure experiences of all workers in two worlds: one world with the

labor demand shock, and one world without the labor demand shock. The reservation wage that is used in job search as an option price becomes irrelevant after the fact, because the sequences of earnings and leisure that occur for each worker are simply what they are and cannot be changed. We could even view them as assigned by some central planner, and their value would be the same, so whatever option prices or reservation wages might be useful at some point as strategies for job search become irrelevant after the changes have been experienced. The value of these changes for workers can be evaluated as the change in earnings for all workers, plus the change in their leisure time evaluated at whatever value workers assign to leisure time, including possible stigma effects. (I ignore here the effect of the change on firms.)

In theory, we can also value the labor demand shock based on the "option value" reservation wage and the changed sequences of workers accepting and leaving jobs. Each such acceptance or departure from a job has a value to the worker of the wage rate minus their option value reservation wage. But the labor market change also changes each worker's reservation wage, because option value reservation wages will vary with prevailing market wages and the ease of finding another job. This will change over time based on who exactly has found a job, which spills over into job availability for other workers. Therefore, in practice, evaluating the entire sequence of job changes using the option value reservation wage faces a difficult and perhaps impossible task of evaluating each worker's gain or loss, equal to their wage paid minus their possibly changed reservation wage, as the sequence of job changes ripples through the labor market. In practice, such an approach appears empirically impossible to implement.

A more empirically practical use of the option value reservation wage is to provide an ex ante measure of the changing value of access to a labor market. As shown by Shimer and Werning (2007), the reservation wage represents the value of a worker's access to a particular

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labor market. If a particular labor market experiences some labor demand shock that changes labor market conditions, this will immediately change reservation wages for all workers, both employed and unemployed. Reservation wages will change because market wages and unemployment rates have changed. The social value of the labor market change can be evaluated as the sum of changes in reservation wages over all workers, both employed and unemployed. These reservation wage changes would be evaluated after the labor demand shock has become apparent, but before the actual sequence of who gets what job has occurred. This change in reservation wages is hard to directly measure. But as argued in Bartik (2012), it is likely to be lower bounded by the predicted change in market wages due to the labor demand shock.

A Specific Example

Consider a specific example. Suppose the labor demand shock is simply the loss of one job. It might seem that the social cost of losing this one job is equal to the wages that are lost, with an adjustment for the "option value" reservation wage of the worker who loses a job, as that represents the minimum wage at which the worker will accept a job. But the social costs of this loss will not be accurately measured in that simple way.

Let us suppose this loss of one job is a subtraction of one job from total employment. Therefore, this job loss changes the employment rate, wage rate, and job offer density facing workers in an unfavorable direction. This unfavorable change is small for each individual worker if we're talking about one lost job in a big labor market. However, the value of the change summed over all workers is not necessarily a small number relative to the earnings of the lost job.

The question is how to value the net costs for all workers from that lost job. (There also is the issue of how employers are affected, which I ignore in this thought experiment.)

Prior to knowing which worker actually loses a job, we can value those benefits as the change in reservation wages for each individual worker, summed over all workers, both employed and unemployed. Reservation wages will go down because market wages will go down, and it will be harder to find jobs with a lower ratio of employment to population and a lower flow rate of job offers. The change in reservation wages for an individual worker will be small, but summed over all workers may not be a small number relative to the earnings associated with the lost job.

Once we know who actually loses this job, that worker has suffered a negative "surprise" of actually immediately losing the job. This increases the costs to this worker compared to her previous small reduction in reservation wage, when she only knew that she might lose her job. The revelation of who loses the job also lowers (in absolute value) the reduction in reservation wages for all other workers, as now these workers know they will not immediately lose a job.

However, all other workers should still have some reduction in their reservation wages for at least three reasons. First, the fact that the worker who loses the job has a reservation wage that is based on her likely future success in finding another job means that at some point, the worker who is displaced is likely to fill another job vacancy. Filling this job vacancy makes it slightly harder for other workers to find a job. In turn, there is a sequence of job chain displacement due to these other workers in the future not getting jobs that they otherwise would have obtained.

Second, unless the first worker who loses the job would have otherwise held that job forever, there would have been some positive probability for other workers holding that job in the future. This positive probability has some value to all other workers, and the loss of this job eliminates this positive probability and its value.

Third, the job loss has some effect, albeit very small, in reducing market wages, which will reduce reservation wages.

Therefore, the net social costs of a job offer, after the worker who will lose the job is identified, shifts from being a small reduction in reservation wages for all workers to being the wages of the lost job adjusted for the reservation wage of the worker who immediately loses the job, plus a slightly smaller (in absolute value) reduction in the reservation wage for all other workers. The two measures should sum to the same amount, at least in expected value terms. (That is, there may be differences depending upon how the probabilities of who gets what job are realized, but the expected value of all possible realizations should be the same.)

Finally, we can consider net worker costs ex post after we know the realizations of who actually gets what jobs when. Suppose we want to know the costs of this job being destroyed from the time the job was lost until some future time, and we are now looking back from the future time to consider the costs over this past period.

At this future date, we now know exactly how everyone's job history and wage history was affected by the one job that was lost. From an ex post perspective, we can calculate net costs without considering a reservation wage based on job search behavior. Ex post the universe is fixed and cannot be changed. In fact, we can imagine that some omniscient central planner has assigned people to the job sequences that were actually observed to be realized in the labor market. If people are assigned to the jobs they actually chose, their utility must be the same as if they had chosen those sequences. But if we view job sequences as assigned, reservation wages based on job search behavior become irrelevant. The cost of the job loss for each worker is the change in their earnings, minus whatever value they put on the change in their leisure time, but this time not adjusting for the value of job search, as I am assuming all jobs are simply assigned,

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or fixed by reality in that ex post what happened cannot be changed. Or in other words, the worker costs of the job loss are 1) earnings lost due to reduced employment rates because of the lost job, plus 2) earnings lost due to decreased wage rates, adjusted for 3) the value of the increased leisure time.

From an ex post perspective, the sequence of who is employed in each time period was realized only in one particular way from all the ways it could have been realized, given that job matches are stochastic. So this actual calculated social cost may be different from the ex ante measures given above. However, on average all three measures, the two ex ante measures and the one ex post measure, should be the same when we figure the average value over all possible job match realizations.[2]

Ex ante, the value of changes resulting from job losses for all workers can be evaluated by the changes in reservation wages for all employed and unemployed workers. This decline will have a lower bound (in absolute value) in the decline in market wages that would be predicted. Ex post, the value of these changes resulting from job loss for all workers can be evaluated as the decline in their earnings, minus some gain if increased leisure time has a net positive value after accounting for stigma effects.

Similar arguments can be applied for job gains. Ex ante, the job gains' benefits for workers can be evaluated as the increase in "option value" reservation wages summed over all workers. Ex post, the job gains' benefits for all workers can be evaluated by the increase in earnings for all workers, adjusted for the net value of the reduced leisure time.

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[2]The ex ante and ex post perspectives could also be seen as the difference between evaluating some change in an individual's well-being based on an indirect utility function defined over prices versus a direct utility function defined over consumption bundles.

These relationships are developed more fully in Bartik (2012). The next section provides some specific equations for evaluating these changes.

Models of Social Values of Job Effects

My previous paper on jobs and benefit-cost analysis (Bartik 2012) provided two alternative equations that express the social value of job losses (or gains). The first method is based on the ex post approach outlined above. It starts by estimating job losses' effects on workers' earnings, due to declines in both employment rates and wage rates. This earnings loss is adjusted for the value of the increased leisure time of workers due to higher unemployment or declining labor force participation.

The second method is based on the "option value" approach to the reservation wage. This method values job loss based on the decline in reservation wages due to the job losses, evaluated over all workers, both employed and unemployed. This reservation wage decline will be understated, in absolute value, by the decline in predicted market wages for all workers.

Both of these methods adjust the losses to workers for possible gains by firms. A job loss leads to wage declines for at least two reasons. First, the loss of jobs leads to workers with particular educational and other credentials being forced to take lower-wage jobs. The jobs may be lower wage in that they are in lower-wage occupations, or be lower job levels within an occupation. Second, the job loss may lead to lower wages for the same type of job. The second source of wage decline clearly will benefit firms. The first type of job loss may not benefit firms. The key issue is the productivity of workers who downgrade to lower-wage jobs. If their productivity is normal for that job type, then the job downgrading has no corresponding benefits for firms. But if these higher credential workers are more productive than typical workers in these jobs, then firms may gain from the downgrading.

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Both methods measure the same social costs of job losses. It is convenient to express these social costs as a percentage of the earnings reduction associated with the job losses. When this is done, either method shows that this percentage depends on various elasticities of how labor market outcomes respond to job loss. This percentage also depends upon parameters for the value of nonworking time and possible gains to firms.

Using method (1), the social costs of policy-induced job loss, as a percentage of the gross earnings associated with that job loss, can be written as follows:

$$[dY - f E (dW_m) - g W_m N (dER)]/[W_m (dE)] = (1 - f) S_{me} + [1 - g] S_{ere} \qquad \text{(Eq. 1)}$$

dY is the loss in earnings. E is employment. dE is the loss in employment due to the policy. W_m is the market wage rate. dW_m is the change in market wage rates, holding worker characteristics constant. dER is the change in the employment rate, defined with respect to the population. N is the population. f is the proportion of wage gains offset by employer losses. g is the proportion of earnings gains from new employment that represents a loss of valued nonmarket time, given stigma effects. S_{me} and S_{ere} are the elasticities of market wages and the employment rate with respect to the employment shock.[3]

Using method (2), the social costs of job loss can be expressed using the "option value" reservation wage concept as a percentage of the gross earnings loss as follows:

$$[dW_r (E + U) - f E dW_m] / (W_m dE) = [1 + (U/E)] (dW_r/dW_m) S_{me} - f S_{me} \qquad \text{(Eq. 2)}$$

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[3]This Equation (1) is a simplified version of Equation (2) in Bartik (2012). I reordered the two methods for the present paper because it emphasizes the direct method of measuring social values of job effects.

W_r and W_m are the "option value" reservation wage and the market wage, holding worker characteristics constant. E is the number of employed. U is the number of nonemployed. dW_r and dW_m are the changes in reservation wages and market wages. dE is the policy-induced employment loss. S_{me} is the elasticity of market wages with respect to an employment loss.[4]

What intuition is behind the second method? The intuition is that the "option value" reservation wage, the lowest wage at which a worker is willing to work, represents the value of access to the labor market. The policy-induced job loss reduces the value workers place on access to the labor market. Labor market access is of lower value because wages are lower and jobs are harder to find. For a full social valuation, we also must consider effects on employers.

Both of these methods require more than knowing the elasticities of market wages and employment rates with respect to job loss. Both methods require us to decide what proportion of wage declines, which will hurt workers, will be offset by benefits to firms. There is not much empirical evidence on the magnitude of these possible benefits for firms.

Method (1) requires us to assign some opportunity cost to the workers' time in nonemployment. There is some evidence, from surveys, of how much value people place on time spent in involuntary unemployment or out of the labor force (Blanchflower and Oswald 2004; Frey and Stutzer 2002; Helliwell and Huang 2011; Knabe and Ratzel 2011; Knabe et al. 2009; Tella, MacCulloch, and Oswald 2001). In addition, the value of this time in nonmarket work is upward bounded by the worker's net take-home wage after all taxes.

Equation (2) can only be given a precise value with estimated effects on "option value" reservation wages. Unfortunately, there is little empirical evidence on how reservation wages respond to changing labor market conditions. However, as implied by the previous discussion,

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[4]This Equation (2) is Equation (1) in Bartik (2012).

we would expect the observed decline in market wages to understate the decline in reservation wages. Holding employment rates constant, reservation wages would be expected to decrease about one-for-one with decreased market wages (Bartik 2012). But policy-induced job loss will lower employment rates, which would increase in magnitude the reservation wage decline, because declining employment rates reduce the value of labor market access. Therefore, method (2) allows us to put some lower bound to the social costs of job loss using observed effects on market wages.

Both of these methods are written in simplified form in the above equations. This simple formulation can be generalized. The simple formulation assumes that the environmental regulation just involves some job loss for which there are uniform values across workers of wage elasticities, employment rate elasticities, values of worker time, and offsets by firms. This could be generalized to writing many such equations for different groups of workers or even for each worker, allowing different groups of workers, or even each worker, to have their own elasticities, leisure time values, and firm offsets. The aggregate social cost of job loss would then sum over all workers these calculations for each worker or group. In addition, I am assuming just one type of job loss. There could be multiple types of job losses and gains in different labor submarkets because of the environmental regulation. We would then sum social values over each of these types of job losses and gains. Finally, the equation as written considers social costs for one time period. In the real world, there are dynamic responses to job losses and gains. We would sum each year's social costs over time using appropriate social discount rates.

ESTIMATES OF SOCIAL COSTS PER LOST JOB

Preliminary Social Cost Estimates

I now provide some estimates of social costs of job loss.

Initially, all these estimates assume that the job loss is permanent. This is a starting point for analysis. If the initial job loss is at least somewhat offset later by job gains, the value of these job gains could be added back in later on.

I also initially assume "average" costs of job loss. Later, I consider variations that may occur because of the size and sign of the job change, the nature of the job loss (e.g., industry mix or wage rate), the types of workers affected, and the labor market situation.

As a reference point, I first calculate the social costs of job loss if all of the associated earnings loss was a social cost. I assume, based on BLS statistics, average annual compensation (including benefits) of $59,997 (2012 dollars).[5] At a 3 percent discount rate, the present value of such an earnings loss over a 20-year future (an assumed time horizon) is $952,605. This present value is a little less than 16 times one-year's compensation. It is, by definition, equal to 100 percent of the gross earnings in the lost jobs (see Table 2).

I then consider the implications of some previous models of how job loss affects workers displaced from jobs. Walker (2012) considers workers who lost jobs because of the Clean Air Act. Davis and von Wachter (2011) consider displaced workers more generally. The resulting estimates of social costs of job loss are about 10 percent of the gross earnings loss associated with these jobs (Table 2). However, this is still a significant amount of money—over $75,000 in present value dollars per job loss.

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[5]This figure comes from BLS's series for Employer Costs for Employee Compensation. I use figures on average compensation of private sector workers. I average the dollar cost per hour across the four quarters of 2011 to get $28.26 per hour. This hourly compensation figure times 2080 hours per year yields a $58,781 figure, which is then adjusted using the CPI to 2012 prices.

However, the displacement numbers in Walker (2012) and Davis and von Wachter (2011) have some limitations as measures of the social costs of job loss. First, these estimates do not adjust for the value of nonworking time for displaced workers, which may increase or decrease social cost estimates. Second, these estimates do not allow for employers to have any gains from any wage reductions for displaced workers. Third, if these estimates are applied only to workers directly displaced by environmental regulations, they omit possible multiplier effects. Finally, these estimates do not allow for possible spillover effects on other workers of the earnings and employment recovery experienced by displaced workers. Suppose the regulation-induced job loss is persistent. Then as the displaced workers recover from the job loss and obtain new jobs, some of that job-finding may come at the expense of reduced job availability for other workers.

Local Labor Market Estimates of Social Costs

To get more inclusive estimates of social costs, my remaining estimates of social costs are derived from local labor market models. The advantage of such models is that we have good estimates in local labor markets of how employment rates and wage rates respond to negative (or positive) labor demand shocks. Job loss due to environmental regulation ultimately does take place in specific local labor market areas. The total effects of some pattern of job loss due to environmental regulation can be derived by summing effects across affected local labor market areas.

My baseline estimates are based on new estimates using metro area data (Bartik 2013). These estimates update previous estimates in Bartik (1991, 2006). An appendix gives more detail on how these estimates are used to create social cost estimates.

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The estimates are for the elasticities of a metro area's real earnings, and its components, in response to a one-time shock to metro employment growth (a once and for all shock to the metro employment level). Real weekly earnings is the product of the labor force participation rate, the employment to labor force ratio, weekly work hours, and the real wage rate per hour. Therefore, the elasticity of response of weekly earnings will be the sum of the elasticity of response of these components. In turn, real wages per hour are the sum of the real wages expected for this occupation based on national norms, and differences between actual real wages and this "occupational rank" wage rate.

The model is estimated using pooled cross-section time series data on year-to-year changes in the following dependent variables: real weekly earnings, real wages, unemployment rates, labor force participation rates, real wage rate predicted based on occupation and national wage rates. These dependent variables are adjusted for local demographic mix. The cross section is across 38 metro areas or 23 metro areas, depending on the availability of local price data that are needed for some of the dependent variables. The time series dimension is over year-to-year changes from 1979–1980 to 2010–2011. These dependent variables are explained as a function of the main independent variable of interest, which is current and lagged metro area annual employment growth. The regressions also control for year dummies to reflect national effects on labor market outcomes. Appendix A provides more detail and representative estimates.

The estimates are for the effects of a one-time growth shock on these various earnings components both immediately and for up to 10 years later. I use these estimates to project how earnings will respond to a job loss in a metro area for up to 20 years.

The initial estimates simply look at the effects of any type of employment growth shock. Later estimates are restricted to employment growth shocks that would be predicted if all local

industries kept their shares of national employment. This industrial-mix-predicted growth is due to changes in demand for the area's specialized industries that sell their goods and services to a national market (Bartik 1991), which regional economists label as "export-base" industries. These estimates that use industry-mix-predicted growth as an instrument can be seen as restricting attention to one particular type of growth shock that is clearly due to labor demand.

I also look at how employment growth shock effects vary with the initial unemployment rate. However, the initial estimates are for a metro area with an average initial unemployment rate. For the metro areas and years in my sample, this is an unemployment rate of 6.7 percent.

The resulting estimates are discussed in more detail in Bartik (2013). The upshot, consistent with previous estimates (Bartik 1991), is that local job loss has initially strong effects in raising local unemployment rates and reducing weekly work hours, but these effects quickly fade. Labor force participation rates are also reduced, and these effects fade more slowly. Local job loss results in persistent effects in reducing local real wages. Some of these effects are due to workers being forced into occupations with lower national wage norms. Other real wage reductions are due to workers receiving lower local real wages than would be expected based on their occupations. Some of these negative real wage differentials from occupational averages are probably due to workers being forced into lower job levels within an occupation. Other negative real wage differentials are due to workers making less for the same job.

For effects in one labor market to accurately measure overall social costs, we must believe that if jobs are lost in one metro area, the labor market effects do not substantially spill over into other labor markets. This might appear implausible. Job loss in one metro area will lead to reduced in-migration from other metro areas, and increased out-migration to other metro areas. However, the best evidence is that the local labor market effects of such population shocks

are slight. Migration shocks appear to yield similar changes in local employment (Greenwood and Hunt 1984; Muth 1971). As a consequence, we would not expect these migration shocks to cause substantial shifts in employment rates, wage rates, and other labor market outcomes in other metro areas.

The consequence of assuming no net labor market spillovers is that we can analyze the social costs of any national job loss using the local labor market model. The national job loss will be some pattern of local job losses. Each of these local job losses can be analyzed using the local labor market model. The national loss will be the sum of these local losses. If the elasticities are similar across local labor markets, then only the net national job loss must be known to evaluate national social costs.

To allow an apple to apple comparison of this local labor market model with the Walker (2011) and Davis and von Wachter (2011) results, I first simply provide estimates of the likely earnings effects under the local labor market model. These earnings costs are a little more than three times those estimated by Walker and Davis and von Wachter. However, these costs are still less than a third of the gross earnings associated with the lost jobs—workers in local labor markets do adjust to the loss of a job. However, the costs of job loss are greater in the local labor market model because the model allows for spillover effects of job loss on all workers. Job loss lowers wage rates and employment rates for workers other than those in the regulated industries.

However, these earnings loss numbers are not true social cost numbers. They do not adjust for the value of increased worker leisure or gains to firms. For better social cost figures, I must apply the two methods outlined above.

I initially assess social costs with the local labor market model using method (1). This involves looking at how job loss affects both employment rates and wage rates. To convert

effects on these different components of earnings into social costs, I must make some additional assumptions. For my baseline social cost estimates, I assume a middle ground for the value of nonworking time. Knabe and Ratzel (2011) value nonworking time based on surveys of how life satisfaction responds to current income, permanent income, and labor force status. Their estimates imply that the value of worker time while involuntarily unemployed is equal to minus 50 percent of the market wage. The stigma effects of unemployment add about 50 percent to the direct earnings loss. The value of nonworking time while out of the labor force is estimated to be about minus 10 percent of the market wage. These estimates might be seen as providing relatively large estimates of stigma effects and social costs of nonemployment. On the other extreme, estimates suggest that it is likely that marginal taxes at all levels on labor earnings amount to at least 30 percent of labor earnings (CBO 2005; Kotlikoff and Rapson 2007). This suggests a maximum value of nonworking time of 70 percent of the wage rate.

For my baseline estimates, I assume an opportunity cost of nonworking time of halfway in-between these two figures. Thus, the net value of additional nonworking time in unemployment is assumed to be 10 percent of the wage rate (= halfway between −50 percent and +70 percent). The net value of additional nonworking time that is outside the labor force is assumed to be about 30 percent of the wage rate (= halfway between −10 percent and +70 percent). For reduced weekly work hours, the baseline middle of the road assumption is that the value of this time is 35 percent of the wage rate (halfway between 0 and 70 percent).

While these opportunity costs of labor assumptions are arbitrary, they appear reasonable. The public clearly views unemployment as a very damaging status. Our valuation of the unemployed's time must be low enough to correspond to this public perception. If we fail to match public perceptions, our social cost estimates will be irrelevant to political debate.

I also need to make assumptions about what portion of wage reductions will be offset by gains to employers. For these baseline assumptions, I also make middle-of-the-road assumptions. For wage reductions due to occupational downgrading, I assume that half of these wage rate reductions will be offset by gains to employers in greater worker productivity. The estimates also show reduced wages due to differentials of local wages from occupational norms. Seventy-five percent of the wage reduction in these differentials is assumed to be offset by gains to employers.

Finally, I assume for these calculations that we are already working with job loss numbers that have been adjusted for possible multiplier effects. If this were not so, we would have to add in multiplier effects of the direct job loss before calculating social costs.

Obviously a number of assumptions are being made here to generate these estimated social costs of job loss. My defense is that the assumptions seem reasonable. Furthermore, I will consider alternative assumptions below.[6]

Social costs for the baseline version of this local labor market model are of similar magnitude to the estimates derived from displacement studies. Estimated social costs of job loss are about 14 percent of the gross earnings associated with the job loss. The present value of social costs due to the permanent loss of one direct job is around $134,000 (Table 2). These similar costs are due to the higher earnings effect being roughly offset by allowing for the opportunity costs of labor and benefits to firms.

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[6]In the local labor market context, we might also wonder about the decrease in local prices, particularly in local housing prices, and the possible gains to employers of decreases in nominal wages due to decreases in local prices. I assume that these housing price effects net out from an economic efficiency perspective. Even if such effects were included, previous studies indicate that property value effects of local employment shocks have a much lower present value than real earnings effects of local employment shocks (Bartik 1991, 2011).

I can also calculate social costs of job loss using the method (2) approach. I use market wages to lower bound this reservation wage measure. The same offsetting firm benefits are assumed as with method (1).

The resulting social cost estimates are a little less than 9 percent of the earnings associated with these lost jobs. Because this is a lower bound, this implies that the 14 percent result from method (1) may be a reasonable estimate.

Alternative Estimates

The baseline estimates rely on one specific set of estimated effects of local employment shocks on local labor market outcomes (Bartik 2013). How sensitive are these estimated social costs to alternative estimates? Table 3 presents some alternatives.

I consider how estimates vary if we focus on the effects of local employment reductions that are due to local industry mix and national industry growth trends. These estimated effects are more clearly due to labor demand, whereas employment changes in general may be due to both labor demand shifts and labor supply shifts. These estimates show larger negative effects of local job losses. Other assumptions about offsets for firms and the social value of nonworking time are the same as before.

Moving to "demand shock" estimates more than doubles the estimated social costs of job loss. The present value of the social cost of one lost job increases to almost $300,000. The social costs of lost jobs are just below 32 percent of the earnings associated with these lost jobs (Table 3).

I also calculate social costs using the estimated effects of local growth in Bartik (1991). All other assumptions are the same. Social costs using these Bartik (1991) estimates are also

somewhat higher than in the baseline estimates: $237,000 per job and about 25 percent of the gross earnings associated with the job loss.

Although these alternative estimates are higher, note that social costs are still considerably below the gross earnings associated with the loss jobs. Workers adjust to job loss, and there are some offsetting benefits to workers and firms. Thus, not all the earnings associated with lost jobs are a true social cost. In addition, all these estimates assume some permanent job loss. If the job loss leads to some offsetting job gains as capital and consumer demand shift to other industries, social costs will be even lower as a percentage of the earnings associated with the original job loss.

Alternative Assumptions about Opportunity Costs of Nonworking Time and Employer Offsets

The baseline estimates rely on hard-to-test assumptions about the social value of increased nonworking time that occurs due to job loss. The baseline estimates also rely on hard-to-test assumptions about how much of the wage reductions will be offset by gains to employers.

I consider effects on social cost calculations of more extreme assumptions in Table 4. One set of extreme assumptions pushes social costs down. I alter the estimates by assuming much higher social value to increased nonworking time and much higher employer offsets. I assume that the increased nonworking time due to job loss is valued at 70 percent of the wage rate, which reflects taxes on work. I assume that all wage reductions that exceed those predicted by occupational downgrading are fully offset by benefits for employers. And I assume that occupational downgrading results in productivity gains to employers that offset 75 percent of the costs of these wage reductions to workers.

Under this set of extreme assumptions, social costs of job loss are cut by more than two-thirds (Table 4). The social cost is about 4 percent of the associated reduction in earnings. On the other hand, this set of extreme assumptions still results in a social cost of over $38,000 per lost job.

I also go to another extreme. I make assumptions that dramatically increase social costs. I assume high stigma effects of nonworking times, and small offsetting employer benefits. I assume that increased time in involuntary unemployment has a social cost of 50 percent more than the associated earnings, based on estimates in Knabe and Ratzel (2011). I also assume that increased time outside the labor force has a social cost of 10 percent more than the associated earnings loss. Reduced weekly work hours are assumed to have a social cost just equal to the earnings lost. Finally, I assume that only one-quarter of wage reductions are due to occupational downgrading, and 50 percent of other wage reductions are offset by gains for employers.

These assumptions drive social costs up to about 24 percent of the associated earnings loss. Present value social costs per lost job are about $229,000.

More extreme assumptions about how workers value leisure and how much firms benefit from wage reductions can drive social cost estimates for job loss to near zero. However, these extreme assumptions are unlikely to increase social costs of job loss to anywhere close to the full value of the earnings associated with the job loss.

The Bottom Line on Social Costs of Typical Job Loss

These varying estimates and assumptions do yield varying results. But I think the estimates do help narrow the range of the plausible social costs of job loss for a typical job loss. By typical job loss, I mean that the jobs lost have employees with typical characteristics, that the jobs are average wage jobs, and that the unemployment rate is not extremely high. For this

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typical job loss, at one extreme it seems implausible that social costs could be much less than the lower bound provided by method (2), which relies on a reservation wage model. This social cost is 8 percent of the gross earnings associated with the direct job loss. As an upper bound, we can't rule out the estimates based on labor demand shocks due to local industry mix. This upper-bound measure has social costs of a little less than 32 percent of gross earnings associated with lost jobs.

A fourfold range from 8 to 32 percent could be argued to be wide; however, it is narrower than considering a range from 0 to 100 percent of the direct earnings effect, which is what the EPA Handbook (2011a) recommends.

Variations from Typical Job Loss Based on Who Loses Jobs, Types of Jobs, Size and Sign of Job Growth, and Labor Market Conditions

The above calculations ignore the potential for social costs of job loss to vary across different types of negative demand shocks. Social costs might vary with the characteristics of who loses the jobs, the types of jobs, the size and sign of job growth, and labor market conditions. Unfortunately, we do not have a huge amount of information how estimated labor market adjustments vary with these factors. I briefly review some of the research evidence for these variations from typical job loss.

Davis and von Wachter (2011) do consider how job loss effects vary across different types of workers. They find similar social costs as a percentage of the associated earnings of the lost jobs, with one important exception: older workers. For such workers, social costs are 100 percent greater as a percent of earnings (e.g., for men aged 51–60, versus men aged less than 50, they find lost earnings as a percent of counterfactual earnings of 24.0 percent versus 11.9

percent). Of course, it should be recognized that it would be unusual for some job loss to have 100 percent of its displaced workers be workers older than age 50.

Bartik (1993) has estimates that look at how effects of job growth shocks vary with different types of jobs. I find that effects do not vary much with whether the jobs tend to employ a particular education group, racial group, or age group, even when we focus on earnings effects on particular demographic groups. Bartik (1993, 1996) finds that effects of job growth shocks vary greatly with the average "wage premium" implied by the jobs' industrial mix. The wage premium measures what that industry typically pays relative to the all-industry average, controlling for the demographics of the industry's workforce. I find that a shift in a local labor market's industry mix toward industries that pay an x percent lower wage premium tends to reduce overall area earnings by from two (Bartik 1993) to five (Bartik 1996) times x percent. It appears that a lower wage premium spills over into lower wage rates in other industries. In addition, a lower wage premium spills over into some decline in employment rates and annual hours worked. These spillover wage premium effects would imply possibly considerably higher social costs as a percent of earnings if the lost jobs have high wage premia. However, if one examines overall job loss including multiplier effects, wage premia effects may not be large. The manufacturing jobs lost might pay high average wage premia, but many of the multiplier jobs in retail and service industries will pay below average wage premia.

Davis and von Wachter (2011) also consider job loss effects during a recession. (The estimates above are for nonrecession years.) During a recession, social costs of job loss are over 60 percent greater as a percent of earnings (e.g., around 19 percent versus around 11 percent— see their Table 1). Somewhat smaller differentials are obtained in Bartik (2013) for variations with local labor market conditions. The baseline calculations above found social costs of 14.1

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percent of gross earnings loss when the initial local unemployment rate was 6.7 percent (the sample average). However, social costs were 16.2 percent of gross earnings changes when the initial unemployment rate was 8.7 percent, and 11.9 percent when the initial unemployment rate was 4.7 percent.[7]

Several points should be noted here. First, social costs of job loss are large even when the macroeconomy is booming. Second, social costs might need to be blown up by 30 percent to 60 percent if either the national economy is distressed, or if the job loss happens to be in a high unemployment local economy. Third, if the job loss is in a high-unemployment local economy, there may be net costs of labor readjustment even if the job loss is immediately offset by job gains in lower-unemployment local areas. There is some net social cost of redistributing jobs from high-unemployment to low-unemployment areas.

Bartik (1991) examines whether the effects of local job growth on labor market outcomes varies with the sign and size of growth. I do not find strong and consistent variations of labor market effects with the size and sign of job growth.

What can we conclude from this analysis of variations in social costs of job loss? First, if we really want to get precise benefit-cost estimates that adjust for the effects of job loss or gains, we need to adjust for factors such as worker age, the wage premia paid for the jobs, and initial labor market conditions. Second, the existing research base is sparse in providing precise consensus estimates on how social costs vary. Third, it seems unlikely that these variations will do much more than double social cost estimates from the typical values given previously. This puts some likely upper bound on how important social costs of job loss can be.

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[7]The standard deviation of the local unemployment rate in this 1979–2011 sample of 38 metro areas was 2.2 percent, so the range of unemployment rates considered is about plus or minus one standard deviation.

POTENTIAL EFFECTS OF JOB LOSS ON OVERALL SOCIAL COSTS OF REGULATIONS

How much of a difference do these estimates of job losses' social costs make to benefit-cost analysis? We have many benefit-cost analyses of environmental regulations and other regulations. These analyses typically do not assign any social costs to job losses (or gains) in calculating the net benefits or benefit-cost ratio for a regulation. The ideal benefit-cost analysis would include the social costs of job loss. If this were systematically done, would it make much difference in which regulations were judged to pass a benefit-cost test? Would it much affect our ranking of regulations?

To address these questions, I analyze a number of prominent regulations that have been discussed as cases in which job losses might be considered. In particular, I consider the environmental regulations analyzed by Masur and Posner (2012), and the Clean Air Act analysis of Walker (2012).

Appendix B presents more details on my results for each of these regulations. In Table 5, I present summary results for 12 of the regulations analyzed in Appendix B.

As Table 5 shows, for nonhabitat regulations, the social costs of job loss, as a percentage of total costs, are low. The average is 5 percent. The maximum calculated percentage boost to social costs is 13 percent.

For habitat regulations, the situation is different. Social costs of job loss are a far larger percentage of measured social costs. This might be attributable to the nature of these particular regulations. For most of the other environmental regulations, the regulation is applied to most of an industry or at least a large segment. Therefore, the increased regulatory costs are being

imposed in a context in which many costs will be shifted forward into higher product prices. This forward shifting is likely to reduce direct job losses.

In contrast, for habitat preservation, we are imposing a regulation on a very tiny segment of an industry. Therefore, modest imposed regulatory costs could cause considerable direct job effects on that industry segment.

I now consider three regulations for which there has been particularly prominent discussion of job effects: 1) Walker's (2012) analysis of job effects of the Clean Air Act, 2) the industrial boiler regulations that have been attacked for causing job losses by industry groups, and 3) Masur and Posner's (2012) lengthy focus on effluent guidelines for pulp and paper manufacturing. Table 6 presents more details on these three regulations and their job effects.

Walker (2012) estimates that the direct effect of the Clean Air Act on regulated industries is a loss of 150,000 jobs. His job loss estimate is based on comparing employment trends for the polluting industries versus nonpolluting industries in newly designated nonattainment counties versus attainment counties. Because the comparison is in part relative to nonpolluting industries in nonattainment counties, it does not include a multiplier effect, but is only the estimated direct job loss in the polluting industries. Therefore, I use a multiplier of 2 to get an estimated job loss of 300,000 jobs. This results in a present value cost of the job loss due to the regulation of over $36 billion. This $36 billion figure multiplies 300,000 jobs by my estimated present value of social costs of job loss of $134,000 per job lost. This is a large number, but the Clean Air Act overall has a net present value of costs of over $423 billion. As a percentage of overall social costs, including job effects only raises social costs by 8 percent.

Therefore, I confirm Walker's (2012) conclusion that "the wage costs borne by workers [due to the Clean Air Act] are a small fraction of the benefits," as benefits are estimated to be

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over 31 times overall social costs. But I further strengthen his conclusion by arguing that the social costs of this job loss are also small compared to overall social costs. Furthermore, my conclusion follows even though I assume that the job effect with a multiplier is twice his estimated job loss, and I also assume higher social costs per job lost than in his model. As shown in Table 2, my local labor market social cost estimates per job lost are over 30 percent greater than Walker's (−\$134,000 versus −\$98,000). Finally, this job loss number assumes that the only job effects of the Clean Air Act are a permanent job loss of 300,000 jobs. Yet it is implausible that the Clean Air Act permanently reduces overall jobs in the United States by 300,000 jobs. Presumably the consumer spending and capital that went into some of these regulated industries will eventually find other uses.

Critics of the air pollution standards for toxic pollutants from industrial boilers have claimed that this regulation might cost around 50,000 jobs.[8] This is apparently based on unreleased research from the U.S. Commerce Department, which the outside critics claim "support[s] the findings of independent research conducted by . . . industry groups." I use this job loss number not because it is necessarily accurate, but rather because it is the kind of large job loss figure sometimes claimed by critics of environmental regulations. Fifty thousand jobs is clearly a large job loss number for these regulations. I assume that these claimed job losses already include multiplier effects, so the social cost of each lost job would be around \$134,000 per job lost. The social cost of these lost jobs is considerable: over \$6 billion in present value losses. However, this is still less than 13 percent of the overall present value costs of this regulation. Furthermore, these 50,000 lost jobs ignore the possibility that the consumer demand and capital involved in these regulated industries will go somewhere else in the economy.

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[8]The specific claim by opponents is 40,000–60,000 jobs lost. I take the midpoint of these job loss estimates.

It might appear that my results are quite different from Masur and Posner (2012) for the regulation that is their special focus, effluent guidelines for pulp and paper manufacturing. They report that the regulatory option chosen by EPA "is no longer cost-benefit justified once . . . unemployment costs are figured into the equation" (p. 630). In contrast, I estimate that the social costs of job loss due to the regulation will increase overall social costs by less than 7 percent. This seems unlikely to tip any benefit-cost analysis.

Both of our analyses are using the same estimate of a loss of 5,711 jobs. These cost estimates start with judgmental engineering cost studies of what plants will close due to these regulations. These direct job losses are then combined with an input-output model to estimate the total job loss of 5,711.

The biggest reason that Masur and Posner (2012) got their results is that they compared the costs of job loss with a case in which what they call "median benefits" only slightly exceeded costs. They used the average present value of benefit number from the range of estimates presented in EPA (1997, Table 10-2 on p. 10-4). It so happens that this average benefit number is only 2.1 percent above EPA's estimated present value of costs. As a result, even slight variations in costs are able to tip a benefit-cost analysis. In fact, given that I estimate that the job loss increases social costs by 6.8 percent, my estimated social costs of job loss are also enough to tip the benefit-cost analysis under Masur and Posner's assumptions about median benefits. They actually use similar cost per job numbers to what I use. I assume a cost per job figure of $134,000; they use two possible costs per job figures, which, in 2012 dollars, are calculated to be $52,000 and $150,000.

However, it is highly unusual for the benefits and costs numbers to be so close in magnitude for an adopted regulation. In this particular case, this appears to be an accident of the

range of benefit estimates produced by EPA, and the incompleteness of these estimates. First, these estimates are incomplete and underestimate benefits. EPA argued in their Federal Register filing on this regulation that an estimate of net benefits would be misleading for this regulation because too many categories of water quality benefits are not monetized: "EPA did not estimate annual net benefits . . . because so many categories of benefits are unmonetized that the comparison would be misleading" (p. 18590, 63 Fed. Reg.,1998). In EPA's 1997 economic analysis of this regulation, EPA also argues that "monetized benefits are underestimated. Given this shortfall in the benefit estimates, it would be misleading to subtract benefits from the estimated costs and make conclusions about the net benefits of the regulation to society" (EPA 1997, p. 10-1). EPA obviously is unable to state the quantitative magnitude of benefits it doesn't measure, but it would not be surprising if these unmeasured benefits are a larger percentage of benefits and costs than is true for the social costs of job loss.

Second, the median economic benefit presented by Masur and Posner (2012) is the average of widely varying estimates by EPA. In 2012 dollars, EPA estimates that the present value of social costs of the regulation is $11.312 billion. The present value of benefits is estimated to range from −$21.950 billion to +$45.051 billion. Masur and Posner average the two extremes of this benefit estimate range to get median benefits of $11.551 billion, which just so happens to be 2.1 percent greater than estimated social costs. And it also so happens that plausible costs of job loss are somewhat greater than the difference between costs and median benefits. But surely the more important issue is how to narrow down the range of benefit estimates. The social costs of job loss are dwarfed by the uncertainty in EPA's benefit estimate—the range of EPA's benefit estimates of $67 billion, from −$22 billion to +$45 billion, is over 80 times what I estimate the social costs of job loss to be, at $0.766 billion.

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The main impediment to better benefit-cost analysis of these pulp and paper regulations is not EPA's failure to include the social costs of job loss. Rather, the more important issue is the estimate of benefits, due to the wide range of possible estimates and the omission of benefits.

In sum, job losses from environmental regulation can be large. The associated social costs can also be large. However, under plausible estimates of typical social costs of job loss, it is unlikely that adding in social costs of job loss will cause a large percentage increase in overall social costs. Therefore, including typical social costs of job loss will rarely tip benefit-cost analyses of these regulations.

The caveat is that for some regulations, assuming the maximum plausible values of social costs of job loss could make a difference to benefit-cost analysis. For example, if we use the demand instrument estimates using local labor market data, costs per job loss approximately double. If we further assume that the jobs lost are in a severe recession or a severely depressed local labor market, we might get a further 30–60 percent increase in social costs of job loss. If the affected plants happened to employ a great many older workers, social costs of job loss might further increase. If we assume an extreme enough scenario, for at least some of the nonhabitat regulations in Table 5, we could push estimated social costs of job loss up to 20 percent or more of overall social costs.

On the other hand, these calculations assume that all of this job loss is permanent. In a more realistic scenario, the capital and consumer demand displaced in regulated industries will boost job growth elsewhere in the economy. As a result, even with involuntary unemployment, the most plausible conclusion is that social costs of job loss will rarely make a big difference to the overall costs of environmental regulation.

CONCLUSION

The social cost of a lost job is plausibly high. This corresponds to how the public and politicians perceive job loss. However, the estimates suggest that the social costs of a lost job are much less than 100 percent of the earnings associated with that lost job. A maximum plausible value for typical losses is 32 percent of the associated earnings. Other figures are significantly less than 20 percent of the associated earnings. A midpoint figure used in this report is 14 percent. A plausible minimum figure might be 8 percent of the earnings associated with the job loss. Estimating the bottom-line net job effects of environmental regulation is challenging. Determining direct effects on the regulated industry is difficult enough, but it is even more difficult to determine the level and timing of possible offsetting job gains in the overall national economy.

However, even if we only look at the direct job losses and don't consider possible offsets, in most cases the social costs of job loss due to regulation will add less than 10 percent to the measured social costs of the regulation. It takes quite a bit of regulatory costs to destroy one job. The social costs of job loss, although high, are not high enough to play a major role in driving benefit-cost analysis of environmental regulations.

One caveat is that social costs of job loss may loom higher for certain types of environmental regulation, such as some habitat regulations that entirely prohibit rather than regulate some economic activity.

Another caveat is that social costs of job loss vary with the age of the workers affected, the wage premia of the jobs lost, and with how high unemployment is in the national or local economy. When we combine this with the uncertainty in the general estimates of social costs of

job loss, there are some extreme cases of job loss in which social costs will be more important than they are typically.

For research, this points to the need to improve our estimates of the social costs of job loss. In particular, we need more precise estimates about how social costs of job loss vary with worker demographics, the types of jobs, and economic conditions. We need better estimates of possible effects on firms of some of the occupational and job downgrading associated with job loss. We need better estimates of how quickly and to what extent the consumer demand and capital supply that is displaced by regulation leads to job gains in other industries.

What can we say to Congress about including the social costs of job loss in benefit-cost analysis of environmental regulation? I think we can definitely include job loss in benefit-cost analysis if that is demanded. Adding in the social costs of job loss would probably increase the uncertainty of the overall social cost figures. There is more uncertainty in the social cost of job loss figures than in most of the other regulatory costs. This uncertainty is due to uncertainty in both the job effects and the appropriate social cost per job lost. But although the resulting social cost figures would be more uncertain, these overall social cost figures would be more comprehensive in addressing the benefits and costs that the public values.

What also needs to be said is that if jobs gained or lost have a high value per job, the most efficient response is to have policies that specifically target job creation. Trying to create jobs through reforming environmental regulation is an inefficient way to address the need for jobs. If the economy is short of overall jobs, this can in many cases more effectively be addressed through monetary policy than through restructuring all the other operations of the government to address the jobs issue. If monetary policy is constrained by the zero bound on interest rates, or by other factors, then fiscal policy or other job creation policies can potentially

address job creation in a cost-effective way. There are a number of overall job creation policies whose net fiscal costs will be less than $134,000 per job, including public spending on labor-intensive goods and services, public service jobs, wage subsidies, and work sharing (Bartik 2010). From a policy wonk perspective, it is completely inconsistent for a politician to argue against environmental regulations because they are "destroying valuable jobs" while also opposing policies that would create jobs at a lower cost than these jobs' value. But political stances are often inconsistent.

If monetary and other policies are effectively addressing the need for jobs, then including jobs in benefit-cost analysis of government regulation is less important in at least two senses. It is less important in that with lower unemployment, the costs of any job loss will be less. Therefore, benefit-cost numbers will be altered less by including the social costs of job loss. Including jobs in benefit-cost analysis will also then be less important because if we can count on public policy to maintain adequate overall employment, we can also count on any job loss from environmental regulation to be offset by job gains elsewhere. Net job effects will be small. There remains the distributional issue of some individuals being displaced by job loss, while other persons may gain from the offsetting job gains. But worker readjustment policies should have greater chance of success if the overall job market is maintaining adequate growth of overall employment.

The demand for including jobs in environmental benefit-cost analysis is just one of the more modest costs of the United States' failure to aggressively address the need for higher aggregate employment. Until we achieve and maintain a healthier aggregate labor market, we can expect the political and economic need for more jobs to distort many areas of U.S. public policy.

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Table 1 Benefits and Costs of Pollution Regulations Incorporating Job Effects

Category	Labor demand or supply	Sub-category	Direct job effects	Indirect job effects
Business regulatory effects				
	Labor demand	Direct cost effects on regulated industry	Job reduction in regulated industry, losses for affected workers	Affects overall labor market for all workers with reduced employment rates and wage rates
	Labor demand	Pollution compliance effects	Additional activity in regulated industry and suppliers to comply with regulation, which creates jobs	This job creation will affect overall labor market with increased employment rates and wage rates
	Labor demand	Multiplier effects of direct effects	Lower activity in regulated industries, and higher activity in pollution control industries, may have multiplier effects on suppliers to these industries and on suppliers to these industries' workers	Effects on supplier industries affects overall labor market, not just workers in supplier industries
	Labor demand	Displaced capital and consumer demand effects	Capital and consumer spending that would have gone to polluted industry go elsewhere, with job creation effects	This job creation affects not just hired workers, but overall labor market conditions
	Labor supply	Increased prices in regulated industry increases overall prices, which lowers real wages	Lower real wages may lower aggregate labor supply if labor supply responds to real wages	Lower labor supply of some workers affects labor market for other workers
Amenity and health benefits of reduced pollution				
	Labor demand and supply	Amenities may be complements or substitutes for leisure or various goods and services	Increased amenities may cause various shifts in consumer demands or supply of labor, with uncertain effects on overall labor demand and supply	Whatever labor demand or supply shocks occur will have effects on overall market equilibrium
	Labor supply	Health benefits of reduced pollution	May increase quantity or quality of labor supply	Addition to labor supply will possibly have some displacement effects in labor market, lowering others' real wages and employment rates

Table 2 Baseline Estimates of Social Costs of Job Loss

	Present value of social costs in dollars per lost job (2012 dollars)	Present value of social costs as ratio to annual earnings in lost jobs	Present value of social costs as % of present value of future earnings in lost jobs
Social cost = gross earnings	−952,605	−15.88	−100.0
Walker (2012) displacement estimates	−98,375	−1.59	−10.0
Davis and von Wachter (2011) displacement estimates	−76,845	−1.61	−11.4
Earnings estimates from local labor market model	−296,959	−4.95	−31.2
This paper's baseline estimates	−134,207	−2.24	−14.1
Reservation wage approach	−81,227	−1.35	−8.5

NOTE: Gross earnings figures assume all earnings associated with job loss are complete social loss. Walker figures are taken from dollar effects of displacement in column 5 of his Table 2, and percentage of earnings figures are taken from column 3 of his Table 2. I recalculate present values using a 3% discount rate. Davis and von Wachter figures are equally weighted averages of their results for men and women aged 21–50 with three or more years tenure, from their Tables 1 and 2, results for all years. The remaining estimates are based on local labor market model estimated in Bartik (2013) (see also Appendix A of the present paper). The earnings effects row estimates are comparable to Walker and Davis and von Wachter in not considering value of leisure or benefits for firms. The baseline estimates use method (1) from text, and baseline assumptions about leisure values and firm benefits. Reservation wage approach uses method (2) from text, and baseline assumptions about firm benefits. All estimates use 3% discount rate, except for Davis and von Wachter, which uses 5%. A 5% discount rate does not change other rows much.

Table 3 Alternative Social Cost Estimates, Using Different Local Labor Market Estimates

	Present value of social costs in dollars per lost job (2012 dollars)	Present value of social costs as % of annual earnings in lost jobs	Present value of social costs as % of present value of future earnings in lost jobs
This paper's baseline estimates	−134,207	−2.24	−14.1
Demand shock estimates	−298,658	−4.98	−31.4
Bartik (1991) estimates	−237,321	−3.96	−24.9

NOTE: Baseline estimates are same as in Table 2, and are based upon Bartik (2013) and assumptions outlined in text. Demand shock estimates are based on effects of growth estimated in Bartik (2013) based on instrumental variable estimates for effects of local job growth. Instrument for growth is predicted metro growth based on initial local industry mix and national industry growth trends. The last row uses estimates of growth effects from Bartik (1991). All other assumptions are same across all estimates in this table.

Table 4 Social Cost Estimates under Alterative Assumptions about Offsets

	Present value of social costs in dollars per lost job (2012 dollars)	Present value of social costs as % of annual earnings in lost jobs	Present value of social costs as % of present value of future earnings in lost jobs
This paper's baseline estimates	−134,207	−2.24	−14.1
Higher opportunity costs of labor and higher employer offsets	−38,941	−0.65	−4.1
Lower opportunity costs of labor and lower employer offsets	−229,473	−3.82	−24.1

NOTE: Baseline estimates are same as in Tables 2 and 3, and rely on baseline assumptions outlined in text and Appendix A. The next two rows alter those assumptions, as described in text, to higher or lower valuations offsets of the earnings loss for workers by either gains in nonwork time or gains for employers.

Table 5 Summary of Social Costs of Job Loss, as Percent of Total Estimated Social Costs of Environmental Regulations

	Average social costs of job loss as % of total measured social costs of environmental regulation	Range of social costs of job loss as % of total social costs, across regulations considered
Nine environmental regulations from Walker (2012) and Masur and Posner (2012) (nonhabitat)	5	1–13
Three habitat regulations (from Masur and Posner 2012)	84	24–167

NOTE: This summarizes information from Appendix B, Table B1. I consider percentage change in social costs due to job effects reported in that table, and summarize means and range. The three habitat regulations are identified in table. The nine nonhabitat regulations are all other regulations in Table B1 except for last two rows, which were suggested to me by EPA staff, and also other rows where percentage change in costs is zero or negative. In cases where range of social costs is reported in Table B1, I use largest positive percentage. The estimates used in this table end up being most of Masur and Posner's regulatory cases, and Walker's Clean Air Act analysis. Calculated mean percentage is unweighted mean across nine or three regulations.

Table 6 Social Costs of Job Loss Compared to Overall Social Costs for Three Prominent Regulations

Regulation	Source of benefit-cost and job info	Benefit-cost ratio	Overall social costs: present value (billions of 2012$)	Jobs lost (or gained)	Job effects: cost (or benefit) in present value (billions of 2012$)	% change in costs due to job effects
Clean Air Act	Walker (2012); EPA (2011b)	31.58	−432.663	−300,000	−36.640	8.5
Industrial boiler air pollution standards	76 Fed. Reg. 15,608 (2011); American Forest and Paper Assoc. (2010)	25.33	−53.311	EPA says small; others claim −50,000	0 to −6.710	0 to 12.6
Pulp/paper: total package of air and water pollution regulations	Masur and Posner (2012); EPA (1997)	?	−11.312	−5,711	−0.766	6.8

NOTE: This table is an excerpt of three rows from Table B1 in Appendix B.

APPENDIX A

MORE DETAILS ON ESTIMATED LOCAL LABOR MARKET MODEL AND ITS USE IN THIS PAPER

This paper's local labor market models of social costs are derived from new estimates of how local labor market outcomes respond to employment growth. The relevant "growth shock" is a one-time shock to growth, or a once and for all shock to the employment level. More details on this estimation are in Bartik (2013).

These local labor market elasticities are based on estimates of equations such as the following:

$$\ln Y_{mt} - \ln Y_{mt-1} = B_0 + B(L)G_{mt} + C(L)\ G_{mt}*U_{mt-k} + F*\ U_{mt-k} + D_t + e_{mt} \qquad \text{(Eq. A1)}$$

$\ln Y_{mt} - \ln Y_{mt-1}$ is the logarithmic change in some average labor market outcome variable in a metropolitan area m from year $t-1$ to year t. G_{mt} is logarithmic metro employment growth from one year to the next. B(L) is a polynomial in the lag operator, which indicates that the equation includes both current and possibly several lags in employment growth. Some specifications include $G_{mt}*U_{mt-k}$, which is an interaction term between metro growth and the initial unemployment rate in the metro area. C(L) indicates some lags in growth are included in this interaction term. These terms are included in some specifications to see if the effect of growth on labor market outcomes varies with initial labor market conditions. The lagged unemployment rate variable is also included by itself in specifications that include initial

unemployment rate's interaction with subsequent growth shocks. D_t is a set of year dummies, so that we are examining differentials in labor demand shocks across metro areas and how they are related to differentials in labor market outcomes across metro areas. e_{mt} is the disturbance term.

This model is estimated using pooled time series cross section data on average labor market outcomes for either 23 (for real wages) or 38 metro areas (for labor force variables) over the years 1979–2011. More details on the derivation of the data are in Bartik (2013).

The immediate effect of a growth shock is the coefficient on current period growth. The long-run cumulative effect of a one-time growth shock (a once and for all shock to the employment level) is the sum of all the B(L) coefficients up to the last lag of growth included. The cumulative effect after s years of a one-time growth shock (a once and for all shock to the employment level) is the sum of all the B(L) coefficients up to the sth lag in growth. In all models, we consider what lag length in growth optimizes the Akaike Information Criterion, a standard model selection criterion.

The estimates from this model are used in various Excel calculations to calculate social costs of job loss. The estimates from this model are used to derive an Excel table that looks like Table A1.

This table shows cumulative elasticities effects implied by "optimal" models from Bartik (2013) of cumulative effects after various years of a one-time negative reduction in employment. For example, the −0.278 for the year zero row, employment to labor force column, means that if there is a one-time reduction in metro employment of one percent in logarithmic terms (the log of metro employment declines by 0.01), then the natural logarithm of the metro area's ratio of employment to the labor force will decline by 0.278 times as much, or by −0.00278. This effect

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on the employment to labor force ratio diminishes over time and is estimated to disappear after

five years.

Table A1 Job Loss Elasticities Used in Local Labor Market Baseline Model

Year after job loss	Weekly work hours	Employment to labor force ratio	Labor force participation rate	Real wage rate	Real wage rate predicted based on occupation	Wage differential from occupational prediction
0	−0.0724	−0.278	0.0167	−0.18	−0.0654	−0.1146
1	−0.0364	−0.25	−0.103	−0.248	−0.0542	−0.1938
2	−0.0174	−0.0908	−0.0763	−0.0662	−0.0545	−0.0117
3	−0.0974	−0.0719	−0.0899	−0.256	−0.0504	−0.2056
4	−0.0213	−0.113	−0.0379	−0.358	−0.0646	−0.2934
5	−0.0581	0.0111	−0.105	−0.319	−0.117	−0.202
6	0.00607	0	−0.0522	−0.16	−0.0481	−0.1119
7	0	0	0.0236	−0.226	−0.0606	−0.1654
8	0	0	0.0126	−0.337	−0.0934	−0.2436
9	0	0	−0.0137	−0.3	−0.0351	−0.2649
10	0	0	−0.00154	−0.197	−0.0449	−0.1521
11	0	0	0	−0.197	−0.0449	−0.1521
12	0	0	0	−0.197	−0.0449	−0.1521
13	0	0	0	−0.197	−0.0449	−0.1521
14	0	0	0	−0.197	−0.0449	−0.1521
15	0	0	0	−0.197	−0.0449	−0.1521
16	0	0	0	−0.197	−0.0449	−0.1521
17	0	0	0	−0.197	−0.0449	−0.1521
18	0	0	0	−0.197	−0.0449	−0.1521
19	0	0	0	−0.197	−0.0449	−0.1521
20	0	0	0	−0.197	−0.0449	−0.1521

NOTE: Estimates for first five columns (weekly work hours to real wage rate predicted based on occupation) come from Bartik (2013) but are multiplied by (−1) to correspond to job loss. Estimates are for elasticity of that labor market outcome with respect to one-time employment job loss shock; effects reported after s years represent cumulative elasticity after that many years. Wage differential is equal to difference between two preceding columns.

Because earnings is the product of weekly work hours, the employment to labor force

ratio, the labor force participation rate, and the wage rate, the percentage change in earnings in

response to some percentage job loss can be expressed as the sum of these various elasticities.

To translate Table A1 into social costs, I have to decide what proportion of the different components of earnings loss may be offset by various gains. I also have to decide on a discount rate. This is done in a combined calculation, in which the numbers in Table A1 are first multiplied by one minus an assumed offset factor, and then are discounted at a 3 percent real discount rate back to year zero, the year in which the job loss occurs.

The workforce activity elasticities are multiplied by various factors to reflect the value of nonworking time to workers. The weekly work hours' elasticities are multiplied by $(1 - 0.35)$ to reflect an assumed value of increased weekly nonwork hours to workers of 35 percent of the wage rate. The employment to labor force ratio numbers are multiplied by approximately $(1 - 0.10)$ to reflect the assumption that increased time in involuntary unemployment is valued at 10 percent of the market wage. The labor force participation rate numbers are multiplied by approximately $(1 - 0.3)$ to reflect the assumption that increased time outside the labor force is valued at 30 percent of the market wage. These assumptions are discussed in more detail in the paper text.

The wage numbers are multiplied by various factors to reflect the value of wage reductions to employers. The reduction in wages due to occupational downgrading are multiplied by $(1 - 0.50)$ to reflect the assumption that 50 percent of this wage reduction results in benefits to employers. The wage differential reduction is multiplied by $(1 - 0.75)$ to reflect the assumption that 75 percent of this wage reduction results in benefits to employers.

After multiplying by these adjustment factors for offsets, I then discount each year's effects using a 3 percent annual discount rate back to year zero. I then sum the elasticities for each column, and then sum over all columns. The estimated effect summed over all variables is

the social value of the reduction in earnings, expressed as a ratio to the initial percentage job loss. This initial percentage job loss is also the same percentage earnings loss. Therefore, this discounted sum over all variables is the social cost as a ratio to the annual earnings loss associated with the jobs loss.

This ratio is then multiplied by average compensation for one job of $59,997 to get the social cost associated with the loss of one job paying that amount. Finally, this ratio is divided by 15.88, which is the ratio of the present value at a 3 percent real discount rate of the gross earnings losses over a 20-year time horizon of the gross earnings losses that are directly due to a negative job loss. This shows the present value of social cost of job loss as a percentage of the present value of the gross earnings loss associated with the direct job loss.

Table A2 Elasticities Adjusted for Offset Factors and Discount Rate

Offset factor for each column	0.35	0.104061	0.298432	0.5	0.75
Year	Weekly work hours	Employment to labor force ratio	Labor force participation rate	Real wage rate predicted based on occupation	Wage differential
0	−0.04706	−0.24907	0.011716	−0.0327	−0.02865
1	−0.02297	−0.21746	−0.07016	−0.02631	−0.04704
2	−0.01066	−0.07668	−0.05046	−0.02569	−0.00276
3	−0.05794	−0.05895	−0.05772	−0.02306	−0.04704
4	−0.0123	−0.08995	−0.02362	−0.0287	−0.06517
5	−0.03258	0.008579	−0.06354	−0.05046	−0.04356
6	0.003304	0	−0.03067	−0.02014	−0.02343
7	0	0	0.013462	−0.02464	−0.03362
8	0	0	0.006978	−0.03687	−0.04808
9	0	0	−0.00737	−0.01345	−0.05076
10	0	0	−0.0008	−0.0167	−0.02829
11	0	0	0	−0.01622	−0.02747
12	0	0	0	−0.01575	−0.02667
13	0	0	0	−0.01529	−0.02589
14	0	0	0	−0.01484	−0.02514
15	0	0	0	−0.01441	−0.02441
16	0	0	0	−0.01399	−0.0237
17	0	0	0	−0.01358	−0.02301
18	0	0	0	−0.01319	−0.02234
19	0	0	0	−0.0128	−0.02169
20	0	0	0	−0.01243	−0.02105
Sum of column	−0.1802	−0.68354	−0.27218	−0.44121	−0.65975
			Sum of all columns	−2.24	

NOTE: Each column takes elasticities from corresponding variable in Table A1, and multiplies those elasticities by (1 minus offset factor) at top, and then divides by 1.03 (the discount rate) raised to the power of the corresponding year for that row. The sum of all these factors is the ratio of social cost to one-year's annual earnings. 2.24 times average compensation per worker of $59,997 results in the social cost implied by the loss of one job. 2.24 is divided by 15.88, the ratio if all gross earnings of the lost jobs are counted over 20 years, to get the ratio of the present value of social costs to the present value of the gross earnings associated with the lost jobs, which yields the 14.1% in the text Table 2.

APPENDIX B

MORE DETAILS ON THE ANALYSIS OF HOW JOB EFFECTS ALTER SOCIAL COSTS OF ENVIRONMENTAL REGULATIONS

This appendix summarizes some calculations on how job effects alter the social costs of various environmental regulations. I focus on some prominent regulations that have been discussed as cases in which job losses might need to be considered. I consider the Clean Air Act, which is obviously a major environmental regulation. More importantly, recent empirical work by Walker (2012) provides estimates of job loss for the CAA that were done independently of government regulatory officials. I also analyze 12 of the 13 regulatory examples listed by Masur and Posner (2012) in their recent article arguing that including social costs of job loss may often make a difference to benefit-cost analysis of regulations.[9] Masur and Posner give a special focus to effluent regulations for pulp and paper manufacturing; they argue that this is a case in which including job loss might tip the overall net benefits. Therefore, I devote some extra attention to these pulp and paper regulations. Finally, I consider two recent examples suggested by EPA officials: air toxic standards for utilities; the proposed cleanup of an ash spill by TVA.

I rely in most cases on the costs and benefits of the regulation that are reported in the official government analyses. I also rely in most cases on the job impacts reported by official government analyses. One exception is that I use Walker's estimates of job loss from the Clean Air Act. Another exception is emission standards for industrial boilers, for which I also consider

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[9]One of their 13 examples, "conservation of roadless forest land," is omitted because the regulatory analysis does not estimate overall social costs, so it is impossible to calculate how including job loss would affect social costs.

the job impacts claimed by businesses opposed to these regulations. Finally, for the TVA ash cleanup, I do my own job effect analysis based on reported clean-up costs.

The job impacts for these regulations vary greatly in how they are calculated. In some cases, these are only direct job effects on the regulated industry due to the regulation. Some of these direct job loss numbers are due to engineering cost studies, which assume some number of plants will become uncompetitive due to regulations and therefore will close. In other cases these job effects include some multiplier effects, in many cases estimated using some input-output model. In still other cases these job effects include some offsets due to effects on pollution control jobs or effects on relocating consumption and output to other industries. Some of the models estimate direct job effects and these offsets using the model developed by Morgenstern, Pizer, and Shih (2002).

My focus is on how overall social costs would have been altered by including the social costs of job loss. To do this analysis, for each study I take the cost figure in the original study, which is typically an annual dollar figure, and use a 3 percent real discount rate to convert that cost estimate into a present value number. (I also convert all dollar figures to 2012 dollars.) If the job loss estimate of the original study only includes direct jobs, I assume a multiplier of 2.0 to calculate total jobs loss. This size multiplier is a conservative estimate for job losses in manufacturing (Crihfield and Campbell 1991, 1992; Grimes, Fulton, and Monardelli 1992; Moretti 2010; Rickman and Schwer 1995). I then take the total job loss estimate and multiply it by the $134,000 present value figure per lost job that is the baseline social cost per job estimate from the previous Table 2.[10]

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[10]The social cost of jobs numbers assume a 20-year time horizon, whereas the overall social costs assume an infinite time horizon. I think this is realistic as regulatory costs will be quite persistent, whereas job costs should

What is most interesting from these calculations is the percentage effect of job loss on overall social costs. For many of these regulations, benefit-cost ratios might be 2-to-1, 3-to-1, or even 30-to-1. The bottom line of whether a regulation passes a benefit-cost test is not going to be altered unless there is a huge percentage effect of job loss on overall social costs. Even the relative ranking of regulations will not be much altered unless the job loss increases social costs of a regulation by more than 10 or 20 percent. The measurement error in social costs probably exceeds 10 or 20 percent.

For a wide variety of regulations, I find that including job loss usually increases social costs by less than 10 percent (Table B1). There are a few exceptions. For regulation of toxic air pollutants for industrial boilers, if one uses the job loss numbers of this regulation's critics, social costs increase by 13 percent. For some habitat preservation regulations, social costs of job loss are an even higher percentage. It is unclear whether this pattern is due to differences across government agencies in how economic effects are calculated, or due to differences in the nature of the regulations. The text presents some reasons why this difference might be related to the nature of the regulations.

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eventually fade. If we instead assume an infinite time horizon for the social costs of job loss, the social costs per job loss increase by 49.9 percent, based on calculations of social costs in the 20th year, extended into an infinite future. This 50 percent increase in social costs numbers would only modestly change the conclusions reached in Table B1. For example, the calculations in Table B1 for the Clean Air Act show that adding in job losses increases social costs by around 9 percent. If the social costs of jobs have an infinite time horizon, this figure would increase by 50 percent to around 13 percent.

Table B1 Social Costs of Job Loss Compared to Overall Social Costs of Various Regulations

Regulation	Source of benefit-cost and job info	Benefit-cost ratio	Overall social costs: present value (billions of 2012$)	Jobs lost (or gained)	Job effects: cost (or benefit) in present value (billions of 2012$)	% change in costs due to job effects
Clean Air Act	Walker (2012); EPA (2011b)	31.58	−432.663	−150,000	−36.640	8.5
Pulp/paper: total package of air and water pollution regulations	Masur and Posner (2012); EPA (1997)	?	−11.312	−5,711	−0.766	6.8
Desert tortoise habitat protection	59 Fed. Reg. 5,820 (1994)	?	−0.024	−310	−0.042	166.5
Landfills: wastewater discharges	65 Fed. Reg. 3,008 (2000)	?	−0.358	−109	−0.014	4.1
Aluminum production: hazardous air pollutants	65 Fed. Reg. 15,690 (2000)	?	−3.916	−94	−0.026	0.6
Coal mining effluent standards: discharges into water and drainage	67 Fed. Reg. 3,370 (2002)	Saves costs	0.572	−29	−0.004	−0.7
Peirson's milk-vetch (wildlife plant) habitat preservation—adopted alternative	69 Fed. Reg. 47,330 (2004)	?	−0.034	−60	−0.008	24.2
Peirson's milk-vetch—rejected alternative	69 Fed. Reg. 47,330 (2004)	?	−0.416	−1,896	−0.254	61.2
Fuel economy standards for cars and light trucks, for model year 2011 only	74 Fed. Reg. 14,196 (2009)	1.70	−1.268	−1,024	−0.008	0.6
Energy conservation standards for small electric motors	74 Fed. Reg. 61,410 (2009)	4.21	−4.163	0	0.000	0.0
Construction and development industries—Clean Water Act regulation of discharges	74 Fed. Reg. 62,996 (2009)	0.38	−34.073	−7,257	−1.947	5.7
Portland cement plants: air pollution standards	75 Fed. Reg. 54,970	13.54	−36.767	−807	−0.216	0.6%

Table B-1 (Continued)

Regulation	Source of benefit-cost and job info	Benefit-cost ratio	Overall social costs: present value (billions of 2012$)	Jobs lost (or gained)	Job effects: cost (or benefit) in present value (billions of 2012$)	% change in costs due to job effects
Industrial boiler air pollution standards	76 Fed. Reg. 15,608 (2011) ; American Forest and Paper Assoc. (2010)	25.33	−53.311	EPA says small; others claim −50,000	0 to −6.710	0 to 12.6
Incinerators: emission standards	76 Fed. Reg. 15,704 (2011)	2.79	−7.762	EPA central case: +200; worst case : −400	0.054 to −0.107	−0.7% to +1.4
Utilities: air toxic standards	77 Fed. Reg. 9,304 (2011)	6.61	-354.296	Central case: 8,000; worse case: −15,000	2.148 to -4.027.	−0.6% to 1.1
TVA ash cleanup	TVA (2010)	?	−0.296	Net job creation of 266 for four years, reduced to 2 jobs after that	0.004	−1.4

NOTE: This analysis was sped up by using Federal Register references from Masur and Posner (2012) for all except the Clean Air Act regulation, the utilities regulation of air toxic standards, and TVA ash cleanup. However, I did not use the net benefit figures from Masur and Posner, but rather used benefit-cost ratios and overall cost figures in present value terms. Also, although I looked at Masur and Posner's estimated job loss figures, I independently examined these regulatory filings to determine the job loss, and my figures sometimes differ slightly from theirs. EPA analyses generally present annual costs and benefits for some typical future year when the regulation is fully effective. (One prominent exception is the pulp and paper regulation, for which I used the present value figures at a 3% discount rate from Table 10-4 of EPA (1997). EPA did not report a benefit-cost ratio for this regulation.). I used the annual benefit-cost ratio. I used a 3% real discount rate to convert annual costs to present values. This probably slightly increases present value given that regulations are often phased in. All costs are presented as negative numbers, and if instead there are cost savings or jobs created, these are presented as positive numbers. Present value figures for cost of job losses are calculated for all except the TVA case by directly using the baseline local labor market estimates from this study. The jobs numbers reported in the table are the jobs numbers reported by study, which in some cases included multiplier, but in other cases only included direct jobs affected. In calculating cost of job effects, I multiplied total job change by $134,000, from my baseline social cost estimates in Table 2. If the study did not include a multiplier, I assumed multiplier of 2.0 to get total job change. For the TVA case, I assume that TVA spending on project over 4 years, plus permanent spending, would have balanced budget multiplier effects in creating jobs. I assumed that spending would create jobs at $92,000 per job (in 2009 dollars), while increased taxes would destroy jobs at $145,000 per job (in 2009 dollars), based on Council of Economic Advisers (2009). I evenly spread TVA capital spending on this project over four years. The value of the temporary job creation for four years was calculated as present value of permanent job creation of 266 minus present value of permanent job destruction of 264 jobs four years from now, with appropriate discounting.