

natural solar potential, then the upward trends in job creation found by the authors may be picking up these alternative effects.

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GENERAL DISCUSSION Jason Furman asked about the implications of the findings of the paper for welfare analysis. He noted that, generally, in educational settings students are taught to ignore jobs in cost-benefit analyses or even to treat jobs as a cost, given that the presence of jobs indicates a need to divert resources to that program (though this treatment depends on whether or not the economy is in a recession). He additionally asked if the implications for welfare or policy analysis change depending on whether the economy is in a recession or is closer to full employment.

Laurence Meyer critiqued the use of the American Recovery and Reinvestment Act (ARRA) as the framework for the paper, as the law was a deficit-financed stimulus package, and future green packages would likely have to be at least partially paid for through tax increases. He also suggested that the key benefits of green fiscal spending do not come from employment gains but rather from addressing the climate crisis.

David Popp addressed the questions from Furman and Meyer, stating that the central purpose of the paper was to respond to existing policy proposals to address climate change and to discuss the political feasibility of these proposals. While employment may not be as important a goal as emissions reductions when evaluating the effectiveness of green spending, it does impact the political feasibility of passing climate policy, he concluded.

Robert Hall suggested that the ARRA's effects on employment would comprise only a small portion of total effects due to the low elasticity of labor supply. He posited that the effects on wages may be stronger than the effects on employment and encouraged the authors to explore the impact of green spending on wages.

Olivier Blanchard noted that the nature of labor and skills required by green jobs may change over time, especially since many green projects are temporary. As an example, he remarked that proposals to expand the electric vehicle charging infrastructure in the United States would likely generate strong demand for local labor but that this demand would fade after charging stations have been installed. He expressed concern over applying the results from the paper to predict the impact of future policies, as doing so would require knowledge of the skills needed for future green jobs.

Heather Boushey echoed Blanchard's concerns that applying lessons from this paper to future policies requires the ability to identify green jobs in the future. For instance, she noted that all jobs in auto manufacturing could be categorized as a green job in the future, since many expect that all new cars sold will be zero-emission vehicles.¹ She also revisited Meyer's concern that the lessons learned from analyzing the employment impact of

1. In California, the governor issued an executive order; Office of Governor Gavin Newsom, "Governor Newsom Announced California Will Phase Out Gasoline-Powered Cars and Drastically Reduce Demand for Fossil Fuel in California's Fight against Climate Change," September 23, 2020; <https://www.gov.ca.gov/2020/09/23/governor-newsom-announces-california-will-phase-out-gasoline-powered-cars-dramatically-reduce-demand-for-fossil-fuel-in-californias-fight-against-climate-change/>. See also Neal E. Boudette and Coral Davenport, "G.M. Will Sell Only Zero-Emission Vehicles by 2035," *New York Times*, January 28, 2021, <https://www.nytimes.com/2021/01/28/business/gm-zero-emission-vehicles.html>; and Honda, "Summary of Honda Global CEO Inaugural Press Conference," April 23, 2021, <https://global.honda/newsroom/news/2021/c210423eng.html>.

green spending from the ARRA may not apply to current and future green spending thanks to two key distinctions between the two policies. First, the ARRA occurred in a weaker economy, and green spending will occur in an economy that is closer to full employment. Second, the ARRA was focused on stimulus, while green spending will likely center on fostering innovation and effecting structural transformation.

Addressing Boushey and Blanchard, Popp agreed that readers should be careful when generalizing lessons from 2009 to understand current policies and policy proposals. For example, as pointed out in the paper, much of the focus on energy retrofitting in the ARRA was to bolster the construction industry. He argued that the implications from this paper center on the importance of being aware of skills changing and determining which skills line up with policy needs at any given moment.

Popp responded to Hall's question regarding the ARRA's impact on wages and said that the authors had already estimated the impact of ARRA green spending on wages but found no relationship in the short run or long run. These results had been excluded from the presentation due to time constraints.

Michael Kiley commented that the paper was framed to look at the effect of stimulus on employment. However, he commented that most present and future investments in green technologies—including President Biden's Build Back Better agenda—will not necessarily increase the level of capital as the proposals are instead focused on reallocating activity or changing the nature of capital investment toward, for example, greener activities, rather than focused on increasing the level of activity. He wondered if the authors could shift the focus of the paper to discuss how to make reallocation most effective.

Caroline Hoxby noted that the classification of green jobs versus non-green jobs can be arbitrary. While the Bureau of Labor Statistics has a definition of green jobs, considerable judgment is necessary to apply it.² Only a portion of jobs are *obviously* green—for instance, a wildlife conservation or stormwater management worker. Others are harder to categorize—such as a worker who enforces environmental regulations among numerous other regulations. The more incentives exist to report a job as green, the more that firms will find ways to reclassify jobs as green. Therefore, a comprehensive study of the impact of green spending may have to examine both categories as well as employment overall.

2. See US Bureau of Labor Statistics, "Green Jobs Overview," <https://www.bls.gov/green/overview.htm>.

James Stock argued that the authors should control for renewable portfolio standards, as renewable portfolio standards were one of the two most active policies used to address climate change (alongside ARRA subsidies) at the time.³ However, he mentioned that this control might be more important in theory but not as impactful in practice.

Popp first responded to Stock's question on renewable portfolio standards. He argued that since all renewable portfolio standards began before the 2008 recession, the paper's fixed effects should control for the impact of those policies. He noted that the authors also controlled for wind potential, which would also relate to renewable portfolio standards. However, he also observed that certain smaller policies for renewable energy, such as solar tax credits which had been mentioned by discussant Valerie Ramey, may be harder to control for.

Popp also acknowledged the validity of the comment from Hoxby on defining the green jobs of the future. He stated that responding to that issue might be best accomplished through future research rather than through this paper.

Citing a paper by Sanya Carley, Sean Nicholson-Crotty, and Eric J. Fisher, Popp addressed the comment by discussant Gabriel Chodorow-Reich and noted that there is often a gap between annual allocations and realized expenditures due to bureaucratic requirements.⁴ For example, he mentioned that "Made in America" requirements hampered energy retrofitting projects because it was difficult to find LED light bulbs that had been manufactured in America. Thus, both the effects of allocated money or of actual spending on a yearly basis could be valid measures. One measures what was intended and the other measures how the program was actually implemented.

Francesco Vona added that an important contribution of the paper was to extend a measurement framework that explores the skills requirements for green jobs of the future, based on the previous paper by Vona and others (2018).⁵ This framework is rooted in the task-based framework to labor

3. R. Wiser, G. Barbose, J. Heeter, T. Mai, L. Bird, M. Bolinger, and others, *A Retrospective Analysis of the Benefits and Impacts of U.S. Renewable Portfolio Standards* (Washington: National Renewable Energy Laboratory and Lawrence Berkeley National Laboratory, 2016), <http://www.nrel.gov/docs/fy16osti/65005.pdf>.

4. Sanya Carley, Sean Nicholson-Crotty, and Eric J. Fisher, "Capacity, Guidance and the Implementation of the American Recovery and Reinvestment Act," *Public Administration Review* 75, no. 1 (2015): 113–25, doi: 10.1111/puar.12294.

5. Francesco Vona, Giovanni Marin, Davide Consoli, and David Popp, "Environmental Regulation and Green Skills: An Empirical Exploration," *Journal of the Association of Environmental and Resource Economists* 5, no. 4 (2018): 713–53.

markets that has been advanced by David Autor and others.⁶ He added that an additional contribution was a structure for measuring reallocation costs based on “skill distances.” Finally, he argued that the basic framework they employ will be useful in calibrating models of the effects of climate change with friction, where reallocation is frequent but employment effects are small overall.

6. David H. Autor, “The ‘Task Approach’ to Labor Markets: An Overview,” working paper 18711 (Cambridge, Mass.: National Bureau of Economic Research, 2013), <http://www.nber.org/papers/w18711>; David H. Autor, Frank Levy, and Richard J. Murnane, “The Skill Content of Recent Technological Change: An Empirical Exploration,” *Quarterly Journal of Economics* 118, no. 4 (2003): 1279–333.

