<u>Labor Market Outcomes of the Clean Energy Transition</u>

Intellectual Merit: The transition from fossil fuels to clean energy will profoundly alter the U.S. labor market. Mitigating climate change requires shifting production away from carbon-intensive sectors, leading to job destruction. At the same time, massive investment in domestic clean energy has the potential to create millions of jobs. Despite the political salience of these issues, the labor market impacts of environmental policies are not well documented or understood. The majority of studies use reduced-form methods to evaluate the employment effect of particular environmental regulations. These studies tend to use unregulated yet similar firms in different regions as controls, resulting in upwards biased estimates of total job losses if regulations cause employment to increase in unregulated regions. In order to account for these spillover effects, a small but growing literature uses computable general equilibrium (CGE) models (e.g., Hafstead and Williams, 2018). However, the norm in both the reduced-form and structural literatures is to examine the effect of a particular policy such as a carbon tax or clean electricity standard. This project seeks to evaluate the labor market impact of the energy transition *writ-large*.

I will build on the recent environmental CGE models to study the relationship between the sectoral energy transition and the associated labor market transition. More specifically, I seek to determine: (1) the magnitude of the employment impact; (2) the heterogeneity of impact across industries and skill levels; and (3) the key determinants of labor market frictions that delay workers' transitions. Using a quasi-experimental approach, I will estimate the causal impact of an increase in the clean energy market share on job creation and loss probabilities. This parameter will serve as an input into my model which evaluates the search frictions (e.g., skill mismatch) that prevent or delay these job creation and loss probabilities from materializing. In so doing, I hope to add to a growing body of work that marries causal analysis with structural economic theory (Low and Meghir, 2017).

Theoretical Model: Building on Hafstead and Williams (2018), my model has two energy-producing sectors $s \in \{0,1\}$, where 0 is the dirty sector and 1 is the clean sector. Workers and firms in each sector face search-and-matching frictions resulting in equilibrium unemployment, as in Pissarides (1985). Each worker begins with human capital η_i sampled from an exogenous skill distribution that differs by sector. Workers are further differentiated by two factors: (1) skill accumulation via learning-by-doing during employment, and (2) a temporary skill penalty imposed after workers transition that is dependent on substitutability of skill. Wages in each sector w_i are a function of human capital and all unemployed workers receive a benefit B_i. In order to link the sectoral energy transition with the labor market transition, I introduce a clean energy market share variable θ, which evolves as a logistic function to approximate the S-curve shape of the transition (Way et al., 2022). Workers receive job offers with probability δ^s and are laid off with probability Π^s as a function of θ. I choose to model θ as an exogenous force, capturing the perspective of workers who do not internalize their own ability to influence the sectoral transition. As this sectoral transition progresses, it becomes increasingly likely to lose a job in the dirty sector and find a job in the clean sector.

At the heart of the model is a discrete choice problem representing a worker's decision-making process to transition to the clean sector. A worker maximizes lifetime-discounted utility based on her choice of sector in the next period s'. This problem can be written dynamically as a Bellman equation, where the state of an employed worker, for example, is given by her current sector s:

$$\mathrm{v}_{\mathrm{i,t}}\,(s_t) = \max_{s_{t'} \in \{0,1\}} \Big\{ (1 - s_t)\Big((1 - \Pi_t^0)\,\phi_t^0 u(w_i^0) + \Pi_t^0(u(B_i)\Big) \\ + s_t\big((1 - \Pi_t^1)\,\phi_t^1 u(w_i^1) + \Pi_t^1(u(B_i))\big) + \beta E\big[\big(v_{i,t'}\,(s_{t'})\big)\big]\Big\}$$

In each period, an employed worker can keep her job with probability $(1 - \Pi_{\mathrm{t}}^{\mathrm{s}})$ and increase in skill level with probability ϕ_t^0 or become unemployed with probability Π_t^s and earn unemployment benefits. Since θ_t asymptotes at K, I can derive analytical solutions for job loss and arrival probabilities. I have solved and calibrated a simplified version of this discrete choice problem which effectively captures the idea that the labor market transition lags the energy sector transition. Workers wait until the transition is well underway due to the possibility of wage cuts or job loss. High skill workers are attracted by high wages and are first to switch sectors while low skill workers do not switch sectors until the likelihood of losing their jobs is sufficiently large.

This framework can be expanded by including transitions to and from other sectors, accounting for geographic immobility, and capturing multidimensional skill. Including multidimensional skill is particularly important in a model of sectoral transition: manual skills adjust quickly (they are easily accumulated on the job and lost relatively easily when unused), cognitive skills are much slower to adjust, and interpersonal skills are essentially fixed over a worker's lifetime (Lise and Postel-Vinay 2020).

Empirical Strategy: I will divide model calibration into two steps: 1) direct calibration from previous literature and microdata and 2) simulated method of moments to calibrate remaining parameters. For the first step, I will use the North American Industry Classification System (NAICS) to link the Manufacturing Energy Consumption Survey, the Quarterly Census of Employment and Wages, and the Panel Study of Income Dynamics for data on energy intensity by industry, aggregate employment, and sector-specific human capital accumulation, respectively. In addition, I will identify skill substitutability using occupation skill profiles from the O*NET database by calculating a Jaccard coefficient for each clean/dirty occupation pair and then aggregating to the sectoral level. Finally, I will estimate the relationship between clean energy market share and job arrival and destruction probabilities with an instrumental variable approach, using quasi-random timing in the establishment of new clean energy facilities following the significant increases in the Production and Investment Tax Credits in 2022. For this method to be credible, I must demonstrate that the establishment of new clean energy facilities is unrelated to other factors influencing job arrival and destruction probabilities.

Broader Impacts: The energy transition is already underway: the cost of generating electricity from solar PV and wind is now cheaper than gas, oil, and coal and more than $1.7 trillion will be invested in clean energy technologies this year alone. But the shape of the transition for workers is unknown. While a substantial literature evaluates the negative impact of regulation on fossil fuel employment and a small (and likely to grow) literature evaluates the positive impact of subsidies on clean energy employment, the net outcome of these two forces over the next 50 years is an open question. My model and associated calibration would partially help fill this gap. A unified approach is needed to estimate the aggregate and distributional implications of these countervailing forces and, importantly, to communicate findings in a format that is directly interpretable by policymakers.

Indeed, while economists largely agree on the set of policies necessary to accelerate the energy transition, no similar playbook exists on how to smooth the transition for U.S. firms and communities. I am committed to the development of that playbook through policy briefs, presentations, conference organization, and data sharing. For example, I anticipate that my analysis may be particularly relevant to the Office of Energy Jobs in the Department of Energy: metrics on skill substitutability can target workforce development programs. Collaboration with policymakers will enable an iterative approach in which I continuously refine my framing and output to meet the changing needs of the policy community.

A related but distinct outcome of this project is the insight it provides on labor market frictions. Such frictions can delay the deployment of new energy infrastructure. The ability to model these frictions is highly desirable given the importance of understanding capital and labor dynamics for macroeconomic forecasting. While my model is not intended to yield precise quantitative predictions given its stylized nature, key parameter relationships can be included in the workhorse models used by the Council of Economic Advisors and the U.S. Treasury. I am familiar with this process given my role as the primary staffer on an interagency group working to capture energy transition risks in the President's Budget.

References

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