Extended Abstract

International students and innovation: Evidence from restrictions on US-trained foreign STEM workers

Michael A. Clemens
George Mason University, IZA, PIIE, CReAM/LSE
August 2025

Policy reform that shapes productivity-enhancing innovation could offer some of the highest social returns of any regulation (Jones and Summers 2022). The recent literature suggests a key role for one such regulation: evolving restrictions on immigrant workers in Science, Technology, Engineering, and Mathematics or STEM fields (Bloom et al. 2019; Kerr and Kerr 2022; Agarwal et al. 2023). Visa quotas on immigration by high-skill foreign STEM labor affect productivity and innovation at the level of US firms and regions (Kerr and Lincoln 2010; Peri et al. 2015; Mahajan et al. 2025; Prato 2025). But too little is known about how policy specifically affects the largest single channel of STEM worker immigration: foreign students who graduate from US universities and transition into the labor market (Hunt and Gauthier-Loiselle 2010; Glennon 2024). The need for evidence is acute at a moment when US student visas are expected to decline.

In this paper, I explore the effects of a policy experiment that induced a sharp change in the labor supply of foreign STEM workers trained at US universities. Since 1992, international students at US universities have been authorized to remain in the country to work for 12 months after graduation—while still on their student visas—under a federal regulation called Optional Practical Training (OPT). OPT has served as a crucial bridge between international student visas and longer-term work visas (Grogger and Hanson 2015; Amuedo-Dorantes et al. 2019; Beine et al. 2023). A nationwide policy reform extended OPT from 12 to 29 months in 2008 for graduates in STEM fields *only*, then to 36 months in 2016. This raised the supply of US-graduate foreign STEM workers to firms and regions according to their predetermined demand, exogenously to post-2008 changes in demand. I then use administrative data on the full universe of OPT workers 2004–2022 and the full universe of granted utility patents through 2025, among others, to consider the effects of this US-graduate supply shock on innovation and productivity in US metropolitan and micropolitan areas.

This policy-disciplined strategy for causal identification partially addresses recent concerns about the more standard shift-share design, which pervades immigration studies (Adão et al. 2019; Goldsmith-Pinkham et al. 2020; Borusyak et al. 2025). One key concern is that standard designs take their *shift*

as nationwide post-treatment changes in the endogenous variable, which can be driven by endogenous shifts in just a few high-leverage units. The shift in the present paper, in contrast, is fixed by a deterministic policy rule; there is no sense in which (e.g.) Silicon Valley's post-treatment outcomes contribute to the shift-share.

Another central concern of the recent literature is that baseline *shares* are not randomly assigned and results can be driven by a handful of high-share units. The paper presents several transparent diagnostics recommended by Borusyak et al. (2025) and Callaway et al. (2024), including tests and controls for pre-trends by baseline share, Visual Instrumental Variables plots (Angrist and Pischke 2009, 139), truncating the highest-share metropolitan areas, re-tests with placebo outcomes (patents of low STEM relevance) and placebo treatments (non-STEM OPT workers), and recasting the analysis with synthetic differences-in-differences on pairs of treatment exposure quantiles.

I find that the evidence is consistent with an increase of 10 in the supply of high-skill US-trained OPT STEM workers in a US city causing the filing of 1.4 additional utility patents that are later granted. Because 53.7 percent of OPT STEM workers remain on other work visas at the end of OPT, this suggests that this patenting effect arises from approximately 15 additional US-trained foreign STEM workers overall, comprising OPT and post-OPT. This effect captures not only invention by immigrant workers themselves, but any laboratory- or firm-level spillovers to other workers, as well as neighborhood- or city-level spillovers via information transfer, matching, or specialization. It does not capture national or international spillovers. The core finding is robust to metropolitan-area and year fixed effects, census-region-by-year fixed effects, weak-instrument-robust inference, controls for the supply of non-STEM OPT workers, and several other checks used frequently in the literature.

The contribution of this paper lies in its focus on international students, cities, policy change, and causal identification. Much prior work has highlighted the effects of high-skill foreign STEM workers by standard shift-share variation in the supply of H-1B work visas, which are used by both US graduates and overseas graduates, rather than international students specifically. A substantial thread of work has focused on innovation by individual firms, laboratories, or even individuals (Stuen et al. 2012; Mahajan et al. 2025; Bernstein et al. 2025); I consider cities in order to capture cross-organization productivity spillovers within innovation hubs. Finally, the strategy for causal identification is a policy rule, distinguishing it from standard shift-share designs and raising the external validity of the findings to inform policy change.

Extensions of this ongoing research will include tests for hetergeneous effects by degree level (undergraduate, master's, PhD), heterogeneous effects on patenting by patent influence and economic value (Kogan et al. 2017), effects on international knowledge transfers measured by foreign patent citations, and alternative innovation outcomes including entrepreneurship (Beine et al. 2024) and entrepreneurial outcomes.

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