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Abstract

Against a backdrop of sharply rising inequality, the Tokyo Round of the GATT resulted in a 1.6 percentage point reduction in average US tariffs – larger than CUS-FTA, NAFTA, and the liberalization accompanying the granting of PNTR to China. We construct a novel IV based on the so-called “Swiss formula” that governed Tokyo Round tariff liberalization to provide the first evidence of its effects on imports and inequality. Instrumented tariff reductions explain 17% of the within-industry rise in income inequality between skilled and unskilled workers between 1979 and 1988. This effect is largest in more technology-intensive industries, suggesting a complementarity between trade liberalization and skill-biased technological change. We also show that tariff liberalization in upstream industries produced a shift away from labor more broadly and towards intermediate inputs. Finally, we show that policymakers dampened the observed impact of tariffs on inequality by assigning smaller tariff reductions to industries more reliant on low-skilled labor.

JEL-Codes: F130, F140, F660.

Keywords: tariffs, Tokyo Round, Swiss formula, inequality, skill biased technological change.

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1 Introduction

Over the past decade, an enormous body of work has documented large and persistent consequences of trade for US firms and workers, exploiting differential exposure across geographic locations (Autor et al., 2013), industries (Pierce and Schott, 2016), or some combination of the two (Hakobyan and McLaren, 2016). In doing so, this literature has overwhelmingly focused on the post-1990 era of "hyper-globalization". This focus, however, comes with an important but often overlooked caveat: by the 1990s, much of the post-war US trade liberalization process was already complete. The US ad valorem equivalent (AVE) tariff, defined as the ratio of duties collected to total imports, reached its twentieth century peak of around 20% following the Tariff Act of 1930 – the so-called "Smoot-Hawley" tariff. By 1990, this had fallen to 3.3%.[1] This suggests that much of the economic impact of trade on the US economy was likely felt in the decades prior to those emphasized by scholars.

In particular, the distributional effects of the Toyko Round of the GATT – a multilateral liberalization that governed US tariff reductions between 1980 and 1987 – have received almost no attention. This is despite the fact that, in terms of implied aggregate tariff changes, the Tokyo Round represents a larger liberalization than the Canada-US Free Trade Agreement (CUSFTA) in 1989, the North American Free Trade Agreement (NAFTA) in 1994, or the granting of Permanent Normal Trade Relations (PNTR) to China in 2001. Between 1979 and 1987, the average tariff across US manufacturing imports fell by 2.5 percentage points resulting in a 1.6 percentage point decline in the US average tariff. The corresponding reductions in the US average tariff are 1.07 percentage points under PNTR, 0.75 percentage points under CUSFTA, and 0.14 percentage points under NAFTA.[2] Indeed, from this perspective, the Tokyo Round tariff cuts were larger than PNTR and more than twice the size of CUSFTA and NAFTA.[3]

[1] https://www.usitc.gov/documents/dataweb/ave_table_1891_2016.pdf

[2] The average tariff decline, across manufacturing and non-manufacturing imports, was 4 percentage points for Canada under CUSFTA (Trefler, 2004) which at its onset in 1989 applied to 18.8% of US imports ($-4 \times 0.188 = -0.75$ percentage points.) Similarly, a 2.1 percentage point cut for Mexico under NAFTA (Hakobyan and McLaren, 2016) impacted only 6.7% of imports in 1993. And while tariffs on Chinese imports did not change following PNTR, Handley and Limão (2017) estimate a reduction in uncertainty equivalent to a 13 percentage point reduction in tariffs, covering 8.2% of US imports in 2000 (USITC Dataweb). The manufacturing share of 1978 US imports was 63.5%, with Tokyo Round liberalization covering more than 95% of all 1978 US imports and approximately 75% of these imports facing strictly positive tariffs.

[3] One potential reason that prior work has overlooked the Tokyo Round is that, as we detail in Greenland et al. (2023), the substantial tariff cuts in this period were accompanied by a compositional shift in US imports towards high tariff goods that left the import-weighted average tariff relatively constant.

In this paper, we explore the effects of the Tokyo Round liberalization on inequality between skilled and unskilled workers in the US manufacturing sector. Our approach exploits newly available data on US tariffs in the era (Greenland et al., 2023) and a unique feature of the Tokyo Round negotiations that allows us to circumvent standard concerns regarding endogenous tariff policy. We instrument for US tariffs between 1979 and 1988, exploiting the fact that the so-called "Swiss formula" served as the starting point for Tokyo Round negotiations. The Swiss formula compressed the tariff distribution by assigning larger tariff reductions to goods with higher pre-Tokyo tariff levels. Crucially, the *only* reason for differential liberalization across goods under the Swiss formula was differential pre-Tokyo tariffs. Instrumenting for observed tariffs with those dictated by the Swiss formula thus allows us to avoid the concern that US policymakers may have protected certain industries in this period due to, e.g., expected import growth. To address the concern that pre-Tokyo tariffs reflect historical protection choices of policymakers, our instrument replaces pre-Tokyo "column 1" (MFN) tariffs in the Swiss formula with their "column 2" counterpart. Column 2 tariffs were primarily determined by the Tariff Act of 1930 (Pierce and Schott (2016); Handley and Limão (2017)) and were reserved for a small subset of communist countries at the onset of the Tokyo Round. The exclusion restriction for our "Swiss IV" thus rests on unobserved factors that drive changes in 1980s labor market outcomes not depending on 1930 tariffs.

We devote substantial effort to validating our Swiss IV. First, we use it to estimate the impact of Tokyo Round tariff cuts on US industry-level trade flows between 1979 and 1988. Our estimated trade elasticity of 9 falls within the typical range for similar empirical settings (Ruhl, 2008; Head and Mayer, 2014). In contrast, the effect on exports is only one-sixth as large, mitigating concerns that the instrument primarily captures the effects of reciprocal tariff cuts received by the US or productivity improvements stemming from, e.g., skill-biased technological change (SBTC). Moreover, we show that our results are robust to a wide range of controls for both industry- and sector-level trends, including those related to SBTC. Ultimately, we argue that our Swiss IV has strong claims to reflecting exogenous tariff cuts.

The instrument reveals an important role for tariffs in driving within-industry *income* inequality between skilled and unskilled workers.[4] We find that the mean industry-level tariff reduction throughout our sample period increases income inequality by 17% of the mean

[4] As is standard in the literature, we use the terms "skilled" and "unskilled' to represent, respectively, non-production and production workers. We define income inequality as the ratio of skilled labor income to unskilled labor income.

industry-level change. We decompose this effect into changes in the relative employment of skilled to unskilled workers – the "skill intensity" channel – and changes in relative wages between worker types – the "wage inequality" channel – and find that the increase is overwhelmingly driven by rising skill intensity. Our results suggest that, at most, one-quarter of the effect stems from rising wage inequality, with the remainder accounted for by rising skill intensity. Falling tariffs also reduce the labor share of output, producing a distributional shift away from labor more broadly.

These findings complement the large literature on 1980s trade and inequality. Early work in this literature concluded that trade had little effect on inequality, but also struggled to identify trade-driven changes in goods prices.[5] More recently, Batistich and Bond (2023) identify notable effects on racial inequality in US labor markets due to rising imports from Japan in the 1970s and 1980s. In particular, they find relative reductions in manufacturing employment and labor force participation and declining wages for black males compared to white males. We differ from these prior studies by focusing on a broad-based, multilateral policy shock with an approach that does not rely on assumptions about the exogeneity of export growth in foreign markets – as in, e.g., Batistich and Bond (2023) – but rather on the institutional details of historical US tariff policy.[6] While complementary to existing work, our results emphasize an important role for trade policy – both tariff reductions and the endogenous manipulation thereof – in explaining inequality.

We find key roles for both offshoring and SBTC in explaining the distributional effects of the Tokyo Round. The shift away from labor, and towards intermediate inputs in particular, is driven by increased offshoring incentives rather than falling own-industry tariffs, as in, e.g., Feenstra and Hanson (1997, 1999, 2003). In contrast, the distributional shift from unskilled to skilled labor reflected by increased income inequality is driven by reductions in own-industry tariffs rather than those on upstream inputs. This suggests that rising inequality is not simply driven, for instance, by cheaper imported capital inputs combined with a complementary between capital and skilled labor, as emphasized by Parro (2013).

[5]See Slaughter (2000) and Feenstra and Hanson (2003) for excellent surveys. Slaughter (2000) in particular notes that this literature "made substantial progress understanding how to relate a given change in relative product prices to changes in relative factor prices ... [but] made less progress understanding whether these product-price changes have any thing to do with international trade."

[6]In separate work, Lu and Ng (2013) instrument for US import penetration with UK import penetration and find that US manufacturing industries between 1971 and 2001 respond to import competition by substituting away from routine occupations towards non-routine occupations. This requires the assumption that UK import penetration is driven by supply-side forces in the rest of the world and not, for instance, UK demand shocks that are correlated with those in the US. Our approach requires no such assumption.

Turning to the role of SBTC, we contribute to the numerous studies exploring the effects of trade on innovation and, in turn, inequality. Consistent with the disparate theoretical predictions on the link between import competition and innovation (Lawrence, 2000; Acemoglu, 2003; Aghion et al., 2005), empirical evidence on the direction of the impact is mixed.[7] In our sample, we find evidence consistent with the notion that trade-driven SBTC leads to rising income inequality. Suggestive of an innovation response to import competition, we show that investment increases in response to falling own-industry tariffs. Further, we show that technology-intensive industries, as captured by higher pre-existing levels of computer usage and patenting, drive the increase in income inequality that accompanies Tokyo Round liberalization. Taken as a whole, our results suggest that technological change does not shape inequality in isolation but, rather, in conjunction with import competition.

Our Swiss IV also affords us the rare opportunity to explore the sources of endogeneity that could bias estimates of the effects of liberalization while simultaneously producing causal estimates in their presence. Virtually all prior studies of trade policy rely on the idea that tariff changes, or protection from those changes, are orthogonal to outcomes of interest.[8] Unconditionally, this precludes the possibility of analyzing the endogenous determinants of protection *by assumption*. Alternatively, one might condition on a set of correlates of protection. However, causal identification in this case requires conditioning on *all* such correlates. In contrast, we explore the correlates of endogenous protection by comparing the tariff cuts prescribed by the Swiss formula to those implemented in practice while also identifying the causal impact of the liberalization. As our identification is rooted in the *planned* tariff changes based on *historical* tariffs rather than the *implemented* tariff changes based on *contemporaneous* tariffs, this is true even without identifying the full set of endogenous determinants of protection. We show that policymakers protected low-skill industries from the tariff cuts prescribed by the Swiss formula. This implies that politicians may have sought to curb the effects of import growth on inequality. Further, we show that the estimated effects of tariffs on inequality using observed AVE tariffs are substantially biased towards

[7] For instance, Bustos (2011), Mion and Zhu (2013) and Bloom et al. (2016) find positive effects of trade on innovation, while Autor et al. (2020) and Aghion et al. (2022) find negative effects.

[8] For instances in which the extent of liberalization depends on pre-liberalization tariff levels, see work in the context of Chile (Pavcnik, 2002), India (Topalova, 2010), CUSFTA (Romalis, 2007; Kovak and Morrow, 2022), NAFTA (Caliendo and Parro, 2015; Hakobyan and McLaren, 2016; Besedes et al., 2020; Benguria, 2023), and the US granting normal trade relations (NTR) status to Vietnam (McCaig and Pavcnik, 2018) and PNTR to China (Pierce and Schott, 2016; Handley and Limão, 2017; Greenland et al., 2019). For instances in which the tariff changes are chosen by policymakers, see work in the context of the US-China trade war (Fajgelbaum et al., 2020; Flaaen and Pierce, 2021; Lake and Nie, 2023) or the 2001 Bush steel tariffs (Cox, 2022; Lake and Liu, 2022).

zero, suggesting that policymakers were to some extent successful.

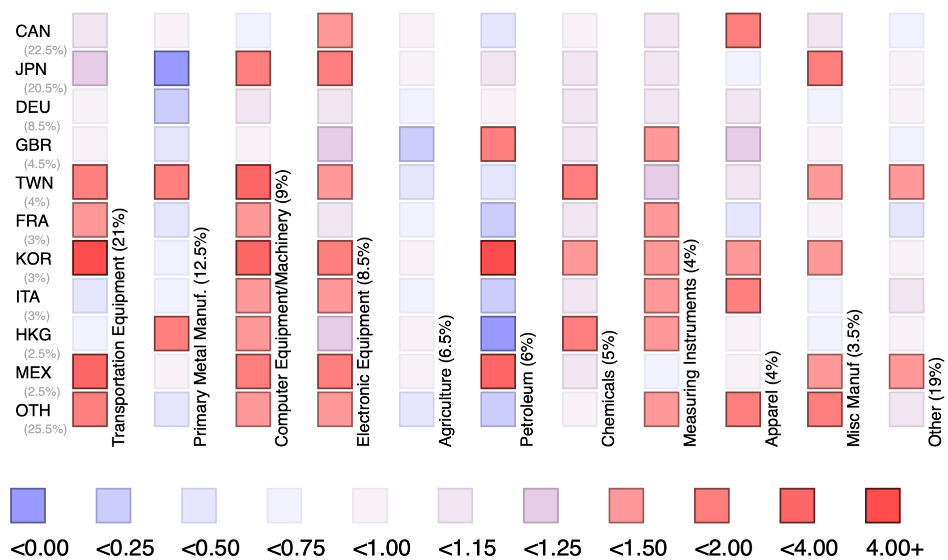
A small number of papers have explored the effects of trade policy in this era. In Greenland et al. (2023), we introduce 1970s and 1980s US legislated tariff data to the literature. We use the data to show that the protection provided by specific tariffs was eroded by 1970s inflation despite the absence of tariff policy changes, and that this "accidental liberalization" generated larger welfare gains for US consumers than the Tokyo Round legislated tariff cuts. Most other work exploring trade policy during this era took place during the early years of the Tokyo Round phase-in and focused on predicted effects. Several papers emphasize consequences for the structure of production across member countries using general equilibrium models (Brown and Whalley, 1980; Deardorff and Stern, 1981, 1983), while others focus on the nature of the negotiations themselves (Ahmad, 1978; Chan, 1985). Closer to us, Gaston and Trefler (1994) explore the labor market consequences of tariffs in this era. Using cross-industry variation in 1983 US tariffs, they find that more protected industries paid higher wages but find no differential impact on imports. Moreover, they argue that policymakers did not manipulate the Tokyo Round tariffs in ways that affected labor market outcomes or imports. In contrast, our Swiss IV reveals a substantial role for endogenous policy setting in the era. Not only did policymakers tend to protect low-skill industries from the Swiss-prescribed tariff cuts, they successfully mitigated the liberalization-induced impacts on inequality.

The paper proceeds as follows. Section 2 describes the data. Section 3 describes our estimation strategy and identification challenges. Section 4 describes the results and Section 5 concludes.

2 Data

To evaluate the effects of the Tokyo Round on inequality we require information on industry outcomes, tariffs, and trade flows from 1978-1988. Our final dataset draws primarily from four sources. Primary industry outcomes come from the NBER-CES Manufacturing Database (Becker et al., 2021). From this dataset we take measures of the value of shipments and industry expenditures on materials, investment, and labor. Separately for production and non-production workers, we also take employment and total wage payments. Annual industry imports and exports come from Schott (2008). Both of these databases measure industry outcomes at the 4-digit level of the 1987 Standard Industrial Classification (SIC) system. Third, we take tariff line-level legislated tariffs from Greenland et al. (2023) and, as Appendix C.1 describes in detail, concord them to calculate AVE tariffs at the 4-digit SIC level.[9] Finally, we use 1977 US input-output tables from the US Bureau of Economic Analysis. We concord these from the native BEA classification to the 1972 SIC system using a concordance accompanying the BEA input-output tables, and to the 1987 SIC system using a concordance from the NBER-CES Manufacturing Database. Appendix Table A.1 contains summary statistics.

Figure 1: Import Growth by Country and Sector



Notes: Each cell represents US log import growth between 1979 and 1988 from an exporting country in a 2-digit 1987 SIC sector. The numbers in parentheses on the vertical and horizontal axes are, respectively, shares of total US imports in 1978 accounted for by the exporter and 2-digit SIC sector.

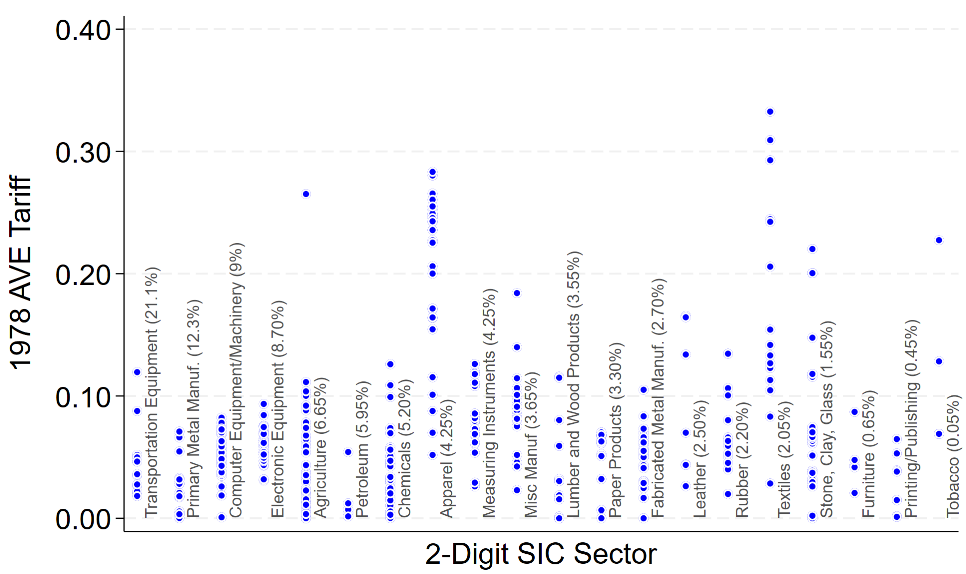
Before moving to our empirical methodology in Section 3, we briefly describe the trade environment during our sample as well as the evolution of inequality. To this end, Figure 1 presents a heat map describing 1980s US import growth across sectors and countries. Descending along the vertical axis are the largest exporters to the US in 1978, with Canada and Japan comprising more than 40% of US imports immediately preceding the Tokyo Round. The horizontal axis orders 2-digit SIC sectors from largest to smallest in terms of the sector's 1978 share of US imports. Cooler colored squares in the figure represent smaller

[9]Because the US uses both ad valorem and specific tariffs in this era, the dataset contains legislated ad valorem tariffs and the AVE of legislated specific tariffs that together sum to the AVE legislated tariff for the good. The AVE of a legislated specific tariff is the legislated specific tariff divided by its unit value. The dataset covers over 5000 5-digit TSUSA goods and over 98% of imports during our sample.

log import growth between 1979 and 1988, while warmer colors represent larger growth.

The key takeaway from Figure 1 is that, unlike many other episodes studied in the literature on trade and labor in the US, import growth following the Tokyo Round is not limited to a few countries nor to a few sectors. Illustrating the breadth of import growth across countries, imports from every country except Germany grow by at least 1.25 log points (250%) in at least two sectors. Similarly, imports in every sector except agriculture see growth of at least 1.25 log points from at least two countries. Moreover, import growth is negative only for Japanese primary metals manufacturing and Hong Kong petroleum. That is, while import growth is most pronounced in high-tech sectors such as electronics equipment, computer equipment, and measuring equipment and from countries that were not the top few US trade partners – i.e., countries other than Canada, Japan, and Germany – import growth is not limited to particular trade partners or industries.

Figure 2: Pre-Tokyo 1978 AVE Tariffs by 2-digit Sector

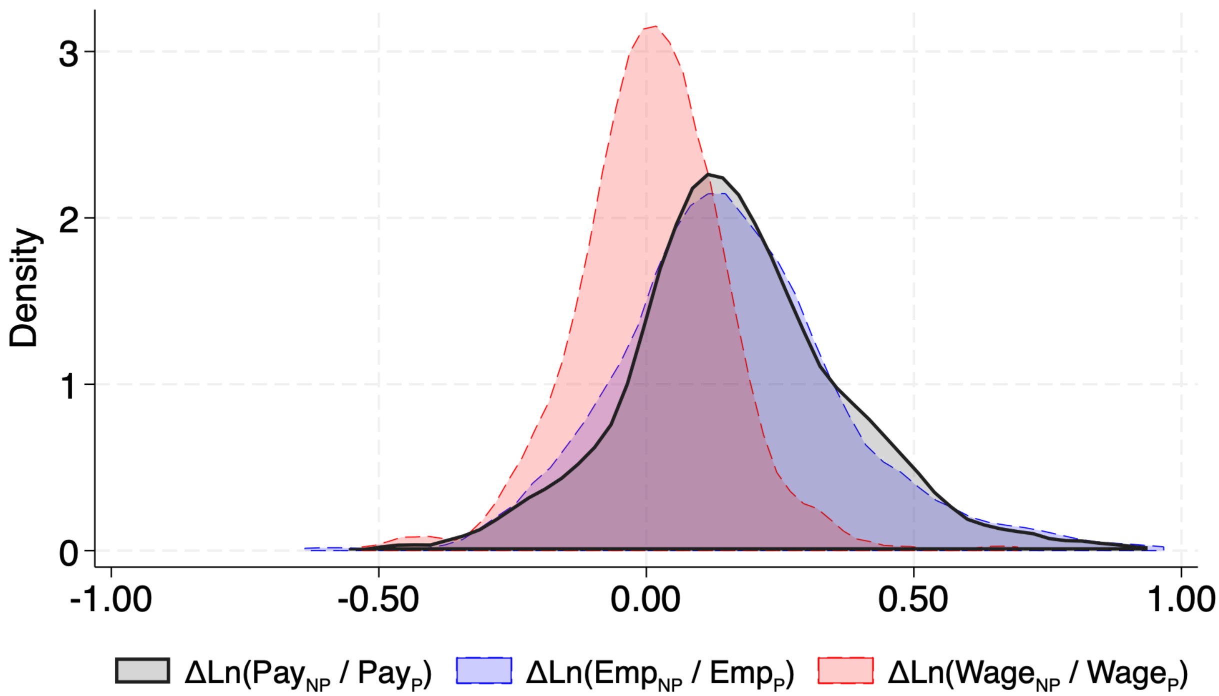


Notes: Each dot represents the 1978 AVE tariff of a 4-digit 1987 SIC industry. Dots clustered by two-digit SIC sectors and ordered by 1978 share of US imports, which are indicated in parentheses. Data from Greenland et al. (2023) and authors' calculations.

This broad-based growth in imports mirrors the nature of the tariff liberalization following the Tokyo Round. Figure 2 displays the 4-digit SIC AVE tariffs in 1978, with each dot representing one of the 381 industries, and with industries grouped according to their 2-digit SIC sector. On average, 4-digit industries have a pre-Tokyo AVE tariff of 7.1%. However, the variation is considerable, both within and across sectors, with a standard deviation of

6.2%. The variation in pre-Tokyo AVE tariffs corresponds directly to variation in Tokyo Round tariff cuts since, as we discuss in detail below, the Swiss formula reduces tariffs by more for industries with higher pre-Tokyo AVE tariffs. In sum, the Tokyo Round led to large and varying exposure to tariff liberalization both within and across sectors.

Figure 3: Variation in Sources of Industry Inequality



Notes: Figure displays a kernel density of the industry-level change in log pay to non-production (NP) workers relative to production (P) workers between 1979 and 1988 in grey. Blue and red densities decompose this log change into log changes in relative employment and relative wages respectively. Data from the NBER-CES manufacturing database, and authors' calculations.

Finally, we display the industry-level variation in changing inequality throughout our sample. Figure 3 displays three kernel densities of log changes between 1979 and 1988. The gray distribution outlined in black represents changes in income paid to skilled relative to unskilled workers. The blue and red distributions represent the two components of income inequality: employment of skilled relative to unskilled workers and the wage of skilled relative to unskilled workers, respectively. We refer to these three variables as income inequality, skill intensity, and wage inequality. Two points stand out in the figure. First, more than 80% of our 381 industries see rising income inequality, producing an average increase of approximately 0.17 log points. Second, this is accompanied by rising skill intensity which grows, on average, by 0.16 log points. In contrast, on average, wage inequality increases by a modest 0.01 log points, with a distribution that is nearly symmetric around 0. In formally exploring the effects of the Tokyo Round liberalization along each of these margins, we find a similarly dominant role for skill intensity in driving income inequality.

3 Empirical Methodology

We explore the effects of tariff liberalization under the Tokyo Round on US trade flows and industry outcomes. The sample period for our outcome variables begins in 1979 – the year before the US begins implementing Tokyo Round tariff cuts – and ends in 1988 – the year after the US completes implementing the liberalization. Specifically, our main analysis estimates annual industry-level regressions of the form

$$y_{it} = \beta_0 AVE_{it} + \boldsymbol{\beta}_1 \mathbf{X}_{it} + \eta_i + \eta_t + \varepsilon_{it} \tag{1}$$

where, for 4-digit SIC industry i and year t, y_{it} is a trade flow or other outcome of interest and AVE_{it} is the industry's AVE tariff. $\mathbf{X}_{it}$ is a vector of industry-year controls. η_i and η_t are industry and year fixed effects, respectively. ε_{it} is the error term.

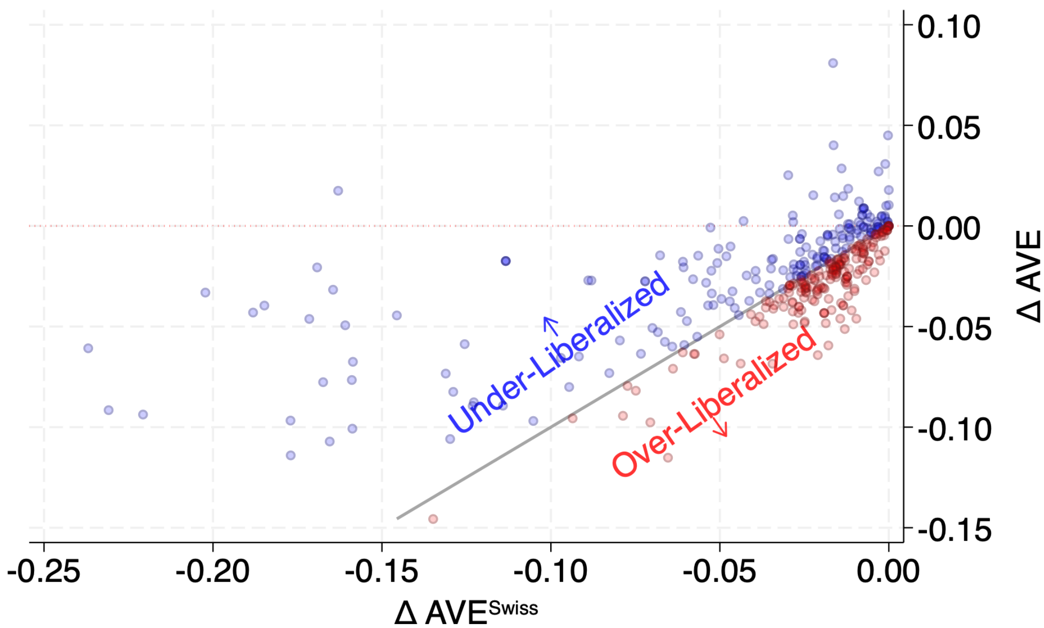
Despite including industry and year fixed effects in estimating equation (1), we still face the standard identification concern that tariffs are set non-randomly. The specific concern in our context is that industry-level tariff reductions may be correlated with industry-level trends in import growth or labor market outcomes. For example, policymakers may choose to protect industries facing high expected import growth by assigning them smaller tariff reductions. Such endogenous policy setting would bias the estimate of any negative effect of tariffs on imports towards zero, as larger tariff cuts would be associated with lower average imported growth. Alternatively, against a backdrop of rising inequality and surging import competition, policymakers may choose to protect industries in which they expect rising inequality to be most pronounced. This would bias any positive impact of tariff liberalization on income inequality towards zero.

To address these concerns, we rely on a unique institutional detail of the Tokyo Round negotiations. In part due to fears that strategic protectionism would hamper the liberalization process (Swiss Delegation, 1976), the Swiss delegation to the negotiations proposed a simple formula for post-Tokyo tariffs that depended only on a good's initial tariff. This so-called "Swiss formula" compressed the distribution of final AVE tariffs in year T by imposing a maximum AVE tariff of 0.14 and assigning larger tariff cuts to goods g with larger tariffs in an initial year t_0.[10] Specifically, the Swiss formula is

$$AVE_{gT}^{Swiss} = \frac{0.14 \times AVE_{gt_0}}{0.14 + AVE_{gt_0}}. \tag{2}$$

Importantly for our estimation strategy, conditional on pre-Tokyo tariffs, the extent of an industry's liberalization under the Swiss formula is uncorrelated with industry characteristics *by construction.*[11] In turn, the initial AVE tariffs AVE_{gt_0} are the only potential source of endogeneity in the tariffs implied by the Swiss formula – a possibility that we address below.

Figure 4: AVE Tariff Cuts During the Tokyo Round



Notes: Figure displays a scatterplot of the 381 4-digit 1987 SIC industry-level tariff changes from 1979-1988 observed in practice (on the vertical axis) versus those implied by the Swiss formula (on the horizontal axis). The grey line indicates strict adherence to the Swiss formula. Points above this line (indicated in blue) received a smaller tariff cut than prescribed while those below the line (indicated in red) received a larger tariff cut than prescribed. Data taken from Greenland et al. (2023) and authors' calculations.

Figure 4 displays the extent to which the US followed the Swiss formula when setting

[10] The tariff cut implied by the Swiss formula tariff is $AVE_{gT}^{Swiss} - AVE_{gt_0} = \frac{-AVE_{gt_0}^2}{0.14+AVE_{gt_0}}$, which is increasing in AVE_{gt_0}. Further, the maximum final tariff is $\lim_{AVE_{gt_0}\to\infty} \frac{0.14\times AVE_{gt_0}}{0.14+AVE_{gt_0}} = \lim_{AVE_{gt_0}\to\infty} \frac{0.14}{\frac{0.14}{AVE_{gt_0}}+1} = 0.14$.

[11] The Swiss delegation proposed the value 0.14 and, in practice, the US followed the proposal and used this value (Swiss Delegation, 1976; Deardorff and Stern, 1979).

tariffs following the Tokyo Round. The figure plots the 4-digit SIC AVE tariff change between 1979 and 1988 implied by the Swiss formula on the horizontal axis against the observed AVE tariff change over this period on the vertical axis.[12] The grey 45 degree line represents exact adherence to the Swiss formula, such that industries above the line are "under-liberalized" and receive less-than-prescribed tariff cuts while industries below the line are "over-liberalized" and receive more-than-prescribed cuts. Three points stand out in the figure. First, as discussed above, Tokyo Round tariff changes constitute a substantial liberalization: the mean observed tariff reduction is 2.5 percentage points, with a standard deviation of 2.7 percentage points. Second, the strong positive correlation of 0.64 between observed and prescribed tariff cuts implies that the Swiss formula does indeed serve as a benchmark for tariff liberalization under the Tokyo Round. Finally, the dispersion across industries in observed tariff cuts for a *given* Swiss-prescribed tariff cut – that is, the extent of the deviation from the 45 degree line – is an empirical representation of the concerns regarding endogenous tariff setting that motivate our instrument. We explore this issue more fully before detailing our solution to it.

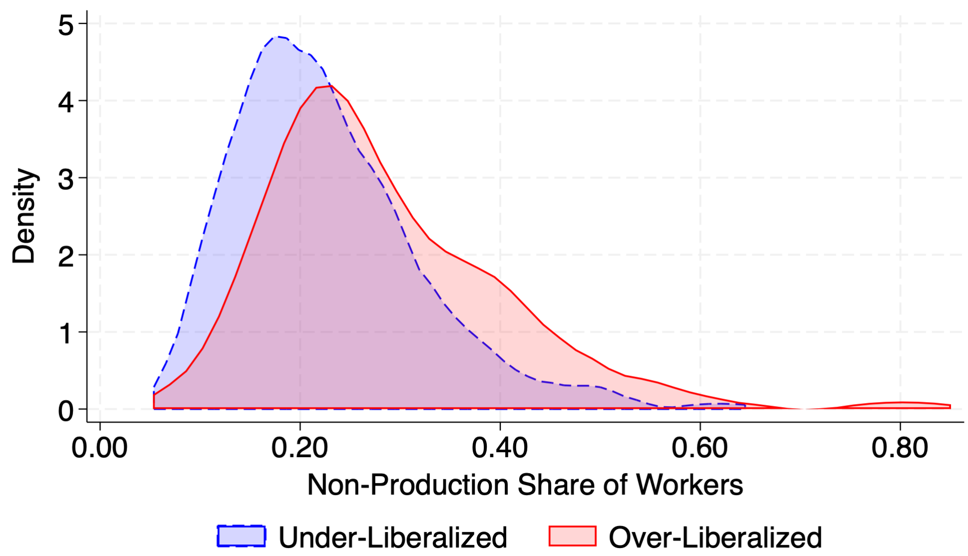
3.1 Endogenous Liberalization

An appealing feature of our setting is that we are able to explore the nature of endogenous protection: what factors drove US policymakers to deviate from the Swiss formula? Specifically, we explore the characteristics of the under-liberalized industries relative to the over-liberalized industries. This is a rare opportunity, as studies analyzing the causal impact of trade policy typically require settings in which the observed policy changes are plausibly exogenous, ruling out an exploration of the endogenous determinants of those changes by definition, or require that all such determinants have been identified. By exploiting the planned tariff reductions from the Swiss formula, we are able to identify the causal effects of Tokyo Round tariff reductions while simultaneously identifying endogenous correlates of observed protection.

Motivated by our focus on inequality between skilled and unskilled workers, we begin by highlighting the imprint of industry skill intensity on the Tokyo Round tariff cuts chosen by policymakers. Figure 5 presents separate kernel densities of the 1978 skilled labor share of

[12] Section 2 explained that we aggregate legislated tariff-line level g AVE tariffs to the 4-digit SIC industry-level i, as detailed in Appendix C.1. See Figure A.3 in Appendix B for the analogous version of Figure 4 at the tariff line 5-digit TSUSA level.

Figure 5: Skilled Labor Shares and Endogenous Liberalization



Notes: Kernel density of skilled labor shares of employment displayed separately for 4-digit 1987 SIC industries receiving lower tariff cuts than prescribed by the Swiss formula (Under-Liberalized) versus those receiving greater tariff cuts than prescribed (Over-Liberalized). Data from Greenland et al. (2023), the NBER-CES manufacturing database, and authors' calculations.

employment within the 192 under-liberalized (blue) industries and the 189 over-liberalized industries (red). While there is considerable overlap in the densities, the overall pattern is stark: under-liberalized industries tend to have smaller employment shares of skilled labor than over-liberalized industries. That is, policymakers are more likely to deviate from the Swiss formula to protect industries with lower pre-Tokyo skill intensity.

We analyze this relationship more formally in Table 1. Specifically, we estimate a linear probability model relating 1978 industry characteristics to whether or not an industry is under-liberalized. Column (1) of the table includes only 1978 observed industry tariff levels, and suggests a persistence in protection: industries receiving more protection on the eve of the Tokyo Round are more likely to be under-liberalized than industries with lower pre-Tokyo tariffs. Column (2) introduces the industry-level skilled share of employment. Including this variable reduces the coefficient on initial tariffs by approximately 25%, suggesting that the skill composition of employment shapes the *pre-Tokyo* protection decisions of policymakers with more unskilled-labor intensive industries receiving more protection. Moreover, as Figure 5 highlighted, the probability of *post-Tokyo* under-liberalization increases with the unskilled share of employment. The remaining columns of the table sequentially introduce controls for

1978 industry capital-to-labor ratios, total factor productivity (TFP), log investment, and two-digit SIC sector fixed effects. The magnitude of the effects on both 1978 AVE levels and skill intensity are reduced slightly, but the key point remains: pre-Tokyo protection and industry skill intensity are key determinants of differential protection in the Tokyo Round.

Table 1: Determinants of Under-Liberalization

	(1)	(2)	(3)	(4)	(5)	(6)
$AVE_{i,1978}$	2.296***	1.735***	2.212***	2.150***	2.142***	1.363***
	(0.273)	(0.316)	(0.366)	(0.370)	(0.370)	(0.497)
$\frac{Emp^{NP}_{i,1978}}{Emp_{i,1978}}$		-0.860***	-0.880***	-0.881***	-0.869***	-0.683**
		(0.217)	(0.217)	(0.218)	(0.223)	(0.295)
$\ln\left(\frac{Capital_{i,1978}}{Emp_{i,1978}}\right)$			0.076**	0.069**	0.074**	-0.032
			(0.032)	(0.032)	(0.036)	(0.053)
$TFP_{i,1978}$				-0.182	-0.181	-0.123
				(0.143)	(0.143)	(0.153)
$\ln(Investment_{i,1978})$					-0.007	0.014
					(0.022)	(0.022)
Constant	0.337***	0.596***	0.288*	0.496**	0.501**	0.759***
	(0.037)	(0.079)	(0.155)	(0.217)	(0.218)	(0.272)
SIC-2 FE	N	N	N	N	N	Y
Obs.	381	381	381	381	381	381
Adj. R^2	0.080	0.111	0.121	0.122	0.120	0.200

Notes: Dependent variable is a dummy variable taking on the value of 1 if an industry's tariff cut was smaller than prescribed by the Swiss formula. All data are measured or concorded to the 4-digit 1987 SIC classification. Emp^{NP} is the non-production employment in industry i. OLS estimation of linear probability models. Robust standard errors. *, **, and *** indicate p-values less than 10%, 5% and 1%, respectively.

To gain a sense of magnitudes, consider the implied increase in the probability of an industry being under-liberalized due to an interquartile increase in the pre-Tokyo 1978 AVE tariff and an interquartile decrease in the 1978 skilled labor share of employment, respectively. The point estimates in column (6) imply that the former, which corresponds to a 5 percentage point tariff cut, increases the probability of post-Tokyo under-liberalization by approximately 7%. Similarly, the latter increases the probability of under-liberalization by approximately 8.5%. The economically meaningful magnitudes of these effects suggests that politicians appear to have considered pre-existing characteristics in a way that materially impacted the distribution of Tokyo liberalization across industries. Such endogenous manipulation of tariff changes, of course, may yield biased estimates of the effects of observed changes on industry outcomes. We turn to our proposed solution to this issue now.

3.2 A Swiss IV

As noted earlier, Tokyo Round tariff cuts under the Swiss formula are exogenous *conditional on the initial tariff*. As we have just highlighted, however, these initial tariffs are themselves non-random. In particular, industries receiving more protection on the eve of the Tokyo Round use unskilled labor more intensively and are more likely to receive protection from their Swiss-formula prescribed tariff cut. As such, using the tariff variation implied by the Swiss formula could still generate biased estimates through the endogenous relationship between outcomes and initial tariff levels.

To address this concern, we rely on a second institutional feature of the US tariff schedule: while the US imposes so-called "column 1" (i.e. MFN) tariffs on imports from most countries, it imposed "column 2" tariffs on imports from a small subset of communist countries at the onset of the Tokyo Round.[13] These column 2 tariffs were themselves originally the column 1 tariffs from the Smoot-Hawley Tariff Act of 1930. This implies that the column 1 tariffs immediately preceding the Tokyo Round reflect the six GATT rounds between 1930 and 1979 and, in turn, the decisions of policymakers to protect certain industries during these rounds. However, they also reflect the 1930s column 1 tariffs themselves – that is, Tokyo-era column 2 tariffs. As a result, there is a strong positive correlation between the pre-Tokyo column 2 tariffs and their column 1 counterparts. But, as they were set nearly 50 years prior to our period of study, the column 2 tariffs are less likely to be correlated with omitted determinants of our 1980s outcomes of interest than the pre-Tokyo column 1 tariffs.[14]

The final construction of our instrument rests on each of the two institutional features of US tariff policy described above: that Tokyo Round negotiations used the Swiss formula as a benchmark and that column 2 tariffs were determined by the Tariff Act of 1930 but still strongly correlate with their column 1 counterparts on the eve of the Tokyo Round. Specifically, we rely on the Swiss formula to dictate the magnitude of tariff cuts across goods, but substitute column 2 AVE tariffs into the formula in lieu of the observed column 1

[13]As is well known, GATT Article I requires that GATT members apply MFN tariffs on imports from all member countries. This, however, leaves discretion for the tariffs imposed on non-members. The extent of discretion is substantial at the onset of the Tokyo Round, when fewer than 90 countries belonged to the GATT. In practice, during our sample period the US imposes column 1 tariffs on the vast majority of non-GATT members and imposes column 2 tariffs on a small subset of communist non-GATT members, but violates GATT Article I by imposing column 2 tariffs on some communist GATT members.

[14]Appendix Figure A.1 illustrates the strong positive correlation between column 1 and column 2 tariffs at the tariff-line TSUSA level. It also shows substantial dispersion across column 1 tariffs for a given column 2 tariff, implying that policymakers did indeed protect some industries more than others during the six preceding GATT rounds. Figure A.2 produces the same figure for 4-digit SIC industries in 1978.

AVE tariffs. At the 5-digit TSUSA level, we construct time-varying values of our instrument. The value of the instrument at the end of the phase-out period in 1987, and in the last year of our sample in 1988, is given by

$$AVE_{gT}^{IV} = \frac{0.14 \times AVE_{g,1978}^{Col2}}{0.14 + AVE_{g,1978}^{Col2}}. \tag{3}$$

The instrument value in 1979, the first year of our sample, is the 1978 column 2 AVE tariff, $AVE_{g,1978}^{Col2}$.[15] For each year between 1980 and 1987, the value of AVE_{gt}^{IV} linearly phases out from $AVE_{g,1978}^{Col2}$ to AVE_{gT}^{IV}, following the approach taken in practice. Appendix C.1 details the aggregation from the 5-digit TSUSA level AVE_{gt}^{IV} to the 4-digit SIC industry level AVE_{it}^{IV} using time-invariant 1978 import weights.[16] As the only source of cross-industry variation in our instrument is the 1978 column 2 AVE tariff – that is, the 1930 column 1 AVE tariff – the key exclusion restriction is that any unobserved factors determining US column 1 tariffs in 1930 do not also directly affect 1980s US trade or labor market outcomes.[17]

Figure 6 illustrates the two-stage least squares intuition behind our Swiss IV at the 4-digit SIC level. The left panel plots the first stage relationship: the instrumented change in AVE tariffs between 1979 and 1988 on the horizontal axis against the observed change in tariffs over this period on the vertical axis.[18] Our instrumented change in AVE tariffs strongly predicts observed tariff changes: industries with higher 1978 column 2 AVE tariffs, and thus greater predicted cuts by the Swiss formula, see substantially larger AVE tariff cuts following the Tokyo Round.

The right panel of the figure displays the second stage relationship, with the predicted AVE tariff change from the left panel on the horizontal axis plotted against observed import growth on the vertical axis. The figure suggests that the Tokyo Round liberalization generated substantial import growth, as industries with larger predicted tariff reductions exhibit stronger import growth between 1979 and 1988. This relationship also suggests a role for Tokyo Round tariff cuts explaining other industry outcomes in this era. We explore this possibility now.

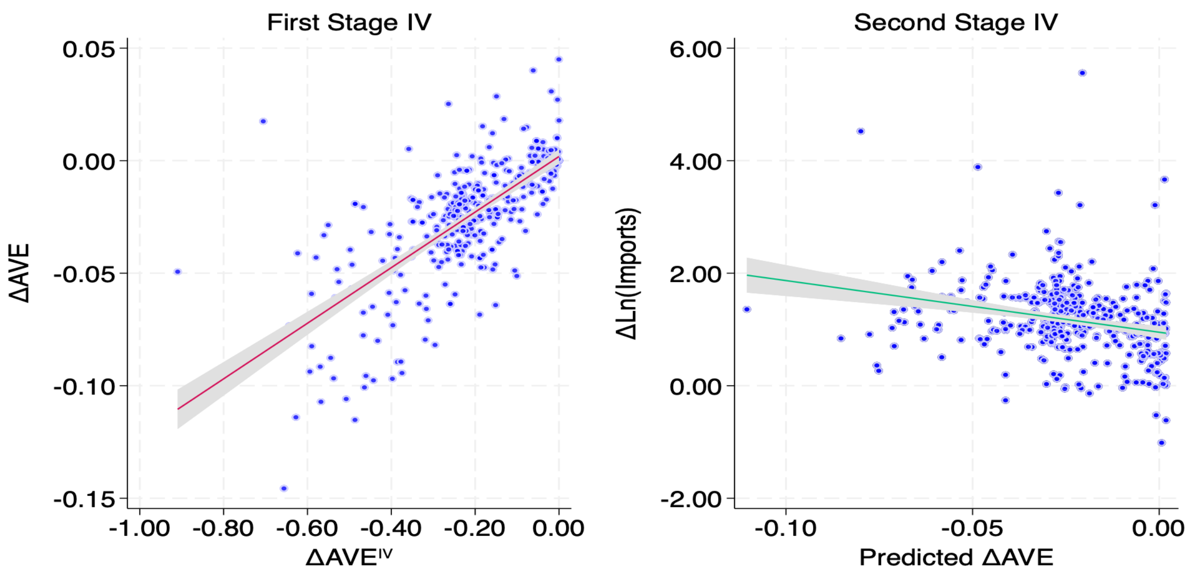
[15] We construct the instrument using the AVE in 1978 instead of 1979 to avoid concerns regarding endogenous determination of contemporaneous unit values. Our results are unchanged by using 1979 AVE tariffs.

[16] Note that we apply the phase-out only to those exporters and goods facing column 1 legislated tariffs.

[17] See Appendix C.3 for a formal derivation of our exclusion restriction.

[18] A small number of industries see AVE tariff increases. This is possible even in the absence of legislated tariff increases due to falling unit values in the presence of specific tariffs. Approximately one-third of US tariffs lines before the Tokyo Round faced specific tariffs (Greenland et al., 2023).

Figure 6: Import Growth Versus Instrumented Tariff Changes



Notes: Scatterplot displaying two-stage least squares regression of import growth on changes in observed AVE tariffs AVE_{it} instrumented by our Swiss IV AVE_{it}^{IV} as defined in Equation 3. Long differences taken from 1979-1988. Two points omitted from this figure for improved visibility. Results are not dependent on their omission. Full un-suppressed figure available upon request. Data from Schott (2008), Greenland et al. (2023) and authors' calculations.

4 Results

4.1 Trade flows

We now turn to our primary analysis. To the extent that tariffs affect labor market outcomes, they do so through their effect on goods prices and, in turn, trade flows. With this in mind, Table 2 explores the relationship between industry-level tariffs and trade flows. Column (1) presents the effect of industry tariffs on log imports using our Swiss IV to instrument for observed AVE tariffs. Consistent with our expectations, the relationship is negative and statistically significant: imports rise as tariffs fall. The column (1) elasticity of approximately 9 is consistent with other analyses of trade liberalizations.[19] Further, consistent with the discussion in Section 3, the first-stage F-statistic suggests that the instrument is strong.

As discussed above, our instrument addresses the concern that policymakers may have either chosen tariff levels prior to the Tokyo Round or chosen tariff reductions following

[19]See, e.g., Ruhl (2008) and Head and Mayer (2014).

Table 2: Tariff Liberalization and Trade

	(1) ln($Imports$)	(2) ln($Imports$)	(3) ln($Exports$)	(4) ln($Exports$)
AVE_{it}	-9.062***	-2.468**	-1.426*	-1.575***
	(1.102)	(1.159)	(0.816)	(0.501)
Estimation	IV	OLS	IV	OLS
1^{st} Stage Coeff.	0.128	-	0.128	-
1^{st} Stage F	474.4	-	466.2	-
Obs.	3774	3774	3770	3770

Notes: Dependent variable indicated in the column header. All columns include year and 4-digit 1987 SIC fixed effects. All data measured at or concorded to the 4-digit 1987 SIC classification. IV estimation instruments AVE_{it} with AVE_{it}^{IV} as defined in Equation 3. F-statistic is Kleibergen-Paap Rk F-statistic. Robust standard errors reported in parentheses. *, **, and *** indicate p-values less than 10%, 5% and 1%, respectively.

Tokyo with an eye towards industry outcomes such as import growth. To underscore this point, column (2) repeats the column (1) specification but does not instrument for observed AVE tariffs. The results clearly illustrate the concern regarding endogenous tariff setting vis-à-vis import growth. The column (2) elasticity estimate is approximately one-fourth the size of our preferred estimate in column (1). The bias toward zero evident in column (2) places structure of the nature of the endogeneity concern. Specifically, it suggests that policymakers protected industries in which they expected more rapid import growth.

While our estimates imply that tariff liberalization increases imports, one may be concerned that our instrument also captures reciprocal tariff liberalization abroad due to the multilateral nature of the Tokyo Round. To explore this possibility, columns (3) and (4) examine the impact of tariffs on log exports. While the effect is negative and weakly significant, the export elasticity using our Swiss IV in column (3) is approximately 15% of the import elasticity. Further, column (4) indicates that there is little difference in the export elasticity whether or not we instrument for observed AVE tariffs. Both of these results suggest that the Swiss IV is in fact capturing US tariff cuts rather than reciprocal tariff cuts abroad.

Ultimately, Table 2 delivers two key messages. First, exogenous Tokyo Round tariff cuts in the US have substantial effects on imports but much more muted effects on US exports. Second, failing to account for endogenous tariff policy in the Tokyo era – both in the years immediately preceding the policy change and during the policy's implementation – yields substantially biased results. In particular, policymakers chose to protect industries that were more exposed to import growth during the liberalization, highlighting the value of our instrument in isolating random variation in tariff cuts.

4.2 Industry Outcomes

We now turn to the impact of tariff cuts on other industry-level outcomes. Specifically, Table 3 explores how tariffs affect industry-level output, input usage, investment, and inequality between skilled and unskilled workers.[20]

Table 3: Tariff Liberalization and Industry Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ln($Ship$)	$\frac{LaborPay}{Ship}$	$\frac{Materials}{Ship}$	$\ln(Invest)$	$\ln\left(\frac{Pay_{NP}}{Pay_P}\right)$	$\ln\left(\frac{Emp_{NP}}{Emp_P}\right)$	$\ln\left(\frac{Wage_{NP}}{Wage_P}\right)$
AVE_{it}	0.355	0.222***	-0.187**	-2.948***	-1.148***	-1.096***	-0.0520
	(0.462)	(0.0414)	(0.0855)	(0.908)	(0.318)	(0.344)	(0.240)
Estimation	IV	IV	IV	IV	IV	IV	IV
1^{st} Stage Coeff.	0.128	0.128	0.128	0.128	0.128	0.128	0.128
1^{st} Stage F	472.8	472.8	472.8	472.8	472.8	472.8	472.8
Obs.	3810	3810	3810	3810	3810	3810	3810

Notes: Dependent variable indicated in column header. All columns include year and 4-digit 1987 SIC fixed effects. Estimation via IV with AVE_{it} instrumented using AVE_{it}^{IV} as defined in Equation 3. All data measured at or concorded to the 4-digit 1987 SIC classification. F-statistic is Kleibergen-Paap Rk F-statistic. Robust standard errors reported in parentheses. *, **, and *** indicate p-values less than 10%, 5% and 1%, respectively.

Columns (1)-(3) focus on output and on input choices. While the liberalization does not affect output in a statistically significant way, it does lead to a nearly one-to-one shift in the composition of inputs away from labor and towards materials.[21] The implied change in the labor and materials share due to the mean change in AVE_{it} between 1979 and 1988 accounts for 39.6% and 23.4%, respectively, of the mean industry-level change in these shares over the same period. This shift is consistent with increased offshoring in the face of falling tariffs, a possibility we return to below. Column (4) also suggests that industries respond to falling tariffs by increasing investment, potentially in an attempt to innovate away from competition. Specifically, we find that the mean change in AVE_{it} increases investment by approximately 7%, or 51% of the contemporaneous mean industry-level change.

Next, we turn to the effects on within-industry inequality over time, with columns (5)-(7) analyzing inequality between skilled and unskilled workers. Column (5) explores the impact on income inequality, defined as the log ratio of total payments to skilled workers relative

[20] We define output as shipments deflated by an industry-specific shipment price deflator. Investment is also deflated by an industry-specific investment price deflator.

[21] One can essentially interpret materials as intermediate inputs in our data. In input-output tables, the value of output is allocated between the value of intermediate inputs and value added so that the ratio of intermediate inputs plus value added relative to output is 1. The ratio of materials plus value added relative to the value of shipments in our data takes on values of .9913 and 1.034 at, respectively, the 5th and 95th percentiles. The mean and median values are, respectively, 1.008 and 1.007.

to total payments to unskilled workers. The point estimate implies that tariff reductions increase income inequality within industries, and the economic magnitude is sizeable: the implied increase in industry-level income inequality due to the mean fall in AVE_{it} over our sample period explains 17% of the contemporaneous mean industry-level rise in income inequality.

Rising income inequality within an industry can reflect either rising wage inequality or rising skill intensity in the form of a shift in the composition of labor towards skilled workers. Columns (6) and (7) explore this distinction, decomposing income inequality into its skill intensity margin, defined as the log ratio of skilled to unskilled employment, and its wage inequality margin, defined as the log ratio of skilled labor payroll per skilled worker relative to unskilled labor payroll per unskilled worker. Strikingly, the columns reveal that the increased income inequality accompanying tariff liberalization is driven entirely by rising skill-intensity, with no role for rising wage inequality.

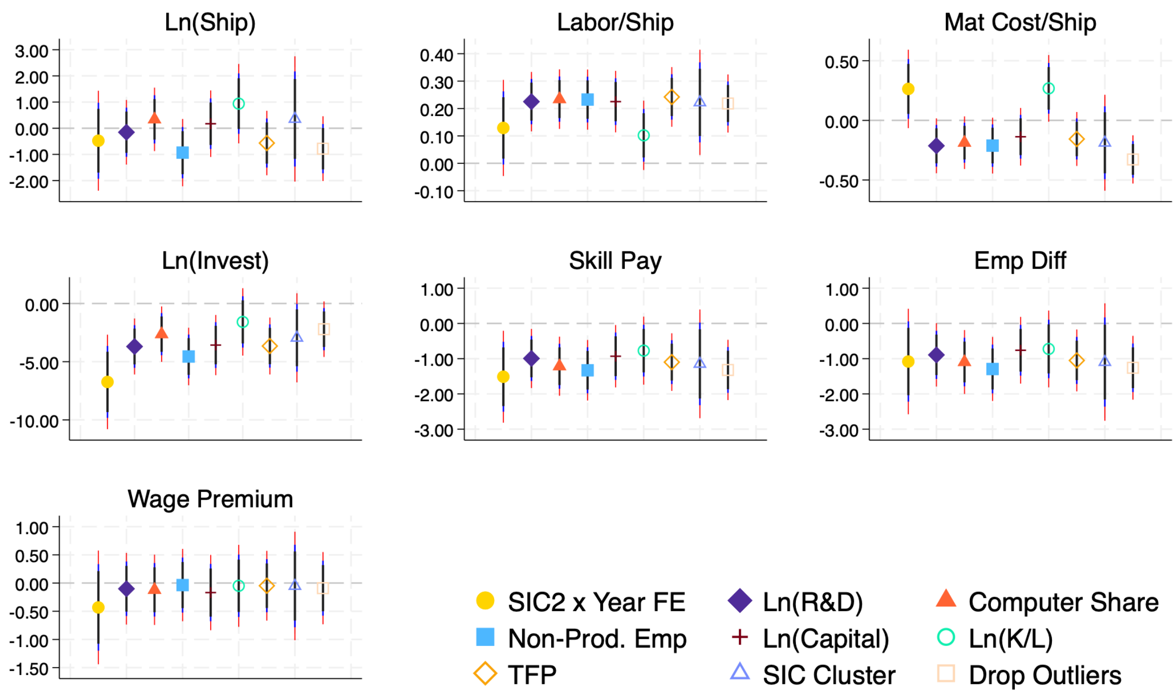
Figure 7 reports results of a number of robustness exercises that address potential confounding factors or specification choices that might drive our baseline results. A primary concern is that our instrument may capture other determinants of industry outcomes, such as technological change. More specifically, the industry-level factors that drove 1930 column 1 tariffs, and thus the liberalization implied by our instrument, could persist and also drive 1980s labor market outcomes. With this in mind, the figure reports results from alternative specifications for each outcome from Table 3. The bar and whiskers plot illustrates the point estimates of interest with a symbol and the different colored whiskers – black, blue, and red, respectively – represent the 90%, 95%, and 99% confidence intervals.

We begin by adding two-digit SIC-by-year fixed effects to control for sector-level time-varying shocks including, but not limited to, SBTC. Next, to control for industry-specific characteristics that may predict outcomes in the 1980s, we separately interact industry levels of the following variables with year trends: 1975 log R&D; the 1977 computer input share; and 1978 values of the share of employment accounted for by non-production workers, log capital stock, log capital-to-labor ratio, and five-factor TFP.[22]

A separate set of concerns relate to estimation choices. To this end, the final two bars in each panel introduce alternative specifications. First, while we follow the suggestion of

[22]Non-production employment shares, capital stocks, capital-to-labor ratios, and TFP are taken from the NBER-CES Manufacturing Database. R&D data come from Scherer (1984), while computer industry shares are defined as the share of inputs sourced from two-digit SIC categories 35 and 36 in the 1977 BEA input-output tables.

Figure 7: Robustness



Notes: Each bar and whiskers plot represents a separate regression that adds a single additional control to our baseline specification in equation (1). Symbols indicate AVE_{it} point estimate when adding control indicated in the legend. Black, blue, and red whiskers indicate 90% 95% and 99% confidence intervals respectively. All data measured or concorded to the 4-digit SIC 1987 classification. Estimation via IV with AVE_{it} instrumented using our Swiss IV AVE_{it}^{IV}. Each regression uses robust standard errors unless otherwise specified.

Abadie et al. (2023) and do not cluster our standard errors because industry-year variation drives both our outcomes and AVE tariffs, one may prefer clustering the standard errors at the industry level to account for correlation within industries over time. Second, to guard against the impact of outliers, we drop observations that lie in the 1% tails of the outcome variable or AVE_{it}.

A primary message from Figure 7 is that the results from Table 5 are largely robust to these alternative specifications. The point estimates are generally stable, with the exception of the material cost share, which is not robust to the inclusion of sector-year fixed effects or log capital-to-labor. This suggests that it is indeed tariff liberalization, and not omitted variables or particular specification choices, that drive our baseline estimates.

4.3 Endogenous Protection and Industry Outcomes

Section 3.1 documents that US policymakers protected certain industries from the tariff cuts prescribed by the Swiss formula. In particular, they were more likely to under-liberalize industries with higher pre-Tokyo tariff levels and lower skill intensity. To underscore the implications for industry outcomes, Table 4 repeats our baseline specifications from Table 3 without instrumenting for AVE tariffs. Panel B reports these OLS estimates and, for reference, panel A reproduces the baseline IV results.

Not accounting for the fact that policymakers endogenously set tariffs dramatically impacts the estimated effects of tariff liberalization on non-trade outcomes. The point estimates in columns (2) and (4), capturing the effects on labor shares and investment, respectively, are no longer statistically significant. Moreover, column (5) shows that the estimated effect of tariffs on income inequality falls by two-thirds, while column (6) shows the estimated effect on skill intensity falls by more than half. Taken together, these results clearly demonstrate the importance of accounting for endogenous tariff setting when identifying the causal effect of tariff liberalization.

The substantial bias towards zero of the impact of liberalization on inequality in particular is consistent with our findings on endogenous tariff setting in Table 2. Policymakers protected industries that were more exposed to import growth following the Tokyo Round by sparing them from the full brunt of tariff cuts prescribed by the Swiss formula. As our IV estimates in Table 3 show, tariffs cuts, and the import growth associated with them, increase inequality. Thus, failing to account for the endogenous choice of policymakers to protect industries with

Table 4: **Tariff Liberalization and Endogenous Protection**

	(1) $\ln(Ship)$	(2) $\frac{LaborPay}{Ship}$	(3) $\frac{Materials}{Ship}$	(4) $\ln(Invest)$	(5) $\ln\left(\frac{Pay_{NP}}{Pay_P}\right)$	(6) $\ln\left(\frac{Emp_{NP}}{Emp_P}\right)$	(7) $\ln\left(\frac{Wage_{NP}}{Wage_P}\right)$
				Panel A: IV			
AVE_{it}	0.355	0.222***	-0.187**	-2.948***	-1.148***	-1.096***	-0.052
	(0.462)	(0.0414)	(0.0855)	(0.908)	(0.318)	(0.344)	(0.240)
1^{st} Stage Coeff.	0.128	0.128	0.128	0.128	0.128	0.128	0.128
1^{st} Stage F	472.8	472.8	472.8	472.8	472.8	472.8	472.8
Obs.	3810	3810	3810	3810	3810	3810	3810
				Panel B: OLS			
AVE_{it}	-0.141	0.0341	-0.151***	-0.796	-0.398**	-0.504**	0.106
	(0.287)	(0.0221)	(0.0424)	(0.540)	(0.193)	(0.212)	(0.142)
Obs.	3810	3810	3810	3810	3810	3810	3810

Notes: Dependent variable indicated in column header. All specifications include year and 4-digit 1987 SIC fixed effects. All data are measured or concorded to the 4-digit 1987 SIC classification. Panel A reproduces results from Table 3, Panel B reports OLS results. F-statistic is Kleibergen-Paap Rk F-statistic. Robust standard errors reported in parentheses. *, **, and *** indicate p-values less than 10%, 5% and 1%, respectively.

larger expected import growth will bias the negative effect of tariffs on inequality towards zero.

Further, as we also document in Table 1, policymakers protected industries that more intensively used unskilled labor. This, combined with our results in Table 4, suggests that the decisions of policymakers to protect such industries mitigated the negative effects of tariff cuts on inequality. Put another way, it appears that policymakers may have sought to protect unskilled workers from the negative effects of liberalization when implementing Tokyo Round tariff cuts, with at least some success.

4.4 Mechanisms

The results above clearly establish an important role for falling tariffs in shaping 1980s industry-level outcomes. We now explore the specific channels through which this operates.

As noted above, the shift away from labor and towards materials as tariffs decline suggests a role for offshoring in explaining both the changes in the industry-level composition of inputs and the increase in income inequality throughout the 1980s. Indeed, offshoring has occupied a central place in the literature on trade and labor markets in this era. To explore the role played by input tariff liberalization in our findings, we create a weighted average of observed tariffs on an industry's upstream inputs. An input tariff receives a higher weight in the average when the industry relies more on the input for its own production, as calculated using the 1977 BEA input-output table, and the input represents a larger share of 1978 US imports. To account for endogeneity of tariffs on inputs, we also calculate this measure using our Swiss IV to instrument for upstream tariffs.[23]

Table 5 separately analyzes the effects of an industry's own tariff, AVE_{it}, and the tariffs on its upstream inputs, AVE_{it}^{Up}. Columns (1)-(3) confirm an important role for offshoring incentives in driving industry outcomes. Column (1) reveals that the null effect of tariff liberalization on output in Table 3 masks offsetting effects from an industry's own tariff liberalization and that of its upstream inputs. The point estimates in the column imply that the mean industry-level reduction in own-industry tariffs reduces output by approximately 6%. At the same time, an interquartile increase in input tariff liberalization *increases* output by approximately 7.5%. Offshoring thus plays a substantial role in driving in industry-level output in our sample.

Table 5: Tariff Liberalization and Offshoring

	(1) $\ln(Ship)$	(2) $\frac{LaborPay}{Ship}$	(3) $\frac{Materials}{Ship}$	(4) $\ln(Invest)$	(5) $\ln\left(\frac{Pay_{NP}}{Pay_P}\right)$	(6) $\ln\left(\frac{Emp_{NP}}{Emp_P}\right)$	(7) $\ln\left(\frac{Wage_{NP}}{Wage_P}\right)$
AVE_{it}	2.452***	0.0536	0.145	-2.859**	-1.320***	-0.979**	-0.341
	(0.660)	(0.0559)	(0.118)	(1.282)	(0.409)	(0.478)	(0.327)
AVE_{it}^{Up}	-15.08***	1.288***	-2.354***	1.613	0.798	-0.793	1.591
	(2.948)	(0.247)	(0.431)	(5.551)	(1.817)	(2.236)	(1.390)
Estimation	IV	IV	IV	IV	IV	IV	IV
1^{st} Stage F	132.3	132.3	132.3	132.3	132.3	132.3	132.3
Obs.	3780	3780	3780	3780	3780	3780	3780

Notes: Dependent variable indicated in column header. All columns include year and 4-digit 1987 SIC fixed effects. All data measured or concorded to the 4-digit SIC 1987 classification. Estimation via IV. AVE_{it} and AVE_{it}^{Up} instrumented using AVE_{it}^{IV} as defined in Equation 3, and the weighted average of AVE_{it}^{IV} where the weights correspond to the weights used to construct AVE_{it}^{Up}. F-statistic is Kleibergen-Paap Rk F-statistic. Robust standard errors reported in parentheses. *, **, and *** indicate p-values less than 10%, 5% and 1%, respectively.

Further, it is indeed input tariff liberalization, rather than own-industry tariff liberalization, that explains input choices. Columns (2) and (3) show that the shift away from labor and towards material inputs is driven entirely by input tariff liberalization. Specifically, column (2) indicates that the implied change in the labor share of output due to the industry-level interquartile increase in input tariff liberalization represents 46% of the contemporaneous mean change in the labor share. Column (3) implies that the same input tariff liberalization explains 58.9% of the contemporaneous mean change in the materials share.

[23] We detail construction of these variables in Appendix C.2.

Taken together, columns (1)-(3) are consistent with an offshoring mechanism, whereby industry output rises as input tariffs fall and firms purchase cheaper imported inputs rather than producing those inputs using labor within the boundary of the firm.

While an offshoring mechanism can explain the industry-level adjustment along the output and input choice margins, it does not explain rising income inequality in the post-Tokyo era. Indeed, the impact of input tariff liberalization in columns (5)-(7) is far from conventional levels of statistical significance. Rather, despite controlling for the liberalization of an industry's input tariffs, columns (5)-(7) preserve the results from columns (5)-(7) of Table 3: own-industry tariff liberalization drives the impact on income inequality, with an effect driven exclusively by the skill intensity margin. These columns imply that cheaper imported inputs do not explain rising income inequality in our sample. Table 5 provides support for an alternative mechanism: trade-induced innovation. That is, column (4) shows that own-industry tariff liberalization triggers increased investment, potentially by encouraging innovation to mitigate the consequences of import competition.

Table 6 explores this possibility further. To the extent that skill-biased technological change as a response to tariff liberalization plays an important role in explaining increased inequality, we expect the most pronounced effects of own-industry tariff reductions in industries most susceptible to technological change. As such, we introduce an interaction between an industry's own tariff and an indicator variable for high-tech industries. Panel A defines high-tech industries as those with an above-median 1977 share of inputs from the two-digit SIC sectors of Electronic Equipment (SIC 35) and Computer Equipment/Machinery (SIC 36). Figure 1 showed these sectors were not only among the largest sources of pre-Tokyo US imports but also experienced the most post-Tokyo import growth. Alternatively, Panel B defines high-tech industries and those with an above median level of patenting between 1970 and 1978.[24] As in previous tables, Table 6 separately explores the effect of AVE_{it} on labor shares, income inequality, skill intensity, and wage inequality.

Consistent with the notion that SBTC was in part a response to rising import competition, we find dramatically different results for low- and high-tech industries. Panel A shows no statistically significant relationship between AVE_{it} and labor market outcomes for industries with below median computer input shares. In computer-intensive industries, on the other hand, falling tariffs correspond to both falling labor shares and rising income inequality. Moreover, contrary to our baseline results, we find a role for both the skill intensity and

[24] Patent data are taken from Marco et al. (2015) and concorded to the SIC classification using a concordance created by Goldschlag et al. (2019).

Table 6: Tariff Liberalization and SBTC

	(1) $\frac{LaborPay}{Ship}$	(2) $\frac{Pay_{NP}}{Pay_{P}}$	(3) $\ln\left(\frac{Emp_{NP}}{Emp_{P}}\right)$	(4) $\ln\left(\frac{Wage_{NP}}{Wage_{P}}\right)$
	Panel A: Computer Intensity			
AVE_{it}	0.009	-0.374	-0.309	-0.065
	(0.0470)	(0.383)	(0.460)	(0.302)
$AVE_{it} \times Computer-Intensive$	0.127**	-2.704***	-1.916***	-0.789**
	(0.0640)	(0.434)	(0.459)	(0.318)
AVE_{it}^{Up}	1.437***	-2.387	-3.049	0.662
	(0.210)	(1.639)	(2.045)	(1.255)
Estimation	IV	IV	IV	IV
1^{st} Stage F	79.86	79.86	79.86	79.86
Obs.	3780	3780	3780	3780
	Panel B: Patenting			
AVE_{it}	0.030	-0.754*	-0.447	-0.307
	(0.0549)	(0.427)	(0.526)	(0.348)
$AVE_{it} \times HighPatent$	0.012	-1.455***	-1.662***	0.207
	(0.0494)	(0.409)	(0.441)	(0.288)
AVE_{it}^{Up}	1.322***	1.237	-0.364	1.601
	(0.253)	(1.831)	(2.323)	(1.437)
Estimation	IV	IV	IV	IV
1^{st} Stage F	89.70	89.70	89.70	89.70
Obs.	3580	3580	3580	3580

Notes: Dependent variable indicated in column header. All columns include year and 4-digit 1987 SIC fixed effects. All data are measured or concorded to the 4-digit SIC 1987 classification. Estimation via IV. All variables listed in Panels A and B are treated as endogenous. Each panel uses the two instruments described in the notes Table 5. Additionally, Panel A uses the instrument $AVE_{it}^{IV} \times Computer-Intensive$ and Panel B uses the instrument $AVE_{it}^{IV} \times HighPatent$. F-statistic is Kleibergen-Paap Rk F-statistic. Robust standard errors reported in parentheses. *, **, and *** indicate p-values less than 10%, 5% and 1%, respectively.

wage inequality channels. That said, the skill intensity channel still dominates: a mean reduction in AVE_{it} corresponds to 6.7% increase in within-industry inequality between skilled and unskilled workers in computer-intensive industries, with approximately 70% of the effect coming from the employment margin. Similarly, panel B shows the effect of tariff reductions is overwhelmingly concentrated in industries with above median 1970s patenting. Taken as a whole, Table 6 confirms the primary role of SBTC as a driver of inequality through mediating the impact of own-industry tariff liberalization.

5 Conclusion

Despite representing a tariff liberalization larger in magnitude than any of CUSFTA, NAFTA, or granting PNTR to China, the Tokyo Round of the GATT has received relatively little empirical attention. In this paper, we exploit newly available data and a novel identification strategy to explore the trade and distributional consequences of the Tokyo Round. We show that the formulaic nature of Tokyo Round tariff negotiations via the Swiss formula, combined with historical 1930s tariffs, allows construction of a simple IV that circumvents standard concerns about endogenous tariff protection.

We use our Swiss IV to show that tariff cuts led to rising 1980s import growth and were associated with a decline in the labor share of output. Moreover, these tariff cuts led to an increase in income inequality between skilled and unskilled workers that is overwhelmingly driven by rising industry-level skill intensity, rather than rising wage-inequality, and is most pronounced in high-tech industries. Combined with the finding that tariff cuts promoted increased investment, our analysis points towards a prominent role for trade-induced skill-biased technological change in generating increased inequality in this era.

Further, by analyzing deviations from the planned cuts under the Tokyo Round, we are able to explore determinants of endogenous protection that would bias estimates based on observed tariffs. We provide evidence that policymakers deviated from the formula governing tariff liberalization by reducing tariffs in low-skill industries by less than was prescribed. This suggests that politicians may have been aware of the potential effects of the liberalization on inequality, and actively mitigated those effects by protecting low-skill industries.

The Tokyo Round represents an interesting laboratory for future work given the magnitude of the liberalization alongside the clean and transparent identification strategy provided by our Swiss IV. Indeed, this is an era of falling manufacturing employment, rising women's labor force participation, declining unionization, and enormous shifts between workers of differing education levels. Each of these trends is potentially related, either directly or indirectly, to the Tokyo Round tariff liberalization.

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A Additional Tables

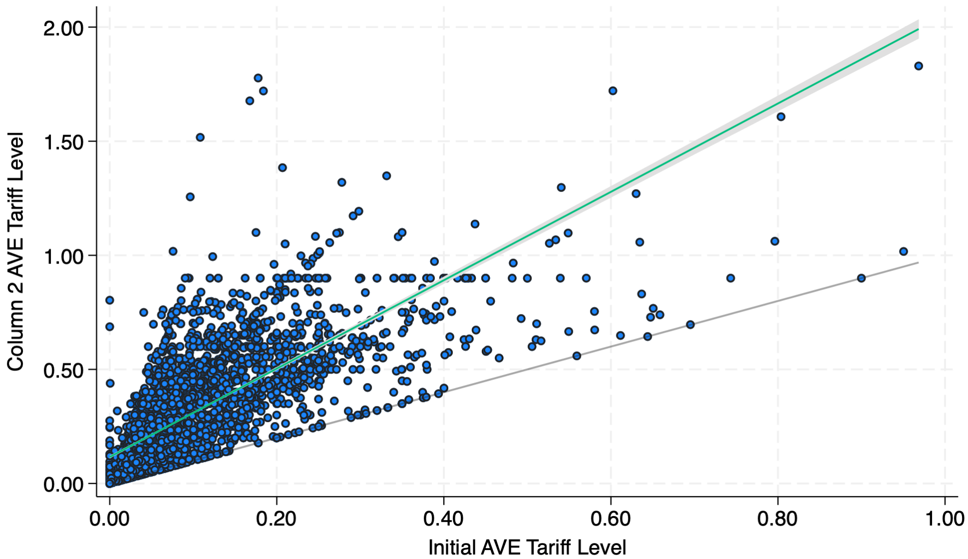
Table A.1: Summary Statistics

	Δ 1979-1988	1979	1988
$\ln(Imports)$	1.181	4.367	5.548
	(0.881)	(1.847)	(1.721)
$\ln(Exports)$	0.494	4.573	5.067
	(0.506)	(1.677)	(1.693)
AVE	-0.025	0.071	0.046
	(0.027)	(0.062)	(0.047)
AVE^{Swiss}	-0.034	0.073	0.039
	(0.042)	(0.063)	(0.023)
AVE^{IV}	-0.216	0.291	0.075
	(0.152)	(0.178)	(0.031)
$\ln(\frac{Wage_{NP}}{Wage_P})$	0.011	0.462	0.473
	(0.139)	(0.209)	(0.201)
$\ln(\frac{Emp_{NP}}{Emp_P})$	0.158	-1.141	-0.983
	(0.211)	(0.578)	(0.597)
$\ln(\frac{Pay_{NP}}{Pay_P})$	0.169	-0.680	-0.511
	(0.209)	(0.535)	(0.562)
$\ln(Ship)$	0.092	7.881	7.973
	(0.392)	(1.121)	(1.185)
$\frac{LaborPay}{Ship}$	-0.014	0.206	0.192
	(0.026)	(0.081)	(0.076)
$\frac{Materials}{Ship}$	-0.020	0.520	0.501
	(0.053)	(0.125)	(0.125)
$\ln(Invest)$	-0.145	4.352	4.207
	(0.611)	(1.335)	(1.498)

Notes: Summary statistics of key variables. Means reported above standard deviations in parentheses. All observations at 4-digit 1987 SIC level. Import data are taken from Schott (2008), AVE reflect authors' calculations based on data in Greenland et al. (2023), remaining data are taken from the NBER Manufacturing Database. AVE_i is the observed AVE tariff. AVE_i^{Swiss} is the tariff implied by the Swiss formula defined in equation (2), linearly phased out, and aggregated to the 4-digit 1987 SIC level as described in Appendix C.1. AVE_i^{IV} is the AVE tariff implied by the Swiss formula under the column 2 tariffs as defined in equation (3), linearly phased out, and aggregated to the 4-digit 1987 SIC level as described in Appendix C.1.

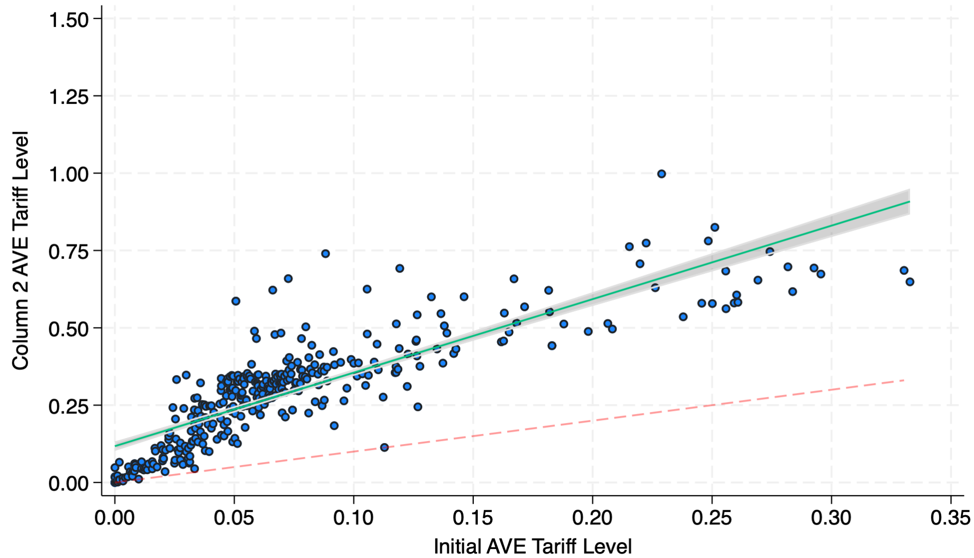
B Additional Figures

Figure A.1: Column 1 versus Column 2 AVE Legislated Tariffs



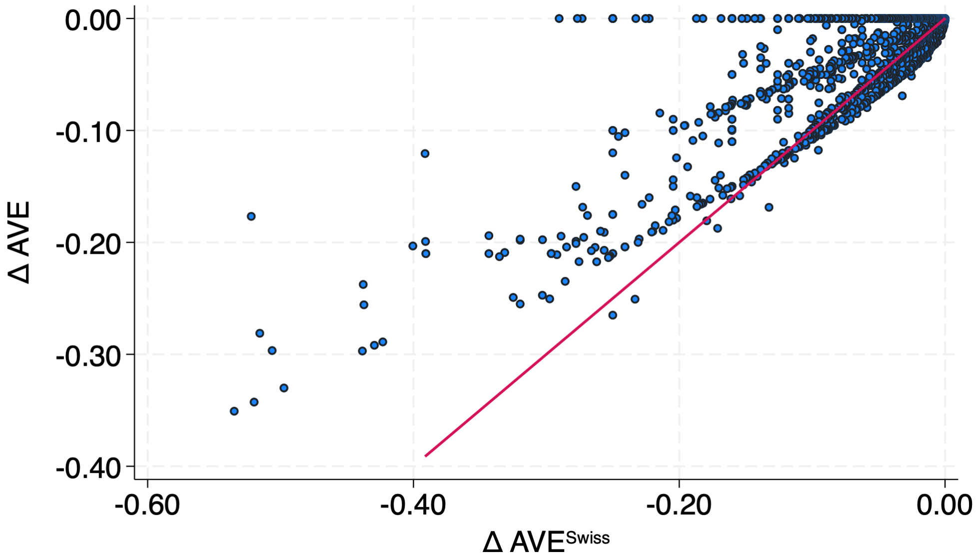
Notes: The figure depicts 1978 column 1 and column 2 AVE legislated tariffs at the tariff-line (TSUSA 5-digit) level. The legislated ad valorem tariff and the AVE of the legislated specific tariff together sum to the AVE legislated tariff of a good. The AVE of a legislated specific tariff is the legislated specific tariff divided by its unit value. Data from Greenland et al. (2023) and authors' calculations.

Figure A.2: Observed versus Column 2 Industry-level AVE Tariffs



Notes:
The figure depicts osberved 1979 AVE tariffs and 1978 column 2 AVE tariffs for the 381 4-gigit 1987 SIC industries in our sample. Correlation is 82.9%. Data from Greenland et al. (2023) and authors' calculations.

Figure A.3: AVE Tariff Cuts During the Tokyo Round



Notes: Figure displays observed (vertical axis) versus tariff cut implied by the Swiss formula (horizontal axis) at the 5-digit TSUSA level between 1979 and 1988 as described in equation 2. Strict adherence to the Swiss formula indicated by the red line. Sample restricted to set of codes observed in both years. Source: Greenland et al. (2023) and authors' calculations.

C Data Appendix

C.1 Aggregating Legislated Tariffs to SIC Industry Tariffs

Our goal is to calculate annual AVE tariffs at the 4-digit SIC level, defined as duties collected divided by the value of imports. To do so, we concord from the disaggregate TSUSA level to the 4-digit SITC rev. 2 classification and then to the 4-digit SIC 1987 system via the 6-digit HS level. Two issues emerge immediately. First, the concordance from the TSUSA system to the 4-digit SITC rev. 2 level maps uniquely from 7-digit TSUSA codes even though legislated tariffs are defined at the 5-digit TSUSA level. Second, exporters of a given 7-digit TSUSA good may face one of three tariffs: (i) the vast majority of exporters and products face the column 1 tariffs but, in practice during our sample period, (ii) a small subset of communist countries face column 2 tariffs, and (iii) a subset of products from a subset of developing countries have duty free access (e.g. due to the US Generalized System of Preferences (GSP) program). To this end, we use annual legislated tariffs between 1978 and 1988 from Greenland et al. (2023) at the exporter by 7-digit level. We also take import data provided by Greenland et al. (2023) at the same level of disaggregation.

Starting at the 7-digit TSUSA level, duties collected on good k in year t across exporters n are

$$d_{kt} = \sum_{n} (\tau_{knt} m_{knt} + f_{knt} q_{knt}) \tag{A.1}$$

where τ is the ad valorem tariff, f is the specific tariff, q is the quantity of imports, and m is the value of imports. Aggregating across the set of 7-digit TSUSA goods $K(j)$ that uniquely map to 4-digit SITC j gives

$$d_{jt} = \sum_{k \in K(j)} d_{kt} \tag{A.2}$$

$$m_{jt} = \sum_{k \in K(j)} m_{kt}. \tag{A.3}$$

For later purposes, it is useful to note that we can always rewrite an aggregate AVE tariff – defined as aggregate duties collected divided by the aggregate value of imports (for example, aggregated across 7-digit TSUSA goods k to the 4-digit SITC industry j) – as an import weighted average of disaggregate AVE tariffs. To this end, let $Col1$ and $Col2$ denote that imports are subject to column 1 and column 2 tariffs. Then,

$$\begin{aligned}
AVE_{jt} \equiv \frac{d_{jt}}{m_{jt}} &= \left[\sum_{k\in K(j)} d_{kt}^{Col1} + \sum_{k\in K(j)} d_{kt}^{Col2}\right]\left[\sum_{k\in K(j)} m_{kt}\right]^{-1} \\
&= \frac{1}{m_{jt}} \sum_{k\in K(j)} \left(\frac{d_{kt}^{Col1}}{m_{kt}^{Col1}} m_{kt}^{Col1} + \frac{d_{kt}^{Col2}}{m_{kt}^{Col2}} m_{kt}^{Col2}\right) \\
&\equiv \frac{1}{m_{jt}} \sum_{k\in K(j)} \left(AVE_{kt}^{Col1} m_{kt}^{Col1} + AVE_{kt}^{Col2} m_{kt}^{Col2}\right) \\
&= \sum_{k\in K(j)} \left(AVE_{kt}^{Col1} \frac{m_{kt}^{Col1}}{m_{kt}} \frac{m_{kt}}{m_{jt}} + AVE_{kt}^{Col2} \frac{m_{kt}^{Col2}}{m_{kt}} \frac{m_{kt}}{m_{jt}}\right) \\
&\equiv \sum_{k\in K(j)} \left(AVE_{kt}^{Col1} \omega_{kt}^{Col1} + AVE_{kt}^{Col2} \omega_{kt}^{Col2}\right) \omega_{kjt} \qquad \text{(A.4)} \\
&\equiv \sum_{k\in K(j)} AVE_{kt} \omega_{kjt}. \qquad \text{(A.5)}
\end{aligned}$$

Equation (A.5) says the aggregate AVE tariff AVE_{jt} is simply the import weighted average of the disaggregate AVE tariffs AVE_{kt} with the weights ω_{kjt} denoting the time-varying share of industry j imports accounted for by good k. And, equation (A.4) says each disaggregate AVE tariff AVE_{kt} is the import weighted average AVE tariff across column 1 imports, AVE_{kt}^{Col1}, and column 2 imports, AVE_{kt}^{Col2}, with the weights ω_{kt}^{Col1} and ω_{kt}^{Col2} denoting, respectively, the time-varying share of good k imports accounted for by column 1 and column 2 imports.[25]

To concord from 4-digit SITC industries j to 4-digit SIC industries i, we use the HS system as an intermediate step. In general, 4-digit SITC codes are more aggregate than 6-digit HS codes. Thus, a 4-digit SITC code j typically maps to multiple 6-digit HS codes. Denote the number of such 6-digit HS codes by l_j^{HS}. Similarly, 6-digit HS6 codes are generally more disaggregate than 4-digit SIC codes. Thus, a given 6-digit HS code h typically maps to a unique 4-digit SIC code. Nevertheless, denote the number of such 4-digit SIC codes by l_h^{SIC}. Then the number of "connections" from 4-digit SITC code j to 4-digit SIC code i is $l_j^{HS} l_h^{SIC}$. Naturally, some of these connections start with the same 4-digit SITC code j and end with the same 4-digit SIC code i. Thus, denote the number of such unique 4-digit SIC codes i "connected" from 4-digit SITC code j by l_j^{SIC}.[26]

[25] Equation (A.4) omits a third term for the category of imports subject to zero tariffs due to, e.g. the US GSP program. This is without loss of generality because these imports have zero AVE tariffs and still enter the total import terms m_{kt} and m_{jt}.

[26] For example, SITC code 0011 maps to the two HS codes 010210 and 010290 (i.e. $l_j^{HS} = 2$). And, each

Let $J(i)$ denote the set of SITC industries j that concord to SIC industry i. Then, the AVE tariff for 4-digit SIC industry i is the weighted sum of duties collected across 4-digit SITC industries $j \in J(i)$ divided by the weighted sum of imports across these 4-digit SITC industries:

$$\begin{aligned} AVE_{it} &= \left[\sum_{j \in J(i)} \frac{1}{l_j^{SIC}} d_{jt} \right] \left[\sum_{j \in J(i)} \frac{1}{l_j^{SIC}} m_{jt} \right]^{-1} \\ &\equiv \left[\sum_{j \in J(i)} d_{jit} \right] \left[\sum_{j \in J(i)} m_{jit} \right]^{-1} \\ &= \sum_{j \in J(i)} AVE_{jt} \omega_{jit} \end{aligned} \tag{A.6}$$

where the last line follows from the general interpretation of an aggregate AVE in Equation (A.5). Equation (A.6) says the AVE tariff for 4-digit SIC industry i, AVE_{it}, is the import weighted average of AVEs across the associated 4-digit SITC industries j, AVE_{jt}, where the weights ω_{jit} correspond to the time varying share of industry i's imports accounted for by industry j. And, as described above, equation (A.5) says the AVE tariff for SITC industry industry j is the important weighted average AVE tariff across 7-digit TSUSA goods k which, per equation (A.4), is the import weighted average AVE tariff across good k column 1 and column 2 imports. Thus, ultimately, the AVE tariff for a 4-digit SIC industry i is an import weighted average of the AVE of the underlying legislated tariffs at the TSUSA tariff-line level.

Construction of our instruments now follows naturally in two steps. First, we calculate an instrumented value for AVE_{kt} with fixed 1978 import weights to substitute into equation (A.5). This gives instrumented values for AVE_{jt}. Second, we substitute the instrumented values for AVE_{jt} into equation (A.6) using fixed 1978 import weights. This gives instrumented values for AVE_{it}.

Our Swiss IV substitutes column 2 tariffs into the 1978 Swiss formula and phases out linearly between 1980 and 1987. Note that Figure A.3 and in Appendix B re-creates Figure 4 at the tariff line 5-digit TSUSA level. And, Figure A.3 and in Appendix B plots the column 1 1978 AVE tariff against the 1978 column 2 AVE tariff at the tariff-line 5-digit TSUSA

of these HS codes map to the two SIC codes 0211 and 0241 (i.e. $l_h^{SIC} = 2$ for each of the two HS codes). But, among these $l_j^{HS} l_h^{SIC} = 4$ connections, the SITC code 0011 only maps to two SIC codes (i.e. l_j^{SIC}=2): 0211 and 0241.

level. In 1979, the instrument value for good g at the 5-digit TSUSA level is

$$
\begin{aligned}
AVE_{g,1979}^{IV} &= \frac{\sum_n \left(\tau_{gn,1978}^{Col2} m_{gn,1978}^{Col1} + f_{gn,1978}^{Col2} q_{gn,1978}^{Col1}\right)}{m_{g,1978}^{Col1}} \\
&= \tau_{g,1978}^{Col2} + \frac{f_{g,1978}^{Col2}}{p_{g,1978}} \qquad \text{(A.7)}
\end{aligned}
$$

where $p_{g,1978}$ is the 1978 unit value for 5-digit TSUSA good g column 1 imports. Once the US has fully implemented their Tokyo tariff cuts in $t = 1987, 1988$, the instrument value is:

$$
AVE_{gt}^{IV} = \frac{0.14 \times AVE_{g,1979}^{IV}}{0.14 + AVE_{g,1979}^{IV}} \text{ for } t = 1987, 1988 \qquad \text{(A.8)}
$$

For the phase-out years $t = 1980, ..., 1986$, we phase out AVE_{gt}^{IV} linearly between $AVE_{g,1979}^{IV}$ and $AVE_{g,1987}^{IV}$. Substituting AVE_{gt}^{IV} for AVE_{gt}^{col1} in equation (A.4) and fixing import weights at their 1978 values gives:

$$
\begin{aligned}
AVE_{jt}^{IV} &\equiv \sum_{k \in K(j)} \left(AVE_{g(k),t}^{IV} \omega_{k,1978}^{Col1} + AVE_{g(k),1978}^{Col2} \omega_{k,1978}^{Col2}\right) \omega_{kj,1978} \\
&= \sum_{g \in G(j)} \left(AVE_{gt}^{IV} \omega_{g,1978}^{Col1} + AVE_{g,1978}^{Col2} \omega_{g,1978}^{Col2}\right) \omega_{gj,1978} \\
&\equiv \sum_{g \in G(j)} AVE_{gt}^{IV} \omega_{gj,1978}. \qquad \text{(A.9)}
\end{aligned}
$$

where $g(k)$ in the first line denotes the 5-digit TSUSA good g associated with 7-digit TSUSA good k. Finally, substituting equation (A.9) into equation (A.6) gives

$$
\begin{aligned}
AVE_{it}^{IV} &\equiv \sum_{j \in J(i)} AVE_{jt}^{IV} \omega_{ji,1978} \\
&= \sum_{j \in J(i)} \sum_{g \in G(j)} AVE_{gt}^{IV} \omega_{gj,1978} \omega_{ji,1978}. \qquad \text{(A.10)}
\end{aligned}
$$

That is, the value of our Swiss IV for 4-digit SIC industry i is an import weighted average of the Swiss IV at the tariff line 5-digit TSUSA level g.

C.2 Upstream Input Tariffs

Our measure of input tariffs faced by industry i is a weighted average of AVE tariffs on all manufacturing inputs z used by industry i. The time-invariant weights depend on (i) s_{iz}, the total requirement for industry i of input z per dollar of industry i output from the 1977 IO table from the US Bureau of Economic Analysis, and (ii) 1978 US imports of z, m_z, as a share of 1978 US manufacturing imports (Schott, 2008). Specifically,

$$AVE_{it}^{Up} = \sum_z AVE_{zt}\omega_z \tag{A.11}$$

where the time-invariant weight is

$$\omega_z = \frac{s_{iz}\frac{m_z}{\sum_z m_z}}{\sum_z s_{iz}\frac{m_z}{\sum_z m_z}}. \tag{A.12}$$

Finally, using equation (A.10) to substitute AVE_{zt}^{IV} into (A.11) for AVE_{zt} gives our instrument for AVE_{it}^{Up}. Note that, for industry i, the weight on its input tariff z relative to the weight on its input tariff z' is

$$\frac{\omega_z}{\omega_{z'}} = \frac{s_{iz}}{s_{iz'}}\frac{m_z}{m_{z'}}. \tag{A.13}$$

Intiutively, this relative weight is higher when (i) industry i uses more of input z relative to input z' and/or (ii) the US imports more of input z than input z'.

C.3 Exclusion restriction

Our exclusion restriction when estimating equation (1) using our Swiss IV is

$$
\begin{aligned}
\operatorname{cov}\left(\frac{zAVE_{it}^{IV}}{z+AVE_{it}^{IV}}, \varepsilon_{it}\right) &= 0 \\
\mathrm{E}\left[\left(\frac{zAVE_{it}^{IV}}{z+AVE_{it}^{IV}} - \mathrm{E}\left(\frac{zAVE_{it}^{IV}}{z+AVE_{it}^{IV}}\right)\right)\varepsilon_{it}\right] &= 0 \text{ using } \mathrm{E}\left(u\right)=0 \\
\mathrm{E}\left[\frac{zAVE_{it}^{IV}}{z+AVE_{it}^{IV}}\varepsilon_{it} - \mathrm{E}\left(\frac{zAVE_{it}^{IV}}{z+AVE_{it}^{IV}}\right)\varepsilon_{it}\right] &= 0 \\
\mathrm{E}\left(\frac{zAVE_{it}^{IV}}{z+AVE_{it}^{IV}}\varepsilon_{it}\right) - \mathrm{E}\left(\frac{zAVE_{it}^{IV}}{z+AVE_{it}^{IV}}\right)\mathrm{E}\left(\varepsilon_{it}\right) &= 0 \\
\mathrm{E}\left(\frac{zAVE_{it}^{IV}}{z+AVE_{it}^{IV}}\varepsilon_{it}\right) &= 0 \text{ using } \mathrm{E}\left(u\right)=0 \\
\mathrm{E}\left(\frac{zAVE_{it}^{IV}\varepsilon_{it}}{z+AVE_{it}^{IV}}\right) &= 0. \qquad \text{(A.14)}
\end{aligned}
$$

Using the standard Taylor approximation for the expectation of a non-linear function of random variables, we have

$$
\mathrm{E}\left(\frac{zAVE_{it}^{IV}\varepsilon_{it}}{z+AVE_{it}^{IV}}\right) \approx \frac{\mathrm{E}\left(zAVE_{it}^{IV}\varepsilon_{it}\right)}{\mathrm{E}\left(z+AVE_{it}^{IV}\right)} - \frac{\operatorname{cov}\left(zAVE_{it}^{IV}\varepsilon_{it}, AVE_{it}^{IV}\right)}{\left[\mathrm{E}\left(z+AVE_{it}^{IV}\right)\right]^2} + \frac{\operatorname{var}\left(z+AVE_{it}^{IV}\right)\mathrm{E}\left(zAVE_{it}^{IV}\varepsilon_{it}\right)}{\left[\mathrm{E}\left(z+AVE_{it}^{IV}\right)\right]^3} = 0 \qquad \text{(A.15)}
$$

Assuming exogeneity of the column 2 tariffs says that

$$
\mathrm{E}\left(AVE_{it}^{IV}\varepsilon_{it}\right) = 0 \qquad \text{(A.16)}
$$

and hence, given $z > 0$ does not vary across i or t, equation (A.15) reduces to

$$
\begin{aligned}
\mathrm{E}\left(\frac{zAVE_{it}^{IV}\varepsilon_{it}}{z+AVE_{it}^{IV}}\right) \approx -\frac{\operatorname{cov}\left(zAVE_{it}^{IV}\varepsilon_{it}, AVE_{it}^{IV}\right)}{\left[\mathrm{E}\left(z+AVE_{it}^{IV}\right)\right]^2} &= 0 \\
\Leftrightarrow \operatorname{cov}\left(zAVE_{it}^{IV}\varepsilon_{it}, AVE_{it}^{IV}\right) &= 0 \\
\Leftrightarrow z\operatorname{cov}\left(AVE_{it}^{IV}\varepsilon_{it}, AVE_{it}^{IV}\right) &= 0 \\
\Leftrightarrow \operatorname{cov}\left(AVE_{it}^{IV}\varepsilon_{it}, AVE_{it}^{IV}\right) &= 0. \qquad \text{(A.17)}
\end{aligned}
$$

Finally, using $\mathrm{E}(u) = 0$ and equation (A.16), our exclusion restriction restriction from equation (A.17) can be expressed as

$$\begin{aligned}
\operatorname{cov}\left(AVE_{it}^{IV}\varepsilon_{it}, AVE_{it}^{IV}\right) &= \mathrm{E}\left[\left(AVE_{it}^{IV}\varepsilon_{it} - \mathrm{E}\left(AVE_{it}^{IV}\varepsilon_{it}\right)\right)\left(AVE_{it}^{IV} - \mathrm{E}AVE_{it}^{IV}\right)\right] \\
&= \mathrm{E}\left[AVE_{it}^{IV}\varepsilon_{it}\left(AVE_{it}^{IV} - \mathrm{E}AVE_{it}^{IV}\right)\right] \\
&= \mathrm{E}\left[\left(AVE_{it}^{IV}\right)^2\varepsilon_{it} - AVE_{it}^{IV}\varepsilon_{it}\mathrm{E}AVE_{it}^{IV}\right] \\
&= \mathrm{E}\left[\left(AVE_{it}^{IV}\right)^2\varepsilon_{it}\right] - \mathrm{E}\left[AVE_{it}^{IV}\varepsilon_{it}\right]\mathrm{E}AVE_{it}^{IV} \\
&= \mathrm{E}\left[\left(AVE_{it}^{IV}\right)^2\varepsilon_{it}\right] = 0 \qquad \text{(A.18)} \\
&\Leftrightarrow \operatorname{cov}\left[\left(AVE_{it}^{IV}\right)^2, \varepsilon_{it}\right] = 0 \qquad \text{(A.19)}
\end{aligned}$$

This says that, in addition to the exogeneity of the column 2 tariff as expressed in equation (A.16), we also need the square of the column 2 tariff to be uncorrelated with unobservables ε_{it}.