The (Un)intended Consequences of Export Restrictions: Evidence from Indonesia

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ONLINE APPENDIX

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OA1 Background: Further details

OA1.1 Export restrictions by mineral

In 2009, a full ban on the export of raw materials was announced. However, by 2014, the policy was revised to introduce a two-tier system where minerals were split into two categories. *Category 1* comprised copper, iron, lead, zinc, and manganese, while *Category 2* included nickel, bauxite, tin, gold, silver, chromium, zirconium and antinomy. The revised regulation permitted the export of lower-grade ores from Category 1 minerals but upheld a strict ban on unprocessed Category 2 minerals, which were required to be fully refined domestically to meet minimum refinement standards. Among Category 2 minerals, the ban had the most pronounced impact on nickel and bauxite, as tin, gold, silver, and chromium had already undergone sufficient processing domestically to meet the requirements (Warburton, 2018). A full overview of all export restrictions on raw materials can be found below:[1]

Category 1 minerals

Copper. From 2014 onward, the export of low-grade copper concentrate (<15% Cu) was prohibited. High-grade copper concentrate ($\geq$ 15% Cu) was exempted from this ban initially for three years, with the exemption later extended to June 2023.[2] The exemption came with conditions, including the requirement to develop processing capacity and the imposition of a progressive export duty starting at 25% and increasing to 60% after three years, and was later replaced by a duty based on construction of processing capacity (0-10%). From June 2023 onward, only companies that had completed more than 50% of their smelter construction were eligible for the exemption.[3]

Iron. From 2014 onward, the export of low-grade iron concentrate (<51-62% Fe, depending on the mineral), was prohibited. High-grade iron concentrate was exempted from this ban initially for three years, with the exemption later extended to June 2023. The exemption came with conditions, including the requirement to develop processing capacity. From June 2023 onward, only companies that had completed more than 50% of their smelter construction were eligible for the exemption.

Manganese. From 2014 onward, the export of low-grade manganese concentrate (<49% Mn) was prohibited. High-grade manganese concentrate was exempted from this ban initially for three years, with the exemption later extended to June 2023.

Lead and zinc. From 2014 onward, the export of low-grade lead and zinc concentrate (<51-52% Zn and <56-57% Pb) was prohibited. High-grade lead and zinc concentrate was exempted from this ban initially for three years, with the exemption later extended to June 2023. From June 2023 onward, only companies that had completed more than 50% of their smelter construction were eligible for the exemption.

Category 2 minerals

Nickel. From 2014 onward, the export of all unprocessed nickel was prohibited. From 2017-2020, export of some unrefined nickel (<1.7% Ni) was allowed, subject to arrangements with domestic smelters. From January 2020 onward, any export of unprocessed nickel has been banned.

Bauxite. From 2014 onward, the export of all unprocessed bauxite was prohibited. From 2017-2023, export of some unprocessed bauxite (<42% Al2O3) was allowed, subject to arrangements

[1] Sources: PWC reports (Mining in Indonesia, Investment and Taxation Guide) in 2014-2023 & OECD.
[2] Source: USGS (2025), also see Ministry of Energy and Mineral Resources (MEMR) No. 17/2020
[3] (USGS, 2025)

with domestic smelters. From June 2023 onward, only companies that had completed more than 50% of their smelter construction were eligible for the exemption.

Tin. From 2014 onward, the export of all unrefined tin (<99.9% Sn) was prohibited.

Gold. From 2014 onward, the export of all unrefined gold (<99% Au) was prohibited.

Silver. From 2014 onward, the export of all unrefined silver (<99% Ag) was prohibited.

Chromium. From 2014 onward, the export of all unrefined chromium (<99% Cr) was prohibited. Moreover, from 2019 onward, the export of all chromite ore (<40% Cr_2O_3) was prohibited.

Zirconium. From 2014 onward, the export of all unrefined zirconium (62%) was prohibited.

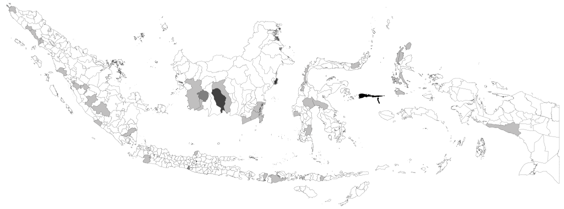
Antimony. From 2014 onward, the export of all unrefined antimony (<99% Sb) was prohibited.

OA1.2 Location of minerals and palm oil

Figure OA1: Geographical dispersion of other export restricted raw materials, coal and palm oil

(a) Copper

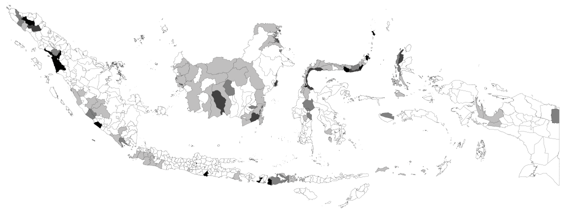
(b) Iron



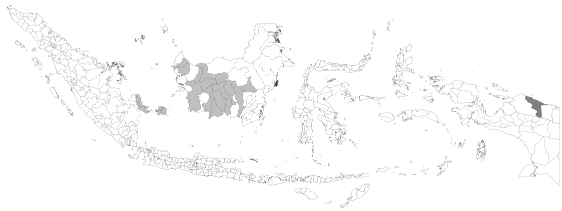
(c) Manganese

(d) Tin

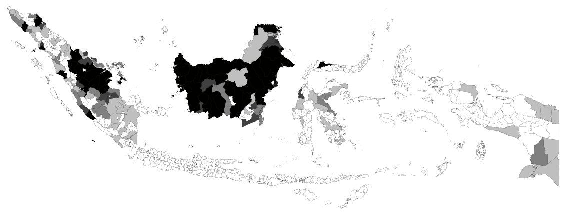
(e) Gold



(f) Zirconium



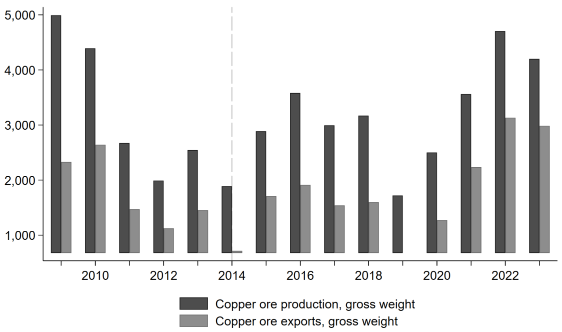
(g) Palm oil



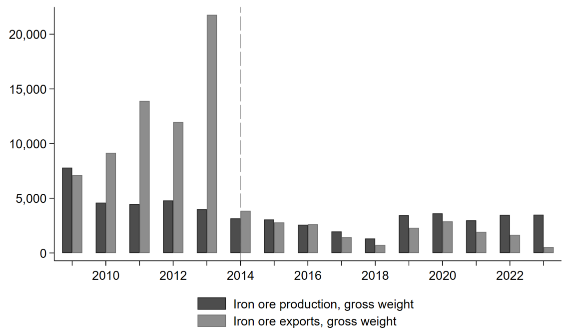
OA1.3 Production and export volume by mineral

Figure OA2: Production and export of other export restricted raw materials (2009-2023)

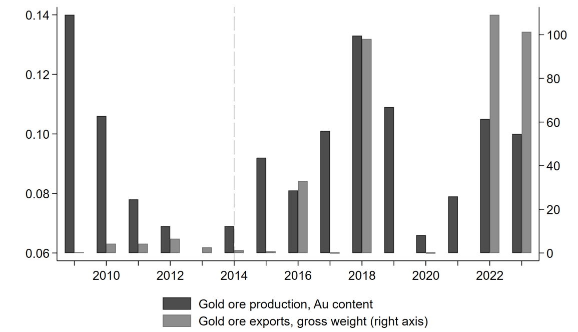
(a) Copper



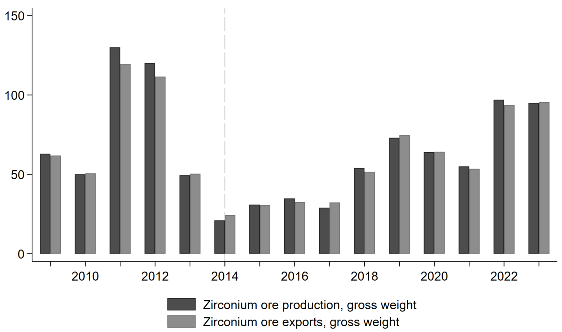
(b) Iron



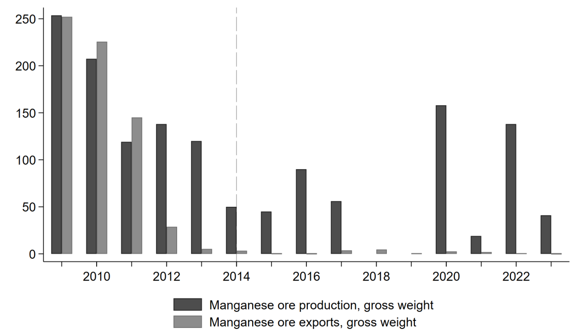
(c) Gold



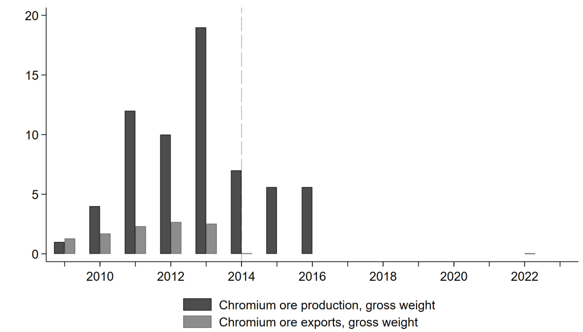
(d) Zirconium



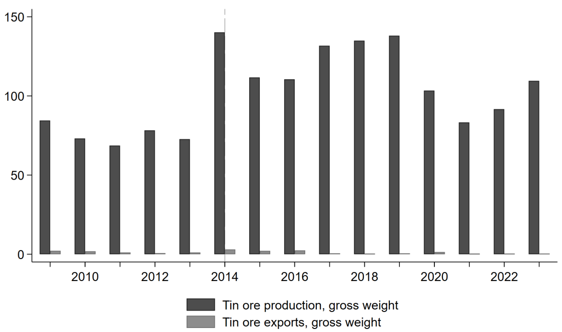
(e) Manganese



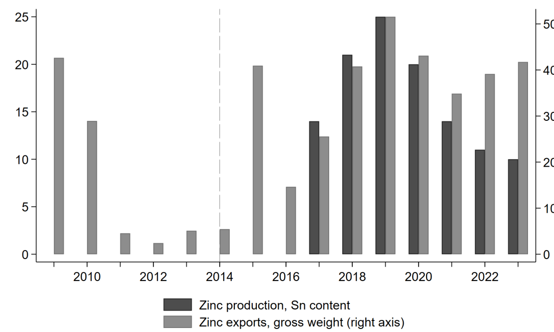
(f) Chromium



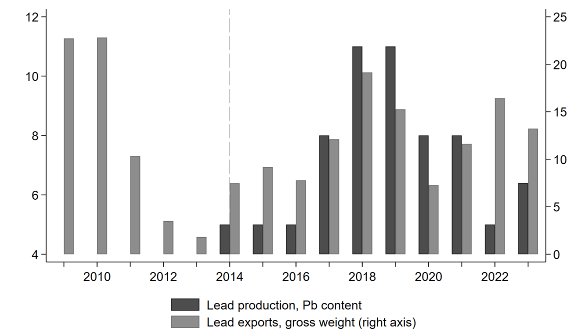
(g) Tin



(h) Zinc (production data not available for 2008–2014)



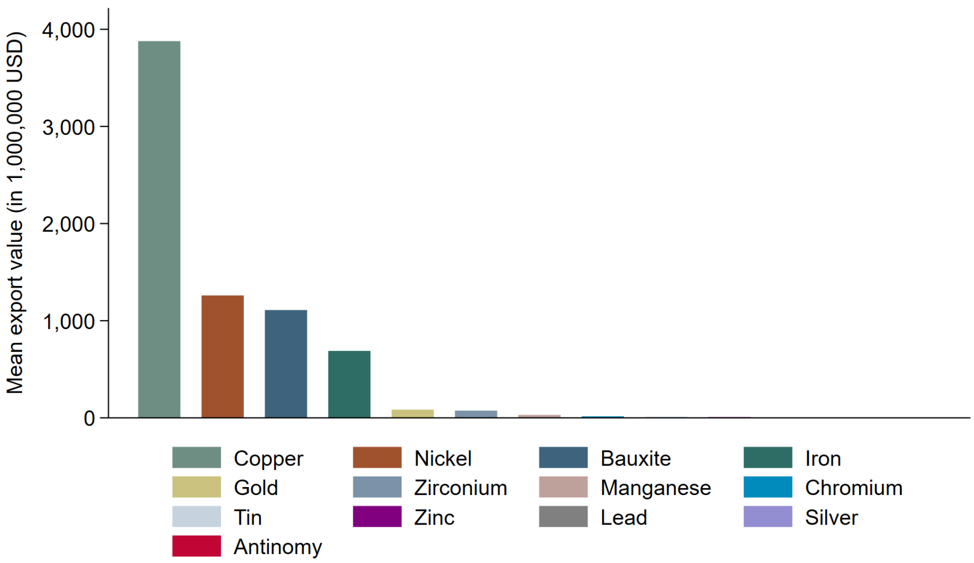
(i) Lead (production data not available for 2008–2014)



Notes: This figure shows the production and exports of other export prohibited raw materials in Indonesia. The unit is either gross weight or content in 1,000 metric tons. Export data is based on the following HS-6 codes: copper (260300), iron (260111 & 260112), manganese (260200), lead (260700), zinc (260800), tin (260900), gold (261690), silver (261610), chromium (261000), zirconium (261510) and antinomy (261710). Source: Comtrade.

OA1.4 Export value of minerals

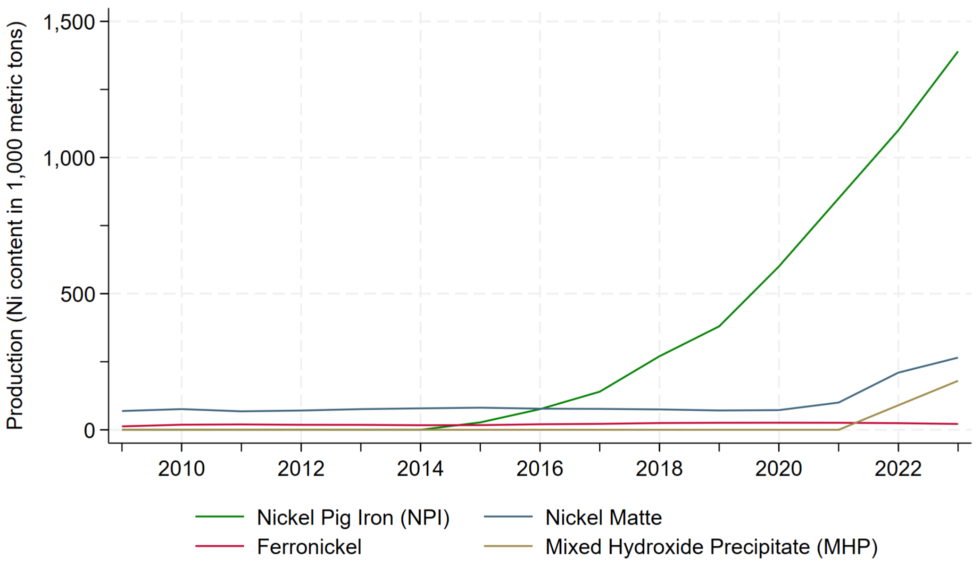
Figure OA3: Mean export value of raw materials in Indonesia (2007-2013)



Notes: This figure shows the mean export value of raw materials in Indonesia over the 2007-2013 period. The unit is average export revenue in 1,000,000 USD. Export data is based on the following HS-6 codes: copper (260300), iron (260111 & 260112), manganese (260200), lead (260700), zinc (260800), tin (260900), gold (261690), silver (261610), chromium (261000), zirconium (261510) and antinomy (261710). Source: Comtrade.

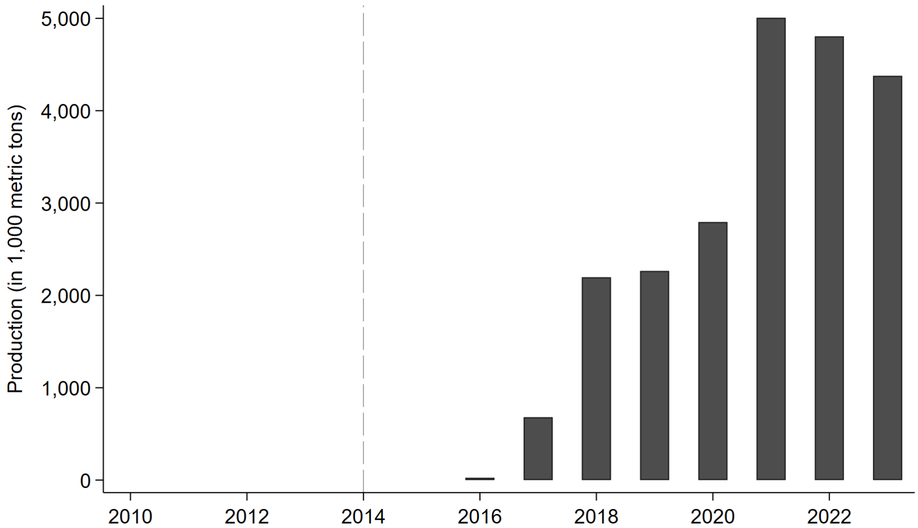
OA1.5 Nickel products

Figure OA4: Nickel processing production in nickel content in Indonesia (2009-2023)



Notes: This figure shows the annual production of various processed nickel products in Indonesia. The unit is nickel content in 1,000 metric tons. Source: USGS.

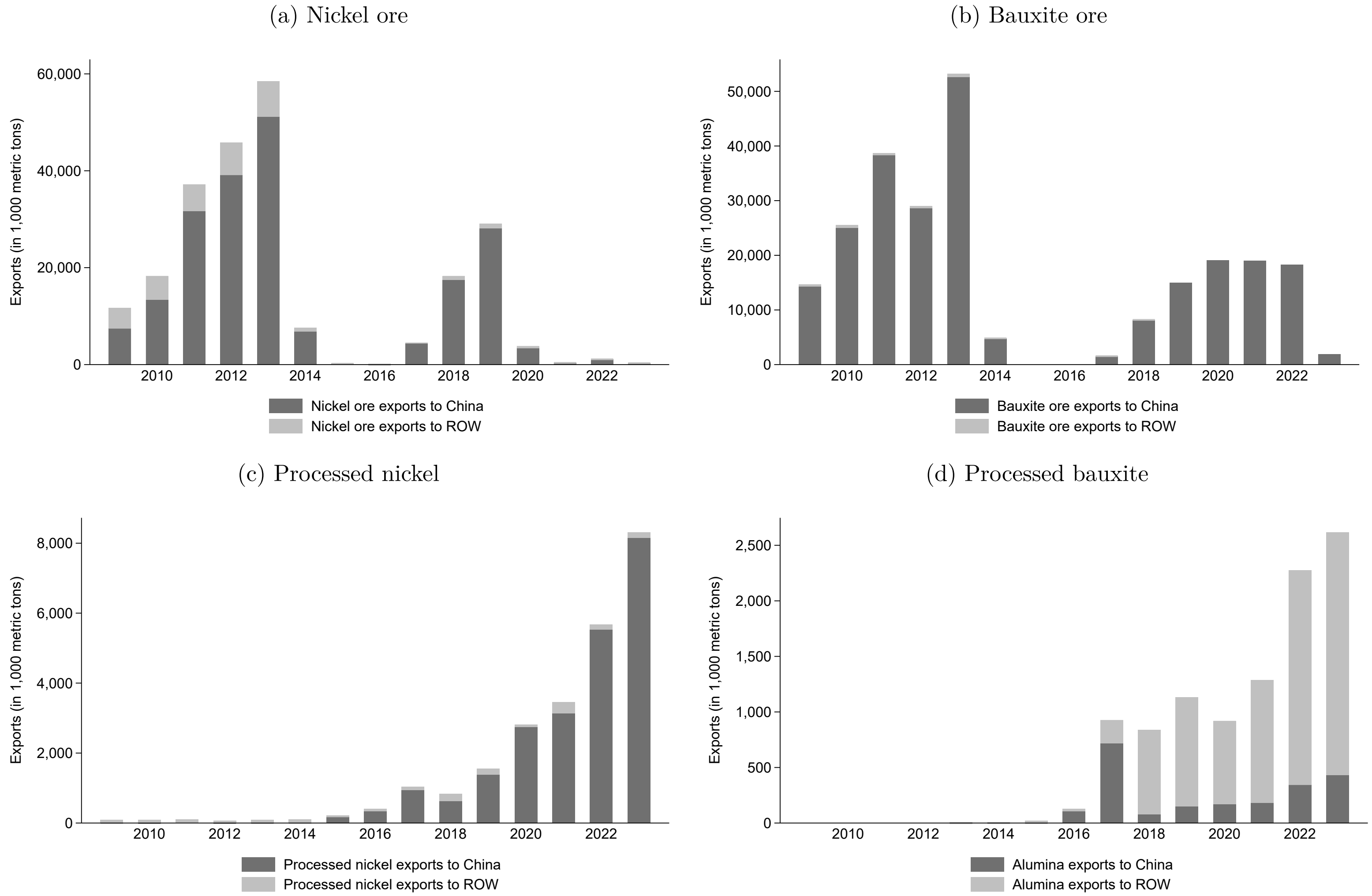
Figure OA5: Stainless steel production (2009-2023)



Notes: This figure shows the annual production of stainless steel slabs in Indonesia. The unit is 1,000 metric tons. Sources: Statista (via Stainless Steel World) for 2016-2021 & Stainless Club for 2022-2023.

OA1.6 Nickel and bauxite trade with China and Rest Of the World

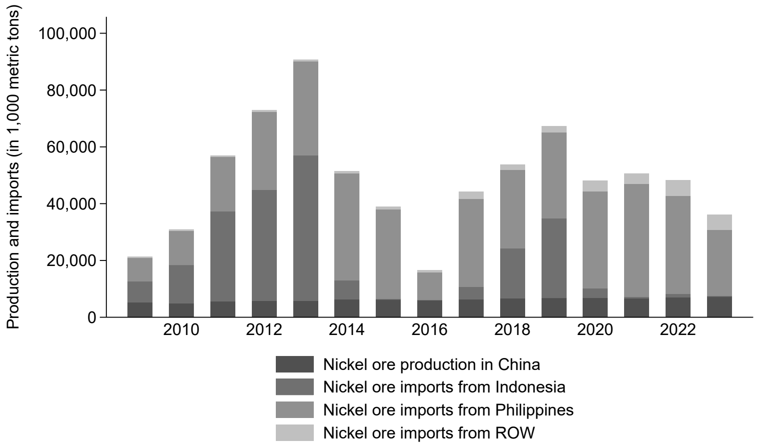
Figure OA6: Export of raw and processed nickel and bauxite from Indonesia to China (2009-2023)



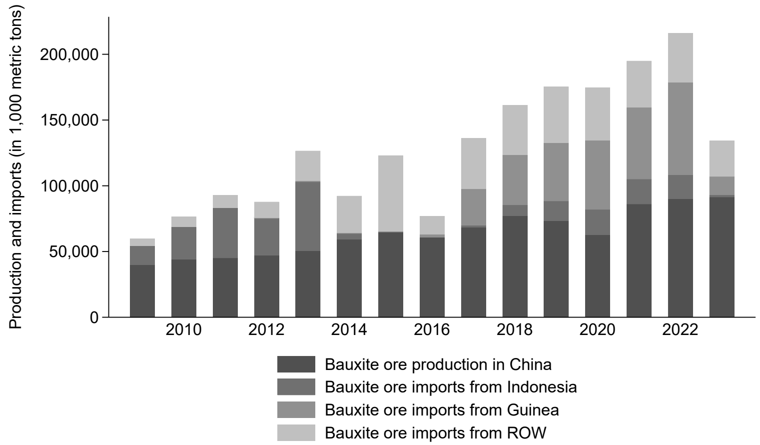
Notes: This figure shows the annual export of raw and processed nickel and bauxite from Indonesia to China. Processed nickel (ferronickel/nickel pig iron, nickel matte and mixed hydroxide precipitate) is made from nickel ore; alumina is made from bauxite ore. The unit is gross weight in 1,000 metric tons. Export figures are based on the following HS-6 codes: nickel ore (260400), ferronickel (720260, which includes nickel pig iron), nickel matte (750110), mixed hydroxide precipitate (282540), bauxite ore (260600) and alumina (281820). Sources: USGS & Comtrade.

Figure OA7: Production and import of raw and processed nickel and bauxite in China (2009-2023)

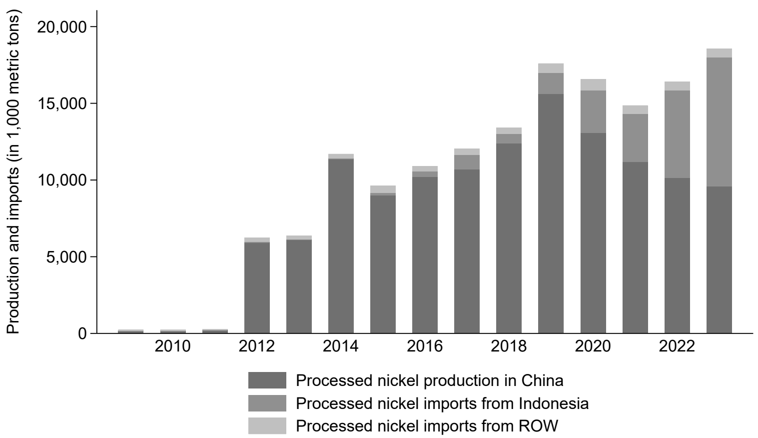
(a) Nickel ore



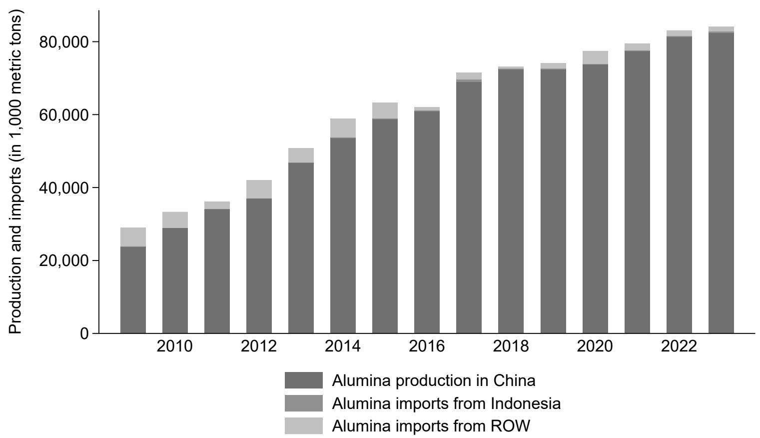
(b) Bauxite ore



(c) Processed nickel



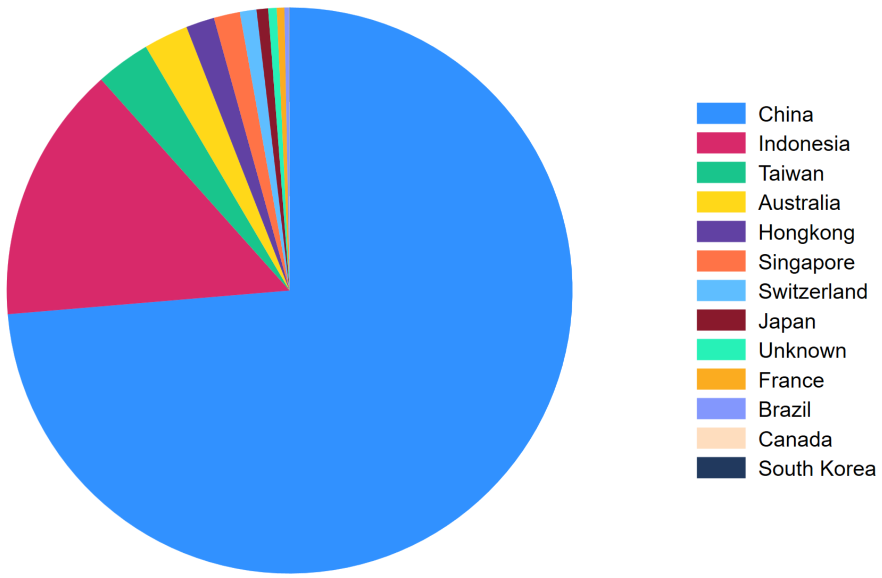
(d) Processed bauxite



Notes: This figure shows the annual production and import of raw and processed nickel and bauxite in China. The unit is gross weight in 1,000 metric tons. Processed nickel (ferronickel/nickel pig iron, nickel matte and mixed hydroxide precipitate) is made from nickel ore; alumina is made from bauxite ore. The unit is gross weight in 1,000 metric tons. Import figures are based on the following HS-6 codes: nickel ore (260400), ferronickel (720260, which includes nickel pig iron), nickel matte (750110), mixed hydroxide precipitate (282540), bauxite ore (260600) and alumina (281820). Sources: USGS & Comtrade.

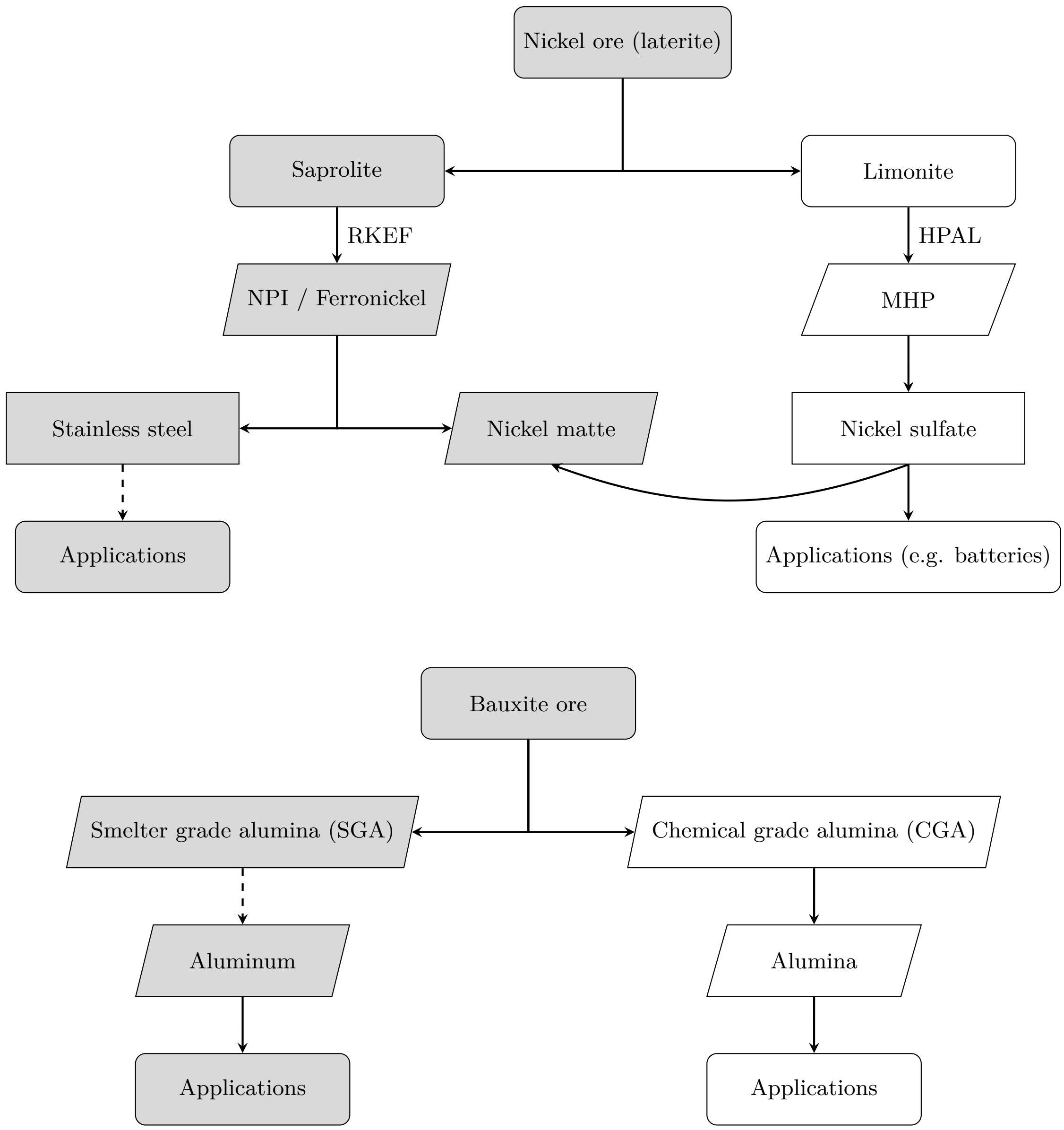
OA1.7 Ownership of nickel processing capacity

Figure OA8: Ownership of nickel processing capacity by country in 2023



OA1.8 Processing stages of nickel and bauxite

Figure OA9: From nickel and bauxite ore to applications in Indonesia



Notes: The diagram shows four stages: (a) ore, (b) smelting/refining, (c) forming, and (d) applications. RKEF stands for the pyrometallurgical process Rotary Kiln–Electric Furnace, while HPAL stands for the hydrometallurgical process High Pressure Acid Leach. MHP stands for mixed hydroxide precipitate. Grey nodes show products manufactured in Indonesia in 2024, while white nodes indicate products produced in Indonesia only to a limited extent. In 2023, for bauxite, CGA capacity is 1 smelter (300,000 mt) compared with SGA capacity of 3 smelters (3,000,000 mt). For nickel, there are 4 MHP smelters (250,000 mt) versus 50 non-MHP smelters (NPI/FeNi/Matte; 15,800,000 mt). Notably, 3 of the 4 MHP smelters began operation only from 2021 onward. Dotted arrows indicate products currently not supplied to the next stage in Indonesia. All aluminum production uses imported SGA; all nickel applications use imported stainless steel. Source: MINERBA (2021).

OA2 Data

Licenses MINERBA provides two types of datasets for mining licenses: WIUP ("Wilayah Izin Usaha Pertambangan", which translates to Mining Business License Area) and IUP ("Izin Usaha Pertambangan", which translates to Mining Business License). WIUP refers to the geographical area allocated for mining exploration and production, essentially the spatial zone within which a mining company can operate. However, it does not grant permission for specific mining activities yet. In contrast, IUP is the business license that permits a company to perform mining activities within a designated WIUP area, such as exploration, exploitation (mining), and resource production. To capture resources within a district in the widest sense, we focus on WIUP areas with "operasi produksi" (production operation) licenses.

Sectors For the years 2007–2015, detailed sector data is available at the three-digit KBLI level. However, from 2015–2022, only aggregated data across 17 categories is provided. We harmonize this information by grouping it into seven distinct categories, as shown in Table OA1. For reasons of space, and because stratification in Sakernas is at the district level but not also at the sector level—representing a larger issue for comparatively small sectors, we do not show results for the relatively small public, construction, and utility sectors.

Ownership of nickel smelters In Section 3, we mention the share of Indonesia's 2023 nickel processing capacity that is foreign-owned (85%), and do the same for Chinese ownership (74%). Figure OA8 shows ownership shares of all countries that (via state-owned firms, non-state-owned firms, or non-negligible shares held by individuals) own one or more smelters, at least partially. We arrive at the ownership shares by country by computing a country's weighted average ownership share across all 54 smelters, using a smelter's capacity as smelter-specific weight. As sources, we use annual reports, academic papers or news articles, and cross-validate every smelter's ownership information using alternative sources whenever possible. Whenever there is evidence of ownership changing over time, we use ownership as of 2023, the last year of our sample period. Note that the evidence of 74% Chinese ownership as produced using our dataset closely corresponds to IEA (2025), which states in the context of Indonesian nickel that "Chinese companies account for around 75% of refining capacity in the country" (but does not provide sources or information on the foreign ownership share more generally). Below, we further detail our methodology.

If a smelter is a joint venture of two or more firms, we retrieve the exact ownership share of every firm involved. We also account for indirect ownership, such as foreign shares in firms that are majority Indonesian-owned, or Indonesian shares in firms that are majority foreign-owned. For example, the Indonesian firm Merdeka Battery Materials owns 50.1% of PT Cahaya Smelter Indonesia (while the rest is owned by the Chinese Tsingshan Group), but 7.5% of Merdeka Battery Materials itself is owned by a Hong Kong firm (with the remainder being Indonesian-owned), yielding a foreign ownership share in PT Cahaya Smelter Indonesia of $49.9 + 0.075 \times 50.1 \approx 53.7\%$. Similarly, the Australian firm Nickel Industries owns 80% of (the smelter associated with) PT Angel Nickel Industry (while the rest is owned by the Tsingshan group), but two Indonesian companies jointly own 24% of Nickel Industries, and the Chinese firm Shanghai Decent owns 22.4% of Nickel Industries. These pieces of information are accordingly taken into account when computing the domestic, Australian, and Chinese ownership share of PT Angel Nickel Industry.[4]

On a similar note, we account for firms being subsidiaries of others; for example, partial smelter ownership of Vale Canada is counted towards Brazilian ownership, given that Vale Canada is a

[4]Note that for tractability, we do not track for example whether the mentioned Indonesian firms, which have shares in Nickel Industries, are partially foreign-owned.

Table OA1: Classification of sectors into categories

Sector	Category
A1 Agriculture, Forestry & Fisheries	agriculture
B2 Mining and Quarrying	mining
C3 Manufacturing	manufacturing
D4 Electricity, Gas, Steam/Hot Water & Cold Air Supply	utility
E5 Water Treatment, Wastewater Treatment, Treatment and Recovery	utility
F6 Construction	construction
G7 Wholesale & Retail Trade; Automobile Repair & Maintenance	services
H8 Transportation & Warehousing	services
I9 Accommodation & Food & Beverage Provision	services
J10 Information & Communication	services
K11 Financial & Insurance Activities	services
L12 Real Estate	services
M,N13 Professional & Corporate Services	services
O14 Government Administration, Defense & Social Security Waj	public
P15 Education	public
Q16 Human Health & Social Activities	services
R,S,T,U17 Other Services	services

Notes: This table describes how the sectors in the Sakernas data were divided into categories. High-skilled services (J10, K11, L12, M, N13, and Q16, those with an average education level of at least junior high school) account for only 2.8% of total pre-export restrictions employment in non-nickel and non-bauxite districts, compared to (on average) 1.8% in nickel and bauxite districts. Consequently, we combine both low-skilled and high-skilled sectors into a single category labeled 'services'.

wholly-owned subsidiary of the Brazilian multinational Vale. Further note that for firms listed on the Indonesian Stock Exchange, we treat the free-float portion of shares as domestically owned. For example, if 35% of a company's shares are free-float on the Indonesian stock exchange (as is the case for PT Aneka Tambang, with the remainder being owned by the Indonesian state), we classify those 35% as Indonesian ownership, given that we cannot track foreign ownership among these free-float shares.

If a certain individual is explicitly listed as owning a certain share of a smelter (by sources such as marketscreener.com), we account for that. Depending on the context, we assign that ownership share to the country of citizenship of the individual, or the firm he/she works at. For example, the individual Yuan Yuan Xu owns 2.7% of Nickel Industries according to our specific source for this company. Since the source also states that Yuan Yuan Xu currently works at Nickel Industries Ltd., we assign her ownership share to Australia, although her profile suggests that she is Chinese rather than Australian citizen. However, in the exemplary case of the Harita Group, which partially owns several nickel smelters and is an Indonesian business conglomerate owned and controlled by the Lim family, we consider the fact that the Lim family (including for example the billionaire Lim Hariyanto Wijaya Sarwono) are Indonesian citizens. Finally, note that our ownership results are very similar if we for example assigned Yuan Yuan Xu's ownership share in Nickel Industries to China rather than Australia.

Table OA2: Overlap of resources across districts

	au	ba	coal	cu	fe	mn	ni	palm	pb	sn	zn	zr
gold (au)	91	4	22	7	20	5	2	38	0	1	1	10
bauxite (ba)	4	9	1	0	2	0	0	7	0	2	0	3
coal	22	1	66	0	9	3	0	52	1	0	1	6
copper (cu)	7	0	0	12	4	4	0	2	0	0	0	0
iron (fe)	20	2	9	4	38	3	2	20	1	1	1	3
manganese (mn)	5	0	3	4	3	16	1	5	0	0	0	0
nickel (ni)	2	0	0	0	2	1	17	8	0	0	0	1
palm oil	38	7	52	2	20	5	8	124	0	2	1	15
lead (pb)	0	0	1	0	1	0	0	0	4	1	0	1
tin (sn)	1	2	0	0	1	0	0	2	1	10	0	6
zinc (zn)	1	0	1	0	1	0	0	1	0	0	1	0
zirconium (zr)	10	3	6	0	3	0	1	15	1	6	0	21

Notes: This table illustrates the district-level overlap of resources. For example, there are four districts that host both bauxite and gold endowments.

Table OA3: Sectoral employment and shares (2013)

	nickel (N=17)		bauxite (N=9)		coal (N=66)	
	mean	%	mean	%	mean	%
mining	4,313	4.6	7,169	3.7	8,379	5.1
agriculture	60,836	56.6	98,557	48.7	110,260	54.7
manufacturing	5,852	4.8	6,560	4.4	8,614	4.0
services	24,948	18.7	39,105	25.5	46,010	22.2
total	114,011		176,435		202,917	

	post-ban nickel processing (N=12)		non-nickel/bauxite/coal (N=395)		non-nickel/bauxite/coal/Java (N=278)	
	mean	%	mean	%	mean	%
mining	4,057	4.7	3,245	1.6	2,571	2.0
agriculture	56,827	42.1	110,747	43.5	71,564	50.3
manufacturing	27,146	7.4	52,138	9.2	11,081	5.7
services	58,856	26.2	127,092	30.5	47,040	26.0
total	180,467		339,195		157,395	

Notes: This table reports the number of people employed in each sector and their shares (%) of total employment in 2013. Note that 11 districts are missing in 2013.

OA3 Robustness

OA3.1 Robustness checks on the results of Section 5.1

Indonesia's islands The first set of results shows that our findings are robust to excluding districts on Java, the most developed and industrialized island of Indonesia. Likewise, the results are robust to excluding the top 25% of districts with the highest population density in 2013. Also, they are, with exception of our agricultural and manufacturing employment findings (that become stronger and weaker, respectively), robust to including a full set of island-year dummies instead of the year dummies that we include in our baseline specification. But, do note that including these island-year dummies comes with a substantial loss of identifying variation. See Figure OA10 and Figure OA16.

Control districts Second, our findings are robust to excluding districts without any mining licenses, or the 25% of districts with the lowest mining employment share from the non-bauxite and non-nickel districts (our 'control group'). It shows that our findings are not driven by comparing nickel and bauxite districts to districts without any (substantial) natural mineral resources. See Figure OA11 and Figure OA17.

Additional controls Third, we find the same results when adding the share of a district's area under any of the other, much less important, export restricted minerals,[5] or a district's 2013 employment share in manufacturing interacted with a full set of year dummies to our regressions. Differential trends in (sectoral) employment patterns related to a district's initial manufacturing share or its dependence on these other, much less important, minerals, are not confounding our findings. See Figure OA12 and Figure OA18.

(too) Important mining districts Fourth, Figure OA13 and Figure OA19 show that our main results hold up to excluding the five nickel districts with the largest share of their total area under nickel mining licenses (between 13.1-15.7%; it is 8.4% for the sixth largest nickel district). If anything, they become even more pronounced, be it much less precisely estimated. In contrast, the results for bauxite (not shown in the Figures) are sensitive to excluding the three districts with the largest share of their total area under bauxite license. But, doing so leaves us with six bauxite districts only whose area is covered for 1.9% or less by bauxite mining licenses (and one with 6.9%), whereas it is 10.9-12.6% for the three excluded, most important bauxite districts. The variation between these three districts, all in West Kalimantan, and the other much less well-endowed bauxite districts is crucial to identify the significant mining employment effects of Indonesia's export restrictions in bauxite districts shown in Figure 6 and Table 1. Moreover, the results also hold when controlling for the other export-restricted resource endowment shares interacted with year dummies.

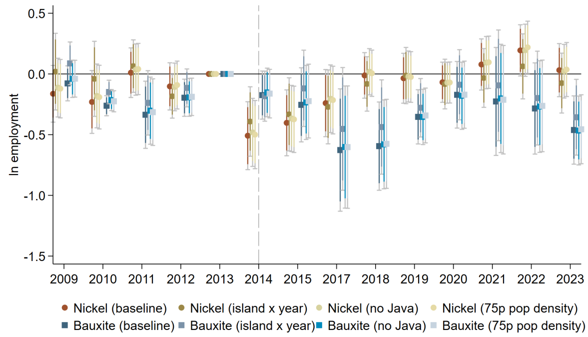
Alternative endowment measure Finally, we show what happens when using alternative measures of a district's nickel or bauxite mining dependence. More specifically, instead of using a district's area's share under nickel or bauxite mining licenses respectively, Figure OA14 and Figure OA20 show what happens when using a simple dummy variable for the presence of any mining licenses in the district.

[5]Do remember that in our baseline specification we always separately include a district's area share covered by copper and iron mining licenses, respectively, interacted with a full set of year dummies.

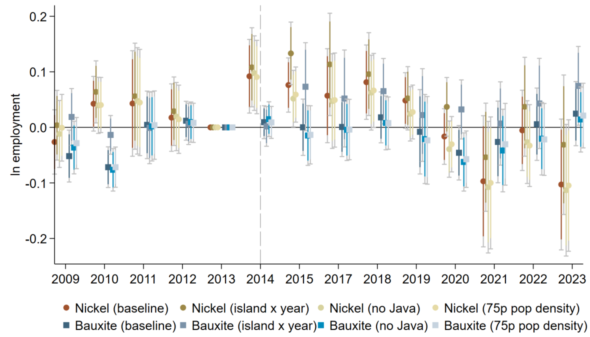
OA3.1.1 Employment

Figure OA10: Robustness check on sectoral employment: Indonesia's islands

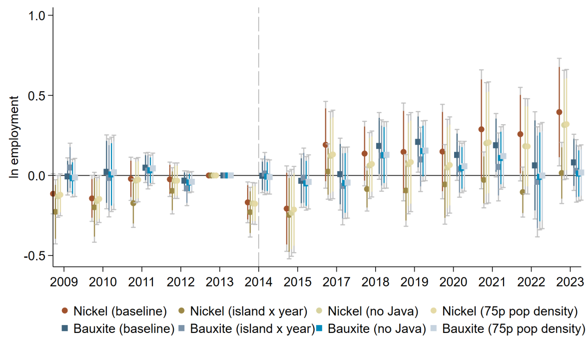
(a) mining



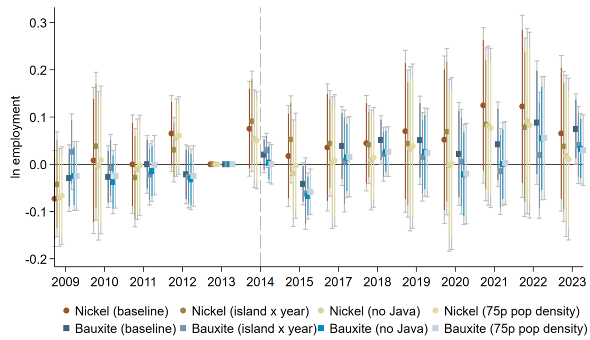
(b) agriculture



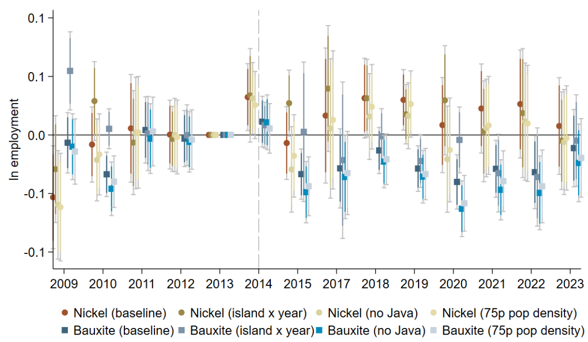
(c) manufacturing



(d) services



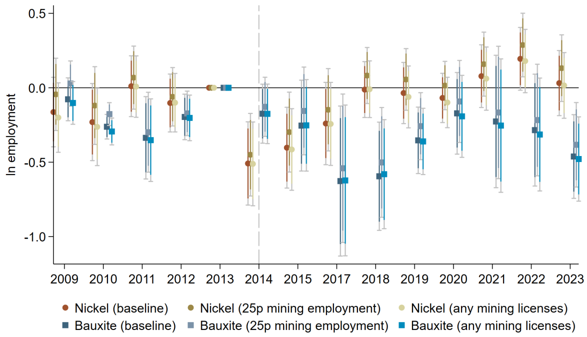
(e) total



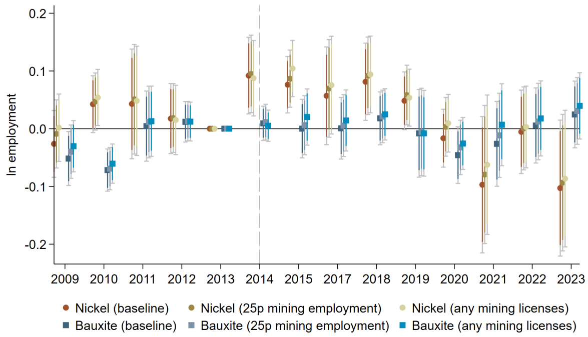
Notes: The results are based on Equation (4). The dependent variable is the total number of people employed in a specific sector (in ln). 'nickel (bauxite)' is a continuous variable measuring the share of nickel (bauxite) endowments of the surface area in district d, scaled by the average endowment across all nickel (or bauxite-) endowed districts. 'island × year' includes island × year FE. 'no Java' only includes the 379 non-Java districts. '75p pop density' only includes the 375 districts with a population density in 2013 below the 75th percentile. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

Figure OA11: Robustness check on sectoral employment: Control districts

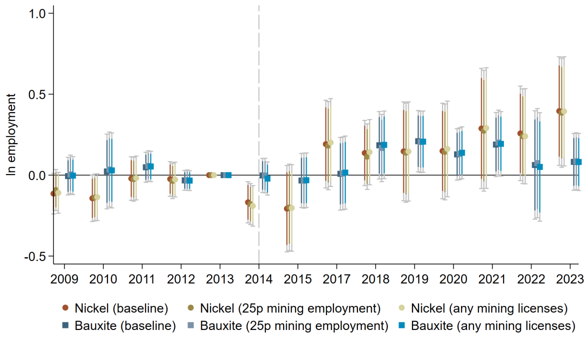
(a) mining



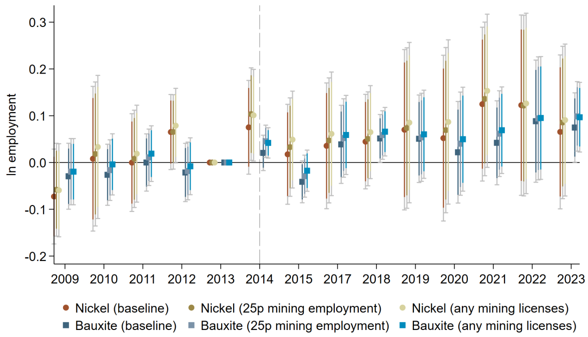
(b) agriculture



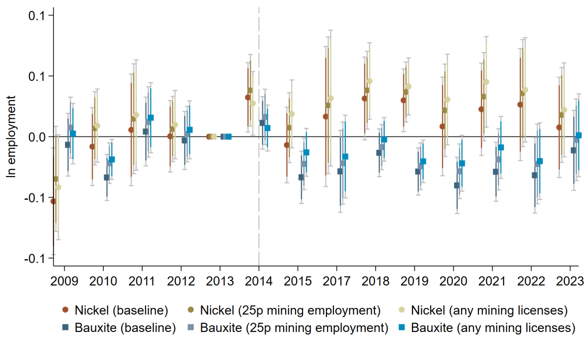
(c) manufacturing



(d) services



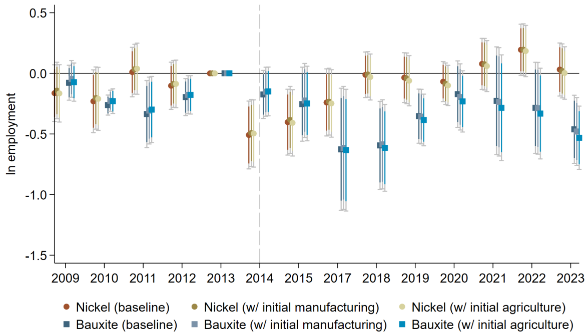
(e) total



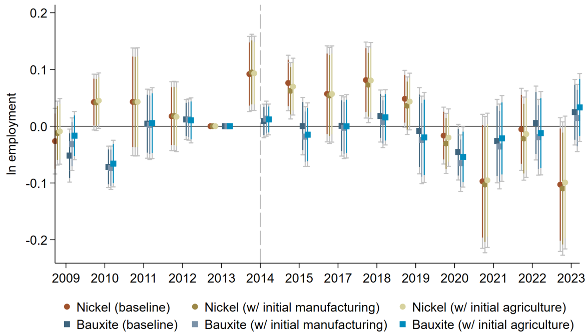
Notes: The results are based on Equation (4). The dependent variable is the total number of people employed in a specific sector (in ln). 'nickel (bauxite)' is a continuous variable measuring the share of nickel (bauxite) endowments of the surface area in district *d*, scaled by the average endowment across all nickel (or bauxite-) endowed districts. '25p mining employment' only includes the 373 districts above the 25th percentile mining employment in 2013. 'any mining licenses' only includes the 329 districts which had any mining licenses. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

Figure OA12: Robustness check on sectoral employment: Additional controls

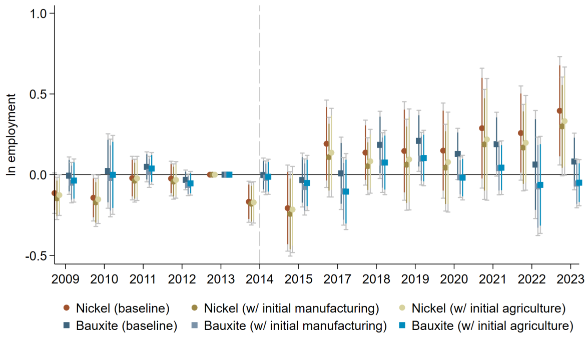
(a) mining



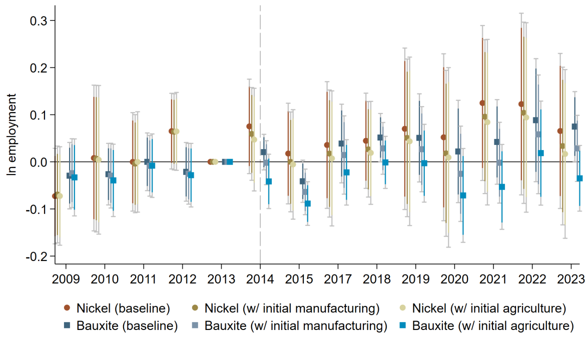
(b) agriculture



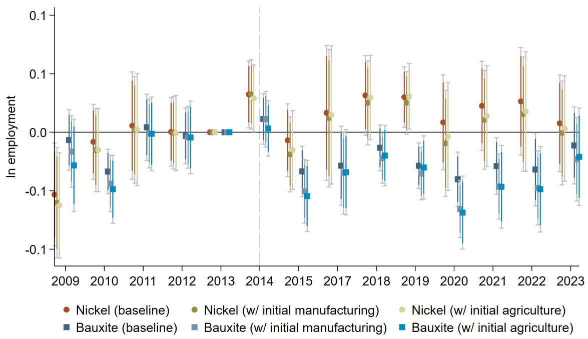
(c) manufacturing



(d) services



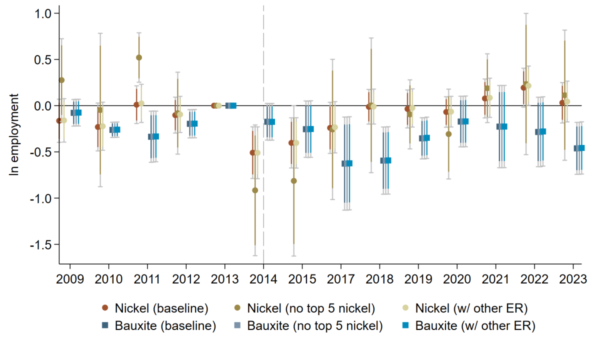
(e) total



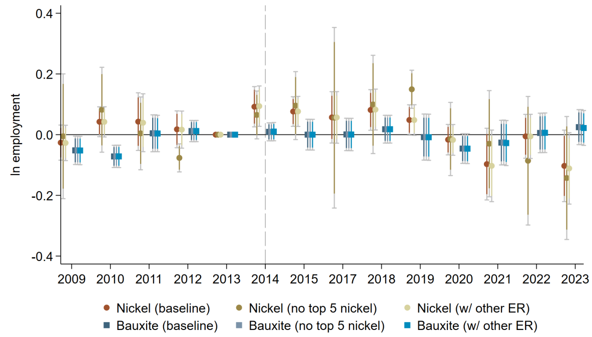
Notes: The results are based on Equation (4). The dependent variable is the total number of people employed in a specific sector (in ln). 'nickel (bauxite)' is a continuous variable measuring the share of nickel (bauxite) endowments of the surface area in district *d*, scaled by the average endowment across all nickel (or bauxite-) endowed districts. 'w/ initial manufacturing' means that we include the share of manufacturing in 2013 interacted with year dummies. 'w/ initial agriculture' means that we include the share of agriculture in 2013 interacted with year dummies. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

Figure OA13: Robustness check on sectoral employment: (too) Important mining districts

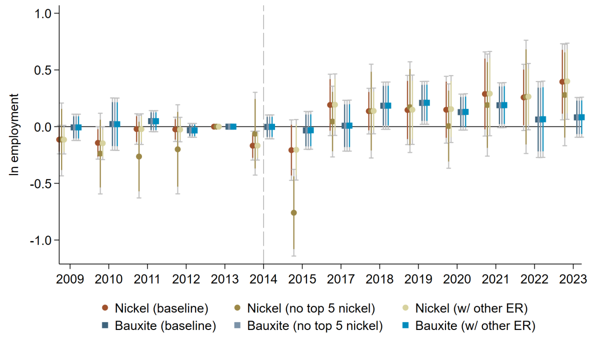
(a) mining



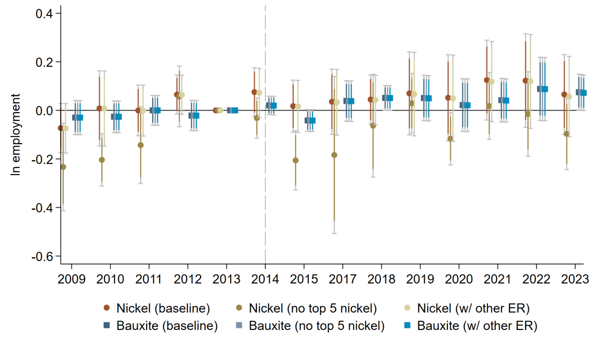
(b) agriculture



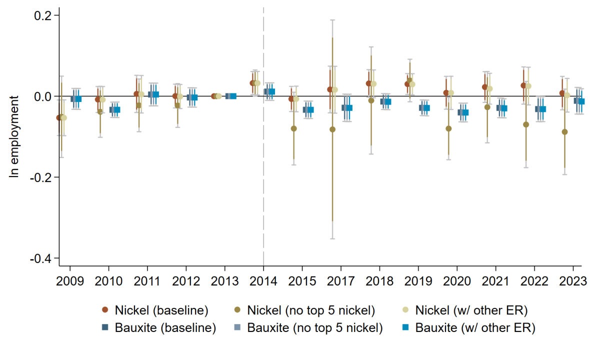
(c) manufacturing



(d) services



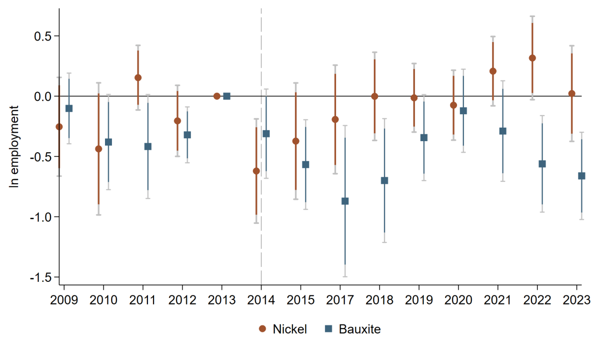
(e) total



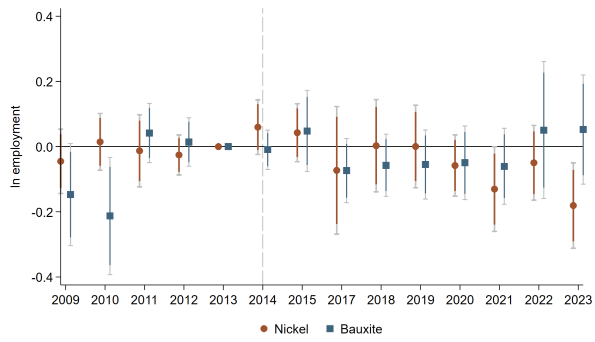
Notes: The results are based on Equation (4). The dependent variable is the total number of people employed in a specific sector (in ln). 'nickel (bauxite)' is a continuous variable measuring the share of nickel (bauxite) endowments of the surface area in district d, scaled by the average endowment across all nickel (or bauxite-) endowed districts. 'no top 3 nickel' means that we exclude the top five nickel districts (with a share between 13.1-15.7%). 'w/ other ER variables' means that we include the sum of all other export-restricted resource endowment shares interacted with year dummies. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

Figure OA14: Robustness check on sectoral employment: Alternative endowment measure

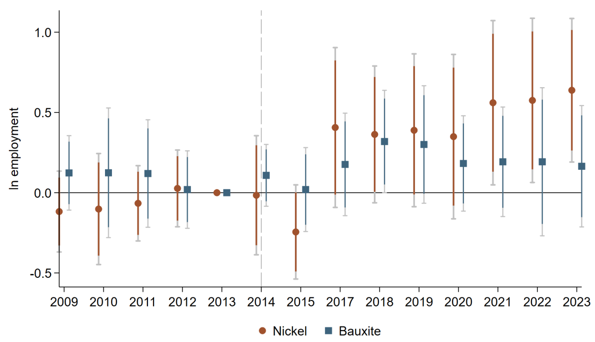
(a) mining



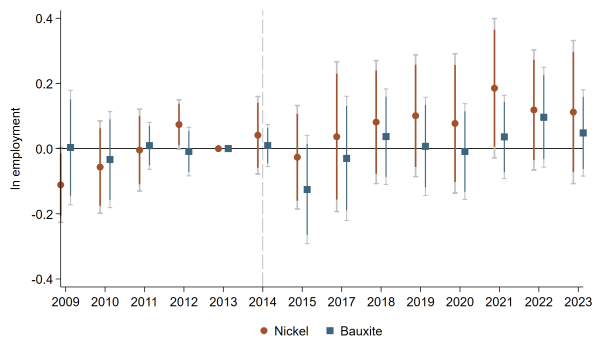
(b) agriculture



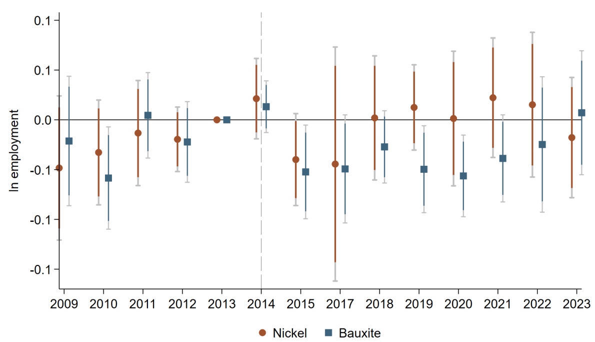
(c) manufacturing



(d) services



(e) total



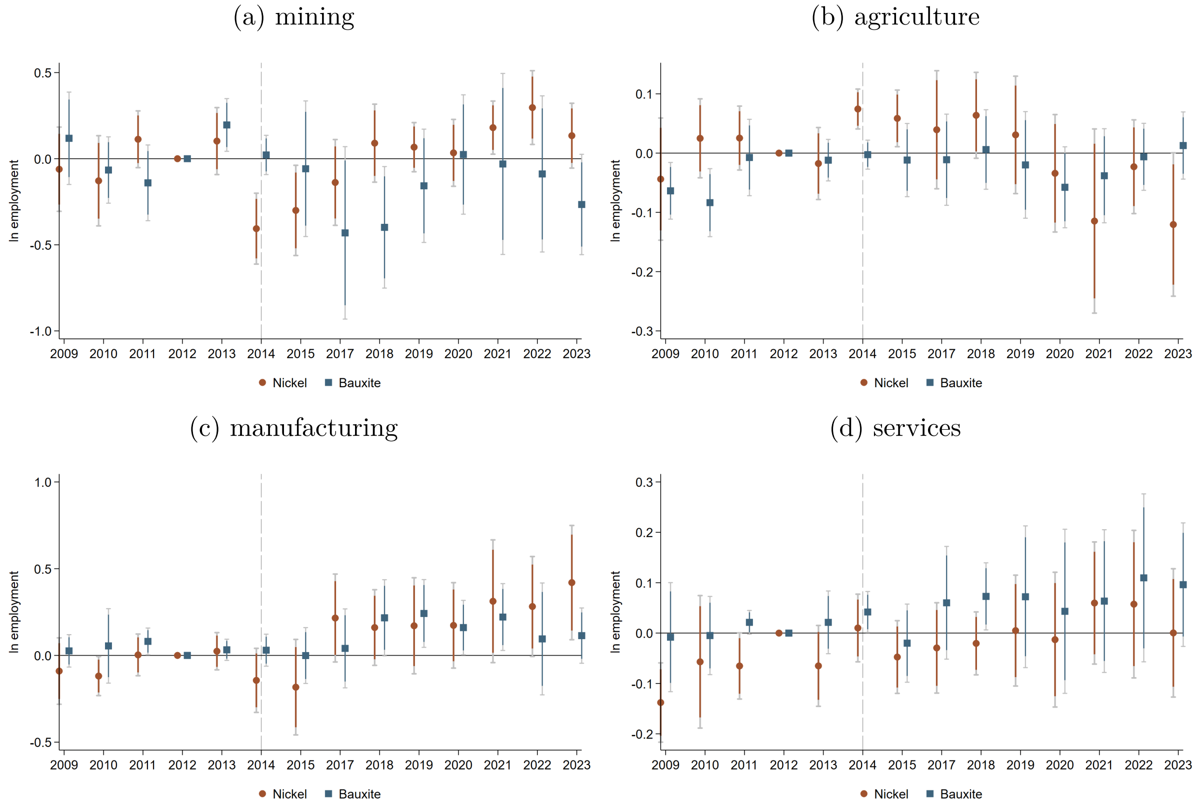
Notes: The results are based on Equation (4). The dependent variable is the total number of people employed in a specific sector (in ln). 'nickel (bauxite)' is a dummy variable measuring whether there is at least one nickel (bauxite) endowment. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

Table OA4: Robustness check on anticipation effects

dependent var	ln employment				
	(1) total	(2) mining	(3) agriculture	(4) manufacturing	(5) services
nickel endowment × ER	0.032**	0.015	-0.007	0.197*	0.069***
	(0.012)	(0.088)	(0.018)	(0.105)	(0.024)
bauxite endowment × ER	-0.008	-0.122	0.032**	0.099	0.054
	(0.009)	(0.130)	(0.013)	(0.108)	(0.046)
N	6416	5667	6412	6273	6383

Notes: In this table we study how export restrictions on raw materials impact sectoral employment in districts where these resource deposits are located. The sample period is 2009-2023, but we exclude 2013. 'ln employment' is the number of people employed in a specific sector (in ln). 'nickel (bauxite) endowment' is a continuous variable measuring the nickel (bauxite) endowment as a share of the district's surface area in district d, scaled by the average endowment across all nickel (or bauxite-) endowed districts. 'ER' is a dummy variable which takes the value one if there is an export restriction active for this specific resource in year t. All columns include a full set of control variables, including interaction terms of the copper and iron endowment with the export restriction and the palm share with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$.

Figure OA15: Robustness check on anticipation effects

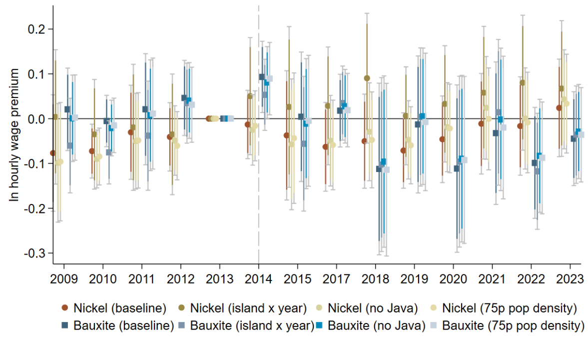


Notes: The results are based on Equation (4). The dependent variable is the total number of people employed in a specific sector (in ln). 'nickel (bauxite)' is a continuous variable measuring the share of nickel (bauxite) endowments of the surface area in district d, scaled by the average endowment across all nickel (or bauxite-) endowed districts. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue (grey) lines indicate 95% (90%) confidence intervals. The year 2012 is the reference year.

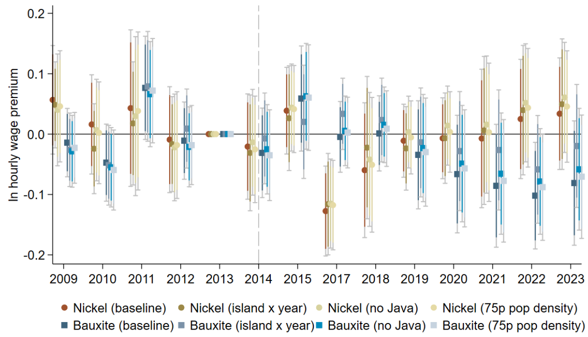
OA3.1.2 Earnings

Figure OA16: Robustness check on sectoral earnings: Indonesia's islands

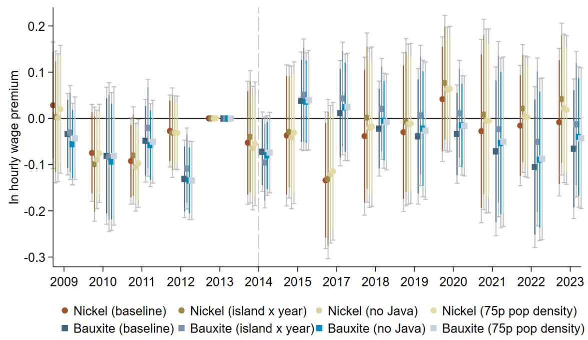
(a) mining



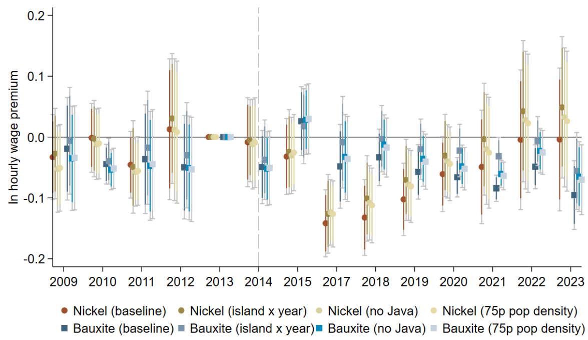
(b) agriculture



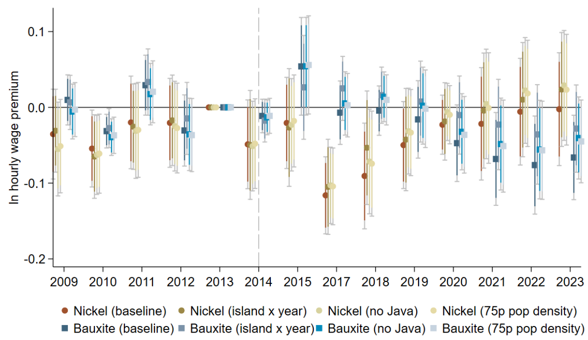
(c) manufacturing



(d) services



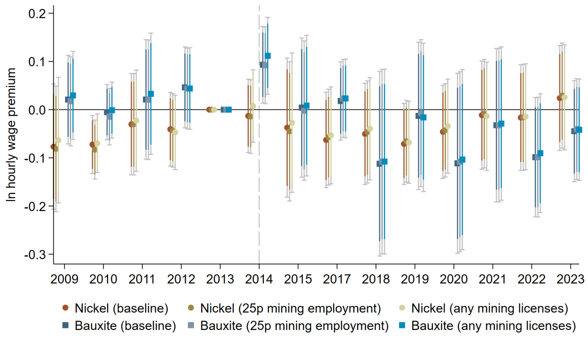
(e) total



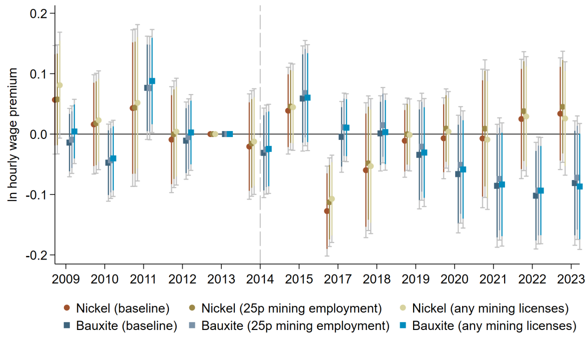
Notes: The results are based on Equation (4). The dependent variable is the average hourly wage premium in a specific sector (in ln) (see Section 4 for more details). 'nickel (bauxite)' is a continuous variable measuring the share of nickel (bauxite) endowments of the surface area in district d, scaled by the average endowment across all nickel (or bauxite-) endowed districts. 'island × year' includes island × year FE. 'no Java' only includes the 379 non-Java districts. '75p pop density' only includes the 375 districts with a population density in 2013 below the 75th percentile. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

Figure OA17: Robustness check on sectoral earnings: Control districts

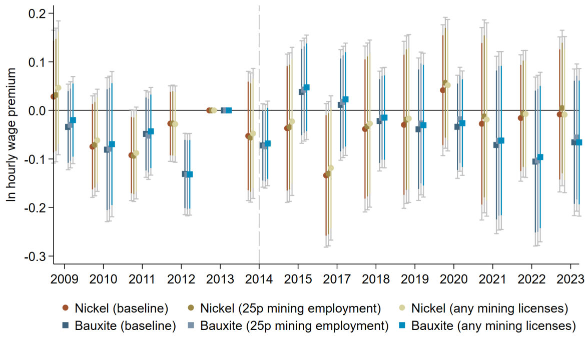
(a) mining



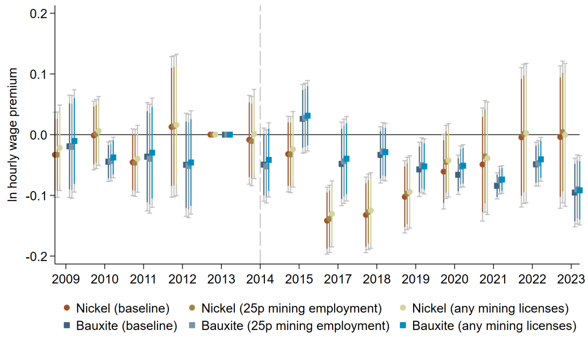
(b) agriculture



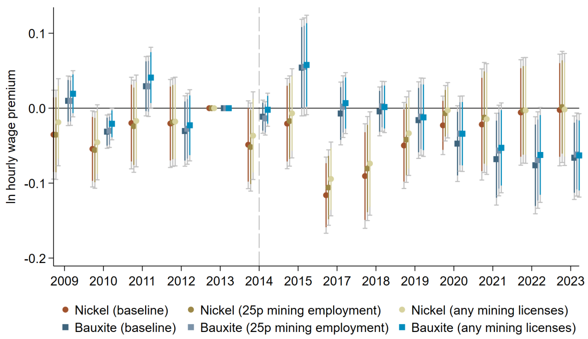
(c) manufacturing



(d) services



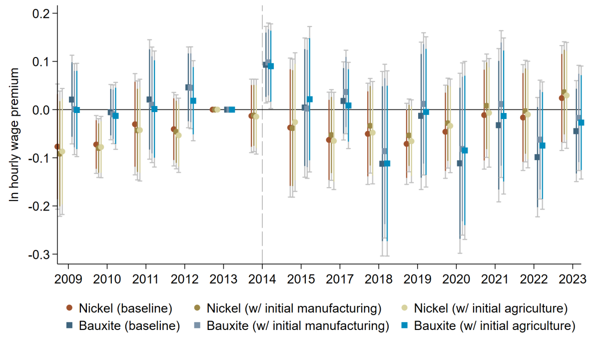
(e) total



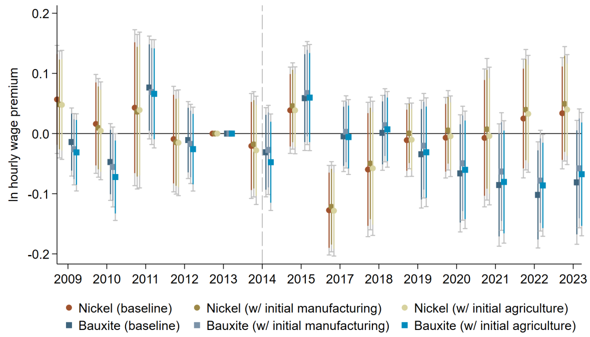
Notes: The results are based on Equation (4). The dependent variable is average hourly wage premium in a specific sector (in ln) (see Section 4 for more details). 'nickel (bauxite)' is a continuous variable measuring the share of nickel (bauxite) endowments of the surface area in district *d*, scaled by the average endowment across all nickel (or bauxite-) endowed districts. '25p mining employment' only includes the 373 districts which were above the 25th percentile mining employment in 2013. 'any mining licenses' only includes the 329 districts which had any mining licenses. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

Figure OA18: Robustness check on sectoral earnings: Additional controls

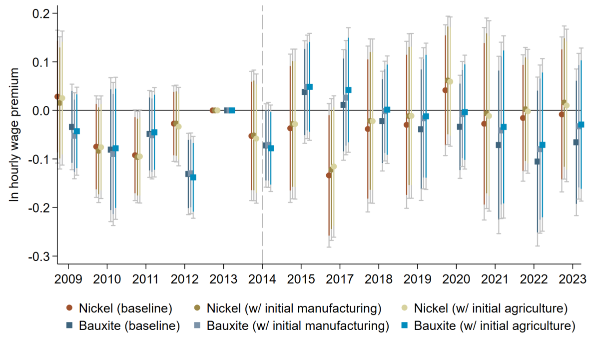
(a) mining



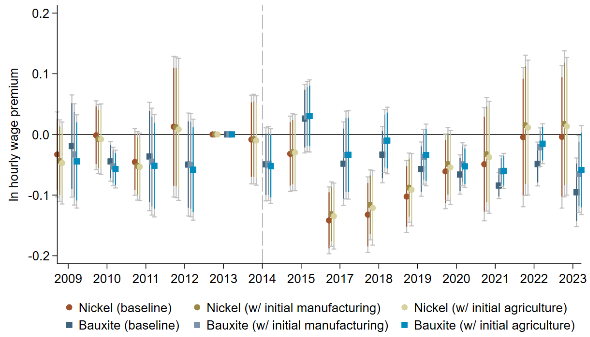
(b) agriculture



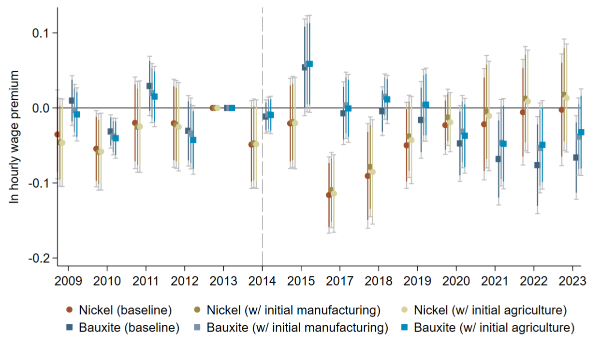
(c) manufacturing



(d) services



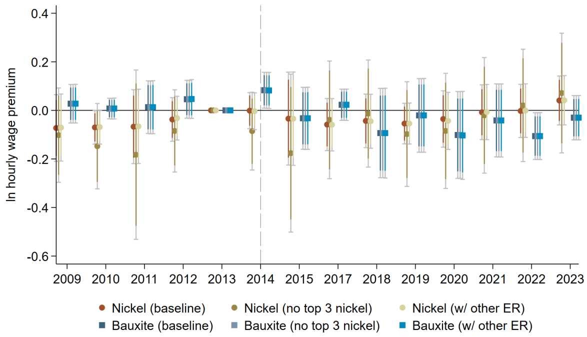
(e) total



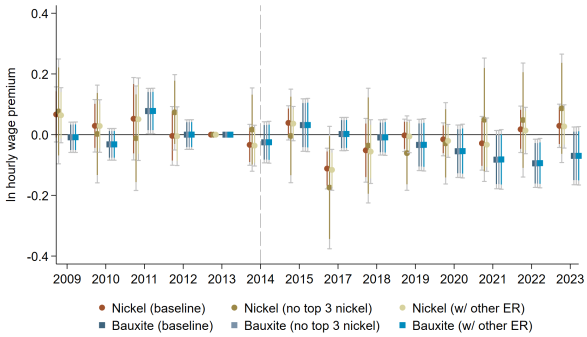
Notes: The results are based on Equation (4). The dependent variable is the average hourly wage premium in a specific sector (in ln) (see Section 4 for more details). ‘nickel (bauxite)’ is a continuous variable measuring the share of nickel (bauxite) endowments of the surface area in district d, scaled by the average endowment across all nickel (or bauxite-) endowed districts. ‘w/ initial manufacturing’ means that we include the share of manufacturing in 2013 interacted with year dummies. ‘w/ initial agriculture’ means that we include the share of agriculture in 2013 interacted with year dummies. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

Figure OA19: Robustness check on sectoral earnings: (too) Important mining districts

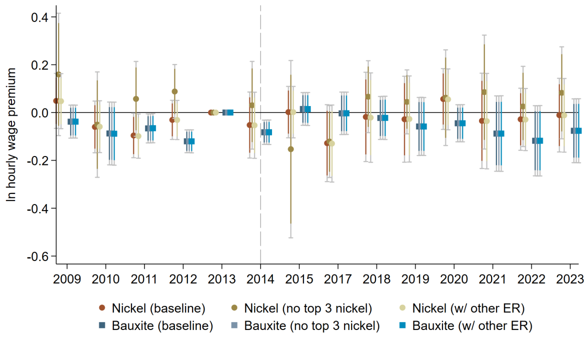
(a) mining



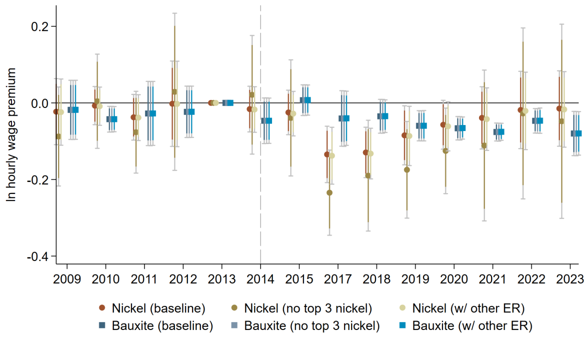
(b) agriculture



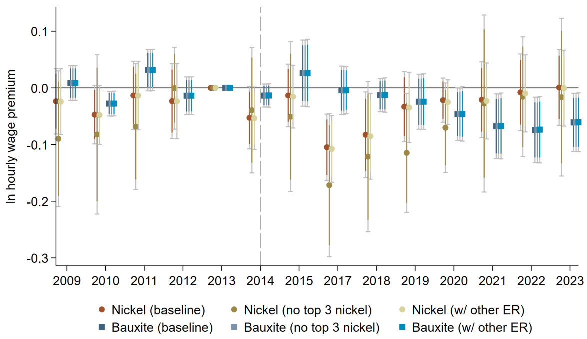
(c) manufacturing



(d) services



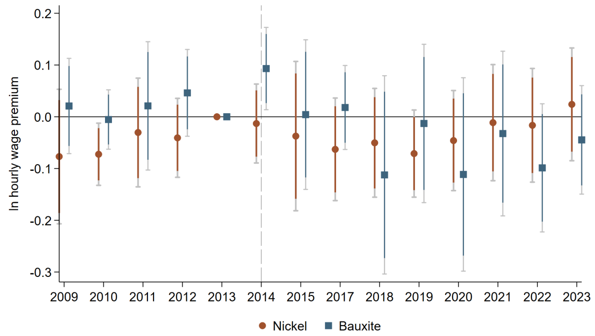
(e) total



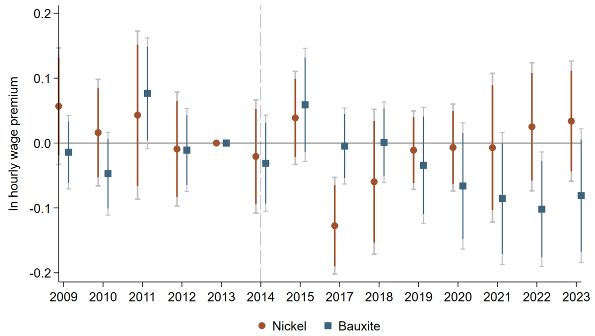
Notes: The results are based on Equation (4). The dependent variable is the average hourly wage premium in a specific sector (in ln) (see Section 4 for more details). 'nickel (bauxite)' is a continuous variable measuring the share of nickel (bauxite) endowments of the surface area in district d, scaled by the average endowment across all nickel (or bauxite-) endowed districts. 'no top 5 nickel' means that we exclude the top three nickel districts (with a share between 13.1-15.7%). 'w/ other ER variables' means that we include the sum of all other export-restricted resource endowment shares interacted with year dummies. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

Figure OA20: Robustness check on sectoral earnings: Alternative endowment measure

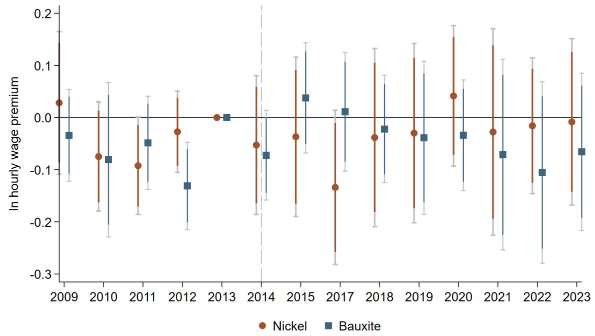
(a) mining



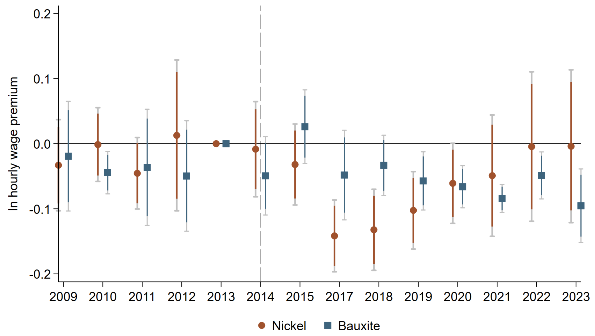
(b) agriculture



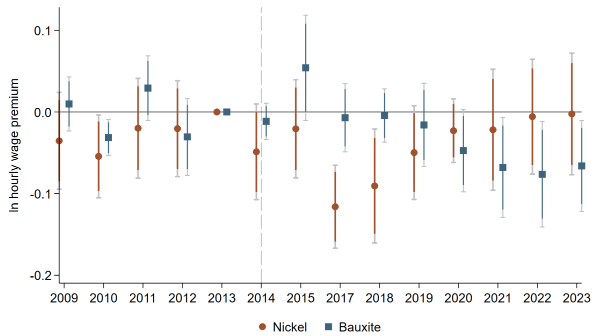
(c) manufacturing



(d) services



(e) total



Notes: The results are based on Equation (4). The dependent variable is the total number of people employed in a specific sector (in ln). 'nickel (bauxite)' is a dummy variable measuring whether there is at least one nickel (bauxite) endowment. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

OA3.2 Robustness checks on the results of Section 5.2

Morowali First, Table OA5, Panel I, shows that our results are not driven by the Morowali district, that is, as mentioned earlier, home to 23 smelters that together account for 50% of all nickel smelter capacity in Indonesia's nickel districts in 2023. Moreover, almost all of Indonesia's stainless steel plants are found in Morowali, as well as 73% of all of captive coal power plant capacity in Indonesia's nickel districts. The labor market effects of smelters are not only present in this very important nickel processing hub, but can be found in all nickel processing districts.

Additional controls Second, we find the same results when adding a district's 2013 employment share in manufacturing interacted with a full set of year dummies to our regressions. Thus, differential trends in (sectoral) employment patterns related to a district's initial manufacturing share are not confounding our findings, which is reassuring given that smelters might be placed in districts based on (pre-trends in) a district's available manufacturing employment. Similarly, controlling for whether a district was classified as a *kota* (city) or hosted a processed nickel-exporting port in 2023, each interacted with year dummies, does not alter the results. In light of our discussion on endogenous placement, this also accounts for the potentially time-varying importance of these two largely time-invariant determinants of smelter placement (proximity to a port and location outside the densest urban areas). This suggests that our findings are not driven by these factors, see Table OA5, Panels II and III.

Indonesia's islands Third, Table OA6 shows that our findings are robust to excluding districts on Java, the most developed and industrialized island of Indonesia, from the sample. Likewise, the results are robust to excluding the top 25% of districts with the highest population density in 2013. Also, they are, with the exception of our mining employment findings (that are now less precisely estimated), robust to including a full set of island-year dummies instead of the year dummies that we include in our baseline specification. But, do note that including these island-year dummies again comes with a substantial loss of identifying variation.

Smelter concentration Finally, Table OA7 shows the robustness of our results to excluding districts that host only a single smelter in 2023. This test accounts for the possibility that in areas with limited processing activity, local factors may play a larger role in determining the location or timing of openings. In contrast, in industrial hubs such as Morowali or Weda Bay Industrial Park, smelter establishment and timing are largely shaped by national strategic decisions. Reassuringly, our labor market results are not driven by districts with only one smelter.

Table OA5: Robustness check on the downstream effect on employment in processing districts

dependent var	ln employment				
	(1) total	(2) mining	(3) agriculture	(4) manufacturing	(5) services
	robustness I: excluding Morowali				
Panel A					
nickel smelter	-0.014	0.072	-0.122**	0.438*	-0.030
	(0.013)	(0.144)	(0.052)	(0.225)	(0.058)
Panel B					
ln # nickel smelters	-0.003	0.159	-0.164***	0.652***	0.050
	(0.016)	(0.121)	(0.041)	(0.195)	(0.071)
Panel C					
ln nickel smelter capacity	0.014	0.166	-0.194**	0.995**	0.089
	(0.020)	(0.190)	(0.082)	(0.460)	(0.113)
N	6846	6031	6841	6691	6810
	robustness II: w/ initial manufacturing share × year				
Panel A					
nickel smelter	-0.014	0.118	-0.107**	0.431***	-0.036
	(0.015)	(0.137)	(0.051)	(0.156)	(0.056)
Panel B					
ln # nickel smelters	-0.006	0.225***	-0.105**	0.371*	0.004
	(0.010)	(0.087)	(0.045)	(0.200)	(0.050)
Panel C					
ln nickel smelter capacity	0.002	0.321**	-0.114*	0.440	0.002
	(0.011)	(0.149)	(0.063)	(0.305)	(0.061)
N	6860	6045	6855	6705	6824
	robustness III: w/ city and port × year				
Panel A					
nickel smelter	-0.004	0.044	-0.108*	0.417**	-0.035
	(0.016)	(0.140)	(0.058)	(0.199)	(0.050)
Panel B					
ln # nickel smelters	0.013	0.129	-0.115**	0.415**	0.013
	(0.017)	(0.110)	(0.057)	(0.198)	(0.052)
Panel C					
ln nickel smelter capacity	0.028	0.191	-0.111	0.467	0.006
	(0.020)	(0.156)	(0.072)	(0.307)	(0.062)
N	6860	6045	6855	6705	6824

Notes: In this table we study how active nickel smelters impact sectoral employment in districts where these smelters are located. The sample period is 2009-2023. Starting from the full list of districts, the used sample always excludes 3 districts that had a smelter before the export ban. This leaves us comparing the 12 districts with post-ban smelters to 482 districts with no smelters. 'ln employment' is the number of people employed in a specific sector (in ln). 'nickel smelter' is a dummy variable which takes the value one if there is at least one nickel smelter active in the district. 'ln # nickel smelters' is the number of nickel smelters in a district (in ln). 'ln nickel smelter capacity' is the total nickel smelter capacity (in 1,000,000 metric tons) in a district (in ln). 'excluding Morowali' means that we exclude the Morowali district with 23 nickel smelters. 'w/ initial manufacturing' means that we include the share of manufacturing employment in 2013 interacted with year dummies. 'w/city and port trends' means that we include dummies for a district being a city ('kota') (98 districts) or having a processed nickel-exporting port in 2023 (12 districts) interacted with year dummies. All columns include a full set of control variables, including interaction terms of the nickel, bauxite and copper share with the export restriction and the palm share with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$.

Table OA6: Robustness check on the downstream effect on employment in processing districts (continued)

dependent var	ln employment				
	(1) total	(2) mining	(3) agriculture	(4) manufacturing	(5) services
	robustness IV: excluding Java				
Panel A					
nickel smelter	-0.004	0.044	-0.108*	0.417**	-0.035
	(0.016)	(0.140)	(0.058)	(0.199)	(0.050)
Panel B					
ln # nickel smelters	0.013	0.129	-0.115**	0.415**	0.013
	(0.017)	(0.110)	(0.057)	(0.198)	(0.052)
Panel C					
ln nickel smelter capacity	0.028	0.191	-0.111	0.467	0.006
	(0.020)	(0.156)	(0.072)	(0.307)	(0.062)
N	6860	6045	6855	6705	6824
	robustness V: $\leq$ 75th percentile population density				
Panel A					
nickel smelter	-0.025	0.154	-0.134**	0.618***	-0.026
	(0.016)	(0.177)	(0.062)	(0.184)	(0.062)
Panel B					
ln # nickel smelters	-0.007	0.246***	-0.108**	0.445*	0.019
	(0.011)	(0.088)	(0.050)	(0.233)	(0.054)
Panel C					
ln nickel smelter capacity	0.005	0.310**	-0.109*	0.465	0.007
	(0.012)	(0.155)	(0.062)	(0.316)	(0.063)
N	5225	4580	5225	5070	5189
	robustness VI: w/ island $\times$ year FE				
Panel A					
nickel smelter	-0.027*	0.133	-0.148**	0.636***	-0.031
	(0.016)	(0.179)	(0.063)	(0.192)	(0.066)
Panel B					
ln # nickel smelters	-0.008	0.247***	-0.111**	0.443*	0.013
	(0.011)	(0.090)	(0.051)	(0.236)	(0.054)
Panel C					
ln nickel smelter capacity	0.001	0.333**	-0.109*	0.456	-0.007
	(0.011)	(0.153)	(0.063)	(0.315)	(0.061)
N	5115	4537	5115	4960	5079

Notes: In this table we study how active nickel smelters impact sectoral employment in districts where these smelters are located. The sample period is 2009-2023. Starting from the full list of districts, the used sample always excludes 3 districts that had a smelter before the export ban. This leaves us comparing the 12 districts with post-ban smelters to 482 districts with no smelters. 'ln employment' is the number of people employed in a specific sector (in ln). 'nickel smelter' is a dummy variable which takes the value one if there is at least one nickel smelter active in the district. 'ln # nickel smelters' is the number of nickel smelters in a district (in ln). 'ln nickel smelter capacity' is the total nickel smelter capacity (in 1,000,000 metric tons) in a district (in ln). 'excluding Java' means that we exclude the 118 districts in Java. '$\leq$ 75p pop density' means that we exclude the 125 districts above the 75th percentile population density in 2013. 'w/ island $\times$ year FE' means that we include island $\times$ year fixed effects. All columns include a full set of control variables, including interaction terms of the nickel, bauxite and copper share with the export restriction and the palm share with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table OA7: Robustness check on the downstream effect on employment in processing districts (continued)

dependent var	ln employment				
	(1) total	(2) mining	(3) agriculture	(4) manufacturing	(5) services
	robustness VII: excluding districts with only one smelter				
Panel A					
nickel smelter	-0.015 (0.019)	0.340*** (0.091)	-0.166** (0.069)	0.745*** (0.231)	0.046 (0.074)
Panel B					
ln # nickel smelters	0.001 (0.010)	0.308*** (0.051)	-0.107** (0.052)	0.454* (0.254)	0.052 (0.062)
Panel C					
ln nickel smelter capacity	0.011 (0.011)	0.413*** (0.125)	-0.083 (0.053)	0.370 (0.307)	0.039 (0.076)
N	6776	5961	6771	6621	6740

Notes: In this table we study how active nickel smelters impact sectoral employment in districts where these smelters are located. The sample period is 2009-2023. Starting from the full list of districts, the used sample 'excluding districts with only one smelter' excludes 3 districts that had a smelter before the export ban, as well as 6 additional districts with only one nickel smelter in 2023. This leaves us comparing the 6 districts with post-ban smelters to 481 districts with no smelters. 'ln employment' is the number of people employed in a specific sector (in ln). 'nickel smelter' is a dummy variable which takes the value one if there is at least one nickel smelter active in the district. 'ln # nickel smelters' is the number of nickel smelters in a district (in ln). 'ln nickel smelter capacity' is the total nickel smelter capacity (in 1,000,000 metric tons) in a district (in ln). All columns include a full set of control variables, including interaction terms of the nickel, bauxite and copper share with the export restriction and the palm share with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$.

OA3.3 Robustness checks on the results of Section 5.3

Indonesia's islands The first set of results in Table OA8 again shows that our findings are robust to excluding districts on Java, the two most developed and industrialized island of Indonesia, from the sample. Likewise, the results are robust to excluding the top 25% of districts with the highest population density in 2013. Also, our finding regarding the effect on mining employment in coal-districts is robust to including a full set of island-year dummies instead of the year dummies that we include in our baseline specification. This does not hold for the manufacturing and services employment results, with coefficient becoming much smaller and much less precisely estimated. But again, do note that including these island-year dummies comes with a substantial loss of identifying variation.

Control districts Second, Table OA9, Panels IV and V, show that our findings are robust to excluding district without any mining licenses, or the 25% of districts with the lowest mining employment share from the non-coal districts (our 'control group' here). Our findings are not driven by comparing coal districts to districts without any (substantial) natural mineral resources.

(too) Important mining districts Third, Table OA9, Panel VI, shows that our findings are not driven by the districts with the largest coal area shares. We find the same results when excluding coal-districts with an endowment share larger than 10% (corresponding to 18 out of 66 coal districts). Moreover, Table OA10, Panel VII, shows what happens when excluding Sumatra from the sample. While the main coal-producing islands are Sumatra and Kalimantan, virtually all of the coal that is used in Indonesia's downstream nickel industry is sourced from Kalimantan, which is located nearest to the smelters and stainless steel plants on Sulawesi and Maluku. Transporting coal from Sumatra, the other island with significant coal deposits, is simply much more expensive. Reassuringly, our mining employment findings remain robust when we exclude districts in Sumatra.

Alternative endowment measure Finally, we show what happens when using alternative measures of a district's coal-mining dependence. More specifically, instead of using a district's area's share under coal mining licenses respectively, Table OA10, Panel VIII, shows what that our findings are robust to using a simple dummy variable for the presence of any coal mining licenses in the district.

Table OA8: Robustness check on employment in upstream coal mining districts

dependent variable	ln employment				
	(1) total	(2) mining	(3) agriculture	(4) manu- facturing	(5) services
	robustness I: excluding Java				
Panel A					
coal endowment × nickel smelter capacity	0.0001	0.0028***	0.0003	-0.0009	-0.0005*
	(0.0001)	(0.0009)	(0.0004)	(0.0006)	(0.0003)
Panel B					
coal endowment × nickel power plant capacity	-0.0002	0.007***	0.0002	-0.003**	-0.002**
	(0.0003)	(0.002)	(0.001)	(0.002)	(0.0007)
N	3403	3013	3403	3316	3390
	robustness II: ≤ 75th percentile population density				
Panel A					
coal endowment × nickel smelter capacity	-0.0000	0.0039***	-0.0001	-0.0016**	-0.0008**
	(0.0002)	(0.0008)	(0.0003)	(0.0006)	(0.0004)
Panel B					
coal endowment × nickel power plant capacity	-0.0005	0.010***	-0.001*	-0.005***	-0.002**
	(0.0005)	(0.002)	(0.0007)	(0.002)	(0.0009)
N	3339	2991	3339	3252	3326
	robustness III: w/ island × year FE				
Panel A					
coal endowment × nickel smelter capacity	0.0004*	0.0032***	0.0003	0.0002	0.0002
	(0.0002)	(0.0011)	(0.0004)	(0.0006)	(0.0003)
Panel B					
coal endowment × nickel power plant capacity	0.0004	0.0068**	-0.0001	-0.0010	0.0003
	(0.0004)	(0.0027)	(0.0013)	(0.0016)	(0.0007)
N	4464	3968	4462	4377	4451

Notes: In this table we study how the increase in total nickel smelter capacity impacts sectoral employment in districts where coal deposits - a key input for the downstream processing industry - are located. The sample period is 2014-2023. 'ln employment' is the number of people employed in a specific sector (in ln). 'coal endowment' is a continuous variable measuring the coal endowment as a share of the district's surface area in district d, scaled by the average endowment across all coal-endowed districts. 'nickel smelter capacity' is the total output capacity of nickel smelters in 1,000,000 metric tons, scaled by the mean smelter capacity in nickel districts (297,000 metric tons). 'nickel power capacity' is the total capacity in 1,000 MW of captive power plants in nickel districts, scaled by the mean power plant capacity (171 MW). 'excluding Java' means that we exclude the 118 districts on Java. '≤ 75th percentile population density' means that we exclude the 125 districts above the 75th percentile population density in 2013. 'w/ island × year FE' means that we include island × year fixed effects. All columns include a full set of control variables, including interaction terms of the nickel, bauxite, copper and iron endowment with the export restriction and the palm share with the palm oil price (in ln), and interaction terms with coal share with a post-2018 dummy, with aggregate Australian coal exports and with the total capacity in MW of power plants in non-nickel districts. Moreover, we also include year fixed effects and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$.

Table OA9: Robustness check on employment in upstream coal mining districts (continued)

dependent variable	ln employment				
	(1) total	(2) mining	(3) agriculture	(4) manu-facturing	(5) services
	robustness IV: $\geq$ 25th percentile mining employment				
Panel A					
coal endowment × nickel smelter capacity	-0.0001	0.0026***	0.0000	-0.0012*	-0.0004*
	(0.0001)	(0.0009)	(0.0005)	(0.0007)	(0.0002)
Panel B					
coal endowment × nickel power plant capacity	-0.0005	0.0060***	-0.0003	-0.0037**	-0.0010*
	(0.0003)	(0.0022)	(0.0013)	(0.0018)	(0.0006)
N	2230	2156	2228	2228	2230
	robustness V: excluding districts w/o mining licenses				
Panel A					
coal endowment × nickel smelter capacity	-0.0001	0.0031***	0.0001	-0.0014**	-0.0005*
	(0.0001)	(0.0009)	(0.0005)	(0.0007)	(0.0003)
Panel B					
coal endowment × nickel power plant capacity	-0.0007*	0.0079***	-0.0005	-0.0042**	-0.0012**
	(0.0004)	(0.0023)	(0.0013)	(0.0018)	(0.0006)
N	3128	2957	3128	3116	3127
	robustness VI: excluding districts with $\geq$ 10% coal				
Panel A					
coal endowment × nickel smelter capacity	0.0000	0.0055**	-0.0001	-0.0034*	-0.0001
	(0.0004)	(0.0027)	(0.0007)	(0.0018)	(0.0008)
Panel B					
coal endowment × nickel power plant capacity	-0.0004	0.0153**	-0.0020	-0.0085*	-0.0006
	(0.0010)	(0.0073)	(0.0019)	(0.0047)	(0.0020)
N	4302	3806	4300	4216	4289

Notes: In this table we study how the increase in total nickel smelter capacity impacts sectoral employment in districts where coal deposits - a key input for the downstream processing industry - are located. The sample period is 2014-2023. 'ln employment' is the number of people employed in a specific sector (in ln). 'coal endowment' is a continuous variable measuring the coal endowment as a share of the district's surface area in district d, scaled by the average endowment across all coal-endowed districts. 'nickel smelter capacity' is the total output capacity of nickel smelters in 1,000,000 metric tons, scaled by the mean smelter capacity in nickel districts (297,000 metric tons). 'nickel power capacity' is the total capacity in 1,000 MW of captive power plants in nickel districts, scaled by the mean power plant capacity (171 MW). '$\geq$ 25th percentile mining employment' only includes the 373 districts which were above the 25th percentile mining employment in 2013 (corresponding to a mining employment share of 0.198%). 'any mining licenses' only includes the 329 districts which had any mining licenses. 'excluding districts with $\geq$ 10% coal' means we exclude the 18 districts with a coal endowment share that exceeds 10%. All columns include a full set of control variables, including interaction terms of the nickel, bauxite, copper and iron endowment with the export restriction and the palm share with the palm oil price (in ln), and interaction terms with coal share with a post-2018 dummy, with aggregate Australian coal exports and with the total capacity in MW of power plants in non-nickel districts. Moreover, we also include year fixed effects and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$.

Table OA10: Robustness check on employment in upstream coal mining districts (continued)

dependent variable	ln employment				
	(1) total	(2) mining	(3) agriculture	(4) manu-facturing	(5) services
	robustness VII: excluding Sumatra				
Panel A					
coal endowment × nickel smelter capacity	-.0004***	0.0027**	-.0000	-0.0015*	-0.0010***
	(0.0002)	(0.0011)	(0.0007)	(0.0009)	(0.0003)
Panel B					
coal endowment × nickel power plant capacity	-0.0010**	0.0073***	-0.0004	-0.0038	-0.002***
	(0.0004)	(0.0027)	(0.0018)	(0.0023)	(0.0008)
N	3168	2807	3166	3083	3155
	robustness VIII: alternative endowment measure				
Panel A					
coal dummy × nickel smelter capacity	-0.0002	0.0039**	0.0003	-0.003***	-0.0012**
	(0.0003)	(0.0018)	(0.0005)	(0.0011)	(0.0006)
Panel B					
coal dummy × nickel power plant capacity	-0.0010	0.0113**	-0.0007	-0.008***	-0.0035**
	(0.0008)	(0.0044)	(0.0014)	(0.0026)	(0.0015)
N	4464	3968	4462	4377	4451

Notes: In this table we study how the increase in total nickel smelter capacity impacts sectoral employment in districts where coal deposits - a key input for the downstream processing industry - are located. The sample period is 2014-2023. 'ln employment' is the number of people employed in a specific sector (in ln). 'coal endowment' is a continuous variable measuring the coal endowment as a share of the district's surface area in district d, scaled by the average endowment across all coal-endowed districts. 'coal dummy' is a dummy variable measuring the presence of any coal licenses. 'nickel smelter capacity' is the total output capacity of nickel smelters in 1,000,000 metric tons, scaled by the mean smelter capacity in nickel districts (297,000 metric tons). 'nickel power capacity' is the total capacity in 1,000 MW of captive power plants in nickel districts, scaled by the mean power plant capacity (171 MW). 'excluding Sumatra' excludes the 144 districts on Sumatra. 'alternative endowment measure' means that we use a dummy for whether there is at least one coal endowment in district d. All columns include a full set of control variables, including interaction terms of the nickel, bauxite, copper and iron endowment with the export restriction and the palm share with the palm oil price (in ln), and interaction terms with coal share with a post-2018 dummy, with aggregate Australian coal exports and with the total capacity in MW of power plants in non-nickel districts. Moreover, we also include year fixed effects and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01, ^{**} p < 0.05, ^{*} p < 0.1$.

OA4 Additional results

OA4.1 The effect of the export restrictions on mining districts

OA4.1.1 Mining or processing?

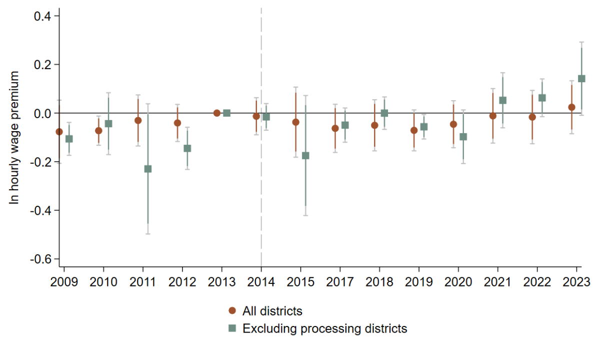
Table OA11: Accounting for the processing industry

sample	excluding processing districts				
dependent var	ln hourly wage premium				
	(1) total	(2) mining	(3) agriculture	(4) manufacturing	(5) services
nickel endowment × ER	0.039	0.097***	-0.013	0.057	-0.027
	(0.038)	(0.032)	(0.060)	(0.082)	(0.048)
bauxite endowment × ER	-0.024	-0.054	-0.041	0.010	-0.022
	(0.025)	(0.058)	(0.028)	(0.040)	(0.022)
N	6661	3287	6512	6185	6581

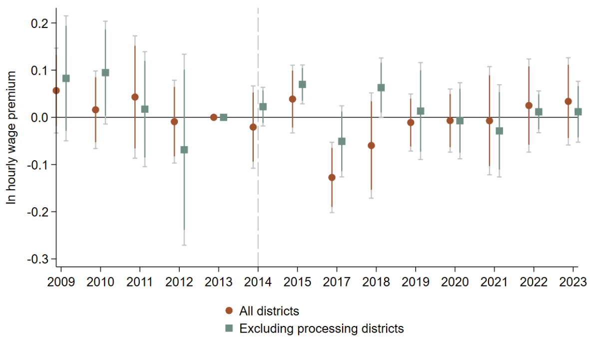
Notes: In this table we study how export restrictions on raw materials impact the earnings in mining districts that never had processing. The sample period is 2009-2023. This table excludes all 15 districts that ever had a nickel smelter. This leaves us comparing the 6 districts with nickel mining but no smelters to the 476 districts with neither mining nor smelters. 'ln hourly wage premium' is the sectoral hourly wage premium (in ln) (see Section 4 for more details). 'nickel (bauxite)' is a continuous variable measuring the nickel (bauxite) endowment as a share of the surface area in district d, scaled by the average endowment across all nickel (or bauxite-) endowed districts. 'ER' is a dummy variable which takes the value one if there is an export restriction active for this specific resource in year t. All columns include a full set of control variables, including interaction terms of the copper and iron share with the export restriction and the palm share with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$.

Figure OA21: Accounting for the processing industry

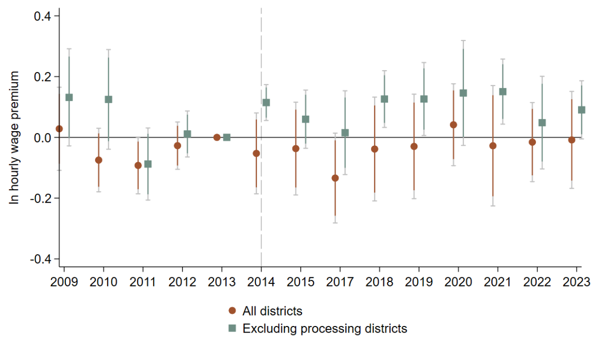
(a) mining



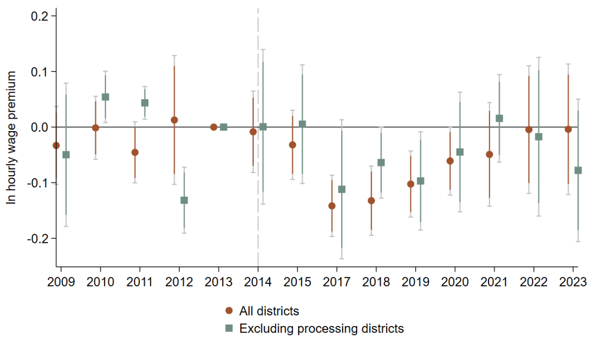
(b) agriculture



(c) manufacturing



(d) services



Notes: The results are based on Equation (4), but we only show nickel point estimates. The dependent variable is the sectoral hourly wage premium (in ln). 'Excluding processing districts' excludes all 15 districts that ever had a nickel smelter. 'nickel' is a continuous variable measuring the nickel endowment as a share of the surface area in district d, scaled by the average endowment across all nickel endowed districts. All specifications include a vector of control variables, including the copper and iron endowment interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/green (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

OA4.1.2 Other outcomes

Table OA12: Export restrictions and non-adjusted sectoral wage

dependent var	ln non-adjusted sectoral wage				
	(1) total	(2) mining	(3) agriculture	(4) manufacturing	(5) services
nickel endowment × ER	0.007	0.007	-0.109*	0.205**	0.026
	(0.034)	(0.077)	(0.059)	(0.086)	(0.045)
bauxite endowment × ER	-0.019	-0.309**	-0.028	0.024	-0.002
	(0.021)	(0.125)	(0.030)	(0.053)	(0.026)
N	6889	3907	6800	6560	6825

Notes: This table examines how export restrictions on raw materials impact the non-adjusted sectoral wage in districts where these resource deposits are located. The sample period is 2009-2023. 'ln non-adjusted sectoral wage' is the non-adjusted hourly wage (in ln). We only include district-sector-years with at least five wage records. 'nickel (bauxite) endowment' is a continuous variable measuring the nickel (bauxite) endowment as a share of the district's surface area in district d, scaled by the average endowment across all nickel (or bauxite-) endowed districts. 'ER' is a dummy variable which takes the value one if there is an export restriction active for this specific resource in year t. All columns include a full set of control variables, including interaction terms of the copper and iron endowment with the export restriction and the palm share with the palm oil price (in ln), and year and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$.

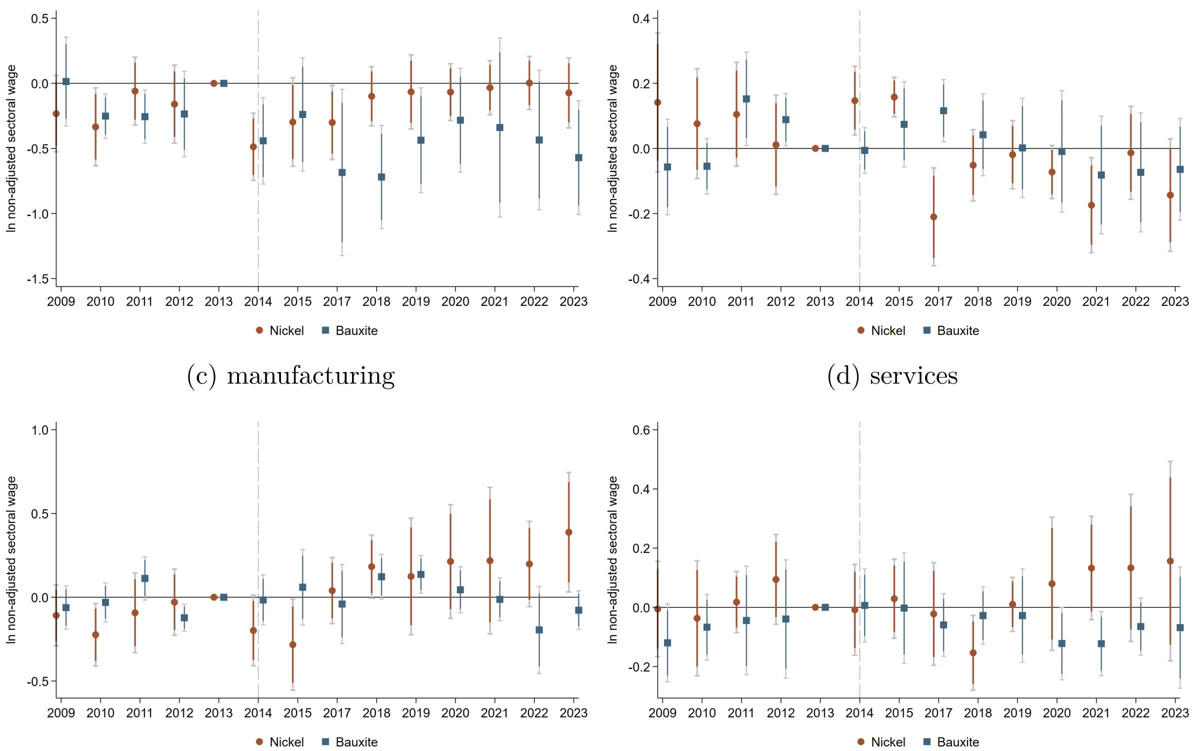
Figure OA22: Export restrictions and non-adjusted sectoral wage

(a) mining

(b) agriculture

(c) manufacturing

(d) services



Notes: The results are based on Equation (4). The dependent variable is the average non-adjusted hourly average wage in a specific sector (in ln). We only include district-sector-years with at least five wage records. 'nickel (bauxite)' is a continuous variable measuring the nickel (bauxite) endowment as a share of the surface area in district d, scaled by the average endowment across all nickel (or bauxite-) endowed districts. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), and year and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

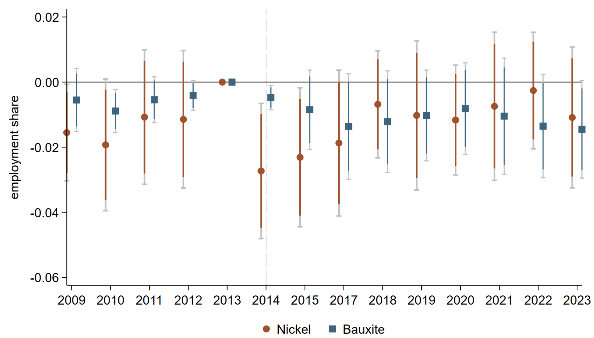
Table OA13: Export restrictions and sectoral employment shares

dependent var	employment share			
	(1) mining	(2) agriculture	(3) manufacturing	(4) services
nickel endowment × ER	-0.002 (0.003)	-0.028*** (0.009)	0.018** (0.008)	0.003 (0.003)
bauxite endowment × ER	-0.006 (0.006)	-0.003 (0.010)	0.000 (0.002)	0.007 (0.005)
N	6902	6902	6902	6902

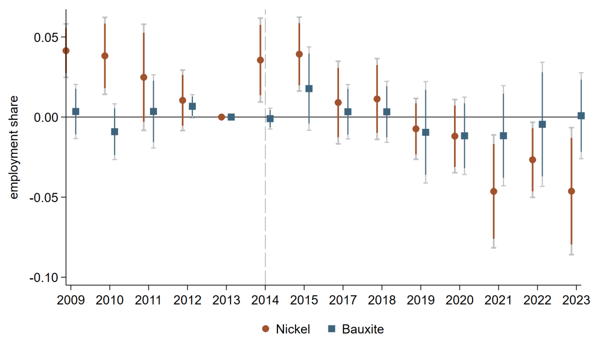
Notes: In this table we study how export restrictions on raw materials impact sectoral employment shares in districts where these resource deposits are located. The sample period is 2009-2023. 'employment share' is the share of people employed in a specific sector. 'nickel (bauxite) endowment' is a continuous variable measuring the nickel (bauxite) endowment as a share of the district's surface area in district d, scaled by the average endowment across all nickel (or bauxite-) endowed districts. 'ER' is a dummy variable which takes the value one if there is an export restriction active for this specific resource in year t. All columns include a full set of control variables, including interaction terms of the copper and iron endowment with the export restriction and the palm share with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01,^{**} p < 0.05,^{*} p < 0.1$.

Figure OA23: Export restrictions and sectoral employment shares

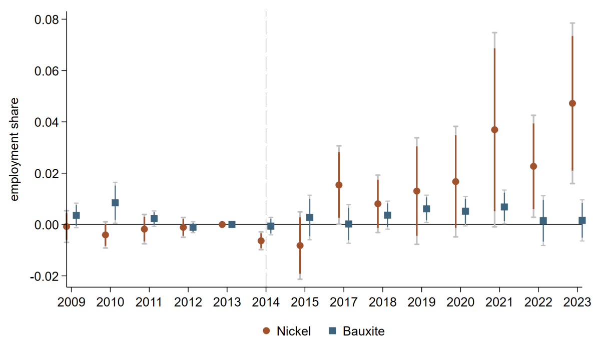
(a) mining



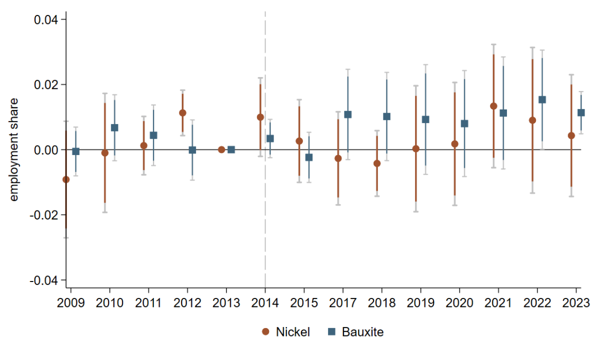
(b) agriculture



(c) manufacturing



(d) services



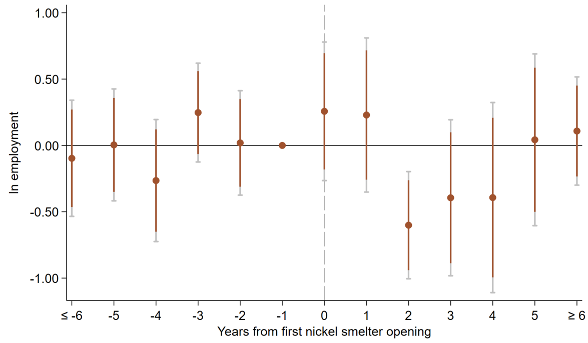
Notes: The results are based on Equation (4). The dependent variable is the share of people employed in a specific sector. 'nickel (bauxite)' is a continuous variable measuring the share of nickel (bauxite) endowment of the district's surface area in district d, scaled by the average endowment across all nickel (or bauxite-) endowed districts. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

OA4.2 Local effects of downstream nickel processing

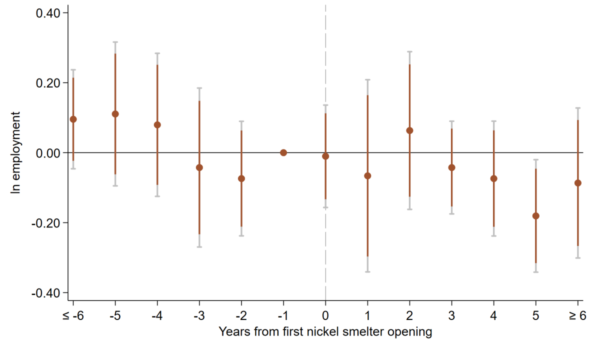
OA4.2.1 Employment

Figure OA24: Downstream effect on employment in processing districts

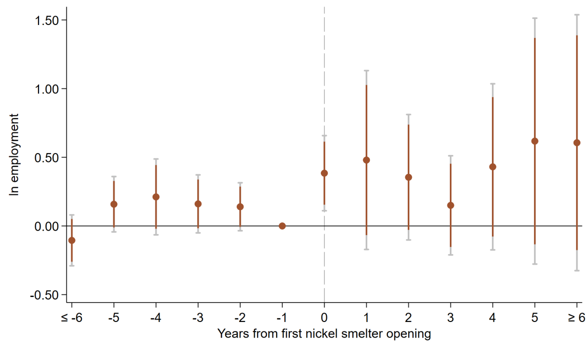
(a) mining



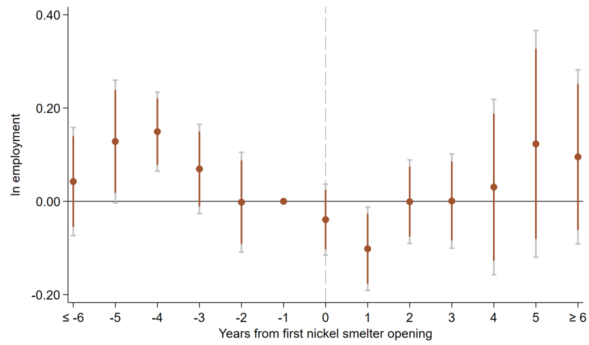
(b) agriculture



(c) manufacturing



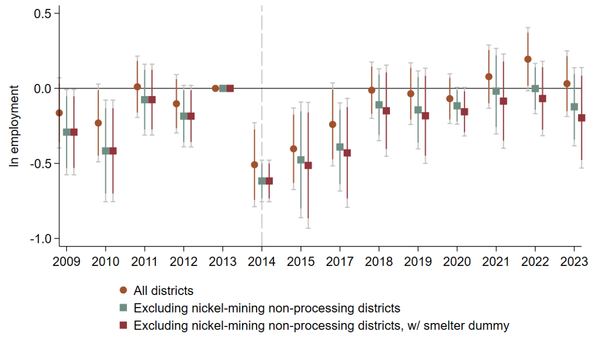
(d) services



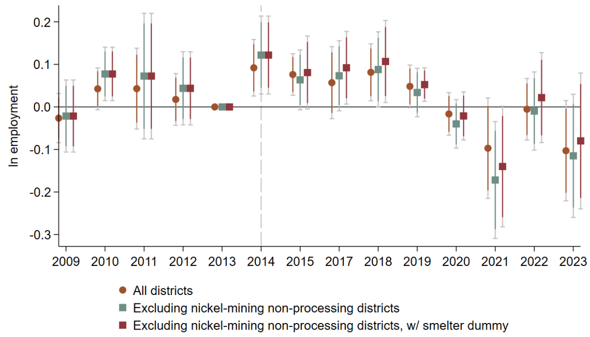
Notes: The results are based on event study regressions estimating the impact of the first nickel smelter opening on ln employment from six years before $(t-6)$ to six years after $(t+6)$ the opening of the first nickel processing plant. All specifications include a vector of control variables, including the nickel, bauxite, copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), and year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange (grey) lines indicate 95% (90%) confidence intervals. The reference period is one year prior to the opening $(t-1)$.

Figure OA25: Effect of nickel share on employment in processing districts

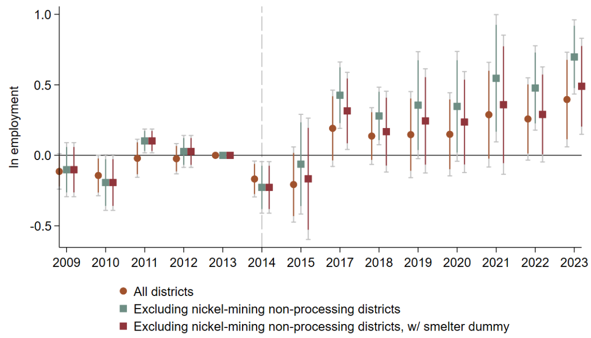
(a) mining



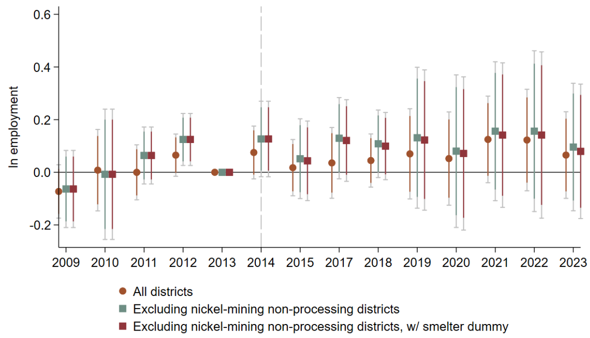
(b) agriculture



(c) manufacturing



(d) services



Notes: The results are based on Equation (4), but we only show nickel point estimates. The dependent variable is the total number of people employed in a specific sector (in ln). 'nickel (bauxite)' is a continuous variable measuring the share of nickel (bauxite) endowment of the surface area in district *d*, scaled by the average endowment across all nickel (or bauxite-) endowed districts. The sample 'Excluding nickel mining non-processing districts' only includes nickel districts that ever become processing districts. Therefore, it excludes (a) 6 districts with mining but no smelters, as well as (b) 3 districts that had a smelter before the export ban and (c) 5 districts with a smelter but no mining. This leaves us comparing the 7 districts with post-ban nickel processing and mining to 476 districts with neither mining nor smelters. 'w/ smelter dummy' means that we include a dummy for whether a district has at least one nickel smelter. All specifications include a vector of control variables, including the copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; orange/blue/red (grey) lines indicate 95% (90%) confidence intervals. The year 2013 is the reference year.

OA4.2.2 Earnings

Panels A-C of Table OA14 reveal that increased nickel processing activity does not have robust, and mostly statistically insignificant, effects on a district's wage premia, neither when studying aggregate nor sectoral-specific earnings. Although the large standard errors prevent us from drawing definite conclusions, these findings are consistent with the notion that the main adjustment mechanism of labor markets in the nickel-processing regions during the post-ban period operates through changes in employment rather than earnings.

Table OA14: Downstream effect on earnings in processing districts

dependent var	ln hourly wage premium				
	(1) total	(2) mining	(3) agriculture	(4) manufacturing	(5) services
Panel A					
nickel smelter	0.031	-0.053	0.029	0.088	0.032
	(0.040)	(0.060)	(0.055)	(0.056)	(0.037)
Panel B					
ln # nickel smelters	0.041	-0.005	0.032	0.073	0.058
	(0.037)	(0.056)	(0.053)	(0.047)	(0.040)
Panel C					
ln nickel smelter capacity	0.075*	0.105	0.063	0.131*	0.087
	(0.045)	(0.074)	(0.054)	(0.077)	(0.071)
N	6829	3425	6680	6351	6749

Notes: In this table we study how an active nickel smelter impacts earnings in districts where these smelters are located. The sample period is 2009-2023. Starting from the full list of districts, the used sample excludes 3 districts that had a smelter before the export ban. This implies that we compare the 12 districts with post-ban nickel smelters to the 482 districts with no nickel smelters. 'ln hourly wage premium' is the sectoral hourly wage premium (in ln) (see Section 4 for more details). 'nickel smelter' is a dummy variable which takes the value one if there is at least one nickel smelter active in the district. 'ln # nickel smelters' is the number of nickel smelters in a district (in ln). 'ln nickel smelter capacity' is the total nickel smelter capacity (in 1,000,000 metric tons) in a district (in ln). All columns include a full set of control variables, including interaction terms of the nickel, bauxite and copper share with the export restriction and the palm share with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01,^{**} p < 0.05,^{*} p < 0.1$.

Table OA15: Downstream effect on non-adjusted sectoral wage in processing districts

dependent var	ln non-adjusted sectoral wage				
	(1) total	(2) mining	(3) agriculture	(4) manufacturing	(5) services
Panel A					
nickel smelter	-0.005	0.184	-0.059	0.475^{**}	-0.009
	(0.045)	(0.129)	(0.092)	(0.203)	(0.050)
Panel B					
ln # nickel smelters	0.018	0.247^{***}	-0.097	0.438^{**}	0.083
	(0.037)	(0.089)	(0.069)	(0.193)	(0.076)
Panel C					
ln nickel smelter capacity	0.055	0.449^{***}	-0.117	0.639^{**}	0.181
	(0.053)	(0.165)	(0.096)	(0.323)	(0.140)
N	6847	3872	6758	6518	6783

Notes: In this table we study how active nickel smelters impact earnings in districts where these smelters are located. The sample period is 2009-2023. Starting from the full list of districts, the used sample excludes 3 districts that had a smelter before the export ban. This implies that we compare the 12 districts with post-ban nickel smelters to the 482 districts with no nickel smelters. 'ln non-adjusted sectoral wage' is the non-adjusted hourly wage premium (in ln). 'nickel smelter dummy' is equal to one if there is at least one nickel smelter active in the district, zero otherwise. 'ln # nickel smelters' is the number of nickel smelters in a district (in ln). 'ln nickel smelter capacity' is the total nickel smelter capacity (in 1,000,000 metric tons) in a district (in ln). All columns include a full set of control variables, including interaction terms of the nickel, bauxite and copper share with the export restriction and the palm share with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01,^{**} p < 0.05,^{*} p < 0.1$.

OA4.2.3 Other outcomes

Table OA16: Downstream effect on employment shares in processing districts

dependent var	employment share			
	(1) mining	(2) agriculture	(3) manufacturing	(4) services
Panel A				
nickel smelter	0.004	-0.030	0.042^{**}	-0.013
	(0.003)	(0.025)	(0.019)	(0.011)
Panel B				
ln # nickel smelters	0.006^{**}	-0.041^{**}	0.040^{**}	-0.005
	(0.003)	(0.021)	(0.020)	(0.008)
Panel C				
ln nickel smelter capacity	0.010^{*}	-0.054^{*}	0.050^{*}	-0.005
	(0.005)	(0.029)	(0.030)	(0.008)
N	6860	6860	6860	6860

Notes: In this table we study how active nickel smelters impact employment shares in districts where these smelters are located. The sample period is 2009-2023. Starting from the full list of districts, the used sample excludes 3 districts that had a smelter before the export ban. This implies that we compare the 12 districts with post-ban nickel smelters to the 482 districts with no nickel smelters. 'employment share' is the share of people employed in a specific sector. 'nickel smelter dummy' is equal to one if there is at least one nickel smelter active in the district, zero otherwise. 'ln # nickel smelters' is the number of nickel smelters in a district (in ln). 'ln nickel smelter capacity' is the total nickel smelter capacity (in 1,000,000 metric tons) in a district (in ln). All columns include a full set of control variables, including interaction terms of the nickel, bauxite and copper share with the export restriction and the palm share with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01,^{**} p < 0.05,^{*} p < 0.1$.

OA4.3 Local effects in upstream coal districts

OA4.3.1 Employment

In order to assess the presence of differential pre-trends in coal-endowed districts before nickel smelters (and their associated captive coal power plants) became operational at a large scale, we estimate Equation (OA1) below. It estimates year-specific coefficients on our district-level coal endowment variable—the share of area under coal license—$Coal_d$, and includes the same set of control variables and fixed effects as in Equation (7).

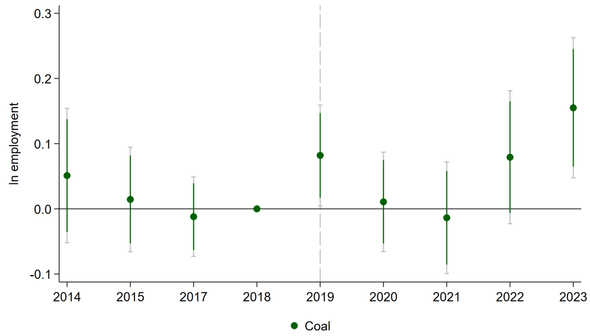
$$Y_{dt} = \sum_{\tau \in \mathcal{T}} \delta_\tau \left(\mathbf{1}\{t = \tau\} \times Coal_d \right) + X_{dt}\psi + \alpha_d + \alpha_t + \varepsilon_{dt}, \tag{OA1}$$

where $\mathcal{T} = \{2014, \ldots, 2017,\ 2019, \ldots, 2023\}$. Every year-specific coefficient is estimated relative to that of the year 2018, i.e. we set $\delta_{2018} = 0$. We do so because 2017-18 is the moment in time when the capacity of captive coal power plants in nickel districts, as well as Indonesia's coal production and domestic use, increased markedly after being largely constant beforehand, following the expansion of domestic nickel processing. The choice of using 2018 is ad hoc, and also coincides with the Indonesian government starting to strictly enforce its Domestic Market Obligation for coal mining. Do note, however that in this exercise, we are first and foremost interested in the temporal pattern coefficient on our $Coal_d$ variable *before the expansion of Indonesia's downstream nickel processing industry.* Reporting estimates, relative to 2020 instead (the year after which nickel refining capacity witnessed a strong increase—see Figure 2), would show a largely similar picture.

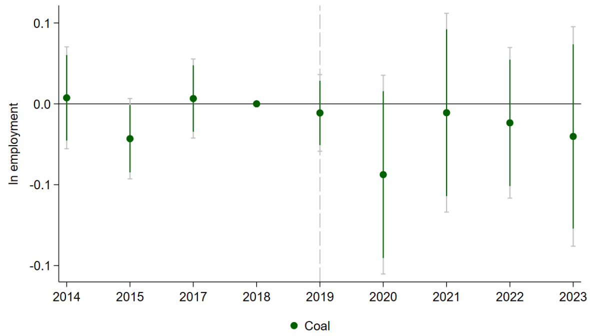
Reassuringly, Figure OA26 shows little evidence of differential pre-trends in (sectoral) employment in coal-mining districts prior to 2018.

Figure OA26: Upstream impact on employment in coal districts

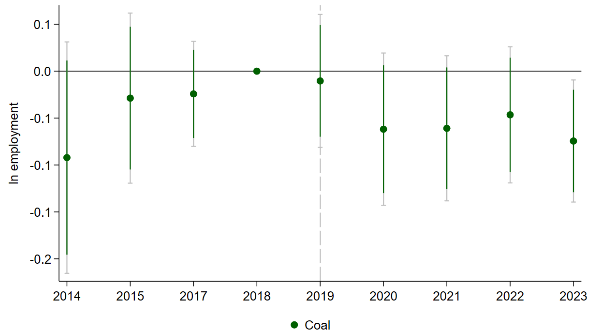
(a) mining



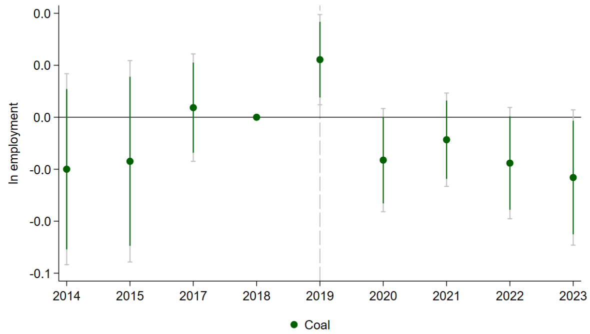
(b) agriculture



(c) manufacturing



(d) services



Notes: The results are based on Equation (4). The dependent variable is the total number of people employed in a specific sector (in ln). 'coal' is a continuous variable measuring the share of coal licenses of the surface area in district d, scaled by the average endowment across all coal endowed districts. All specifications include a vector of control variables, including the nickel, bauxite, copper and iron share interacted with year dummies, as well as the palm share interacted with the palm oil price (in ln), as well as year fixed effects and district fixed effects. Standard errors are clustered at the district level. Dots represent point estimates; green (grey) lines indicate 95% (90%) confidence intervals. The sample period is 2014-2023. The year 2020 is the reference year.

OA4.3.2 Earnings

Table OA17 shows the results on earnings, with coefficients very close to zero. As national nickel processing capacity increases, they rise significantly in coal mining districts, which is consistent with an overall rise in labor demand in those districts.

Table OA17: Earnings in upstream coal districts

dependent var	ln hourly wage premium				
	(1) total	(2) mining	(3) agriculture	(4) manu-facturing	(5) services
Panel A					
coal endowment × nickel smelter capacity	0.0004***	0.0002	0.0003*	-0.0005	0.0002
	(0.0001)	(0.0004)	(0.0002)	(0.0004)	(0.0002)
Panel B					
coal endowment × nickel power plant capacity	0.0003	0.0006	-0.0002	-0.0010	-0.0001
	(0.0004)	(0.0009)	(0.0004)	(0.0009)	(0.0005)
N	4455	2268	4368	4216	4411

Notes: In this table we study how the increase in total nickel smelter capacity impacts sectoral earnings in districts where coal deposits - a key input for the downstream processing industry - are located. The sample period is 2014-2023. 'ln hourly wage premium' is the sectoral hourly wage premium (in ln) (see Section 4 for more details). 'coal endowment' is a continuous variable measuring the coal endowment as a share of the district's surface area in district d, scaled by the average endowment across all coal endowed districts. 'nickel smelter capacity' is the total output capacity of nickel smelters in 1,000,000 metric tons, scaled by the mean smelter capacity in nickel districts (297,000 metric tons). 'nickel power capacity' is the total capacity in 1,000 MW of captive power plants in nickel districts, scaled by the mean power plant capacity (171 MW). All columns include a full set of control variables, including interaction terms of the nickel, bauxite, copper and iron share with the export restriction and the palm share with the palm oil price (in ln), and interaction terms with coal share with a post-2018 dummy, with aggregate Australian coal exports and with the total capacity in MW of power plants in non-nickel districts. Moreover, we also include year fixed effects and district fixed effects. Standard errors are clustered at the district level and shown in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

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