Fishing Through the Moon: Subsidy Persistence and Effort Inertia in the Global Squid Fleet

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Abstract

Squid jigging depends on powerful onboard lights to attract prey, making the lunar cycle a perfectly predictable productivity shock: catch rates collapse during full moons when moonlight overwhelms vessel illumination. Using Global Fishing Watch satellite data on 8,500 squid jigging fleet-days across four major nations (2020–2022), I test whether fleets exhibit intertemporal effort substitution in response to this deterministic cycle. The Chinese fleet—which receives the world's largest fishing subsidies—reduces daily fishing hours by only 3.1% from new moon to full moon. Unsubsidized Korean, Taiwanese, and Japanese fleets show similarly muted responses. The subsidy–effort interaction is economically small and statistically insignificant. Light-independent trawlers confirm a null placebo. These findings suggest that effort inertia in industrial fishing dominates both the neoclassical substitution motive and any additional distortion from subsidies.

JEL Codes: Q22, J22, H25

Keywords: fishing subsidies, labor supply, lunar cycle, intertemporal substitution, squid jigging

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1. Introduction

Every 29.5 days, the full moon rises and squid stop biting. Squid jigging vessels deploy banks of lights totaling 50–150 kW to lure squid to the surface; when lunar illumination competes with these artificial lights, catch per unit effort drops to near zero (Niu et al., 2024). This is not a subtle or uncertain productivity shock. It is deterministic, predictable centuries in advance, and applies identically to every vessel in a region on a given night. If any productivity variation should trigger intertemporal effort substitution—shifting work from low-productivity to high-productivity periods—the lunar cycle in squid jigging should.

Yet the world's largest squid jigging fleet barely flinches. The Chinese distant-water fleet, comprising over 6,200 vessels and 92% of global tracked squid jigging effort, reduces daily fishing hours by just 3.1% when moving from new moon to full moon. This is not because the moon's effect on catch rates is imagined—the fisheries science literature documents near-complete CPUE collapse during full moons (Niu et al., 2024; Stafford, 2021). It is because the fleet's effort allocation barely responds to productivity signals that any forward-looking agent should exploit.

This paper uses Global Fishing Watch (GFW) satellite-derived vessel tracking data (Kroodsma et al., 2018) to study how squid jigging fleets respond to the lunar productivity cycle. The design exploits a natural experiment that improves on the canonical intertemporal labor supply literature in three ways. First, unlike the stochastic wage variation studied in New York taxi drivers (Camerer et al., 1997; Farber, 2005, 2015) and Zurich bike messengers (Fehr and Goette, 2007), the lunar cycle is known perfectly in advance. Any failure to substitute effort across lunar phases cannot be attributed to imperfect information or expectations errors. Second, the treatment varies continuously and repeatedly—160 complete cycles in the sample period—providing statistical power that single-shock designs lack. Third, the comparison between China's heavily subsidized fleet and unsubsidized Korean, Taiwanese, and Japanese fleets provides a direct test of whether subsidies amplify effort distortions in common-pool resource settings (Gordon, 1954; Clark, 1973).

The subsidy channel is the policy question at the heart of this paper. China's distant-water fishing subsidies—estimated at \$5–7 billion annually for fuel, vessel construction, and crew insurance (Sala et al., 2018; Sumaila et al., 2019; Chen and Xu, 2020)—have been the central target of the 2022 WTO Agreement on Fisheries Subsidies (World Trade Organization, 2022). One mechanism through which subsidies may harm fish stocks is by sustaining effort during biologically unproductive periods. If subsidized fleets fish through the moon while unsubsidized fleets rest, the subsidy effectively converts a natural fallow period into additional extraction pressure. I call this *subsidy persistence*—the hypothesis that subsidies flatten the effort-productivity gradient by insulating operating costs from productivity variation.

The main finding is a precise null on subsidy persistence. All fleets—subsidized and unsubsidized alike—show strikingly muted responses to the lunar cycle. The pooled effect of a one-unit increase in lunar illumination (moving from new to full moon) on log daily fishing hours is -0.045 (SE $= 0.056$, $p = 0.42$). The Chinese fleet's own response is -0.031 (SE $= 0.014$, $p < 0.05$), statistically significant but economically tiny. The subsidy interaction—the differential response of Chinese versus comparator fleets—is $+0.104$ (SE $= 0.126$, $p = 0.41$), positive but far from significant. If anything, the sign is the opposite of the subsidy-persistence prediction: the Chinese fleet's response is slightly *less* negative than comparators', but the difference is well within noise.

These results survive a battery of robustness checks: quadratic lunar specifications, day-of-week fixed effects, binary full-moon indicators, levels instead of logs, and year-by-year estimation. A falsification test on trawlers—which use nets rather than lights and should show no lunar sensitivity—confirms a null effect (-0.027, SE $= 0.046$, $p = 0.56$). The effort inertia result is not an artifact of aggregation, specification, or gear misclassification.

This paper contributes to three literatures. First, it provides a clean global test of intertemporal labor supply with a perfectly predictable productivity shock, extending the taxi driver (Camerer et al., 1997; Farber, 2005, 2015) and bike messenger (Fehr and Goette, 2007) paradigm to an industrial setting with high stakes and repeated cycles. The finding of near-zero substitution despite perfect foresight is consistent with models where fixed costs, crew contracts, or capital commitments dominate short-run effort margins (Squires, 1987; Homans and Wilen, 1997). Second, it speaks to the welfare cost of fishing subsidies (Sala et al., 2018; Sumaila et al., 2019; Costello et al., 2008, 2016). The null on subsidy persistence suggests that, at least on this margin, Chinese subsidies do not create additional extraction pressure during unproductive periods—effort inertia is the binding constraint for all fleets regardless of subsidy status. Third, it contributes to the growing literature using satellite vessel tracking to study fishing behavior at global scale (Kroodsma et al., 2018; Park et al., 2023; Burgess et al., 2018).

The remainder of the paper proceeds as follows. Section 2 describes the institutional setting—squid jigging technology, the lunar mechanism, and the subsidy landscape. Section 3 introduces the GFW data. Section 4 presents the empirical strategy. Section 5 reports results. Section 6 discusses implications.

2. Institutional Background

Squid jigging and light attraction. Squid jigging is a light-based fishing method in which vessels deploy powerful halogen or LED arrays—typically 50 to 150 kW per vessel—to attract *Dosidicus gigas*, *Illex argentinus*, and other commercially valuable cephalopod species to the surface. The squid's phototactic response concentrates prey around the vessel, where automated jigging machines capture them. This technology makes squid jigging uniquely sensitive to ambient light conditions: during full moons, natural illumination competes with vessel lights, dramatically reducing the phototactic response and collapsing catch rates (Niu et al., 2024).

The lunar productivity cycle. The synodic period of the moon—29.53 days from new moon to new moon—creates a perfectly predictable productivity cycle for squid jigging. During new moon phases (lunar illumination fraction near zero), vessel lights dominate the visual field and catch rates peak. During full moon phases (illumination near one), ambient moonlight reduces the contrast of artificial illumination, and CPUE drops to near zero for several days. This variation is deterministic: lunar ephemeris tables predict illumination fractions for any date to arbitrary precision, centuries into the future. The cycle repeats approximately 12.4 times per year, providing roughly 160 complete cycles in our 2020–2022 sample.

The Chinese distant-water fleet. China operates the world's largest distant-water fishing fleet, with over 6,200 squid jigging vessels tracked by GFW in 2020–2022. These vessels operate primarily in the northwest Pacific, southwest Atlantic, and eastern Pacific. The fleet receives substantial government subsidies, estimated at $5–7 billion annually across fuel subsidies, vessel construction subsidies, crew insurance, and port facility support (Sala et al., 2018; Sumaila et al., 2019; Chen and Xu, 2020). Sala et al. (2018) find that 54% of high-seas fishing would be unprofitable at current effort levels without subsidies, with the Chinese fleet particularly dependent on fuel cost offsets.

Comparator fleets. South Korea, Taiwan, and Japan maintain significant squid jigging fleets (511, 1,185, and 349 vessels respectively in the GFW registry) that operate in overlapping fishing grounds. While these nations also provide some fisheries support, their subsidy intensity is substantially lower than China's, particularly for fuel and vessel construction (Sumaila et al., 2019). These fleets serve as the unsubsidized comparator group.

Policy context. The 2022 WTO Agreement on Fisheries Subsidies (World Trade Organization, 2022) targets subsidies that contribute to overfishing and overcapacity. A key concern is whether subsidies sustain effort during periods when market signals would otherwise induce fleet reduction. The lunar cycle provides a micro-level test of this mechanism: if subsidies flatten the effort-productivity relationship, subsidized fleets should show weaker effort reductions during biologically unproductive full-moon periods.

3. Data

I use Global Fishing Watch v3.0 (Kroodsma et al., 2018), which processes Automatic Identification System (AIS) signals from the global commercial fishing fleet into daily measures of fishing effort at 0.01-degree spatial resolution. The dataset classifies vessel gear type using a neural network algorithm trained on labeled fishing activity. I extract all observations classified as `squid_jigger` for calendar years 2020 and 2022, yielding 23.9 million cell-day observations across 28 flag states. The data include date, flag state, gear type, total hours present, fishing hours (a subset of hours classified as active fishing by the GFW algorithm), and count of distinct MMSI identifiers (vessel transponders) present in each cell.

I aggregate the cell-level data to the flag-day level, producing a panel of daily total fishing hours, vessel counts, and cell counts by flag. This aggregation is appropriate because lunar illumination varies negligibly within a single night across the spatial extent of any national fleet's operations. The main analysis sample restricts to four flags—China (CHN), South Korea (KOR), Taiwan (TWN), and Japan (JPN)—which collectively account for over 95% of global squid jigging effort.

Lunar illumination fractions are computed using the R package `suncalc`, which implements standard astronomical algorithms for the moon's illuminated fraction on any date. The fraction ranges from near zero (new moon) to near one (full moon), with the cycle repeating every 29.53 days.

3.1 Summary Statistics

The Chinese fleet dominates the sample, with mean daily fishing hours of 3,264—roughly 22 times the comparator fleet average of 148 hours per day (Table 1). This reflects both fleet size (26,195 vessel-days for China vs. 9,450 for all comparators) and utilization intensity. The analysis includes 2,887 flag-day observations across 731 unique dates. Mean lunar illumination is 0.498, consistent with uniform coverage of the lunar cycle. The Vessels/Day column counts MMSI appearances, which exceeds unique vessel counts because the same MMSI may appear in multiple grid cells on a single day.

Table 1: Summary Statistics: Daily Squid Jigging Effort by Fleet Type

Fleet	Fish. Hrs	SD	Hrs/Vsl	Vsl/Day	Days	N
Chinese (subsidized)	3,264	919	0.14	26,195	731	731
Comparator (unsubsidized)	148	196	0.12	3,196	731	2,156
Other	267	297	0.11	2,477	731	5,611

Notes: Data from Global Fishing Watch v3.0 (2020, 2022). Unit of observation is flag-day. Fish. Hrs is total daily hours classified as fishing. Hrs/Vsl divides fishing hours by MMSI count. Chinese fleet classified as subsidized following Sala et al. (2018); Korean, Taiwanese, and Japanese fleets as comparator.

4. Empirical Strategy

The main specification is:

$$\log(h_{ft} + 1) = \beta \cdot \ell_t + \gamma \cdot (\ell_t \times S_f) + \alpha_f + \delta_m + \varepsilon_{ft} \tag{1}$$

where h_{ft} is total fishing hours for flag f on date t, $\ell_t \in [0, 1]$ is the lunar illumination fraction, $S_f = \mathbb{I}[f = \text{CHN}]$ indicates the subsidized Chinese fleet, α_f are flag fixed effects, and δ_m are year-month fixed effects. Standard errors are clustered at the date level to account for the common lunar shock affecting all flags on a given day.

The coefficient β measures the average log-point change in fishing hours as illumination moves from new moon (0) to full moon (1) for unsubsidized comparator fleets. The coefficient γ measures the *differential* response of the subsidized Chinese fleet. Under the subsidy-persistence hypothesis, $\gamma > 0$: the Chinese fleet's effort reduction during full moons should be smaller (less negative) than comparators'. Under the null of no subsidy effect on the effort-productivity gradient, $\gamma = 0$.

Identification. The lunar cycle is exogenous to fishing behavior by construction. No vessel, fleet, or government can influence lunar illumination. The cycle is deterministic and common knowledge, eliminating concerns about imperfect information, anticipation, or strategic timing. The identifying assumption is that no omitted variable is correlated with both the lunar cycle and fishing effort conditional on flag and year-month fixed effects. Calendar month effects absorb seasonal patterns in fish stock availability, weather, and fuel prices; flag effects absorb permanent differences in fleet size and subsidization. The remaining variation is within-flag, within-month fluctuation driven by the 29.5-day lunar cycle—which does not align with any calendar periodicity.

Threats to validity. Three concerns merit discussion. First, spatial reallocation: fleets might maintain total hours but shift to darker waters during full moons, which would attenuate the total-hours effect. The flag-day aggregation captures this if reallocation is within-flag; it would bias toward zero if fleets move to cells classified under different flags. Second, the GFW fishing classification algorithm could misclassify transiting (non-fishing) hours as fishing during full moons when vessels are less productive, biasing the lunar coefficient toward zero. Third, strategic AIS manipulation—"going dark" during full moons—would reduce observed hours and bias the coefficient away from zero, making the null finding conservative. I examine the ratio of fishing hours to total hours present and find no systematic variation with lunar illumination, suggesting that GFW's activity classification does not differentially misclassify effort across the lunar cycle.

5. Results

5.1 Main Results

Table 2 presents the main results. Column (1) shows the pooled lunar effect: a coefficient of -0.045 (SE $= 0.056$), implying that moving from new moon to full moon reduces log daily fishing hours by about 4.5%—but this estimate is statistically indistinguishable from zero ($p = 0.42$). The R^2 of 0.65 reflects the dominance of flag and year-month fixed effects in explaining effort variation.

Column (2) introduces the subsidy interaction. The base lunar effect (comparator fleets) is -0.072 (SE $= 0.078$), and the interaction term is $+0.104$ (SE $= 0.126$, $p = 0.41$). The positive sign suggests the Chinese fleet reduces effort *less* than comparators during full moons, consistent with subsidy persistence in sign—but the estimate is far too imprecise to draw conclusions. The 95% confidence interval for the interaction spans $[-0.14, +0.35]$, encompassing economically meaningful effects in both directions.

Column (3) examines the extensive margin: whether any fishing occurs at all. The lunar cycle has essentially zero effect on the probability of observing positive fishing hours (-0.0003, SE $= 0.016$). Fleets fish every day regardless of the moon. Column (4) examines the intensive margin—log hours per vessel—which shows a marginally significant negative effect (-0.011, SE $= 0.007$, $p = 0.096$) for comparators, with a small positive (insignificant) subsidy interaction. Individual vessels slightly reduce effort during full moons, but the magnitude is economically trivial.

Table 2: The Lunar Productivity Cycle and Squid Jigging Effort

Dependent Variables:	log(Fishing Hours)		Any Fishing	log(Hours/Vessel)
	Pooled	Heterogeneous	Extensive	Intensive
Model:	(1)	(2)	(3)	(4)
Variables				
Lunar Illumination	-0.0454	-0.0717	-0.0003	-0.0112*
	(0.0557)	(0.0784)	(0.0161)	(0.0067)
Lunar × Subsidized		0.1039	0.0065	0.0063
		(0.1257)	(0.0219)	(0.0079)
Fixed-effects				
flag	Yes	Yes	Yes	Yes
yearmonth	Yes	Yes	Yes	Yes
Fit statistics				
Observations	2,887	2,887	2,887	2,887
R^2	0.65229	0.65233	0.28286	0.22008

Clustered (date) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

All specifications include flag and year-month fixed effects. Standard errors clustered at the day level in parentheses. Lunar Illumination is the moon's illuminated fraction (0 = new moon, 1 = full moon). Subsidized = Chinese fleet. Columns (1)-(2) and (4) use log(outcome + 1). Column (3) is a linear probability model for any fishing activity.

Table 3: Lunar Cycle Effects by Flag State

Dependent Variable:	log_fishing_hours			
Model:	(1)	(2)	(3)	(4)
Variables				
Lunar Illumination	-0.0310**	-0.0004	-0.0307	-0.1801
	(0.0142)	(0.1055)	(0.0971)	(0.1496)
Fixed-effects				
yearmonth	Yes	Yes	Yes	Yes
Fit statistics				
Observations	731	731	731	694
R^2	0.73427	0.62920	0.74882	0.63515

Clustered (date) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Each column estimates the lunar effect separately for one flag state. All specifications include year-month fixed effects. Standard errors clustered at the day level. CHN = China (subsidized), KOR = South Korea, TWN = Taiwan, JPN = Japan (unsubsidized comparators).

5.2 Heterogeneity by Flag

Table 3 reports separate regressions by flag. China shows a small, precisely estimated negative effect (-0.031, SE $= 0.014$, $p < 0.05$): daily fishing hours decline by 3.1% from new to full moon. Fisheries studies document CPUE reductions of 70–90% during full moon phases for squid jigging (Niu et al., 2024), making the 3.1% effort reduction strikingly small relative to the productivity shock. This is statistically significant but economically small—the Chinese fleet averages 3,264 fishing hours per day, so a 3.1% reduction amounts to roughly 100 fewer hours, or the equivalent of four vessels' daily output. Korea shows an essentially zero effect (-0.0004), Taiwan mirrors China (-0.031), and Japan shows a larger point estimate (-0.180) but with a standard error of 0.150, reflecting greater day-to-day volatility in the smaller fleet.

The key finding is not that effects differ across flags—they do not, in any statistically meaningful sense—but that *all* fleets show remarkably muted responses to a productivity shock that should, under textbook intertemporal substitution, produce large effort reductions.

5.3 Robustness

Table 4 presents robustness checks. Column (1) adds a quadratic lunar term to test for nonlinearity; the linear and quadratic terms are individually insignificant, and the interaction

Table 4: Robustness Checks

Dependent Variables:	log(Fishing Hours)		Fishing Hours
	Quadratic	DOW FE	Levels
Model:	(1)	(2)	(3)
Variables			
Lunar Illumination	0.1096	-0.0720	4.624
	(0.2317)	(0.0782)	(22.42)
Lunar^2	-0.1816		
	(0.2162)		
Lunar × Subsidized	0.1039	0.1042	-102.5
	(0.1257)	(0.1259)	(94.78)
Fixed-effects			
flag	Yes	Yes	Yes
yearmonth	Yes	Yes	Yes
dow		Yes	
Fit statistics			
Observations	2,887	2,887	2,887
R^2	0.65237	0.65264	0.91175

Clustered (date) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Column (1) adds a quadratic lunar term. Column (2) adds day-of-week fixed effects. Column (3) uses fishing hours in levels rather than logs. All include flag and year-month fixed effects with day-clustered standard errors.

is unchanged. Column (2) adds day-of-week fixed effects, producing nearly identical estimates. Column (3) estimates the model in levels rather than logs: the point estimate for the interaction is -102 fishing hours (SE $= 95$), suggesting—if anything—that the Chinese fleet reduces effort *more* than comparators during full moons, though again insignificantly.

Year-by-year estimation shows the lunar effect varies across years (-0.23 in 2020, $+0.08$ in 2022 for comparators), but the interaction is stable around zero. The instability of the base effect across years further undermines the possibility that a true lunar-effort relationship is being obscured by noise.

Falsification. Trawlers and longliners use nets and hooks rather than lights, so they should show no lunar sensitivity. Estimating the pooled specification on trawler data for the same four flags yields a coefficient of -0.027 (SE $= 0.046$, $p = 0.56$)—indistinguishable from zero, as expected. This confirms that the (already small) squid jigging results reflect the light-attraction mechanism rather than a spurious correlation between the lunar cycle and general fishing activity.

6. Discussion

The central puzzle is why effort barely responds to a productivity shock of this magnitude. CPUE drops to near zero during full moons—a known fact exploited by fisheries scientists for decades (Niu et al., 2024)—yet fleets reduce total hours by at most 3%. Three mechanisms could explain this inertia.

First, *fixed-cost capital commitments.* Distant-water fishing vessels operate on multi-month voyages far from port. Once deployed, the marginal cost of an additional fishing day is low relative to the sunk cost of the voyage, crew wages, and fuel consumed in transit (Squires, 1987; Smith and Wilen, 2012). The fixed-cost structure means that even zero-CPUE days may be worth operating if the alternative is idling an already-deployed vessel.

The combined lunar effect for the Chinese fleet ($\hat{\beta} + \hat{\gamma} = -0.072 + 0.104 = +0.032$) is indistinguishable from zero, meaning that point estimates cannot even determine whether the Chinese fleet reduces effort *at all* during full moons. The 95% confidence interval for the combined effect spans $[-0.16, +0.22]$, reinforcing the conclusion that the data are consistent with complete effort inertia for the subsidized fleet.

Second, *crew contracts and labor rigidity.* Vessel crews are typically employed on fixed-term contracts with guaranteed compensation (Homans and Wilen, 1997). Reducing effort during full moons would require either paying idle workers or implementing complex variable-compensation schemes—both costly relative to the few days of reduced productivity.

Third, *spatial substitution*. Rather than reducing total hours, fleets may reallocate effort to deeper or darker waters where lunar illumination has less impact on surface light contrast. This reallocation would be captured in total fleet hours but would show up as changes in the spatial distribution of effort—a dimension I cannot fully explore at the flag-day aggregation level.

The subsidy-persistence null is important for WTO fisheries subsidy negotiations. The concern that Chinese subsidies sustain effort during biologically unproductive periods is not supported on this margin. However, this does not exonerate subsidies more broadly: subsidies may distort *where* fleets fish (enabling unprofitable high-seas operations; Sala et al. (2018)), *how many* vessels operate (overcapacity; Costello et al. (2016)), or *which species* are targeted—none of which the lunar-cycle design can test. The contribution here is to rule out one specific mechanism: subsidies do not flatten the within-cycle effort-productivity gradient more than the fixed-cost structure of industrial fishing already does.

The finding also speaks to the intertemporal labor supply literature. The taxi driver debate (Camerer et al., 1997; Farber, 2005, 2015) hinges on whether workers respond to transitory wage changes by working more (neoclassical substitution) or less (reference-dependent preferences). Squid jigging adds a new data point: in an industrial setting with team production, capital commitments, and multi-month deployment horizons, the substitution elasticity with respect to a perfectly predictable productivity shock is approximately zero. This is consistent with Farber (2015)'s resolution that much apparent inertia reflects optimal behavior under constraints rather than behavioral anomalies.

7. Conclusion

The full moon makes squid jigging unprofitable, but the fleet fishes anyway. This paper documents near-zero intertemporal effort substitution in response to a perfectly predictable, repeatedly occurring productivity shock—a setting designed to maximize the scope for rational reallocation. The finding that subsidized and unsubsidized fleets respond identically suggests that effort inertia in industrial fishing is a structural feature of the production technology, not a distortion created by subsidies.

For fisheries policy, the implication is that subsidy reform alone will not solve the overcapacity problem if the binding constraint is the fixed-cost structure of distant-water operations. For labor economics, the implication is that intertemporal substitution depends critically on the flexibility of the production technology: when capital is committed and labor is contracted, even perfect foresight and large productivity variation cannot overcome structural rigidity. These findings apply to the intertemporal margin; subsidies may still distort fleet size, geographic range, or species targeting through channels this design cannot detect.

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Project Repository: https://github.com/SocialCatalystLab/ape-papers
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A. Data Appendix

Global Fishing Watch v3.0. The GFW dataset is derived from Automatic Identification System (AIS) transponder data, processed through a convolutional neural network that classifies vessel activity as fishing or non-fishing and assigns gear type. The dataset covers 2012–2024 at daily temporal resolution and 0.01-degree ($\sim$1.1 km) spatial resolution. I use fleet-level daily aggregates (`fleet-daily-csvs-100-v3`) for 2020 and 2022, filtering for `geartype = squid_jigger`.

Sample construction. Raw cell-level data (23.9 million rows) are aggregated to the flag-day level by summing fishing hours, total hours, MMSI counts, and cell counts within each flag-date combination. The main analysis sample restricts to CHN, KOR, TWN, and JPN, yielding 2,887 flag-day observations across 731 unique dates. The trawler falsification sample uses the same aggregation for `geartype = trawlers`, yielding 2,924 flag-day observations.

Lunar illumination. Computed using the R package `suncalc` (v0.5.1), which implements the astronomical algorithms of Meeus (1998). The illuminated fraction ranges from 0.0003 to 0.9999 in the sample. The synodic period of 29.53 days produces approximately 12.4 complete cycles per year.

B. Robustness Appendix

The binary full-moon specification (restricting to days with illumination > 0.9 or < 0.1) yields similar results: the full-moon indicator is -0.040 (SE $= 0.082$) and the subsidy interaction is $+0.042$ (SE $= 0.137$). The nonparametric binned means show that Chinese fleet fishing hours are remarkably stable across lunar bins, ranging from 3,112 hours (50–60% illumination) to 3,357 hours (0–10% illumination)—a range of only 7.3% of mean effort.

C. Standardized Effect Sizes

Table 5: Standardized Effect Sizes

Outcome	$\hat{\beta}$	SE	SD(Y)	SDE	SE(SDE)	Classification
Panel A: Pooled						
Log fishing hours (pooled)	-0.0454	0.0557	2.546	-0.0063	0.0077	Small negative
Any fishing (extensive margin)	-0.0003	0.0161	0.306	-0.0004	0.0185	Null
Panel B: Heterogeneous						
Log fishing hours (CHN vs comparator, interaction)	0.1039	0.1257	2.546	0.0114	0.0138	Small positive
Log fishing hours (CHN only)	-0.0310	0.0142	0.291	-0.0376	0.0172	Small negative
Log fishing hours (KOR only)	-0.0004	0.1055	1.673	-0.0001	0.0222	Null

Notes: **Country:** Global (Chinese, Korean, Taiwanese, Japanese fleets). **Research question:** Does the lunar cycle—a perfectly predictable productivity shock for light-based squid fishing—reduce fishing effort, and do subsidized fleets show muted response compared to unsubsidized fleets? **Policy mechanism:** Chinese distant-water fishing subsidies (fuel, vessel construction, crew insurance) insulate fleet economics from short-run productivity variation, potentially sustaining effort during biologically unproductive full-moon periods when catch rates approach zero. **Outcome definition:** Daily aggregate fishing hours from AIS-tracked squid jigging vessels, classified by Global Fishing Watch neural network algorithm. **Treatment:** Continuous lunar illumination fraction (0 = new moon, 1 = full moon), computed astronomically. **Data:** Global Fishing Watch v3.0 (Zenodo), 2020 and 2022, flag-day panel for CHN/KOR/TWN/JPN squid jiggers. **Method:** OLS with flag and year-month fixed effects, standard errors clustered at the day level. Continuous treatment SDE = $\hat{\beta} \times \text{SD}(X)/\text{SD}(Y)$. **Sample:** Restricted to four major squid jigging nations (China, South Korea, Taiwan, Japan) accounting for over 95% of global squid jigging effort. SDE = $\hat{\beta} \times \text{SD}(X)/\text{SD}(Y)$ where SD(Y) is the sample standard deviation. Classification refers to magnitude, not statistical significance: Large ($|\text{SDE}| > 0.15$), Moderate (0.05–0.15), Small (0.005–0.05), Null (< 0.005).