Title: AJAE Appendix for Measuring Benefits from a Marketing Cooperative in the Copper River Fishery

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Institutional Detail

In what follows, we provide a description the CRFC's financial structure and the CRFC's production process based on interviews with key CRFC members in 2009 and 2012. Specifically, we draw from interviews with the former CRFC president, general manager, treasurer, plant manager, director, and board members.

Typically agricultural marketing cooperatives set up a pooling system in order to distribute cooperative profits to members. This is the mechanism through which cooperatives fulfill the goal of maximizing net benefits to members. The CRFC adopted a pooling system and tailored it to the salmon industry. According to interviews, the CRFC's pooling system operated as follows: upon delivery, members were paid an advance, which was set at 75% of the expected value of harvest. Members were not paid according to product quality, likely because implementing a quality-differentiated payment scheme would be costly in the fast-paced salmon fishing industry. At the end of the fiscal year (exact date unknown), members received an additional payment equal to the balance owed for the value of their catch plus a share of cooperative profits less capital investments.

The CRFC changed its capital investment requirements several times in the early years of its formation. However, by 1983, the cooperative had settled on a policy requiring that members invest 20% of their patronage dividend into a capital account until the account reached $10,000 (1983 USD). Upon leaving the CRFC, members' capital accounts would divest over a five-year period, beginning one year after they left.

The CRFC made several investments in marketing, including investments in advertising and building relationships with both domestic and Japanese salmon buyers. Members volunteered their time to brand and market Copper River salmon into high-quality, high-value markets. For example, a former CRFC director, volunteered to design the CRFC's logo. According to the interviewee, she visited the Cornish Art School and persuaded a professor there to make the logo design a class project. The logo is still used today. Additionally, CRFC members visited Seattle restaurants to directly market their salmon.

Working with their Japanese buyers, the CRFC developed quality standards and a sorting process that separated fish by quality category. Quality standards were set at each stage in the supply chain. At the first stage of production, the CRFC required fishermen to bleed their fish, package fish in bags with ice that held up to 200 pounds, and deliver their fish within six hours of harvest. At the second stage of production, fish were dressed and packed with ice for sale into fresh markets or quickly frozen and glazed for sale into frozen markets. Each of these practices represented a departure from traditional production procedures in the CR fishery and led to improved product quality.

The CRFC was successful in creating markets for high-quality salmon and in generating a price premium for fishermen. As a result, the CRFC quickly attracted members and within four years roughly 33% of sockeye salmon harvested in the CR fishery was sold through the cooperative. However, the benefits generated by the CRFC were not restricted to its members. The following quote from an interview with a fisherman who served as the CRFC president and then as the general manager, describes how the CRFC had a pro-competitive effect by introducing price competition into the CR fishery:

> Local fisherman received better prices than they would have had the CRFC not existed. This fact was not lost on most of them. There were residual resentments against the co-op, but there was a general acceptance that the co-op had created a more competitive environment that resulted in better prices.

Additionally, interviews with fishermen suggest that nonmember fishermen benefited from the markets for high-quality salmon created by the cooperative. This point is made in the following passage from a transcribed 2012 interview with the former CRFC president and treasurer:

> He reflected that the co-op "was a victim of its own success." It was created to solve a market problem, which it did by producing high-quality fresh and frozen Copper River salmon for the high-end Japanese market. Once the market was created, other processors began competing both for market share and for fishermen. … He added, "Fishermen joked that the co-op is good for fishermen, but I don't have to join to receive benefits."

Wu-Hausman Tests

In this section, the Wu-Hausman tests that we conducted as part of our analysis are described in detail. Our general econometric model is as follows:

(B.1) $$y = x_1\beta_1 + \mathbf{X}_2\beta_2 + \epsilon \ ,$$

where y is an outcome variable of interest, x_1 is a potentially endogenous explanatory variable, and X_2 are exogenous controls including our DiD dummy variables (T, A, and TA).

The use of instrumental variables Z_1 is desirable if x_1 is truly endogenous. We construct an endogeneity test following Wu (1973) and Hausman (1978) by first estimating the following equation with OLS to obtain the residuals $\hat{u}$:

(B.2) $$x_1 = Z_1\psi_1 + X_2\psi_2 + u$$

and then estimating the following equation, which includes $\hat{u}$:

(B.3) $$y = \hat{\mu}\sigma + x_1\beta_1 + \mathbf{X}_2\beta_2 + \epsilon$$

The null hypothesis of the test is that x_1 is exogenous (i.e., $\sigma = 0$).

We identify several instrumental variables that exogenously impact the supply of salmon, and therefore can be used to test for the endogeneity of quantity in the ex-vessel price regressions. First, we use four-year and six-year lags of harvest for sockeye and Chinook, respectively. These variables were chosen because sockeye salmon return to the fishery four years after spawning, meaning that escapement in time period *t* impacts recruitment in *t*+4. Chinook salmon return to the fishery 6 years after spawning. We also use the number of rain days and the minimum temperature because these variables affect river width and therefore salmon escapement rates and harvest. The instrumental variables are strong for both sockeye and Chinook, with first-stage F-statistics above 10.

In testing for the endogeneity of quantity in the deliveries regressions, we use the following instrumental variables that exogenously impact the supply of salmon: lagged sockeye harvest from the previous year in the same month and lagged total harvest of sockeye and Chinook from the previous year in the same month.

Test results are summarized in Table SM.1 The p-values correspond to the test of the null hypothesis that $\sigma = 0$. We fail to reject the null hypothesis of exogeneity of quantity in the sockeye deliveries model and adopt the sockeye delivery IV DiD estimate as our central specification.

Table SM.1. Wu-Hausman Test Results

Model dependent variable	P-value from Wu-Hausman test
Sockeye ex-vessel prices	0.236
Chinook ex-vessel prices	0.959
Sockeye deliveries	**0.005****
Sockeye deliveries per permit holder	0.216

Note: Significance codes: ** 1% level.

Full Regression Results

Table 3b. Full Price Analysis Regression Results

	Dependent variable					
	Sockeye price			Chinook price		
	(1)	(2)	(3)	(1)	(2)	(3)
CR fishery	–0.115	–0.126	–0.222	0.0714	0.0925	–1.091*
	(0.467)	(0.147)	(0.163)	(0.523)	(0.189)	(0.406)
After the CRFC	–0.911*	–0.827**	–0.646	–1.453**	0.0459	–0.944
	(0.377)	(0.222)	(0.325)	(0.349)	(0.823)	(0.726)
*CR fishery**	0.721	0.732**	0.640*	1.366*	1.345**	2.032**
After the CRFC	(0.564)	(0.186)	(0.272)	(0.571)	(0.290)	(0.394)
Quantity			–0.016*			0.710
			(0.006)			(0.386)
Lagged CV			–0.526			–3.718**
			(0.378)			(0.855)
Lagged variance			2.34e-14			2.5e-09
			(3.9e-14)			(1.2e-09)
1980 weak returns in CR			0.207			1.284**
			(0.204)			(0.346)
1987 oil spill in UCI			0.517*			0.937*
			(0.226)			(0.383)
Year = 1972		0.136	0.133		0.318	0.631
		(0.157)	(0.222)		(0.261)	(0.603)
Year = 1973		1.732**	1.662**		0.824*	1.145

	(0.238)	(0.320)	(0.380)	(0.640)
Year = 1974	1.991**	1.927**	1.691**	1.675*
	(0.462)	(0.386)	(0.408)	(0.758)
Year = 1975	0.602	0.552*	0.516	0.667
	(0.304)	(0.265)	(0.258)	(0.602)
Year = 1976	1.245**	1.225**	1.688**	2.520**
	(0.145)	(0.205)	(0.122)	(0.610)
Year = 1977	1.710**	1.848**	2.970**	3.153**
	(0.310)	(0.291)	(0.241)	(0.588)
Year = 1978	2.730**	2.904**	2.418**	2.401**
	(0.160)	(0.336)	(0.382)	(0.699)
Year = 1979	2.687**	2.749**	3.071**	3.238**
	(0.135)	(0.178)	(0.101)	(0.577)
Year = 1980	0.611**	0.633**	1.484**	0.948
	(0.141)	(0.188)	(0.325)	(0.592)
Year = 1981	1.986**	2.031**	1.138	1.629**
	(0.166)	(0.319)	(0.949)	(0.335)
Year = 1982	1.213*	1.388**	0.388	0.462
	(0.456)	(0.430)	(0.998)	(0.432)
Year = 1983	0.651**	0.964**	–0.460	–0.327
	(0.170)	(0.267)	(1.038)	(0.572)
Year = 1984	0.914*	1.064**	–0.157	0.467

	(0.353)	(0.316)	(0.947)	(0.342)
Year = 1985	1.638**	1.769**	0.254	0.942
	(0.174)	(0.261)	(0.844)	(0.505)
Year = 1986	1.897**	1.941**	–0.327	–0.163
	(0.163)	(0.299)	(0.820)	(0.409)
Year = 1987	2.138**	2.180**	0.394	–0.246
	(0.189)	(0.295)	(0.892)	(0.469)
Year = 1988	4.207**	4.300**	0.638	0.878*
	(0.452)	(0.380)	(0.829)	(0.399)
Year = 1989	2.408**	2.469**	0.454	0.690
	(0.307)	(0.315)	(0.835)	(0.423)
Year = 1990	1.937**	1.869**	0.234	0.338
	(0.267)	(0.351)	(0.832)	(0.441)
Year = 1991	0.625**	0.524	–0.386	0.0152
	(0.172)	(0.255)	(0.881)	(0.569)
Year = 1992	2.058**	2.379**	0.485	0.879
	(0.479)	(0.290)	(0.813)	(0.441)
Year = 1993	0.611**	0.548	–0.388	–0.0738
	(0.158)	(0.371)	(0.840)	(0.535)
Year = 1994	0.810	0.676	–0.906	–0.831
	(0.488)	(0.582)	(0.901)	(0.630)
Year = 1995	0.828**	0.726*	–0.385	–0.620

		(0.183)	(0.322)		(0.827)	(0.476)
Year = 1996		0.555*	0.660		–0.622	–0.977*
		(0.211)	(0.369)		(0.806)	(0.387)
Year = 1997		0.155	0.356		–0.642	–0.728
		(0.541)	(0.641)		(0.806)	(0.416)
Year = 1998		0.563**	0.429		–0.626	–0.684
		(0.171)	(0.277)		(0.807)	(0.409)
Year = 1999		0.867**	0.851*		0.272	0.252
		(0.173)	(0.311)		(1.288)	(0.678)
Year = 2000		0.417	0.298		0.626	0.743
		(0.329)	(0.486)		(1.514)	(1.148)
Constant	3.165**	1.821**	2.134**	3.521**	2.023**	3.441**
	(0.323)	(0.145)	(0.234)	(0.319)	(0.122)	(0.686)
Observations	61	61	61	61	61	61
R-squared	0.117	0.949	0.962	0.401	0.849	0.922

Note: Asterisk (*) and double asterisk (**) denote variables significant at 5% and 1% levels, respectively. Heteroskedasticity-robust standard errors are in parentheses.

Table 4b. Full Quality Analysis Regression Results

	Dependent variable					
	Target Species Deliveries			Target Species Deliveries per Permit Holder		
	(1)	(2)	(3)	(1)	(2)	(3)
CR fishery	47,064	41,875	46,828*	70.37	67.75	59.29
	(29,980)	(22,271)	(20,940)	(53.49)	(43.73)	(39.76)
After the CRFC	1,091**	496.2*	49.05	1.566**	0.642	0.231
	(290.7)	(207.7)	(480.0)	(0.504)	(0.390)	(0.603)
*CR fishery **	670.9	840.3**	994.9*	0.143	1.103*	1.178*
After the CRFC	(351.3)	(231.2)	(386.9)	(0.628)	(0.481)	(0.564)
Rain days		-52.05	-47.92		0.0171	-0.00869
		(44.09)	(40.33)		(0.103)	(0.0925)
Minimum temperature		3.280	2.784		0.00755	0.00748
		(2.740)	(3.292)		(0.00519)	(0.00525)
Quantity		222.1**	444.4**		0.343**	0.536**
		(36.34)	(144.7)		(0.0594)	(0.175)
Year	–22.90	–20.99	–23.60*	–0.0328	–0.0334	–0.0293
	(15.17)	(11.30)	(10.69)	(0.0271)	(0.0222)	(0.0202)
Fishing month = 2	–42,440	–38,016	–43,848*	–60.33	–59.67	–51.92
	(30,057)	(22,303)	(20,815)	(53.60)	(43.81)	(39.63)
Fishing month = 3	–91,168	–79,306	–87,923*	–130.0	–124.0	–105.8

	(59,971)	(44,540)	(42,051)	(107.0)	(87.45)	(79.77)
Fishing month = 4	–138,294	–121,135	–134,781*	–198.1	–190.3	–163.4
	(89,993)	(66,835)	(62,957)	(160.5)	(131.2)	(119.5)
Fishing month = 5	–185,619	–163,146	–181,928*	–268.3	–258.8	–223.5
	(119,984)	(89,101)	(83,773)	(214.0)	(175.0)	(159.2)
June	45,179	40,392	46,126*	65.43	64.05	56.18
	(30,035)	(22,276)	(20,788)	(53.60)	(43.73)	(39.60)
July	93,005	80,948	89,789*	134.8	128.2	110.2
	(59,993)	(44,561)	(42,000)	(107.1)	(87.51)	(79.82)
August	136,925	120,170	134,486*	196.6	189.0	162.8
	(89,997)	(66,809)	(62,817)	(160.5)	(131.2)	(119.4)
September	182,812	161,124	180,533*	263.6	254.9	220.3
	(119,976)	(89,071)	(83,701)	(214.0)	(174.9)	(159.1)
1980 weak returns in CR		–1,261	–1,089		2.297	2.209
		(734.0)	(578.1)		(1.729)	(1.715)
1987 oil spill in UCI		–263.7	–821.7		0.149	–0.531
		(376.4)	(1,029)		(0.674)	(1.264)
1989 oil spill in CR & UCI		–1,068*	–1,034*		–2.028*	–1.941*
		(507.4)	(418.6)		(1.008)	(0.921)
Observations	220	220	212	220	220	212
First-stage F-statistic			17.30			17.30
Hansen's J P-val.			0.556			0.603

R-squared	0.906	0.950		0.928	0.954

Note: Asterisk (*) and double asterisk (**) denote variables significant at 5% and 1% levels, respectively. Heteroskedasticity-robust standard errors are in parenthesis.