The Effects of Quinoa's Price Change in the Welfare of Bolivian Households

Ximena Paz, Carlos E. Carpio, Jaime Malaga, and Chenggang Wang

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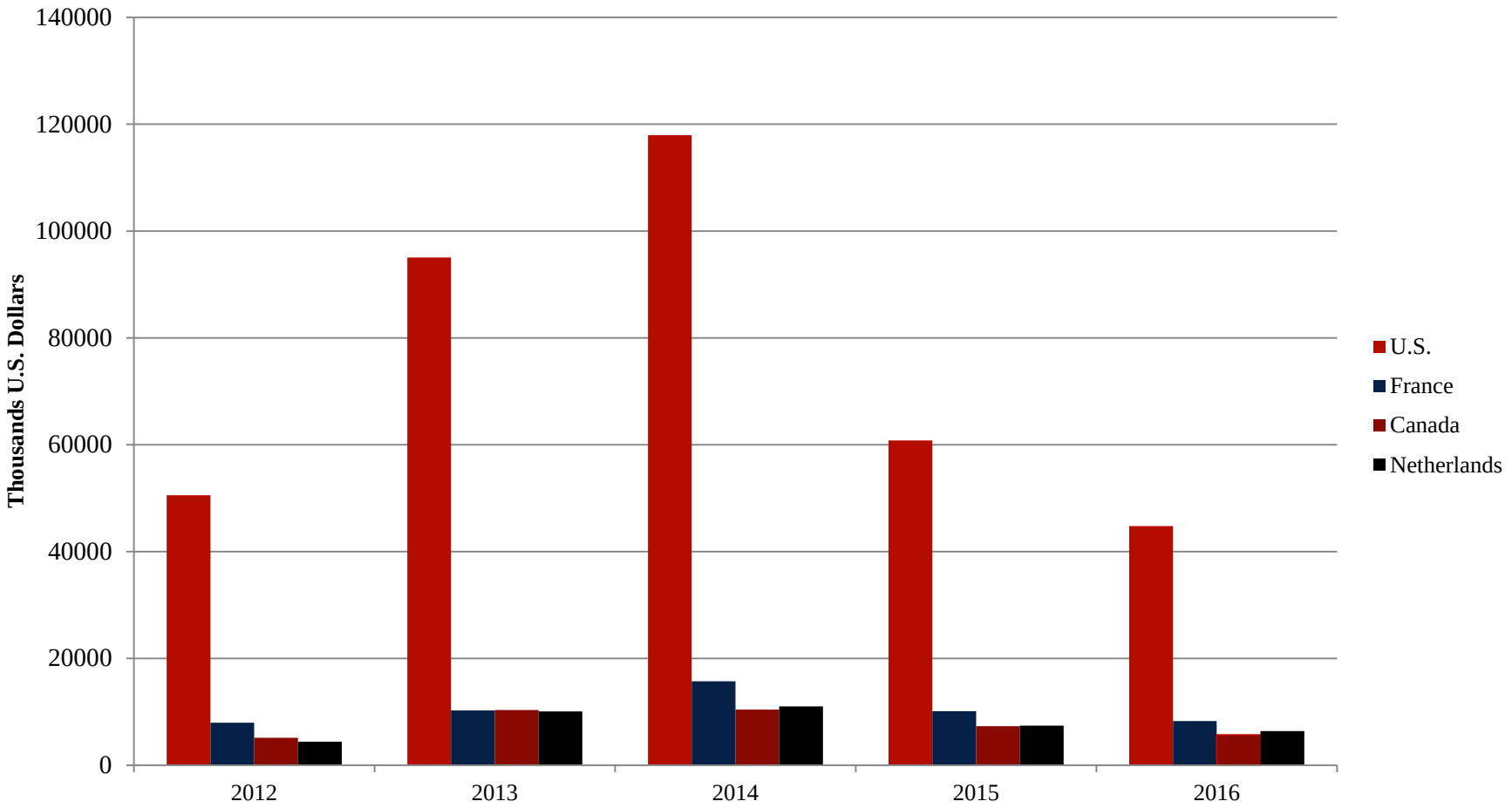
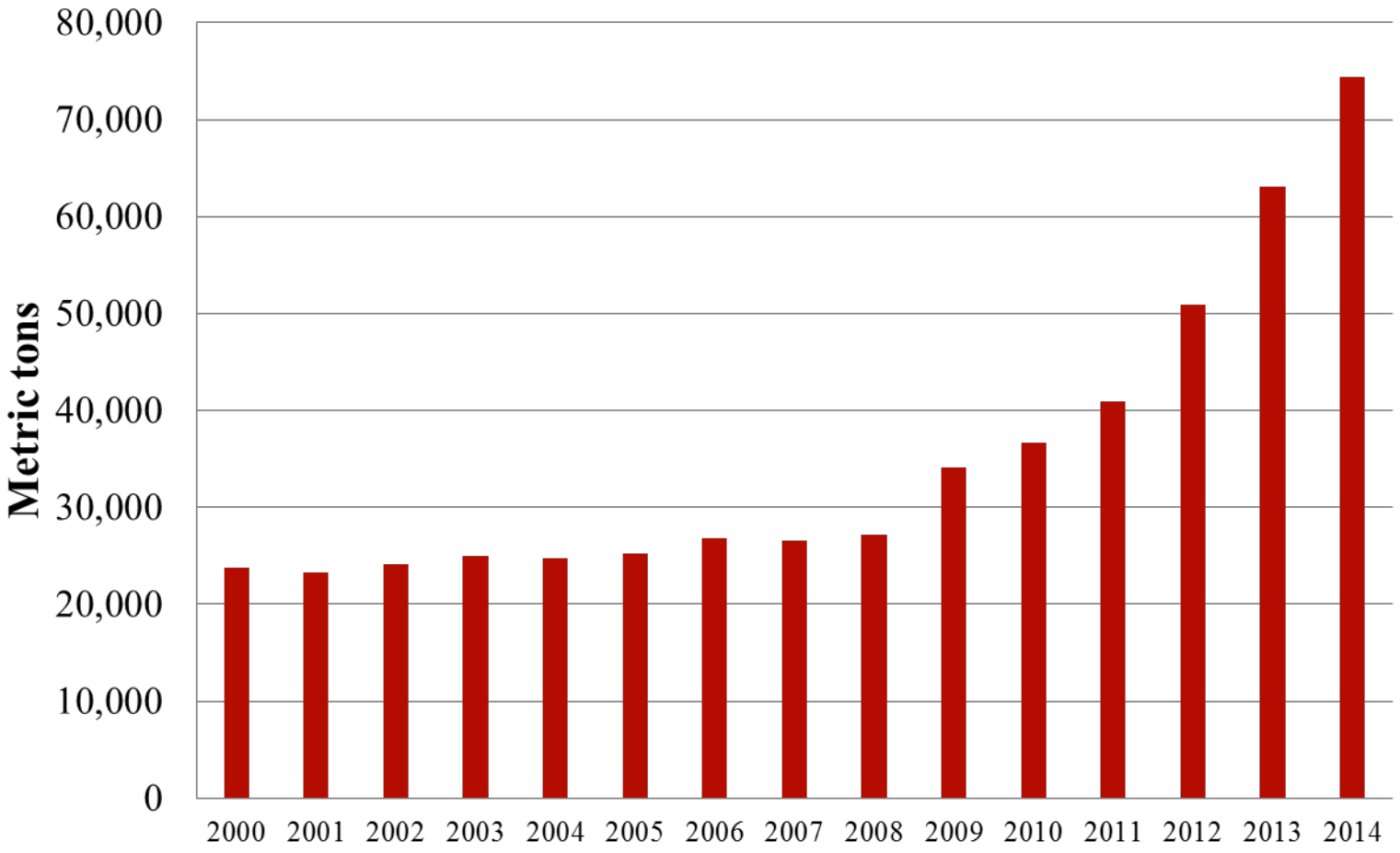
Introduction

- Bolivia, Peru and Ecuador are the main exporters of quinoa
- Increasing demand from developed countries
- Increasing production as a response to the worldwide demand

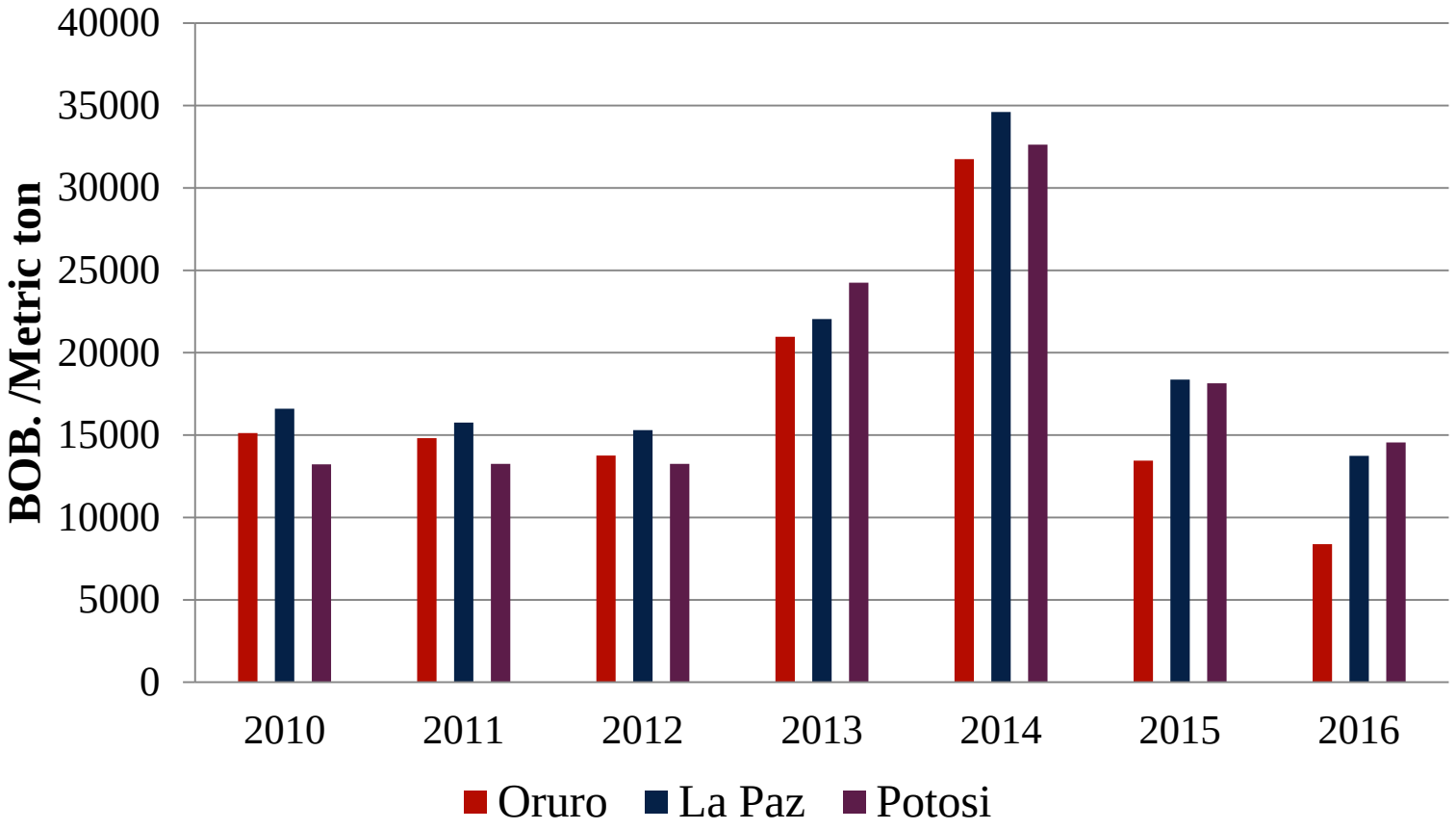
Quinoa Exports from Bolivia



Quinoa production in Bolivia

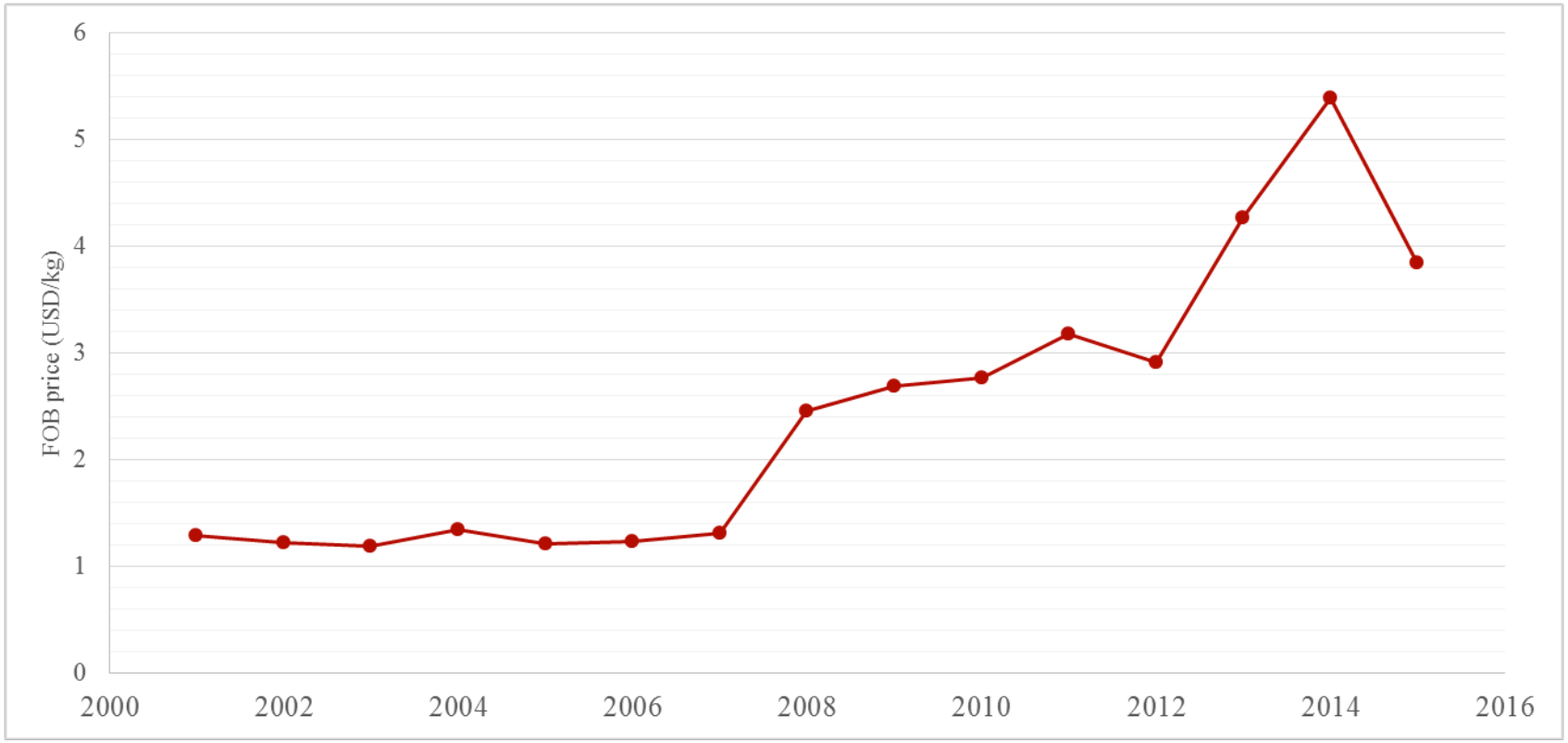


Quinoa local prices in Bolivia



Quinoa export prices

Evolution of the average FOB price for quinoa



Research Problem

- Change in the use of land
  - Farmers are now using land to cultivate just quinoa
  - Change in their diets
- Bolivian policies
  - Aim that quinoa becomes the primary food in the southern and central highlands of Bolivia
- Higher quinoa prices
  - The effect in household welfare has not been assessed yet
  - The impacts on producers and consumers has not been studied yet

Objectives

Main Objective

- The main objective of this study is to assess the effects of quinoa's price changes in the welfare of Bolivian households

Specific Objectives

- Assess the overall importance of quinoa expenditure, as a share of total expenditures and food expenditures
- Assess the sensitivity of supply and demand of quinoa to price changes
- Assess the welfare impacts across different sociodemographic groups.

Literature Review

- Welfare effects of rising food prices (Hertel and Winters, 2006)
  - Rising food prices has different impacts depending on the country's poverty and development
  - In developing countries the poorest people spend around 75% of their incomes on food
- Evidence from Peru (Bellemare, Fjardo-Gonzalez and Gitter, 2016)
  - Surveys from 2004-2013 (It includes production data for all the years)
  - Positive relationship between the price of quinoa and household welfare

Conceptual Framework

- Living Standard Measurement Study surveys (World Bank, 1980)
  - The main objective is to provide household level data for evaluating the effect of many kinds of government policies on the living conditions of the population.
- The distributional effects of price changes (Deaton, 1989)
  - Estimate the economic effect or price changes on the distribution of real incomes across different households, using household surveys.
  - Consider households' indirect utility function,

$$u_h = \psi_h(x_h, \boldsymbol{p}) = \psi_h(m_h + \pi_h, \boldsymbol{p}),$$

Where:

ψ_h: indirect utility function

x_h: income

p: price vector of the commodity

m_h: income from non-farm activities

π_h: profits

Conceptual Framework Continued

- Compensated variation (Deaton,1989)
  - If is dp_i, and the required compensation is dB, then Analyzed by taking the first derivatives of the indirect utility function with respect to price,

$$dB = (q_i - y_i)dp_i = p_i(q_i - y_i)d\ln p_i,$$

if dB is expressed as a fraction of household expenditure (x_h) we have

$$\frac{dB}{x_h} = \left(\frac{p_i y_i}{x_h} - \frac{p_i q_i}{x_h}\right) d\ln p_i$$

Conceptual Framework Continued

- Simplified compensating variation:

$$\left(\frac{\Delta x_h}{x_h}\right) = \frac{\Delta p_i}{p_i}\frac{(yi - q_i)p_i}{x_h} = \frac{\Delta p_i}{p_i} PR_h - CR_h = \frac{\Delta p_i}{p_i} NBR$$

  - Where:
    - Production Ratio : $PR_h = yip_i/x_h$
    - Consumption Ratio: $CR_h = qip_i/x_h$
    - Net Benefit Ratio: $NBR = PR_h - CR_h$

Conceptual Framework Continued

- Second order approximation (Minot and Goletti, 2000)
  - Alternative approximation that accounts for changes in quantities demanded and supplied as a response to price changes.

$$\left(\frac{\Delta x_h}{x_h}\right) = \frac{\Delta p_i^p}{p_i^p} PR_h + \frac{1}{2}\left(\frac{\Delta p_i^p}{p_i^p}\right)^2 PR_h \varepsilon_q^s - \frac{\Delta p_i^c}{p_i^c} CR_h - \frac{1}{2}\left(\frac{\Delta p_i^c}{p_i^c}\right)^2 CR_h \varepsilon_q^d$$

where

ε_q^s =price elasticity for of supply

ε_q^d =price elasticity of demand for quinoa

Methods and Procedures

- Data
  - Bolivian Household surveys (*Encuesta de Hogares)* from 2006 to 2014
    - The survey is conducted each year and is representative of the country's population.
    - 2008 data will be used to calculate the welfare effects

Methods and Procedures Continued

- Consumption Ratio
  - $CR_h = \frac{Q_c p_q^c}{TE_h}$

Q_c = *quantity of quinoa consumed in a month,*

p_q^c = *the self-reported price of purchased quinoa*

TE_h = *the household's total expenditures.*

Methods and Procedures Continued

- Production Ratio
  - $PR_h = \frac{Q_p p_q^p}{TE_h}$

Q_c = *quantity of quinoa produced in a month,*

p_q^c =*self-reported selling price of quinoa*

TE_h =*household's total expenditures.*

Methods and Procedures Continued

- Price elasticities
  - Quinoa producing households

$$\log q_s = \alpha_0 + \alpha_1 logp_s + \alpha_2 year + \varepsilon$$

  - Quinoa consuming households

$$w_q = \beta_0 + \beta_1 logp_q + \beta_2 logI + \beta_1 logD_h + \varepsilon$$

Methods and Procedures Continued

Household	Production (kg/month)	Price (p)	Consumption (kg/month)	Price (c)	Total Expenditures
1	15	2.5	10	3.0	500
2	0	0	15	2.7	650
3	25	2.0	27	2.5	550

E.g.

- Household 1: (15*2.5/500)-(10*3.0/500) = 0.075-0.06= 0.015
- Hosehold 3: (25*2.0/650)-(27*2.5/650)= 0.077-0.10= -0.023

- Households with positive NBR→ Net Sellers
- Households with negative NBR→ Net Buyers

Results

- Summary statistics
- Supply and demand elasticities
- Net Benefit Ratio (short-term effect)
- Mid-term effects

Summary Statistics

Variable	2006	2007	2008	2009	2011	2012	2013	2014
Income								
Nominal total household income (BOB.)	2152.07	2382.91	2746.06	2898.12	3643.00	3861.79	4755.1	4950.06
Income per capita (BOB.)	671.26	796.42	904.69	911.62	1147.44	1199.24	1502.56	1592.88
Demographics								
Male household head (%)	76.52	75.10	70.66	73.12	76.40	74.26	73.95	74.20
Household head age	44.79	45.43	45.45	44.84	46.39	47.11	47.60	46.03
Member of an ethnic group (%)	56.10	56.10	62.11	62.05	34.65	59.52	47.80	53.86
Residents in the household	4.04	3.90	3.79	3.87	3.82	3.79	3.73	3.71
Children in the household	1.86	1.83	1.63	1.68	1.60	1.54	1.43	1.48
Nominal food expenditure	769.88	971.3	1219.64	1126.15	1317.16	1324.56	1518.55	1594.71
Education								
Household head years of education	4	4	4	5	5	6	4	3
Household head literate (%)	9.34	9.29	10.83	9.39	8.34	8.25	6.19	5.58
Socioeconomic stratus								
Poor household (%)	51.18	53.83	51.41	45.75	40.06	38.61	29.98	31.84
Non-poor household (%)	48.82	46.17	48.59	54.25	59.94	61.39	70.02	68.16
Area								
Urban (%)	67.75	68.26	59.14	60.39	67.37	68.65	75.75	76.53
Quinoa								
Households that consume quinoa (%)	26.84	28.25	26.31	24.59	25.38	29.5	25.64	23.56
Monthly consumption (kg)	0.69	0.84	0.70	0.76	0.61	0.80	0.60	0.53
Monthly expenditure (BOB.)	3.97	5.31	6.72	7.61	7.61	9.13	12.41	12.18
Estimated price (BOB.)	6.04	6.9	10.94	12.08	13.5	14.23	23.69	28.37
Quinoa food share	0.004	0.004	0.006	0.006	0.005	0.007	0.007	0.007
Quinoa total expenditures share	0.002	0.002	0.003	0.003	0.002	0.003	0.003	0.002

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Quinoa total expenditures share	0.002	0.002	0.003	0.003	0.002	0.003	0.003	0.002

Supply price elasticity

$$\log q_s = \alpha_0 + \alpha_1 logp_s + \alpha_2 year + \varepsilon$$

Variable	Parameter	Parameter estimates
Intercept	α_0	8.622* (0.691)
log(price)	α_1	0.403 (0.258)
year	α_2	0.039* (0.007)
R^2		0.8135

- If price increases by 1% we'd expect production to increase 0.40%

Demand price elasticity

$$w_q = \beta_0 + \beta_1 log p_q + \beta_2 log I + \beta_3 log D_h + \varepsilon,$$

Variable	Parameters	Parameter estimates
Intercept	β_0	-0.057* (0.0039)
log(price)	β_1	0.007* (0.0005)
log(income)	β_2	-0.007* (0.0003)
log(age)	β_3	0.002* (0.0009)
log (members)	β_4	-0.003* (0.0006)

e_D =-0.694

Net Benefit Ratio

Net Benefit Ratio (Area)

	Rural	Urban	Total
Net Buying households (%)	16.240	33.147	26.240
Net Selling households (%)	6.780	0.210	2.900
Autarky (%)	76.980	66.640	70.860
Mean NBR	0.019	-0.002	0.006
Mean NBR, net sellers	0.325	0.392	0.328
Mean NBR, net buyers	-0.022	-0.009	-0.012

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Net Benefit Ratio

Net Benefit Ratio (Region)

	Andes	Other regions	Total
Net Buying households (%)	31.990	21.570	26.240
Net Selling Households (%)	5.660	0.645	2.900
Autarky (%)	62.340	77.780	70.860
Mean NBR	0.016	-0.002	0.006
Mean NBR, net sellers	0.362	0.084	0.328
Mean NBR, Net buyers	-0.013	-0.010	-0.012

Net Benefit Ratio

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Net Buying households (%)	31.990	21.570	26.240
Net Selling Households (%)	5.660	0.645	2.900
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Net Benefit Ratio

Net Benefit Ratio (Department)

	Chuquisaca	La Paz	Cochabamba	Oruro	Potosi	Tarija	Santa Cruz	Beni	Pando
Net Buying household (%)	11.110	37.370	23.890	35.860	13.390	34.440	22.740	5.340	16.670
Net Selling households (%)	2.380	5.490	1.080	10.970	2.890	0.000	0.000	0.000	0.000
Autarky (%)	86.510	57.140	75.030	53.160	83.730	65.560	77.260	94.660	83.330
Mean NBR	0.001	0.002	-0.002	0.110	0.001	-0.004	-0.002	0.000	-0.001
Mean NBR, net sellers	0.107	0.119	0.068	1.064	0.094	0.000	0.000	0.000	0.000
Mean NBR, Net buyers	-0.017	-0.013	-0.011	-0.018	-0.011	-0.011	-0.008	-0.005	-0.007

Net Benefit Ratio

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Net Buying household (%)	11.110	37.370	23.890	35.860	13.390	34.440	22.740	5.340	16.670
Net Selling households (%)	2.380	5.490	1.080	10.970	2.890	0.000	0.000	0.000	0.000
Autarky (%)	86.510	57.140	75.030	53.160	83.730	65.560	77.260	94.660	83.330
Mean NBR	0.001	0.002	-0.002	0.110	0.001	-0.004	-0.002	0.000	-0.001
Mean NBR, net sellers	0.107	0.119	0.068	1.064	0.094	0.000	0.000	0.000	0.000
Mean NBR, Net buyers	-0.017	-0.013	-0.011	-0.018	-0.011	-0.011	-0.008	-0.005	-0.007

Net Benefit Ratio

Net Benefit Ratio (Expenditure deciles)

	1	2	3	4	5	6	7	8	9	10
Total										
Net Buyer	36.690	35.280	30.710	34.860	32.740	29.440	25.450	15.740	13.710	4.830
Net Seller	0.760	0.000	0.250	0.510	1.270	2.030	2.800	5.580	7.870	7.890
Autarky	59.540	64.720	69.040	64.630	65.990	68.530	71.760	78.680	78.430	87.280
Mean NBR	-0.002	-0.002	-0.002	-0.003	0.000	0.016	0.002	0.014	0.012	0.028
Mean NBR, net sellers	0.000	0.000	0.017	0.067	0.341	0.381	0.237	0.298	0.219	0.379
Mean NBR, Net buyers	-0.004	-0.007	-0.007	-0.010	-0.013	-0.012	-0.018	-0.018	-0.036	-0.037
Rural										
Mean NBR	0.000	-0.003	-0.002	-0.002	0.008	0.059	-0.001	0.023	0.016	0.030
Mean NBR, net sellers	0.000	0.000	0.000	0.066	0.340	1.257	0.108	0.311	0.218	0.378
Mean NBR, Net buyers	-0.002	-0.008	-0.009	-0.011	-0.021	-0.014	-0.028	-0.019	-0.040	-0.038
Urban										
Mean NBR	-0.002	-0.002	-0.002	-0.003	-0.004	-0.003	0.004	-0.003	-0.004	-0.002
Mean NBR, net sellers	0.000	0.000	0.000	0.000	0.000	0.148	0.813	0.033	0.000	0.000
Mean NBR, Net buyers	-0.004	-0.007	-0.006	-0.009	-0.009	-0.011	-0.012	-0.016	-0.023	-0.028

Net Benefit Ratio

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Autarky	59.540	64.720	69.040	64.630	65.990	68.530	71.760	78.680	78.430	87.280
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Mean NBR, Net buyers	-0.004	-0.007	-0.007	-0.010	-0.013	-0.012	-0.018	-0.018	-0.036	-0.037
Rural										
Mean NBR	0.000	-0.003	-0.002	-0.002	0.008	0.059	-0.001	0.023	0.016	0.030
Mean NBR, net sellers	0.000	0.000	0.000	0.066	0.340	1.257	0.108	0.311	0.218	0.378
Mean NBR, Net buyers	-0.002	-0.008	-0.009	-0.011	-0.021	-0.014	-0.028	-0.019	-0.040	-0.038
Urban										
Mean NBR	-0.002	-0.002	-0.002	-0.003	-0.004	-0.003	0.004	-0.003	-0.004	-0.002
Mean NBR, net sellers	0.000	0.000	0.000	0.000	0.000	0.148	0.813	0.033	0.000	0.000
Mean NBR, Net buyers	-0.004	-0.007	-0.006	-0.009	-0.009	-0.011	-0.012	-0.016	-0.023	-0.028

Mid-term effects

Mid-term effect (Area)

	Rural	Urban	Total
Mean Mid-term effect	0.021	-0.001	0.011
Mean Mid-term effect, net sellers	0.349	0.421	0.353
Mean Mid-term effect, Net buyers	-0.014	-0.006	-0.008

Mid-term effects

Mid-term effect (Area)

	Rural	Urban	Total
Mean Mid-term effect	0.021	-0.001	0.011
Mean Mid-term effect, net sellers	0.349	0.421	0.353
Mean Mid-term effect, Net buyers	-0.014	-0.006	-0.008

	Rural	Urban	Total
Mean NBR	0.019	-0.002	0.006
Mean NBR, net sellers	0.325	0.392	0.328
Mean NBR, net buyers	-0.022	-0.009	-0.012

Mid-term effects

Mid-term effect (Region)

	Andes	Other regions	Total
Mean Mid-term effect	0.019	-0.001	0.011
Mean Mid-term effect, Net sellers	0.380	0.091	0.353
Mean Mid-term effect, Net buyers	-0.009	-0.007	-0.008

Mid-term effects

Mid-term effect (Region)

	Andes	Other regions	Total
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Mean Mid-term effect, Net sellers	0.380	0.091	0.353
Mean Mid-term effect, Net buyers	-0.009	-0.007	-0.008

	Andes	Other regions	Total
Mean NBR	0.016	-0.002	0.006
Mean NBR, net sellers	0.362	0.084	0.328
Mean NBR, Net buyers	-0.013	-0.010	-0.012

Mid-term effects

Mid-term effect (Department)

	Chuquisaca	La Paz	Cochabamba	Oruro	Potosi	Tarija	Santa Cruz	Beni	Pando
Mean Mid-term effect	0.001	0.004	-0.001	0.122	0.002	-0.003	-0.001	0	-0.001
Mean Mid-term effect, Net sellers	0.114	0.128	0.073	1.146	0.101	0	0	0	0
Mean Mid-term effect, Net buyers	-0.011	-0.008	-0.007	-0.012	-0.007	-0.007	-0.006	0	-0.005

Mid-term effects

Mid-term effect (Department)

	Chuquisaca	La Paz	Cochabamba	Oruro	Potosi	Tarija	Santa Cruz	Beni	Pando
Mean Mid-term effect	0.001	0.004	-0.001	0.122	0.002	-0.003	-0.001	0	-0.001
Mean Mid-term effect, Net sellers	0.114	0.128	0.073	1.146	0.101	0	0	0	0
Mean Mid-term effect, Net buyers	-0.011	-0.008	-0.007	-0.012	-0.007	-0.007	-0.006	0	-0.005

	Chuquisaca	La Paz	Cochabamba	Oruro	Potosi	Tarija	Santa Cruz	Beni	Pando
Mean NBR	0.001	0.002	-0.002	0.110	0.001	-0.004	-0.002	0.000	-0.001
Mean NBR, net sellers	0.107	0.119	0.068	1.064	0.094	0	0	0	0
Mean NBR, Net buyers	-0.017	-0.013	-0.011	-0.018	-0.011	-0.011	-0.008	-0.005	-0.007

Mid-term effects

Mid-term effect (Expenditure Decile)

	1	2	3	4	5	6	7	8	9	10
Total										
Mean Mid-term effect	-0.001	-0.002	-0.001	-0.002	0.002	0.002	0.004	0.002	0.015	0.031
Mean Mid-term effect, Net sellers	0	0	0.018	0.071	0.367	1.055	0.255	0.321	0.235	0.408
Mean Mid-term effect, Net buyers	-0.003	-0.004	-0.004	-0.006	-0.008	-0.008	-0.011	-0.012	-0.023	-0.024
Rural										
Mean Mid-term effect	-0.003	-0.002	-0.001	-0.001	0.012	0.065	0.002	0.025	0.019	0.033
Mean Mid-term effect, Net sellers	0	0	0.018	0.071	0.366	1.353	0.118	0.334	0.235	0.408
Mean Mid-term effect, Net buyers	-0.001	-0.005	-0.006	-0.007	-0.013	-0.009	-0.018	-0.013	-0.026	-0.024
Urban										
Mean Mid-term effect	-0.001	-0.002	-0.001	-0.002	-0.002	-0.001	0.005	-0.001	-0.003	-0.001
Mean Mid-term effect, Net sellers	0	0	0	0	0	0.16	0.875	0.036	0	0
Mean Mid-term effect, Net buyers	-0.003	-0.004	-0.004	-0.006	-0.007	-0.007	-0.008	-0.011	-0.015	-0.018

Mid-term effects

Mid-term effect (Expenditure Decile)

	1	2	3	4	5	6	7	8	9	10
Total										
Mean Mid-term effect	-0.001	-0.002	-0.001	-0.002	0.002	0.002	0.004	0.002	0.015	0.031
Mean Mid-term effect, Net sellers	0	0	0.018	0.071	0.367	1.055	0.255	0.321	0.235	0.408
Mean Mid-term effect, Net buyers	-0.003	-0.004	-0.004	-0.006	-0.008	-0.008	-0.011	-0.012	-0.023	-0.024
Rural										
Mean Mid-term effect	-0.003	-0.002	-0.001	-0.001	0.012	0.065	0.002	0.025	0.019	0.033
Mean Mid-term effect, Net sellers	0	0	0.018	0.071	0.366	1.353	0.118	0.334	0.235	0.408
Mean Mid-term effect, Net buyers	-0.001	-0.005	-0.006	-0.007	-0.013	-0.009	-0.018	-0.013	-0.026	-0.024
Urban										
Mean Mid-term effect	-0.001	-0.002	-0.001	-0.002	-0.002	-0.001	0.005	-0.001	-0.003	-0.001
Mean Mid-term effect, Net sellers	0	0	0	0	0	0.16	0.875	0.036	0	0
Mean Mid-term effect, Net buyers	-0.003	-0.004	-0.004	-0.006	-0.007	-0.007	-0.008	-0.011	-0.015	-0.018

	1	2	3	4	5	6	7	8	9	10
Total										
Mean NBR	-0.002	-0.002	-0.002	-0.003	0	0.016	0.002	0.014	0.012	0.028
Mean NBR, net sellers	0	0	0.017	0.067	0.341	0.381	0.237	0.298	0.219	0.379
Mean NBR, Net buyers	-0.004	-0.007	-0.007	-0.010	-0.013	-0.012	-0.018	-0.018	-0.036	-0.037
Rural										
Mean NBR	0	-0.003	-0.002	-0.002	0.008	0.059	-0.001	0.023	0.016	0.030
Mean NBR, net sellers	0	0	0	0.066	0.340	1.257	0.108	0.311	0.218	0.378
Mean NBR, Net buyers	-0.002	-0.008	-0.009	-0.011	-0.021	-0.014	-0.028	-0.019	-0.040	-0.038
Urban										
Mean NBR	-0.002	-0.002	-0.002	-0.003	-0.004	-0.003	0.004	-0.003	-0.004	-0.002
Mean NBR, net sellers	0	0	0	0	0	0.148	0.813	0.033	0	0
Mean NBR, Net buyers	-0.004	-0.007	-0.006	-0.009	-0.009	-0.011	-0.012	-0.016	-0.023	-0.028

Summary and conclusions

- 3% of the households are net sellers and would benefit from the increase in price of quinoa.
- The percentage of net sellers in the Andes is 5.6% and in the other regions is 0.6%.
- The poorer net selling households from rural areas are the ones that would benefit the most.
- Households located in the urban area have a negative effect across all deciles.
- Net-selling households benefit from price increase and the effect at a national level would be positive.

Limitation of this study

- After 2008 the **production section** was removed from the "*Encuesta de Hogares*" survey.
  - The price estimation is based on self reported prices by the households
  - The sample size of quinoa producers is reduced and may not representative
- The information regarding quinoa prices is limited.
  - Quantities produced
  - Income generated from this activity

Further research

- Assess the effects on the poverty level in the households
- Assess the nutritional impact caused by the increase in the price of quinoa

Thank you for your time!!!

Questions?