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Philippine Institute for Development Studies  
*Surian sa mga Pag-aaral Pangkaunlaran ng Pilipinas*

## Who Weans with Commodity Price Shocks? Rice Prices and Breastfeeding in the Philippines

*Michael R.M. Abrigo*

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# Who weans with commodity price shocks? Rice prices and breastfeeding in the Philippines

Michael R.M. Abrigo \*

June 29, 2016

## Abstract

Commodity market fluctuations have been linked with a number of adult outcomes. Recent evidence on the lasting impact of early life conditions, however, suggests that the effects on children may be important as well. Using large spatio-temporal variations in rice prices in the Philippines as a natural experiment, we estimated the effect of increasing food prices on parental behavior regarding an inexpensive yet time-intensive child investment: breastmilk feeding. We document a countercyclical relationship between breastfeeding duration and rice prices, which may be a consequence of poorer health and induced labor force participation among mothers. Our results highlight that even food producers may not be insulated against food price inflation.

JEL Code: I18, J13, Q02

Keywords: Food prices, Breastfeeding, Child investments

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# Who weans with commodity price shocks? Rice prices and breastfeeding in the Philippines

Michael R.M. Abrigo

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## 1 Introduction

The recent trend in food prices has renewed greater attention on the effect of increasing food prices on consumer welfare. While there has been a long history of studies analyzing the impact of agricultural commodity prices on household outcomes, most notably on labor supply and health, little is known, however, of the effect of food inflation on infants. This is a pressing concern especially in light of growing evidences of the influence of early life conditions on future adult outcomes.

In this article, we estimate the impact of increasing food prices on a critical child investment: breastmilk feeding. Evidence from various observational and experimental studies show that breastfeeding is associated with better child health outcomes, as well as various later-life neurobehavioral and cognitive development measures. Results from a meta-analysis of fourteen observational studies by Horta et al. (2007), and from separate randomized trials by Kramer et al. (2008) and Lucas et al. (1992) suggests that breastfeeding improves cognitive development among children. Breastfeeding is also found to be positively related with IQ scores, educational attainment and income among adults in a large cohort study by Victora et al. (2015). These studies are related to the growing literature on the long-term impacts of early life conditions, including on life expectancy, height, cognitive ability, and productivity (e.g., Barker (1990); Banerjee et al. (2010); Maccini and Yang (2009); Van den Berg et al. (2006)).

In addition to the beneficial impacts of breastfeeding on child development, an equally important health concern is the availability of safe and nutritious food sources for infants other than breastmilk. Even when nutritious alternatives are available, improper handling may increase the risk of infant infection from food-borne pathogens. In the US, for instance, several studies (e.g., Labiner-Wolfe et al. (2008); Fein and Falci (1999)) document failure of mothers to comply with recommended safe infant formula-handling practices, which has been observed in other countries (e.g., Carletti and Cattaneo (2008); Dunne et al. (2001)) as well.

Breastfeeding is an inexpensive, yet time-intensive child investment. With increased commodity prices, the opportunity cost of time may increase or decrease depending on whether a household is a net consumer or net producer of the commodity. Thus different households could have different child-care responses to food price inflation. Among consumer-only households, real income declines. In an economy where savings is limited or insurance markets are not fully developed, households supply more labor to augment falling incomes, i.e., price effect, which effectively limits time available for child-care.<sup>1</sup> Alderman and Sahn (1993), and De Janvry et al. (1991), for instance, show that labor supply

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<sup>1</sup>For households who have access to insurance and storage mechanisms, the effect of food price inflation will be

increases with food prices. On the other hand, producer-only households enjoy higher income because of the price increase, i.e., profit effect. Provided that child investment is a normal good, households will allocate more time for child-care as a result. For consumer-producer households, the effect of shifts in commodity prices is unclear and depends on the saliency of the price and the profit effects.

Examining the impact of food prices on breastfeeding duration requires relatively high frequency infancy data and exogenous variations in prices. The few existing studies tend to be limited in this direction. Saha et al. (2008), for instance, found no association between household food security and breastfeeding duration using observational data from Bangladesh. Miller and Urdinola (2010), using annual data in Colombia, did not find evidence of any impact by large coffee price shocks on breastfeeding duration, although they had found substantial negative impact on other child investments, including vaccination. Breastfeeding duration rarely exceeds two years from birth. Analyses using coarsely aggregated data may not be sensitive to changes in household behavior. Even when commodity prices are external to households, their coping strategies may still potentially confound effect estimates.

We improve on these earlier studies on the role of food commodity markets on infant breastfeeding in a number of directions. First, we exploit large exogenous spatio-temporal variations in rice prices in the Philippines to examine the effect of food price inflation on the duration of infant breastfeeding. Second, we further purge possible endogeneity bias by instrumenting domestic rice prices with prices experienced in another rice trading country. While market prices may be external to households, selection in birth timing, in particular, and in coping to market shocks, in general, by households will confound estimates. Finally, we provide separate estimates for agricultural and non-agricultural households to determine any differential impact by producer status.

We find that child-investment through breastfeeding falls with increased food prices. Infants born to agricultural households appear to be similarly negatively affected as those from non-agricultural households, indicating the relative importance of the price effect among agricultural households. The reduction in breastfeeding duration appears to be largely mediated by household labor supply decisions rather than the impact of food prices on health. Female members provide additional household resource by working in paid employment, thereby acting as a household insurance mechanism (Bhalotra (2010)) to the detriment of time available for important — but usually unpaid — child-care investments.

## 2 Rice in the Philippines

Rice farming is an important source of income among Philippine households. While the gross value added of rice production is less than three percent of the total economy, the industry employs the bulk of the agricultural labor force (Balisacan and Ravago (2003)), which in turn comprise close to half of the total labor force in the early 1990s but just about a third in more recent years. Despite rapid growth in the sector in the 1960s and 1980s, low labor productivity remains to be a major concern, especially in alleviating poverty (Balisacan (1993); Mapa et al. (2012)).

Like in many Southeast Asian economies, rice is an integral component of the average Filipino muted since they are able to (partially) offset the decline in income, and be able to smooth their consumption. Earlier evidence in the Philippines suggests imperfect consumption and income smoothing among households (Fafchamps and Lund (2003); Yang and Choi (2007)).

diet. Recent estimates by Lantican et al. (2011) show that on average rice consumption comprises about half of the total household expenditure. Local rice demand is very inelastic, with household demand changing by only about half a percent for every percent increase either in rice prices or in household income. Rice has no close substitute in the local diet. Traditional substitutes like corn, sweet potato, taro, cassava and banana are not responsive to changes in rice prices, with demand for substitutes increasing only by less than 0.1 percent for every percent increase in rice prices. Indeed, an increase in rice prices results to a statistically significant increase in hunger incidence in the five quarters succeeding the price shock (Mapa et al. (2011)), although the effect on poverty incidence may be heterogeneous across different types of households (Fujii (2013); Reyes et al. (2010)).

Since the government abolished rice price controls in 1985, the country had experienced two major inflationary episodes (Figure 1). In the 1995 Philippine rice- and the 2008 international food-price crises, domestic rice prices had increased by 6 and 3.5 standard deviations of the previous years average price, respectively. In both episodes, rigidities in rice policy are perceived as important contributors (Balisacan et al. (2010); David (1997); Tolentino (2002)). While price controls have been abolished, international rice trading in the Philippines remains highly regulated, with the government providing concessions to rice traders and at the same time directly participating in importation. This effectively limits the domestic markets ability to respond to demand and supply conditions (David (1997)).

The domestic rice market is highly competitive despite direct interventions by government, which has a substantial market share ranging from a high 12 percent in 1990 to a low 6 percent in 2010. Rice farm holdings are capped at three hectares per household by the 1988 Comprehensive Agrarian Reform Program, thereby limiting the possible market power by any individual household. Between 1991 and 2002, for instance, average farm size declined from 2.2 to 2.0 hectares. Rice traders, on the other hand, exercise limited market power if at all (Mangahas et al. (1966); Reeder et al. (2000)).

### 3 Empirical specification

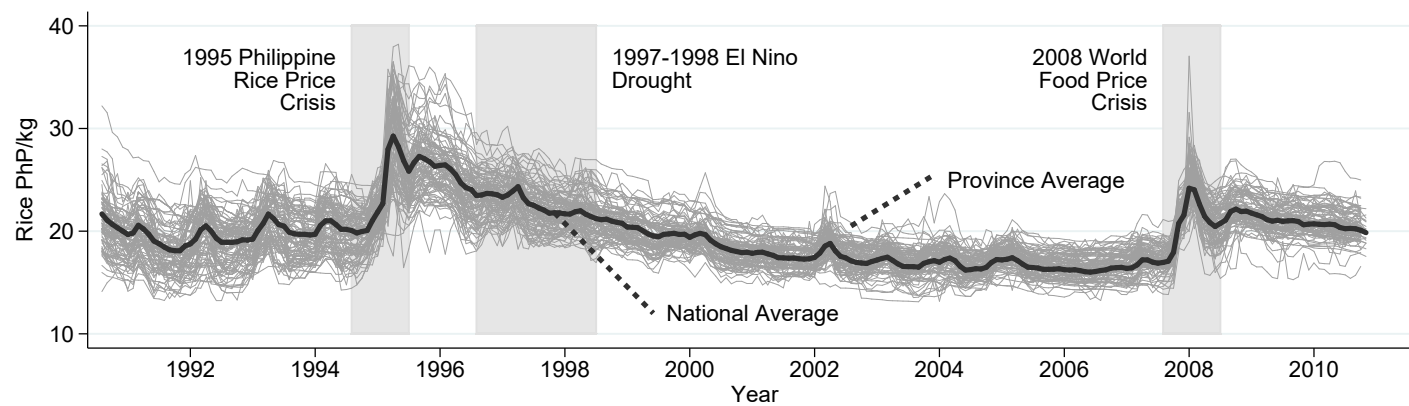
#### 3.1 Data

We obtained provincial monthly average prices of well-milled rice from the Philippine Statistics Authority (PSA). While households have no market power to influence rice prices, our identification strategy primarily relies on two large shocks on the Philippine rice market that resulted in substantial increase in local prices. Figure 1 presents the evolution of rice prices<sup>2</sup> in 82 Philippine cities and provinces between 1991 and 2010. The cross-sectional dispersion in sub-national prices in 1995/1996 and in 2008 indicates large heterogeneity in crisis levels and timing of rice price shocks within the country. This is confirmed in Figure 2, which shows the peak annual inflation rates during the two crises periods and their onset month across provinces in the country.

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<sup>2</sup>Provincial rice prices are deflated using the regional non-food consumer price index by PSA. There are 18 regions in the Philippines, organized primarily by geographical proximity, which serve as administrative divisions for many government offices.

Figure 1: Rice prices by province, Philippines 1991-2010



Note: Author's calculation based on Philippine Statistics Authority (PSA) data. Provincial rice prices are deflated by regional non-food consumer price index.

Table 1 provides a descriptive summary of the children (Panel A) and ever-married adult women (Panel B) samples used in our analysis. The variables in the table are the primary outcomes and demographic controls used in our empirical models.

The 1995 rice price crisis has been confined largely in the northern and central islands of the country, which largely share the same rice production chain. The 1995 crisis began during the lean months of August-September, before the first cropping seasons peak harvest months of October-November, in the small-island provinces of Visayas. These central island provinces rely heavily on rice imports from the plains of the larger island of Luzon in the north. Although rice supply has increased by 6.6 percent relative to the previous years production, prices have increased even during the October-November 1995 and the March-April 1996 harvest periods. Rice prices in some provinces remained two standard deviations above average prices until December 1996. The 2008 food price crisis, on the other hand, lasted only for two months, and was confined in the northern and southern islands of the country. Similar to the 1995 crisis, there were no significant domestic supply-side shocks in 2008 that would explain the sudden increase in rice prices. Local production had generally been favorable, increasing by 3.5 percent relative to the previous year. These support previous claims that the increase in domestic rice prices are not necessarily driven by unfavorable shifts in domestic production patterns.

To study how infants are affected by rice price fluctuations, we pooled the 1998, 2003, 2008 and 2013 Philippine National Demographic and Health Surveys (NDHS). NDHS is a nationally representative survey of reproductive-age women (operationally defined as 15-49), and is designed to provide information on population, family planning, and health. The survey contains detailed health histories, including birth dates and intervals, breastfeeding duration, and health investments, of children aged five years and below regardless of survival at the time of the survey.

Additionally, we also pooled Quarterly Labor Force Surveys (LFS) from 1991 to 1995 to analyze immediate labor supply responses to rice price shocks. Although maternity status of individuals is not captured in the survey, it contains detailed information on household membership, labor force participation, employment status, hours worked and occupation of individuals, which could provide indication of labor supply responses by women. We limit our analysis to the population of ever-married women aged 20 to 49 to coincide with peak female reproductive ages. In our NDHS sample, for instance, about 98 percent of births are to women in this age group.

### 3.2 Estimation

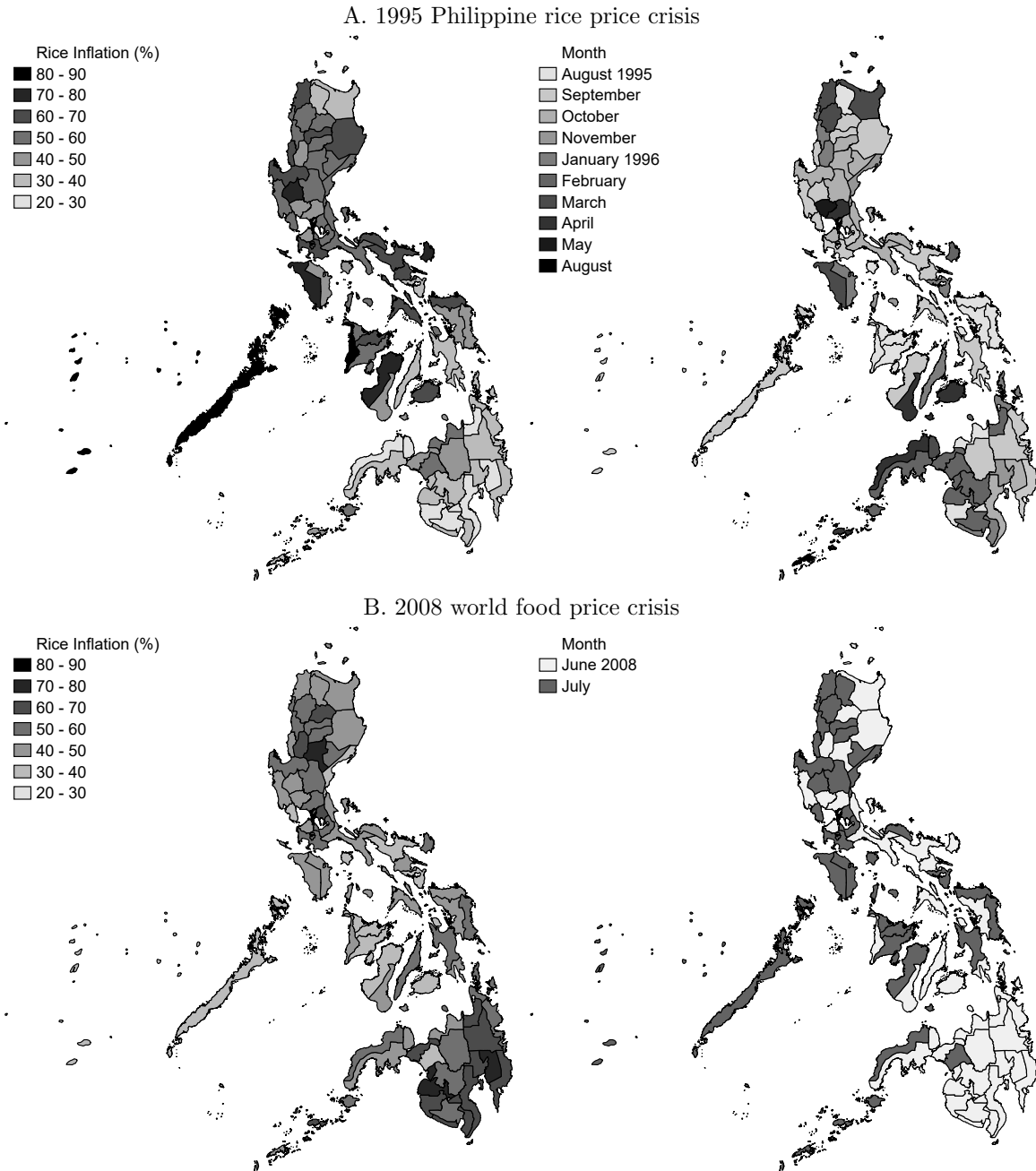
We estimate the impact of increasing rice prices on infant breastfeeding duration by estimating the following reduced-form equation:

$$y_{iht} = P_{iht}\beta + X_{iht}\gamma + M_{iht}\theta + T_{iht}\varphi + e_{iht} \quad (1)$$

where  $y_{iht}$  is breastfeeding duration for infant  $i$  born to mother  $h$  at period  $t$ .  $P_{iht}$  is the province-specific rice price at birth, while the parameter  $\beta$  captures the effect of rice price fluctuations on breastfeeding duration. The vector  $X_{iht}$  provides child-specific controls, including dummy variables for birth order, sex, whether the child was wanted at birth, and whether there is a preceding or succeeding birth that is within two years from the child's own birth. The vector  $M_{iht}$  includes household-specific



Figure 2: Peak inflation rate and onset month, 1995 and 2008 Philippine rice crises



Note: Author's calculation based on Philippine Statistics Authority (PSA) data. Provincial rice prices are deflated by regional non-food consumer price index.

Table 1: Summary statistics

	Full Sample		Rice Price Regime			
			Normal		High	
	Mean	SD	Mean	SD	Mean	SD
<b>A. 1998-2013 NDHS: Children 18-60 months old</b>						
Months breastfed	10.20	6.90	10.15	6.88	10.79	7.08
Months exclusively breastfed	4.21	2.17	4.23	2.16	4.00	2.23
Birth weight (grams)	3,033.15	780.38	3,035.21	775.04	3,012.03	833.39
Birth weight $\geq$ 2,500 grams	0.19	0.40	0.19	0.39	0.22	0.41
Child is female	0.48	0.50	0.48	0.50	0.48	0.50
Child was wanted at birth	0.61	0.49	0.62	0.49	0.60	0.49
Preceding birth more than 2 years	0.76	0.43	0.76	0.43	0.77	0.42
Succeeding birth more than 2 years	0.79	0.41	0.79	0.41	0.81	0.40
Wealth index, z-score	-0.21	0.99	-0.22	0.99	-0.07	1.03
Mother with at least college units	0.25	0.43	0.25	0.43	0.28	0.45
Agricultural household	0.30	0.46	0.31	0.46	0.23	0.42
Rice price at birth	20.32	3.35	19.86	2.66	29.48	2.28
<b>B. 1991-1995 LFS: Ever-married women 20-49 years old</b>						
In the labor force	0.47	0.50	0.47	0.50	0.47	0.50
Hours worked in past week (if employed)	41.00	19.45	40.89	19.44	43.72	19.50
With child aged 0-11 months in household	0.14	0.36	0.14	0.36	0.13	0.35
With child aged 12-23 months in household	0.17	0.38	0.17	0.38	0.15	0.37
Crop-grower household	0.33	0.47	0.33	0.47	0.25	0.43
Rice price at survey month	20.82	3.21	20.42	2.45	31.44	2.57

Note: "High" price regime refers to months when real rice prices are at least two (2) standard deviations higher than the 1991–2011 average rice price. "Normal" rice price regime refers to months when rice prices are below two standard deviations of the long-run average. In Panel A, about eight (8) percent of infants were born in a "high" price regime. In Panel B, about three (3) percent of the sample were observed in "high" price regime.

controls, such as household wealth  $z$ -score and indicator variables for highest educational attainment by the child’s mother. We also include dummy variables for year- and for month-of-birth to isolate the impact of cohort-specific shocks and of seasonality that may confound our estimates.  $e_{iht}$  is the model residual.

We exploit geographic differences in timing and in level of the 1995 and 2008 rice price crises to identify the effect of fluctuations in rice prices on breastfeeding duration among infants. Because children are born at different periods relative to the onset of the shock, this study is able to exploit exogenous temporal variations in the level of rice price shock that the infants are exposed to. Households have no market power to influence rice prices because of their size relative to the domestic market, thus the level of the shocks is external to them.

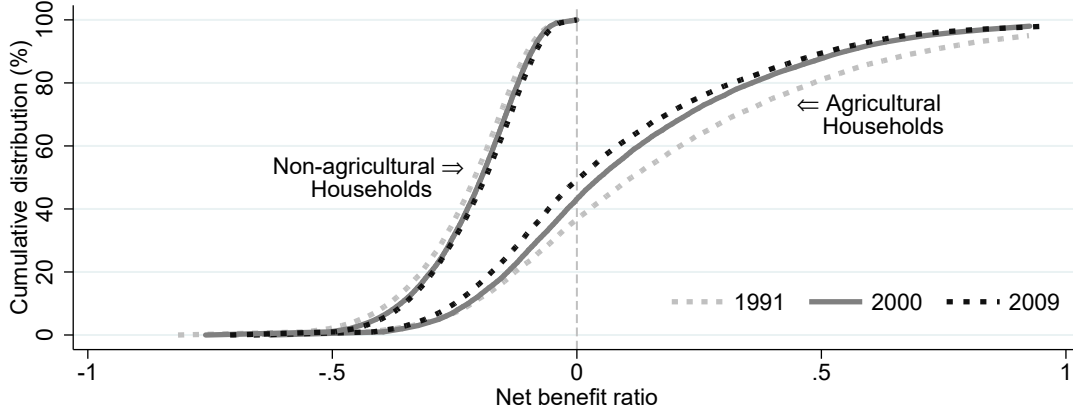
A serious threat to our identification strategy however is the non-random timing of births due to selection among mothers choosing when to give birth, or due to changes in behavior as a response to changes in economic incentives (Dickert-Conlin and Chandra (1999); Dehejia and Lleras-Muney (2004)). For instance, in our NDHS sample, household wealth is positively correlated with rice price at birth (Pearson’s  $\rho = 0.10$ ,  $p$ -value  $< 0.01$ ), possibly indicating that less affluent households delay pregnancy in response to market conditions. Households could also migrate to regions not as badly hit by the crisis as a strategic response, thereby possibly biasing effect estimates. This may be a costly coping response among households with already pregnant women or with new-born infants, however, especially if shocks are seen as transitory. Furthermore, inspection of the data reveals that this does not pose any serious problem in our case. For instance, only about five percent of women aged 20-49 years in 1995 reside in a different province in 1990 using migration history information in the 2000 Census of Population conducted by PSA.

To correct for possible endogeneity bias, we instrument provincial rice prices with Thailand Grade B rice price, which arguably cannot be influenced by any single rice consumer household in the Philippines. The Philippines is a major importer of rice from other Southeast Asian economies, including Thailand, thus the instrument should be relevant in explaining domestic rice prices.

Censoring in our observational breastfeeding data could also bias our estimates if not taken into account. Infants born closer to the survey are observed in fewer periods, thus would appear to have been breastfed shorter durations than those children who were born earlier. As a remedy, we top-code any- and exclusive-breastfeeding durations at 18 and 12 months, respectively, and exclude in the analyses children who have not reached these ages at the time of the survey. At 12 months, 99.8 percent of infants have been already introduced to food sources other than breastmilk. At 18 months, 75.6 of children have already been completely weaned from breastmilk.

We also investigate the effects of rice prices on health and on labor supply to describe how households reallocate resources in response to commodity price shocks. This provides indications of possible mechanisms of how breastfeeding duration is affected by rice prices. We estimated empirical models similar to (1), but using child’s birth weight, and adult female labor force participation and hours worked as outcome variables.

Figure 3: Crop farming and gardening net benefit ratio: 1991, 2000 and 2009



Note: Author's calculations based on 1991, 2000 and 2009 Family Income and Expenditure Surveys by PSA. The net benefit ratio (NBR), calculated as the net share of production to total consumption, measures the price elasticity of welfare (Deaton (1989)). Negative NBR indicates net consumption.

## 4 Results

Households' response to food price shocks may vary depending on whether it is a net producer or a net consumer of the product. In economies with neither saving nor insurance markets, non-food producer households are expected to consume less food and supply more labor in response to food price inflation, while this relationship may be muted or even reversed for food producer households.

Figure 3 shows the distribution of households over the production-consumption divide, which appears to have changed dramatically between 1991 and 2009 for agricultural households. The net benefit ratio (NBR), measured as production net of consumption as a share of total household consumption, may be interpreted as the price-elasticity of welfare (Deaton (1989)). While agricultural households comprise about a third of all households in the Philippines between 1991 and 2009, net crop producers declined from 62 percent of all agricultural households in 1991 to only 47 percent by 2009. Overall, more than three quarters of households in the country are net consumers, who would be negatively affected by any increase in rice prices. With rice inflation going above 50 percent during the 1995 and 2008 crises, the NBR distribution implies that about a third of all households in the Philippines experienced at least 10 percent reduction in real income.

### 4.1 Breastfeeding duration

An increase in rice prices may affect mothers' breastfeeding duration choice in a number of ways. Consider an economy where storage cost is prohibitively high, and financial markets are incomplete or non-existent. In general, an increase in rice prices would result in decreased consumption brought about by depressed real income and possible substitution with alternative nutrient sources. Since rice has no close substitute in the local diet, then increasing rice prices would result in increased hunger and poorer health, which may affect the production of breast milk (Jelliffe and Jelliffe (1978); Chapman

and Nommsen-Rivers (2012)). Furthermore, if a minimum level of sustenance is required to be able to function in succeeding periods then mothers may be forced to (re-)enter the labor force to augment income, thereby resulting to earlier weaning of infants from breastmilk. Rice farmers, however, benefit from a second-round profit effect that expands real income. Provided that breastfeeding is a normal good, the profit effect increases the propensity of a mother breastfeeding her child, which counteracts the direct price effects.

The World Health Organization (WHO) recommends exclusive breastfeeding of infants up to six months from birth, with continued breastfeeding up to two years (Kramer and Kakuma (2011)). While there has been a general increase in breastfeeding propensity and duration among infants in the Philippines, they remain to be below the WHO-recommended level. For instance, infants who were exclusively breastfed for at least 6 months increased from 27.7 percent of infants born in 2000 to 51.6 percent of infants born in 2010. Children who were breastfed for at least two years have also increased from only 19.8 percent of children born in 2000 to 51.5 percent of those born 10 years later. Despite the dramatic increase in breastfeeding propensity, infants born in 2010 were, on average, exclusively breastfed for only 4.9 months, and completely weaned from breastmilk at 16.7 months.

Table 2 presents the impact of a one standard deviation increase in rice prices at month of birth on breastfeeding duration. Separate estimates are provided for agricultural (Panel C) and non-agricultural (Panel B) households, in addition to the pooled households models (Panel A). Columns (1) to (3) present results using ordinary least squares, while columns (4) to (6) shows results using Thai Grade B rice price as instrumental variable (IV) for provincial rice price. The IV estimates correct for possible endogeneity bias arising from unobserved household coping response to unfavorable economic shocks, like sudden surges in food prices. It is noteworthy that including wealth index and mother’s educational attainment (Cols. 3 and 6) more than doubles the adjusted coefficient of determination (denoted by R-sq.) relative to the preceding model, indicating the importance of maternal and household characteristics in explaining breastfeeding decisions. Focusing on the IV models, the estimates suggest that infants from non-agricultural households are weaned earlier by about 20 days for every one standard deviation increase in rice price at birth. We have no enough evidence to suggest that infants from agricultural households are weaned earlier or later because of rice price shocks.

Table 3 shows the effect of rice price shocks on household breastfeeding intensity. While we find no evidence that infants from agricultural households are completely weaned earlier or later because of rice price shocks, we see that they are introduced to other food sources earlier by about eight days for every one standard deviation increase in rice prices at birth. Infants from non-agricultural households are likewise introduced earlier to other food sources by about five days for every one standard deviation increase in rice prices at birth.

The above estimates represent the effect of price shocks to an “average” household. It may be the case however that the effect is heterogeneous across different types of households. For instance, rice price shocks may only be a relevant constraint to households with substantially limited resources. Households who are fully insulated against food price shocks may not change their behavior even with a sizeable increase in prices. We capture such possible differences in responses by re-estimating Column 6 in Tables 2 and 3, but interacting rice prices with dummy variables for different levels of wealth index. Households within -0.5 and 0.5 standard deviation of wealth  $z$ -score are assigned “Middle-”,

Table 2: Rice prices at birth and any-breastfeeding duration, 1993–2011

		OLS						IV-2SLS					
		(1)		(2)		(3)		(4)		(5)		(6)	
<b>A. All Households</b>													
	Rice price	-0.510	***	-0.499	***	-0.165	***	-0.455	**	-0.476	**	-0.345	
		(0.093)		(0.090)		(0.084)		(0.232)		(0.227)		(0.213)	
	Observations	13,922		13,911		13,911		13,922		13,911		13,911	
	Adjusted R-sq.	0.016		0.075		0.18		0.016		0.075		0.179	
<b>B. Non-Agricultural Households</b>													
	Rice price	-0.465	***	-0.460	***	-0.176	*	-0.700	**	-0.761	***	-0.655	**
		(0.116)		(0.114)		(0.106)		(0.287)		(0.283)		(0.269)	
	Observations	9,461		9,452		9,452		9,461		9,452		9,452	
	Adjusted R-sq.	0.014		0.06		0.154		0.013		0.059		0.152	
<b>C. Agricultural Households</b>													
	Rice price	0.062		0.030		0.021		0.214		0.381		0.386	
		(0.139)		(0.134)		(0.133)		(0.368)		(0.356)		(0.346)	
	Observations	4,461		4,459		4,459		4,461		4,459		4,459	
	Adjusted R-sq.	0.014		0.084		0.117		0.014		0.083		0.115	
	Year and Month Dummies	Yes		Yes		Yes		Yes		Yes		Yes	
	Child characteristics			Yes		Yes				Yes		Yes	
	Household characteristics					Yes						Yes	

Note: Sample includes children 18 to 60 months old at the time of the survey. Rice prices are standardized. First-stage F-statistics for IV-2SLS models are all greater than 400. Standard errors (in parentheses) are clustered by siblings. Child characteristics include birth order, sex, and dummy variables for whether the child is wanted at birth, and whether there is a preceding or a succeeding birth respectively within two years. Household characteristics include household wealth  $z$ -score, and dummy variables for mother's highest grade completed. \*\*\*, \*\*, and \* indicate significance at the 1-, 5- and 10-percent alpha levels, respectively.

Table 3: Rice prices at birth and exclusive-breastfeeding duration, 1993-2011

		OLS						IV-2SLS					
		(1)		(2)		(3)		(4)		(5)		(6)	
<b>A. All Households</b>													
	Rice price	-0.250	***	-0.247	***	-0.209	***	-0.246	***	-0.244	***	-0.219	***
		(0.035)		(0.035)		(0.035)		(0.077)		(0.077)		(0.076)	
	Observations	8,601		8,599		8,599		8,601		8,599		8,599	
	Adjusted R-sq.	0.034		0.038		0.067		0.034		0.038		0.067	
<b>B. Non-Agricultural Households</b>													
	Rice price	-0.235	***	-0.232	***	-0.205	***	-0.185	**	-0.185	**	-0.168	*
		(0.042)		(0.042)		(0.041)		(0.091)		(0.091)		(0.089)	
	Observations	5,690		5,689		5,689		5,690		5,689		5,689	
	Adjusted R-sq.	0.044		0.046		0.071		0.044		0.046		0.071	
<b>C. Agricultural Households</b>													
	Rice price	-0.140	**	-0.136	**	-0.147	**	-0.281	**	-0.270	*	-0.269	*
		(0.064)		(0.064)		(0.064)		(0.143)		(0.144)		(0.143)	
	Observations	2,911		2,910		2,910		2,911		2,910		2,910	
	Adjusted R-sq.	0.015		0.016		0.024		0.013		0.014		0.022	
	Year and Month Dummies	Yes		Yes		Yes		Yes		Yes		Yes	
	Child characteristics			Yes		Yes				Yes		Yes	
	Household characteristics					Yes						Yes	

Note: Sample includes children 12 to 60 months old at the time of the survey. Rice prices are standardized. First-stage F-statistics for IV-2SLS models are all greater than 400. Standard errors (in parentheses) are clustered by siblings. Child characteristics include birth order, sex, and dummy variables for whether the child is wanted at birth, and whether there is a preceding or a succeeding birth respectively within two years. Household characteristics include household wealth  $z$ -score, and dummy variables for mother's highest grade completed. \*\*\*, \*\*, and \* indicate significance at the 1-, 5- and 10-percent alpha levels, respectively.

those within -1.5 and -0.5 (1.5 and 0.5) are assigned “Low (High) Middle-”, and those below -1.5 (above 1.5) “Low (High)-” wealth status.

Figure 4 summarizes the estimates for the effect on any-breastfeeding (Panel A) and exclusive breastfeeding (Panel B) by household wealth status. Except for agricultural households in Panel A, the estimates by household wealth status are statistically different from each other, confirming that price shocks have heterogeneous impacts to households. It is interesting to note that while infants from poorer non-agricultural households are weaned earlier from breastmilk, those from richer households introduce breastmilk substitutes and other food sources earlier. Infants from richer agricultural households likewise introduce infants to other food sources earlier.

Taken together, these results suggest that households reallocate resources in response to rice price shocks, which ultimately affects time investments on children. An important concern is how this lost time investment may affect children in adulthood. Based on long-term impact estimates of breastfeeding on IQ and educational attainment by Victora et al. (2015), and on returns to education estimates by Maluccio (1997) as reported in Card (1999), we simulate the long-term impacts of a one standard deviation increase in rice prices at birth through its effect on breastfeeding duration.<sup>3</sup> Table 4 summarizes the results.

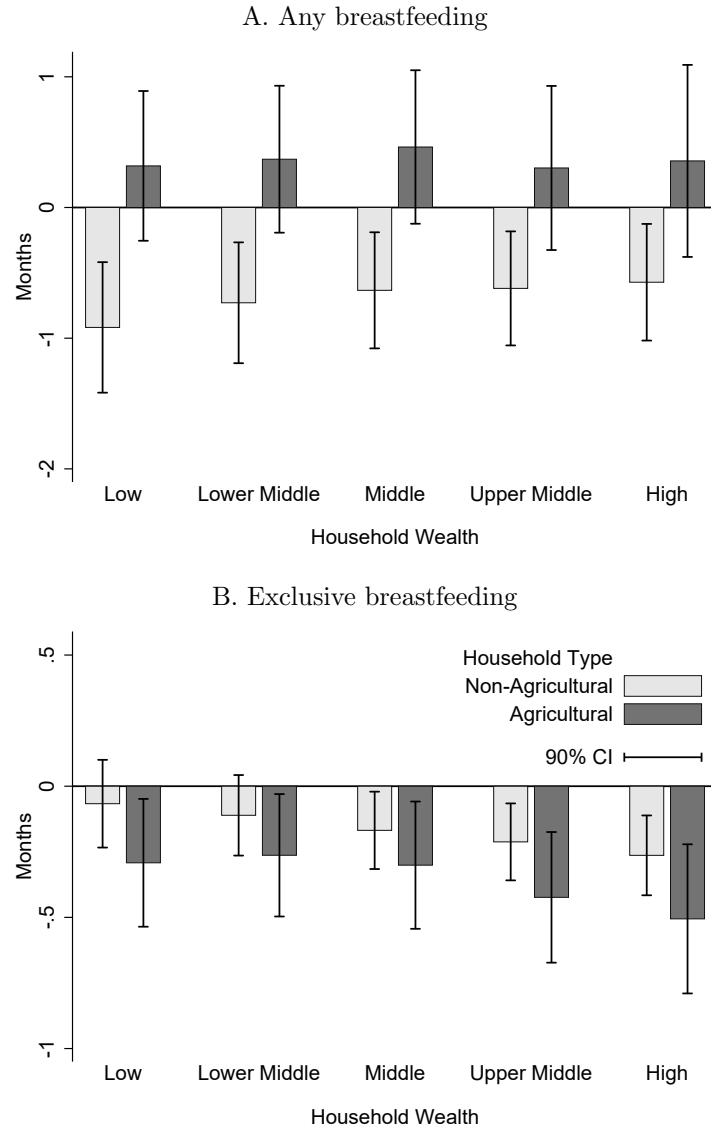
The simulation highlights the differential long-term impact of surges in rice prices on households. The estimates suggests that infants from non-agricultural households would have 0.83 percent lower lifetime income as a result of earlier breastmilk weaning in response to a food price increase. We have no sufficient information, however, to conclude the same for infants born to agricultural households.

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<sup>3</sup>See Appendix A for estimation details.



Figure 4: Rice prices and breastfeeding duration by wealth status, 1993–2011



Note: Any-breastfeeding sample includes children 18 to 60 months old at the time of the survey. Exclusive breastfeeding sample includes children 18 to 60 months old at the time of the survey. Rice prices are standardized. Estimates are based on IV-2SLS model with year- and month-fixed effects, and child and household characteristics as controls. First-stage F-statistics for IV-2SLS models are all greater than 400. Standard errors (in parentheses) are clustered by siblings. Child characteristics include birth order, sex, and dummy variables for whether the child is wanted at birth, and whether there is a preceding or a succeeding birth respectively within two years. Household characteristics include household wealth  $z$ -score, and dummy variables for mothers highest grade completed.

Table 4: Rice prices, breastfeeding duration and simulated long-term impacts, 1993–2011

		Any breastfeeding			Exclusive breastfeeding						
		Full sample	Non-Agricultural		Agricultural	Full sample	Non-Agricultural		Agricultural		
<b>A. Breastfeeding duration</b>											
	Days breast-fed	-4.13	-20.01	***	11.76	-6.64	**	-5.11	**	-8.16	**
		(18.47)	(8.16)		(10.53)	(3.99)		(2.75)		(4.43)	
<b>B. Long-term impact</b>											
	IQ (Points)	-0.04	-0.21	**	0.12	-0.07		-0.05	*	-0.08	*
		(0.21)	(0.12)		(0.13)	(0.05)		(0.04)		(0.06)	
	Education (Years)	-0.02	-0.07	**	0.04	-0.02		-0.01		-0.02	
		(0.07)	(0.04)		(0.04)	(0.02)		(0.01)		(0.02)	
	Lifetime income (Percent)	-0.17	-0.83	*	0.49	-0.18		-0.14		-0.23	
		(0.85)	(0.54)		(0.53)	(0.19)		(0.13)		(0.22)	

Note: Estimates are based on Column 6 of Tables 2 and 3. Long term-impacts are based on back of the envelope calculations using estimates by Victora et al. (2015) on the impact of breastfeeding duration on IQ and year of education, and on Maluccio (1997) as reported in Card (1999) on the returns to schooling. See Appendix A for estimation details. Standard errors are based on 10,000 Monte Carlo replications. \*\*\*, \*\*, and \* indicate significance at the 1-, 5- and 10-percent alpha levels, respectively.

## 4.2 Health

After establishing the effect of rice price shocks on breastfeeding duration, we then seek to uncover the underlying mechanisms that could explain the change in household behavior. Suppose health is an increasing function of food consumption, then an increase in food prices would lead to poorer health, taking all else equal, even among agricultural households if profit effects are minimal.

Using qualitative and actual measures of infant birth weight from NDHS, we estimate the effect of rising rice price on infants health status. Estimates presented in Table 5 show that a one standard deviation increase in rice prices a month before an infants birth decreases birth weight by as much as 43 grams among infants from non-agricultural households (Panel B, Column 2). We find no evidence that infants born to agricultural households are similarly negatively affected. Estimates based on qualitative measure of birth weight using a 5-point Likert scale point to the same conclusions (Columns 3 and 4).

Our results indicate that infant health is counter-cyclical with rice prices. Since infant birth weight is positively associated with maternal health (Kramer (1987)), this could possibly indicate that maternal health likewise deteriorates with increased rice prices. That maternal health has suffered because of increased food prices cannot fully explain the decline in breastfeeding duration, however. Maternal undernutrition, unless severe, has little effect on breastmilk volume and composition (Black et al. (2008)). Although there is evidence that increasing food prices have a negative impact on birth weight, we find not enough evidence to conclude that rice price shocks increase the propensity of a child being born underweight (Columns 5 and 6).

## 4.3 Labor supply

Another mechanism through which food prices may affect breastfeeding duration is the labor supply decision of mothers. With an unfavorable price shock, mothers may be forced to work for pay to maintain a minimum level of consumption. This would effectively lead to less time for children, and ultimately for breastfeeding, which is a time-intensive child investment. Using pooled Labor Force Surveys between 1991 and 1995, we investigate the effect of rice price fluctuations on labor force participation and hours worked among the population of ever-married women aged 20 to 49. Estimates by household type are summarized in Table 6.

At the extensive margin, women with infants and very young children have lower propensity to be in the labor force (Column 1). However, their labor force participation increase by about 3.2 to 6.7 percentage points for every one standard deviation increase in rice prices depending on the age of their child. At the intensive margin, there is limited evidence that mothers significantly increase their hours worked with increased rice prices (Columns 2 and 3), possibly reflecting rigidities in labor demand. While women participate more in the labor market when rice prices go up, those employed can supply labor only up to the maximum hours required of them, which may be different across industries.<sup>4</sup>

This impact on female labor supply is consistent with the insurance-like role women play in many developing economies (Bhalotra (2010)). With limited insurance markets and with inadequate house-

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<sup>4</sup>The Philippine Labor Code sets normal working hours to not exceed eight (8) hours a day. Some class of workers, including family-members in family-operated businesses, e.g. in agriculture, are excluded from this provision. On average, women aged 20–49 employed as crop growers worked 29.1 hours a week in our 1991–1994, i.e. 1995 pre-crisis, sample. Women employed in other industries, on the other hand, worked for 46.3 hours per week on average during the same period.

Table 5: Rice prices at birth and infant birth weight, 1993–2011

	Birth weight (grams)		Birth weight (Likert)		Born underweight	
	(1)	(2)	(3)	(4)	(5)	(6)
<b>A. All Households</b>						
Rice price	-38.454 (20.256)	* -39.003 (20.051)	-0.03 (0.020)	-0.032 (0.020)	0.006 (0.012)	0.007 (0.012)
Observations	16,135	16,127	20,875	20,865	16,135	16,127
Adjusted R-sq.	0.011	0.024	0.003	0.014	0.003	0.017
<b>B. Non-Agricultural Households</b>						
Rice price	-41.957 (23.218)	* -43.395 (22.966)	-0.045 (0.026)	* -0.047 (0.025)	0.014 (0.014)	0.015 (0.014)
Observations	12,691	12,685	14,296	14,288	12,691	12,685
Adjusted R-sq.	0.01	0.022	0.007	0.017	0.003	0.018
<b>C. Agricultural Households</b>						
Rice price	-4.330 (40.770)	-13.316 (40.498)	-0.002 (0.034)	-0.005 (0.034)	-0.027 (0.029)	-0.027 (0.030)
Observations	3,444	3,442	6,579	6,577	3,444	3,442
Adjusted R-sq.	0.039	0.067	0.006	0.02	0.02	0.034
Year and Month Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Child characteristics		Yes		Yes		Yes

Note: Sample includes all children below 5 years old at the time of the survey with reported birth weights. Rice prices are standardized. Birth weight Likert scale ranges from 1 to 5, with 5 being the heaviest. Estimates are based on within-siblings fixed effects model. Standard errors (in parentheses) are clustered by siblings. Child characteristics include birth order, sex, and dummy variables for whether the child is wanted at birth, and whether there is a preceding or a succeeding birth respectively within two years. \*\*\*, \*\*, and \* indicate significance at the 1-, 5- and 10-percent alpha levels, respectively.

Table 6: Rice prices and labor supply of women aged 20-49, 1991:Q1–1995:Q4

	In the labor force (%)		Hours worked (Employed Sample)	
			Short-term	Permanent
	(1)		(2)	(3)
<b>A. All households</b>				
Rice price	0.42 (0.53)		-0.16 (0.54)	-0.59 (0.29) **
With child aged 0-11 months	-26.58 *** (1.42)		0.63 (1.80)	-2.32 (1.14) **
With child aged 12-23 months	-14.75 *** (1.38)		-2.40 (1.53)	-2.18 (0.92) **
Rice price x With child aged 0-11 months	6.66 *** (0.76)		-1.10 (0.97)	0.58 (0.60)
Rice price x With child aged 12-23 months	3.24 *** (0.74)		0.98 (0.85)	0.90 (0.49) *
Observation	349,719		32,792	123,687
Adjusted R-sq.	0.14		0.03	0.05
<b>B. Non-crop grower household</b>				
Rice price	2.97 (0.89)		0.04 (0.66)	-0.56 (0.48)
With child aged 0-11 months	-0.27 *** (0.02)		-0.13 (2.31)	-0.12 (1.79) **
With child aged 12-23 months	-0.13 *** (0.02)		0.72 ** (1.84)	-2.04 (1.37) *
Rice price x With child aged 0-11 months	0.05 *** (0.01)		-0.89 (1.30)	-0.95 (0.98)
Rice price x With child aged 12-23 months	0.01 *** (0.01)		-0.98 ** (1.05)	0.85 (0.75)
Observation	115,414		17,492	38,100
Adjusted R-sq.	0.18		0.03	0.06
<b>C. Crop grower household</b>				
Rice price	-0.59 *** (0.65)		-0.51 (0.87)	-0.44 (0.37)
With child aged 0-11 months	-0.20 *** (0.02)		1.77 (2.92)	-3.06 (1.47)
With child aged 12-23 months	-0.14 *** (0.02)		-5.52 (2.60)	-2.14 (1.22)
Rice price x With child aged 0-11 months	0.04 *** (0.01)		-1.39 (1.51)	1.09 (0.77)
Rice price x With child aged 12-23 months	0.03 (0.01)		2.82 (1.37)	0.89 (0.63)
Observation	234,305		15,300	85,587
Adjusted R-sq.	0.15		0.03	0.04

Note: Sample includes ever-married women aged 20-49 at the time of the survey. Rice prices are standardized. Column (1) reports pooled OLS regressions of labor force status (1 = in the labor force, 0 = otherwise) on controls. Columns (2) and (3) report pooled Tobit regressions of hours worked on controls. Each model controls for age, education, marital status, household members age distribution, survey month and year, province, and province-specific linear time trend. Hours worked models also control for occupation and industry of employment. Standard errors (in parentheses) are clustered by household. \*\*\*, \*\*, and \* indicate significance at the 1-, 5- and 10-percent alpha levels, respectively.

hold assets to draw from, women act as reserved pool of workers from which households may rely on when needed, providing additional income to smooth consumption over economic downturns. As a result, unpaid child-care time declines as mothers are drawn to work for pay in the labor market.

#### 4.4 Alternative mechanisms

While our estimates correct for possible endogeneity bias arising from unobserved household coping strategies, there might be other important variables not present in our empirical models that may confound our breastfeeding duration estimates. Spatial and temporal heterogeneity across our sample infants that are correlated with rice prices may be reflected in our estimates, and not just the effect of increasing rice prices on breastfeeding. Without prior knowledge of the direction of these possible correlations, we cannot meaningfully bind our estimates. In this section, we identify salient sources of heterogeneity, as well as other mechanisms, that may affect breastfeeding decisions, and discuss the probable direction of their bias.

**Local public spending.** In 1992, the Philippines adopted the immediate post-delivery rooming-in of babies with their mothers as a national policy to encourage breastfeeding. Evidence from other developing countries, for instance by Perez-Escamilla et al. (1994), show that rooming-in of infants with their mothers is associated with higher breastfeeding incidence. Health care provision, however, has been largely decentralized since 1991 with the adoption of the Local Government Code, which may result to differences in the depth and breadth of breastfeeding practices across the country. While decentralization may result in heterogeneous implementation of the national post-delivery rooming-in policy at the local level, the expected effect of the policy intervention is to expand breastfeeding adoption among mothers, and not to contract breastfeeding practices as observed in our analysis.

**Infant formula advertisement.** Many studies have observed the negative association between active marketing of infant formula substitutes and of breastfeeding duration (Abada et al. (2001); Sobel et al. (2011)). Although marketing campaigns are often programed at the national level, advertising penetration may be different across regions due to differences in campaign exposure of households. With increasing media access by households, unobserved advertising penetration rates may bias our estimates upwards. This implies that our estimates may actually be interpreted as lower bound estimates of the effect of rice price inflation on breastfeeding.

**International trade and market integration.** PSA data between 1990 and 2010 show that total international trade with the Philippines increased by about 2 to 3 percent annually in real terms. Gains from trade and market integration however may not be uniform across the population, and it is likely that some may even suffer losses (Venables (2003); Williamson (2005)). In addition, globalization may likewise affect consumer preferences (Cowen (2009)), possibly including demand for breastmilk substitutes. These effects are explicitly taken into account in our empirical model by including year fixed-effects to the extent that these variables capture the effect of increased trade and market integration on breastfeeding propensity.

**Insurance and storage.** Overall, our estimates point to imperfect insurance and storage mechanisms among households, which results to non-smooth labor supply and consumption decisions in

response to transitory price shocks in the rice market. This is similar to findings on imperfect smoothing in consumption (Fafchamps and Lund (2003)) and income (Yang and Choi (2007)) among households in the Philippines. While agricultural households, by virtue of own-production, are in a greater position than non-agricultural households to smooth consumption, this is only possible when storage markets are existent, or, alternatively, relevant financial or insurance markets are present. The evidence suggests that even agricultural households are not insulated against food price shocks.

## 5 Conclusion

Using large exogenous spatio-temporal variations in rice price fluctuations, we examine the impact of increasing food prices on breastfeeding duration among infants in the Philippines. We provide evidence that infants are also significantly affected by food price movements. These early-life impacts are expected to affect them until later in adulthood as shown in other studies (e.g., Victora et al. (2015); Horta et al. (2007); Barker (1990); Banerjee et al. (2010); Maccini and Yang (2009); Van den Berg et al. (2006)). We document behavioral responses by mothers to food inflation that constrains their breastfeeding decisions.

We provide new evidence that producers are not necessarily insulated against food price inflation. While crop growers could at least partially offset direct price effects by their expanded income, we find no evidence that such is the case. This suggests that agricultural households have more inelastic demand or that profit effects are negligible. Our findings support earlier evidences of imperfect income- and consumption-smoothing among households.

Our results are consistent with the long literature on the effect of food prices on household labor supply and health outcomes. Studies especially in developing economies report pro-cyclical labor supply (Alderman and Sahn (1993); De Janvry et al. (1991)), and counter-cyclical nutrients intake and morbidity (Pitt and Rosenzweig (1985); Lee et al. (2011)). These impacts effectively limit the ability of households to provide accessible and inexpensive, yet time-intensive investments, such as breastfeeding, to children.

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# Appendices

## Appendix A Simulating long-run impacts of rice price shocks through infant breastfeeding duration

To assess the possible impact of rice price shocks on future adult outcomes, we simulate the expected changes in IQ, educational attainment, and income brought about by changes in household breastfeeding duration decision in response to rice price shocks. This provides a concrete measure of the possible impact of food price fluctuations on child welfare through their future adult outcomes.

First, we simulate the effect of a one standard deviation increase in rice prices on IQ and educational attainment based on our impact estimates in Column 6 of Tables 2 and 3 of rice prices on any- and exclusive-breastfeeding duration, and on the long-term impacts of breastfeeding on IQ and educational attainment estimated by Victora et al. (2015). Specifically, we estimated the following

$$\tau_j = \beta_j \gamma \Delta P \quad (2)$$

where  $\tau_j$  is the simulated long-run impact of rice price shock on outcome  $j$ , where  $j$  is either IQ or years of education, through the effect of rice prices on breastfeeding duration.  $\beta_j$  is the impact of breastfeeding duration on outcome  $j$  taken from Victora et al. (2015), and  $\gamma$  is the impact of rice price shocks on breastfeeding duration estimated in this study.  $\Delta P$  is our assumed rice price shock, equal to one standard deviation. Standard errors are estimated by independently drawing 10,000 replicates from the sampling distributions of  $\beta_j$  and  $\gamma$ , respectively.

Second, based on the results of the simulation outlined above, we then estimate the expected change in income  $\theta$  as a result of changes in years of schooling  $\tau_S$ . We simulate the effect of rice prices on income by estimating

$$\theta = \tau_S \phi \quad (3)$$

where  $\phi$  is the expected returns to schooling estimated for the Philippines by Maluccio (1997) as reported in Card (1999). Ideally, we would want to also incorporate the effect of changes in IQ level on income, but no estimates for the Philippines are available taking this variable into consideration. As such, our estimates on the impact of rice prices on income through breastfeeding duration could be an underestimate of the true impact if schooling and IQ are complementary. Standard errors are similarly estimated as above by independently drawing 10,000 replicates from the distributions of  $\tau_S$  and  $\phi$ , respectively.