Global Food Security 2 (2013) 110–116

Contents lists available at SciVerse ScienceDirect

Global Food Security

journal homepage: www.elsevier.com/locate/gfs

A framework for analyzing the interplay among food, fuels, and biofuels ☆

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ARTICLE INFO

Article history:
Received 23 October 2012
Accepted 25 April 2013

Keywords:
Food price
Biofuel
Energy

ABSTRACT

This paper provides a framework for analyzing the complex relationship among food, fuels, and biofuels. It first notes that high energy prices increase the costs of producing food and can induce policies that divert food crops to the production of biofuels. Then, it argues that sustained high crude oil prices, in addition to rendering biofuels profitable, could also induce innovations by increasing the energy content of (existing or new) crops grown on arable land, in turn causing further food price increases. Hence, as we move forward, crude oil prices are likely to play an even more important role in shaping food price trends.

1. Introduction

The commodity price boom that emerged in the mid-2000s, after nearly two decades of low prices, has been especially marked for agriculture (Fig. 1). From their 1974 peaks to the 2000 lows, world real agricultural and food prices declined by 60 and 70 percent, respectively. Starting in the early 2000s, however, prices reversed course, eventually leading to an unprecedented boom. Between 1997–2004 and 2005–2012 energy, fertilizer, and precious metals nominal prices tripled, metal prices went up by more than 150 percent, while food prices almost doubled. A vast literature has emerged on the causes of the boom, some of which have been hotly debated, especially the role of speculation and loose monetary policies, and in the case of food commodities, the role biofuels. This paper focuses on the role of energy and biofuels in the determination of food prices.

The price boom took place during a period when most countries sustained strong economic growth. Indeed, during 2005–2012, emerging economies grew by 6.2 percent, one of the highest 8-year averages in recent history. Yet, although economic growth played its role, it was only one among numerous causes of the boom. Fiscal expansion in many countries along with low interest rates created an environment that favored high commodity prices. The depreciation of the U.S. dollar strengthened demand from (and limited supply for) non-US$ commodity consumers (and producers). Other important contributing factors included low past investment, especially in extractive commodities (in turn a response to a prolonged period of low prices), investment fund activity by financial institutions that chose to include commodities in their portfolios, and geopolitical concerns, especially in energy markets.

In the case of food commodities, prices were affected by additional factors specific to agriculture such as higher energy costs, more frequent than usual adverse weather conditions, and the diversion of some food commodities to the production of biofuels. These conditions led the global stock-to-use ratios of some commodities down to levels not seen since the early 1970s (Table 1). Lastly, policy responses including export bans and prohibitive taxes to offset the impact of high world prices set the stage for what has been often called a 'perfect storm' since almost all factors contributed in the same direction, that of increasing prices (Baffes and Haniotis, 2010).

Against this backdrop, the paper examines the energy–biofuel–food price link under two ("High" and "Low") oil price scenarios. The paper begins by noting that, in addition to increasing production costs of food commodities, high energy prices induce policies that divert food crops to the production of biofuels. Thus, under a "Low" oil price scenario, food prices may decline considerably due to lower production costs and likely easing of biofuel policies. The paper then conjectures that under a "High" oil price scenario, not only biofuel production could become profitable (since food becomes another form of energy), but induced innovations could increase the energy content of crops grown on arable land, thus pushing food prices even higher. The key conclusion is that in the longer term oil prices are likely to play a pivotal role in determining food prices that goes far beyond the costs of production.

2. The energy–food price link

To motivate the discussion, we begin by identifying the key channels through which energy and food markets interact with

☆I would like to thank Achilleas Adamantiades, Ataman Aksoy, David Dawe, Tassos Haniotis, Ioannis Kessides, Shane Streifel, and two anonymous reviewers for helpful comments and suggestions on earlier drafts. The views expressed here are those of the author.

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2211-9124/$ - see front matter
http://dx.doi.org/10.1016/j.gfs.2013.04.003

each other (Fig. 2). The first channel reflects the fuel cost side, whereas higher fuel prices increase the cost of producing and transporting food commodities (link A). Higher energy prices increase the cost of chemicals and fertilizers, some of which are crude oil byproducts or directly made from natural gas, a substitute to crude oil (links B/C). The second channel relates to policies favoring the production of biofuels, which are often driven by the objective of reducing dependence on imported crude oil (links D/F). (Link E denotes non-biofuel policies affecting food prices than may or may not be affected by energy prices, not discussed in this paper). Third, high oil prices could make biofuels profitable even in the absence of policy measures (link G1). Last, profitable biofuels could spur innovations in crops grown in arable land by increasing their energy content, thus boosting food prices even further (link G2). The remaining of this section elaborates on these four links.

2.1. The cost link (A and B/C)

The strong relationship between energy and non-energy prices has been established long before the post-2004 price boom. Gilbert (1989), for example, using quarterly data between 1965 and 1986, estimated transmission elasticity from energy to non-energy commodities of 0.12 and from energy to food commodities of 0.25. Hanson et al. (1993) based on a General Equilibrium Model found a significant effect of oil price changes to agricultural producer prices in the United States. Borensztein and Reinhart (1994), using quarterly data from 1970 to 1992, estimated transmission elasticity to non-energy commodities of 0.11. A strong relationship between energy and non-energy prices was found by Chaudhuri (2001) as well. Baffes (2007), using annual data from 1960 to 2005 estimated elasticities of 0.16 and 0.18 for non-energy and food commodities, respectively. Moss et al. (2010) found that U.S. agriculture's energy demand is more sensitive to price changes than any other input. Interestingly, most of these studies show that the effect of energy prices on food prices is much higher than raw materials and metals. Indeed, the input-output values of the GTAP database show that the direct energy component of agriculture is four to five times higher than manufacturing sectors (Fig. 3).

Pindyck and Rotemberg (1990) examined the degree of comovement among seven commodity prices (cocoa, copper,

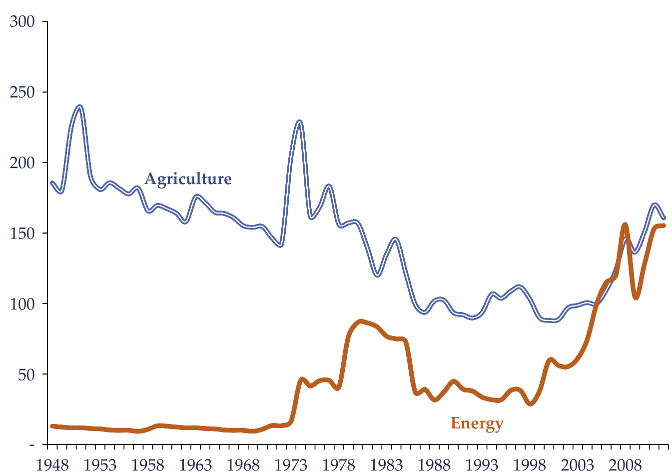

Fig. 1. Long term price trends (MUV-deflated indices, 2005 = 100).
Source: World Bank.

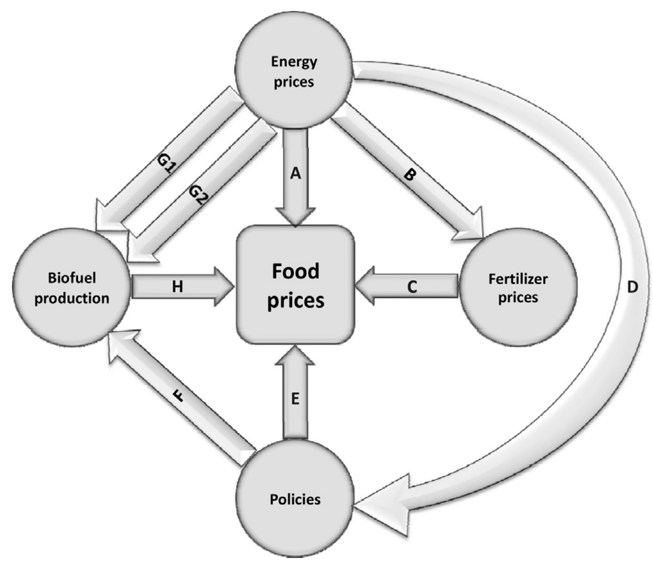

Fig. 2. The relationship among energy, biofuels, and food.

Table 1
Most macroeconomic and sectoral drivers are consistent with high prices.
Sources: BarclayHedge, Center for Research for the Epidemiology of Disasters, Federal Reserve Bank of St. Louis, Organization of Economic Co-operation and Development, U.S. Department of Agriculture, U.S. Treasury, World Bank, and author's calculations.

	1997–2004	2005–2012	Change (percent)
Food price index (nominal, 2005 = 100)	**89**	**154**	**73**
Macroeconomic drivers			
GDP growth (emerging economies, percent p.a.)	4.6	6.2	36
Industrial production growth (emerging economies, percent p.a.)	5.4	7.3	36
Crude oil price (nominal, US$/barrel)	25	79	223
Exchange rate (US$ against a broad index of currencies, 1997 = 100)	118	104	−11
Interest rate (10-year U.S. Treasury bill, percent)	5.2	3.6	−31
Funds invested in commodities (US$ billion)	57	230	302
Sectoral drivers			
Stocks (total of maize, wheat, and rice, months of consumption)	3.5	2.5	−27
Biofuel production (million tons of oil equivalent, annual)	11.5	44.8	290
Fertilizer price index (nominal, 2005 = 100)	69	207	201
Growth in yields (average of wheat, maize, and rice, percent p.a.)	1.4	0.5	−63
Yields (average of wheat, maize, and rice, tons/hectare)	3.7	4.0	10
Natural disasters (droughts, floods, and extreme temperatures)	174	207	19
OECD policies (Producer NPC, percent)	1.3	1.1	−13

Notes: 2012 data for some variables are preliminary.