Literature review on the consequences of food price spikes and price volatility

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LITERATURE REVIEW ON THE CONSEQUENCES OF FOOD PRICE SPIKES AND PRICE VOLATILITY

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Abstract

Food price volatility has drawn much attention from the international community in the beginning of the 21st century, in the aftermath of the 2008 and 2010 food riots. One strand of the literature aimed at identifying the economic origins of the increased variability of prices (supply shocks, underinvestment in the agricultural sector, financial speculation and increased demand from the emerging markets), while several articles were trying to assess whether there had actually been a change in the volatility regime in the first place.

Yet another strand of the literature focused on the consequences of food price shocks and volatility. This paper provides a comprehensive review of this extensive literature on the impacts of food price shocks and food commodity volatility. The consequences are assessed both in micro- and macroeconomic terms, from the consumer's and producer's sides, as well as from the theoretical and empirical points of view. If the vast majority of studies points to a detrimental impact of food price shocks on the livelihood of many in the developing world, and on potentially dire consequences on production, growth and political stability, this literature review reveals, above all, the lack of proper investigation about the consequences of food price volatility in itself. The hype around the excessive volatility of the food markets did not translate into an academic focus on the consequences of this price instability.

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Introduction

The primary goal of this paper was to propose an analytical review of the academic literature on the economic consequences of food price volatility: We aimed at understanding why food price volatility was at the root of unprecedented political and humanitarian stakes, and at identifying the mechanisms through which it could transpose in the real economy, especially in developing countries.

One might think that such a broadly defined subject might be confronted with far too large a corpus of academic papers to provide an efficient synthesis, especially given the intense lights that have been shed on the issue over the past decade in the media. Yet it so happens that it did not turn out to be the case, and only did a handful of papers precisely address the consequences of food price volatility. In order to get some more insights on the issue at stake, we were forced to even enlarge our topic so that to include individual food price shocks on the one hand, and macroeconomic volatility broadly defined on the other hand. As such, our paper deals more broadly about the consequences of food price movements, and do not constrain itself to food price volatility strictly speaking.

Even if price volatility and price shock are theoretically two distinct concepts, it nevertheless makes sense to survey their consequences jointly. Some high volatility episodes actually stem from a succession of price shocks, and getting insights on the way people react to a given price shock can help better understand the impact of price instability.

Price movements are an issue on both the production and consumption sides: The risk that is associated with sudden and unexpected variations of prices (volatility) puts many farmers into difficulty, since they cannot manage to estimate their revenues on the long run in a reliable way, which leads them to limit investment in productive capital, all the more so as credit and insurance are often not available to them. Simultaneously, price shocks, even when predictable, threaten the survival of the poorest, for which food expenditure amounts for an extremely important fraction of their current budget and who often lack access to credit markets.[1] The survival mechanisms implemented in crisis situations are most likely to involve women and children labor, the interruption of schooling and medical care, as well as a dramatic reduction of the food intake. In economic terms, price shocks often induce a suspension of investment in human capital.

The difficulties that most inhabitants of developing countries face to access international markets (may they be physical, financial or insurance-related), as well as the low level of initial

[1] See, e.g. FAO (2011): "Furthermore, even perfectly predictable changes in prices can cause problems for poor households that are unable to borrow when prices are high and thus are unable to 'smooth' their consumption over time. Thus, in Asia, where seasonal price changes are relatively more predictable than in Africa, there is still widespread concern over the ability of poor households to cope during the lean season immediately before the harvest, despite the fact that this lean season is very predictable". (p.18)
The impact of financial development initiatives (access to savings pools or insurance) on production and investment decisions, food security, and consumption smoothing has been reviewed in Karlan et al (2016).

resources are additional factors that magnify their vulnerability. Whether volatility translates into predictable variability or into uncertainty, it presumably induces a strong liquidity risk that limits investment in physical capital, as well as in human capital. It is therefore reasonable to think that food price volatility damages long-run economic growth since it reduces the constitution of productive capital stock, and limits the productivity gains that are traditionally associated with the population's health and education.

Our analysis builds on a very large collection of scientific articles addressing the link between food prices and the economy at large. We believe that limiting ourselves to the rare articles investigating the consequences of food price volatility would have been far too restrictive. We are perfectly aware that volatility and shocks are not overlapping concepts, yet we believe that, in the absence of thorough investigation on the consequences of volatility *per se*, analyses of shocks are the most relevant information available. Put it simply, the response of an economy to a given shock is often the best proxy we have to assess the impact of highly variable prices. Although it is necessary to distinguish between volatility and price levels, it is important to understand that the analysis of a given price shock provides valuable indications of what happens at each positive jump of a price series that is characterized by its great variability.

We also included in our review articles addressing the impact of macroeconomic variability broadly speaking, as we figured out that omitting them would have led to ignoring part of the scarce information on the way economic instability can affect the economic structure and its performances. Talking about the volatility of commercial situations (may that be reflected by the terms of trade,[2] by the exchange rate, or by the share of exports in the gross domestic product), or even about the volatility of growth might very well look out of purpose. Yet these phenomena can sometimes be understood as consequences of food price volatility, in large net exporting or importing countries for instance. In the absence of dedicated research on the consequences of food price volatility, these studies can help shed light on the issue.

Eventually, we also included studies investigating the impact of climate shocks on growth or on the formation of human capital, even if they did not consider explicitly the price channel. Indeed, as the climate has a direct influence on the volume of agricultural production (and thus on its price), these studies give us complementary indications on the impact of food price shocks.

[2] i.e. the imports' price level divided by the exports' price level.

Proposed outline:

The neo-classical theories of economic growth consider that the improvement in a society's standards of living is made possible by the accumulation of productive capital on the one hand and by technological progress and productivity gains on the other hand. In the words of Jacks, O'Rourke & Williamson (2009): "Indeed, the development literature offers abundant contemporary microeconomic evidence linking income volatility to lower investment in physical capital, human capital and even research and development."

Along these lines, it appeared logical to organize this paper in the following way: first, we will study the economic theories and the empirical validations that link price volatility to productive investment. Second, we will try to understand why volatility can modify the constitution of the human capital stock (encompassing health, education, or even mere survival), at the root of innovation and technological progress. Last, we will expose the empirical proofs that link volatility to long run economic growth.

1. Impact of volatility on the accumulation of productive capital

a) General theory of investment in a volatile environment

It is rather difficult to conclude about the impact of price volatility on investment in a purely theoretical way. Indeed, considering volatility as the manifestation of an increased macroeconomic risk, one could expect, as explained in Deaton (1992), that the precautionary savings would increase. The increase of savings on its own would induce a decrease in the interest rates (the price of capital), and would thus lead to an increase in the actual realized investment. Nevertheless, it would be a mistake to consider that the accumulated savings would be integrally available on the capital markets. Indeed, precautionary saving aims at constituting a buffer that must be quickly usable in case of emergency (if prices do indeed increase). As a consequence, precautionary saving must be liquid, and one can doubt it would feed in the investments in productive capital, illiquid by nature (Timmer, 2002). What is more, the constitution of precautionary saving supposes the ability for firms and households to save, that is to say wages enough above the subsistence threshold, which is obviously not the case for many inhabitants of the least advanced countries.

Additionally, risk in itself has a strong impact on the demand for capital. The classical theory of investment goes that there is a strict trade-off between the return on an investment and its safeness: the less risky the investment, the lower the risk premium so that in expectation and in equilibrium, marginal investors are indifferent between two projects featuring different risk-return features. An important qualification of this theory is that you need to know the probability distribution that rules the payoffs.[3]

[3] cf. the distinction introduced by Knight (1921) between risk and uncertainty: in the former, the economic agents are able to distribute objective probabilities on the different states of the world; in the latter, they are not able to do so.

In the situation where the investors have convex utility functions (i.e. with risk aversion), they tend to prefer investments with lower but safer returns. A rise in volatility for a given level of overall profitability would therefore induce a reduction in the amount of investment. This phenomenon could be amplified should we consider that economic agents adapt their risk aversion to the general perception of risk (i.e. the risk aversion parameters are endogenous to the aggregate level of risk). In a riskier, more volatile environment, we could observe a systemic decrease in agents' willingness to take on risk, leading to a decrease in the level of available funding.

The volatility increase is problematic for investment for yet another reason: considering the work of Lucas (1973) about the extraction of information from the price signal, Timmer (2002) explains that investment decisions could be blurred by a wrong estimation of long term trends, estimations that are more complicated because of the disorderly movements of prices. In such circumstances, it is not the quantity of investment that is at stake, but rather its quality. Savings still go to capital markets and still are allocated to projects, but not necessarily to the more sensible ones (those whose returns are, ex post, the greatest). In his analysis of the links between speculation and food price volatility, Spratt (2013) writes: "The clear need is for prices to accurately reflect real demand conditions, and therefore to send correct signals. Artificially high or low prices send spurious price signals, while excessive volatility distorts these signals: in order to respond to high prices by raising supply, producers need some degree of certainty that price levels will be maintained." This phenomenon could be linked with the recent concerns about current accounts disequilibrium (savings glut): the excess saving is channeled towards investments that are riskier and riskier, and yet do not provide a high yield.

Eventually, it is extremely important to account for the non-linearities and the constraints that characterize investment decisions, such as irreversibility (e.g. for physical investment), or limits to the credit supply that could prevent agents to take full advantage of beneficial situations, and would thus prevent them to cover the risk of negative states of the world (Aizenman & Marion, 1999). These constraints are particularly present in countries where markets are not sufficiently developed, or where the sovereign risk is high. Easterly et al. (2000) show for instance that the development of financial markets is the major contributing factor to the reduction of growth volatility (up to a certain level where the leverage effects become a source of "macro-vulnerability"). The potential for loss aversion[4] (a cognitive feature that generally makes people 'value' a one-dollar-gain more than a one-dollar-loss) can amplify the impact of these non-linearities at the microeconomic level.

Many theoretical models of physical investment have been proposed to describe the mechanisms presented above, under various hypotheses. Pindyck (1988) shows that when investments are irreversible (with asymmetric adjustment costs for instance), a greater volatility

[4] See Gul (1991).

can lead to a reduction of physical capital investment (see also Bernanke (1983) and Pindyck (1991)). The model developed in Pindyck and Solimano (1993) indicates that volatility should increase the required return of investments, thus lowering investment spending in the short run. On the other hand, Hartman (1972) and Abel (1983) demonstrate that, when supposing symmetrical adjustment costs, risk neutral firms, and perfectly competitive markers, it is possible to come across situations where volatility actually increases investment. Aizenman & Pinto (2004) indeed explain that if the profit function is convex, volatility can increase expected profits. Caballero (1991) concludes that when we suppose that firms are risk neutral, volatility increases investments if we have both perfect competition and increasing returns to scale. In Caballero's own words, "The relationship between changes in price uncertainty and capital investment under risk neutrality is not robust… it is very likely that it will be necessary to turn back to risk aversion incomplete markets and lack of diversification to obtain a sturdier negative relationship between investment and uncertainty."

The role of financial development in the relationship between commodity price volatility and growth has been investigated in Aghion et al (2010) in a model with two types of investments (long term, productivity enhancing and short term). The authors point to the fact that under credit constraints, the share of long term investment to total investment turns from being contra-cyclical into being pro-cyclical, thus amplifying the impact of economic shocks on productivity and growth.

We conclude that macroeconomic volatility tends to be detrimental to investment, except under very specific circumstances that in general are not gathered in developing countries (complete and perfect markets, risk neutrality …).

b) **Some empirical results on this general relationship**

In this section, we present some empirical evidence on the relationship between investment and volatility in a broad sense. As we already stressed, there is only a very limited number of studies investigating the consequences of food price volatility in itself, let alone on physical capital investment. In order to provide some insights on the issue at stake, we therefore had to broaden the spectrum of our survey, and consider other kinds of volatility measures, that can be somewhat logically correlated to food price volatility, although not perfectly. If the volatility of terms of trade affects aggregate investment, then one could hypothesize that the volatility of food prices would affect agricultural investment in a similar way. Another way to justify this scope broadening would be to underline that food price volatility can induce macroeconomic instability by means of terms of trade variations, exchange rate fluctuations, or policy emergency responses for instance (see e.g. von Braun and Tadesse, 2012). Hence, looking at the consequences of macroeconomic volatility can be a roundabout way of assessing the potential consequences of food price volatility.

We have seen in the previous section that theoretically, the net impact of price volatility on investment was not straightforward. The empirical investigations of the link between macroeconomic volatility and aggregate investment are also rather mixed.

Analyzing aggregate investment and growth volatility over time for different panels of countries, Ramey & Ramey (1995) fail to exhibit a statistically significant correlation between the two macro-level variables. They conclude that volatility affects growth through its impact of the total factor productivity rather than through the investment channel.[5] On the contrary, redefining macroeconomic instability as the volatility of foreign trade, Dawe (1996) pointed at a positive correlation with investment. A more instable macroeconomic environment was associated with a higher level of investment, a result which he attributed to an increase in the aggregate level of savings, potentially for precautionary reasons. Interestingly though, despite the increase in investment, he observed a decrease in the growth rate, and thus leaned towards the theory of price signal blurring, with a decrease in investment quality. More recently, Blattman et al (2007) used a macro-level dataset with an economic history perspective (between the end of the 19th and the beginning of the 20th century) and demonstrated that the English financial markets (the main funding platform at the time) were less likely to fund peripheral countries with large terms of trade volatility. The authors concluded that British direct foreign investment had been the main channel through which volatility had affected growth.

As one can see, the evidence is rather ambiguous and the results depend strongly upon the period, method, and volatility indicator. Aizenman & Marion (1999) shed new lights on the relationship between investment and macroeconomic volatility by disaggregating the former into its public and private components, and analyzing more systematically the different volatility measures.[6] They conclude that aggregate investment is not much correlated to volatility, whereas decomposed data are. Private investment is greatly reduced by a stronger volatility, whatever the index used as a control, whereas public investment generally evolves in the same direction as volatility. This study shows that the response of investment to volatility could very well have been confused by the contra-cyclical reactions of governments, who were compensating the decrease in private investment with increases in public investment. Another decomposition of total investment (between long-term productivity-enhancing and short-term) is proposed by Aghion et al (2010). The authors also conclude that although the total amount of investment is not much altered by macroeconomic shocks, the composition thereof varies greatly depending on the degree of financial development, leading to a more volatile growth with even lower mean for those countries with tighter credit constraints. Hausman and Gavin (1996) had previously shown

[5] Pindyck and Solimano (1993) showed that the volatility of the marginal profitability of capital had a significant detrimental effect on investment for low income countries, but not for OECD countries.

[6] Aizenman et Marion focus on three types of volatility: that of government consumption expenditure, as a fraction of GDP (fiscal policy instability), that of the nominal growth of money (monetary policy instability) and that of the real exchange rate (trade policy instability). Each of these indices was calculated using the standard deviation of the residuals of first order auto-regressive processes. The third measure is the most accurate for our analysis of the impact of food price volatility on investment.

that the link between GDP volatility and investment could disappear when controlling for the depth of local financial markets (see also Easterly et al, 2000).

In the theoretical presentation, we had seen that the response of investment could depend on the market structure considered. The results of Aizenman & Marion (1999) question the role of public institution and governing bodies in both the observed volatility and in the correlation between investment and volatility. Some insights are given for instance by Myers (2006), when he writes that "food price fluctuations may lead to macroeconomic fluctuations and political instability that, in turn, retard investment and reduce the rate of economic growth". As for Rodrick (1999), he advances the hypothesis that the instability or the weakness of governments increases the verification and enforcement costs, which could limit the investment possibilities in economic downturns. Aizenman & Pinto (2004) note that "[…] strong institutions dampen volatility, while weak ones enhance its negative consequences."

On the microeconomic side, Minton and Schrand (1999) analyzed a dynamic panel of American firms and were able to show that higher cash-flow volatility was associated with higher funding costs. Even when controlling for this increased cost of capital, cash-flow volatility was still associated with lower investments (specifically capital expenditures, R&D and advertisement). According to the authors, "cash flow volatility is related to investment because it increases the likelihood that a firm will need to access capital markets and it also increases the costs of doing so"(p.455). Interestingly, even with one of the most mature capital markets, revenue volatility appears to drastically reduce the propensity to invest.

The hypotheses on the market structure, the financial development, the reversibility of investments, as well as the reliability of governments and their ability to support the formation of productive capital in the downturns of the economic cycle can therefore modify the conclusions concerning the consequences of volatility on overall investment, which could explain the different results obtained.

c) **The particular case of agricultural investment**

This section focuses on the economic literature dedicated to the impact of agricultural price volatility on producers' investment decisions. Indeed, if we can apply the results linking price volatility and investment to the agricultural sector, it is nevertheless necessary to note that this sector has specific characteristics because of the very nature of the goods it produces. In developing countries, agricultural land has the dual function of creating revenue and guaranteeing the family's food rations. It is thus necessary to distinguish between two types of production, cash crop and food crop, as they enter into competition in the allocation of land and labor.

Fafchamps (1992) developed an analytical framework for investment under uncertainty allowing for the explanation of widely observed feature of the agricultural Third World: the poorest farmers dedicate a larger share of their land and labor to the production of food crop.

This phenomenon can seem paradoxical since food crops are generally more vulnerable to climate shocks and have lower yield. Fafchamps explains that the incompleteness or even absence of robust markets in least advanced countries forces farmers to rely primarily on themselves to feed (self-sufficiency). In other words, they cannot take the risk of producing high yield crops unless they secured their food supply. One could hypothesize a land acreage threshold above which it would be possible to consider a partial conversion toward cash crops. Yet below this threshold, farmers are locked in a poverty trap, with a specialization in low return, high volatility food crops, and sometimes not even enough to cover the household needs. Poulton et al (2006) estimate these net deficit producers (who do not produce enough to meet their own food needs) around 70 to 80% of rural households in Africa.

Fafchamps's model demonstrates that food crops are a rational means of insurance against the probability of bad harvest, even if the insurance process is greatly (and even almost perfectly) correlated with what it is supposed to insure (indeed, we are talking of local markets for which the risk of bad harvest is highly likely to be systemic). The importance of growing one's own food as a means to reduce the exposure to price risk had also been recognized by Roumasset (1976).

Price instability affects agricultural investment patterns at the microeconomic level, in particular when markets are incomplete or isolated. The response to increased volatility will depend on the characteristics of the farming population. As remarked by Poulton et al. (2006), "from a theoretical prospective, food price volatility will have different consequences for surplus and deficit households. It will tend to discourage investment in staple production by surplus households, who are important sources of food both locally and national, but will encourage deficit households to continue devoting scarce resources to staple food production, thus impeding progress towards diversification into higher value crops. Thus, food price volatility could be a major impediment to many poor households climbing out of poverty."[7] Anecdotal evidence is provided by Place, Adato and Hebinck (2007) who use formal surveys to document the lower propensity of the poor in Kenya to grow a cash crop, to use hybrid seeds, or to use fertilizer.

Looking at the broader picture, food price volatility could also lead to a dramatic decrease of investment all along the agricultural value chain, thus maintaining the overall sector in a trap combining low productivity and high volatility (cf. Poulton et al., 2006).

It is commonly said that poor producers' inability to predict and smooth their revenues leads them to limit their investment in the productive scheme, and focus their production on low risk technologies (see e.g. FAO (2011), p.19), and this is indeed what Fafchamps' model indicated. On the empirical side, though, the impact of food price volatility on agricultural investment has seldom been investigated.

[7] see also Gouel (2013)

Kurosaki and Fafchamps (2002) demonstrated that the crop choice was influenced by the level of price and yield risk borne by the households in Pakistan Penjab, and estimated that the elimination of risk could increase the acreage dedicated to cash crop up to 30% for the median household. Using Ethiopian household data, Dercon and Christiaensen (2011) were also able to demonstrate a link between vulnerability and technology uptake: those households whose consumption was most responsive to shocks were making less use of fertilizers (even after controlling for household characteristics). Fertilizers indeed increase yields on average, but they do not really protect against a weather shock. In the bad state of the world, they therefore represent a sunk cost, and contribute to lowering returns further, which vulnerable farmers cannot afford. Rosenzweig and Binswanger (1993) developed a framework linking the agricultural asset portfolio allocation to weather risk, which they applied to Indian data. They were able to show that the riskiness of the portfolio was indeed inversely correlated with the weather risk borne by the farmer.

The results of the randomized field experiment by Giné and Yang (2009) are less conclusive: they offered loans to purchase high-yield hybrid seeds to Malawian farmers, with half the loans being tied to a weather-insurance (at an actuarially fair price, but still making the loan more expensive). They were surprised to find that the uptake of the yield improving loan was more than a third lower with insurance. Yet they conclude that this result is most likely due to the limited liability of the farmer associated with the higher cost of the insured loan, and not to the fact that reduced risk would lower the investment in higher yield technologies.

Additional studies investigated the impact of a climate (or economic) shock on the investment strategies of agricultural households. Zimmerman & Carter (2003) indeed documented that farmers' investment behaviors did vary depending on initial allocations, with wealthy farmers investing in productive capital (high yield) in order to smooth their consumption while the poorest stock grains (more liquid, but with a lower yield), and smooth their capital rather than their consumption.[8] Along the same line, Hoddinott (2006) documented a significant increase in cattle sales during the severe rainfall shock that hit Zimbabwe in 1994-1995, especially among those households owning initially more than two animals. The sale enabled some households to smooth consumption and to reduce the draught impact on health outcomes (which the author interprets as a change in asset portfolio: less physical capital, but a preservation of human capital). The case studies reported in FAO (2009) showed also that during food crises, poor households tended to sell part of their productive assets (livestock) as a coping strategy,[9] yet the dominance of an asset-smoothing strategy over a consumption-smoothing one appears to be context-specific (FAO, 2011), and indeed the actual behavior of farmers is often a mix of both. Fafchamps, Udry and Czukas (1998) showed that livestock sales had only

[8] Rosenzweig & Wolpin (1993) had previously shown that limited access to credit had prevented Indian farmers to resort to investment in productive capital (bullocks) as an insurance mechanism against income variation, which maintained revenues at low levels and fed in volatility (cf. also Myers, 2006).

[9] This behavior was observed in Armenia, Ghana, Nicaragua and Zambia, but not reported in Bangladesh.

compensated for a small fraction of the income losses that resulted from a major draught in Burkina-Faso. These results were confirmed by Kazianga and Udry (2006), who found very little evidence of consumption smoothing (over half the value of the income shock being directly passed to consumption): most of the shock absorption had come from extra labor and variations in grain buffer stocks. A more recent analysis of the data by Carter and Lybbert (2012) pointed to the co-existence of consumption smoothing and asset smoothing regimes depending on the asset level: the poor tend to hold on to their scarce assets at the expense of current consumption, while the rich stabilize consumption almost perfectly thanks to livestock sales.

Let's now turn to the link between volatility and output. Building on Sandmo (1971) and Newbery & Stiglitz (1981), Subervie (2008) explains that, from a static point of view, the supply response to price volatility depends on the producers' risk aversion characteristics: farmers who more specifically fear risk will tend to work more (and thus to increase supply) so as to hedge against particularly bad states of the world, while those with a moderate risk aversion will tend to reduce their production. The author adds however that from a purely dynamic perspective, supply is more likely to be negatively correlated to price instability since it "discourag[es] investment and innovation ha[s] a more uncertain return."[10] Using country-specific production and price indices over a broad range of agricultural commodities in a dynamic panel setting, Subervie (2008), is able to exhibit a negative correlation between price variability and output. Additionally, she shows that the effect of world agricultural prices' variability on production is all the more important that the country lacks proper infrastructure, that inflation is not controlled and that financial markets are not sufficiently developed. These circumstances characterize in general the developing countries, which makes producers particularly vulnerable to volatility. Haile et al (2016) builds on the difference in planting months for four food commodities to generate country- and commodity-specific price data. They build a dynamic panel model to investigate the impact of own and cross price (and volatility) on production, and also decompose the effects on planted areas and yields. They also conclude to a negative impact of price instability on the producers' planting decisions, yields, and consequently production. Subervie (2008) and Haile et al (2016) are among the very scarce macro-level cross-country investigations of the impact of volatility (beyond the effect of price shocks).

To take a step aside and conclude this section, let's mention the comprehensive analysis by Binswanger et al (1993) on Indian data, which shed light on a causal channel linking agroclimatic endowment to investment. They demonstrate that sectors endowed with generous agroclimatic conditions (e.g. rare flood or draught events) had attracted more public infrastructure spending, which in turn had incentivized banks agencies to set up, and eventually fostered private investment. Vulnerable areas, on the contrary, received less attention with long lasting consequences on their ability to invest and receive investment flows.

[10] Other authors investigated the link between risk and output, or the impact of insurance on the quantity of output. See for instance Hau (2006).

2. Impact of volatility on the building of the human capital stock

a) Welfare impact and food security

We did not find many investigation of the likely impact of food price volatility on the livelihoods in developing countries, yet a very large number of studies aimed at assessing the impact of the price hikes on welfare and poverty (see e.g. the reviews by von Braun and Tadesse (2012) or Johnson Idan (2014)). In this section, we start with a review the different methods used to assess the welfare impact of food price shocks. We then turn to the scarce studies on the impact of volatility *per se*.

Simulating the consequences of a price shock

When trying to estimate the impact of a food price shock on the populations, the first and necessary step to take consists in gathering information on the actual consumption and production patterns at the household level. Indeed, the likely vulnerability to food price shocks depends on the share of food expenditure in the consumption basket, as well as on the origin of the food consumed (whether self-produced or bought from the markets). This initial stock-take exercise makes it possible to identify and characterize the net food sellers, who are likely to gain when prices rise, and the net food buyers, more likely to lose. Several developing countries conducted nationally representative surveys, which made it possible to identify vulnerable populations.[11] Such an ex ante vulnerability analysis enabled for instance Poulton et al (2006) to document that, for the vast majority of the African rural population food expenditures amounted to more than 50% of the household budget, and to warn about the dreadful resource exhaustion that could induce a significant rise in food prices, even temporary.[12] Similarly, Verma & Hertel (2009) reported that food amounted for about 70% of the budget for the poorest quartile of the Bangladeshi population. Prakash (2011) and FAO (2011) provided some cross-country comparisons of the dependence of the poor's budget on food expenditure in the developing world. The food expenditure share of the lowest quintile of the populations generally oscillates between 60% and 70%.

These surveys sometimes also enable to refine the vulnerability assessment. For instance, Poulton et al. (2006) further estimated that, due to liquidity constraints, 15 to 20% of rural African households are forced to sell a fraction of their harvest even though they know their

[11] When nationally representative data was not readily available, some academics undertook smaller scale, non-necessarily representative ad-hoc surveys (e.g. Elijah, 2010), but the methods are not necessarily transparent or standardized.

[12] See for instance Hertel, Preckel and Reimer (2001), even if the references are a little dated: in particular, the authors refer to Cranfield (1998), an analysis on 1985 international data. The authors add that the strong reliance of poor households on cereals, which Tyers and Anderson (1992) showed are more relatively volatile, made them even more vulnerable.

production does not cover their own needs. Those people correspond to the most vulnerable fringe of the population as they even suffer of the regular agricultural cycle price variations: they have to sell just after the harvest to get cash (when market prices are low), knowing that they will have to buy back when they run out of their reserves (when prices are high).[13]

The descriptive information contained in the surveys was also used at a more macroeconomic level, to assess the net impact of price shocks on a country as well as their redistributive consequences on its population. Looking at data on nine low-income countries, Aksoy and Isik-Dimelik (2008) argued that, although the poor net food buyers outnumbered the net food sellers, more than 50% of these poor net food buyers were actually marginal food buyers (with less than 10% of income spent on food, and thus a limited vulnerability to price shocks). Their data further indicated that the net food buyers were on average richer that the net sellers, thus implying that a price shock would actually redistribute wealth on average. This kind of analysis can be helpful in targeting international aid to those countries most at risk on an aggregate basis. Yet reasoning in terms of averages can be very misleading, since average redistribution does not preclude that many poor could still become even poorer or face starvation. For already deprived populations, it does not require much of an income loss to fall into severe poverty (see also Naylor and Falcon, 2010).

Going beyond static assessment of vulnerability, Deaton (1989) proposed a method to estimate the first order household-level impact of a given food price increase. He introduced the concept of net benefit ratio, a variable built at the household level by applying the producer price change ΔPPI, to Q_H^p, the quantity of food produced (thus measuring the potential gain from the increase), and substracting the quantity of food bought Q_H^b, times ΔCPI, the consumer price change (which therefore measures the increased cost of purchasing food). This amount is then normalized by the total expenditure (or income) of the household.

$$NBR_H = \frac{Q_H^p \times \Delta PPI - Q_H^b \times \Delta CPI}{Income_H}$$

More than simply identifying the net buyers and net sellers, this method provides a monetary estimate of the net gains or losses undergone because of the price shock (assuming production and consumption do not react to the price change), see e.g. FAO (2008). Deaton's net benefit ratio is adopted by Zezza et al (2008) to compare, across 11 developing countries, the welfare impact of a theoretical 10% price shock for the main tradable food staples. Their analysis concludes to the higher vulnerability of the poor (both income and asset poor). They are more likely to experience losses, and the losses will be proportionally larger. De Janvry and Sadoulet (2009) resort to the same method to simulate the welfare impact of the 2008 food crisis had the international prices been passed through entirely to the Indian market. They point to the vulnerability of urban households, and estimate that the vast majority of Indian farmers would

[13] See Matz, Kalkuhl and Abegaz (2015) who provide evidence of the strong seasonality of food consumption among rural households, linked to both the agricultural cycle and the lack of credit.

have also been negatively affected by such a shock. See also Levinsohn and McMillan (2005) about the distributional consequences of the food price level in Ethiopia.

These simulations are very useful first approximation of the welfare impact of a food price shock since they enable policymakers to identify particularly vulnerable populations and design targeted support to them. Yet the computations do not account for the fact that consumption patterns react to price levels: when a good becomes more expensive in real terms, one tends to buy less of it. As long as price changes remain in a reasonable range, the approximation stays valid. Yet when one considers shifts of the order of magnitude observed during the 2008 food crisis, it is no longer possible to ignore the adaptation of consumption to prices. Most authors who neglect own price (or real income) elasticity in their simulations argue that they only consider direct short term impacts. In the very short term indeed, it is likely that consumption patterns will stay the same despite the price change. In the medium term, though, one must account for the reaction of consumers to the new prices. Assuming constant quantities tends to overestimate the welfare impact of a price shock, as adapting quantities is clearly a coping strategy.

To gain more precision, Cudjoe et al (2010) plugged own-price and income elasticity estimates in their simulation of the welfare impact of the 2008 crisis in Ghana. A similar path was followed by de Janvry and Sadoulet (2010) with Guatemalan data. Even after accounting for induced changes in consumption patterns, some groups still end up severely affected by the price hike.

It is possible to refine further the simulations by considering the potential substitution between foodstuffs: indeed the evolution of relative prices dictates reallocations in the food basket in the short to medium run. The quantity that is consumed of a good not only depends on its own price, but also on the price of its close substitutes (e.g. a local staple). Once again, the adaptation of the consumption pattern tends to dampen the first order impact of a price shock.

Dimova and Gbakou (2013) showed that the welfare impact of the food price rise in Côte d'Ivoire appeared less detrimental (and even positive for some categories of households) when broadening the scope of the simulation to include all food products rather than focusing on rice alone. This, they argue, points toward households' ability to substitute rice for cheaper local staples, and to limit the effect of cash crop price increases. Along the same line, Pons (2011) and Weber (2015) added substitution to the analysis of Indian data by de Janvry and Sadoulet (2009). Although the refined simulations do not change the conclusion about the higher vulnerability of rural households relative to urban ones, the demand modeling provides some hints about the consequences of the price hike on the worsening of the diet quality. More specifically, Weber (2015) finds that households would tend to substitute high value food items (milk, meat, fruits) for cheaper cereals. The nutritional impacts of food price shocks will be surveyed in more detail below.

Instead of looking at the overall distribution of gains and losses, some authors focused on a more synthetic indicator of the evolution of social welfare: the poverty rate, which is simply

computed by confronting the simulated post-shock real incomes to a standard poverty threshold. Ivanic et al (2012) simulated the impact of the 2010 food price rise on the poverty headcount in 28 countries (including price and substitution effects). They conclude that "on balance, the adverse welfare impact on the net consumers outweighs the benefits to net producers resulting in an increase in the number of poor and in the depth of poverty." (p.2311)

Rather than measuring welfare in monetary terms (real income gains and losses), some authors looked are calorie intake. Simulating the new consumption basket (with or without elasticity parameters), they convert quantity purchased into energy, in order to better relate to the concept of food insecurity[14] (see e.g. FAO, 2008). Harttgen and Klasen (2012) developed a rough methodology posing that a doubling of each foodstuff's price would translate into a halving of the corresponding nutrient intake, and comparing the simulated household-level outcomes with standard minimal energy requirement.[15] Anriquez, Daidone and Mane (2013) introduce proper own-price elasticity parameters taken from previous studies in their nutritional analysis of the price spikes in eight developing countries. Their simulations point to increased undernourishment across countries, income groups and location (urban vs. rural), with food price spikes inducing both a reduction in the quantity consumed and in the variety of food intake.

However refined the models, the simulations of monetary or calorie losses are not necessarily the best indicators of the real impact of a food price change on livelihoods. Including more and more elasticity parameters can be a tempting solution to capture the complexity of consumption decisions; it is yet not sure that the simulations would come closer to the reality.

First, it is unclear that elasticity estimates derived from cross-sections actually reflect the reaction of a given household to a shock. Furthermore, cross-sectional elasticity estimates are not bounded to remain constant over large fluctuations in income, or across major crises: for instance, Dimova et al (2014) documented large variations in the income, own-price, and cross-price elasticity estimates they obtained for Bulgaria around the economic crisis and structural adjustment period, indicating that the crisis induced significant changes in consumer behaviors for various food groups and nutrients and across the income distribution (see also the estimates by Shabnam et al (2016) who argue that the two food crises made Pakistani households' nutrient intake more sensitive to prices).

Another serious critique to simulated impacts of crises is that they cannot easily account for medium-term market adjustments. Aksoy and Isik-Dimelik (2008) indeed acknowledge that the contraction of demand from those who suffer from the shock can have a second round effect on those who would win in first approximation, while Ivanic et al (2012) regret that their simulation

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14 The canonical definition of food insecurity can be found, for instance in FAO (2003): "Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (p.29). The same definition is recalled in FAO (2009), p.8.

15 The minimal and average energy requirements.

cannot account for longer term wage adjustment (e.g. a rise in prices should push agricultural wages up, and thus compensate partially for the loss in real income for day laborers).

Despite their limitations, simulations, however rough they may be, are efficient tools to provide policymakers with a first estimate of the likely consequences of a significant shock. They enable them to take action quickly and target the likely vulnerable populations. Indeed, contemporaneous information would probably be more accurate, but the inherent timeframe of a proper post-shock survey data collection would definitely delay the course of political action. Yet, ex post, the analysis of new household information can however help understand the challenges better and tailor more accurate emergency responses for the future.

Analysis of post-shock data: measuring the actual consequences

Simple static examinations of cross-sectional data that happened to be collected at the time of the crisis provide researchers with interesting information on the actual consumption patterns under acute stress. Such an analysis of contemporary data was conducted by Dimova and Gbakou (2013) for Côte d'Ivoire, and by Raihan (2009) on Bangladesh.

Using successive survey rounds, or even sometimes the pacing of interviews along a survey campaign,[16] several studies measured the actual evolution of food consumption patterns thorough the crises, using them as natural experiments. Resorting to such strategies, Alem and Söderbom (2012) demonstrated that households headed by a woman, or by a casual worker had been particularly vulnerable to the 2008 price shocks in Ethiopia (see also Kumar and Quisumbing, 2013). In Ouagadougou (Burkina-Faso), Martin-Prevel et al (2012) documented a significant decrease in both food security and in dietary diversity between 2007 and 2008, a conclusion shared by D'Souza and Joliffe (2012) for Afghanistan. Similarly, Tandon and Landes (2014) documented a significant decrease in diet diversity in India because of a reduction of non-staple consumption attributed to the 2008 food crisis. Matz et al (2015) observed that in 2012, food price rises in Ethiopia were associated with significant decreases in the number of meals taken, and a switch toward the consumption of less preferred food in both rural and urban areas. See also the results by Brinkman et al (2010) on the negative correlation between local food prices and the food consumption score[17] in Haiti, Nepal and Niger. Eventually, Juárez Torres (2015) computed nutrient elasticity estimates over seven rounds of a Mexican household survey to document the differential consumption patterns and sensitivities across the income ladder.

Aside from the standard cross-sectional analyses, let's mention some more original methods: Shabnam et al (2016) applied a time-varying quantile regression demand model for food to Pakistani data in order to investigate the evolution of calorie and macro-nutrient consumption before and after the 2008 food crisis with year-specific elasticity estimates. DeMatteis (2014)

[16] See e.g. Jensen and Miller (2008) or D'Souza and Joliffe (2012)

[17] The FCS is a survey-based indicator of the diversity and frequency of the food consumed over the previous week

used a time-series approach (error correction model) to investigate the link between food prices (domestic and international) and nutrition-related data at the country level. He demonstrated that higher prices were associated with lower food availability in most countries, and to a significant increase in food deficit in low-income countries.

To conclude this section, let's mention two synthetic articles: On the one hand, the review by Dorward (2012) summarizes the theoretical and empirical findings on the short-and medium-term impacts of staple food price shocks. He points to the vulnerability of the poor, especially in economies that underwent large price shocks and did not benefit from a "broad based growth process". The vulnerability of net food buyers is highlighted, while there does not seem to be much evidence a second round beneficial effect due to the price and wage adjustment. On the other hand, Green et al (2013) realized a meta-analysis over 136 studies reporting 3495 own-price elasticities from 162 different countries (no substitution). They find significantly higher elasticities in poor countries, and also point to a greater reduction of food consumption among poorer households within a given country.

Impact of variability per se:

Applying a CGE model to Bangladeshi data, Verma & Hertel (2009) demonstrated that agricultural price volatility and income volatility translated into more uncertain food intake. They also stressed that the initial state of malnutrition observed among the poorest made them all the more vulnerable to price increases and price fluctuations. The economic literature even went as far as posing equations linking volatility with the survival probability of the poorest, as indicated by Myers (2006) [cf. McGregor (1998)]. Indeed, it is not counterintuitive to imagine that food price variability could induce a reduction of nutritional rations, even below the subsistence intake level, especially in the most vulnerable households, and thus could impact the survival rate. For example, Glomm & Palumbo (1993) adapted the intertemporal consumption model with random income and endogenized the survival probability (consumption in one period determines the survival rate in following periods). If credit markets are inexistent (and even if we keep the possibility of storage available), the agents constitute a health capital stock at the expense of their precautionary savings, which limits their investment capacity.

Bellemare, Barrett & Just (2010) showed on Ethiopian data that households are indeed "on average significantly price risk-averse over the prices of specific commodities as well as over co-fluctuations in the prices of the same commodities." They were willing to pay between 6 and 32% of their income to get full price stabilization for the seven major agricultural crops to their mean value.[18] The risk aversion of Indian producers had been demonstrated by the model

[18] The agricultural commodities taken into account by Bellemare are coffee, maize, horse beans, barley, wheat, teff and sorghum. They are not all staple food crops.

developed by Rosenzweig & Wolpin (1993) concerning the dynamic investment in the asset "bullock".

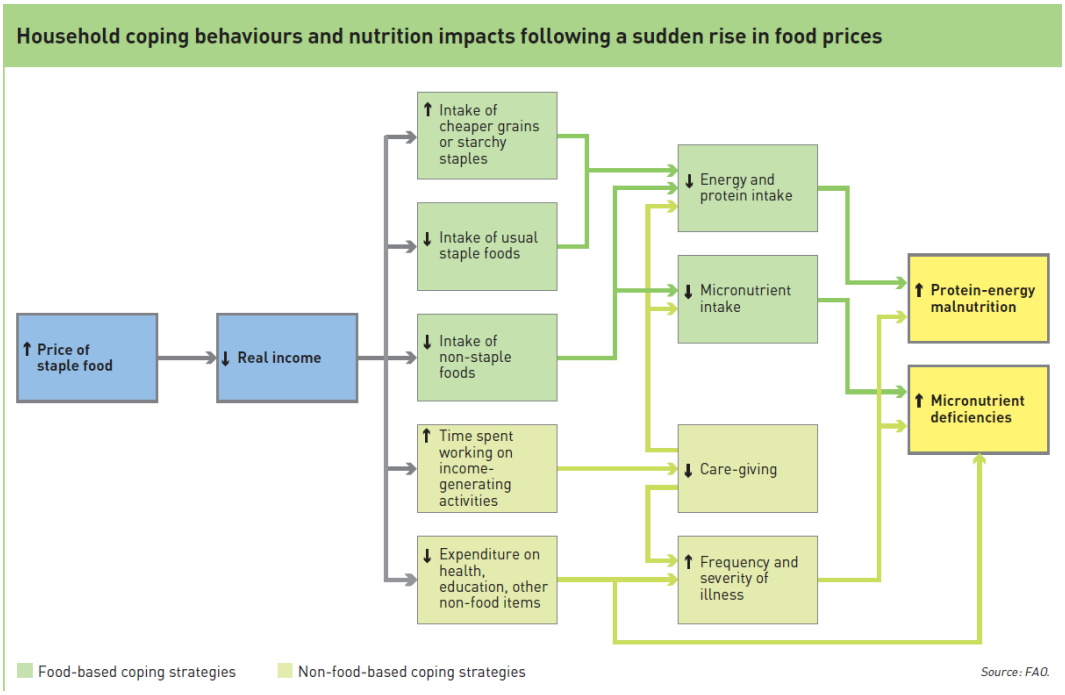
Self-assessed food insecurity:

Instead of looking at actual changes in consumption, some authors addressed the issue of self-reported food insecurity. After all, in many aspects of social sciences, the perception that people have of a phenomenon can often be as important as the actual observed consequences. Such a change in perspective can be found for instance in Headey (2011) who uses Gallup World Poll and finds that actually fewer people reported food insecurity in the world in 2007/2008 than in 2005/2006. The detrimental impact of the high food prices was partially offset by the high economic growth rates observed thorough the developing world: large and populous countries managed to limit the price hikes domestically and also benefitted from dynamic growth. Similarly, Verpooten et al (2013) analyzed the evolution of self-reported food insecurity in 18 Sub-Saharan African countries between 2005 and 2008 using the Afro-barometer data. The study concluded that although higher average prices were associated with an increased incidence of reported food insecurity over the previous 12 months, they were also associated with a lower probability of reporting a severe food insecurity status. Self-reported food insecurity variables could also be used as explanatory variables (see e.g. Akter and Basher (2014) who found that the self-assessed dummy for having experienced acute food shortage in 2007 did come out as significantly lowering the household expenditure growth between 2007 and 2010 in Bangladesh).

b) **Human capital accumulation, health and education.**

There again, despite the general focus and hype on volatility, the extant literature on the consequences of volatility per se was only seldom studied. Yet the impact of price shocks received impressive attention from academics. Agricultural price shocks and volatility not only jeopardize the economic welfare and the access to food of the poorest, it also has more pernicious effects on capabilities, in the sense of Sen (1993). Jensen (2000) talks of "investment in children", a phrase that encompasses both youngsters' continuous education and proper feeding. In his own words, "investment in children and the development of human capital are the cornerstones of enhancing well-being and breaking the cycle of poverty, and they are also central to national growth and economic development."

Graph 1A: Mapping of coping behaviors



Source: FAO (2008), Figure 24 p.28

In a remarkable synthesis, Meerman and Aphane (2012) describe the impacts of rising food prices in terms of coping mechanisms at the household level.[19] A first reaction it to reduce quality and shift to cheaper, less preferred, food items. If more adjustment is needed, households also reduce the quantity consumed. Understandably, reducing the number of meals and the quantities served can have dramatic health consequences, but substitution can also prove very harmful: as noted in Shabnam et al (2016), "Substitutes in taste may not be close substitutes for nutrients, and therefore food substitution may alter nutrient intake". The rise in food prices is generally associated with a less diversified food intake, with food expenditures being concentrated on cereals and high carbohydrate items that fill the stomach, at the expense of other foods which provide other necessary micronutrients such as vitamin A, Iron, Zinc. Macro and micro-nutrient deficiency (even temporary) is known to induce severe and permanent diseases.

Within a given household, all family members are not affected the same way: food shortage is generally associated with significant intra-household food reallocation. The redistribution pattern within the family is very likely to depend on the prevailing cultural values, but those most prone to be shock absorbers are definitely women and children across the developing world. To some extent, it makes sense that the limited food ration be directed toward the principal breadwinner to maintain the resources of the household. Yet undernutrition among women and children can lead to long-term consequences, both physical and cognitive (fetal and infant development).

[19] See also e.g. the graphical depiction in FAO (2008), p.28 as well as FAO (2009), p.26 sqq.

Meerman and Aphane also review second order consequences of food price shocks. The tight budget constraint leads to a decrease in school attendance combined with an increase in child labor. A lower real income at the household level tends to decrease health-related expenditures (drugs or visits to the doctor).[20] It is also generally associated with an increase in women laborforce, with detrimental consequences on the household health status: indeed, women are traditionally the primary care-givers and wage labor implies that they have less time to care after the children, prepare their meals or breastfeed them. In some extreme cases, the budget constraints can even lead to the sale of productive assets and a reinforcement of the poverty dynamics. Prakash (2011) summarizes all these impacts neatly when he writes that that a "diminished income in already low-income countries can result in malnutrition, mortality, withdrawal of children from education and sustained high unemployment."

In the paragraphs below, we propose a thorough review of the various consequences briefly introduced above.

Anthropometric evidences of nutritional deficiency:

A substantial strand of academic literature investigated the visible health consequences of the changes in consumption induced by price variations. This literature generally focuses on standard anthropometric indices constructed through various combinations of age, weight and height data.

The most famous such index is the body mass index (BMI), which corresponds to the ratio of weight over the square of height. According to the WHO the "normal" range of this ratio (for male and female adults indifferently) is 18.5 to 25 $kg.m^{-2}$. People below the lower bound of this interval are said to be underweight (severely thin when below 16 $kg.m^{-2}$), and those beyond the 25 $kg.m^{-2}$ threshold are declared overweight (obese when the ratio is larger than 30 $kg.m^{-2}$). Another three indices are used to assess the actual growth of children relative to world (or national) standards: the weight-for-age Z-score (WAZ), the height-for-age Z-score (HAZ), and the weight-for-height Z-score (WHZ).[21] These standard scores are tabulated by the WHO and measure how far a child is (in terms of standard deviation) from the mean of the reference population. Low height for age is generally interpreted as the cumulative impact of under-nutrition during the entire life of the child, from the mother's womb. It is widely understood as an indication of the child's health capital. "Stunting" corresponds to the status of children whose HAZ falls two standard deviations below the mean (or median) and therefore reflects severe

[20] see e.g. Tandon and Landes (2014) who demonstrates the significant decrease in health expenditure associated with the food price rise in India, in 2008

[21] The distribution of raw ratios is normalized by subtracting the population mean from all the observations, and dividing the result by the population standard deviation.
Mathematically, the z-score associated with a raw number b is therefore:

$$b_z = \frac{b-\mu}{\sigma},$$

where μ and σ are respectively the population's mean and standard deviation.

chronic deprivation. On the contrary, the WHZ is deemed a good indicator of the flow of investment in children's health. A low weight for age ratio points to acute weight loss due to temporary undernutrition. Children with a WHZ below -2 (two standard deviations below the mean) are falling in the "wasted" category. A combination of the previous two indices, the WAZ is less straightforwardly interpretable. Indeed, a low weight for age ratio can result from either long-lasting or acute undernutrition.

Jensen (2000) used local weather shocks across Côte d'Ivoire as a natural experiment to assess the impact of rainfall on the children WHZ ratio in this rural economy extremely dependent on rain-fed agriculture. Undernutrition in the shock regions soared dramatically, even doubling for boys. Hoddinott (2006) documented a significant, but temporary, reduction in women's BMI following the 1994-1995 draught in Zimbabwe, as well as a significant drop in growth velocity among young children. Looking at the impact of the more recent 2007-2008 food crisis in Bangladesh, Sulaiman et al (2009) observed an increase in the prevalence of wasting among rural children, especially in the middle of the income distribution: despite the price increase, households had consumed more rice, and thus significantly reducing their consumption of non-grain foods (typically lentils and fish).[22] Chibuye (2014) documented a lowering of the HAZ of under-5 children in Zambia between 2006 and 2010. Arndt et al (2016) highlighted the short run impact of the 2008 food crisis on child malnutrition in Mozambique (as measured by the WHZ and WAZ scores). Vellakkal et al (2015) used longitudinal cohort data of children from Andhra Pradesh (India) to observe the evolution of the wasting rates (low WHZ) with the food crisis: from 19.4% in 2002 and 18.8% in 2006 wasting prevalence jumped to 28.0% in 2009. Juárez Torres (2015) demonstrated the strong sensitivity of poor children's weight gains to cereal price changes in Mexico. Analyzing survey data from Bangladesh, Thorne-Lyman et al (2010) found that dietary diversity was strongly correlated with income. Campbell et al. (2010) further showed that stunting in children as well as maternal underweight were strongly correlated with higher expenses on rice (and lower non-rice food expenditures).

The long term consequences of undernutrition are numerous. Of course, death is the most dramatic, but there are also more pernicious effects. Growth impairment seriously reduces individuals' physical aptitudes. Additionally, undernutrition impacts cognitive abilities and compromises educational successes. Meerman and Aphane (2012) eventually point to recent surveys linking childhood undernutrition with type 2 diabetes.

[22] Analyzing the consequences of the late 1990's economic crisis in Indonesia, Sari et al (2010) also demonstrate a negative correlation between child stunting and the proportion of household income spent on non-grain food.

Food prices and micronutrient deficiencies:

The nutrition literature investigated further the link between high food prices and longer term health outcomes, especially by looking at micro-nutrient intakes.

Meerman and Aphane (2012) review some of the most well know implications of macro and micronutrient deficiencies: for instance, lack of vitamin A is commonly associated with sight deficiency, up to blindness. It also induces impairement of the immunological functions, and leads to higher mortality risk among mothers and children. Similarly, severe iron deficiency is linked to anemia with consequences on the cognitive and physical development of children. It is also associated with increased tiredness and lower productivity.

Iannotti et al. (2012) estimated income-nutrient elasticity parameters in Guatemala to simulate the impact of the 2007-2008 food crisis: they conclude to a likely increase in the probability of nutrient inadequacy, especially zinc and vitamin A. Vitamin A is found mainly in animal products (livers, eggs, fish, whole fat dairy products). West and Mehra (2010) had previously documented the strong relationship between lower consumption of non-grain food and the higher risk of night blindness due to vitamin A deficiency among women of reproductive age.

Child Mortality:

The investigations on the child death toll of the recent major food crises are extremely limited. Yet, taking a step back and considering that food crises are actually one sort of real income shock, it is possible to find very enlightening pieces of research: Ferreira and Schady (2009) developed an analytical framework linking child mortality to economic downturns through the channel of traditional caregivers laborforce participation: on the one hand, lower household income tends to increase laborforce participation within the family (including mothers, who are traditional care-givers), while on the other hand lower wages also reduce the opportunity cost of not working (i.e. staying at home and caring for the children). The eventual relationship between economic cycles and investment in children's health is therefore the net result competing income and substitution effects. Ferreira and Schady argue that in developed economies with functioning credit markets, the income effect can be eliminated through borrowing against future revenues, and indeed they observe that in the US for instance, economic downturns are associated with decreases in child mortality. In low income countries, on the contrary, the income effect dominates the substitution effect, and child mortality thus increases in recessions (see e.g. Bhalotra (2010) or Baird et al (2011) for India). In between these two extremes (i.e. for middle income countries), the final direction of the relationship is undetermined a priori – see Schady and Smitz (2010) see also Cutler et al (2002) for a specific analysis of Mexico.

The aforementioned studies investigated the general correlation between income and child mortality over long periods. We now turn more specifically on the impact of food crises, which, according to Christian (2010) can affect directly child mortality trough three main nutritional channels: childhood under nutrition (leading to stunting and wasting); childhood micronutrient deficiency; and even before this could happen, intrauterine growth restriction (linked to maternal under nutrition and micronutrient deficiency). The only empirical assessment we found on the 2008 food crisis is the analysis by Fledderjohann et al (2016) on Indian data concluding that every 1% increase in total food prices was associated with a 0.49% increase in neonatal mortality.[23]

The evidence of maternal labor and lower care-giving availability as a transmission channel from economic shock to lower health outcomes is rather circumstantial. Indeed, economic downturns are said to increase female laborforce participation, but the evidence is mixed (see for instance the conflicting results in Bhalotra and Umaña-Aponte (2012) and in another undated paper by the same authors).[24] Jensen (2000) documented that, in regions of Côte d'Ivoire affected by a serious draught, the percentage of sick children brought to the medical consultations had dramatically decreased by about a third, while the nutritional status was reported to deteriorate significantly. However, his analysis did not quantitatively link these observations to maternal labor. Pongou et al (2006) provide some useful insights with their work on the impact of the 1990's economic crises and structural adjustments programs in Cameroon, as they found that child malnutrition had been significantly linked to a variable coding for maternal health-seeking behavior (MHSB).

The most thorough empirical investigation of the channel between economic shock and mortality is probably Cutler et al (2002), who analyze Mexican demographic data spanning from 1980 to 2000. They demonstrated a strong correlation between female labor force participation and the increase in mortality rate for the vulnerable age groups (infants and elders). They were able to test the "missing care-giver" hypothesis, but the data did not support it, and they concluded that increased female laborforce participation might actually simply indicate economic shocks of a larger magnitude (i.e. large shocks simultaneously induce female labor and increased mortality for the vulnerable populations).

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[23] Note that the authors did not find significant impact of the aggregate price on infant or under-5 children mortality rates. Yet, when decomposing the price shocks across food groups, they exhibited a significant detrimental impact of the price of meat and dairies on the mortality rates of all children age groups.

[24] Bhalotra and Umaña-Aponte (2012) estimated that female laborforce participation was pro-cyclical in Sub-Saharan Africa, contrary to the belief that economic shocks push women to enter the market to complement their husband's income. However, in an undated working paper on a broader scope of developing and emerging countries, the same two authors came up to an opposite conclusion about Sub-Saharan Africa. They also found that the relationship between income and female laborforce participation was heavily depending on women's educational attainment. For women with less than secondary education, a drop in income was associated with increased participation, but the opposite was true for women with higher education.

Impact of food prices on education:

Ferreira and Schady (2009) describe a two periods setting in which households face tradeoff: they can either put their child to work right away (in which case they do not pay tuition fees, and receive unskilled labor wage in both period 1 and 2); or they can send their kids to school, and derive skilled labor wage in period 2 only. A recession lowers parents' and children's wages, inducing both an income effect and a substitution effect going in the opposite direction: indeed, as the traditional breadwinners' income decreases, the family is incentivized to send more members to work; yet the opportunity cost of schooling shrinks simultaneously, as the wage a child could make is lower. The authors argue that with functioning credit markets, inter-temporal consumption will be smoothed (parents will borrow from future incomes). The income effect should therefore vanish, and the substitution effect will dominate (thus leading to an increase in schooling). On the other hand, when credit markets do not exist or are imperfect), the variation in schooling is theoretically undetermined. Reviewing the empirical evidence, they indeed show analyses on least advanced countries conclude to a detrimental effect of economic crises on education, while the relationship goes in the reverse direction for the US, and appears undetermined for middle-income countries. In other words, investment in children appears counter-cyclical in developed countries, while it is pro-cyclical in poorer markets with limited access to credit (see Jacoby and Skoufias (1997) for an analysis of the consequences of income seasonal variations in terms of children school attendance in rural India; see also Thomas et al (2004) which documented a significant decline in household spending on education during the Indonesian crisis – especially among the poorest).

Jensen (2000) complemented his analysis of "investment in children's health" through an analysis of the schooling consequences of the rainfall shocks in rural Côte d'Ivoire. He demonstrated that class attendance had decreased by about a third in the regions that suffered the draught relatively to others. Exploring a limited field survey he conducted across Bangladesh in the aftermath of the 2008 food crisis, Raihan (2009) documented that about 90% of households reported a detrimental impact of the food price increase on their children's education. About half households experienced dropout of their children, and nine out of ten reported that their children education had to be interrupted for health/nutrition reasons. In addition to the health-related reasons put forward, 20% of households admitted that they could not meet education expenses, and 20% recognized that they had to involve their kids in money making activities. Summing the actual tuition fees with the child wage rate, Raihan estimated the opportunity cost of schooling to about one fourth of the household's monthly expenses. The declarative results are complemented by an analysis of school attendance sheets. The data show a tremendous decline in secondary level enrolment (about 15% fewer kids in 2008 relative to 2007) and an increase in first term dropout rate of about 6 percentage points between 2007 and 2008.

This section established that price shocks and income volatility do have disastrous consequences on children's health and education across the developing world. Investment in

capability appears particularly reactive to disposable income. These interruptions in the flow of investment in children cannot but have extremely serious consequences on the pace of development at the macroeconomic level.[25] In Jensen's words, "[…] to the extent that even temporary schooling interruptions or shortfalls in medical care or nutrition have lasting impacts, and given the importance of such investments for human development, the results suggest that aid and public insurance programs should be used to help households overcome adverse economic shocks."

c) **Volatility, inequality and exclusion**

Again, the specific empirical evidence linking food price volatility to inequalities is scarce. We can only get insights on the issue by broadening the scope of the survey, to encompass either macroeconomic volatility or food price shocks.

Macroeconomic volatility, as measured by the volatility of the growth process for instance, has indeed proved positively correlated to the rise of inequalities. Laursen and Mahajan (2005) demonstrated that the revenue share of the poorest quintile was significantly lower when volatility was larger. The relationship was particularly strong in least advanced countries: the correlation was funneled by inflation and appeared to be dampened by the development of the financial system as well as by the extent of the safety nets. Similarly, but focusing more specifically on Latin American countries, IDB (1995) as well as Hausman and Gavin (1996) had shown that GDP volatility was also strongly correlated to a persistent increase in inequalities, with the main transmission channel assumed to be education. Bourguignon et al (2004) investigated the consequences of agricultural commodities' volatility on inequality. They documented the vulnerability of poor export-dependent countries,[26] and argued for a broader use of risk-augmented income distribution to assess the consequences of volatility within a given country. Their model indeed pointed that the poor bore a larger share of the risk burden.

At the microeconomic level, Zimmerman & Carter (2003) developed a stochastic model to simulate the wealth trajectories of farmers given the macroeconomic environment. They exhibited an initial capital threshold (a Micawber threshold)[27] that split the population into two groups. Those below were trapped into poverty and gradually sold all their assets while those

[25] Research papers comparing effectively the short term impacts to the longer term outcomes (on education, on health) are fairly scarce. Frankelberg and Thomas (2017) propose such an analysis for the specific case of Indonesia, considering both the financial crisis of 1998 and the Tsunami of 2004. They insist on the remarkable resilience of the Indonesians and the coping mechanisms they implemented to mitigate short- and longer term impacts to the young generations.

[26] See also Fafchamps (2000)

[27] The concept of "Micawber Threshold" was introduced by Lipton (1993) as a reference to a character in Charles Dickens' David Copperfield.

above could expand theirs. In the case of Burkina Faso, they located the threshold to around 4 hectares of arable land.

In the section on welfare impacts of food price shocks, we mentioned that most studies had concluded to the greater vulnerability of the poor, less able to insulate their consumption from the price variations. Food amounts to a larger share of their expenses and when prices rise, they end up downgrading the quality of their diet, reducing the number of meals, cutting other expenses (education, healthcare,…), or selling their already scarce assets. Price shocks are thus generally deemed to exacerbate economic inequality as well as to jeopardize poor households' development prospects. Kumar and Quisumbing (2013) also demonstrated that food price shocks affected gender inequality in Ethiopia: Female-headed household, which on average started from a worse situation than their male-headed counterpart in terms of schooling, wealth and social networks were also more likely to experience food shortages, suffered from longer periods of deprivation. They were consequently more likely to cut back on food consumption, even for children meals. In the words of Zezza et al (2008), "while richer households may cope with the price shock by cutting on other non-essential expenditures or drawing on their savings, this option is less open to the poorest, who may be driven into further depleting their meager asset base, or cutting on essential expenditures such as education. This is especially true for poor female-headed households, who are particularly hard hit from the increase in food prices. This, and the longer term impact of inadequate food consumption, would definitely translate into lower productivity and income generation potential in the medium- to long-term."

Food price shocks and their differential impact along the income ladder can also have insidious stigmatizing social consequences, such as the exclusion of the poorest from the traditional ceremonies. In their qualitative assessment of the impact of the 2011 food crisis on the urban poor in Ethiopia, Hadley et al (2012) stressed the consequences of the food crisis on the overall social structure. Many interviewees reported that the situation prevented them from participating in the social life of the community. For instance, tradition goes that people who attend funerals prepare some food that they bring to the family of the deceased. As they had nothing to bring, several people gave up going to the social rituals. In a similar fashion, it became more complicated to share food items, let alone meals, with relatives or neighbors, thus distorting the social networks, and insulating further the poorest from the community.

3. Empirical evidence of the impact of volatility on economic growth

As we mentioned in our introduction, the classical models go that economic growth relies on technical progress and the constitution of an appropriate stock of capital (in the convergence phases). In the previous two chapters, we described how food price shocks, macroeconomic volatility, and sometimes more precisely food price volatility seriously dampened the accumulation of capital stock on the one hand, and the investment in human capital on the other, both in the short run in the long term. Those tragic intermediary consequences should therefore translate into a lower long run economic growth.

Many articles demonstrate a large negative impact of macroeconomic volatility on a country's economic performances. Ramey and Ramey (1995) investigated the relationship linking GDP growth to its volatility. They showed, on two different panels (world and OECD), that indeed a more volatile growth process was also less dynamic on average. IDB (1995) and Hausman and Gavin (1996) came to a similar conclusion for Latin America, as did a more recent analysis by Hnatkovska & Loayza (2004).

Other studies defined macroeconomic volatility more precisely as terms of trade volatility (thus relating the concept of volatility more closely to a price issue). There again, volatility was proved to significantly hamper the growth process. Guillaumont et al (1999) concluded that terms of trade and political instability partly explained the difference in growth rates between Africa and other developing countries between 1970 and 1990. Blattman et al (2007) showed that commercial specialization in commodities (whose price is particularly volatile) could explain a large part of the economic divergence observed in the World over the 19th and 20th centuries: they exhibited strong negative correlation between a country's terms of trade volatility and its GDP growth. More recently, Brückner and Carneiro (2015) exhibited a strong negative relationship between terms of trade volatility and growth cross-sectionally (relationship that vanishes when including country fixed effects). Still considering the impact of trade volatility Dawe (1996) concluded that an increase in exports instability of the order of magnitude of 1% of GDP per year leads to a growth slow-down of about 250 basis points.

Among all the studies we reviewed, the one that most closely relates to the growth consequences of food price volatility is probably Timmer (2002) who estimated that the rice price stabilization scheme implemented in Indonesia in the 70s had induced a growth increase between ½ and 1 percentage point. Grabowski and Self (2016) neatly explained the mechanisms through which food price stability could enable the structural change of an economy from agriculture to manufacturing and services. According to them, food price instability is associated with a lower level of investment in the agricultural sector. Agricultural production thus requires a large share of the laborforce and therefore dampens the transition to manufacturing. By contrast, productivity gains in the primary sector would free up workers who would move to the cities and apply to industry jobs. They also highlight the positive consequences of stable food price on

health and education, and thus on the quality of the labor that will eventually be hired by the manufacturing companies. Looking more specifically at Indonesia between 1969 and 2014, they show that indeed, rice price volatility was significantly associated with a lower share of manufacturing in the GDP.

Turning to the causes of macroeconomic volatility, Koren and Tenreyo (2007) demonstrated that developing countries' more volatile growth process was largely explained by the fact that they underwent more frequent aggregate shocks. Jacks et al (2009) indeed noted that, relative to the industrial economies, terms of trade volatility had been more than three times higher in Latin America, South Asia and Africa. They attributed the exacerbated variability to a less diversified economic structure, centered primarily on particularly volatile activities such as the production of commodities. In a way, this phenomenon is a consequence of the Heckscher-Ohlin theorem, which explains that countries specialize in and export the goods that use intensively the factors they are largely endowed with. Developing countries, who are largely endowed with low qualification labor force and land (relatively to qualified labor and capital), export the products that use these factors intensely.

Not only did developing countries face more macroeconomic volatility overall, the impact of an increased volatility was also comparatively more incapacitating for them. Hnatkovska & Loayza (2004) indeed found that the correlation between the GDP growth rate and its variability was globally negative, yet they proved that the relationship was not homogeneous along the income ladder: among least advanced countries, a more volatile growth pattern was also lower on average, while the reverse was true for rich countries. Rodrick (1999) insisted on the importance of social and institutional factors in the resilience of countries to macroeconomic shocks (see also Acemoglu et al, 2003). Brückner and Carneiro (2015) pointed to a strong and significant role of financial development in explaining the cross-sectional differences in the relationship between terms of trade volatility and growth. Aghion et al (2009, 2010) indeed showed that the detrimental impact of real exchange rate (resp. commodity price) volatility on economic growth was stronger in countries with a less developed financial sector (and tighter credit constraints).[28] It thus seems legitimate to analyze the vulnerability of various countries to volatility in addition to their exposure to it, as Combes and Guillaumont (2002) invite us to.

The smaller vulnerability of industrial countries relatively to developing ones could be explained on the one hand by the fact that price shocks could have reinforced the specialization patterns induced by the comparative advantages, and on the other hand by the ability of developed countries to recourse to financial markets or to elaborated contracts to hedge against the risk of price volatility.

[28] See also Hausman and Gavin (1996) on the specific case of Latin America.

Food price shocks and conflict:

The link between food price shocks and conflicts has been incidentally studied over the past 20 years (see e.g. Brinkman and Hendrix, 2011 for a review). Indeed, as most researchers attempted to demonstrate a causal link from revenue to conflicts, they ended up instrumenting income with international commodity price shocks (including food commodities), and with weather shocks.

Low per capita incomes and slow economic growth are the two most robust correlates of civil war (Blattman and Miguel, 2010). Pinstrup-Andersen and Shimokawa (2008) also documented that the likelihood of armed conflict onset was significantly increased by economic poverty as well as by deteriorated health and nutritional status.

Three competing theories are usually used to explain how income can affect the likelihood of civil unrest: the opportunity cost to rebel, the State's ability to defend itself and the "State as a prize" theory (Bazzi and Blattman, 2014). The first theory goes that a wealthier population has more to lose with rebellion than poorer people. Hence, by lowering the opportunity cost of rebelling, a negative income shock can trigger civil unrest. The second theory links civil wars not to the population's average income, but rather to the State's revenue. A wealthier State has more leeway to support a strong military, to buy off the opposition, or to hire a militia. Hence, according to this theory, more revenues accruing to the State would make it more resilient. Eventually, the "State as a prize" theory poses that a wealthier State should be more desirable to opposition groups, and higher State income should therefore correlate with more numerous attempts to seize it (this is labeled the "rapacity effect" in Dube and Vargas, 2013). In order to disentangle the effects of the different theories (and manage the strong potential endogeneity) many authors instrumented income with commodity prices (agricultural or extractive) or with meteorological variables. These analyses enable us to assess the impact of food price shocks (or agricultural production shocks) on conflicts.

Miguel et al (2004) instrumented income growth with an annual rainfall index in Sub-Saharan Africa. They found that rainfall growth had been associated with fewer conflicts and were able to exhibit a strong causal link between income growth and conflict. Ciccone (2008) argued however that the effect of rainfall growth on civil conflict was not robust, contrary to that of rainfall shocks.[29]

Instead of weather shocks, several studies investigated the consequences of price shocks affecting trade (most often commodity price shocks). Besley and Persson (2008) demonstrated that violence generally increased with more expensive import (thus supporting the opportunity cost theory), but also with higher export prices (a finding coherent with the State as a prize theory). Similarly, Brückner and Ciccone (2010) documented that civil wars in Sub-Saharan Africa were more likely to burst following a drop in the price of exported commodities. Analyzing district level Colombian data, Dube and Vargas (2013) showed that the likelihood of

[29] "a 50% drop in rainfall levels raises the probability of civil conflict onset in the following year by 7 percentage points"

civil violence was higher in the agricultural regions when international coffee prices (and thus farmer's real income) fell, thus supporting the opportunity cost theory.[30] Bazzi and Blattman (2014) proposed a more systematic investigation of the directional impact of export price shocks on conflicts, in order to disentangle between the three competing theories. Their results indicate that the joint effect of the opportunity cost and State resilience theories dominates the impact of the State as a prize theory, as higher export prices appear to lower conflicts. Additionally, they show that the main consequence of price shocks is not to increase the likelihood of conflict onset, but rather to extend the duration of existing conflicts. Carter and Bates (2011) argued however that it was necessary to include policy responses while modeling the impact of trade-related variables on civil wars, in order to account for the possible disconnect between domestic and border prices. Indeed, policies targeting urban consumers significantly decrease the risk of civil war. Several authors suggested that it was indeed a matter of political survival for governments to be seen to be trying to do something to address large income shocks (e.g. Poulton et al (2006) and Gouel (2013)).

Another strand of the literature focused more specifically on food riots.[31] Bush (2010) illustrated that food riots of the late 2000s were likely sparked by the surge in food prices, but that the crowds' messages were much broader (e.g. more civil and political freedom, less globalization). Looking at the 2008 and 2011 episodes, Lagi et al (2011) conceptualized food-related protests as a non-linearity. They hypothesized the existence of a price-threshold above which riots are likely to spring. Their hypothesis is that "widespread unrest does not arise from long-standing political failings of the system, but rather from its sudden perceived failure to provide essential security to the population". Using his own food riot index, Bellemare (2015) was able to demonstrate that, between 1990 and 2011, high food prices had indeed caused more food riots over the world.[32] Looking at international macro-level panel data, Arezki and Brückner (2011) demonstrated that a rise in food prices was correlated with social unrest but also more generally to a deterioration in the quality of the political institutions.

Hendrix and Haggard (2011) analyzed data on urban unrest from 55 large cities spread across 49 developing countries between 1961 and 2010. They observed that food price rises were more likely to provoke civil unrest in democracies than in autocracies: they demonstrate that autocracies disproportionally implemented policies favoring the urban population relative to the rural ones, thus targeting their support to the denser areas, mechanically more prone to civil unrest. These findings are in line with Carter and Bates (2011) who showed that a policy bias

[30] The impact of oil price shocks is the opposite: higher international oil prices induce more violence in the areas where oil-extracting activities are dominant, indicating the prevalence of the rapacity effect. These findings are in line with the theoretical model developed by Dal Bó and Dal Bó (2004)

[31] Note that Barbet-Gros and Cuesta (2014) tried to provide an operational definition of food riots and built a dataset of 55 such events between 2007 and 2014. Yet their index does not seem to have been much used in the academic literature.

[32] Bellemare (2015) is the only article we found that attempted to relate food price volatility to food riots, yet he was not able to conclude to a significant impact.

toward the urban population significantly weakened the causal link between food prices and civil wars. Berazneva and Lee (2013) found that likelihood of a country experiencing food riots during the 2007-2008 food crisis was significantly correlated with its the food production index, as well as its poverty level and its degree of urbanization. Contrary to Hendrix and Haggard (2011), they observed that riots were more likely to burst in more oppressive regimes.

In a very recent publication, McGuirk and Burke (2017) investigated the impact of food price shocks on violence across Africa, distinguishing between "factor conflicts" ("large-scale conflict battles associated with the permanent control of territory") and "output conflicts ("violence over the appropriation of surplus"). To some extent, their work covers both civil wars and food riots and enables them to document the strong impact of income shocks on conflicts.They found that, in food producing areas, high food prices tended to decrease conflict over the permanent control of territory: as farmers experience a positive income shock, the opportunity cost of soldiering becomes larger. Nevertheless, they note an increase in food riots and theft, indicating tensions on poor consumers' budget constraints. In non-producing areas, both types of conflicts become more likely when prices rise, as the income shock is negative across the board.

Considering the potentially dreadful consequences of food price shocks in terms of civil wars and violence, several academics support the idea of international food aid responses. Yet, they point to some biases in aid allocation, and advocate for a support that would be much more focused on recipients' needs rather than on donors' surpluses (Blattman and Miguel, 2010, p.32). Nunn and Qian (2010) documented for instance that US food aid flows were largely determined by lagged US wheat production and donors' strategic objectives. In a companion paper, Nunn and Qian (2014) were able to demonstrate a strong and significant causal link between the provision of food aid by the US and the incidence of civil conflict in the recipient country. The authors qualify this finding by showing that US food aid has no impact on the onset of conflicts, but rather on their duration. Taken together, these results are in line with observers' accounts of fighting groups stealing food aid either en route or from the civilians once it has been distributed. This large scale diversion of food aid is said to fuel conflicts as it provides militias with resources to keep on the fight.

Given the empirical evidence that agricultural price shocks may cause civil unrest and wars, and knowing the dire impacts of civil wars and violence on economic growth (see Blattman and Miguel, 2010, or Gates et al, 2012), one can conclude to an indirect (but strong) effect of food price variations on growth and development.

Is it really optimal to care about volatility?

If it becomes clear that agricultural price volatility, and more generally macroeconomic volatility, is detrimental to economic growth and human development, one still needs to wonder whether the costs of a possible price stabilization mechanism could overcome the benefits of such a stabilization scheme.

Lucas (1987) and Newberry and Stiglitz (1981) show, by linearizing the equations around the equilibrium points, that price stabilization could be redundant, and that its costs would by no means be compensated by the alleged benefits. Newberry and Stiglitz add that the principal beneficiaries of such a price stabilization system could very well be the developed countries that are importing, and that some developing countries could actually be worse-off. Concerning the intra-national evolutions, Bellemare et al. (2010) conclude from their study on Ethiopia that the majority of the benefits from a stabilization of agricultural prices would be concentrated on the wealthiest 40% of the population. Furthermore, the study by Kannapiran (2000) on Papua-New Guinea, shows shat the commodity price stabilization mechanism had only a negligible effect on macroeconomic data (consumption and investment).

Yet, Aizenman et Pinto (2004) question the legitimacy of Newberry and Stiglitz' linearization (which is only valid around the equilibrium) and Myers (2006) explains that if the traditional welfare analysis (static) concludes that price stabilization does not lead to significant gains, nor benefits particularly the poorest (it would mainly benefit the large producers), when taking into account the threshold effects (food security) and the dynamic aspects (growth) in the analysis, the conclusion gets modified. Price stabilization could lead to very large improvements in the welfare of the poorest.[33] Ahmed (1988) had concluded from his study on rice price in Bangladesh that stabilization was beneficial and that the theoretical oppositions that were mentioned were not supported by his data.

Last, this literature revue would not be complete if we were not to take into account the probable evolutions of agricultural price volatility. It is then very relevant and accurate to look at the alarming predictions on climate change that the international scientific community makes available to all. Indeed, climate change is most likely to lead to an increased frequency of extreme meteorological events such as draught and floods. When inserting estimates by the IPCC (International Panel on Climate Change) in a computable general equilibrium model, Ahmed, Diffenbaugh & Hertel (2009) manage to quantify the vulnerability of the poorest to potential changes in climate volatility. Their results indicate that some developing countries could see an increase in poverty. This increase could reach 5 percentage points for Mexico and up to 14 for Zambia. The authors show that the category of urban wage earners would be most affected: poverty could double in that category for Mexico, Malawi and Zambia for instance.

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33 "In summary, standard welfare analysis confirms the frequent findings in the literature that food price stabilization usually has small potential economic efficiency gains, has limited impacts on the poor, and generates the most benefits for large-scale food producers (Newbery and Stiglitz, 1981; Kannapiran, 2000; Larson et al., 2004). The potential gains from stabilization may be higher when poor consumers who produce little food spend a large proportion of their income on food, and are highly risk averse, make up a high proportion of the population.
Include growth and food security effects, however, and the situation changes. Even small improvements in the rate of economic growth can generate large welfare gains. Similarly, even small increases in the probability of survival can generate relatively large welfare gains for food insecure households." Myers (2006), p.206

Conclusion

The impacts of food price volatility, although much talked about, have not been systematically investigated by the academic literature. To nevertheless provide insights on the likely consequences of the increased variability of food prices over the past decade, we broadened the scope of the survey so as to include conclusions regarding macroeconomic volatility, as well as food price shocks.

Our general analysis indicates that food price volatility could have very strong consequences on economic growth and development. Increased price risk generally tends to discourage private investment and distort production patterns, especially so in developing countries. As insufficient agricultural investment and production shortages have been pointed as potential explanations for the recent price shocks, volatility could very well be a self-reinforced process. Simultaneously, food price shocks proved to significantly alter the constitution of human capital, with particularly damaging consequences on nutrition and schooling. They were also associated with civil conflicts and more generally to social unrest. Bearing in mind that food price shocks are actually the realization of price risk, the likely consequences of food price volatility on long term development appear daunting.

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