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INVESTMENT, TRADE, OUTPUT AND COMMODITY PRICES

Executive Summary

This paper examines the impacts of changes in international food prices on investment flows. It focuses on the price period from 1995 to 2015 and analyses, in particular, the impacts of higher prices from 2007 to 2012 on investment in domestic markets (Gross Fixed Capital Formation, GFCF) and in countries abroad (Foreign Direct investment, FDI). The paper further describes changes in fixed capital formation at the global, regional and country level and draws inferences on possible future production and price developments. The salient findings include:

- Higher international prices for food and agricultural products were associated with, or followed by, a strong increase in GFCF. This finding holds for the world as a whole, most individual countries and essentially all regional aggregates. The results also suggest a recent decline in growth of GFCF as international prices have receded.
- The higher growth in GFCF was associated with higher growth rates in agricultural output, measured as Gross Output (GO).
- Countries with sufficient financial but constrained natural resources, generally responded to higher prices by stepping-up outbound foreign investment. These were mainly, though not exclusively, countries in the Middle East and North Africa (MENA) region. As prices retrenched, so did FDI flows. These countries shifted back to trade as a source of supply.
- Higher domestic and foreign investments may not only have responded to higher prices, they may also have contributed to the price decline in the subsequent period (2012–18).
- As many of the capital items purchased during the high price period are reaching the end of their service lives, lower prices over the recent past (2013–2018) could have led to a gradual underinvestment in fixed capital items, potentially opening up renewed scope for price increases. Obviously, fixed capital formation is only one of many factors in determining medium-term price paths.
- All of the findings presented in this paper are on a “before vs after” basis. No modelling effort has been undertaken to construct a counterfactual scenario that would allow a “with vs without” comparison. This may also mean that the findings are mere correlations; they do not



necessarily allow us to draw firm inferences on causation and the contribution of the various factors to the observed findings.

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I. Introduction

1. The past 20 years have seen strong growth in agricultural fixed capital formation. They have also seen strong growth in agricultural output. Most of the increases were concentrated in the second half of these 20 years, i.e. 2005–2015. This second half was also ushered in by a sharp increase in international agricultural prices, with prices receding again after 2013. Numerous factors have been put forward to explain these trends in prices and the large swings around them. They include, amongst others, low inventories, high energy prices, robust food and feed demand, changes in biofuel policies as well as adverse weather effects (droughts). But there is also growing recognition that these higher prices may have spurred investment in agriculture and that higher investments have contributed to higher output and lower prices in the years following the price hikes.

2. No doubt, the links between prices, investment and output are complex. Sustained high prices, for instance, can stimulate agricultural investment and production, and in turn put downward pressure on prices over the medium-term. By contrast, highly volatile prices increase investment risks, lower investment levels and lead to lower output. In practice, the linkages are even more complex, resulting from time lags, cross-commodity effects as well as exogenous factors (e.g. swings in and levels of energy prices).

3. In response to these developments and their potential importance for global commodity markets, the 71st Session of the CCP asked FAO to analyse the linkages between investment, output, trade and commodity prices. The present document has been prepared in response to this request.

II. Analytical challenges

4. Analytical challenges arise in at least three areas. The first is in measuring the level and composition of fixed capital formation in agriculture. In accordance with the request by the CCP, the analysis focuses on investment flows in agriculture in the narrow sense. The most comprehensive datasets¹, however, cover the broader aggregate, i.e. $GFCF_{AFF}$. As this broad definition masks important links and developments that are key for agriculture, the analysis shifted to the more narrow definition, i.e. $GFCF_{Ag}$. This meant a trade-off in accepting more disaggregated data in exchange for a more limited dataset.

5. The second challenge is related to linking capital formation to prices. Their relationship is not direct, but potentially highly dynamic. The dynamics include positive and negative feedbacks, lagged effects, substitution effects, and cross-commodity and cross-country impacts. Broadly speaking, investment affects production capacity, production capacity affects actual output, and output affects prices. Prices, in turn, affect new investment decisions. In addition, each of these elements is also affected by exogenous factors. Consequently, the findings of this document, which are mainly derived from examining trends, should be viewed as a broad contour of a deep and complex process, which would require substantially more data to isolate the type and extent of causation.

6. A third major challenge concerns the need to distinguish between capital formation and production capacity², which is the more important correlate that affects production³, trade and prices. For instance, the rapid production response following the price spikes of 2007 and 2011 could be due to new investments or using available spare production capacity more intensively, or both. The issue is that while production capacity and capital stock are equivalent in the long-term, their association

¹ Neither land nor any other type of natural resource used in agriculture are included in $GFCF_{AFF}$. This is key in explaining to a large extent the differences that exist between countries on average product of capital.

² Production capacity is here understood as the maximum potential output of primary agriculture at any point in time in any particular region, which is determined by the *ensemble* of existing tangible and intangible assets on-farm, plus the enabling environment.

³ See in particular FAO. 2001. Agricultural Investment and Productivity in Developing Countries. FAO Economic and Social Development Paper No. 148. FAO, Rome.

weakens in the short and medium-term. This may not affect the impacts on longer-term prices but certainly the short-term links between investment, output and prices. The lack of data to capture production capacity such as Net Capital Stocks (NCS)⁴, necessarily limited the analysis to price and trade links with GFCF.

III. Investment, production capacity and agricultural output

A. Gross Fixed Capital Formation in Agriculture, Forestry and Fishery (GFCF_{AFF})

7. The broadest available dataset contains a total of 204 countries with data for GFCF_{AFF}, covering the period from 1990 to 2015. Official (computed) data are only available for one third of the countries, mostly OECD countries; data for all other countries are imputed.⁵ For some large countries, such as the Russian Federation, the time series start only in 1995.

8. Considering all these constraints, consistent data for GFCF_{AFF} were available for 202 countries spanning the entire period from 1995 to 2015.

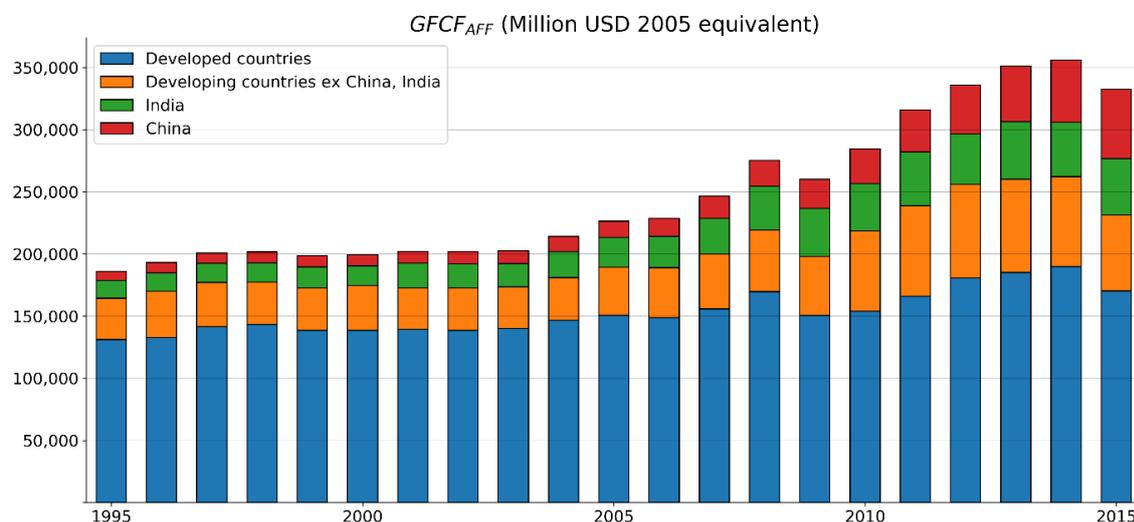


Figure 1: Evolution of Gross Fixed Capital Formation in Agriculture, Forestry and Fishery 1995–2015

9. Figure 1 depicts the entire timespan, for which consistent data on GFCF_{AFF} were available, and shows a rapid global increase in fixed capital formation from 1995 to 2015. By 2014, GFCF_{AFF} had reached an overall volume and maximum of USD 356 billion, nearly twice the level reached in 1995, measured in constant prices of 2005. Even a precursory inspection of the time series reveals a much faster increase in the second part of that period, i.e. roughly from 2006 to 2015.

B. GFCF_{AFF} growth across countries and regions

10. Within the overall global expansion, a notable rebalancing process took place at the regional level. At the broadest level, there was a shift in GFCF_{AFF} from developed to developing countries. While developed countries still accounted for more than 70 percent of GFCF_{AFF} in 1995, 20 years later their share had declined to 51 percent.

⁴ FAOSTAT does not compute NCS_{AFF} from existing inventories, but constructs estimates through applying the Perpetual Inventory Method to GFCF_{AFF}.

⁵ FAO. 2018. FAO Global Database on Agriculture Investment and Capital Stock: content and methodological description. FAO, Rome (forthcoming).

11. Figure 2 depicts the growth of world $GFCF_{AFF}$ over the past two decades, distinguishing two basic periods, i.e. from 1995 to 2005 and from 2006 to 2015. Between these two decades, the global average growth rate in $GFCF_{AFF}$ nearly quadrupled from 1.0 percent per annum to 3.7 percent per annum, and it increased even more in developing countries with the highest rates attained in Southeast Asia, where the rate of growth in fixed capital formation was ten times higher in the second decade than in the first.

12. Arguably, the most important change in the context of impacts on world markets took place in North America. Not only did the rate of growth in $GFCF_{AFF}$ more than triple, the sheer size of North American agriculture meant that these growth rates translated into large absolute additions in fixed capital. $GFCF_{AFF}$ in North America, measured in constant prices of 2005, increased from USD 29.8 billion in 1995 to USD 60.0 billion in 2015. As shown below, agriculture alone accounted for the lion’s share of this growth and within agriculture, investment in machinery is the single largest item. It can be argued that these investments added particularly to the crop production capacity of the region. As North America’s agriculture is largely export-oriented, the additional fixed capital increased the region’s ability to respond to rising international crop prices in a significant manner.

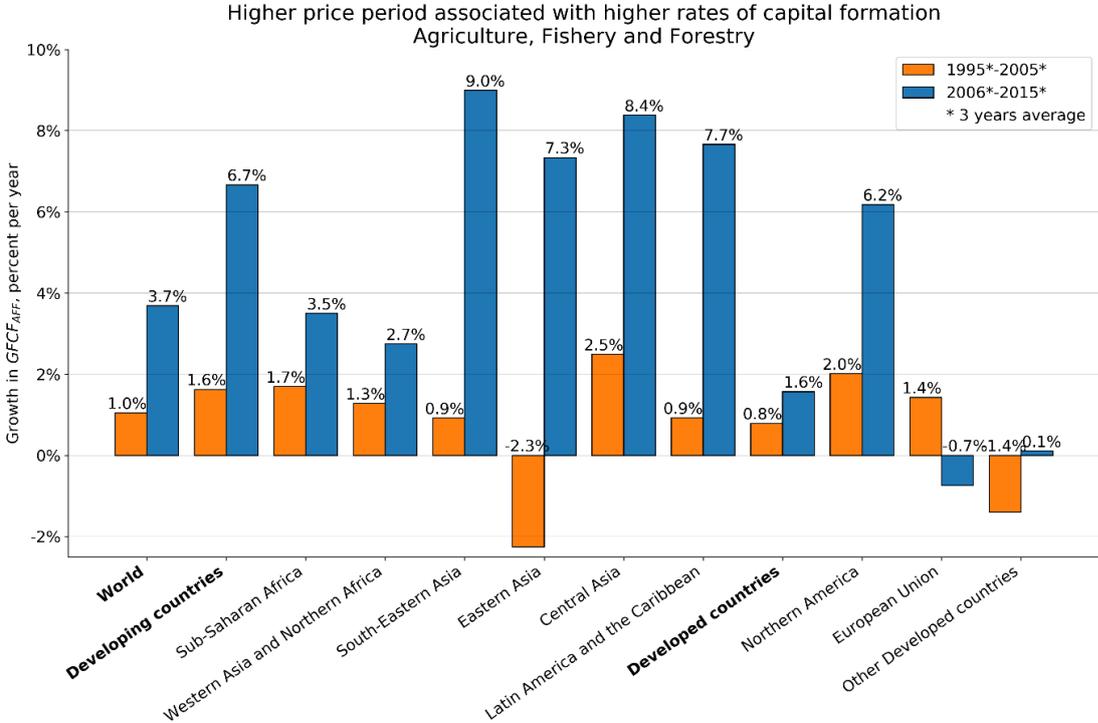


Figure 2: Annual growth of $GFCF_{AFF}$ in different periods for selected country groups

13. While the world and nearly all regional aggregates show rising capital formation rates (Figure 2), rising rates of $GFCF_{AFF}$ were not a ubiquitous phenomenon at the country level. About 60 percent (i.e. 125) of all countries (i.e. 202) for which $GFCF_{AFF}$ data were available over the entire period saw an increase in investment growth; the remaining 77 countries experienced lower growth in the period, if not a decline in investment. Obviously, these were countries with smaller agricultural sectors, insulated from world markets through natural barriers (Small Island Developing States, SIDS as well as the MENA region) and/or were insulated by policy measures. The concentration of $GFCF_{AFF}$ growth is also borne out by the increase in the absolute amounts of investment increases. The 60 percent of the countries with $GFCF_{AFF}$ growth accounted for 77 percent of $GFCF_{AFF}$ (Table 1).

Table 1: Headcount of countries with higher rates of capital formation

	Countries with increased growth in GFCF 2015-2005 vs 2005-1995	Countries with reduced growth in GFCF 2015-2005 vs 2005-1995
Number of Countries	125 (60%)	77 (40%)
Total GFCF _{AFF} (billion USD in 2005 prices, 2013/15 average)	256 (74%)	88 (26%)

14. Within the group of developing countries, China has seen the most impressive investment dynamics, more than quadrupling its fixed capital formation in the decade from 2005 to 2015. The process of capital deepening in agricultural production evolved in tandem with a rapid structural transformation process of China's agriculture. Between 1995 and 2014, GFCF_{AFF} per worker went up by a factor of nine, and by more than a factor of seven when expressed per hectare of agricultural land. This shift from labour-intensive to more capital-intensive agriculture was accompanied and supported by a rapid industrialisation process, which absorbed a lot of the excess labour from agriculture. Comparing current capital/labour ratios of China's agriculture with those of OECD countries (Table 2), it would seem that this process is far from finished. With further structural reforms foreseen⁶, the agricultural transformation process may proceed unabated, resulting in a further deepening of capital in parallel with a reduction in the agricultural labour force.

Table 2: Headcount of countries with higher rates of capital formation

	Year	Developing ex. China	China	Developed
GFCF _{AFF} per agricultural worker (2005 USD equivalent)	1995	181	20	2,962
	2014	321	186 (2013)	9,285
GFCF _{AFF} per hectare of agricultural land (2005 USD equivalent)	1995	17	14	86
	2015	38	105	140

C. GFCF in Agriculture (GFCF_{Ag})

15. While GFCF_{AFF} data are widely available and statistically more robust (fewer imputed observations) than further disaggregated investment data, they include fisheries and forestry and hence sectors that were not exposed, or were less exposed to the price rises and swings from 2007 to 2012. The more aggregated capital formation data may thus mask some of the investment dynamics that have arisen in agriculture only and which may stem from specific developments in agriculture only. However, narrowing the analysis to agriculture (GFCF_{Ag}) also narrows the available statistical basis to fewer countries. Generally, these are OECD countries as well as some advanced emerging economies.

⁶ See e.g. the "No. 1 central document" by the Ministry of Agriculture and Rural Affairs of the People's Republic of China, http://english.agri.gov.cn/news/dqnf/201702/t20170206_247179.htm

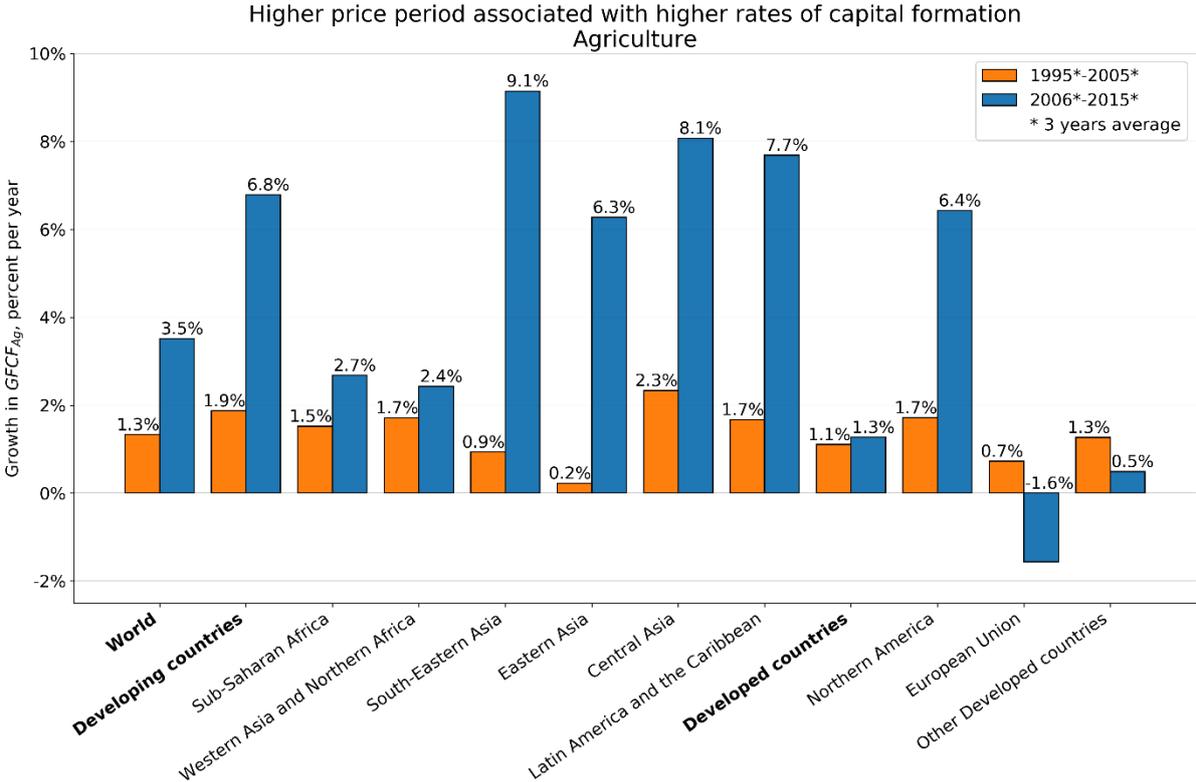


Figure 3: Annual growth of $GFCF_{Ag}$ in different periods for selected country groups

16. A first look at the global developments suggests that the broad trends remain intact, when limiting the statistical basis to agriculture only. Just like for $GFCF_{AFF}$, $GFCF_{Ag}$ saw rapid growth from 2005 to 2015. There are some noticeable differences for the first period, which suggests that the negative growth in fixed capital formation in East Asia during the first period is still a period of investment growth for $GFCF_{Ag}$. Most importantly, however, the narrower focus on agriculture provides a better basis for the analysis of, and links to, agriculture, including agricultural prices, production and trade.

D. The price–investment link

17. Figure 4 focuses on $GFCF_{Ag}$ using data from 1995 to 2015, and juxtaposes the series with the evolution of the FAO food price index (FAO-FPI) over the same period. Even a cursory look at Figure 4 suggests a positive correlation between the two series. Implicit here is a certain investment responsiveness of investors/farmers to prices, i.e. that $GFCF_{Ag}$ moves with agricultural prices and even with shorter-term price swings. Particularly in recent years, the links from prices to investment evolve through time lags of one to two years which is economically more intuitive than a synchronous, i.e. instantaneous price – investment reaction.

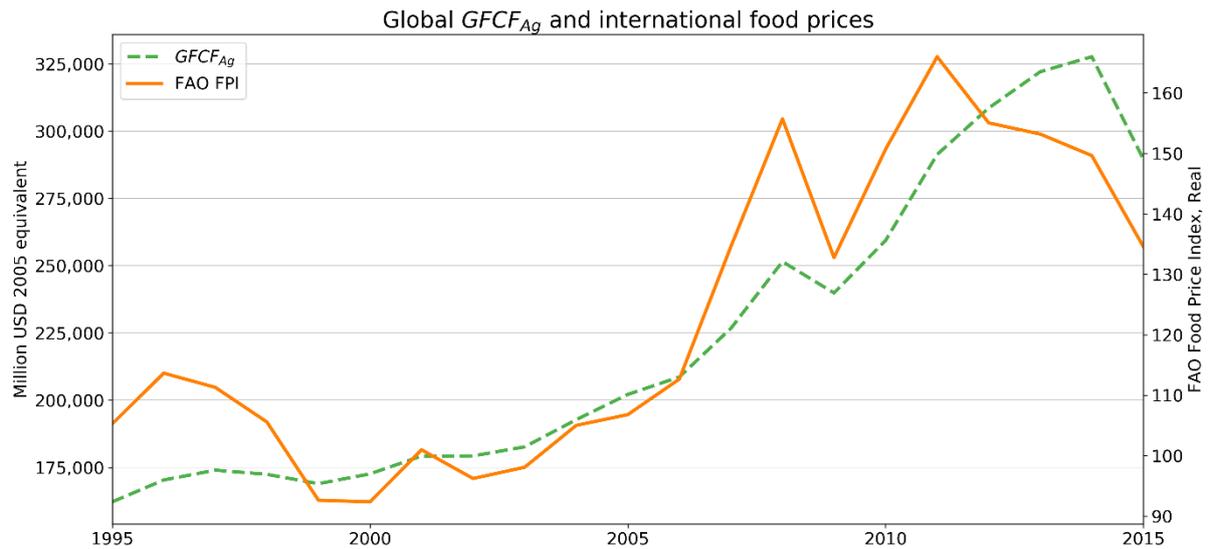


Figure 4: Global fixed capital formation and international food prices

18. Also the more disaggregated data (individual countries) confirm that the boom and bust in fixed capital formation went in sync with the rise and fall in prices. In the United States of America, for instance, $GFCF_{Ag}$ moved in line with swings in international agricultural prices and, with a certain time lag, followed prices even in the short-term (Figure 5). Apart from annual fluctuations, the period of elevated price levels from 2007 to 2012 was generally associated with a noticeable increase in fixed capital formation. The more recent data suggest that the reverse may hold for the period of lower prices after 2012.

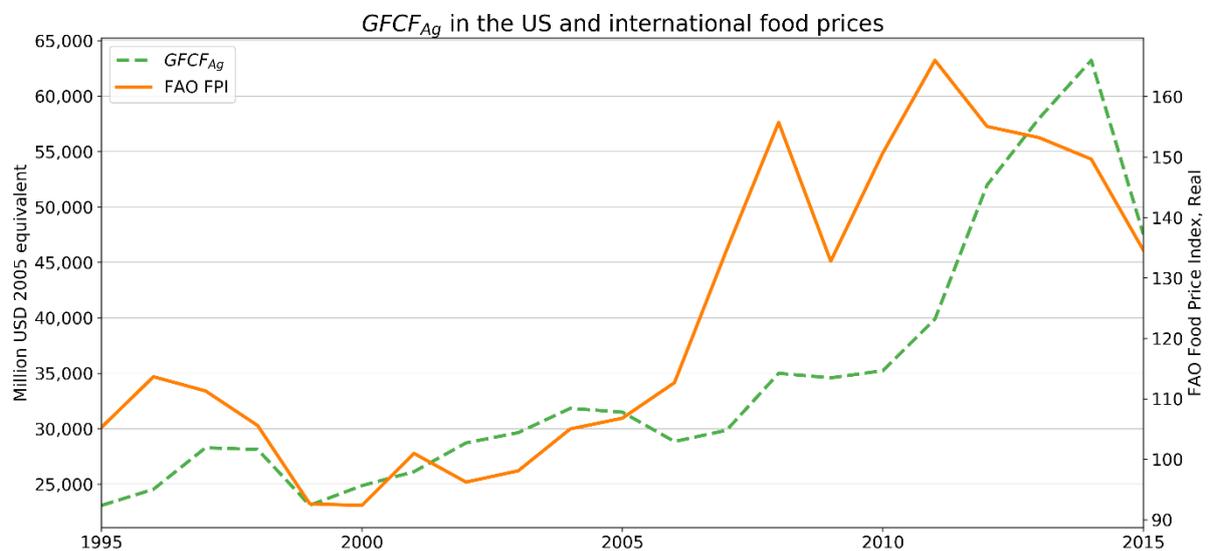


Figure 5: $GFCF_{Ag}$ in the USA and international food prices

19. If falling prices will be associated with lower trend investments, farmers may have overinvested in fixed capital during the high price period. They could now see themselves locked into the investment decision made during the high price period and have continued to produce when prices had receded after 2012. The lock-in effect can mean that farmers continued to produce above “equilibrium levels”, i.e. at price levels that are unprofitable from a long-term perspective, which is when prices fall below the total costs of production. Obviously, farmers would continue to produce in the short-term as long as prices are above variable costs, i.e. allowing them to cover some of the

(sunk) fixed costs. The “excess” investment itself could therefore have contributed to the downwards pressure on international prices after 2012.

E. The investment-output link⁷

20. In addition to the investment-price link, an even more intuitive link should exist between investment and production. Available data indeed suggest that such links exist, i.e. that higher output prices have incentivised producers to commit more fixed capital to production, increase their production capacity and ultimately actual production. In reality, these links are more complex and less linear than described here. They involve time lags, cross-commodity and cross-country effects and feedback loops on consumption, production and prices. Disentangling these linkages would exceed the scope of this document; it would require a comprehensive modelling framework in which such cross-commodity and cross-country effects and their dynamics are formulised.

21. Taking these limitations into account and reducing the analysis to the mere description of changes, this section will first describe the growth in agricultural production, measured by GO, then juxtapose it to growth in GFCF and eventually look at the responsiveness of GO to changes in GFCF, i.e. the elasticities of output with respect to fixed capital formation.

Growth in gross output

22. Available data on GO and GFCF suggest that the period of higher prices was associated not only with higher investment in fixed capital items (GFCF), it was also associated with higher growth rates in agricultural production, as measured by GO (Figure 6). This holds for the world as a whole as well as for developed and developing countries in aggregate. Some individual regions, however, deviated from the global trend, in part in a noticeable manner. The two cases in point are sub-Saharan Africa and Latin America, where output growth slowed in the second decade from 4.7 percent to 3.9 percent p.a. and 2.7 percent to 2.0 percent p.a., respectively.

⁷ The focus of the analysis in this section is on the impacts of fixed capital investment on output. The impacts of intermediate input are left aside. Separate analyses undertaken suggest that the importance of intermediate inputs rose in line with output, however, not faster. China is a notable exception. In China, intermediate inputs nearly doubled their importance in final output. Differently put, not only did China use more machinery, structures or irrigation equipment, it also stepped up more than proportionally the use of fertilizer, pesticides, power and other intermediate inputs.

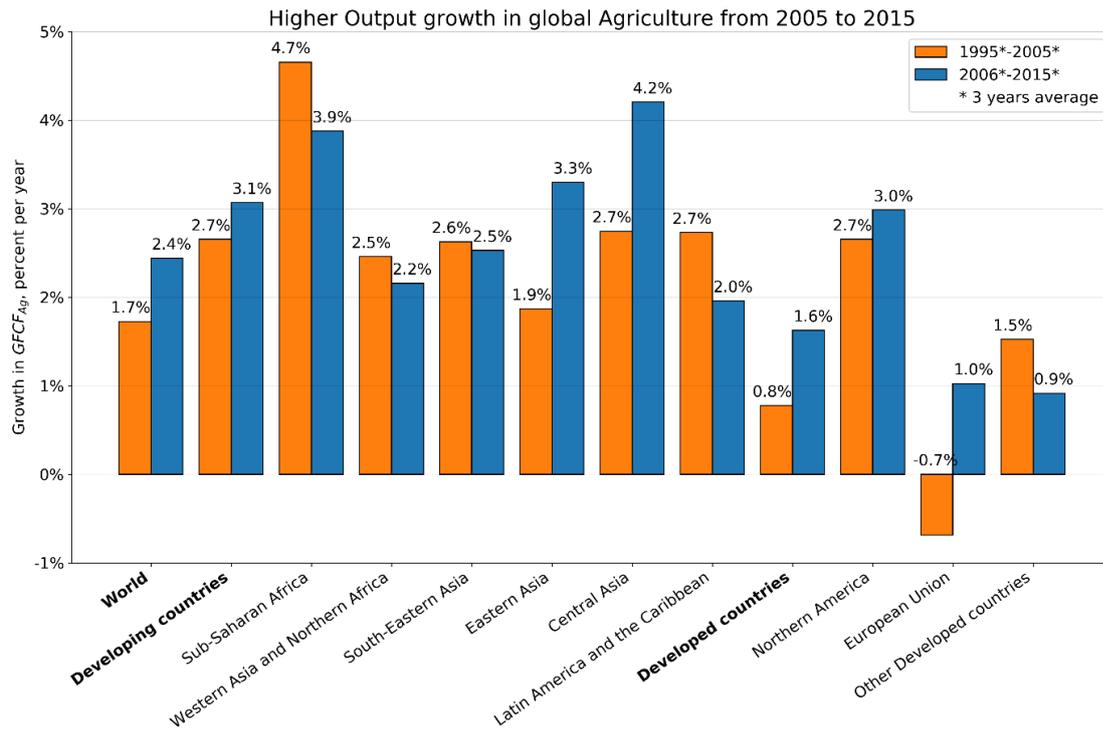


Figure 6: Output growth accelerated in most regions in the decade from 2005 to 2015

Responsiveness of output (GO) to investment (GFCF)

23. There are two principal possibilities for output to be driven by higher investment. The first is that investment volumes increased and spurred output in a proportional manner, i.e. with a constant responsiveness. The second could come from the fact that every dollar of additional investment had rendered higher output, i.e. that the responsiveness of agricultural output with respect to investment has increased over time (here with higher prices). To this end, the responsiveness of output to investment was estimated, for the world as a whole and for individual regions. The two variables (in logs) were regressed against each other with both variables in logarithms, which allows the resulting coefficient to be interpreted as an elasticity. The results for developed and developing countries are visually presented in Figure 7, regional details are summarized in Table 3.

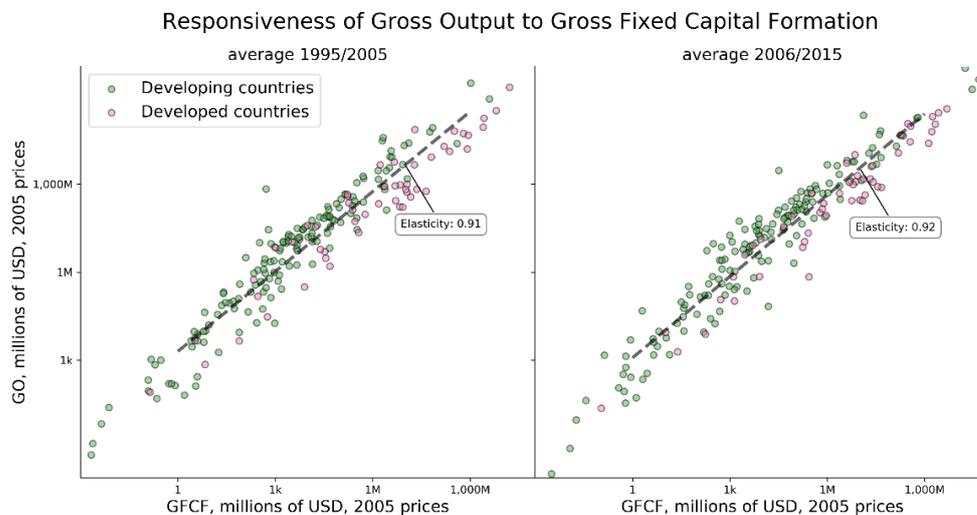


Figure 7: Responsiveness of Gross Output to GFCF

24. The results show a strikingly constant relationship of about 0.9 for both periods. It has a similar magnitude, albeit with some variation, over essentially all individual regions (Table 3). This constant responsiveness suggests that the output growth came from higher investments (GFCF) rather than from a higher efficiency of such investment in generating higher output.

Table 3: Responsiveness by region

Region	Responsiveness of Gross Output wrt GFCF (elasticity)		Gross output, 2013/15 average, billion USD, 2005 prices	Share (%) in global gross output
	1995/2005	2006/2015		
World	0.91	0.92	2869	100%
Developing countries	1.00	0.99	1710	60%
Sub-Saharan Africa	0.91	0.92	207	7%
Western Asia and Northern Africa	0.81	0.98	189	7%
Eastern Asia and South-eastern Asia	0.91	0.96	810	28%
Latin America and the Caribbean	1.06	0.98	258	9%
Developed countries	0.87	0.92	1158	40%
Northern America	0.94	0.96	344	12%
European Union	0.84	0.90	482	17%

F. High prices and Foreign Direct Investment (FDI)⁸

25. The high price period from 2007 to 2011 was also characterised by concerns that a strong reliance on trade as a source of food supply may not always be an apt strategy for all countries to ensure food security at home. High international prices and low food availabilities on international markets prompted investors to look for added or new sources of supply either by investing in agriculture at home ($GFCF_{Ag}$) or by investing in production capacity abroad (FDI). The latter is analysed below.

26. The preceding analysis focused on the links between higher prices and domestic investment. It showed that higher investments at home rose with international prices and were associated with a marked increase in production. The higher domestic investment option was typically pursued in countries with sufficient financial and natural resources. This part of the analysis will focus on the role of FDI, i.e. the extent to which countries, typically rich in financial resources but with scarce natural resources, invested in countries abroad.

⁸ There is an important distinction to be made between the investment flow and its financing. GFCF denotes the investment while FDI is a part of the financing sources. In reality, the distinction can be more complicated and the flows empirically less straightforward to disentangle. GFCF consists of outlays on additions to the fixed assets plus net changes in the level of inventories, while FDI relates to financing—that is, the purchase of agricultural assets in foreign countries or of shares in foreign companies where the buyer has a lasting interest. FDI can therefore be used to finance GFCF, however it can also be used to cover a deficit in a company or pay off a loan. In agriculture in its narrow definition (primary agricultural production), most FDI is in land and tenure, hence used to finance GFCF.

FDI outflows in land and related assets

27. Where the natural resource base to step up production is more limited or already exhausted as is the case in a number of MENA countries, higher domestic investment is not an obvious option to increase agricultural output. Many of these countries therefore resorted to investment in countries abroad, i.e. countries with fewer financial but more natural resources.

28. Typically, these resource-poor countries stepped-up outbound FDI to invest in countries with a rich natural resource base, but insufficient financial resources. The basic idea was to increase production abroad with a view to securing supplies through imports back home. FDI in agriculture often takes place in the form of land purchases and long-term leases.⁹

29. Figure 8 depicts FDI in land (purchases and long-term leases) and juxtaposes these with the FAO Food Price Index as an indicator of international prices.

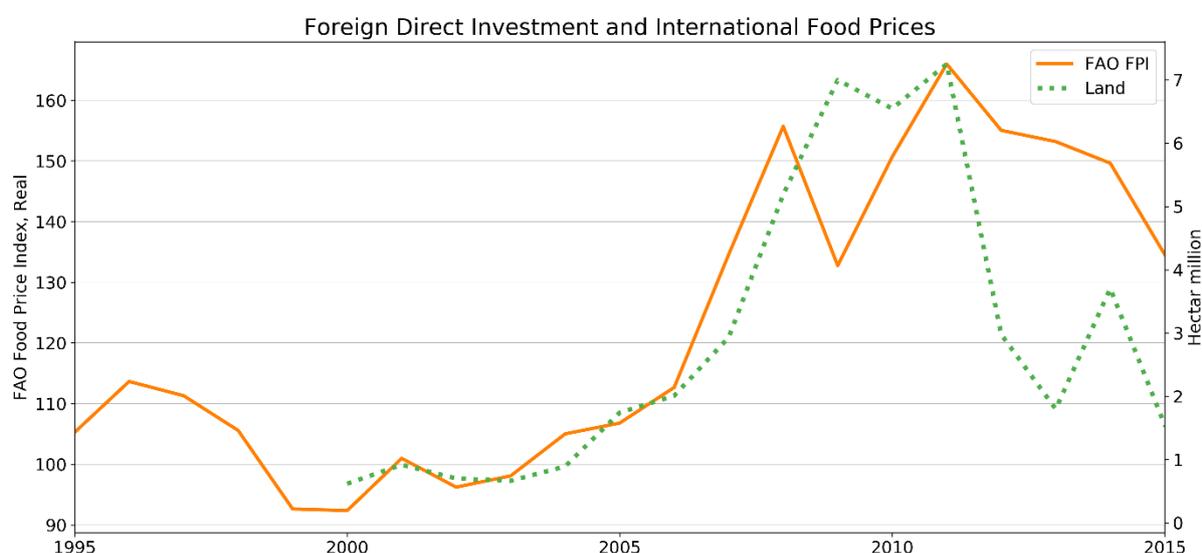


Figure 8: FDI and International Food Prices

30. Interestingly, the links between prices and investment abroad are at least as pronounced as for domestic investment ($GFCF_{Ag}$) and prices. Available data¹⁰ suggest that land deals intensified during and shortly after the price hikes between 2007 and 2012. Unsurprisingly, there are time lags between the price hikes and the land deals, simply indicating that the often complicated negotiation processes required time for completion. As prices receded after 2012, so did land acquisitions and long-term leases. This mirrors the developments on the domestic investment side, where growth in $GFCF_{Ag}$ also declined with falling prices. It also suggests that investments in agricultural land were largely motivated by the desire to secure food security at home. As prices receded and trade resumed its role as a vital and reliable source of food supplies, FDI in land declined in parallel.

31. In response to a request from the 71st Session of the CCP, asking FAO to analyse the linkages between investment, output, trade and commodity prices, this paper has made a first effort towards better understanding how such linkages influence global commodity markets. The paper adopted an exploratory approach to gain insight into how changes in each of the variables may manifest on one

⁹ As such investment flows can come at the expense of the recipient countries, popular media frequently referred to them as “land grabbing”.

¹⁰ Data for FDI have been taken from the “Land Matrix”. They have been compiled, i.e. normalised and standardized by the Trade and Markets Division. The data in the chart exclude domestic investment in land, which also saw a rapid rise during the high price period, particularly in 2011.

another. It is clear that the interplay between prices, investment, output, and trade is highly complex and seemingly influential. Moving forward, a more formal analytical framework would need to be developed to identify the precise mechanisms of causality. The results of such an effort could be critically important for understanding future production and price developments in agricultural commodity markets.

Annex

Glossary of terms

FDI: Foreign direct investment is the category of international investment that reflects the objective of a resident entity in one economy to obtain a lasting interest in an enterprise resident in another economy.

GFCF: The Gross Fixed Capital Formation is the total value of a producer's acquisitions, less disposals of fixed assets during the accounting period plus certain additions to the value of non-produced assets (such as subsoil assets or major improvements in the quantity, quality or productivity of land) realised by the productive activity of institutional units. It does not account for the consumption (depreciation) of fixed capital and excludes land purchases.

Gross Output: The value of agricultural output sold or put to other uses.

Intermediate Inputs: Intermediate inputs consist of the value of the goods and services that are consumed as inputs by a process of production, excluding fixed assets whose consumption is recorded as consumption of fixed capital.

NCS: The Net capital stock is the sum of the written-down values of all the fixed assets still in use is described as the net capital stock; it can also be described as the difference between gross capital stock and consumption of fixed capital.

PSE: The Producer Support Estimate is an indicator of the annual monetary value of gross transfers from consumers and taxpayers to support agricultural producers, measured at farm gate level, arising from policy measures, regardless of their nature, objectives or impacts on farm production or income.

PNPC: The Producer Nominal Protection Co-efficient is an indicator of the nominal rate of protection for producers measuring the ratio between the average price received by producers (at farm gate), including payments per tonne of current output, and the border price (measured at farm gate level).

Value Added: Value added measures the value created by production. It is an unduplicated measure of output in which the values of the goods and services used as intermediate inputs are eliminated from the value of output. In this document, it is defined as the gross value added, i.e. the value of output less the value of intermediate consumption, or algebraically:
$$GVA = (Q \times P) - (q \times p)$$