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Take an inch for a mile. About an error of metrics in WTO rules and its impact on the ability of countries to build public stocks for food security☆

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ABSTRACT

Many developing countries use public stocks to provide free or subsidised grain to food-insecure households or to mitigate sharp increases in grain prices. However, the building of public stocks is regulated by the WTO, as public procurement may be used to provide farmers with a price support. This support is bounded jointly with the other forms of non-exempt domestic support for agriculture. Since 2012, WTO rules on public stockholding programmes have been questioned by a group of 33 member countries, and are at the top of the WTO negotiation agenda. The topics debated are i) the way this support should be calculated, and ii) the maximum level of support allowed. This article addresses the first topic. It identifies three biases in WTO rules and estimates the magnitude of the gap between the support actually provided and the support calculated according to WTO rules. It appears that, for grains, the support calculated is generally several times higher than the real support, compromising countries' compliance with their domestic support commitments and thereby significantly reducing their ability to build public stocks. Moreover, the gap is not the same for all countries and is generally much higher for poor countries: the countries that most need public stocks for food security are those with the least freedom to build them. This article thus proposes a simple way to correct the rules that specify how the support provided by public stockholding programmes should be calculated.

1. Introduction

As part of their public stockholding programmes for food security purposes, the governments of many developing countries purchase food products (mainly grains), store them and either distribute them for free to food-insecure households or sell them on the market when prices reach unacceptable levels. The expected effect on food security is that this will maintain food-insecure households' access to food, either by transferring food to them or by mitigating food price increases. These programmes may provide support to farmers either directly (by paying a high price to their suppliers), or indirectly if public procurements generate an increase in the domestic market price. This is why the building of public stocks (henceforth PS) is regulated by the World Trade Organization (WTO). WTO rules on public stockholding programmes are set out in the Agreement on Agriculture (AoA), which entered into force with the establishment of the WTO on 1 January 1995. The support provided by public stockholding programmes is bounded jointly with the other forms of non-exempt domestic support.

However, WTO rules on public stockholding programmes have been questioned by some member countries (Kask, 2020). They claim that these rules prevent them from implementing the policies they need in order to guarantee food security for their population. In 2012 and 2013, a group of 33 member countries led by India (the G33) proposed modifications to these rules (Bellmann et al., 2013), which were consequently debated during the Bali Ministerial Conference in December 2013. However, the Bali Conference failed to produce an agreement on this issue: members simply agreed on a "peace clause" exempting the public stockholding programmes already existing from legal challenges until a "permanent solution" is found (WTO, 2013; Diaz-Bonilla, 2014). The need to find a permanent solution to the issue of public stockholding for food security purposes was reaffirmed during the 2015 and 2017 WTO Ministerial Conferences (WTO, 2015; Glauber, 2016). This need

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has become even more obvious since the recent dispute concerning China's public stockholding programme highlighted the limitations of the peace clause (Brink and Orden, 2020; WTO, 2020).[2] The current food price crisis on international markets has again stressed the importance of the PS issue, which is therefore likely to be central to the next WTO Ministerial Conferences.

The topics debated are i) the way this support should be calculated, and ii) the maximum level of support allowed. Both issues have been questioned by member countries. However, they are very different questions. Indeed, the first is mainly technical: estimating the domestic support actually provided by public stockholding programmes is a matter of fact, and people acting in good faith should readily agree on this issue. The second issue is more political, as it is not related to how the world is, but rather to how it should be, and countries' interests obviously diverge on this point.

This article focuses exclusively on the first issue.

WTO rules are based on the idea that when procurements for public stockholding programmes are made at administered prices, they generate a market price support (MPS), which can be estimated, added to other forms of domestic support (mainly input subsidies) and compared with the country domestic support limit (DSL). According to the AoA (WTO, 1994), the market price support provided by public stockholding programmes to the producers of a specific commodity (MPS_{WTO}) should be estimated as the product of i) the difference between the PS procurement price (called "applied administered price" or AAP) and the fixed external reference price (FERP), and ii) the quantity of "eligible" production (QEP):

$$MPS_{WTO} = (AAP - FERP)\ QEP \quad (1)$$

The FERP "shall generally be the average free on board (fob) unit value for the basic agricultural product concerned in a net exporting country and the average cost insurance and freight (cif) unit value for the basic agricultural product concerned in a net importing country in the base period" (WTO, 1994, Annex 3, Article 9), the base period being 1986–88 for the countries that joined the WTO at the outset. The quantity of eligible production (QEP) is defined by the AoA as "the quantity of production eligible to receive the applied administered price" (Annex 3, Article 8).

Several debates emerged among experts and WTO members regarding the right way to interpret the definitions of the FERP and the QEP. This gave rise to an extensive (grey) literature, which developed in three directions:

1. Works comparing WTO and economic definitions of MPS. These works highlight the gap between economic and WTO measurements of MPS (Hoda and Gulati 2007; Brink, 2011; Orden et al. 2011a; Diaz-Bonilla, 2013; Hoda and Gulati 2013; Konandreas and Mermigkas, 2014; Matthews, 2014; Montemayor, 2014; Josling, 2015; Glauber, 2016). This gap is a huge problem, because if real support and the support calculated and bounded by the WTO diverge substantially, then WTO rules will be incapable of fulfilling their economic objectives, such as reducing distortions while allowing countries to implement the policies they need to improve their food and nutritional security (Orden et al., 2011a; Matthews, 2014). These works led to proposals for interpreting the FERP and the QEP in a way that reduces the gap between the two approaches. Acknowledging the fact that taking as a reference price the average price over a fixed past period is problematic, some experts and countries attempted to propose solutions. They argued that the FERP should be considered as a real price (instead of a nominal price), meaning that the FERP should be corrected by the country inflation rate since the base period (Bellmann et al., 2013; Hoda and Gulati, 2013; Diaz-Bonilla, 2014; Konandreas and Mermigkas, 2014). Another proposal made is to express the FERP in US dollars instead of national currency units (see for instance Glauber, 2016) in order to remove the effect of exchange rate movements between the base period and the current period. Moreover, arguing that the share of production self-consumed by farmers does not benefit from any MPS, Hoda and Gulati (2007) and Montemayor (2014) proposed using the marketable quantity instead of the national production as the QEP.

2. Works assessing whether the different interpretations of the FERP and the QEP are compatible with WTO rules. This is mainly a legal approach and is based on an analysis of the articles of the AoA (WTO, 1994), but also on clarifications produced by the WTO Committee on Agriculture (WTO, 2014) and by the jurisprudence (decisions made by Panels and the WTO Appellate Body when disputes occurred). The main clarifications produced by these works reject the key proposals made in order to reduce the gap between economic and WTO definitions of the MPS.

The experts who proposed correcting the FERP by the country inflation rate based their arguments on Article 18.4 of the AoA, which states that "in the review process members shall give due consideration to the influence of excessive rates of inflation on the ability of any member to abide by its domestic support commitments". The fact that only "excessive" rates of inflation are mentioned led the authors of the September 2013 non-paper (a subset of G33 countries, see Bellmann et al., 2013) to propose taking into account rates of inflation exceeding 4% when estimating the support provided by public stockholding programmes. However, it seems that Article 18.4 deals more with considerations to be taken into account when assessing the situation of countries that have been unable to comply with their commitments than with calculating the support itself, as argued by some experts (Brink, 2014) and clarified by the WTO Committee on Agriculture (WTO, 2014).

Whether countries have the right to use a FERP expressed in US dollars is unclear. This is in fact a rather technical debate: the text of the AoA says both that the support should be calculated by "taking into account the constituent data and methodology used in the tables of supporting material incorporated by reference in Part IV of the member's Schedule [meaning country's notification for the base period]" (Article 1.a.ii) and that it should be calculated "in accordance with the provisions of this Agreement, including Article 6, and with the constituent data and methodology used in the tables of supporting material incorporated by reference in Part IV of the member's Schedule" (Article 1.h.ii). While the first formulation ("taking into account") seems to give countries some flexibility, the second ("should be in accordance to") seems much more restrictive. The Appellate Body decision during the Korea beef case (WTO, 2000b) clarified that the correct wording is "in accordance with" for the text of the Agreement (with its annexes), but is only "taking into account" regarding the methodology used by countries for their first notification (related to the base period). According to Diaz-Bonilla (2014), this means that a change in the currency used by a country to notify its FERP is acceptable. But Brink (2014) disagrees with this interpretation. This has many implications, because "only a handful of developing countries have specified FERPs or AMS ceilings in foreign currency in their commitments (Argentina, Brazil, Columbia, Costa Rica, Turkey, and Venezuela)" (Matthews, 2014). Therefore, if Brink's interpretation is correct, many developing countries have to express the FERP in their own currency units.

During the Korea beef dispute, the government of South Korea argued that the quantity eligible was the quantity actually purchased, because this was the quantity for which there was available money to pay the public procurement price (WTO, 2000a, §371). But the Panel (and then the Appellate Body) explained that this argument was not acceptable and recalculated the support provided. The Panel argued that the quantity eligible was the marketable quantity ("it is marketable production as a whole which benefits from this type of [price] support", WTO, 2000a, §832). However, the decision made by the WTO Appellate

[2] The protection provided by the peace clause is restricted by several limitations, the main ones being that in order to qualify, the public stockholding programme must i) have already existed at the date of the Bali Package (2013), ii) be transparent (the country must provide "relevant statistical information" on its programme), and iii) not "distort trade". When challenged by the US, China did not claim the protection of the peace clause (Brink and Orden, 2020).

Body (after South Korea appealed the decision) did not make any mention of the marketable quantity, but stated that "production eligible refers to production that is 'fit or entitled' to be purchased rather than production that was actually purchased" and that if the quantity to be procured is announced in advance, then this quantity should be considered as the eligible production (WTO, 2000b, §120 and 121).

3. Works estimating the implications of the different definitions of the FERP and the QEP for the calculated MPS and country compliance with their DSL. The main finding of these works is that the different ways of interpreting the FERP and the QEP may significantly affect the estimated support and countries' compliance with their WTO commitments, as shown by Brink (2014) for the case of rice, wheat, cotton, and sugarcane in India, by Konandreas and Mermigkas (2014) for specific country-commodity pairs, and by Montemayor (2014) for food staples in five developing countries. They also highlight a "compliance issue": with the most commonly agreed definitions for the FERP and the QEP, many countries are or will face difficulties complying with their WTO commitments on domestic support. An empirical study examines "the public stockholding policies of selected developing countries from the perspective of WTO rules and assesses whether the provisions of the Agreement on Agriculture (AoA) could hamper these countries' efforts to address the challenges of food security". It concludes that the 12 countries considered "are facing or will face problems in implementing the food security policies due to the provisions under AoA" (Sharma, 2016a).[3] Another study focusing on Indonesia reaches similar conclusions (Thow et al., 2019). This compliance issue is the driver of the G33 initiative to change the WTO rules on PS.

The broad picture resulting from this literature is incomplete and fragmented. There is a compliance issue, but is it due to the magnitude of the price support actually provided by countries through their PS? Or to the fact that the WTO measurement of the MPS overestimates the real support provided (Brink and Orden, 2020)? Can the compliance issue be managed by playing on the ambiguities of WTO definitions of the FERP and the QEP, or is it necessary to change WTO rules? If rules have to be changed, what is the best way to do it? By exempting countries with specific attributes or in specific situations from any disciplines on food security PS? By increasing the level of the DSL? Or by changing the rules that define how the MPS provided by PS should be calculated? The different experts and countries disagree on these questions, as reflected by their diverging recommendations.

The main source of the problem seems to be the lack of an economic analysis of the MPS generated by PS.[4] In this article, we will begin by presenting such an analysis (section 2). This will enable us to provide a systematic analysis of the biases in current WTO rules (section 3). We will then present empirical estimates of the effect of these biases on the calculated MPS and country compliance (section 4). This will lead us to analyse the specific contribution of each of the three identified biases (section 5) and to draw implications for policies (section 6). Section 7 provides concluding remarks.

2. Economic analysis of the MPS provided to farmers through food security PS

2.1. Defining the market price support to be estimated

The MPS is an indicator of the amount of support provided to farmers through policies that result in an increase in the price they receive for their products. It is logically defined by the difference between the price actually received by farmers (P_P) and the price they would have received in the absence of public interventions (P_P'), multiplied by the quantity that benefits from this price support (Q):

$$MPS = (P_P - P_P') \, Q \quad (2)$$

As defined by the OECD, the MPS is a component of the producer support estimate (PSE), which is the annual monetary value of gross transfers from consumers and taxpayers to agricultural producers. The MPS is the part of these transfers arising from policy measures that create a gap between the domestic market prices (measured at the farm gate level) and border prices of a specific agricultural commodity. The MPS is measured by the price gap applied to national production. It is therefore given by the following formula, where P_D is the average producer price on the domestic market, UV is the unit value of imports (for a net importing country) or exports (for a net exporting country), and Q_{PROD} is national production:

$$MPS_{OECD} = (P_D - UV) \, Q_{PROD} \quad (3)$$

The WTO framework seems (at first glance) quite similar, as it also encompasses two levels: the MPS generated by PS is part of the domestic support (to farmers) that also comprises direct subsidies (mainly input subsidies). There are however two main specificities in the WTO approach:

First, the domestic support is not only measured but also bounded. In fact, it is bounded in a rather complex way: all non-exempt domestic support to agriculture (calculated according to WTO rules) are accounted for in the aggregate measurement of support (AMS) if they are above the country de minimis level. As the AMS ceiling is equal to zero for the vast majority of developing countries,[5] in practice, their domestic support limit (DSL) is given by their de minimis level: 10% of the production value of the commodity considered (8.5% for China and 5% for the developed countries).

Second, WTO rules aim to estimate the MPS generated by public stockholding programmes only. From an economic point of view, the relevance of trying to isolate the specific contribution of PS interventions is questionable. Holding the domestic price at a level higher than the international price usually requires some trade measures (import taxes or quantitative restrictions on imports, such as quotas, import licenses, or monopoly of state-owned enterprises; export subsidies). Consequently, public procurements are hardly sufficient to generate an MPS and are not necessary for that purpose. It therefore seems easier and more relevant to estimate the MPS generated by all the policies implemented by a given country. In this case, the MPS will be estimated by measuring the gap between the domestic price and the border price of the commodity considered (as the OECD does). However, as pointed out by specialists, the WTO approach is quite different as, in this organisation's framework, the different types of measures are split into three packages: "market access", "export subsidies" and "domestic support". Trade measures (such as import taxes) have their own disciplines and are not included in domestic support, in spite of the fact that they affect domestic prices (Orden et al., 2011a,b; Matthews 2014). This can be explained by the history of international trade agreements: the General Agreement on Tariffs and Trade (GATT) only covered border measures, and domestic support was added later on with the AoA and the creation of the WTO. The current framework can hardly be changed, at least in the short run, meaning that any attempt to improve WTO rules should focus on estimating the MPS *generated by PS only*.

At first glance, it seems that this MPS is always nil: because of the law of one price, the domestic price is supposed to be determined by the

[3] The 13 country-commodity pairs covered were China-wheat, Egypt-wheat, India-wheat, India-rice, Indonesia-rice, Jordan-wheat, Kenya-maize, Morocco-wheat, Pakistan-wheat, Tunisia-wheat, Turkey-wheat, Zambia-maize and Zimbabwe-maize.

[4] The economic relevance of the WTO MPS was typically assessed by comparing it with the OECD MPS, neglecting the fact that the objective and rationale of the two indicators are different (see section 2).

[5] This is because they declared a zero AMS in their first notification to the WTO. The few developing countries with a positive AMS ceiling usually have a very low one: only Mexico, Venezuela and Colombia have an AMS ceiling above 300 million US dollars.

international price, border measures and transport and transaction costs between the border and the domestic market. It seems there is no space for any effect of PS procurement. However, things are actually more complicated. When quantitative restrictions are applied to trade, PS procurement and releases can be a very effective way to regulate the domestic price, as shown by the experience of Indonesia for rice (Timmer, 1996). Moreover, the domestic price can be within the export and import parity prices, at least for some regions of the country and some periods of the year. In this situation, it is not profitable to export or to import, and the price is determined by domestic supply and demand. In all of these situations, PS interventions can significantly affect the domestic price.

The focus on PS may have led to considering its effect not only on the average price received by farmers, but also on its variability. PS interventions often reduce price variability – this is sometimes one of their explicit objectives – and this price risk reduction can be an advantage in itself, since it is supposed to stimulate farmers' investments (Timmer, 1989; Bellemare et al., 2013; Galtier, 2013). From the viewpoint of economic theory, in terms of incentives, a more stable price is equivalent to a higher average price. So why not consider how PS operations affect both the average and the standard deviation of the producer price? Or aggregate these two variables by calculating a certainty equivalent of the producer price? The reason is that estimating a *counterfactual* price variability would be too complicated. The indicator of the MPS generated by PS should be kept simple: it is calculated and notified by each country, and other WTO member countries (and potentially a Panel or the WTO Appellate Body) should have the means to cross-check it. This is why the WTO MPS only takes into account the average price received by farmers (as does the OECD MPS).

The formula that should be used to calculate the WTO MPS is therefore Formula 2. The challenge is to define the variables P_P, P_P' and Q and to specify how to estimate them.

2.2. Estimating the price received by farmers (Pp)

As already seen, the OECD MPS uses the average domestic price measured at the farm gate level. The WTO approach is quite different because the price used in current rules (Formula 1) is the PS procurement price (also called the "applied administered price" or AAP). According to Orden et al. (2011a, p. 15), "the use of the administered [procurement] price instead of the prevailing domestic price to calculate the level of support per unit of output" is one of the main deficiencies in the WTO measurement of market price support. However, it is important to acknowledge the specificity of the WTO MPS: as its aim is to estimate the price support *generated by PS only*, using the price received by the farmers who supplied the PS agency makes sense. Things are more complicated, however, because PS operations are likely to affect the domestic market price: a price support may thereby be generated for all the quantities sold on this market. Current WTO rules acknowledge this fact: as already seen, the quantity supposed to benefit from the price support (QEP) is greater than the quantity procured. But why does Formula 1 use the PS procurement price to measure the price received by farmers even when they sell their production on the domestic market? This is because of the (implicit) assumption that the PS procurement price makes the price on the domestic market.

However, this assumption is questionable and we have good reason to believe that the domestic price P_D may substantially diverge from the PS procurement price. First, PS procurements are generally concentrated in just a few months of the year (usually during the post-harvest season), whereas farmers sell their grains throughout the year: there is therefore no objective reason to assume that farmers receive the PS procurement price for *all* their sales. Second, during the lean season, part of the PS is usually released in the form of sales or free distribution, exerting downward pressure on domestic prices. In fact, the assumption that the PS procurement price makes P_D is probably related to the fact that when the negotiators designed the WTO rules on PS, they mainly had in mind the former EU Common Agricultural Policy. But the situation in developing countries is much more complex: there, PS interventions usually result in increasing the domestic price during the post-harvest period and decreasing it during the lean season. The net effect on farmers' average sales price is unclear: it depends on i) the quantity sold by farmers during each of these periods, ii) the quantity procured (usually a lot of grain is procured for PS in years with good harvests, but part of the procurement is sometimes made on the international market), iii) the quantity released (usually high in years of crisis), and iv) the way the effect of PS interventions is partially or fully offset by an adjustment in imports or exports (which depends on trade policies and also on the date and place of the interventions). The average price on the domestic market can therefore differ substantially from the PS procurement price and can be higher or lower than what it would have been without PS interventions (World Bank, 2012; Deuss, 2014; European Commission, 2018).

The practical implication is that a correct estimation of the MPS generated by PS requires separating the quantity sold to the PS agency (which receives the PS procurement price P_{PROC}) and the share sold on the domestic market (which receives P_D). The next step is therefore to specify how to measure P_{PROC} and P_D.

Let us begin with P_{PROC}. According to current WTO rules, countries have to calculate an MPS only when PS procurement is made "at administered prices": when public procurement is made "at current market prices", this procurement is exempt from any disciplines (WTO, 1994: Annex 2). There are two incorrect assumptions behind this rule. First, there is the idea that PS agencies use administered P_{PROC} only or mainly to provide support to farmers. In fact, many PS agencies use an administered price "for practical reasons, not to provide support to farmers: purchasing at current market prices would imply using many different procurement prices (depending on the locality) and updating them very frequently (every week or at least every month), which would considerably complicate the governance of purchases" (European Commission, 2018: 64). In practice, purchasing at current market prices is only feasible when the quantity to be procured is small. As a matter of fact, many PS agencies do not buy at a price higher than the international price, even when they use an administered price (ICTSD, 2016). The second incorrect assumption is that procurement at current market price does not affect the domestic price and therefore does not generate any support. In reality, when a PS agency purchases huge quantities on the domestic market, week after week, month after month, it is likely to generate an increase in the domestic price that will benefit farmers. There is therefore no objective reason to make a difference depending on whether P_{PROC} is administered or not.

Estimating P_D may be quite challenging because of the heterogeneity of prices within the country (depending on the region) and throughout the year. This is due to the location of production and consumption areas and to transport costs: for instance, prices may be higher in regions that are connected to the demand from a large town or a neighbouring country. There is also the issue of the seasonal pattern of prices: because of storage costs, prices increase between the post-harvest season and the lean season. In many developing countries, this seasonality is excessive: prices collapse with the arrival of the new harvest, because many farmers have to sell a large amount at that time in order to pay off their debts. In addition, competition may be imperfect, with concentration and market power at some supply chain levels. The practical implication is that the domestic price P_D should be estimated as the average of prices observed at the farm gate level in many parts of the country and throughout the whole year (market information systems usually collect this kind of data, see Galtier et al., 2014). This is the method already used by the OECD (to estimate the domestic price) and the WTO (to estimate the production value of a given commodity).

2.3. Estimating the counterfactual price (P_P')

Estimating P_P' is quite challenging. It cannot be observed, because it is not a real price, but a counterfactual one: the price that would have prevailed on the domestic market in the absence of PS interventions. We must therefore replace P_P' by a proxy. But which one? As PS interventions may affect domestic prices, the only option is to use an external reference price (ERP), i.e. a price related to the price prevailing on the international market. This option is imperfect: on some occasions (especially for large countries), PS interventions may affect the international price. PS procurement may, for instance, result in a reduction in the country's exports (or an increase in its imports), which may provoke an increase in the international price. Using the international price as an ERP then leads to an underestimation of the price support provided. However, in this situation, the share of the price support not included in the MPS is the share that is also provided to the farmers in the rest of the world (through the increase in the international price). Therefore, if we consider that what matters is not the absolute level of support transferred to the country's farmers, but the advantage provided to them compared to the farmers in the rest of the world, it seems relevant to use a price related to the international price as a reference, even when the international price is affected by PS procurement.[6] Moreover, this is the only practicable option, which explains why an ERP is used as a counterfactual price by both the OECD and the WTO in their definition of MPS.

The most intuitive ERP is the unit value of imports or exports. This is a much more accurate indicator than the international price (provided by futures markets or other sources of well-reported reference prices): it fits better with the qualities of the country's imported or exported products and, for importing countries, it also includes freight and insurance costs. A second question thus arises: is it better to choose the unit value of imports (which gives a c.i.f. price), the unit value of exports (which gives a f.o.b. price) or a mix of both? The answer is not simple: because of the spatial heterogeneity of prices, some regions within the same country may export, while others import and the rest are self-sufficient (see, for instance, Barrett, 2008). Moreover, the trade status may change throughout the year: for instance, the country may export during the post-harvest season and import during the lean season.[7] The choice made by the OECD and the WTO is to use the unit value of imports when the country is a net importer of the commodity considered and the unit value of exports when it is a net exporter. An alternative (workable) option would be to take the weighted average of import and export unit values. But whether this would improve the relevance of the ERP is unclear: the small volumes exported (imported) by an importing (exporting) country are often not representative (since they are often related to specific qualities, niche markets, etc.). The most challenging situation is that of self-sufficient countries because, for them, the average domestic price is between the export parity price and the import parity price. In practice however, these countries are always exporting and/or importing small quantities (for the above-mentioned reasons: some regions are connected to the international market or to neighbouring countries). The method used by the OECD and the WTO can therefore still be applied, although its reliability is greatly reduced. However, this is perhaps not a big issue: the probability of being challenged is low for countries that are disconnected from international markets. All in all, in spite of its limitations, the choice made by the OECD and the WTO is probably the best option.

Another question concerns the period considered for measuring the ERP. The OECD logically uses the average unit value of imports or exports (now UV) for the year considered: the price received by farmers in a given year should be compared with the ERP for the same year. Surprisingly, current WTO rules do not use the ERP for the year considered, but an ERP measured during a fixed past period. This "base period" depends on when the country joined the WTO: it is 1986–88 for most countries (those that joined the WTO at the outset because they were already members of the GATT). For grains, using the 1986–88 price as a reference price results in a significant overestimation of the price support: during this period, prices were depressed by EU export subsidies. On the contrary, for commodities like coffee and cocoa, the 1986–88 price was extremely high (because it was supported by international commodity agreements): current WTO rules therefore result in a significant underestimation of the MPS. The reasons for choosing a fixed ERP are unclear (some experts believe the objective of the negotiators was to prevent any return to the former EU CAP). What is sure is that, as stated by Tim Josling – the "father" of the OECD indicators – "the reference prices [used by the WTO] bear little resemblance to current world market conditions" and "as a result, the AMS is now essentially meaningless as an indicator of trade distortion" (Josling 2015).

The OECD MPS uses the border price (for the year considered) as the ERP. But its objective is to estimate the MPS generated by all the policies implemented by the country considered. The objective of the WTO MPS is quite different because it focuses on the MPS generated by PS only. This means that the price support generated by other policies (especially trade policies) should be removed. Let us consider, for instance, two countries A and B, where imports of the commodity considered are taxed at 20%. As the international price is 100, the import price cost is 120 for both countries. Let us assume that in country A there is no PS, while in country B there is PS with interventions that do not affect the domestic price. In both countries, the support provided is exactly the same, and the tool used to provide it is also the same (a 20% tariff on imports). Not including the import tax in the estimation of the support provided by the PS would imply considering that country B provides domestic support, while country A does not. As stated by Matthews (2014, p. 17), in this case, the price support provided by public procurement "is not additional to that provided by the border protection alone so that its incremental trade-distorting effect is minimal". The practical implication is that the taxes or subsidies on imports or exports should be included in the ERP.

The best ERP is therefore the parity price for the year considered (PP). The PP is the price that should prevail on the domestic market in a situation without quantitative restrictions on external trade and without any public intervention on the domestic market. Theoretically, it includes i) the border price, ii) taxes or subsidies on imports or exports, and iii) transport and transaction costs between the border

[6] Apart from the case of large countries, there is another situation where PS operations may affect the country border price (expressed in LCU): when PS procurement generates a reduction in exports or an increase in imports that leads to a reduction in the country's exchange rate. In this situation, using the border price to compute a reference price results in an underestimation of the MPS. This time, contrary to the case of large countries, only the country's farmers benefit from the share of the price support not included in the MPS. However, this situation is mainly theoretical: it can only occur if the exports (imports) of a given food commodity account for a significant share of a country's foreign currency earnings (expenditures), which is uncommon. Moreover, the countries in this situation (if any) are very poor countries.

[7] Note that the country's trade status may also change "endogenously", i.e. because of PS interventions: as PS purchases lead to an increase in imports or a decrease in exports, a country that is importing may have been exporting in the counterfactual situation without PS interventions. Its parity price would therefore have been lower (the import parity price is always higher than the export parity price because of the transport and transaction costs from the international market to the border and from the border to the domestic market). In this case, using the import parity price results in an underestimation of the MPS. The opposite conclusion holds if PS sales or distributions result in a shift in the country's trade status from importer to exporter. However, while these situations are theoretically possible, the probability that they will occur is quite low: the country would need to be close to self-sufficiency and the net quantity injected into or removed from the domestic market would need to be significant.

and the domestic market. To keep it simple and workable (remember that all WTO member countries should be able to cross-check the MPS calculated and notified by one of them), in this article the third component will not be included. The PP is therefore defined as follows: for net importing countries, the PP is equal to the unit value of imports plus import taxes (or minus import subsidies) and, for net exporting countries, it is equal to the unit value of exports minus export taxes (or plus export subsidies).

The PP for the year considered is the best ERP that can be used to estimate the MPS. It is, however, still imperfect as a reference price, for two main reasons. First, it does not make it possible to estimate the effect of PS only, as it also includes the effect of quantitative restrictions. This is perhaps not particularly important. For importing countries, this results in an overestimation of the MPS (as the increase in the domestic price due to import restrictions is wrongly attributed to PS). But such quantitative restrictions are often closely related to PS activities (especially when they are due to the import monopoly of state-owned companies). For exporting countries, the situation is symmetric: quantitative restrictions on exports keep the domestic price below the PP. Therefore, using the PP as a reference price results in an underestimation of the MPS. However, it could be argued that the share of the PS price effect not included in the estimation ($PP - P'_D$) cannot be considered as a price support: rather, it reflects the removal of the penalty (generated by export restriction measures) that would have been incurred by farmers in the absence of PS interventions.[8] The second imperfection is perhaps more problematic: using the PP (as defined above) as a reference price implies comparing two prices of a different nature: P_{PROC} and P_D on the one hand, which are producer prices at the farm gate level, and PP on the other, which is a wholesale border price. The OECD MPS and the WTO MPS consider the possibility that the producer price may refer to a less processed product than the border price (for instance paddy rice versus milled rice). In this situation, it is quite simple to homogenise the two prices by applying a technical coefficient (for instance 1.5 tonnes of paddy rice = 1 tonne of milled rice). But correcting the differences between producer prices and border prices related to transport and transaction costs is much more difficult. This means that there are some margins of error in the estimation of the MPS. We will come back to this issue in section 6.

2.4. Estimating the quantity that benefited from the price support

The OECD approach is based on calculating an MPS (that can be nil) for *each* agricultural commodity by comparing its domestic and border prices. The estimated price gap is applied to the national production of the commodity considered. The WTO objective is more complex because it focuses on estimating the MPS *generated by PS*. And PS exist only for a small number of agricultural commodities. Should an MPS be calculated only for these commodities? Theoretically, PS operations on a given commodity are likely to affect the price of its substitutes. For instance, when the PS of the Sahel countries purchase sorghum, this is likely to have some effect on the price of maize because of the possibilities of substitution between these two grains. However, the price support indirectly provided to the substitutes of a procured commodity is likely to be lower… and quite challenging to measure. The main difficulty is related to the attribution of a possible high price level to PS operations on another commodity: if the price of maize is high in Mali, it may be difficult to know whether this is related to PS procurement of sorghum, to a decrease in imports from Cote d'Ivoire or to an increase in demand from neighbouring Burkina Faso. Current WTO rules entail calculating an MPS only for the commodities procured by a PS agency and this is probably a reasonable choice in order to keep the estimation simple and workable.

Another specificity induced by the focus on the MPS *generated by PS* is the role of "eligibility". Procurement operations sometimes explicitly exclude part of the national production: procurement is made only in specific regions of the country and/or only specific qualities are accepted. Usually this takes the form of a minimum quality requirement, with low grades being rejected, but sometimes the qualities excluded are the better ones: in India, the PS agency only purchases non-basmati rice. Current WTO rules consider that only the eligible quantity benefits from the price support. This makes sense: only the share of the production eligible to be sold to the PS agency will benefit from its procurement price, either directly (when farmers sell to the agency) or indirectly (when farmers sell on the domestic market and traders have to align on P_{PROC}). Of course, strictly speaking, the price of other qualities of the same commodity and the price in the other regions of the country (where there is no procurement) are also likely to be affected. But, as for the case of substitutable commodities, the price support for these is likely to be lower, and taking account of these indirect effects would greatly complicate the estimation of the MPS. The choice of applying the price support to eligible production only (as is the case in current WTO rules) therefore appears to be appropriate to keep the estimation of the MPS simple and workable.

However, as already mentioned in the introduction, the interpretation of the quantity of eligible production (QEP) evolved with the jurisprudence. The only decision on domestic support made by the WTO Appellate Body (known as the "Korea beef case") confirmed that "production eligible refers to production that is 'fit or entitled' to be purchased rather than production that was actually purchased", but it also added that "if the quantity to be procured is announced in advance, this quantity should be considered as the eligible production" (WTO, 2000b, §120 and 121). From a legal point of view, it makes sense to consider that the quantity eligible for PS procurement is restricted to the maximum quantity to be procured when it is announced in advance by the government or the PS agency. But from an economic point of view, this is highly problematic: the price support provided by the PS agency may affect the domestic market price, even when the quantity to be procured is bounded and announced in advance. Indeed, in Indonesia, the PS agency (BULOG) succeeded over several decades in stabilising the price of rice on the domestic market, while always buying less than 10% of national production (Timmer, 1996). Therefore, considering that the "eligible production" is the quantity to be procured when announced in advance may result in a significant underestimation of the real support provided, especially when the procurement price makes the domestic price: in this case, all of the marketed quantity benefits from the price support, while only the announced quantity would be accounted for.

Consequently, the quantity that benefited from the price support would be more accurately estimated by considering "eligible production" in the broad sense of the share of national production that complies with the requirements of the PS agency (in terms of quality and location), and without taking into account any ceiling on the quantity to be procured (even if officially announced in advance).

Does all this eligible production benefit from the price support? Not always. The production can be split into three possible uses: sales to the PS agency, sales on the domestic market and self-consumption. Current WTO rules do not differentiate between these uses. However, as seen above (section 2.2), the price support is likely to be different for the share sold to the PS agency and the share sold on the domestic market. What about the share self-consumed by farmers?

Self-consumption was not taken into account by the negotiators of the AoA when they designed the rules on PS, probably because what they had in mind was the former EU CAP. During the Korea beef case, the Panel proposed considering that only the marketed production benefits from the price support, i.e. excluding the share of QEP self-consumed by farmers from the calculation of the MPS. But the WTO Appellate Body did not validate this interpretation: it clarified that

[8] Note that potential imperfect competition due to the concentration of the import (export) sector generates the same effect as quantitative restrictions on imports (exports): the rent extracted by importers (exporters) fixes the domestic price above (below) PP.

according to current WTO rules, what matters is whether the production is eligible (i.e. whether it meets the requirements to be accepted by the PS agency), and not whether it is sold or consumed by farmers. The WTO Appellate Body did not give any economic justification: it simply produced a legal interpretation of the word "eligible', an interpretation that has nothing to do with economic rationality.

What is the view of economic theory on this issue? At first glance, it seems that the share of production self-consumed by farmers is not affected by price changes because it is not sold. It may be argued, however that, if a price support is provided, farmers would be incentivised to reduce their self-consumption and increase their sales (and possibly to sell all their production). The (methodological) problem can be stated as follows: removing self-consumption from the calculation of the MPS implies applying a self-consumption rate to the estimated eligible quantity. Data on self-consumption rates are produced by field research or agricultural statistical surveys (not every year) and this rate is assumed to be relatively stable in the medium-term. But if the self-consumption rate decreases because of the price support provided to farmers, the self-consumed share of production will be overestimated and the MPS will thus be underestimated. The question is therefore whether the farmers' self-consumption rate is reduced when the producer price increases.

This question has been studied a great deal since the pioneering works of Krishna, Behrman, Bardhan and several others in the 1960s and 1970s on the price elasticity of marketed surplus of foodgrains in developing countries (see for instance Krishna, 1962; Behrman, 1966; Bardhan, 1970). The mechanisms at work are now well identified and recent research has confirmed the findings of previous empirical studies (see, for instance, Sharma, 2016b; Rifin, 2021). The main findings of this literature are as follows. Let us define the self-consumption rate $r = Q_{S\text{-}C}/Q_{PROD}$, where $Q_{S\text{-}C}$ is the quantity self-consumed by an agricultural household and Q_{PROD} its production of the same commodity. What is the expected effect of a price increase on $Q_{S\text{-}C}$? It generates a substitution effect (always negative) and an income effect (that can be either positive or negative depending on whether the household is a net seller or a net buyer and whether the good is an inferior good or not). For grains in developing counties, both effects are likely to be weak. First, the grains that farmers produce are almost always the cheapest source of calories for them (even when their price increases): they are therefore difficult to replace by another food.[9] Second, changes in consumption patterns mostly occur when there is a *structural* increase in income. Third, for deficit farmers, the effect of a price increase on $Q_{S\text{-}C}$ is likely to be positive: they are reluctant to sell because they know they will have to buy again later on (often during the lean season, when prices reach their highest level). They therefore sell only the quantity of grain that enables them to cover their monetary needs, meaning that when the price increases, they sell less and consume a larger share of their production. As deficit farmers often make up a significant proportion of all farmers (more than 60% in many African countries, see Jayne et al., 2006), at the aggregate national level, an increase in grain prices may generate an increase in self-consumption. Consequently, we do not have any reason to think that a price increase may significantly reduce the quantity of grain self-consumed by farmers in developing countries. The situation is somewhat different for Q_{PROD}. Farmers' production is expected to increase when the price increases, especially when the high price level was predictable and guaranteed by the state (as is sometimes the case with PS procurement). The self-consumption rate r is therefore likely to decrease: it is the ratio of an almost stable $Q_{S\text{-}C}$ over an increased Q_{PROD}. However, this decrease in r is likely to be low: a 10% increase in production would only reduce r from 50% to 45% and from 15% to 13.6%. Consequently, the error generated when using the medium-term value of r to estimate the self-consumed quantity is moderate, and much lower than the error made when assuming that the quantity usually self-consumed by farmers entirely benefits from the price support.[10]

2.5. Synthesis: A simple formula to estimate the MPS provided by PS

The most accurate estimation (while ensuring simplicity) of the support provided to farmers by public stockholding programmes is therefore given by the sum of:

- the support directly provided to the farmers who sell their production to the public stockholding programme: equal to the product of the quantity sold to the PS agency (Q_{PROC}) multiplied by the price difference between the procurement price (P_{PROC}) and the PP for the year considered (used as a proxy of the price that would have prevailed on the domestic market without PS intervention);
- the support indirectly provided to the farmers who sell their production on the domestic market: equal to the product of the quantity sold on the domestic market ($Q_{SOLD\ ON\ DM}$) multiplied by the price difference between the domestic price (P_D) and the PP for the year considered.

Thus, the support provided to farmers by public stockholding programmes is given by the following formula:

$$MPS = (P_{PROC} - PP)\ Q_{PROC} + (P_D - PP)\ Q_{SOLD\ ON\ DM} \quad (4)$$

Where $Q_{SOLD\ ON\ DM}$ is calculated by subtracting from the QEP the quantity sold to the PS agency (Q_{PROC}) and the quantity self-consumed by farmers (equal to r * QEP). Note that the formula applies to all types of procurement prices (administered or "at market prices"): this is why we replace AAP by P_{PROC}.

3. Biases in WTO rules

There is usually a gap between the economic measurement of the domestic support provided by public stockholding programmes (presented in section 2) and the WTO measurement of this support (presented in the introduction).

To show that this gap may be huge and to identify the biases that produce it, let us begin by presenting a numerical example. We consider the case of a country where the public stock agency purchases grain at a procurement price equal to 125, while the domestic price (in line with the current international price) is 100. Let us assume that PS procurement, by reducing the quantity available on the domestic market, results in the domestic price increasing from 100 to 110. The price support provided is therefore 25 for the farmers who supply the PS (125 – 100) and 10 for those who sell their production on the domestic market (110 – 100). If we assume that, from the quantity produced (equal to 100), 10 are sold to the PS agency, 40 are sold on the domestic market, and 50 are self-consumed by farmers, the overall support actually provided to farmers is equal to 650: 250 provided to the farmers who supply the PS (25×10) plus 400 provided to the farmers who sell their production on the domestic market (10×40).

However, the support calculated according to WTO rules can be

[9] All the more so given that PS usually target the basic grains (most commonly consumed by the poor).

[10] Some experts argue that even if the quantity usually self-consumed is not sold by farmers, it should be included in the calculation of the MPS because its opportunity cost increased. This reasoning is specious. To show why, let us consider the case of deficit farmers. These farmers have to buy grain during the lean season to feed their family. Let us assume that they consume all of their production and buy 20% of their consumption on the market. If, due to PS interventions, the domestic price increases, then their purchasing power is reduced. But if the price support is applied to their self-consumption, the (incorrect) implication that follows is that these farmers are better-off, simply because the opportunity cost of their production (which covers 80% of their needs) has increased. This does not make sense.

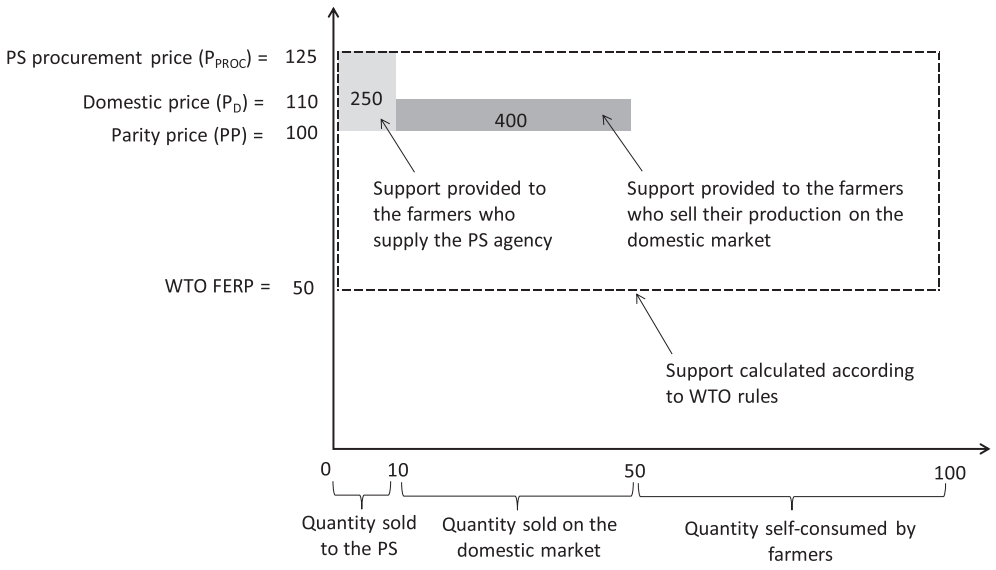

Fig. 1. Numerical illustration of the gap between the real support and the support estimated according to WTO rules.

significantly different, because the price support is calculated using a reference price related to the international price during a past reference period (assumed to be equal to 50 in the numerical example) instead of the PP for the year considered (equal to 100). Moreover, this price support is applied to all national production, without differentiating between the share self-consumed by farmers, the share sold on the domestic market, and the share sold to the PS agency. In this example, the support estimated according to WTO rules is therefore equal to 7 500 ([125 – 50] × 100), more than 11 times the real amount of support provided (see Fig. 1).

The gap between the real support and the support estimated following WTO rules stems from three biases in these rules:

- Bias B1, caused by using the unit value of imports or exports over a fixed past period (1986–88 for most countries) as the external reference price (ERP), instead of using the PP for the year considered (PP).
- Bias B2, caused by using the procurement price P_{PROC} instead of the price prevailing on the domestic market P_D to estimate the price support received by the farmers who sell their production on the domestic market. The implicit assumption is that the PS procurement price P_{PROC} makes the domestic price P_D. As explained in section 2, this may be the case in some situations, but not always.
- Bias B3, resulting from the use of total national production instead of the quantity sold to estimate the support received by farmers. The implicit assumption behind WTO rules is that farmers sell all of their production (no self-consumption). Obviously, this is often far from the reality in developing countries, especially for grain and other staple food products.

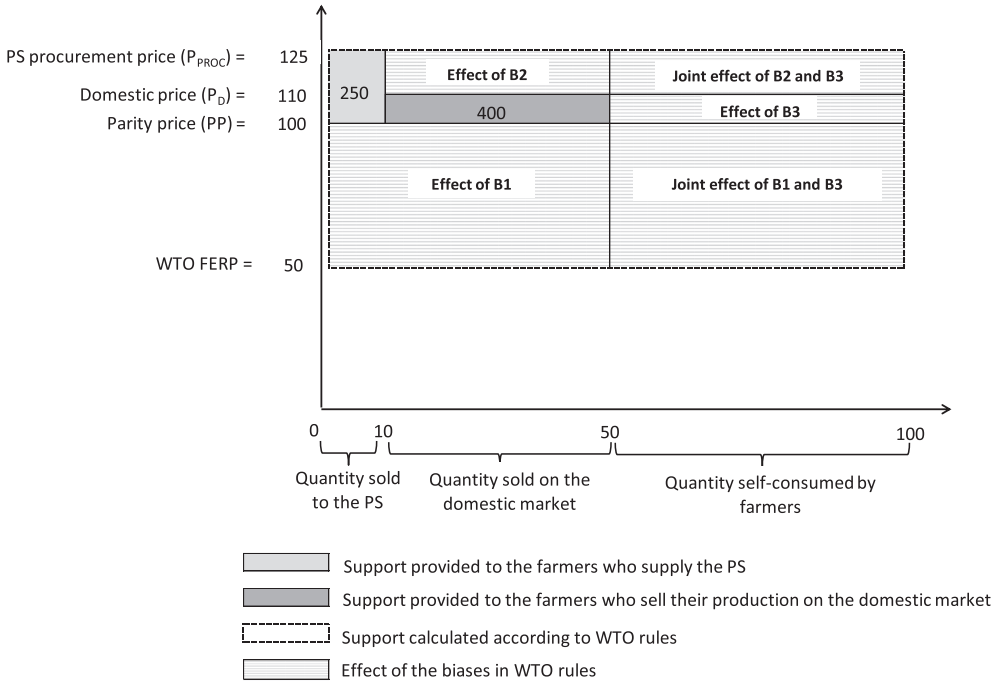

Fig. 2. Illustration of the effect of biases B1, B2 and B3 on the support estimated according to WTO rules.

Table 1
Calculation of the MPS ceiling for wheat in China.

	DSL % of VoP (a)	Crop subsidies % of VoP (b)	Room left for MPS % of VoP (c)=a-b	National production million tonnes (d)	Producer price ¥/tonne (e)	VoP million ¥ (f)=de
2012	8.5%	1.9%	6.6%	121.02	2,166	262,160
2013	8.5%	1.8%	6.7%	121.93	2,356	287,282
2014	8.5%	1.7%	6.8%	126.21	2,412	304,388
2015	8.5%	1.6%	6.9%	130.19	2,329	303,149

Sources: WTO, 2019; Brink and Orden (2020) for (b) and(c).

The effect of these different biases on the estimated support is displayed in Fig. 2 (using the same numerical example as in Fig. 1).

In this numerical example, the support estimated according to WTO rules (MPS_{WTO}) is approximately 11 times the unbiased estimate[11] of the support provided (MPS). However, we have to go beyond this example and investigate the magnitude of the gap between MPS and MPS_{WTO} in the real world.

4. Empirical estimates of the effect of the biases on the calculated MPS and country compliance

4.1. The China-US dispute on wheat

The biases in WTO rules can be illustrated through the case of the China-US dispute on wheat (WTO, 2020). This is a very emblematic case, as China is the first country to be condemned because its PS policy does not comply with its domestic support commitments. High quality data on this dispute are available, the Panel having cross-checked and verified the data provided by China and the US.

The nature of the dispute is as follows. In September 2016, the United States claimed that China provided excessive domestic support in favour of agricultural producers, in particular for wheat, rice and maize in 2012, 2013, 2014, and 2015. Consequently, on January 2017, the WTO Dispute Settlement Body established a Panel. On 28 February 2019, the Panel report (WTO, 2019) was circulated to members. The central element of this dispute was the calculation of the value of China's MPS provided to producers. The Panel found that, following the 2015 maize harvest, China had revised its maize policy and that the support measure related to maize had therefore expired prior to the US initiation of the dispute. It thus declined to estimate the MPS for maize. But it performed the calculation for wheat and rice: by applying WTO rules (Formula 1), it found that in each of the years 2012–2015, China exceeded its 8.5% de minimis level of support for both commodities. On that basis, the Panel concluded that China had acted inconsistently with its obligations under Articles 3.2 and 6.3 of the AoA (WTO, 2019).

As we will see now, if the support had been calculated following rules corrected for biases B1, B2 and B3 (Formula 4), the Panel's conclusions would have been very different. For the sake of brevity, we will focus on the case of wheat (the case of rice is more complicated: it involves two varieties and two harvest periods).

The Panel's calculation of the domestic support ceiling is provided in Table 1. As for the vast majority of developing countries, China's AMS ceiling is equal to zero, meaning that the domestic support it can provide to a specific commodity is given by its de minimis level. For China, this is equal to 8.5% of the value of production (VoP) of the commodity considered. After subtracting the direct subsidies provided to wheat, we get the room left for MPS.

The Panel's calculation of the domestic support provided through the PS agency's procurement is given in Table 2. The QEP is lower than national production because the procurement has been implemented only in some regions of the country (in addition, low percentages of "out-of-grade" grain were removed). The base period used to calculate the FERP is 1996–98 (contrary to 1986–88 for most WTO member countries). This is because China was not a member of the GATT and joined the WTO only in 2001.

Table 2
Calculation of the wheat MPS provided (according to current WTO rules).

	QEP million tonnes (a)	AAP ¥/tonne (b)	FERP ¥/tonne (c)	VoP million ¥ (d)	MPS_{WTO} % of VoP (e)=a(b-c)/d
2012	93.13	2,040	1,698	262,160	12.1%
2013	96.35	2,240	1,698	287,282	18.2%
2014	99.90	2,360	1,698	304,388	21.7%
2015	102.53	2,360	1,698	303,149	22.4%

Source: WTO (2019).

The average MPS calculated by the Panel for the period 2012–15 (18.6%) is between the one calculated by China (3.4%) using Q_{PROC} instead of QEP, and the one calculated by the US (61.9%) using 1986–88 (instead of 1996–98) as a base period for the FERP. More importantly, this MPS (which is the MPS calculated according to WTO rules) is above the ceiling for the four years considered.

Removing bias B1 implies using the PP for the year considered instead of the FERP as a reference price. Table 3 shows the detailed calculation of this PP.

Removing biases B2 and B3 implies removing the share of production self-consumed by farmers and valuing separately the share sold to the PS agency and the share sold on the domestic market. The Panel report mentions that the wheat self-consumption rate in China in 2012–2015 was "between 9 and 18 percent of total wheat production". We therefore used the centre of this range, i.e. a self-consumption rate of 13.5%. $Q_{SOLD\ ON\ DM}$ was estimated as a residue (the share of the QEP not self-consumed and not sold to the PS agency).

It appears that the MPS calculated while correcting biases B1, B2 and B3 is much lower than the MPS_{WTO}: the overestimation factor of MPS_{WTO} is between 2 and 40 depending on the year (Table 4). For three years out of four, it affects the compliance. The gap between MPS and MPS_{WTO} can be visualized in Fig. 3 for 2015, a year when MPS_{WTO} was "only" twice the value of MPS.

It is worth noting that the case of wheat in China is not representative at all. It is a very specific case in which the overestimation of the MPS is low (compared to other country-commodity pairs), for two reasons. First, because China has an atypical base period (1996–98): for 80% of the WTO member countries, the base period is 1986–88. Using this period to calculate the FERP would have given a much lower FERP and a much higher MPS_{WTO} (as can be seen in Fig. 3). Second, because the self-consumption rate is relatively low for wheat in China (13.5%) compared to other grains in other developing countries. The following section is an attempt to generalize the estimation of the gap between MPS and MPS_{WTO}.

4.2. Analysis of a sample of country-commodity pairs

To analyse the effect of the biases on the MPS calculated and on

[11] Meaning the MPS corrected for biases B1, B2 and B3. As explained in section 2, other sources of bias exist. But they are likely to have far less effect on the estimated MPS and they are also much more difficult to correct.

Table 3
Calculation of the wheat import parity price.

	Imports million US$ (a)	Imports million tonnes (b)	UVM US$/t (c)=a/b	Tariff % (d)	PP in US$ US$/t (e)=(1+d)c	ER ¥/US$ (f)	PP in ¥ ¥/t (g)=ef
2012	1,602	5.06	317	6%	336	6.31	2,120
2013	2,359	6.83	345	6%	366	6.20	2,268
2014	1,422	4.27	333	6%	353	6.14	2,171
2015	1,288	4.31	299	6%	317	6.23	1,973

Sources: FAOSTAT for (a) and (b); World Bank (2022a) for (d); World Bank (2022b) for (f).

Table 4
Calculation of the wheat domestic support provided (according to Formula 4).

	QEP million tonnes (a)	Q_{PROC} million tonnes (b)	$Q_{SOLD\ on\ DM}$ million tonnes (c)=0,865*a-b	P_{PROC} ¥/tonne (d)	P_D ¥/tonne (e)	PP ¥/tonne (f)	VoP million ¥ (g)	MPS (h)	MPS_{WTO} / MPS (i)
2012	93.13	23.20	57.36	2,040	2,166	2,120	262,160	0.3%	40.0
2013	96.35	8.20	75.15	2,240	2,356	2,268	287,282	2.2%	8.2
2014	99.90	25.30	61.12	2,360	2,412	2,171	304,388	6.4%	3.4
2015	102.53	20.80	67.89	2,360	2,329	1,973	303,149	10.6%	2.1

(h) = [b (d - f) + c (e – f)] / g
Sources: WTO (2019); Table 3 for (f).

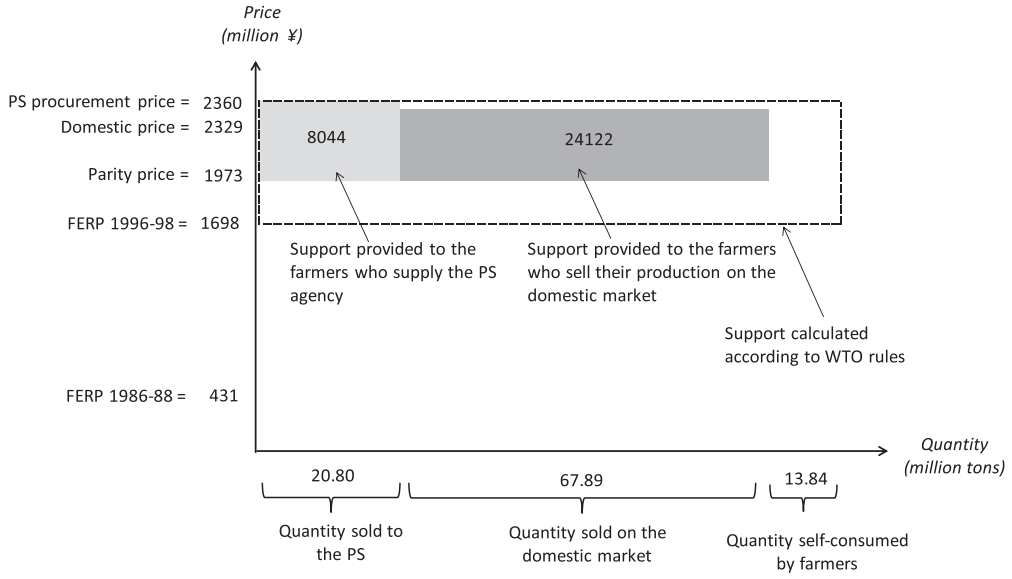

Fig. 3. Illustration of the effect of biases B1, B2 and B3 for the case of wheat in China (in 2015).

country compliance, we produced a sample. In the WTO database on country notifications (WTO, 2022a), we selected all the notifications on domestic support made since 1 January 2021.[12] Among these 131 notifications, only six are related to MPS on grains made by developing countries. The MPS notified by these countries are given on the shaded lines of Table 5.

As the DSL of all of these country-commodity pairs is 10% of the production value of the considered commodity,[13] it seems that all of these countries comply with their WTO commitment, except India for rice. The reality is more complex, however, because none of these countries calculated the MPS according to WTO rules: all of them used Q_{PROC} as the QEP instead of using the national production (or more exactly, the share of the national production that meets the requirement of the PS agency in terms of quality or region of origin, as clarified by the jurisprudence of the WTO Appellate Body, see the introduction and section 2). In addition, Tunisia corrected the FERP for inflation, which is not allowed (see the introduction). Finally, India and Pakistan notified in US dollars, whereas Tunisia did something technically equivalent by correcting its FERP for exchange rate movements. It is so far unclear whether they have the right to do so: according to some experts, countries that used their LCU in their first notification – for the base period – have to use it for all their notifications. This is the situation of the vast majority of member countries and of the five countries considered here.

We therefore did what a Panel or the WTO Appellate Body would do if these countries were challenged: we corrected the calculation of the MPS to align it with WTO rules. We took national production (instead of Q_{PROC}) as the QEP. For Tunisia, we came back to the FERP uncorrected

[12] This search was made on 22 June 2022.
[13] Like almost all developing countries, Pakistan, India, the Philippines and Indonesia have a zero AMS ceiling (because in their first notification to the WTO, they declared a nil domestic support). Their DSL is therefore given by their de minimis level, which is equal to 10% of the VoP of the commodity considered. Tunisia has an AMS ceiling equal to 30 million USD. But as this amount only accounts for 8.9% of the value of wheat production, it is not helpful: the maximum allowed MPS for wheat is given by the de minimis level (10% of the VoP).

Table 5
MPS for grain of a sample of developing countries (as notified and as recalculated according to WTO rules).

Country - Commodity - Year	AAP (USD/t or LCU/t) (a)	FERP (USD/t or LCU/t) (b)	QEP (million tons) (c)	VoP (million USD or LCU) (d)	MPS (% of VoP) (a-b)*c/d
Tunisia, Wheat, 2019					
Notified (LCU)	820	1,496	0.02	985	-1.3%
WTO (USD)	279	139	1.46	336	60.8%
WTO (LCU)	820	115	1.46	985	104.1%
Pakistan, Wheat, 2015-16					
Notified (USD)	292	175	5.81	7,892	8.6%
WTO (USD)	292	175	25.36	7,892	37.7%
WTO (LCU)	30,471	3,150	25.36	822,633	84.2%
India, Rice, 2019-20					
Notified (USD)	384	263	52.00	46,077	13.7%
WTO (USD)	384	263	118.43	46,077	31.2%
WTO (LCU)	27,225	3,520	118.43	3,266,743	85.9%
India, Wheat, 2019-20					
Notified (USD)	272	264	34.13	32,154	0.8%
WTO (USD)	272	264	105.59	32,154	2.5%
WTO (LCU)	19,250	3,540	105.59	2,279,655	72.8%
Philippines, Paddy rice, 2020					
Notified (LCU)	19,000	4,560	0.44	318,711	2.0%
WTO (USD)	383	220	19.29	6,423	48.8%
WTO (LCU)	19,000	4,560	19.29	318,711	87.4%
Indonesia, Rice, 2020					
Notified (LCU)	8,300,000	370,700	1.03	301,533,076	2.7%
WTO (USD)	569	241	36.45	20,678	57.8%
WTO (LCU)	8,300,000	370,700	36.45	301,533,076	95.9%

Sources: for (a), WTO (2022a); for (b), WTO (2022a) and WTO (2022b); for (c) and (d), WTO (2022a) and FAOSTAT .

Table 6
MPS for grain of a sample of developing countries (corrected for biases B1, B2 and B3).

Country, Commodity, Year	P_{PROC} LCU/t (a)	P_D LCU/t (b)	PP LCU/t (c)	Q_{PROC} million tonnes (d)	QEP million tonnes (e)	VoP million LCU (f)	MPS % of VoP (g)
Tunisia, wheat, 2019	820	677	729	0.02	1.46	985	−7.4%
Pakistan, wheat, 2015/16	30,471	32,439	34,512	5.81	25.36	822,633	−7.8%
India, rice, 2019/20	27,225	27,584	28,502	52.00	118.43	3,266,743	−3.9%
India, wheat, 2019/20	19,250	21,589	19,351	34.13	105.59	2,279,655	6.9%
Philippines, paddy rice, 2020	19,000	16,518	20,182	0.44	19.29	318,711	−21.8%
Indonesia, rice, 2020	8,300,000	8,272,281	9,997,466	0.10	36.45	301,533,076	−20.9%

$(g) = [d\ (a - c) + (e - d)\ (b - c)] / f$
Sources: for (a), WTO (2022a); for (b), FAOSTAT and WTO (2022a) for rice in India; for (c), for border prices, FAOSTAT and Apeda Agri Exchange (2022) for rice in India (to have the fob price of non-basmati rice) + for tariffs, World Bank (2022a); for (d), WTO (2022a); for (e) and (f), WTO (2022a) and FAOSTAT.

for inflation (the FERP declared in its first notification of domestic support for the 1986–88 period). For all country-commodity pairs, we calculated two MPS, one using a FERP expressed in LCU, and another using a FERP in USD (see Table 5). We know that the first MPS is correct and that the second may be correct.

It appears that all MPS are well above the DSL (10% of the VoP), even when a FERP expressed in USD is used (except for wheat in India). When a FERP in LCU is used, the calculated MPS are much higher, which reflects the fact that these countries' exchange rates with the US dollar decreased between 1986-88 and today (which is common for developing countries).

We then calculated the MPS corrected for biases B1 and B2 (we had no data on self-consumption rates and assumed that self-consumption – and therefore B3 – are nil). Following Formula (4), we replaced the FERP by the PP for the year considered. The PP was calculated by taking the unit value of imports or exports for the year considered and adding tariffs (if any). In addition, the price support related to the share of production sold on the domestic market was valued by using the domestic production price instead of the procurement price set by the PS agency. The calculated MPS can be seen in Table 6.

The corrected MPS is below the DSL (10% of the VoP) for the six country-commodity pairs, in spite of the fact that only biases B1 and B2 have been corrected. The MPS is negative for five of them and low for the remaining one, which confirms that the aim of building public stocks is usually not to support producer prices, but to use them for food security purposes (free distributions, subsidized sales etc.). This is in line with what was found for China. The reason for P_{PROC} not always being set above PP is explained in section 2: PP is a wholesale price and a border price, whereas P_{PROC} is a producer price. Consequently, because of transport and transaction costs, P_{PROC} (and P_D) can be below PP and the calculated MPS can be negative. This does not imply that PS interventions result in a decrease in the price received by farmers (although this may be the case on some occasions), but simply that if there is any MPS, it is below what can be detected by using the border price as a reference price.

4.3. *Synthesis on the gap between MPS_{WTO} and MPS and implications for compliance*

Table 7 summarizes what was presented in sections 4.1 and 4.2 about i) the MPS notified, ii) the MPS calculated according to WTO rules and iii) the MPS corrected for biases B1, B2 and B3.

Table 7
MPS for grain of a sample of developing countries: gaps between the MPS notified, calculated according to WTO rules and corrected for biases B1, B2 and B3.

Country, Commodity, Year	MPS (notified) (a)	MPS_{WTO} (b)	MPS (c)	E (all biases) (d)=b-c
Tunisia, wheat, 2019	−1.3%	104.1%	−7.4%	111.6%
Pakistan, wheat, 2015/16	8.6%	84.2%	−7.8%	92.0%
India, rice, 2019/20	13.7%	85.9%	−3.9%	89.8%
India, wheat, 2019/20	0.8%	72.8%	6.9%	65.9%
Philippines, paddy rice, 2020	2.0%	87.4%	−21.8%	109.3%
Indonesia, rice, 2020	2.7%	95.9%	−20.9%	116.7%
China, Wheat, 2012	3.0%	12.1%	0.3%	11.8%
China, Wheat, 2013	1.5%	18.2%	2.2%	16.0%
China, Wheat, 2014	5.5%	21.7%	6.4%	15.3%
China, Wheat, 2015	4.5%	22.4%	10.6%	11.8%

The notified MPS is almost always below the DSL (10% of the VoP), which can give the impression that countries usually comply with their domestic support commitments (column a). In fact, this is an illusion: the MPS notified by countries is not usually calculated according to WTO rules (Q_{PROC} is used incorrectly as QEP, FERP is wrongly corrected for inflation etc.), and when it is recalculated to align it with these rules, it is always well above the allowed ceiling (column b). This suggests that, *without always being aware of it, most countries using PS are not complying with their domestic support commitments and are at risk of being successfully challenged at the WTO*.

This is a striking result because most of these countries are in reality providing no MPS, or an MPS much lower than their DSL: the MPS corrected for biases B1 B2 and B3 is lower than 10% of the VoP for nine of the 10 country-commodity-year triplets considered above (column c). *The lack of compliance is therefore caused by biases B1, B2 and B3*. As a matter of fact, for the 10 country-commodity-year triplets considered, the aggregate effect of the three biases is always above 10% of the VoP (column d). This means that whatever the real MPS provided by these countries, if they were challenged by others members countries (for China this actually occurred), the Panel would conclude that they did not comply with their WTO commitments on domestic support.

This suggests that, due to biases B1, B2 and B3, almost all countries that use PS are at risk of being successfully challenged, whatever the real level of MPS they provide. This shows the need to correct these biases. But do they all need correcting? This is the question we will consider in the next section.

5. Analysis of the specific contribution of each of the three biases

In this section, we analyse (for the empirical cases presented in section 4) the contribution of each of the three biases B1, B2 et B3 to the gap between MPS_{WTO} and MPS. The objective is to determine whether correcting each of these biases is necessary or not.

5.1. Contribution of B1

B1 stems from using a FERP instead of the PP for the year considered as the ERP. The contribution of B1 to the overestimation of the MPS can be estimated by applying the following formula:

$$E(B1) = (PP - FERP)\ QEP / VoP \quad (5)$$

E(B1) can be disaggregated into three components, as it stems from wrongly attributing to PS what is in reality due to: i) tariffs, ii) international price movements between the country base period and the year considered, and iii) exchange rate movements between the country base period and the year considered. These effects are given respectively by the following formulas, where all prices are expressed in LCU:

$$E(\text{tariff}) = (PP - BorderP)\ QEP / VoP \quad (6)$$

$$E(\Delta \text{Border price}) = (BorderP - FERP_{currentER})\ QEP / VoP \quad (7)$$

$$E(\Delta ER) = (FERP_{currentER} - FERP)\ QEP / VoP \quad (8)$$

Where BorderP is the border price of the year considered and $FERP_{currentER}$ is the FERP converted at ER of the year considered. The comparison between E(all biases) and E(B1) shows that B1 generates the major part of the gap between MPS and MPS_{WTO} (Table 8). Moreover, the effect of B1 is huge: it is above 10% of the VoP for 9 of the 10 country-commodity-year triplets, and not far from that limit for the remaining one (9.3% of the VoP). This means that B1 alone is enough to compromise the compliance of almost all PS schemes, whatever the real level of MPS they provide.

The same conclusion holds for the different components of B1:

E(tariff) depends on whether the country is a net exporter or a net importer and, when it is a net importer, on the tariff applied (0% for Tunisia, 35% for the Philippines, 25% for Indonesia and 6% for China). For some countries, the bias generated exceeds 10% of the VoP (Philippines, Indonesia) or accounts for a significant share of it (China). In all of these situations, it may affect compliance. The practical implication is that tariffs should be included in the calculation of the MPS: the ERP used should be the PP and not the border price (otherwise the effect due to tariffs will be wrongly attributed to PS operations).

E(ΔBorder price) is above 10% of the VoP for 9 country-commodity-year triplets out of 10. This suggests that E(Δ border price) alone is enough to compromise the compliance of the vast majority of PS programmes in the world, whatever the real level of MPS they provide.

E(ΔER). The same conclusion holds for this bias: for 6 countries out of 7, E(ΔER) is above 10% of the VoP.

The intuition that – beyond our sample – E(ΔBorder price) and E(ΔER) are huge and sufficient to compromise the compliance of many PS programmes in the world can be confirmed with data on international grain prices and exchange rates. Indeed, the variation in country border prices since the base period is closely related to the dynamics of international grain markets. Fig. 4 shows these dynamics. It appears that during the period 1986–88 (which is, for most countries, the "base period" used to calculate the FERP), the maize and wheat prices were approximately 54% of their 2020 level, and for rice they were even lower (46%).[14] Countries' FERPs are therefore likely to account for only half of their current border price, which is reflected by the fact that, in our sample, E(ΔBorder price) is approximately 50% of the VoP for Tunisia, Pakistan and Indonesia. By contrast, China benefited from its more recent base period (1996–98), a period in which the price of wheat was around 65–70% of its 2020 value: its E(ΔBorder price) is

[14] For wheat and maize, the gap with 2021 prices (affected by the current food price crisis) is even wider.

Table 8
Effect of B1 (and its components) on the gap between MPS_{WTO} and MPS.

Country	Year	E(all biases)	E(B1)	Contribution of B1′s components		
				E(tariff)	E(ΔBorder price)	E(ΔER)
		% of VoP	% of VoP	% of VoP	% of VoP	% of VoP
Tunisia, wheat	2019	111.6%	90.7%	0.0%	47.4%	43.3%
Pakistan, wheat	2015/16	92.0%	96.7%	0.0%	50.2%	46.5%
India, rice	2019/20	89.8%	90.6%	0.0%	35.9%	54.7%
India, wheat	2019/20	65.9%	73.2%	0.0%	2.9%	70.3%
Philippines, paddy rice	2020	109.3%	94.6%	31.7%	24.3%	38.6%
Indonesia, rice	2020	116.7%	116.4%	24.2%	54.2%	38.0%
China, Wheat	2012	11.8%	15.0%	4.3%	25.2%	−14.4%
China, Wheat	2013	16.0%	19.1%	4.3%	29.2%	−14.4%
China, Wheat	2014	15.3%	15.5%	4.0%	25.9%	−14.5%
China, Wheat	2015	11.8%	9.3%	3.8%	19.8%	−14.3%

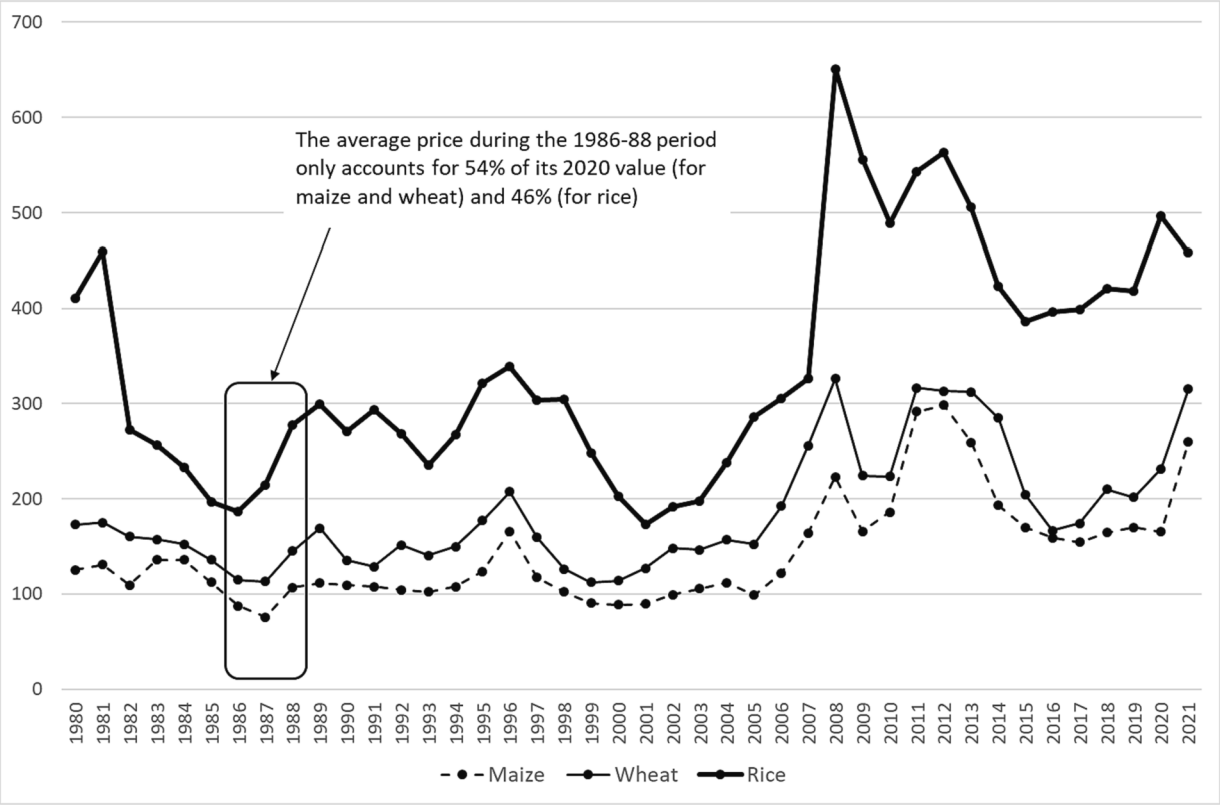

Fig. 4. Dynamics of international grain prices (US$/mt). *Source*: World Bank, 2022c

approximately 20–30% of the VoP.[15]

E(ΔBorder price) is therefore likely to be huge, but also to differ considerably among countries. This is because the base period depends on when a country became a member of the WTO. Of the 133 WTO members subject to domestic support disciplines (all WTO members, except the 28 members of the European Union, because domestic support disciplines are calculated and notified at the EU level), 106 have 1986–88 as a base period — these countries have been members of the WTO since its creation, because they were already members of the GATT. The other 27 members have a more recent base period. For instance, this period is 1996–98 for China, 1999–2001 for Vietnam, and 2006–08 for Russia.

The heterogeneity between countries may even be much stronger because of E(ΔER). As explained in the introduction, it is unclear whether countries are allowed to use a FERP expressed in US dollars. If countries have to express the FERP in LCU, then the gap between the FERP and the current border price stems not only from changes in international grain prices, but also from changes in their exchange rate. For countries whose exchange rates with the US dollar have decreased between the base period and now, the gap between the FERP and the current border price is likely to be much wider. Fig. 5 shows the magnitude of the FERP (expressed as a percentage of the 2020 international price) when the FERP is expressed in LCU. As expected, for high-income countries, the FERP expressed in LCU is of the same order of magnitude as the FERP expressed in US dollars (approximately 50% of the 2020 price). This reflects the fact that these countries' currencies

[15] Other countries (India and the Philippines) have lower than expected E(Δ border price) because they were facing a specific situation in 1986–88. But the general picture is that the magnitude of E(Δ border price) is given by the dynamics of international grain markets.

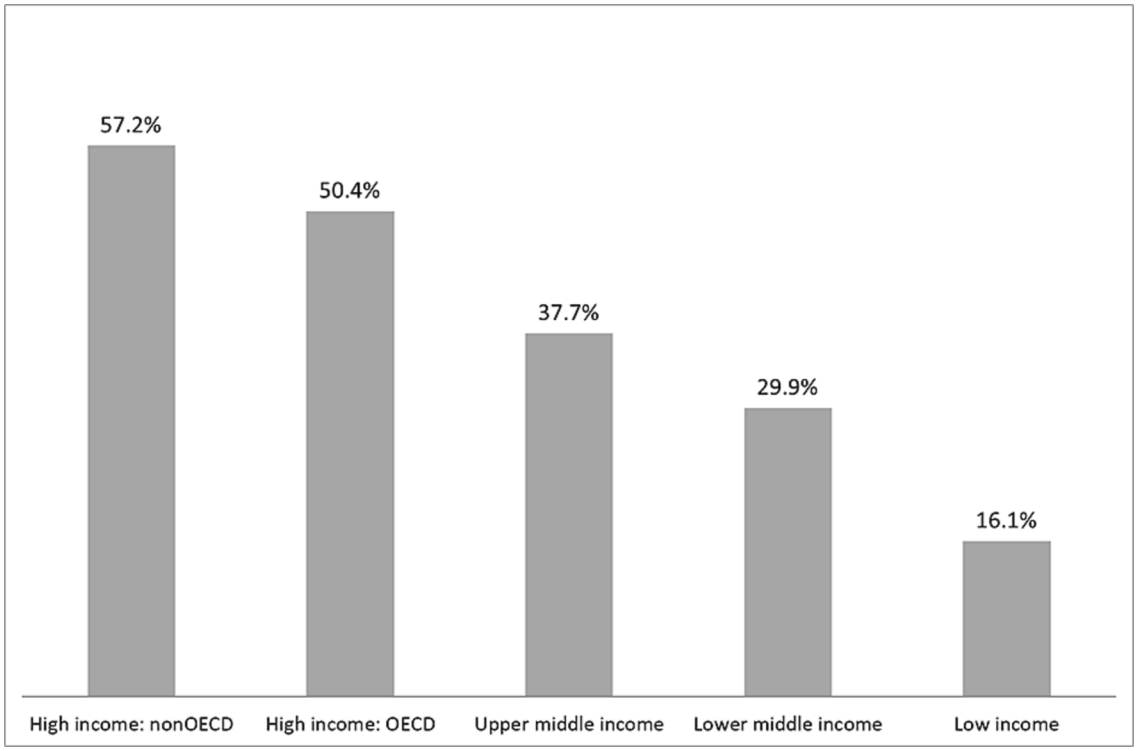

Fig. 5. The FERP (expressed in local currency unit) as a percentage of the 2020 international maize price (by country income group). *Sources*: World Bank, 2022c for maize price data; World Bank (2020b) for exchange rate data; WTO for member countries' base periods.

have remained stable (on average) compared with the US dollar. However, for low-income countries, the situation is very different: because their currencies' exchange rates with the US dollar have decreased over time, the FERP of these countries (when expressed in LCU) accounts for less than 20% of the current international price. In our sample, this is reflected by the fact that the joint effect of E(Δ Border price) and E(Δ ER) is approximately 80% of the VoP, for most countries (see Table 8). Again, the Chinese situation is atypical because the ¥ / USD exchange rate increased between the base period and the period considered (2012–2015). But the general picture is that if countries have to use a FERP expressed in LCU, the effect of bias B1 is likely to be stronger for low-income countries.

To sum up, it appears that each of the three components of B1 can be sufficient to compromise countries' compliance. *It is therefore necessary to correct all three of them.* This is an important conclusion, as some experts recommend correcting E(ΔER) by using a FERP expressed in USD, which may be allowed by current WTO rules (Diaz-Bonilla, 2014; Konandreas and Mermigkas, 2014; Montemayor, 2014). It should therefore be emphasized that this correction would in no way be sufficient to solve the problem of the overestimation of MPS_{WTO}.

5.2. Contribution of B2

B2 stems from using P_{PROC} instead of P_D to value the quantity sold by farmers on the domestic market (the implicit assumption being that the PS procurement price makes the price on the domestic market). The effect of B2 can be estimated with the following formula:

$$E(B2) = (P_{PROC} - P_D)\,(QEP - Q_{PROC})/VoP \quad (9)$$

E(B2) strongly depends on the parameters of PS procurement (Table 9). When the quantity procured accounts for a large share of national eligible production (as is the case for Pakistan, India and China), P_{PROC} and P_D are very close and E(B2) is low (it can be positive or negative depending on whether P_D is slightly above or below P_{PROC}). Conversely, when Q_{PROC} is small compared to QEP, P_D may differ significantly from P_{PROC}. This is the case for Tunisia and the Philippines, where P_{PROC} is 21% and 15% higher than P_D. Then E(B2) matters: valuing the quantity sold on the domestic market at the PS procurement price (P_{PROC}) is problematic and may affect compliance. For Tunisia and the Philippines, E(B2) is above 10% of the VoP: B2 alone is enough to push MPS_{WTO} above the DSL.

B2 is therefore problematic and should be corrected.

5.3. Contribution of B3

Bias B3 arises because WTO rules have not taken into account the fact that, in many developing countries, a significant share of the production is self-consumed by farmers. Of course, this share does not benefit from any kind of MPS.

In the numerical example presented in section 3, we assumed that 50% of production was self-consumed by farmers. How far is this assumption from reality? Although data on grain self-consumption are often collected by research studies or agricultural statistical surveys, it is quite difficult to gather data on self-consumption rates by country and commodity (as this kind of data cannot be found in international databases). In section 4, we saw that for wheat in China, according to the Panel report, the self-consumption rate was "between 9 and 18 percent of total wheat production". We have been able to gather data for maize in many sub-Saharan African countries (see Table 10). This table shows that the percentage of production self-consumed by farmers can be well above 50% in many African countries (in Eastern and Southern African countries, the self-consumption rate is approximately 80%).

What is the effect of such self-consumption rates on the estimated MPS?

The effect on the MPS uncorrected for B1 and B2 is easy to estimate: B3 increases MPS_{WTO} by a factor $f = 1 / (1 - r)$, r being the self-consumption rate (see Fig. 2), which gives:

Table 9
Effect of B2 on the gap between MPS_{WTO} and MPS.

Country, Commodity, Year	E(B2)	P_{PROC}/PP	Q_{PROC}/QEP	P_{PROC}/P_D
	% VoP			
Tunisia, wheat, 2019	20.84%	1.12	1.28%	1.21
Pakistan, wheat, 2015/16	−4.68%	0.88	22.91%	0.94
India, rice, 2019/20	−0.73%	0.96	43.91%	0.99
India, wheat, 2019/20	−7.33%	0.99	32.32%	0.89
Philippines, paddy rice, 2020	14.68%	0.94	2.30%	1.15
Indonesia, rice, 2020	0.33%	0.83	0.28%	1.00
China, Wheat, 2012	−3.36%	0.96	24.91%	0.94
China, Wheat, 2013	−3.56%	0.99	8.51%	0.95
China, Wheat, 2014	−1.27%	1.09	25.32%	0.98
China, Wheat, 2015	0.84%	1.20	20.29%	1.01

Table 10
Percentage of maize production self-consumed by farmers (for selected African countries).

Benin (2011)	35%	Kenya (2007)	78%
Burkina Faso (2003)	51%	Malawi (2007)	79%
Cameroon (2007)	52%	Mozambique (2005)	84%
Côte d'Ivoire (2008)	60%	Zambia (2008)	86%
Ghana (2006)	27%		
Guinea (2007)	78%		
Liberia (2007)	66%		
Mali (2011)	53%		
Mauritania (2008)	60%		
Niger (2011)	8%		
Nigeria (2003)	39%		
Senegal (2010)	31%		
Sierra Leone (2003)	57%		
Chad (2011)	36%		
Togo (2011)	58%		
Western and Central Africa (*average*)	**47%**	**Eastern and Southern Africa (*average*)**	**82%**

Sources: MALVILAO project for West African countries, Chad and Cameroon (Bricas et al., 2016); Jayne et al. (2010) for Eastern and Southern African countries.

- With r = 13.5%, f = 1.16
- With r = 50%, f = 2
- With r = 80%, f = 5

In other words, correcting MPS_{WTO} for B3 only would result in dividing the MPS_{WTO} by 1.16 for wheat in China, by 2 (on average) for maize in Western and Central African countries, and by 5 (on average) for Eastern and Southern African countries.

The effect on the MPS already corrected for B1 and B2 is much lower, because in this case, the joint effect of i) B1 and B3 and ii) B2 and B3 have already been removed (see Fig. 2). The example of wheat in China presented in Table 11 shows that, even in that case, B3 leads to a significant overestimation of the MPS: in 2015, it reached 1.64% of the VoP. If we simulate the effect of higher self-consumption rates (50% and 80%), the overestimation can be much higher and account for a large share of the DSL (10% of the VoP): 6% of the VoP and even 9.6% when r = 80%.

Is it worth correcting B3 when B1 and B2 are already corrected? The answer is yes.

5.4. Conclusion: each of the biases can be sufficient to compromise countries' compliance and their aggregate effect is usually higher for poor countries

Putting together all of the results presented above, we reach the conclusion that each of the biases B1, B2 and B3 alone can be sufficient to modify countries' compliance with their domestic support commitments.

In addition, the magnitude of the resulting overestimation of the MPS is likely to be much higher for poor countries. To understand why, let us consider the case of two countries: a developed country and a developing country. Both procured 10% of national production at a price 25% higher than the PP. Let us assume that, in both cases, this results in an increase in the domestic price up to the level of the PS procurement price (therefore B2 = 0). However, both the unbiased MPS and MPS_{WTO} are likely to be different for the two countries (see Fig. 6).

The real MPS provided is not the same for the two countries: in the developed country, 100% of the production is marketed (the 90% not sold to the PS agency is sold on the domestic market), while in the developing country, 80% of the production is self-consumed by farmers (of the 20% marketed, half is sold to the PS agency, and half is sold on the domestic market). Therefore, the real MPS provided by the public stockholding programme in the developed country is 2,500 (25 × 100), while in the developing country it is only 500 (25 × 20).

Moreover, the calculated MPS_{WTO} is also different: the FERP for the developed country accounts for 50% of the current international price, while for the developing country it accounts for only 20% (because the exchange rate of its currency with the US dollar decreased significantly between the base period and now). Therefore, for the developed country, MPS_{WTO} is 7,500 ([125 – 50] × 100), whereas it is 10,500 for the developing country ([125 – 20] × 100).

The overall result is that for the developed country, the MPS estimated according to WTO rules is three times the real support (MPS_{WTO} = 3 MPS), while for the developing country, it is 21 times the real support (MPS_{WTO} = 21 MPS).

6. Implications for policies

Observing the issue of countries' compliance (often due to the gap between economic and WTO measurements of MPS), experts tried to find solutions to allow enough space for food security PS while preventing governments from providing excessive MPS. Their proposals can be classified according to five categories: i) announce in advance the quantity to be procured, ii) play on the ambiguities of WTO rules, iii) exempt countries with specific attributes and/or in specific situations from WTO disciplines on PS, iv) increase the DSL and v) change the rules on calculating the MPS. In this section, we begin by showing that the first four options would be ineffective, meaning that the only relevant option is to design new rules on calculating the MPS (6.1). We will then propose a simple and operational solution to this: a formula that

Table 11
Residual effect of B3 when B1 and B2 are corrected (the case of wheat in China).

Year	MPS (% of VoP) corr. from B1, B2	MPS (% of VoP) corr. from B1, B2, B3			Residual effect of B3 (% of VoP)		
	(a)	r = 13.5% (b)	r = 50% (c)	r = 80% (d)	r = 13.5% (b) - (a)	r = 50% (c) - (a)	r = 80% (d) - (a)
2012	0.52%	0.30%	−0.30%	−0.79%	0.22%	0.81%	1.31%
2013	2.62%	2.21%	1.14%	0.26%	0.41%	1.48%	2.36%
2014	7.48%	6.40%	3.52%	1.15%	1.08%	3.96%	6.33%
2015	12.25%	10.61%	6.22%	2.62%	1.64%	6.03%	9.63%

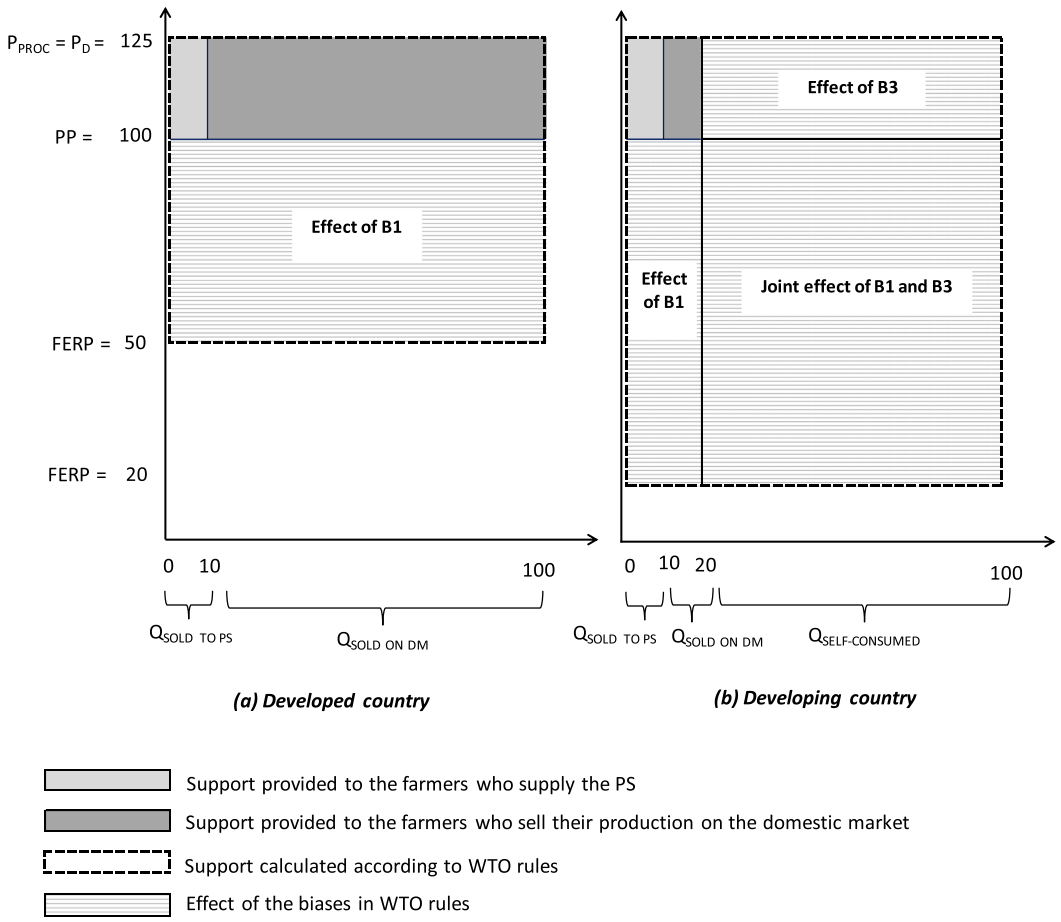

Fig. 6. Unbiased and WTO MPS (comparing the situation of a developed country and a developing country).

estimates the MPS as accurately as possible (6.2). Finally, we will compare it with previous proposals (6.3).

6.1. The need to design new rules on calculating the MPS

We will consider the other options proposed one by one and show that they would be ineffective.

1. Announcing in advance the quantity to be procured. As already mentioned, this option is allowed, since the jurisprudence of the WTO Appellate Body clarified that if the maximum quantity to be procured is announced in advance, the QEP is this quantity. However, it has three main limitations. First, announcing at the beginning of the agricultural year the quantity to be procured may be difficult, as the needs for distributions and subsidized sales depend on many parameters that are unknown at that time (including the level of harvests). Second, it may not be sufficient to offset biases B1 and B2, especially when Q_{PROC} accounts for a significant share of the QEP and/or when countries have to use a FERP expressed in LCU. Third, in some situations, it may on the contrary allow countries to provide an excessive MPS because the price support provided by the PS agency may affect the domestic market price, even when the quantity to be procured is bounded and announced in advance.

2. Playing on the ambiguities of WTO rules. As already explained, there are many ways to interpret the meaning of the FERP and the QEP. Some member countries and experts made proposals on interpreting the rules so as to reduce the gap between the support calculated by the WTO and the real support provided. However, the initial ambiguities have been reduced over time: the proposal to use the marketable quantity instead of the national production as the QEP (Hoda and Gulati, 2007; Montemayor, 2014) was endorsed by the Panel during the Korea beef case (WTO, 2000a), but not validated by the WTO Appellate Body (WTO, 2000b); the proposal to correct the FERP with the country inflation rate (Hoda and Gulati, 2013; Diaz-Bonilla, 2014; Konandreas and Mermigkas, 2014) has been rejected by the WTO Committee on Agriculture (WTO, 2014). The only remaining ambiguity that can be used is expressing the FERP in US dollars instead of national currency units, as proposed by Diaz-Bonilla (2014), Konandreas and Mermigkas (2014) and Montemayor (2014). Playing on this last ambiguity is therefore possible but risky, as it may be rejected by a Panel or the WTO Appellate Body. Moreover, even if accepted, it would not be sufficient: as shown in section 5.1, using a FERP expressed in US dollars is usually not sufficient to solve the compliance issue.

3. Exempting countries with specific attributes or in specific situations from disciplines on food security PS. This can be done in several ways. First, the support provided to farmers may be exempted from WTO disciplines in specific cases, for instance when the food is purchased from low-income or resource-poor producers (as suggested in November 2012 by an informal proposal of the G33, see WTO, 2012), when the quantity procured does not exceed a given percentage of local production (Montemayor, 2014), or when the country is a least developed country (Glauber 2016). Second, countries can be authorised to exceed their domestic support ceiling when justified by specific circumstances (safeguard clauses). For instance, a proposal made by Diaz-Bonilla (2013) and supported by different experts (such as Glauber, 2016, and to some extent Matthews, 2014) is that, if the public procurement price is equal to or below the PP for the year considered, the support provided by the public stockholding programme should be assumed to be non-distortive (and therefore exempt from any discipline). These proposals may be useful, but they would not be sufficient: as seen in sections 4 and 5, the "compliance issue" affects almost all countries in almost all

Table 12
The MPS may be much higher than expected if the PP decreased since the preceding year (illustration with the case of wheat in China).

	P_{PROC}	P_D	PP	MPS (based on PP_{Y-1})	MPS (based on PP_Y)	MPS (based on PP*)
	¥/tonne	¥/tonne	¥/tonne	% of VoP	% of VoP	% of VoP
2011			2,632			
2012	2,040	2,166	2,120	−15.4%	0.3%	−15.4%
2013	2,240	2,356	2,268	6.5%	2.2%	2.2%
2014	2,360	2,412	2,171	3.6%	6.4%	3.6%
2015	2,360	2,329	1,973	4.8%	10.6%	4.8%

Sources: WTO (2019); Table 3 for PP.

situations. Consequently, exemptions covering only some countries or only specific situations will not solve the problem. This can be illustrated with the proposal by Diaz-Bonilla. Let us consider the case of two countries with the same PP (equal to 120) and the same FERP (equal to 50). If the procurement price is 120 for country A and 125 for country B, current WTO rules give a price support of 70 for country A and 75 for country B, while the real support provided by public stockholding programmes is 0 for country A and 5 for country B. The solution proposed by Diaz-Bonilla solves the problem for country A, but leaves the problem for country B unchanged (the calculated price support would be equal to 75, while the real support is 5).

4. Increasing the DSL. The maximum level of non-exempt support allowed may be increased (as proposed by a group of countries in May 2013, see Bellmann et al., 2013). However, this strategy is not appropriate to offset the biases in the estimation of the support provided. This is because the effect of the biases on the gap between MPS and MPS_{WTO} is different for each country-commodity pair. If this gap was the same for all country-commodity pairs, it would be possible to offset the effect of the biases by adjusting the level of the ceiling. However, as seen in sections 4 and 5 and as illustrated by Fig. 6, this is far from being the case. This does not mean that there is no justification for increasing the DSL, but it certainly means that doing so is not an adequate solution to offset the biases in WTO rules.

Solutions based on the fifth strategy (modifying the rules that define how the MPS should be calculated) are therefore the only ones that could establish fairness between countries by fully correcting the biases in WTO rules. A simple solution to ensure the right metrics on the support provided by public stockholding programmes is presented in section 6.2. Section 6.3 highlights the linkages between this solution and other solutions previously proposed by member countries and experts.

6.2. A proposal on new rules for a fair estimation of the MPS provided by public stockholding programmes

Ensuring an unbiased estimation of the support provided by public stockholding programmes means eliminating biases B1, B2, and B3. As shown in section 2, this can theoretically be done by considering that:

- the share of production self-consumed by farmers does not benefit from any price support
- the quantity sold to the public stockholding programmes benefits from a price support equal to the procurement price minus the parity price of the commodity considered ($P_{PROC} - PP$)
- the quantity sold on the domestic market benefits from a price support equal to the price prevailing on the domestic market minus the parity price of the commodity considered ($P_D - PP$)

In other words, the theoretical solution is to apply Formula (4):

$$MPS = (P_{PROC} - PP)\,Q_{PROC} + (P_D - PP)\,Q_{SOLD\ ON\ DM} \quad (4)$$

However, Formula (4) cannot be used by the WTO, because the PP is only known at the end of the year (the PP depends on the average unit value of imports or exports during the year). For countries to choose the parameters of interventions under public stockholding programmes (especially P_{PROC}) with satisfactory knowledge of the WTO support they will generate, they need prior knowledge of the external reference price (ERP) that will be used in the calculation. To set P_{PROC}, countries use the information they have at the beginning of the agricultural year: the PP of the preceding year (now PP_{Y-1}). Therefore, if the ERP used to calculate the MPS is the PP for the year considered (PP_Y), the MPS is likely to be much higher than expected when the PP decreases between Y-1 and Y. This issue can be illustrated with the case of wheat in China in 2012, 2014 and 2015: because $PP_Y < PP_{Y-1}$, the MPS based on PP_Y proved to be much higher than the MPS based on PP_{Y-1} (see Table 12). In 2015, this was enough to compromise compliance (the MPS is higher than 8.5% of the VoP): P_{PROC} was maintained at its 2014 level, but as the PP decreased in the meantime, the calculated MPS was much higher than expected.

The ERP cannot, therefore, be the PP for the year considered (PP_Y): it should be a predictor variable of it. One option would be to use PP_{Y-1}. However, this option is not satisfactory because if the PP increases between Y-1 and Y, P_D will likely increase and consequently the calculated MPS is also likely to increase. It would imply attributing to PS interventions the increase in P_D due to changes in international prices or exchange rates. The best solution is therefore to take the maximum of PP_Y and PP_{Y-1} (now PP*) as the ERP.

The formula to estimate the support provided by public stockholding programmes therefore becomes:

$$MPS = (P_{PROC} - PP^*)\,Q_{PROC} + (P_D - PP^*)\,Q_{SOLD\ ON\ DM} \quad (10)$$

With:

P_{PROC} = PS procurement price.

PP* = max (PP_Y; PP_{Y-1}), PP_Y being the average unit value of imports in the year considered plus import taxes or minus import subsidies (for net importing countries), or the average unit value of exports in the year considered minus export taxes or plus export subsidies (for net exporting countries), and PP_{Y-1} being the same as for the preceding year.

P_D = average price on the domestic market (at the farm gate level) in the year considered.

Q_{PROC} = quantity sold to the PS in the year considered.

$Q_{SOLD\ ON\ DM}$ = quantity of eligible production sold on the domestic market in the year considered.

P_{PROC} and Q_{PROC} are theoretically public data (which should be notified by countries to the WTO). P_D can be observed: it is the average producer price calculated as the annual average of the prices collected on rural markets (the main points of sale for farmers). This data is already used in country notifications to calculate the value of production (which is a key element in determining the maximum level of support allowed). $Q_{SOLD\ ON\ DM}$ is the share of eligible production sold by farmers on the domestic market. It can be estimated as the share of eligible production that is neither self-consumed by farmers nor sold to the PS agency. The quantity self-consumed by farmers is usually estimated by applying a ratio r to the estimated eligible production. This ratio r – farmers' self-consumption rate – is estimated with household survey data (in most countries, research institutes or the country's statistical organisation regularly produce this kind of data). In other words, $Q_{SOLD\ ON\ DM}$ can be estimated by applying the following formula: $Q_{SOLD\ ON\ DM} = QEP\ (1 - r) - Q_{PROC}$. Finally, PP_Y and PP_{Y-1} can easily be calculated with data on i) the country average unit value of imports or exports in the considered and preceding years, and ii) the country import or export tax (or subsidy) rate.

Formula (10) therefore provides a simple way to estimate as accurately as possible the support provided by public stockholding programmes. It is imperfect, however, for all the reasons explained in section 2 of this article. One of these reasons is that the external reference price PP* does not include the transport costs between the border and the domestic market (these costs may be substantial, especially for landlocked countries, see FAO, 2014 for an example). To solve these

problems, we propose *introducing an abatement: the support bounded by the WTO should not be the MPS estimated with Formula (10), but for example 70% of this MPS for landlocked importing countries, and 80% of this MPS for other countries*. The logic behind this abatement is the same as the one used to determine whether drivers are complying with the speed limit. As the measurements taken by speed cameras are imperfect (in Europe the margin of error is around 10%), drivers are given the benefit of the doubt if they are flashed at a speed higher than the speed limit but lower than the speed limit plus the margin of error for speed cameras.

6.3. Comparison with other proposals

A simple way to compare our proposal with those already made by experts or WTO member countries is to check the solutions they suggest for correcting the different biases B1, B2, and B3.

Regarding B3, our proposal is to consider that the share of production self-consumed by farmers does not receive any support. This is very similar to the proposal already made by Hoda and Gulati (2013) and Montemayor (2014). It was also a key element of the Panel's decision in the South Korea beef case (however, as already mentioned, the WTO Appellate Body did not validate this interpretation of current WTO rules).

For B2, our proposal is a new one. Current WTO rules consider that all farmers receive the PS procurement price. Orden et al. (2011a) proposed using the price on the domestic market instead of the PS procurement price. We showed that fully correcting bias B2 implies separating within the marketed quantity the share sold to the PS agency (which receives the PS procurement price) and the share sold on the domestic market (which receives the domestic market price). To the best of our knowledge, we are the first to propose a complete solution to B2.

Correcting B1 is the most complex and challenging issue. Different proposals have been made around the idea of replacing the fixed ERP by a moving ERP based on recent import or export unit values (for instance, the average UV of the preceding year or of the three preceding years, as in some proposals made by the G33 or subsets of G33 members, see Bellmann et al., 2013). This option is likely to considerably reduce the gap between the ERP used by the WTO and the most relevant ERP: the PP for the year considered. However, it has two main limitations. First, it does not include import or export taxes or subsidies: it would therefore wrongly attribute to PS the share of the MPS due to import taxes. Second, it does not address an important issue: any increase in the border price between the past period taken into account to calculate the ERP and the year considered is likely to generate an unexpected increase in the domestic price, and thus in the calculated MPS. Our proposal to use PP* (the maximum of PP_Y and $PP_{Y\text{-}1}$) as the ERP solves these two issues.

Finally, we are also the first to propose an abatement to take into account all the margins of error in the estimation of the MPS.

7. Conclusion

In this article, we assessed the metrics defined by WTO rules regarding the MPS provided to farmers by PS.

We first developed an economic analysis of the MPS generated by PS, which enabled us to identify-three main biases in WTO rules:

- Bias B1, resulting from using the average of c.i.f. or f.o.b. prices over a fixed past period (1986–88 for most countries) instead of the PP for the year considered as the external reference price.
- Bias B2, resulting from using the procurement price instead of the price prevailing on the domestic market to estimate the price support received by the farmers who sell their production on the domestic market (thereby wrongly assuming that the PS procurement price makes the domestic price, which may be the case in some situations, but not always).
- Bias B3, resulting from applying the price support to all of the eligible production instead of the marketed share of this production (thereby disregarding farmers' self-consumption, which can be substantial for some country-commodity pairs).

We then analysed the effect of these biases, which proved to be huge: the MPS calculated according to WTO rules is usually several times higher than the MPS corrected for the three biases. As a result (and more importantly), countries' compliance is affected: the effect of the biases almost always exceeds the countries' domestic support limit, meaning that *there are compliance issues whatever the real level of MPS provided*. In other words, countries that use PS usually do not comply with their domestic support commitments: they are at risk of being challenged and our sample of country-commodity pairs suggests that, most of the time, this is purely an effect of the biases in WTO rules (as their PS interventions provide no or low MPS).

This has many important implications for policies. First, it shows that *something should be done*: obviously, current WTO rules are unable to play their role, which is to reduce distortions (i.e. excessive domestic support) while allowing enough space for countries to implement the policies they need for their food security. Second, it also clarifies *what should be done*. As most countries are affected most of the time by this "compliance issue", this challenges the idea that it can be solved by exempting countries with specific attributes (for instance least developed countries) or in specific situations (through safeguard clauses). As each of the three biases alone may compromise compliance (which is also true for the three sub-components of B1), this challenges the idea that the compliance issue can be managed by playing on the ambiguities of WTO rules (for instance by using a FERP expressed in US dollars). As the effect of the biases in WTO rules is not the same for all countries (the gap between MPS_{WTO} and the unbiased MPS is likely to be much wider for poor countries), this challenges the idea of solving the compliance issue by increasing the domestic support limit. Consequently, the only way to solve this issue is to design new rules for the calculation of the MPS. We proposed a simple formula to do so, removing the three identified biases and considering the need for countries to have prior knowledge of the level of MPS they will generate.

Ensuring the right metrics on the support provided would not only solve a great part of the compliance issue,[16] it would also be likely to facilitate discussions on the second component of the ongoing WTO negotiations on PS: the disciplines (exemptions, maximum level of non-exempt support allowed, safeguard clauses). Many debates on this issue have already been held among member countries and experts. Some of them (rather technical) address the following question: is it better to keep the current system for bounding non-exempt support (de minimis and AMS), or to develop a new approach? The options available have been under discussion for a long time at the WTO (WTO, 2008). Many proposals have been made by member countries (WTO, 2012; Bellmann et al., 2013) and experts, and analyses of these options have been produced (see, for instance, Orden et al., 2011b; Konandreas and Mermigkas, 2014; Matthews, 2014; Montemayor, 2014; Josling, 2015; Glauber, 2016; Greenville, 2017; ICTSD, 2017). Alongside these reflections, a second series of debates focuses on another question: do we need more PS? The answer depends on i) the extent to which PS contribute to improving food security in the countries that implement them, and ii) their effect on the stability of international markets. These two issues are still controversial, but syntheses on them have been produced recently

[16] It should also be noted, as highlighted by different experts (Diaz-Bonilla, 2013; Glauber, 2016; Josling, 2015), that countries' public stockholding programmes can be challenged at the WTO on the basis of the AoA, as well as the Agreement on Support and Countervailing Measures (ASCM). Ensuring the right metrics on the support provided to farmers through public stockholding programmes is therefore important for countries' compliance with not only the AoA, but also the ASCM.

(World Bank, 2012; Deuss, 2014; European Commission, 2018).

Whatever its modalities, an agreement on public stocks would mean including food security concerns in WTO rules. This would be the first time this has happened, and would likely contribute to the revival of this institution and, beyond it, of multilateralism.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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