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Price Transmission and Market Power in Modern Agricultural Value Chains

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Abstract

"Modern" agricultural markets are characterized by, among other things, quality requirements and vertical coordination. The nature of the industrial organization of the value chain depends on a variety of factors, such as local institutions, economic growth, demand, institutional infrastructure etc. In this paper we present a conceptual framework to explicitly integrate key characteristics of these "modern" agricultural markets and derive implications for price transmission and market power in these markets and value chains.

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1. Introduction

Recent changes in global agricultural and food prices have had different impacts on domestic prices across many countries. These different effects have resuscitated interest amongst policymakers on the issue of price transmission, and the implications for producer and consumer welfare.[1] There has been significant debate over to what extent high prices benefit producers.

The debate was strongest for developing countries as some argued that consumers in developing countries were hurt by increasing food prices while producers were not benefiting from high prices for their products, increasing hunger and poverty.[2]

However, also in richer countries the policy discussion on price transmission was stimulated. Evidence shows that in the EU, on average, produces prices varied more than consumer prices (Bukeviciute et al. 2009; Swinnen et al. 2013) but this does not necessarily imply asymmetric changes. Still, in the EU, it was argued that when agricultural commodity prices were on the rise in 2007/08, these increases were passed on to consumers but, when prices declined again in 2008/09, that these price declines were less than fully transmitted to consumers, hindering demand recovery and exacerbating the negative effect of declining producer prices on farm households (European Commission 2009). The European Commission (2009) argued that

[1] There is an intriguing difference in the policy reactions to high and low prices before and after 2007, as documented by Swinnen (2011) and Swinnen and Squicciarini (2012).

[2] Empirical evidence also shows a mixed picture. FAO (2009) argued that in African countries such as Kenya and Mozambique, consumer prices rose significantly, while farmgate prices remained flat (FAO 2009). A review of cereal markets in 52 countries over the period 2007-2011 found that transmission of price shocks from the world market to domestic markets varied from 50% to 100% (Sharma 2011). Nick Minot (2012), on price volatility of agricultural and food commodities in Africa, found that only 7 out of 17 prices were more volatile since 2007, while 17 were significantly less volatile. Jacoby (2013) found that the price hikes benefited poor rural households in India through positive wage effects. Headey (2011) and Verpoorten et al. (2013) found that, on average, self-reported food security improved in net food producing countries and in rural areas over the same period.

the observed discrepancies between producer and consumer price developments reflect '*structural weaknesses in the system, such as the number of intermediaries operating along the chain and the competitive structure*', and '*pervasive inequalities in bargaining power between contracting parties.*' and established a "Task Force Food" within DG Competition to oversee competition in the food sector in 2012.[3]

The transmission of price shocks has been studied extensively. There are different forms of price transmission. Transmission of price shocks at the consumer level (e.g. triggered by a demand shock) to producers in domestic markets – and vice versa – is referred to as *vertical* price transmission. Transmission of price shocks in the world market to domestic markets – and vice versa – is referred to as *spatial* price transmission. Imperfections in spatial price transmission have been attributed to factors including government intervention in markets (such as import tariffs and price stabilization measures), transport and marketing costs, the degree of processing, market structure and consumer preferences (e.g. if imported products are imperfect substitutes for domestic products) (e.g. Rapsomanikis 2011).

Imperfect vertical price transmission, on the other hand, has most often been interpreted as providing evidence of market failure, such as the exercise of market power by processing companies and/or retailers, enabling them to capture supply chain rents and reduce social welfare (Meyer and von Cramon-Taubadel 2004; Wohlgenant 2001). The existing literature mostly focuses on the effects for consumer welfare; and generally assumes a positive correlation between the degree of downstream vertical price transmission and consumer welfare – as a lower

[3] New evidence does not seem to support this claim of asymmetric price transmission: see various studies in the FP7 TRANSFOP project (www.transfop.eu), including Hassouneh et al (2012), Kaditi (2013), Lloyd et al (2012) and Sckokai (2013).

degree of price transmission would attest to a greater share of the rents being captured by powerful intermediaries in the chain.

However, this is not a consensus argument. There is also a set of studies refuting the direct link between the degree of price transmission and market power arguing that one should account for the incidence of vertical coordination in supply chains, the existence of increasing returns to scale, risk mitigating behavior by intermediaries, and the degree of processing (McCorriston et al. 2001; Wang et al. 2006; Weldegebriel 2004; Wohlgenant 2001). For example, Wang et al. (2006) show that in the presence of market power, price transmission can be weaker, identical, or even stronger than in the competitive markets case.[4]

Most of the studies of price transmission focus on the transmission of (global and domestic) producer prices to consumer prices (Goodwin and Holt 1999; Chang and Griffith 1998; von Cramon-Taubadel 1998; Bonnet and Requillart 2012; Holm et al. 2012; Davidson et al. 2012). Less attention has been paid to studying upstream vertical price transmission, i.e. the effects of price shocks originating in consumer markets on producer prices (Wohlgenant 2001). These effects are important however, as globalization and income growth have brought about important shifts in consumer demand, which are transforming supply chains all over the world, with important effects for local producers.

In addition, most of the existing literature on price transmission is empirical in nature and builds upon theoretical work by McCorriston and Sheldon (1996) and McCorriston et al. (1998, 2001). Relatively little attention has gone out to refining the theoretical assumptions underlying

[4] See Swinnen and Vandeplas (2010) for a review of existing studies on the welfare effects of concentration in supply chains, which show that potential negative welfare effects of concentration can be offset by efficiency gains due to scale economies, reduced transaction costs, enhanced incentives for R&D, countervailing bargaining power, and the sustainability of vertical coordination.

these empirical analyses (Meyer and von Cramon-Taubadel 2004), such as the changing architecture of markets.

In this paper, we attempt to contribute to this field by theoretically examining how exogenous consumer price shocks (triggered for instance by income changes, global shocks, or by changes in consumer preferences) are transmitted to producer prices, taking into account the particular nature and institutional characteristics of ("modern") agricultural and food markets and supply chains. Both Swinnen and Vandeplas (2010, 2011), who analyze global supply chains in emerging and developing countries, and Sexton (2012) and Crespi et al. (2012), who focus on U.S. markets, emphasize that production for "modern" markets requires consistency and strict adherence of products and production processes to quality and safety standards. This typically implies important investments by suppliers, but it often also entails substantial complementary costs for buyers. Moreover, both emphasize the need to incorporate vertical coordination as an institutional characteristic. More general, it is argued that economic analysis needs to explicitly consider this "new architecture of modern agricultural markets" as it has important implications for efficiency and equity. For example, Sexton (2012) argues that if high quality supply chains require vertical coordination, and if buyer sunk costs and transaction costs in finding new suppliers are significant, monopsonistic or oligopsonistic buyers may pay suppliers as much –or even more than competitive markets. Similarly, Swinnen and Vandeplas (2011) show that even with unequal bargaining power, buyers may pay suppliers "efficiency premia" to ensure quality supplies in environments with factor market imperfections and weak bargaining power.[5]

[5] Crespi et al. (2012) show that under such conditions, policymakers dealing with issues such as market power based on traditional models of agricultural markets (as highly competitive spot markets of homogeneous products) may devise policies running counter to their own objectives.

In this paper we integrate these arguments to study price transmission. We develop an extended version of the model of Swinnen and Vandeplas (2011) and integrate insights from Sexton (2012) and use this model to show that price transmission depends on the nature of vertical coordination and different types of transaction costs in the supply chain. Our analysis shows that price transmission is likely non-linear in these supply chains. We identify implications for empirical studies. We also show that, contrary to what is often assumed in empirical research, weaker price transmission from consumer to producer prices does not necessary imply a welfare loss for suppliers.

2. Modern Value Chains and Contracting Costs

As explained in the introduction, production for "modern" markets requires consistency and strict adherence of products and production processes to quality and safety standards. While there are important similarities between models focusing on rich countries and those analyzing global emerging and developing markets, there are also differences between the two strands of literature, in particular regarding the nature of the transaction costs and associated market governance. Sexton and colleagues focus on the role of search and switching costs associated with quality and consistency requirements in developed economies. While these types of transaction costs are also increasingly important in emerging and developing economies, the latter are further characterized by major imperfections in rural factor markets and poor contract enforcement institutions. These give rise to additional transaction costs and different vertical coordination strategies. To incorporate these differences, we will develop a "general" theoretical framework for the analysis of price transmission in agricultural supply chains, accounting for quality requirements, contract-specific investments, factor market imperfections, imperfect contract enforcement institutions and market power.

Adherence to quality and safety standards typically implies important investments by suppliers, but it often also entails substantial complementary costs for buyers. Like Sexton (2012) and Swinnen and Vandeplas (2011), we do not consider sunk costs in processing infrastructure, but focus on supplier-specific contracting costs.

In our analysis, we use the concepts of (supplier-specific) "buyer investment" and "contracting costs" interchangeably, since we interpret (and model) them as the cost of the investment which the buyer needs to make in order to make a transaction possible.

We focus on four types of contracting costs: search (or switching) costs incurred in the process of identifying suitable producers; the costs of training suppliers to produce high-quality commodities, which may imply the use of new technologies or complying with new standards; monitoring costs to ensure that suppliers apply the technology as has been recommended; and the costs of providing external inputs (e.g. fertilizers, credit, seeds, and/or other types of technology). We focus on these because (a) they have been described as important in the literature; (b) they differ in two important characteristics which allows to develop a classification of contracting costs along two dimensions; and (c) because these dimensions importantly influence the effects of the contracting costs (as we will show). The two key dimensions are whether there are cost advantages for working with a repeat supplier vis-à-vis working with a potential new supplier; and whether the supplier-specific investment has a value for the supplier outside of the existing contract.

Cost advantage of repeat suppliers

Some contracting costs are the same for first-time and repeat suppliers alike since they need to be incurred for each production cycle. This is the case for instance when the buyer is prefinancing external inputs for its suppliers. In many developing and emerging countries processors provide

their suppliers under contract with seeds, pesticides, and fertilizer in crop production and feed in livestock production (e.g. Bellemare 2012; Birthal et al. 2005; Gow et al. 2000).

Another example is when the buyer has a system in place to monitor contract compliance – e.g. in the form of a set of field officers who conduct field visits on a regular basis. By means of illustration, consider the following quote from Minten et al. (2009: 1733) on monitoring in high value vegetable production in Madagascar:

> *"To monitor the correct implementation of the supplier contracts, the [processor] has … around 300 extension agents who are permanently on the payroll … Every extension agent, the chef de culture, is responsible for about 30 farmers. To supervise these, (s)he coordinates five or six extension assistants … that live in the village itself. … During the cultivation period of the vegetables under contract, the contractor is visited on average more than once … a week … to ensure correct production management as well as to avoid "side-selling." … 99% of the farmers say that the firm knows the exact location of the plot; 92% of the farmers say that the firm will even know … the number of plants that are on the plot. For some crucial aspects of the vegetable production process, representatives of the company will even intervene in the production management to ensure it is rightly done."*

Other contracting costs are non-recurring, and only need to be paid at the start of a collaboration between a buyer and a supplier. Working with a repeat supplier, for which these costs have already been borne, is then cheaper than contracting a new supplier. An example are search costs, which are incurred to identify a suitable supplier. For example, Sexton (2012: 215) points out that "transaction costs of engaging with repeat suppliers will likely be considerably less than transaction costs of locating and contracting with new suppliers".

Another example are training costs. A new supplier typically needs to be trained to become familiar with buyer preferences and standards, and possibly with the use of new technologies. Being trained confers a cost advantage to repeat suppliers compared to potential new suppliers.

Value of investment outside of the contract

Another dimension of these contracting costs is their residual value to the contracted supplier outside the contract.[6] Some types of buyer investments do not have a value for the supplier beyond the existing contract. Examples include search costs and monitoring costs.

Other types of costs may have an important residual value outside of the existing contract. For example, before being applied to crops, external inputs can be used by the supplier for other purposes (e.g. fertilizer use for other, non-contracted, crops) or sold on the secondary market. Even after being applied to crops, external inputs convey additional value to suppliers, which may be realized outside of the contract, for instance when the contracted supplier sidesells his produce to alternative buyers.

Also training costs can have a value outside of the contract, depending on the degree of specificity of the training (Becker 1962). Training increases a supplier's human capital. This is an intangible asset which can be used in other activities and may have a long-lasting positive impact on the supplier's opportunity cost of labor.

Classification of contracting costs

Considering the two dimensions discussed above, we can classify contracting costs into four "types" – as illustrated in Table 1. Monitoring costs and the costs of providing external inputs are recurring costs and do not provide a cost advantage to repeat suppliers; search costs and training costs are non-recurring and therefor do provide a cost advantage to repeat suppliers. External

[6] The costs under study are all "supplier-specific". Hence, once incurred, none of these costs has any residual value to the buyer/investor outside of the current contract relationship. This would have been different if we would have considered sunk costs in infrastructure by the buyer for example.

inputs and training have a value to the supplier outside the contract while monitoring and search costs do not.

For didactic purposes, we consider "pure" forms of the four types of contracting costs in the rest of the paper. In reality, of course, the boundaries between these four types are not always clear-cut. Some of the contracting costs may have mixed characteristics. For example, training may be a combination of an initial investment at the start of a collaboration between a buyer and a supplier; supplemented by regular training sessions, possibly at the beginning of each production cycle, in which suppliers receive updates of best practices. In such case, the relative cost advantage of a repeat supplier to a new supplier depends on the relative importance of initial training sessions vis-à-vis the updates. Similarly, Dries et al. (2009) document how some of the investments in external inputs in the Eastern European dairy sector can be considered as non-recurring investments (e.g. cheap loans for equipment and herd upgrading), while other investments, such as feed concentrate, are incurred for each production cycle. In this paper, when we talk about "external inputs" we have the latter in mind, i.e. those costs that are incurred for each production cycle.

3. A Model of Modern Value Chains

Consider the case where a "supplier" (for example a farm) can sell products to a "buyer" (for example a trader or a retailing or processing company).[7] Assume the buyer can offer a contract to the supplier, which includes the conditions (time, amount and price) for purchasing the supplier's products, and selling these products (possibly after processing) to consumers – either domestically or internationally – in a quality-differentiated product market at a unit price

[7] Our basic set up is based on Swinnen and Vandeplas (2011).

p_h. We assume that consumer demand is perfectly elastic at price p_h and that this implies a quality premium for the buyer over his variable production costs.[8] This quality premium may for instance result if the buyer is a "gate-keeper" to the high-value market (Inderst and Mazzarotto 2008);[9] or if consumers are paying a "quality-assuring price" (Klein and Leffler 1981).

To produce q units of a high-quality product, the supplier needs to invest an amount l of own resources (e.g. labor or land). We assume the supplier's opportunity cost of these own resources is $\bar{l}$. If, for example, his best alternative use of these resources were to produce 1 unit of another product, then $\bar{l} = p_l$, with p_l the price of the alternative product – which could be a low-quality product for the local spot market.

In our model we use two parameters, α and γ to capture the two dimensions of contracting costs as defined in section 2. We assume that the production of high-quality agricultural products requires the buyer to invest an amount of contracting costs k, with $\bar{k}$ the buyer's opportunity cost of this investment. The parameter γ represents the cost advantage for the buyer of working with repeat suppliers vis-à-vis new suppliers. The effective investment costs are $(1-\gamma)\bar{k}$ where $\gamma = 0$ for new suppliers or for recurring investments, which need to be done for each production cycle, irrespective of the supplier; and $\gamma = 1$ for repeat suppliers, when investments are entirely consisting of non-recurring costs. Hence, $\gamma \in [0; 1]$.

We define the residual value of the investment for the supplier outside the contract as a fraction α of $\bar{k}$, its value within the contract. The less specific these investments are, the higher their value outside of the contract will be, i.e. the higher α. If an investment does not have any value outside the contract for the supplier, $\alpha = 0$.

[8] Or, as in Klein and Leffler (1981), over his "salvageable" production costs – whether fixed or variable.

[9] Take for example the case of fruits and vegetables exporters in Sub-Saharan Africa, where high food standard requirements increase the costs of entry for potential exporters, eventually leading to consolidation of the export supply base (Maertens and Swinnen 2008).

The resulting equilibrium and price transmission pattern will depend on the bargaining power of the buyer and supplier and on the conditions for enforcement of the contract. We consider two extreme situations: one where the contract is perfectly (and without costs) enforced and another when there is no external enforcement of the contract and the contract needs to rely on internal enforcement.

4. Price Transmission with Perfect Contract Enforcement

If formal contract enforcement institutions work well and costless (or if a supplier does not have an attractive opportunity for contract violation once a contract is agreed upon), the "perfect enforcement" outcome results. For contracts to be realized both agents' participation constraints need to be satisfied. For the supplier, this means that his income Y must cover the opportunity cost of own resources

$$Y \geq \bar{l}. \tag{1}$$

For the buyer, it means that his income Π must cover at least his opportunity cost of the capital invested in the contract:

$$\Pi \geq (1-\gamma)\bar{k}. \tag{2}$$

The contract surplus S is the net value created by the contract after subtraction of the opportunity costs of all invested resources:

$$S = p_h q - (1-\gamma)\bar{k} - \bar{l}. \tag{3}$$

This surplus will be shared between buyer and supplier according to a fixed sharing rule β with $0 \leq \beta \leq 1$ the share of the supplier.[10] As is usual in a Nash bargaining process, both

[10] The determination of β is a question which has received a lot of attention in the theoretical literature but, as yet, has not been fully resolved (see e.g. Doyle and Inderst 2007). One part of the literature argues that β should be 0.5 in the case of perfect information and in the absence of uncertainty (e.g. Nash 1953); while another part of the literature

participants to the contract receive the opportunity cost of the resources they invest in the contract, topped up with a share of the contract surplus determined by β. The contract (Y, Π) then implies the following incomes:

$$\begin{cases} Y^0 &= \bar{l} + \beta\left(p_h\, q - (1-\gamma)\,\bar{k} - \bar{l}\right) \\ \Pi^0 &= p_h q - Y \end{cases} \quad (4)$$

The resulting producer price p^0 is easily obtained by dividing Y by q:

$$p^0 = \left[l + \beta\left(p_h\, q - (1-\gamma)\bar{k} - \bar{l}\right)\right]/q \quad (5)$$

If we assume that the supplier's fallback option is to produce low-quality goods ($\bar{l} = p_l$), and that there is no output effect from shifting from low-quality production to high-quality production ($q = 1$), then Equation (5) reduces to:

$$p^0 = p_l + \beta\left[(p_h - p_l) - (1-\gamma)\,\bar{k}\right] \quad (6)$$

which is equivalent to $p^0 = p_l + \beta.S$ if $S > 0$. Note that, if $S \leq 0$, there are no gains to be made from high-quality production, and the supplier will produce for the low-quality market, with $p^0 = p_l$.

The second part of the right hand side term in Equation (6) shows how the producer price is a function of the difference in the price of low-value and high-value products ($p_h - p_l$), contracting costs $(1-\gamma)\,\bar{k}$, and the bargaining rule (β). The producer price is positively (and linearly) related to the consumer price and to the sharing rule. The higher the consumer price for high-quality products (p_h) and the higher β, the higher p^0.

We now look at how shocks in consumer prices are transmitted to prices at the supplier-level. Price transmission can be defined as $\tau = \partial p / \partial p_h$ and is illustrated in Figures 1(a) and 2(a) with $p^0 = p_l$ in price region A where $p_h \leq p_l + (1-\gamma)\,\bar{k}$ (meaning $S \leq 0$). In this price

argues that in the real world β may reduce to 0 in a context of extremely unequal bargaining positions (e.g. Svejnar 1986).

region, price transmission is zero. By producing low-quality goods, the supplier is shielded against shocks in the high-quality market (although he may be prone to shocks in the low-quality market).

If $p_h > p_l + (1-\gamma)\,\bar{k}$, the producer price is no longer fixed but varies with changes in the consumer price for high-quality goods (p_h). There, price transmission $\tau = \partial p / \partial p_h = \beta$. As the producer price is determined through a bargaining process, an exogenous price shock in the consumer price Δp_h will be transmitted to the producer only partially. The degree of price transmission equals the share of the surplus that the producer gets. This, of course, is not surprising since a change in the consumer price affects the surplus and the change in the surplus is distributed in the same way as the initial surplus.[11]

The process of bargaining for price determination partially isolates the farmer from the market. The lower β, the stronger he is shielded from price shocks – both when prices go up and when they go down. It reduces the negative effect when prices fall, but it also reduces his gains when prices rise. In the extreme case where the surplus share of the supplier is zero ($\beta = 0$), the supplier is pushed back to his opportunity cost, and the buyer is the residual claimant of the full surplus. In this case, there will be no price transmission at all to the supplier-level. Every change in the surplus (either an increase or a decrease) is absorbed by the buyer.

In summary, with perfect contract enforcement and the higher β is, the larger the surplus share which is appropriated by the supplier, and the stronger the degree of price transmission is. Hence, within this scenario the traditional logic holds, that the stronger the degree of price transmission is, the stronger supplier benefits are – hence there is indeed a positive correlation

[11] Note that with perfect enforcement, price transmission is not affected by contracting costs.

between β and p^0 (or Y^0). Note, however that this also implies that the suppliers are more exposed to price volatility and that they will lose more when prices decline.

5. Price Transmission with Imperfect Contract Enforcement

If contracts are not perfectly enforceable, the outcome may be different. Opportunistic behavior may lead to hold-ups if one of the agents has an attractive alternative to contract compliance. In particular, if the supplier can use the investment costs borne by the buyer to realize more value outside the contract than within the contract, and if contract enforcement is imperfect, a supplier will be tempted to violate the contract.

In practice, contract breach by the supplier can take many forms. For example, in the case where a buyer prefinances the supplier's input costs, the latter can divert these received inputs to other uses, such as selling them or applying them to other production activities. An alternative way to hold up the buyer is when the supplier applies the inputs to the crops, as agreed in the contract, but then sells the high-quality output to an alternative buyer, who may or may not value the product as much as the contracted buyer.

In the case of training costs, opportunistic behavior can arise in a similar way. Instead of applying his own resources (land and labor) in combination with the received training to produce high-quality goods; the supplier can use his training to earn additional income, e.g. using his time and new skills in different production activities, or by producing high-quality goods for other buyers.

We assume that in case of contract breach, the supplier can realize his opportunity cost of labor, in addition to a fraction α of $\bar{k}$, with $\alpha\bar{k}$ the value of the buyer's investment which the supplier can realize outside the contract. The higher α, the more attractive contract breach will

be. We also assume that by doing this the supplier will incur a cost φ^s. This cost can be interpreted in several ways: it can reflect a reputational cost, the loss of social capital, or the loss of future business opportunities (see e.g. Keefer and Knack 2005 for a review).[12] The supplier payoff in case of contract breach is thus $\bar{l} + \alpha\bar{k} - \varphi^s$.

Consider the extreme case that there is no external enforcement of contracts. In this case, contracts have to be self-enforcing. A self-enforcing contract requires that the supplier's contract income *Y* must cover at least his potential income from non-compliance with the contract. This condition constitutes the supplier's incentive compatibility constraint. Hence, in addition to the supplier's and the buyer's respective participation constraints (see Conditions (1) and (2)), the contract must satisfy the supplier's incentive compatibility constraint:

$$Y \geq \bar{l} + \alpha\bar{k} - \varphi^s. \tag{7}$$

A self-enforcing contract (*Y, Π)* then implies the following incomes:

$$\begin{cases} Y = \max\left[\bar{l} + \beta\left(p_h\, q - (1-\gamma)\,\bar{k} - \bar{l}\right);\ \bar{l} + \alpha\bar{k} - \varphi^s\right] \\ \Pi = p_h q - Y, \end{cases}. \tag{8}$$

with *Y* the supplier's income and *Π* the buyer's income from the transaction.

The supplier price, p^* , in this contract is:

$$p^* = \frac{1}{q} max[\bar{l} + \beta\left(p_h\, q - (1-\gamma)\,\bar{k} - \bar{l}\right);\ \bar{l} + \alpha\bar{k} - \varphi^s]. \tag{9}$$

The first term in the maximand in Equation (9) is the supplier price under perfect enforcement (see Equation (6)). This constitutes the lower bound to the supplier price under imperfect enforcement. The supplier price may be higher, however, if the supplier has an

[12] Swinnen and Vandeplas (2011) model an additional alternative for contract breach: if the supplier uses the acquired investment to produce a high-quality product, but sells it on better terms to an alternative buyer, one can show that a contract needs to fulfil an additional condition to be self-enforcing, which depends on *q* and on the price a supplier can fetch on the spot market for the high-value product. This issue is ignored in this paper for reasons of simplicity, but taking it on board should not affect our main conclusions.

attractive option outside of the contract, once the buyer has made the required investment. In particular, if α is sufficiently high (such that $\alpha\bar{k} - \varphi^s > \beta(p_h\, q - (1-\gamma)\bar{k} - \bar{l})$), the second term of the maximand in Equation (9) will bind and the producer price under imperfect enforcement will exceed the producer price under perfect enforcement.

If we assume the supplier's best alternative option is to produce one unit of a low-quality product, and if $q = 1$, Equation (9) can be rewritten as:

$$p^* = max[p_l + \beta\big((p_h - p_l) - (1-\gamma)\,\bar{k}\,\big);\; p_l + \alpha\bar{k} - \varphi^s]. \qquad (10)$$

Hence, the producer price under imperfect enforcement will be at least as high as under perfect enforcement, of course conditional upon the contract being sustainable. As for sustainability, the contract specified in Equation (8) should satisfy the buyer's participation constraint, which is $\Pi \geq (1-\gamma)\bar{k}$ (see Condition (2)). In combination with Conditions (1) and (7), this condition imposes a lower bound on p_h. Only if p_h is sufficiently high, is it possible to set the contract terms such that both agents' participation constraints as well as the supplier's incentive compatibility constraint are simultaneously satisfied. The specific conditions for contract feasibility are summarized in the following restriction on p_h:[13]

$$p_h \geq p_h^{min} = \; max\,(p_l + (1-\gamma)\bar{k},\; p_l + (1 - \gamma + \alpha)\bar{k} - \varphi^s) \qquad (11)$$

This condition captures two major reasons for potential contract failure. First, if $p_h q < p_l + (1-\gamma)\bar{k}$, the net surplus of the transaction will be negative, and there is no incentive for contract formation. Second, and more importantly, if $p_h \geq p_l + (1-\gamma)\bar{k}$ but smaller than $p_l + (1 - \gamma + \alpha)\,\bar{k} - \varphi^s$ $(= p_l + (1-\gamma)\bar{k} + (\alpha\bar{k} - \varphi^s)$ with $\alpha\bar{k} - \varphi^s$ the net benefits of contract breach), the contract surplus is positive, but the surplus is too small to allow the buyer to

[13] We implicitly assume that the buyer can commit to the contract; see Swinnen and Vandeplas (2011) for when this is not the case.

offer a price to the supplier which makes him comply with the contract. Under these conditions, the contract will not be realized, despite its potential positive contribution to social welfare. These conditions are represented by price regions A and B in Figure 1(b). When the potential surplus is negative (region A) or when the potential surplus is too low for the buyer to pay a sufficiently high price to the supplier (region B) there will be no contract and the income for the supplier will be his reservation income p_l.

Once consumer prices are high enough such that $p_h \geq p_l + (1 - \gamma + \alpha)\,\bar{k} - \varphi^s$, contracting will occur and producer prices will increase. With imperfect contract enforcement, a buyer will have to pay his supplier a premium on top of the perfect enforcement outcome to prevent violation of the contract after the buyer has paid the contracting costs.

We refer to this premium as an "efficiency premium" ε, which equals the difference between the supplier's price under (costless) perfect enforcement (p^0) and his price under costly enforcement (p^*): $\varepsilon = p^* - p^0$. Making the contract "self-enforcing" by paying an efficiency premium is a rational strategy for a buyer if it earns him a better payoff than his outcome when being held up; or his outcome when not engaging in a transaction with the concerned supplier, or any other one.

In Figure 1(b), this efficiency premium ε is represented by the difference between the full line and the dashed line. Notice that over price region C the producer price will be fixed at $p^* = p_l + \alpha\bar{k} - \varphi^s$. This implies that the efficiency premium will adjust to reflect the difference between p^* and p^0. This also means that price transmission is zero in this region (see Figure 2(b)). Note however that in region C producer prices are higher than they would be when there would be perfect enforcement (and stronger price transmission), represented by the dashed line in Figure 1(b). In region B however, the producer price with perfect enforcement is higher

than with imperfect enforcement. Note that all this implies that there is no direct relationship between price transmission and producer incomes.

Once consumer prices increase further to where $p_h \geq p_l + (1-\gamma)\bar{k} + (\alpha\bar{k} + \varphi^f)/\beta$ (region D), producer prices will follow the increase in producer prices. Producer prices are $p^* = p_l + \beta\left(p_h - p_l - (1-\gamma)\,\bar{k}\right) = p^0$, the price with perfect enforcement. In this case price transmission is also β.

Figure 2 illustrates the variation in price transmission over the consumer price region. Price transmission (τ) is zero for price changes within regions A, B and C. However note that if the consumer price changes between region B and C there is a large, discontinuous price effect for producers. Similarly, if the consumer price shifts between regions C and D there is a discontinuous effect.

Finally, note that our discussion of the impact of consumer price shocks on suppliers involved in vertical contracts has focused on price shocks originating in the high-quality market. Welfare of suppliers involved in high-quality supply chains may as well be affected by price shocks originating in the low-quality market. A price change in the low-quality market will affect p_l and it is obvious from Figures 1(a) and 1(b) that this would affect the shape of the high-quality price function.

6. Effects of Contracting Costs

It is clear from our analysis that the amount and nature of the contracting costs (reflected in the γ and α parameters) plays an important role. They affect both the shape of the producer price function and the size of the different price regions, which together determine the process of price transmission. The impact of the different costs is illustrated explicitly in Figure 3. Panel

3(a) illustrates the impact of differences in α. Recall that α is an indicator for the value a supplier can realize based on the buyer's contract-specific investment outside of their joint contract. A higher α implies more benefits for a supplier from the associated (higher) efficiency premium. This is reflected in the upward shift of the function for the C- region, and in the enlargement of the C-region, for which the price transmission is zero. However at the same time a higher α makes internal contract enforcement harder. This is reflected in the rightward shift of the function and the enlargement of the B- region where contracting is not possible.

Panel 3(b) illustrates the impact of γ, which captures the impact of search and training costs. With lower costs (and hence a higher γ), the price function shifts to the left. With lower costs there is more surplus which makes contracting easier. This causes the shift to the left with a smaller A region. With more surplus in the contract, the first term in Equation (10) is larger and more likely to bind, reflected in a larger D-region.

Note, however, that these changes in the function do not change the key findings that price transmission is discontinuous and inconsistent with the traditional logic, in which a positive correlation is assumed between producer prices (and hence producer welfare) and the degree of price transmission.

7. Contract Enforcement and Market Power

Our model and its results, as summarized in Figures 1, 2 and 3 also yield additional insights in the concept of "market power" in these modern supply chains. An obvious indicator of market power is the distribution of the surplus between the agents in the chain. With perfect enforcement (as in Figure 1(a)) the distribution is captured by β, the (exogenous) sharing rule as defined in Section 4 (and discussed in Footnote 10). Hence β measures market power in this case.

However, this is not necessarily the case with imperfect enforcement. As is illustrated in Figure 1(b), the contract is feasible over price areas C and D. In area D, β is an indicator of market power, as in the perfect enforcement situation, since it reflects the share of the surplus that goes to the two agents. However, this is not the case in area C. In this price range the share of the surplus that goes to the supplier is higher than β. Hence β is not a good indicator of the effective market power in area C.

Hence, we can now go beyond the simple (exogenous) sharing rule β which defines the supplier's bargaining position under perfect enforcement, and define an (endogenous) ex post bargaining power β_p as the share of the contract surplus he effectively receives. Combining Equations (3) and (9) we can derive that :

$$\beta_p \equiv \max\left(\beta, \frac{\alpha\bar{k}-\varphi^s}{p_h\, q-(1-\gamma)\bar{k}-\bar{l}}\right). \qquad (12)$$

It is clear that β_p is increasing in the ex ante sharing rule (β) but also in parameter α, which reflects the value of the buyer's complementary investment outside of the contract. Note that the additional benefits a supplier derives from a "high α" contract do not depend on β. Hence, even with very strong "ex ante" buyer market power (β very low), if α is sufficiently high (and φ^s sufficiently low), the buyer will have to pay an efficiency premium to the supplier in order to secure his supplies. Hence, even companies which dominate the market – such as in the case of monopolies – will have to share their surplus as the effective market power of supplier will be stronger than the market structure suggests.

8. Concluding Remarks

The empirical literature on price transmission usually assumes that perfect competition amongst buyers makes farmers best off; and that perfect competition will result in perfect

transmission of price shocks along the supply chain, as buyers operate at a zero profit margin. A shortcoming of most models in the literature is however that these models assume that factor markets work well and that contracts are enforced; and they often ignore vertical coordination and search and monitoring costs. However these factors are important in reality. While factor markets work imperfectly mostly in less developed regions, vertical coordination occurs in many sectors in modern food chains, and search costs can be significant everywhere. These conditions not only have major implications for the distribution of rents in food supply chains, but they also have an important impact on price transmission.

The specific architecture of modern supply chains which often involves vertical ties and requires crucial investments by buyers in contract-specific costs implies that the traditional logic, which assumes that weaker price transmission is associated with lower supplier welfare as powerful intermediaries in the supply chain are capturing all rents, is no longer universally applicable. In particular, we have shown formally that in vertically coordinated high-quality supply chains, conditions may arise under which farmers are better off in a context where price transmission is weaker. Our analysis also shows that price transmission is discontinuous and depends on the nature and the amount of contracting costs. This obviously has important implications for empirical research in this area.

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Table 1: A Typology of Contracting Costs

		Value outside of the contract (for supplier)	
		$\alpha = 0$	$\alpha > 0$
Cost advantage of repeat supplier (for buyer)	$\gamma = 0$	Monitoring costs	External inputs
	$\gamma > 0$	Search costs	Training costs

Figure 1: Relationship between producer and consumer prices

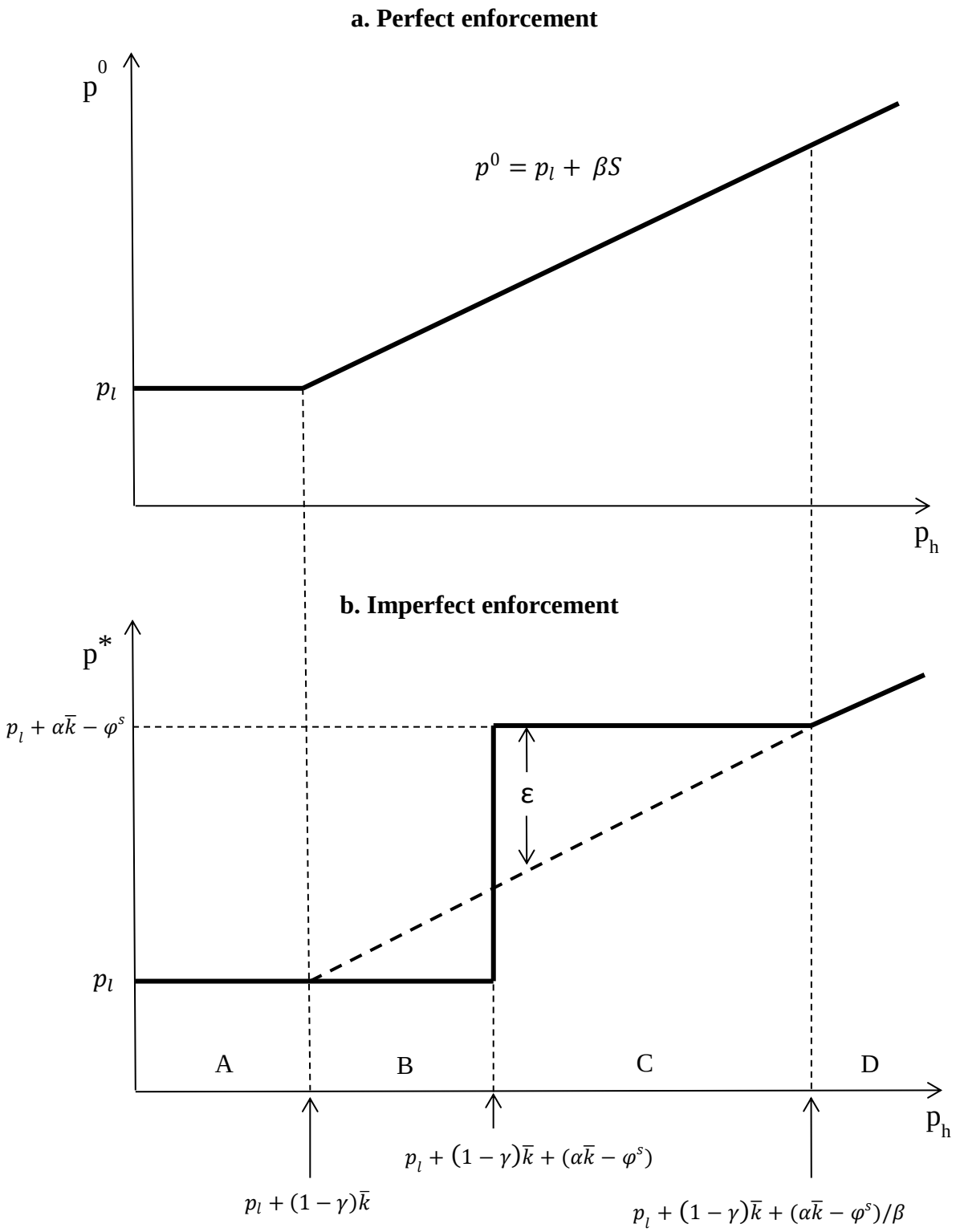
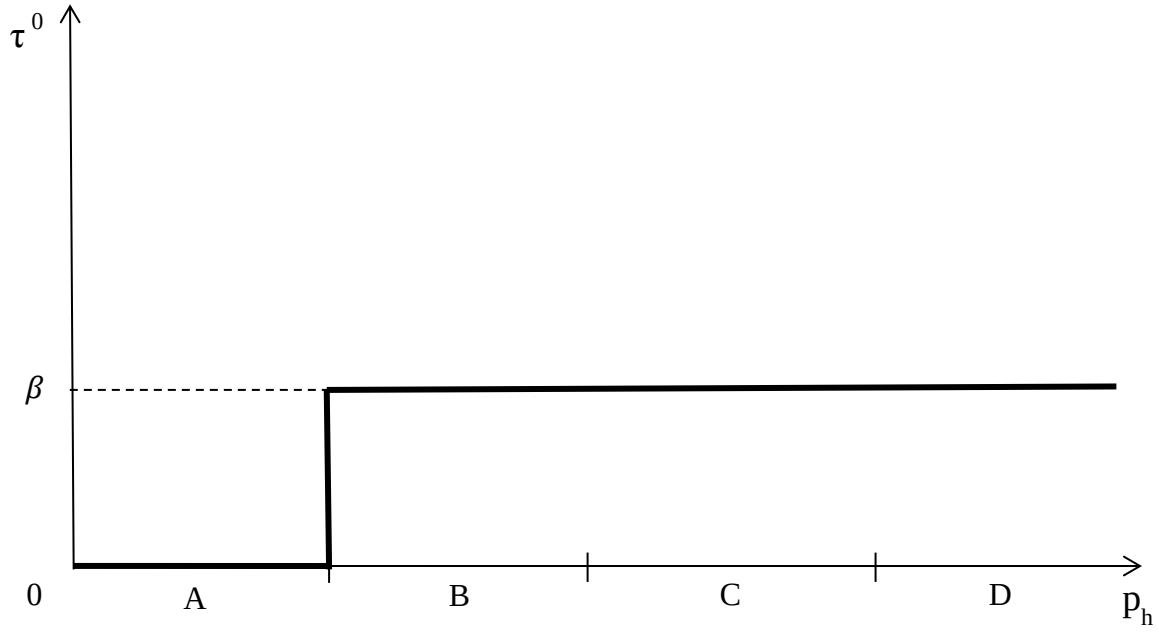


Figure 2: Price transmission (τ)

a. Perfect enforcement



b. Imperfect enforcement

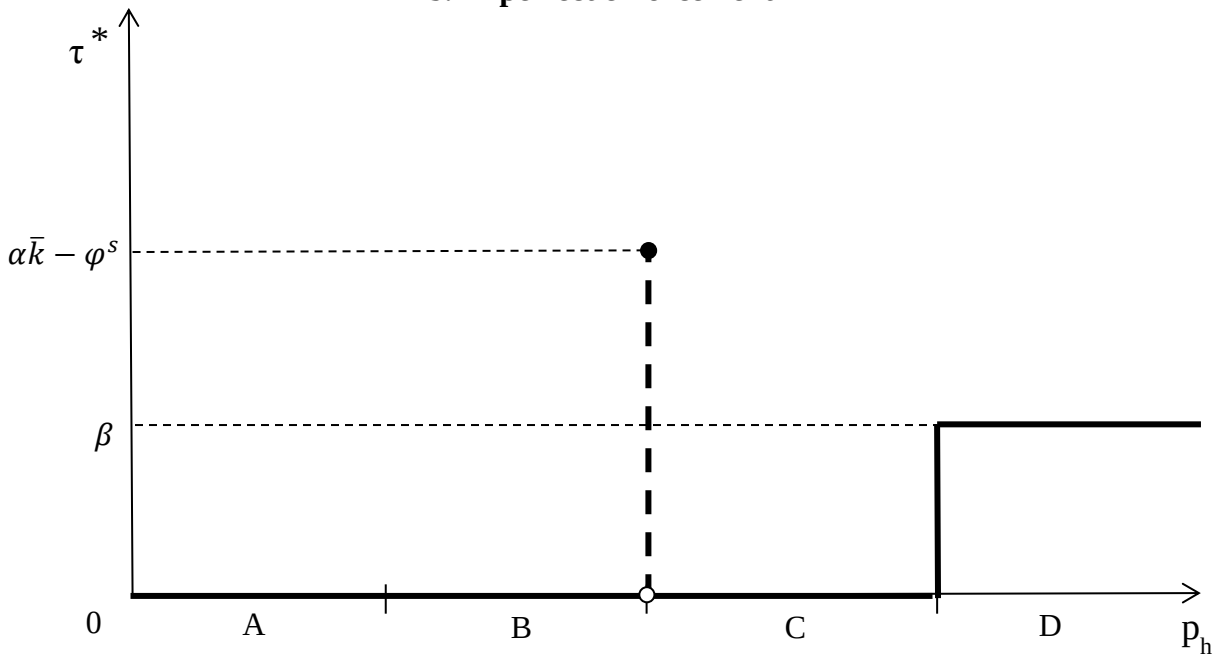
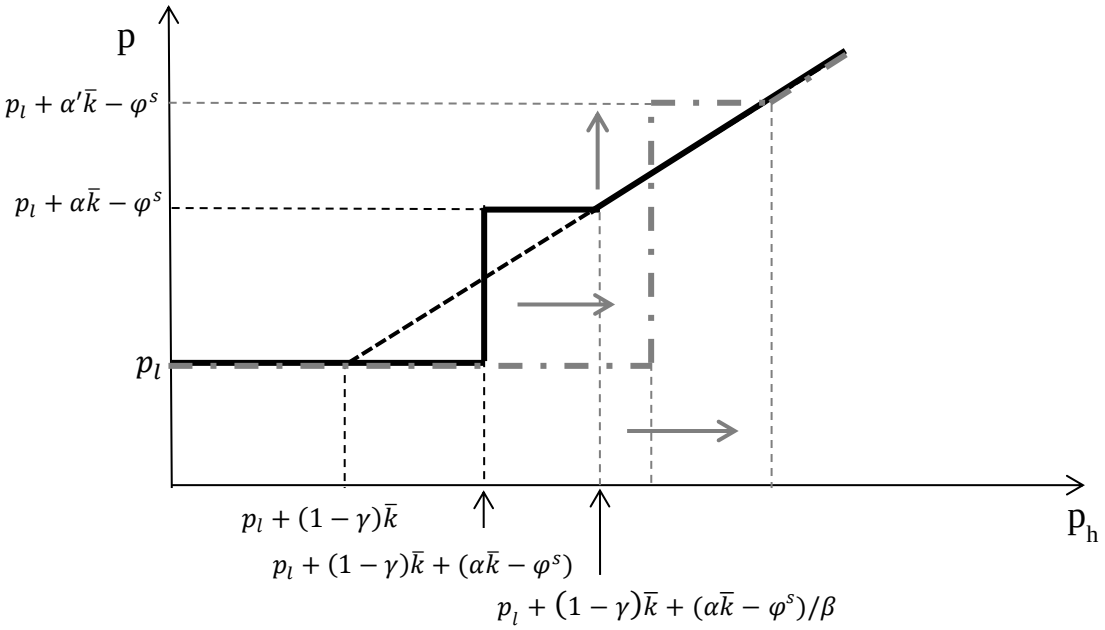


Figure 3: Impact of contract costs

a. Higher α



b. Higher γ