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Evidence from a Supply Shock to Kenyan Rose
Exports

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The Value of Relationships: Evidence from a Supply Shock to Kenyan Rose Exports

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Abstract

This paper provides evidence on the importance of reputation, intended as beliefs buyers hold about seller's reliability, in the context of the Kenyan rose export sector. A model of reputation and relational contracting is developed and tested. We show that 1) the value of the relationship increases with the age of the relationship; 2) during an exogenous negative supply shock sellers prioritize relationships consistently with the predictions of the model; and 3) reliability at the time of the shock positively correlates with future survival and relationship value. Models exclusively focussing on enforcement or insurance considerations cannot account for the evidence.

Keywords: Relational Contracts, Reputation, Exports.

JEL Codes: C73, D23, L14, O12.

1   Introduction

Imperfect contract enforcement is a pervasive feature of real-life commercial transactions. In the absence of formal contract enforcement trading parties rely on informal mechanisms to guarantee contractual performance (see, e.g., Johnson, McMillan and Woodruff (2002), Greif (2005), Fafchamps (2006)). Among those mechanisms, long-term relationships based on trust or reputation are perhaps the most widely studied and have received substantial theoretical attention. The theoretical literature has developed a variety of models that capture salient features of real-life relationships, e.g., enforcement problems (see, e.g., MacLeod and Malcomsom (1989), Baker, Gibbons, and Murphy (1994, 2002), Levin (2003)), insurance considerations (see, e.g., Thomas and Worrall (1988)), or uncertainty over parties commitment to the relationship (see, e.g., Ghosh and Ray (1996), Watson (1999), Halac (2012)). While these different models share the common insight that future rents are necessary to deter short-term opportunism, they also differ in important respects. Empirical evidence on informal relationships between firms, therefore, has the potential to identify which frictions are most salient in a particular context. In turn, such knowledge can be beneficial for policy, particularly in a development context. Empirical progress in the area, however, has been limited by the paucity of data on transactions between firms in environments with limited or no formal contract enforcement and challenges in measuring future rents and beliefs.

This paper provides evidence on the importance of reputation, intended as beliefs buyers hold about seller's reliability, in the context of the Kenyan rose export sector. A survey we conducted among exporters in Kenya reveals that relationships with foreign buyers are not governed by written contracts enforceable in courts. The perishable nature of roses makes it impractical to write and enforce contracts on supplier's reliability. Upon receiving the roses, the buyer could refuse payment and claim that the roses did not arrive in the appropriate condition while the seller could always claim otherwise. The resulting contractual imperfections, exacerbated by the international nature of the transaction, imply that firms rely on repeated transactions to assure contractual performance.

The analysis takes advantage of three features of this setting. First, unlike domestic sales, all export sales are administratively recorded by customs. We use six years of transaction-level data of all exports of roses from Kenya, including the names of domestic sellers and foreign buyers, as well as information on units traded, prices and date. Second, in the flower industry direct supply relationships coexist alongside

a well-functioning spot market, the Dutch Auctions.[1] If roses transacted in the relationships can be traded on the auctions, incentive compatibility considerations imply that the spot market price can be used to compute a lower bound to the future value of the relationship. Third, the reaction of the relationships to a negative exogenous supply shock induced by the post-election violence in January 2008 provides a unique opportunity to test the predictions of the reputation model and distinguish it from alternative models.[2]

We first present a model of the relationship between a rose producer (seller) and a foreign buyer (buyer). The set up of the model matches qualitative features of the market under consideration. A version of the model with no contract enforcement, developed along the lines of the relational contracts literature, is analyzed first. The incentive compatibility constraints of the model clarify how information on quantities transacted, prices in the relationships and auction prices, which are all observable in the data, can be used to compute lower bounds to the value of the relationship for the buyer and the seller. The model is then extended to consider uncertainty over the seller's type and to examine how reputational forces influence seller's reaction to the negative shock.

We then test the predictions of the model. Measures of the value of the future rents in the relationship for the buyers and the sellers are computed. The estimated relationships values correlate positively with the age and past amount of trade in the relationship. The results, which hold controlling for relationship (which include seller, buyer and cohort), time and selection effects, are inconsistent with the pure limited enforcement version of the model but support the version with reputational dynamics. At the time of the violence, exporters located in the region directly affected by the violence could not satisfy commitments with all buyers. The violence was a large shock and exporters had to chose which buyers to prioritize. We document an inverted-U shaped relationship between the age of the relationship with the buyers and the reliability in supply at the time of the violence. The demonstrated reliability at the time of the violence correlates with relationship's survival and future values, but less

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[1]The "Dutch", or "clock", auction is named after the flower auctions in the Netherlands. In a Dutch auction the auctioneer begins with a high asking price which is lowered until some participant is willing to accept, and pay, the auctioneer's price. This type of auction is convenient when it is important to auction goods quickly, since a sale never requires more than one bid.

[2]Following heavily contested presidential elections in Kenya at the end of December 2007, several, but not all, regions of the country plunged into intense episodes of ethnic violence. Flower exporters located in regions where conflict occurred suddenly found themselves lacking significant proportions of their labor force and suffered dramatic drop in exports. In Ksoll et al. (2013) we document that at the average firm in the conflict region 50% of the labor force was missing and exports volumes dropped by 38% at the peak of the violence.

so in older relationships. Both facts are predicted by the reputation model and are not consistent with other models, e.g., those that exclusively focus on enforcement or insurance considerations. We discuss the policy implications of these findings, particularly from the point of view of export promotion in developing countries, in the concluding section.

The findings and methodology of the paper contribute to the empirical literature on relationships between firms. McMillan and Woodruff (1999) and Banerjee and Duflo (2000) are closely related contributions that share with the current paper a developing country setting.[3] In an environment characterized by the absence of formal contract enforcement, McMillan and Woodruff (1999) find evidence consistent with long term informal relationships facilitating trade credit. Banerjee and Duflo (2000) infer the importance of reputation by showing that a firm's age strongly correlates with contractual forms in the Indian software industry. Both McMillan and Woodruff (1999) and Banerjee and Duflo (2000) rely on cross-sectional survey evidence and cannot control for unobserved firm, or client, heterogeneity. In contrast, we exploit an exogenous supply shock and rely on within relationship evidence to prove the existence, study the source, and quantify the importance of the future rents necessary to enforce the implicit contract. Antras and Foley (2012) and Macchiavello (2010) are two closely related studies in an export context. Antras and Foley (2012) study the use of prepayment to attenuate the risk of default by the importer. Using data from a U.S. based exporter of frozen and refrigerated food products they find that prepayment is more common at the beginning of a relationship and with importers located in countries with a weaker institutional environment. Macchiavello (2010), instead, focuses on the implications of learning about new suppliers in the context of Chilean wine exports. In the context of domestic markets, particularly for credit and agricultural products, Fafchamps (2000, 2004, 2006) has documented the importance of informal relationships

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[3]Banerjee and Munshi (2004), Andrabi et al. (2006), Munshi (2010) provide interesting studies of contractual relationships in a development context, but with rather different focus. For example, Munshi (2010) and Banerjee and Munshi (2004) provide evidence on the trade enhancing role of long term relationships based on community ties. Andrabi et al. (2006) provide evidence of how flexible specialization attenuates hold-up problems. Hjort (2012) studies how ethnic divisions impact productivity using data from a Kenyan flower plant. The literature on tied labour in rural contexts has studied the connections existing between spot markets and informal relationships (see, e.g., Bardhan (1983) and Mukherjee and Ray (1995)).

between firms in Africa and elsewhere.[4]

The rest of the paper is organized as follows. Section 2 describes the industry, its contractual practices, and the ethnic violence. Section 3 introduces the model and derives testable predictions. Section 4 presents the empirical results. Section 5 provides a discussion of the findings. Sections 6 offers some concluding remarks and policy implications. Proofs, additional results and further information on the data are relegated to an online Appendix.

2 Background

This section provides background information on the industry, its contractual practices and the ethnic violence. The section relies on information collected through a representative survey of the Kenya flower industry conducted by the authors through face-to-face interviews in the summer of 2008.

2.1 The Kenya Flower Industry

Over the last decade, Kenya has become one of the largest exporters of flowers in the world. The flower industry, one of the largest foreign-currency earners for the Kenyan economy, counts around one hundred established exporters located at various clusters in the country. Roses, the focus of this study, account for about 80% of exports of cut flowers from Kenya. Roses are a fragile and perishable commodity. To ensure the supply of high-quality roses to distant markets, coordination along the supply chain is crucial. Roses are hand-picked in the field, kept in cool storage rooms at a constant temperature for grading, then packed, transported to Nairobi's international airport in refrigerated trucks owned by firms, inspected and sent to overseas markets. The industry is labor intensive and employs mostly low educated women in rural areas. Workers receive training in harvesting, handling, grading, packing and acquire skills which are difficult to replace in the short-run. Because of both demand (e.g. particular dates such as Valentines day and Mothers day) and supply factors (it is

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[4]Alongside a larger literature that studies formal contracts between firms (see Lafontaine and Slade (2009) for a survey), some studies have focused on the relationship between informal enforcement mechanisms and formal contract choice (see, e.g., Corts and Singh (2004), Kalnins and Mayer (2004), Lyons (2002), Gil and Marion (2010)). With the exception of Gil and Marion (2010), these papers also rely on cross-sectional data and proxy the rents available in the relationship with product, firm, or market characteristics that might affect contractual outcomes in other ways.

costly to produce roses in Europe during winter), floriculture is a seasonal business. The business season begins in mid-August.

2.2 Contractual Practices

Roses are exported in two ways: they can be sold in the Netherlands at the Dutch auctions or can be sold to direct buyers located in the Netherlands or elsewhere (including Western Europe, Russia, Unites States, Japan and the Middle East). The two marketing channels share the same logistic operations associated with exports, but differ with respect to their contractual structure. The Dutch auctions are close to the idealized Walrasian market described in textbooks. There are no contractual obligations to deliver particular volumes or qualities of flowers at any particular date. Upon arrival in the Netherlands, a clearing agent transports the flowers to the auctions where they are inspected, graded and finally put on the auction clock. Buyers bid for the roses accordingly to the protocol of a standard descending price Dutch auction. The corresponding payment is immediately transferred from the buyer's account to the auction houses and then to the exporter, after deduction of a commission for the auctions and the clearing agent. Apart from consolidating demand and supply of roses in the market, the Dutch Auctions act as a platform that provides contract enforcement between buyers and sellers located in different countries: they certify the quality of the roses sold and enforce payments from buyers to sellers. It is common practice in the industry to keep open accounts at the auctions houses even for those firms that sell their production almost exclusively through direct relationships. The costs of maintaining an account are small, while the option value can be substantial.

Formal contract enforcement, in contrast, is missing in the direct relationships between the flower exporter and the foreign buyer, typically a wholesaler. The export nature of the transaction and the high perishability of roses makes it impossible to write and enforce contracts on supplier's reliability. Upon receiving the roses, the buyer could refuse payment and claim that the roses sent were not of the appropriate variety and/or did not arrive in good condition. The seller could always claim otherwise. Accordingly, exporters do not write complete contracts with foreign buyers.[5]

Exporters and foreign buyers negotiate a marketing plan at the beginning of the

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[5] Among the surveyed 74 producers, only 32 had a written contract with their main buyer. When a contract is written, it is highly incomplete. Among the 32 firms with a written contract, less than a third had any written provision on the volumes, quality, and schedule at which flowers have to be delivered. Written contracts often include clauses for automatic renewal. Some firms report to have had a written contract only in the first year of their relationship with a particular buyer.

season. With respect to volumes, the parties typically agree on some minimum volume of orders year around to guarantee the seller a certain level of sales. Parties might, however, agree to allow for a relatively large percentage (e.g., 20%) of orders to be managed "ad hoc". With respect to prices, most firms negotiate constant prices with their main buyer throughout the year but some have prices changing twice a year, possibly through a catalogue or price list. Prices are not indexed on quality nor on prices prevailing at the Dutch auctions.

Contracts do not specify exclusivity clauses. In particular, contracts do not require firms to sell all, or even a particular share, of their production to a buyer or to not sell on the spot market. In principle, it would seem possible to write enforceable contracts that prevent firms from side-selling roses at the auctions. The ability to sell on the spot market, however, gives producers flexibility to sell excess production as well as some protection against buyers defaults and/or opportunism. Such contractual provisions might not be desirable.

This paper takes the existence of direct relationships as given and does not explain why relationships coexist along-side a spot-market.[6] Beside lower freight and time costs, a well-functioning relationship provide buyers and sellers with stability. Buyers commitment to purchase pre-specified quantities of roses throughout the season allows sellers to better plan production. Buyers value reliability in supply of roses often sourced from different regions to be combined into bouquets. Parties trade-off these benefits with the costs of managing and nurturing direct relationships in an environment lacking contract enforcement.

2.3 Electoral Violence

An intense episode of ethnic violence affected several parts of Kenya following contested presidential elections at the end of December 2007. The ethnic violence had two major spikes lasting for a few days at the beginning and at the end of January 2008. The regions in which rose producers are clustered were not all equally affected. Only firms located in the Rift Valley and in the Western Provinces were directly affected by the violence (see Figure 1).[7] The main consequence of the violence was that firms located in the regions affected by the violence found themselves lacking significant numbers

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[6]Similar two-tier market structures have been documented in several markets in developing countries (see Fafchamps (2006) for a review). The coexistence of direct relationships alongside spot markets is also observed in several other contexts, such as perishable agricultural commodities, advertising and diamonds. We are grateful to Jon Levin for pointing this to us.

[7]The classification of affected and unaffected regions is strongly supported by the survey conducted in the summer following the crisis and is not controversial. See Appendix for details.

of their workers. Among the 74 firms surveyed, 42 were located in regions that were directly affected by the violence. Table A1 shows that while firms located in regions not affected by the violence did not report any significant absence among workers (1%, on average), firms located in regions affected by the violence reported an average of 50% of their labor force missing during the period of the violence. Furthermore, firms were unable to completely replace workers. On average, firms in areas affected by the violence replaced around 5% of their missing workers with more than half of the firms replacing none. Many firms paid higher over time wages to remaining workers in order to minimize disruption in production.

With many workers missing, firms suffered large reductions in total output. Figure 2 plots deseasonalized export volumes around the period of the violence for the two separate groups of firms. The Figure illustrates that the outbreak of the violence was a large and negative shock to the quantity of roses exported by the firms in the conflict locations.

In the survey, we asked several questions about whether the violence had been anticipated or not. Not a single firm among the 74 producers interviewed reported to have anticipated the shock (and to have adjusted production or sales plans accordingly): the violence has been a large, unanticipated and short-run negative shock to the production function of firms.

2.4 Relationships Characteristics

Using the customs data, we build a dataset of relationships. Overall, we focus on the period August 2004 to August 2009, i.e., five entire seasons. The violence happened in January 2008, i.e., in the middle of the fourth season in the data, which runs from August 2007 to August 2008.

We define the baseline sample of relationships as those links between an exporter and a foreign buyer that were active in the period immediately before the violence. A relationship is active if the two parties transacted at least twenty times in the twenty weeks before the eruption of the violence. The data show clear spikes in the distribution of shipments across relationships at one, two, three, four and six shipments per week in the reference period. The cutoff is chosen to distinguish between relationships versus sporadic orders. Results are robust to alternative cutoffs.

In total, this gives 189 relationships in the baseline sample. Panel A in Table 1 reports summary statistics for the relationships in the baseline sample. The average relationship had 60 shipments in the 20 weeks preceding the violence. The average

age of the relationship in the sample, measured as the number of days from the first shipment observed in the data, is 860 days, i.e., two years and a half. Immediately before the violence, contracting parties in the average relationship had transacted with each other 298 times.[8]

Exporters specialize in one marketing channel alone. The majority of exporters either sells more than 90% of produce through direct relationships, or through the auctions. As a result, among the one hundred established exporters, only fifty six have at least one direct relationship with a foreign buyer in our baseline sample. On average, therefore, exporters in the sample have three direct relationships (see Panel B in Table 1). Similarly, there are seventy one buyers with at least a relationship in our baseline. The average buyer, therefore, has about two and a half Kenyan suppliers.

Figures 3 and 4 document stylized facts that guide the formulation of the model. Figure 3 shows that prices at the auctions are highly predictable. A regression of weekly prices at the auction on week and season dummies explains 76% of the variation in prices in the three seasons preceding the violence period. Figure 4 shows that prices in relationships are more stable than prices at the auctions.

3 Theory

This section introduces a work horse model of the relationship between a flower producer (seller) and a foreign buyer (buyer). The benchmark case with perfectly enforceable contracts is introduced first. The assumption of enforceable contracts is then relaxed. The model predicts stationary dynamics which are inconsistent with the empirical evidence. An extension with uncertainty about seller's reliability is next introduced. The extension matches the empirical evidence and is used to derive further predictions on how sellers react to the violence. The section concludes with a summary of testable implications.[9]

3.1 Set Up and First Best

Time is an infinite sequence of periods t, $t = 0, 1, ...$ The buyer and the seller have an infinite horizon and share a common discount factor $\delta < 1$. Periods alternate between

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[8]These averages are left-censored, since they are computed from August 2004 onward. Since our records begin in April 2004, we are able to distinguish relationships that were new in August 2004 from relationships that were active before. Among the 189 relationships in the baseline sample, 44% are classified as censored, i.e., were already active before August 2004. This confirms the findings of the survey, in which several respondents reported to have had relationships longer than a decade.

[9]Section 5 discusses alternative modeling assumptions. All proofs are in the online Appendix.

high seasons $t = 0, 2, ...$ and low seasons $t = 1, 3...$. Low season variables and parameters are denoted with a lower bar (e.g., $\underline{x}$). Similarly, high season variables are denoted with a upper bar (e.g., $\overline{x}$).

In each period, the seller can produce q units of roses at cost $c(q) = \frac{cq^2}{2}$. The buyer's payoffs from sourcing q units of roses from this particular seller is $r(q) = \frac{v}{2}q - \frac{v}{2}|q - q^*|$. The kink at q^* captures the buyer's desire for reliability and, for simplicity, we assume $\underline{q}^* = \overline{q}^* = q^*$.

There is also a market for roses where buyers and sellers can trade roses. The price at which sellers can sell, p_t^m, oscillates between $p_t^m = \overline{p}$ in high seasons and $p_t^m = \underline{p} < \overline{p}$ in low seasons. Let q^m be the quantity of roses sold on the market and π^m be the seller's optimal profits when she does not sell roses to the buyer. The buyer can purchase roses in the market at price $p_t^b = p_t^m + \kappa$, with $\kappa > 0$ capturing additional transport and intermediation cost.

Contracts are negotiated at the beginning of high seasons. Parties agree on constant prices for the high season and the subsequent low season. The buyer has the ex-ante bargaining power and offers contracts at the beginning of the high season. With constant prices, a contract in period t, then, is given by $\mathcal{C}_t = \left\{ \overline{q}_t, \underline{q}_{t+1}, w_t \right\}$. A contract specifies quantities to be delivered in the high season t when the contract is negotiated, $\overline{q}_t$, in the following low season, $\underline{q}_{t+1}$, and a unit price to be paid upon delivery of roses, w_t, which is constant across seasons.[10]

We omit the period subscript t when this doesn't create confusion and assume:

Assumption 1: $\kappa > v > \overline{p} > cq^* > \underline{p} = 0$.

With perfectly enforceable contracts the buyer offers a contract $\mathcal{C} = \left\{ \overline{q}, \underline{q}, w \right\}$ to maximize her profits across two subsequent high and low season, i.e.,

$$\pi(\overline{q}, \underline{q}, w) = r(\overline{q}) - w\overline{q} + \delta\left(r(\underline{q}) - w\underline{q}\right) \tag{1}$$

subject to the seller participation constraint

$$w\overline{q} + \overline{p}\overline{q}^m - c\left(\overline{q} + \overline{q}^m\right) + \delta\left(w\underline{q} + \underline{p}\underline{q}^m - c(\underline{q} + \underline{q}^m)\right) \geq \overline{\pi}^m + \delta\underline{\pi}^m. \tag{2}$$

The seller's participation constraint takes into account her sales on the spot market: for a given contract with the buyer, the seller sets $\overline{q}^m$ and $\underline{q}^m$ to maximize her profits.

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[10] The buyer cannot write contracts which are contingent on the seller's sales on the market.

Proposition 1: *The buyer offers* $C^* = \left\{ q^*, q^*, \frac{p + \delta(c(q^*)/q^*)}{1+\delta} \right\}$. *The seller accepts and sets* $\overline{q}^m = \frac{\overline{p}}{c} - q^*$ *and* $\underline{q}^m = 0$.

The optimal contract displays i) lower seasonality in direct sales than in sales to the spot market, and ii) price compression, i.e., $\underline{p} < w^* < \overline{p}$. Both features are observed in the data. In a relationship with perfect contract enforcement the optimal contract is repeated forever.

3.2 Limited Enforcement

As revealed by interviews in the field, contracts enforcing the delivery of roses are not available. This, potentially, generates two problems. First, the buyer might refuse to pay the seller once the roses have been delivered. Second, given price compression, the seller might fail to deliver the quantity of roses agreed with the buyer. Buyers and sellers use relational contracts to overcome lack of enforcement.

A relational contract is a plan $\mathcal{C}^R = \left\{ \overline{q}_t, \underline{q}_{t+1}, w_t \right\}_{t=0,2,\dots}^{\infty}$ that specifies quantities to be delivered, $\overline{q}_t$ and $\underline{q}_{t+1}$, and unit prices, w_t, for all future high and low seasons. Parties agree to break-up the relationship and obtain their outside options forever following any deviation. The outside option of the seller is to sell on the market forever and the outside option of the buyer is normalized to zero. The buyer offers the relational contract to maximize the discounted value of future profits

$$\overline{U}_0^R = \sum_{t=0,2\dots}^{\infty} \delta^t \left(\left(r\left(\overline{q}_t\right) - w_t \overline{q}_t \right) + \delta \left(r\left(\underline{q}_{t+1}\right) - w_t \underline{q}_{t+1} \right) \right) \tag{3}$$

subject to incentive compatibility constraints and the seller's participation constraint.

Denote with U_t^R and V_t^R the net present value of the payoffs from the relationship at time t for the buyer and the seller respectively. Let U_t^O and V_t^O denote the net present value of the outside options. The buyer must prefer to pay the seller rather than terminating the relationship, i.e.,

$$\delta \left(\underline{U}_{t+1}^R - \underline{U}_{t+1}^O \right) \geq w_t \times \overline{q}_t \text{ for all } t = 0, 2, \dots \tag{4}$$

and

$$\delta \left(\overline{U}_{t+2}^R - \overline{U}_{t+2}^O \right) \geq w_t \times \underline{q}_{t+1} \text{ for all } t = 0, 2, \dots \tag{5}$$

Similarly, the seller must prefer to produce and deliver the roses to the buyer rather

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than optimally selling on the spot market, i.e.,

$$\delta \left(\underline{V}^R_{t+1} - \underline{V}^O_{t+1} \right) \geq \left(\bar{p} - w_t \right) \bar{q}_t \text{ for all for all } t = 0, 2, ... \tag{6}$$

and

$$\delta \left(\overline{V}^R_{t+2} - \overline{V}^O_{t+2} \right) \geq - \left(w_t \times \underline{q}_{t+1} \right) + c(\underline{q}_{t+1}) \text{ for all } t = 0, 2, ... \tag{7}$$

The relational contract $\mathcal{C}^R$ is chosen to maximize (3) subject to (4), (5), (6) and (7).[11]

Proposition 2: *The optimal relational contract is such that* $\bar{q}^R_t = \bar{q}^R$, $\underline{q}^R_{t+1} = \underline{q}^R$ *and* $w^R_t = w^R < p$ *for all* $t = 0, 2, ...$

The optimal relational contract is stationary. This is a well-known result (see, e.g., Abreu (1988) and Levin (2003)). The optimal relational contract also displays price compression, i.e., $w^R < p$. Price compression implies that (7) is never binding while constraint (6) always is. Constraint (4) can, therefore, be rewritten as

$$\delta \left(\underline{S}^R \right) \geq \bar{p} \times \bar{q}^R \tag{8}$$

where $\underline{S}^R = \underline{U}^R + \underline{V}^R - \underline{V}^O$ is the value of the relationship. Lack of enforcement implies that the amount of roses traded is constrained by the future value of the relationship. The incentive constraints (4) and (6), combined into (8) illustrate how data on auction prices $\bar{p}$, relationship's volumes $\bar{q}^R$ and prices w^R can be used to estimate lower bounds to the value of the relationship to the buyer, the seller and as a whole. The quantity $\widehat{S} = \overline{pq}$ provides a lower bound estimate of the value of the relationship. $\widehat{S}$ is the sum of lower bound estimates of the value of the relationship for the seller $\widehat{V} = (\bar{p} - \bar{w}) \bar{q}$ and for the buyer $\widehat{U} = \overline{wq}$. The estimates $\widehat{S}$, $\widehat{V}$ and $\widehat{U}$ are all directly observed in the data. Together with the quantity of roses traded when incentive constraints are more likely to bind, $\widehat{Q} = \bar{q}^R$, these are the main outcomes of interest in the empirical analysis. Future rents $\delta \left(\underline{S}^R \right)$ do not depend on current auction prices. A binding (8), therefore, implies an elasticity of $\bar{q}^R$ with respect to $\bar{p}$ equal to minus one.

3.3 Seller's Hidden Types

Interviews in the field suggest that concerns over a seller's reputation for reliability are of paramount importance among buyers and sellers. First, delays and irregularity in

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[11]Constraint (6) and the assumption that the seller's outside option is to sell forever on the market imply that the seller's participation constraint is satisfied.

rose deliveries are costly to the buyer. Second, the sector has expanded rapidly and many sellers lack a previous record of success in export markets.[12]

We follow the literature and model reputation introducing uncertainty over types.[13] There are two types of sellers: reliable and unreliable. A reliable seller has a discount factor equal to δ. An unreliable seller, instead, receives shocks which makes her maximize her instantaneous payoff. The probability of the shock, λ, is known to both parties and is constant over time. At the beginning of the relationship, the buyer believes that the seller is reliable with probability θ_0.

Contract terms, trade outcomes and relationship's length are not observed by other market participants. The buyer's outside option is the value of returning to the market to be matched with a new seller of uncertain type. We focus on pooling contracts and equilibria in which the buyer terminates the relationship if the seller is revealed to be unreliable.

The buyer faces a choice between supply assurance and learning. The buyer can offer an initial price $w_0^R = \bar{p}$ and ensure delivery in all periods regardless of the seller's type. A high price, however, is expensive and forces the buyer to trade relatively low quantities of roses. Alternatively, the buyer can offer an initial price $w_0^R < \bar{p}$. A lower price relaxes the buyer's incentive constraint but exposes the buyer to the risk of non-delivery. As before, the buyer pays rents to the seller in the low season. Delivery failure, therefore, doesn't occur in the low season. However, a delivery failure still occurs with probability $(1 - \theta_0) \lambda$ in the first high season. Delivery in the high season (but not in the low season), therefore, conveys positive information about the seller's type. After τ periods of successful delivery the buyer holds beliefs $\theta(\tau)$ given by

$$\theta(\tau) = \frac{\theta_0}{\theta_0 + (1 - \theta_0)(1 - \lambda)^{\lfloor \tau/2 \rfloor}}, \tag{9}$$

with $\theta'(\tau) > 0$ and $\theta''(\tau) < 0$ (for sufficiently large τ). Conditional on delivery in the high season, the relationship is continued with positively updated beliefs about the seller's type.

Proposition 3: *Suppose (8) is binding at the beginning of the relationship. There exists $\bar{\lambda}$ such that for $\lambda < \bar{\lambda}$ the buyer experiments, i.e.: i) $w_t^R < \bar{p}$ for all t and ii)*

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[12]Buyers must, of course, also develop a reputation for respecting contracts. Relative to suppliers, which are all clustered in a handful of locations, buyers are scattered in several destination countries. Suppliers, therefore, can share information about cheating buyers more easily than buyers can share information about cheating suppliers. As a result, uncertainty over a seller's reliability might be more relevant than uncertainty over buyer's reliability.

[13]See, e.g., Mailath and Samuelson (2006) for a survey. The formulation of types follows Araujo and Ornelas (2010) and Antras and Foley (2012).

$\overline{q}_{t+2}^R \geq \overline{q}_t^R$ *with a strict inequality for at least some initial t.*

If λ is sufficiently low, the buyer prefers to risk non-delivery and experiment. Since surplus increases in beliefs, $\theta(\tau)$, the optimal relational contract is non-stationary and the quantity sourced in the high season, alongside with relationship's value, increases with relationships' age.

3.4 The Violence

The violence hits the relationship in the middle of the high season (i.e., before the unreliable type receives the shock to her discount rate). Consider a relationship of age τ. The seller is supposed to deliver quantity $\overline{q}_\tau^R$ at price w_τ^R. Because of the violence, the seller can only deliver a share $\mathcal{R} \in [0, 1]$ of $\overline{q}_\tau^R$. The share $\mathcal{R}$ depends on unobservable effort $e \leq \overline{e}$ and on other random factors. The cost of effort is $\Gamma(e)$.

Denote by $\widetilde{e}_\tau^R$ and $\widetilde{e}_\tau^U$ the buyer's beliefs about the effort exerted by the reliable and unreliable types respectively. In the equilibrium: 1) given buyer's beliefs, a reliable seller sets e_τ^R and an unreliable seller sets e_τ^U to maximize expected payoff, and 2) buyer's beliefs are correct. As before, contracts, including adaptations of the relational contract to information revealed at the time of the violence, are negotiated at the beginning of the following high season.

We make the following assumptions:

Assumption 3:

1) $\Gamma'(\cdot) \geq 0$, $\Gamma''(\cdot) > 0$, $\Gamma'(0) = 0$ *and* $\lim_{e \to \overline{e}} \Gamma'(e) = \infty$.

2) $\mathcal{R}$ *is drawn from a Beta distribution* $f(\mathcal{R}|e) = \frac{\mathcal{R}^{ae-1}(1-\mathcal{R})^{a(\overline{e}-e)-1}}{B(e,\overline{e},a)}$ *where a and $\overline{e}$ are positive constants such that* $e \leq \overline{e}$ *and* $B(\cdot)$ *the appropriate Beta function.*

The beta distribution is widely used to model the random behavior of percentages. In our context, the beta distribution captures the intuition that higher effort makes high $\mathcal{R}$ more likely while imposing sufficient regularity to derive comparative statics results. In particular, the Beta distribution implies i) $\mathbf{E}[\mathcal{R}|e] = \frac{e}{\overline{e}}$, i.e., expected reliability is linear in effort, ii) monotone likelihood ratio, i.e., relatively higher $\mathcal{R}$ is a signal of relatively higher effort, iii) higher effort makes all states above a certain threshold more likely and all states below less likely.

Proposition 4: *Consider a relationship in which* $w_\tau^R < \overline{p}$. *In a separating equilibrium in which* $e_\tau^R > e_\tau^U$, *there exists a threshold* $\widetilde{\mathcal{R}}_\tau > 0$ *such that if* $\mathcal{R} < \widetilde{\mathcal{R}}_\tau$ *the seller*

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doesn't deliver any rose to the buyer and the relationship is terminated. Moreover, if
$\bar{q}_\tau^R$ *and* $\widehat{V}(\tau) = (\bar{p} - w_\tau)\bar{q}_\tau^R$ *increase in* τ, *the (expected) share of roses transacted at the time of the violence is increasing in relationship's age* τ *if* $\tau \leq \tilde{\tau}$.

In a separating equilibrium in which $e_\tau^R > e_\tau^U$, a high $\mathcal{R}$ conveys positive information about the seller's type. A sufficiently low $\mathcal{R}$ leads to beliefs that are too pessimistic to sustain the relational contract. Anticipating this, the seller sells the available roses on the spot market and the relationship ends. The last part of the proposition follows from the trade-off between the higher incentives provided by the desire to protect a higher relationship's value $\widehat{V}_\tau$ against the standard diminished reputational incentives implied by sufficiently optimistic prior beliefs θ_τ.

Conditional on the survival of the relationship, i.e., $\mathcal{R} \geq \tilde{\mathcal{R}}_\tau$, the relational contract is renegotiated at the beginning of the following high season. The new relational contract is negotiated based on updated beliefs that depend on beliefs prior to the violence, $\theta(\tau)$, equilibrium effort levels, e_τ^R and e_τ^U, and observed reliability $\mathcal{R}$. These updated beliefs, $\tilde{\theta}_\tau\left(\mathcal{R}, \tilde{e}_\tau^R, \tilde{e}_\tau^U\right)$, induce relationship value $S(\tilde{\theta}_\tau)$ in the high season following the violence. The relationship value $S(\tilde{\theta}_\tau)$ is (weakly) increasing in $\tilde{\theta}_\tau$. Denoting $\rho_\tau(\mathcal{R}) = f(\mathcal{R}|\tilde{e}_\tau^R)/f(\mathcal{R}|\tilde{e}_\tau^U)$, the updated beliefs are given by

$$\tilde{\theta}_\tau\left(\mathcal{R}, \tilde{e}_\tau^R, \tilde{e}_\tau^U\right) = \frac{\theta_\tau \rho_\tau(\mathcal{R})}{\theta_\tau \rho_\tau(\mathcal{R}) + (1 - \theta_\tau)}. \tag{10}$$

The effect of reliability $\mathcal{R}$ on updated beliefs and, therefore, on relationship's value $S(\tilde{\theta}_\tau)$, is positive for all relationship's age τ and becomes negligible when prior beliefs θ_τ are sufficiently optimistic.

3.5 Summary

The model provides the following three testable predictions:

Test 1: *Consider outcomes* $\hat{y} \in \{\hat{Q}, \hat{S}, \hat{U}, \hat{V}\}$. *The pure limited enforcement model predicts no correlation between the age of the relationship,* τ, *and* $\hat{y}$. *The reputation model predicts a positive correlation between* $\hat{y}$ *and an increasing and concave function of* τ.

Test 2: *A binding aggregate incentive constraint (8) implies* $\partial \log\left(\hat{Q}\right)/\partial \log(\bar{p}) = -1$.

Test 3: *The reputation model further predicts that: 1] Reliability at the time of the violence, $\widehat{\mathcal{R}}(\tau)$, is an (initially) increasing and (possibly) inverted-U shape function of an increasing and concave function of τ; 2] Conditional on age τ and survival, reliability at the time of the violence $\widehat{\mathcal{R}}(\tau)$ positively correlates with future outcomes $\widehat{y} \in \{\widehat{Q}, \widehat{S}, \widehat{U}, \widehat{V}\}$ in the relationship. The correlation is weaker for older relationships.*

4   Empirical Results

4.1   Incentive Constraints and the Value of Relationships

The incentive compatibility constraints (4) and (6), aggregated into (8), provide lower bounds to the value of the relationship for the buyer, the seller and the relationship as a whole. We denote these lower bounds as U, V and S respectively. From an empirical point of view, the appeal of the incentive constraints is that $\overline{q}_t^R, \overline{p}$ and w_t^R are directly observable in the data. The computation of the lower bounds U, V and S, therefore, does not rely on information on the cost structure of the firm, nor on expectations of future trade between the parties, which are typically unobservable and/or difficult to estimate.

Recall that the model implies that only the maximum temptation to deviate has to be considered to obtain an estimate of a lower bound to the value of the relationship. For each relationship and season, therefore, we compute the lower bounds focusing on the time in which the value of the roses on the market, $\overline{q}_t^R \times \overline{p}$, is highest. In bringing the constraint to the data, we need to choose a temptation window, i.e., the length of the period of time during which the temptation is computed. For simplicity, we focus on temptation windows of a week.[14] Denote calendar weeks with ω and let $q_{i,t\omega}^R$ be the quantity traded in relationship i and $p_{i,t\omega}$ be auction prices in week ω of season t. Using unit weight of roses transacted in relationship i, it is possible to use auction prices for large and small roses to index $p_{i,t\omega}$ by relationship i. For each relationship i in season t, define week ω_{it}^* as the one with the largest aggregate temptation to deviate, i.e.,

$$\omega_{it}^* = \arg\max_{\omega} \left\{ q_{i,t\omega}^R \times p_{t\omega} \right\}. \tag{11}$$

The lower bounds to the value of relationship i in season t, denoted by $\widehat{S}_{it}, \widehat{U}_{it}$ and

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[14]Results are robust to considering longer temptation windows.

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$\widehat{V}_{it}$, are given then by

$$
\begin{aligned}
\widehat{S}_{it} &= q^R_{i,t\omega^*_{it}} \times p_{t\omega^*_{it}}, & (12) \\
\widehat{U}_{it} &= q^R_{i,t\omega^*_{it}} \times w_{i,t\omega^*_{it}}, \text{ and} \\
\widehat{V}_{it} &= q^R_{i,t\omega^*_{it}} \times \left(p_{t\omega^*_{it}} - w_{i,t\omega^*_{it}}\right),
\end{aligned}
$$

where $w_{i,t\omega}$ denotes the price paid in relationship i in week ω of season t. Together with $\widehat{Q}_{it} = q^R_{i,t\omega^*_{it}}$, $\widehat{S}_{it}$, $\widehat{U}_{it}$ and $\widehat{V}_{it}$ are the main outcomes in the empirical specifications.

The variation in the estimated values across time and relationships, therefore, comes from different sources: i) the timing of the highest aggregate temptation, ω^*_{it}; ii) quantities transacted during the relevant window, $q^R_{i,t\omega^*_{it}}$; iii) prices at the auction during the relevant window $p_{t\omega^*_{it}}$; and iv) prices in the relationships during the relevant window, $w_{i,t\omega^*_{it}}$. Within seasons, prices in relationships are quite stable, i.e., $w_{i,t\omega} \simeq w_{i,t}$. Conditional on unit weight of roses, prices at the auctions do not vary across relationships.

Figure 5 reports the distribution of weeks ω^*_{it} in the sample used in Columns 1,3,5 and 7 of Table 2. The week of Valentine's day is ω^*_{it} in about 40% of relationships. Other prominent weeks are around Mother's days, which typically fall in March (e.g., UK, Russia, Japan) or later in May (e.g., other European countries and U.S.) depending on the country. Since prices at the auctions are predictable (see Figure 3), the estimated values are not driven by unexpectedly high prices.

For the 189 relationships in the baseline sample, Panel C in Table 1 shows that the aggregate value of the relationship $\widehat{S}$ in the season that preceded the violence was 578% of the average weekly revenues in the average relationship. The values for the buyer $\widehat{U}$ and seller $\widehat{V}$ respectively are 387% and 191% of average weekly revenues.[15]

4.2 Test 1: Relationship's Outcomes and Age

Figure 6 plots the distribution of the estimated $\widehat{S}_{it}$ (in logs) for three different samples of relationships in the season before the violence: relationships in the baseline sample that were active at the Valentine day peak of the season prior to the violence; relationships in the baseline sample that were not active during the Valentine day peak of the

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[15] Under free-entry, initial sunk investments dissipate the ex-post rents generated by the relationship (see, e.g., Shapiro (1983)). The estimates yield a lower bound to the fixed costs of starting a relationship and can be compared to structural estimates of fixed costs of exporting. Das et al. (2007) report that in the Colombian chemicals industry, fixed costs of exports in each year represent 1% of the export revenues of the firm. The corresponding figure for the initial sunk costs is between 18 to 42%. Our estimates are a conservative lower bound since we focus on a temptation window of one week.

season prior to the violence; and relationships that were active during the Valentine day peak of the season prior to the violence but that are not in the baseline sample since they did not survive until the violence period. Figure 6 shows two patterns: i) relationships that have survived have higher values than relationships that did not; ii) young relationships had lower values than established relationships.

The latter observation, however, cannot be interpreted as evidence that the value of a relationship increases with age. Mechanically, the estimated value of a relationship that is too young to have gone through a seasonal peak is low. Table 2 presents correlation patterns between relationship age and the four outcomes of interest $\widehat{Q}_{it}, \widehat{S}_{it}, \widehat{U}_{it}$ and $\widehat{V}_{it}$. Equation (9) in the theory section shows that beliefs about the seller's type are an increasing and (eventually) concave function of the past number of shipments in which prices at the auctions were higher than prices in the relationship. Accordingly, we measure age of the relationship as the log of the number of past shipments during which prices at the auctions were higher than prices in the relationship and denote this variable as $\log(NT_{it})$. For all outcomes $y \in \{Q, S, U, V\}$ odd numbered columns in Table 2 report results that exploit cross-sectional variation in the season before the violence, i.e.,

$$\log\left(\widehat{y}_{fb}\right) = \mu_f + \eta_b + \beta \log\left(NT_{fb}\right) + \varepsilon_{fb}, \tag{13}$$

where μ_f and η_b are exporter and buyer fixed effects respectively and ε_{fb} is an error term. The regression is estimated in the sample of relationships that were active in the season before the violence.

From a cross-section it is not possible to disentangle age and cohort effects. The inclusion of buyer and seller fixed effects controls for cohort effects at the contractual-party level, but does not control for relationship cohort effects, i.e., the fact that more valuable relationships might have started earlier. Even numbered columns in Table 2, therefore, present results from an alternative specification that exploits the time variation across seasons. This allows to include relationship fixed effects that control for time-invariant relationship characteristics, including cohort effects. Normally, even with panel data it is not possible to separately identify age, cohort and season effects since, given a cohort, age and seasons would be collinear. However, our measure of the age of the relationship, $\log\left(NT_{fb}\right)$, is a non-linear function of calendar time and, therefore, allows us to include season fixed effects, i.e.,

$$\log\left(\widehat{y}_{fbt}\right) = \mu_{fb} + \phi_t + \beta \log\left(NT_{fbt}\right) + \varepsilon_{fbt}, \tag{14}$$

where μ_{fb} are relationship fixed effects, ϕ_t season fixed effects and ε_{fbt} is an error term. The selection effect documented in Figure 6 could induce a spurious positive correlation. The specification is therefore estimated on a balanced sample of relationships that where active in all three seasons prior to the violence.

Results in Table 2 indicate a strong, positive, correlation between relationship's age and outcomes. Regardless of whether cross-sectional or time variation are used, the age of the relationship positively correlates with i) volumes traded at the time of the highest temptation $\widehat{Q}_{it}$ (columns 1 and 2), ii) the aggregate value of the relationship $\widehat{S}_{it}$ (columns 3 and 4), iii) the value of the relationship for the buyer $\widehat{U}_{it}$ (columns 5 and 6) and iv) for the seller $\widehat{V}_{it}$ (columns 7 and 8).[16]

4.3   Test 2: Binding Incentive Constraint

The results in Table 2 reject the predictions of the pure enforcement model. The results are potentially consistent with the reputation model. The reputation model implies the dynamics found in the data when the incentive constraint (8) is binding. Table 3 provides evidence suggesting that constraint (8) is binding in many relationships.

The logic for testing whether (8) is binding is as follows. In the model, the future value of the relationship, $\widehat{S}_{it}$, does not depend on current auction prices. If (8) is binding, therefore, a small increase in prices at the auctions should lead to a corresponding decrease in the quantity $\widehat{Q}_{it}$. Table 3 reports correlations between prices at the auctions and relationship's value $\widehat{S}_{it}$ (column 1) and quantities $\widehat{Q}_{it}$ (column 2) in the week of the highest temptation to deviate. In practice, relationship's value might depend on expectations of future prices at the auctions. Figure 3 shows that seasonal variation in auction prices is highly predictable. Controlling for season and seasonality fixed effects, therefore, should account for parties expectations about future auction prices. Seasonality fixed effects are accounted for by including dummies for the week of the season during which the highest temptation to deviate occurs. The combination of season and seasonality effects implies that variation in prices at the auctions captures small unanticipated variation around the expected prices.

Table 3 shows that higher prices at the auctions lead to a proportional reduction in

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[16] The results in Table 2 are extremely robust to a variety of different assumptions and specifications. In particular: 1) outcomes $\widehat{Q}_{it}$, $\widehat{S}_{it}$, $\widehat{U}_{it}$ and $\widehat{V}_{it}$ and age can be measured in levels, instead of logs; 2) age can also be measured as the number of previous shipments, or the calendar time from the first shipment in the relationship; 3) relationships for which estimated $\widehat{V}_{it}$ are negative can also be included (assigning them value of zero); 4) relationship controls, including week of maximum temptation to deviate ω_{fb}^* dummies, can be included; and 5) we do not find evidence of any difference in results between relationships in the conflict and no-conflict regions. Results are available upon request.

quantity traded (column 2) and that, as a result, the aggregate value of roses traded remains constant (column 1). The estimated elasticity between $\widehat{Q}_{it}$ and auction prices is equal to (-0.884), which is very close (and not statistically different from) to the (-1) implied by a binding (8). Increasing prices paid to the seller does not help relaxing the aggregate incentive constraint (8) since a reduction in the seller's temptation to deviate is compensated by an equal increase in the buyer's temptation. Column (3) shows that prices at the auctions do not lead to higher prices in the relationship.[17] Taken together, the evidence is consistent with information from interviews suggesting that parties often agree to allow for a percentage (e.g., 20%) of orders to be managed "ad hoc" and avoid price renegotiations during the season.

4.4 Test 3: Predictions of the Reputation Model

Reliability at the Time of the Violence

This section provides further empirical tests of the predictions of the reputation model by examining how relationships reacted to the violence. We exploit the regularity of shipments within relationships to construct a counterfactual measure of the volumes of roses that should have been exported in a particular relationship during the time of the violence, had the violence not occurred. For each relationship in the baseline sample, we separately estimate a model that predicts shipments of roses in a particular day. The model includes shipments in the same day of the week the previous week, total shipments in the previous week, week and season fixed effects as regressors. For each relationship, we obtain a predicted shipment of roses on a particular day. We aggregate these predicted value at the week level. The model predicts more than 80% of both in and out of sample variation in weekly shipments for the median relationship in the sample.

Denote by y_{fb} the observed shipments of roses in the relationship between firm f and buyer b during the week of the violence, and by $\widehat{y}_{fb}$ the predicted shipments of roses in the same relationship, obtained using the observed shipments in the week immediately before the violence and the coefficients from the relationship specific model

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[17]Figure 7 provides further evidence that parties adjust to unanticipated fluctuations in auctions prices. The Figure shows that number of relationships ending in a given week does not correlate with price at the auctions in that week during the seasons preceding the violence period. Regardless of whether week dummies are controlled for or not, the level of prices at the auctions does not predict the number of relationships ending.

described above. Reliability at the time of the violence is given by

$$\widehat{\mathcal{R}}_{fb} = \frac{y_{fb}}{\widehat{y}_{fb}}. \tag{15}$$

Table 4 shows that the violence reduced reliability $\widehat{\mathcal{R}}_{fb}$. Table 4 reports results from the regression

$$\log \widehat{\mathcal{R}}_{fb} = \alpha_b + \beta \left(\mathbf{I}_f^{C=1} \right) + \gamma Z_{fb} + \eta X_f + \varepsilon_{fb}, \tag{16}$$

where $\mathbf{I}_f^{C=1}$ is an indicator function that takes value equal to one if firm f is located in the region affected by the violence and zero otherwise; X_f is a vector of firm controls, Z_{fb} is a vector of relationship controls, and α_b are buyer fixed effects. Relationship controls are age and the number of shipments, average price and volumes in the twenty weeks preceding the violence. Seller controls are size (in hectares of land under greenhouses), fair trade certification, age of the firm, membership in main business association and ownership dummies (foreign, domestic Indian, indigenous Kenyan). The reliability measure $\widehat{\mathcal{R}}_{fb}$ is a deviation from a relationships-specific counterfactual that accounts for relationship-specific average and seasonal fluctuations in exports. The controls included in specification (16), then, allow the violence period to have affected export volumes in a particular relationship differentially across buyers, sellers and relationship characteristics.[18]

Table 4 shows that the violence reduced reliability. The Table reports results using different empirical specifications that differ in the number of controls included. In column 4, which controls for buyer fixed effects as well as firm and relationship controls, reliability was almost 20% lower, on average, in relationships of firms located in the conflict region.[19]

Reliability and Relationship's Age

Given the positive correlation between relationship age and value for the seller found in Table 2, the reputation model predicts that sellers in older relationships have stronger incentives to exert effort during the violence and deliver roses to the buyers.

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[18] The results from specification (16), therefore, are equivalent to those of a regression of volumes of exports $\widetilde{y}_{fb\tau s}$ at time τ in season s, on relationship-specific seasonality and season fixed effects, $\mu_{fb\tau}$ and μ_{fbs}, in which the effects of the violence are recovered from an interaction between a dummy for the period of the violence, $v_{\tau s}$, and a dummy for the conflict region, c_f, after controlling for the interactions between $v_{\tau s}$ and seller, buyer and relationship characteristics.

[19] The use of logs minimizes outliers. Results are robust to using the level of reliability. For instance, the specification corresponding to column 4 yields a coefficient of -0.316 with associated p-value 0.07. Results are available upon request.

On the other hand, in very old relationships, relatively little uncertainty might be left regarding the seller's type. In those cases, even low delivery would not lead to overly pessimistic beliefs about the seller's type. The model, therefore, predicts a (initially) positive and, potentially, inverted-U relationship between reliability and age.

Table 5 reports results from the regression

$$\log \widehat{\mathcal{R}}_{fb} = \alpha_b + \mu_f + \beta_1 \log (NT_{fb}) + \beta_2 \left[\log (NT_{fb})\right]^2 + \gamma Z_{fb} + \varepsilon_{fb} \qquad (17)$$

where α_b are buyer fixed effects and Z_{fb} are relationship controls described above. This specification is very similar to equation (16), but note that it now includes firm fixed effects μ_f. We are interested in comparing how firms responded differentially across relationships. Given that firms in the violence region faced very different conditions, we include firm fixed effects and estimate regression (17) separately on the sample of firms located in the two regions.

Columns 1 and 2 provide results from relationships in the conflict region. Column 1 shows that older relationships have higher reliability. Column 2 includes the measure of age squared and finds patterns consistent with an inverted-U shape relationship between age and reliability. The estimated coefficients give $-\widehat{\beta}_1/2\widehat{\beta}_2 \simeq 5.35$. This ratio implies approximately one third of relationships in the conflict region for which higher age correlates with lower reliability. Columns 3 and 4 repeat the exercise on the sample of relationships from the no-conflict region and fails to find any evidence of a relationship between age and reliability.[20,21]

Reliability and Relationship's Survival

The model predicts that reliability at the time of the violence correlates with subsequent outcomes in the relationships. We focus on the period starting from the beginning of the season following the violence, i.e., after mid August 2008. This is the period in which buyers and sellers (re-)negotiate the relational contract for the new season.

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[20] Results are robust to a number of alternative specifications. In particular: 1) when age is measured with the log of the number of past shipment $\widehat{\beta}_1 = 0.93$ (p-value 0.001) and $\widehat{\beta}_2 = -0.08$ (p-value 0.021) in the conflict region; 2) when the level of $\widehat{\mathcal{R}}_{fb}$ is used results give $\widehat{\beta}_1 = 0.86$ (p-value 0.007) and $\widehat{\beta}_2 = -0.07$ (with p-value 0.141) in the conflict region; 3) a specification pooling both regions finds similar results, with lower precision depending on the set of interactions included. In all cases $-\widehat{\beta}_1/2\widehat{\beta}_2 \simeq 5$ in the conflict region while no statistically significant pattern is found in the no-conflict region. Results are available upon request.

[21] The model implies a minimum level of reliability $\widetilde{\mathcal{R}}_\tau > 0$: any delivery below the threshold leads to beliefs which are too pessimistic for the relationship to be continued. Consistently with the implication of the model, the minimum level of observed reliability in the conflict region is around 30%.

More relationships did not survive to the following season in the conflict region (16 out of 94, i.e., 17%) than in the no-conflict region (8 out of 95, i.e., 8.5%). The difference in survival rate is statistically significant at the 5 percent level. Table 6 explores the relationship between reliability, age and relationship survival in the two regions separately. In the conflict region (columns 1 and 2) reliability positively correlates with relationships' survival. No such relationship is found in the no-conflict region (columns 3 and 4).[22] Since relationship's value and reliability increase with age (Table 2 and Table 5 respectively), Table 6 implies that the violence destroyed relatively less valuable relationships in the conflict region.

Relationship Outcomes Conditional on Survival

Table 7 reports results on the four outcomes $\widehat{Q}_{it}$, $\widehat{S}_{it}$, $\widehat{U}_{it}$ and $\widehat{V}_{it}$ in the season following the violence. The model predicts that higher reliability correlates with better outcomes and that the strength of these relationship should be smaller for older relationships. For all outcomes $y \in \{Q, S, U, V\}$, the Table reports results from the specification

$$\log\left(\widehat{y}_{fb}\right) = \mu_f + \alpha_b + \beta_1 \log\left(\widehat{\mathcal{R}}_{fb}\right) + \beta_2 \log\left(NT_{fb}\right) + \beta_3 \log\left(\widehat{\mathcal{R}}_{fb}\right) \times \log\left(NT_{fb}\right) + \gamma Z_{fb} + \varepsilon_{fb};$$
(18)

where, as before, μ_f and α_b are seller and buyer fixed effects, $\log NT_{fb}$ is the preferred measure of age before the violence, $\widehat{R}_{fb}$ is reliability at the time of the violence, Z_{fb} are relationship controls, and ε_{fb} is an error term. All independent variables, including controls, measure relationship characteristics prior to the violence. The model predicts $\beta_1 > 0$, $\beta_2 > 0$ and $\beta_3 < 0$.

Panel A in Table 7 considers the conflict region. For all four outcomes, results indicate that higher reliability correlates with higher future outcomes in the relationship, i.e., $\beta_1 > 0$. Similarly, age at the time of the violence, measured by $\log\left(NT_{fb}\right)$, positively correlates with outcomes $\widehat{Q}$, $\widehat{S}$ and $\widehat{U}$ (though not $\widehat{V}$). The interaction between age and reliability at the time of the violence is always negative and statistically significant, i.e., $\beta_3 < 0$. Consistently with the predictions of the model, reliability at the time of the violence translated into better outcomes in younger relationships. For all four outcomes, the Panel B fails to find any systematic pattern in the no conflict

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[22] The Table reports results from two different specifications: with and without seller's controls and buyer fixed effects. Results are robust to alternative specifications, including i) considering the level of reliability instead of log; ii) and a pooled regression of the two regions. The inclusions of seller fixed effects reduces the precision of the estimates, but not their economic interpretation. Results are available upon request.

region.[23]

4.5   Effort at the Time of the Violence

Tables A2 and A3 in the Appendix provide evidence that firms exerted effort during the violence, as assumed in the model. Two margins of effort are considered. Figure A1 in the Appendix shows that at the time of the violence prices in most direct relationships were lower than prices on the spot market. Table A2 in the Appendix shows that, despite higher prices at the auctions, export volumes to the spot market dropped significantly more than export volumes to direct buyers. This differential response holds controlling for seller fixed effects, i.e., comparing sales to the two channels within the same firm. Table A3 in the Appendix shows that firms that specialize in selling to direct buyers retained higher percentages of their workers during the violence.[24] Firms could retain workers by, e.g., setting up camps on or around the farm for workers threatened by the violence and paying higher wages to compensate over time for workers that were still working on the farm. The correlation holds controlling for characteristics of the firm's labor force (education, gender, ethnicity, contract type and housing programs), as well as firm characteristics (ownership type, certifications and land size). In sum, we find evidence that firms exerted efforts along at least two margins to respond to the violence.

5   Discussion

The evidence strongly supports the predictions of the reputation model: i) relationship dynamics are non-stationary (Test 1), ii) the aggregate incentive constraint (8) appears to be binding in many relationships (Test 2) and iii) the reaction to the violence are consistent with further predictions of the reputation model (Test 3), e.g., the non-linear relationship between age and reliability and the long-run effects of reliability. Before concluding, several points are worth discussing. We first consider the role of unobserved rose characteristics and then discuss some of the key assumptions of the model and how the evidence relates to alternative theoretical models.

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[23]Results in Table 7 are qualitatively similar in a number of alternative specifications. In particular, 1) the use of reliability in level (instead of log); 2) a pooled regression gives similar results with lower statistical significance on outcomes $\widehat{Q}$ and $\widehat{S}$; 3) results are stronger when using levels of outcome variables. Results are available upon request.

[24]The Table also appears in Ksoll et al. (2013).

5.1 Unobserved Rose Characteristics

The value of a rose mainly depends on i) its size, which we can proxy with unit weights reported in the customs data, and ii) its variety which, unfortunately, is not reported. Unobserved characteristics of roses present two main concerns for our results. A first concern regards the seller's incentive constraint (6) and its empirical implementation in (12). To estimate the lower bound to the value of the relationship we assumed that the roses can be sold at the auctions. A violation of the assumption introduces measurement error. The auctions are an extremely liquid market in which hundreds of rose varieties are traded each day. Conversations with practitioners suggest that the assumption is likely to be valid in most cases. Still, it is possible that for some relationships the assumption is violated at the time of the highest temptation to deviate. Three aspects of the empirical results are somewhat reassuring regarding the importance of this source of measurement error. First, Table A4 in the Appendix shows that, within firms, there is no difference in the average and standard deviation of unit weights sold to direct buyers and to the auctions. Second, the predictions of the model hold for two outcome variables, $\widehat{Q}$ and $\widehat{U}$, that do not directly depend on prices at the auctions. Third, the evidence of a binding incentive constraint (8) in Table 3 suggests that side-selling to the auction is the relevant deviation in most relationships.

A second concern is that firms might export to different buyers varieties of roses that are differentially affected by the violence (e.g., more labour intensive or perishable varieties). If those rose characteristics correlate with the age of the relationship, the results in Table 2 might be biased. Table A4 shows that average and standard deviation of unit weights do not correlate with the age of the relationship. Further (unreported) results show that average and standard deviation of unit weights do not change with season and at the time of the violence within relationships. To the extent that data allow, we do not find evidence that unobserved rose characteristics pose a threat to our results.

5.2 Assumptions in the Model

Motivated by interviews in the field, we assumed that contracts are negotiated at the beginning of the high season and that prices are constant across seasons. The complexity associated with indexing contracts on weekly auction prices, the inability of sellers and courts to observe the quality of roses delivered and a desire to smooth seasonality in income profiles are likely forces behind the use of constant prices. We

abstract from these forces and take constant prices as a fact of commercial life in our environment. If prices varied across seasons, the qualitative insights of the benchmark and pure enforcement model would be unaffected. The analysis of the model with types, however, would require a different formulation of types and would become more involved.

A second assumption is that outside options do not change over time. The assumption is justified by the fact that outside options are likely to be functions of seller's specific, rather than relationship's specific, variables that evolve over time. The empirical analysis controls for seller's fixed effects, effectively comparing relationships holding constant seller's specific factors that could determine outside options.

We have focused our attention on pooling contracts. In models with dynamic adverse selection it is possible, but potentially very costly, to screen types (see, e.g., Laffont and Tirole (1988)). In our model, both types receive the same pay-off which is equivalent to their outside option. Screening, therefore, would require paying future rents to the reliable type. The buyer's incentive constraint, however, places limits on future payments to the seller potentially limiting the availability of separating contracts.

We have assumed that, following the violence, contracts are renegotiated at the beginning of the following high season. The assumption simplifies the definition of the Bayesian equilibrium following the violence and the derivation of the results in Proposition 4. The unforeseen nature of the shock, the distance between buyers and sellers and the need for a prompt response make the assumption appealing from an empirical point of view as well.

5.3 Informal Insurance

Insurance considerations could also be important determinants of the value of relationships in this context.[25] Informal insurance models also predict non-stationary outcomes: past realizations of shocks influence future continuation values. Because past realization of shocks are unobservable it is difficult to reject informal insurance models. The results, however, suggest that insurance considerations are unlikely to be driving how relationships reacted to the violence. First, insurance models predict that relationships with higher promised value should give more slack to the seller. The evidence suggests the opposite is true: older, and more valuable, relationships tend to

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[25]While seasonal fluctutations in market prices are predictable, buyers and sellers might be subject to idiosyncratic demand and supply shocks.

have higher reliability. Second, insurance considerations imply the use of both current transfers and future values to provide incentives. In contrast, Figure A2 in the Appendix shows that the distribution of prices at the time of the violence is very similar to its counterpart in the twenty weeks before the violence. Prices were not renegotiated upward at the time of the violence.

5.4 Alternative Modeling Assumptions

Levin (2003) extended the relational contracts literature (see, e.g., MacLeod and Malcomson (1989), Baker et al. (1994, 2002)) to the case of moral hazard and adverse selection with i.i.d. types over time. Under both scenarios, provided that i) parties are risk-neutral and have access to monetary transfers, and ii) the buyer's actions are perfectly observable; the (constrained) optimal relational contract is stationary. The evidence, therefore, rejects extensions of the baseline model entirely based on this type of asymmetric information.

Other modeling assumptions, however, imply non-stationary outcomes without assuming learning. When there is moral hazard and the buyer privately observes the quality of the roses delivered stationary contracts are no longer optimal. Levin (2003) and Fuchs (2007), however, show that the optimal contract is a termination contract in which trade between parties continues in a stationary fashion provided performance is above a certain threshold during a certain period of time. If performance falls below the threshold, the relationship ends. The evidence is, therefore, also inconsistent with this extension of the model.

Halac (2012) and Yang (2012) also study relational contract models with types. In a model with binary effort and output, Yang (2012) assumes that agents have different productivity and obtains non-stationary outcomes. Halac (2012), instead, assumes that either party has private information about her outside option and also obtains non-stationary outcomes. In the special case in which the buyer has the bargaining power and the seller has private information, however, the model predicts stationary outcomes.[26]

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[26] Learning models with symmetric information about the seller's type also predict non-stationary outcomes. To account for the evidence, a learning model would have to assume that delivery at the time of the violence provides an informative signal of the seller's type. In the model with types, instead, delivery at the time of the violence endogenously reveals information about the seller's type through an effort decision. Given the unusual circumstances induced by the violence, the model with types appeared to be more natural.

6   Conclusion

Imperfect contract enforcement is a pervasive feature of real-life commercial transactions. In the absence of formal contract enforcement trading parties rely on the future rents associated with long term relationships to deter short-term opportunism and facilitate trade. Empirical evidence on the structure of informal arrangements in supply relationships between firms has the potential to identify salient microeconomic frictions in specific contexts and inform policy, particularly in a development context. This paper presents an empirical study of supply relationships in the Kenya rose export sector, a context particularly well-suited to study informal relationships between firms.

We find evidence consistent with models in which sellers value acquiring and maintaining a reputation for reliability. From a policy perspective, it is important to know whether learning and reputation are important determinants of firms' success in export markets. Firms might have to operate at initial losses in order to acquire a good reputation. Furthermore, if reputation is an important determinant of contractual outcomes, prior beliefs about sellers affect buyers willingness to trade, at least for a while. This generates externalities across sellers and over time, justifying commonly observed institutions such as certifications, business associations and subsidies to joint marketing activities.

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7 Online Appendix A: Proofs

Proof of Proposition 1

Assumption $\tau > v$ implies that the buyer never purchases roses in the market. Assumption $v > \overline{p}$ implies that the buyer's willingness to pay is higher than market prices in both seasons. As a result, the buyer offers $\overline{q} = \underline{q} = q^*$. Assumption $\underline{p} = 0$ is made for convenience alone, and implies $\underline{q}^m = 0$. Assumption $cq^* < \overline{p}$ implies that the marginal cost of producing q^* is smaller than the price in the market in the high season and, therefore, $\overline{q}^m = \frac{\overline{p}}{c} - q^*$. The price w is set by the buyer and, following standard arguments, can be recovered from the binding participation constraint. Simple algebra gives $w = \frac{p + \delta(c(q^*)/q^*)}{1+\delta}$. $\blacksquare$

Proof of Proposition 2

The proof that the constrained optimal relational contract is stationary and, therefore, $\overline{q}_t^R = \overline{q}^R$ and $\underline{q}_{t+1}^R = \underline{q}^R$ for all $t = 0, 2...$follows standard arguments (e.g., Abreu (1988) and Levin (2003)) and is omitted. The logic of the proof is that with risk neutral parties and publicly observed history there is no need to distort future continuation values to provide incentives.

Suppose instead that $w^R = \overline{p}$. Obviously, $\underline{q}^R < q^*$ and $cq^* > \overline{p}$ implies that seller's profits in the low season are strictly positive, $\underline{\pi}^R = w^R \underline{q}^R - c(\underline{q}^R) > 0$. In contrast, profits in the high season in the relationships are equal to profits in the spot market, since $w^R = \overline{p}$. The buyer could, therefore, lower the price by a small amount ε, still satisfy seller's constraints (6) and (7) and increase profits. Increasing profits at any date only helps satisfying buyer's constraints (4) and (5). A contradiction.$\blacksquare$

Proof of Proposition 3

Consider first the strategy that delivers supply assurance. Suppose the buyer decides to pay $\overline{w}_0^{sa} = \overline{p}$, i.e., she does not experiment in the first period. Then, delivery of roses does not lead to any belief updating. If it is optimal not to learn in the first period, then it is also not optimal to learn in future periods as well. The contract is then stationary and since (4) is assumed to be binding in the first period, it will be binding forever. The net present value of the relationship for the buyer at time zero is then given by $\overline{U}_0^{sa} = r(q_0^{sa}) - \overline{w}_0^{sa} q_0^{sa} + \delta \underline{U}_1^{sa}$. Using the binding constraint and $\underline{U}_1^O = 0$ this can be rewritten as $\overline{U}_0^{sa} = r(q_0^{sa})$. Recall that q_0^{sa} is determined as the (unique) solution to maximizing $\overline{U}_0^{sa}$ subject to (4) when paying $\overline{w}_0^{sa} = \overline{p}$.

Consider now the experimentation strategy in which $\overline{w}_0^e < \overline{p}$. Denote with $\widetilde{\theta}_0 = \theta_0 + (1 - \theta_0)(1 - \lambda)$. The net present value of the strategy at the beginning of the

relationship is given by $\overline{U}_0^e = \widetilde{\theta}_0\left(r(q_0^e) - \overline{w}_0^e q_0^e\right) - \left(1 - \widetilde{\theta}_0\right)\frac{v}{2}q^* + \delta\underline{U}_1^e$. Using the binding constraint and $\underline{U}_1^O = 0$ this can be rewritten as $\overline{U}_0^e = \widetilde{\theta}_0 r(q_0^e) - \left(1 - \widetilde{\theta}_0\right)\left(\frac{v}{2}q^* - \overline{w}_0^e q_0^e\right)$. Recall that q_0^e is determined as the (unique) solution to maximizing $\overline{U}_0^e$ subject to (4) when paying $\overline{w}_0^e < \overline{p}$.

Under experimentation, decreasing λ increases the continuation value, relaxes (4) and increases q_0^e. $\overline{U}_0^e$ is therefore monotonically decreasing in λ. Consider now the case in which $\lambda \to 0$, i.e., the likelihood of a delivery failure is arbitrarily small. Then $\overline{U}_0^e \to r(q_0^e)$. Since $\overline{w}_0^e < \overline{w}_0^{sa}$, binding (4) implies $q_0^e > q_0^{sa}$ and, therefore, $\overline{U}_0^e > \overline{U}_0^{sa}$.

Since surplus increases in beliefs, when the buyer experiments in the first period she keeps experimenting in subsequent periods until (8) is not binding anymore. The dynamic implications stated in the proposition then simply follows from the binding aggregate constraint and the fact that aggregate surplus is increasing in updated beliefs.∎

Proof of Proposition 4

First note that the Beta distribution satisfies the monotone likelihood ratio (MLR), i.e., for all $e_H > e_L$, $\rho(\mathcal{R}) = f(\mathcal{R}|e_H)/f(\mathcal{R}|e_L)$ is strictly increasing in $\mathcal{R}$. This implies that low reliability is interpreted by the buyer as a signal of relatively lower effort. Moreover, $\lim_{\mathcal{R}\to 0}\rho(\mathcal{R}) = 0$ and $\lim_{\mathcal{R}\to 1}\rho(\mathcal{R}) = \infty$.

Suppose the buyer believes that $e_\tau^R > e_\tau^U$. Denote with $\rho_\tau(\mathcal{R}) = f(\mathcal{R}|\widetilde{e}_\tau^R)/f(\mathcal{R}|\widetilde{e}_\tau^U)$.

Conditional on observing $\mathcal{R}$, the beliefs of the buyer in the separating equilibrium are given by

$$\widetilde{\theta}_\tau\left(\mathcal{R}, \widetilde{e}_\tau^R, \widetilde{e}_\tau^U\right) = \frac{\theta_\tau \rho_\tau(\mathcal{R})}{\theta_\tau \rho_\tau(\mathcal{R}) + (1 - \theta_\tau)}. \tag{19}$$

Recall that buyers terminate relationships when the seller is revealed to be an unreliable type, i.e., if $\theta_\tau = 0$. At the same time, relationships are started under prior θ_0. Therefore, the fact that $\lim_{\mathcal{R}\to 0}\rho(\mathcal{R}) = 0$ implies that there exists a threshold $\widetilde{\theta} \leq \theta_0$ such that if $\widetilde{\theta}_\tau\left(\mathcal{R}, \widetilde{e}_\tau^R, \widetilde{e}_\tau^U\right) \leq \widetilde{\theta}$ the buyer terminates the relationship. Monotonicity of $\widetilde{\theta}_\tau\left(\mathcal{R}, \widetilde{e}_\tau^R, \widetilde{e}_\tau^U\right)$ with respect to $\mathcal{R}$ implies the existence of a threshold $\widetilde{\mathcal{R}}_\tau$ implicitly defined by $\widetilde{\theta}_\tau\left(\mathcal{R}, \widetilde{e}_\tau^R, \widetilde{e}_\tau^U\right) = \widetilde{\theta}$. If $\mathcal{R} \leq \widetilde{\mathcal{R}}_\tau$ the relationship is terminated. If $\mathcal{R} > \widetilde{\mathcal{R}}_\tau$ the relationship continues with beliefs as in (19).

We now check that for all buyer's beliefs such that $\widetilde{e}_\tau^R > \widetilde{e}_\tau^U$ a reliable type has indeed higher incentives to exert effort. Consider the incentives of both types to exert effort. Denote with $V_i\left(\widetilde{\theta}_\tau\left(\mathcal{R}, \widetilde{e}_\tau^R, \widetilde{e}_\tau^U\right)\right)$ the continuation values associated with posterior beliefs $\widetilde{\theta}_\tau\left(\mathcal{R}, \widetilde{e}_\tau^R, \widetilde{e}_\tau^U\right)$ for a seller of type $i \in \{R, U\}$. Continuation values $V_i\left(\widetilde{\theta}_\tau(\cdot)\right)$ only depend on the realization of $\mathcal{R}$, buyer's beliefs about effort levels $\widetilde{e}_\tau^i$,

and θ_τ. $V_i\left(\widetilde{\theta}_\tau(\cdot)\right)$ is, therefore, taken as given by the seller. The seller's incentives depend on the gains of making high $\mathcal{R}$ states more likely and low $\mathcal{R}$ states less likely. The equilibrium requires $\widetilde{e}_\tau^i = e_\tau^i$ for each $i \in \{R, U\}$ and $\widetilde{e}_\tau^R > \widetilde{e}_\tau^U$.

Each type $i \in \{R, U\}$ choses effort as follows:

$$e_\tau^i \in \arg\max_e \int_0^1 V_i\left(\widetilde{\theta}_\tau(\mathcal{R}, \cdot)\right) f(\mathcal{R}|e) d\mathcal{R} - \Gamma(e) - c(q^m). \qquad (20)$$

Denoting with $\mathcal{V}_i\left(\widetilde{\theta}_\tau(\mathcal{R}, \cdot)\right) = \int_0^1 V_i\left(\widetilde{\theta}_\tau(\mathcal{R}, \cdot)\right) \frac{df(\mathcal{R}|e_\tau^i)}{de_\tau^i} d\mathcal{R}$, the first order condition implies

$$\mathcal{V}_i\left(\widetilde{\theta}_\tau(\mathcal{R}, \cdot)\right) = \Gamma'(e_\tau^i). \qquad (21)$$

Consider first the reliable type. Since contracts are not renegotiated until the following high season and the participation constraint of the seller is binding, the value for a reliable type is given by

$$V_R\left(\widetilde{\theta}_\tau(\mathcal{R}, \cdot)\right) = \begin{cases} \mathcal{R}\overline{q}_\tau^R w_\tau + \delta\underline{\pi}^R + \delta^2 V^O & \text{if } \mathcal{R} \geq \widetilde{\mathcal{R}}_\tau \\ \mathcal{R}\overline{q}_\tau^R p + \delta^2 V^O & \text{otherwise.} \end{cases} \qquad (22)$$

For the unreliable type, instead, we have

$$V_U\left(\widetilde{\theta}_\tau(\mathcal{R}, \cdot)\right) = \begin{cases} (1-\lambda)\left(\mathcal{R}\overline{q}_\tau^R w_\tau + \delta\underline{\pi}^R\right) + \lambda\mathcal{R}\overline{q}_\tau^R\overline{p}) + \delta^2 V^O & \text{if } \mathcal{R} \geq \widetilde{\mathcal{R}}_\tau \\ \mathcal{R}\overline{q}_\tau^R p + \delta^2 V^O & \text{otherwise.} \end{cases}$$

The binding constraint (8) implies $\delta\underline{\pi}^R = \overline{q}_\tau^R(\overline{p} - w_\tau)$. Denoting $\Delta_\tau(\mathcal{R}) = V_R\left(\widetilde{\theta}_\tau(\mathcal{R}, \cdot)\right) - V_U\left(\widetilde{\theta}_\tau(\mathcal{R}, \cdot)\right)$, we have $\Delta_\tau(\mathcal{R}) > 0$ if $\mathcal{R} \geq \widetilde{\mathcal{R}}_\tau$ and $\Delta_\tau(\mathcal{R}) = 0$ if $\mathcal{R} < \widetilde{\mathcal{R}}_\tau$. Part 1) of Assumption 3 guarantees an interior solution. The marginal benefits of efforts are higher for the reliable type if $\int_{\widetilde{\mathcal{R}}_\tau}^1 \Delta_\tau(\mathcal{R}) \frac{df(\mathcal{R}|e_\tau^i)}{de_\tau^i} d\mathcal{R} > 0$. The condition is satisfied since $\Delta_\tau(\mathcal{R}) > 0$ and $\int_{\widetilde{\mathcal{R}}_\tau}^1 \frac{df(\mathcal{R}|e_\tau^i)}{de_\tau^i} d\mathcal{R} > 0$ from Part 2) of Assumption 3. In particular, the Beta distribution implies that there exists $\overline{\mathcal{R}}_\tau$ such that $\frac{df(\mathcal{R}|e_\tau^i)}{de_\tau^i} > 0$ for $\mathcal{R} \geq \overline{\mathcal{R}}_\tau$ and $\frac{df(\mathcal{R}|e_\tau^i)}{de_\tau^i} < 0$ for $\mathcal{R} < \overline{\mathcal{R}}_\tau$. This, together with $\int_0^1 \frac{df(\mathcal{R}|e_\tau^i)}{de_\tau^i} d\mathcal{R} = 0$, implies $\int_{\widetilde{\mathcal{R}}_\tau}^1 \frac{df(\mathcal{R}|e_\tau^i)}{de_\tau^i} d\mathcal{R} > 0$.

The second part of the proposition compares the incentives of a reliable type at age τ and τ', with $\tau' > \tau$. Substituting (22) in the first order condition (21), we obtain

$$\overline{q}_\tau^R p \int_0^1 \mathcal{R}\frac{df(\mathcal{R}|e)}{de} d\mathcal{R} + \int_{\widetilde{\mathcal{R}}_\tau}^1 \left(\mathcal{R}\overline{q}_\tau^R w_\tau - \mathcal{R}\overline{q}_\tau^R p + \delta\underline{\pi}^R\right) \frac{df(\mathcal{R}|e)}{de} d\mathcal{R} = \Gamma'(e). \qquad (23)$$

Noting that $\int_0^1 \mathcal{R} \frac{df(\mathcal{R}|e)}{de} d\mathcal{R} = \frac{\partial \int_0^1 \mathcal{R} f(\mathcal{R}|e) d\mathcal{R}}{\partial e} = \frac{1}{\bar{e}}$ and using the binding constraint (8), the first order condition becomes

$$\frac{\bar{q}_\tau^R p}{\bar{e}} + \widehat{V}(\tau) \int_{\widetilde{\mathcal{R}}_\tau}^1 (1 - \mathcal{R}) \frac{df(\mathcal{R}|e)}{de} d\mathcal{R} = \Gamma'(e) \tag{24}$$

where $\widehat{V}(\tau) = \bar{q}_\tau^R (p - w_\tau)$. If $\bar{q}_\tau^R$ and $\widehat{V}(\tau)$ increase in τ, (24) implies that effort increases in τ. To see why effort might eventually decrease in τ, let $\tau \to \infty$. This gives very optimistic priors, i.e., $\theta_\infty \simeq 1$, which implies posteriors $\widetilde{\theta}_\infty \simeq 1$ regardless of $\mathcal{R}$, i.e., $\lim_{\tau \to \infty} \widetilde{\mathcal{R}}_\tau = 0$. The first order condition (24) then becomes $\frac{\bar{q}_\infty^R w_\infty}{\bar{e}} = \Gamma'(e)$ implying a lower effort level since, by the argument above, $\partial \left(\int_{\widetilde{\mathcal{R}}_\tau}^1 (1 - \mathcal{R}) \frac{df(\mathcal{R}|e)}{de} d\mathcal{R} \right) / \partial \widetilde{\mathcal{R}}_\tau > 0$ for $\widetilde{\mathcal{R}}_\tau$ sufficiently small.∎

8   Online Appendix B: Data Sources

Transaction-Level Export Data

The data cover all exports of roses during the period from April 2004 to August 2009. The data are obtained from the Horticultural Crops Development Authority (HCDA), a parastatal body which promotes and regulates the horticultural industry in Kenya. Records of each export transaction are entered in close collaboration with the Customs Authority. The invoice for each transaction is directly entered into the database at HCDA before the flowers are exported. Each invoice contains information on name of the Kenyan exporter, name of foreign consignee/client, type of produce, weight (kgs), units, unit value, total value, date, destination, currency and freight clause (C&F, FOB). We restrict our sample to established exporters that export throughout most of the season in the year preceding the violence. The sample covers more than ninety five percent of export records in the data.

Survey and Administrative Data

Information provided in the background section was collected through a firm-level survey. The survey was designed in collaboration with Chris Ksoll and was implemented by the authors in July to September 2008. The survey covered i) general questions about the firm (history, farm certification, ownership structure, level of vertical integration, location of farms etc.), ii) contractual relationships in export markets and marketing channels (direct wholesaler and/or auction houses), iii) firm production (covering detailed information on labor force, input use and assets), iv) retrospective post-election violence period (effect on operations, loss of workers by week, issues on transportation and air-freight, financial losses and extra-costs incurred). The survey was administrated to the most senior person at the firm, which on most occasions was the owner himself/herself. Upon previous appointment, face-to-face interviews of one to two hours were conducted by the authors with the respondent.

The location of exporters in the sample is obtained from HCDA, the Kenya Flower Council (KFC) and field visits during the survey. The names and nationality of firms owners and directors are obtained from the Registrar of Companies at the Attorney General's Office. Internet search and interviews guided the classification of foreign buyers into different marketing channels. Prices and volumes at the auctions is obtained at the weekly level from the International Trade Centre, UNCTAD/WTO, Geneva.

Time and Location of the Violence

To classify whether a location was affected by the violence we rely on the Kenya

Red Cross Society's (KRCS) Information Bulletins on the Electoral Violence which were issued daily during the relevant period (see Kenya Red Cross Society (2008) for details). Various other sources were used to supplement and verify the information, including: i) *Disaster Desk* of the Data Exchange Platform for the Horn of Africa (DEPHA),[27] ii) *Ushahidi,*[28] iii) the Kenya National Commission on Human Rights Report (2008), and iv) the Independent Review Commission Report (2008). Finally, we confront this information with the responses in the firm survey. For the locations relevant to the flower industry, the first outbreak of violence occurred on the 29th December 2007 and lasted until Janunary 4th 2008, around Eldoret, Kitale, Kericho and Nakuru. The second outbreak occurred between the 25th and 30th of January 2008 and also involved the towns of Naivasha and Limuru.

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[27]DEPHA provides geographic information data and services to the region under the UN. DEPHA maps of the violence were accessed at `http://www.depha.org/Post_election_Violence.asp` on September 23rd, 2008.

[28]*Ushahidi* is an open-source site launched to gather information from the general public on the events in real time. The general public could on a map of Kenya pin up a town/area where conflict had erupted and when. For details, see `http://legacy.ushahidi.com/` (accessed on September 30th 2008).

Table 1: Descriptive Statistics, Direct Relationships

Variable	Observations	Mean	St. Dev.	Min	Max
Panel A: Relationship Characteristics					
Number of Shipments	189	60.60	35.69	20	140
Number of Stems per Week (in 1000s)	189	102.39	165.14	1.53	971.72
Av. FOB Price (Euro Cents per stem)	189	12.11	11.65	1.25	25.75
Age (in Days)	189	860.12	449.45	33	1352
Number of Previous Transactions	189	298.23	288.80	20	1128
Left Censored (Yes = 1, No =0)	189	0.44	0.49	0	1
Panel B: Number of Relationships per Buyer and Seller					
Number of Relationships per Seller	56	3.38	2.88	1	14
Number of Relationships per Buyer	71	2.66	2.82	1	14
Panel C: Estimated Relationship Values (Season Before the Violence)					
Maximum Q (/ average weekly Q)	189	4.52	2.59	1.02	17.56
Estimated S (/ average weekly revenues)	189	5.78	5.38	1.27	28.19
Estimated U (/ average weekly revenues)	189	3.87	4.66	0.63	24.11
Estimated V (/ average weekly revenues)	189	1.91	2.99	0.00	13.28

Source: Authors calculations from HCDA Transaction level data on all flower exports. The sample is given by all relationships active immediately before the violence, i.e., only relationships that had more than 20 transactions from the beginning of the season. Left censored refers to relationships that were already active before the beginning of the period covered in the data, i.e., relationships that were active before September 2004.

Table 2: Relationships Age and Outcomes [TEST 1]

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Dependent Variable:	Maximum Volume		Relationship Value		Buyer Value		Seller Value	
Number of Past Temptations (log)	0.386***	0.431***	0.457***	0.484***	0.267**	0.307**	0.761***	0.766***
	[0.074]	[0.110]	[0.106]	[0.116]	[0.122]	[0.126]	[0.216]	[0.272]
Firm and Buyer Fixed Effects	yes	--	yes	--	yes	--	yes	--
Relationship Fixed effects	no	yes	no	yes	no	yes	no	yes
Season Fixed Effects	no	yes	no	yes	no	yes	no	yes
Adjusted R2	0.75	0.81	0.72	0.84	0.55	0.72	0.61	0.66
Number of observations	156	444	156	444	156	444	111	444

***, **, * denote statistical significance at the 1%, 5% and 10% level respectively. The Table reports correlations between the main relationships outcomes and two measures of the age of the relationship: number of previous shipments and past temptations, i.e., number of previous shipments at times in which auctions prices were higher than the relationship's price. All variables are in logs. The outcomes are computed for all seasons before the violence and the sample refers to relationships that were active during the period. The sample excludes relationships that are in the baseline sample but were not active in the season preceding the violence and includes relationships that did not survive until the violence season. Robust standard errors, clustered at the firm level are reported in parenthesis.

Table 3: Binding Aggregate Incentive Compatibility Constraint [TEST 2]

	[1]	[2]	[3]
Dependent Variable:	Relationship Value	Maximum Volume	Price
Price at auction (ln)	0.115	-0.884**	0.371
	[0.392]	[0.392]	[0.212]
Relationship Fixed effects	yes	yes	yes
Season Fixed Effects	yes	yes	yes
Seasonality Fixed Effects	yes	yes	yes
Adjusted R2	0.85	0.86	0.65
Number of observations	444	444	444

***, **, * denote statistical significance at the 1%, 5% and 10% level respectively. The Table reports correlations between prices at the auctions and relationships outcomes at the time of the maximum temptation to deviate. All variables are in logs. The outcomes are computed for all seasons before the violence and the sample refers to relationships that were active during the period. The sample excludes relationships that are in the baseline sample but were not active in the season preceding the violence and includes relationships that did not survive until the violence season. Robust standard errors, clustered at the firm level are reported in parenthesis.

Table 4: The Violence Reduced Exports in Direct Relationships

Dependent Variable: Log Reliability During Violence	[1]	[2]	[3]	[4]
Conflict Region	-0.173***	-0.189**	-0.141***	-0.188***
	[0.066]	[0.074]	[0.050]	[0.078]
Relationship Controls	no	yes	yes	yes
Seller Controls	no	no	yes	yes
Buyer Fixed Effects	no	no	no	yes
Adjusted R2	0.04	0.11	0.27	0.56
Number of observations	189	189	189	189

***, **, * denote statistical significance at the 1%, 5% and 10% level respectively. The Table reports the difference in mean in estimated reliability between direct relationships of firms located in regions directly affected by the violence against direct relationships of firms located in regions not directly affected. Reliability is computed as the ratio of realized exports over predicted exports during the second spike of the violence. The predicted values are obtained by fitting a relationships specific regression of shipments in any given day of the week with shipments in the corresponding day for the previous week, taking into account seasonality patterns. For the median relationship in the sample, this regression has an R-square equal to 0.85. Robust standard errors, clustered at the firm level, are reported in parenthesis.

Table 5: Relationship's Age and Reliability [TEST 3]

Dependent Variable: Log Reliability During Violence	[1]	[2]	[3]	[4]
	Conflict Region		No Conflict Region	
Past Temptations (log)	0.193*	0.535***	0.086	0.273
	[0.118]	[0.140]	[0.1827]	[0.473]
Past Temptations (log) Squared		-0.050*		-0.027
		[0.025]		[0.054]
Seller Fixed Effects	yes	yes	yes	yes
Buyer Fixed Effects	yes	yes	yes	yes
Relationship Controls	yes	yes	yes	yes
Adjusted R2	0.87	0.88	0.74	0.75
Number of observations	95	95	94	94

***, **, * denote statistical significance at the 1%, 5% and 10% level respectively. The Table reports correlations between measures of the age of the relationship and reliability at the time of the violence. Reliability is computed as in Table 4. All variables are in logs. Robust standard errors, clustered at the firm level, are reported in parenthesis.

Table 6: Reliability and Relationship's Death [TEST 3]

Dependent Variable: Relationship's Death	[1]	[2]	[3]	[4]
	Conflict Region		No Conflict Region	
Reliability, Log	-0.321***	-0.271***	-0.019	-0.093
	[0.103]	[0.085]	[0.044]	[0.111]
Past Temptations (log)	0.036	0.064	-0.022	0.048
	[0.038]	[0.047]	[0.041]	[0.146]
Seller Controls	no	yes	no	yes
Buyer Fixed Effects	no	yes	no	yes
Relationship Controls	yes	yes	yes	yes
Number of observations	95	95	94	94

***, **, * denote statistical significance at the 1%, 5% and 10% level respectively. The Table shows that the violence has destroyed relationships for which reliability at the time of the violence was sufficiently low. No relationship exists between reliability and relationship survival in regions not affected by the violence. Reliability is computed as in Table 4. The sample is given by all relationships active immediately before the violence. ***, **, * denote statistical significance at the 1%, 5% and 10% level respectively. The sample is given by the set of surviving relationships in the season after the violence. Regressions controls include volumes, prices and frequency of transactions in the period before the violence. Bootstrapped standard errors are reported in parenthesis. Firm controls include size, number of relationships, and share of exports to direct relationships. Bootstrapped standard errors are reported in parenthesis.

Table 7: Reliability, Age and Future Relationship Outcomes [TEST 3]

Dependent Variable:	[1] Maximum Volume	[2] Relationship Value	[3] Buyer Value	[4] Seller Value
Panel A:Conflict Region				
Reliability at Time of Violence	3.705**	3.819***	4.750***	11.260*
	[1.555]	[1.200]	[1.529]	[6.021]
Past Temptations	0.773**	0.819***	1.031***	-0.799
	[0.295]	[0.261]	[0.249]	[0.692]
Reliability at Time of Violence X Past Temptations	-1.125***	-1.181***	-1.526***	-2.145*
	[0.389]	[0.322]	[0.358]	[1.144]
Number of Observations	79	79	79	58
Panel B: No-Conflict Region				
Reliability at Time of Violence	-0.787	-0.616	0.088	-4.261
	[1.533]	[1.416]	[1.862]	[7.198]
Past Temptations	-0.261	-0.232	-0.099	-1.647
	[0.439]	[0.414]	[0.487]	[2.301]
Reliability at Time of Violence X Past Temptations	0.447	0.399	0.193	0.827
	[0.443]	[0.420]	[0.500]	[2.137]
Number of Observations	85	85	85	62
Relationship Controls	yes	yes	yes	yes
Seller Fixed Effects	yes	yes	yes	yes
Buyer Fixed Effects	yes	yes	yes	yes

***, **, * denote statistical significance at the 1%, 5% and 10% level respectively. The sample is given by the set of surviving relationships in the season after the violence. Reliability is computed as in Table 4. Regressions controls include volumes, prices and frequency of transactions in the period before the violence. Bootstrapped standard errors are reported in parenthesis.

Table A1: The Violence, Self-Reported Records

| Dependent Variable:	[1] Did Violence Affect at all the Operations of Your Firm?	[2] Were there any days in which members of your staff did not come to work because of the Violence?	[3] What was the highest proportion of Workers Absent due to the Violence?	[4] To What Extent did Worker Absence Cause a Loss in Production?	[5] Did you Experience Any Transportation Problem to Ship Flowers to the Airport?	[6] Did you Hire Extra Secuirty?
Conflict Region (yes=1)	0.575***	0.702***	43.898***	2.333***	0.477***	0.311***
	[0.103]	[0.072]	[5.609]	[0.124]	[0.100]	[0.099]
Dep. Var. in No-Conflict Region (Mean)	0.333	0.206	1.511	0.167	0.233	0.071
Adjusted R-squared	0.36	0.51	0.35	0.55	0.136	0.116
Number of Firms	74	74	74	74	74	74

***, **, * denote statistical significance at the 1%, 5% and 10% level respectively. The Table reports the difference in mean in responses between firms located in regions directly affected by the violence and firms located in regions not directly affected by the violence respectively. Robust standard errors, clustered at the town level, are reported in parenthesis.

Table A2: Effort at Time of Violence: Retaining Workers at the Farm

Dependent Variable: % Workers Lost	(1)	(2)	(3)	(4)
Only Auction (yes=1)	25.45**	32.47**	30.01**	27.09**
	[12.08]	[13.47]	[13.81]	[12.13]
Firms Using Both Channels (yes=1)	10.11	12.42		
	[11.21]	[15.12]		
Estimated Total Value of Direct Relationships			-2.71*	-4.19**
			[1.43]	[2.1]
Firm Controls	no	yes	no	yes
Location Fixed Effects	yes	yes	yes	yes
Observations (firms)	44	44	44	44
R-squared	0.282	0.352	0.401	0.394

***, **, * denote statistical significance at the 1%, 5% and 10% level respectively. The Table reports correlations between the percentage of workers lost and the marketing channels used by the firm. The Table is taken from Ksoll et al. (2011). Robust standard errors, clustered at the town level, are reported in parenthesis.

Table A3: Effort at Time of Violence: No Sales to Auctions

Dependent Variable: Reliability at Time of Violence	[1]	[2]	[3]
Conflict Region	-0.865***		-0.175*
	[0.082]		[0.096]
Direct Relationship	-0.088	0.023	
	[0.103]	[0.095]	
Direct Relationship X Conflict Region	0.650**	0.512*	
	[0.312]	[0.271]	
Only Direct Relationships [yes = 1]			0.008
			[0.113]
Only Direct Relationships [yes = 1] X Conflict Region			-0.473**
			[0.239]
Relationship Controls	no	no	yes
Firm Fixed Effects	no	yes	no
Direct Relationships Only	no	no	yes
Number of observations	274	274	189

***, **, * denote statistical significance at the 1%, 5% and 10% level respectively. The Table reports the difference in mean in estimated reliability between direct relationships and auctions for firms located in regions directly affected by the violence and firms located in regions not directly affected by the violence. Only direct relationship takes value equal to one if the firm exports more than ninety percent of its produce to direct relationships. Robust standard errors, two-way clustered at the firm and buyer level, are reported in parenthesis.

Table A4: Unit Weights Placebos

|	[1]	[2]	[3]	[4]	[5]	[6]
Dependent Variable:	Unit Weight: Average			Unit Weight: Standard Deviation		
Past Temptations	0.006	0.011		0.024	-0.002	
	[0.067]	[0.045]		[0.037]	[0.051]	
Direct Relationship			0.022			-0.023
			[0.053]			[0.021]
Firm Fixed Effects	yes	--	yes	yes	--	yes
Buyer Fixed Effects	yes	--	no	yes	--	no
Relationship Fixed effects	no	yes	no	no	yes	no
Season Fixed Effects	--	yes	--	--	yes	--
Number of observations	146	444	274	146	444	274

***, **, * denote statistical significance at the 1%, 5% and 10% level respectively. Robust standard errors, two-way clustered at the firm and buyer level, are reported in parenthesis.

Figure 1: Conflict and No-Conflict Regions
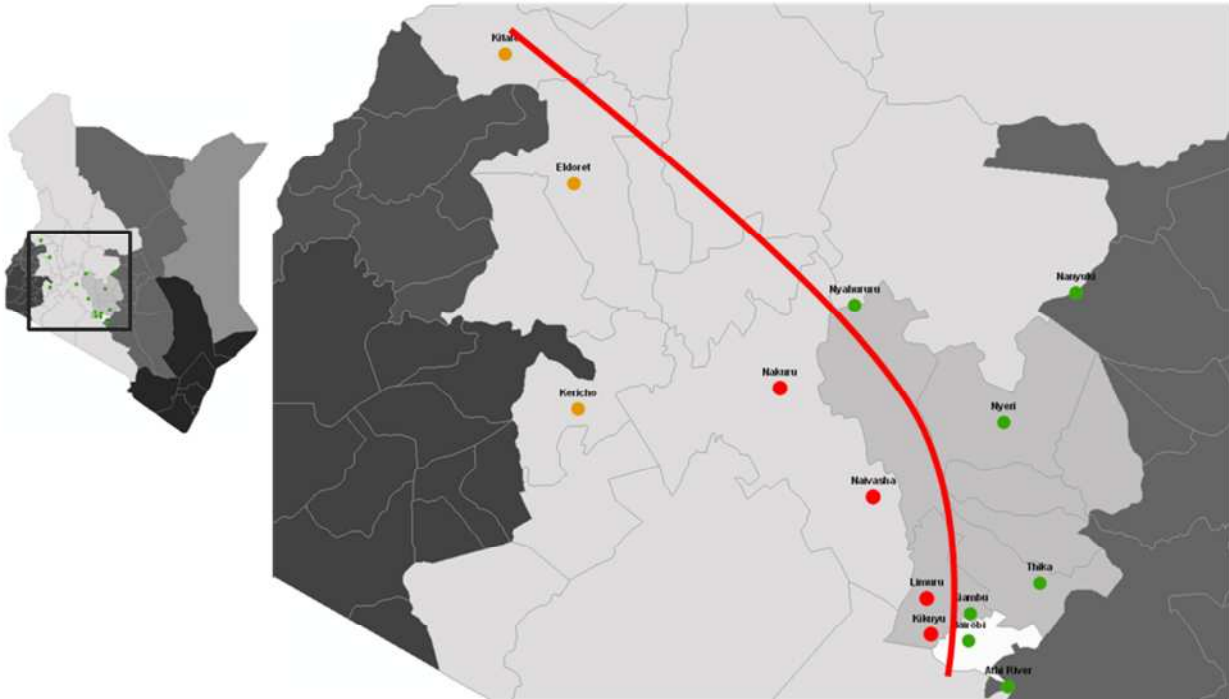
Among the towns around which flower firms are located, the Figure illustrates those locations that were directly affected by the violence to the left of the red line and those locations that were not affected by the violence to the right.

## Figure 2: Effect of Violence on Export Volumes
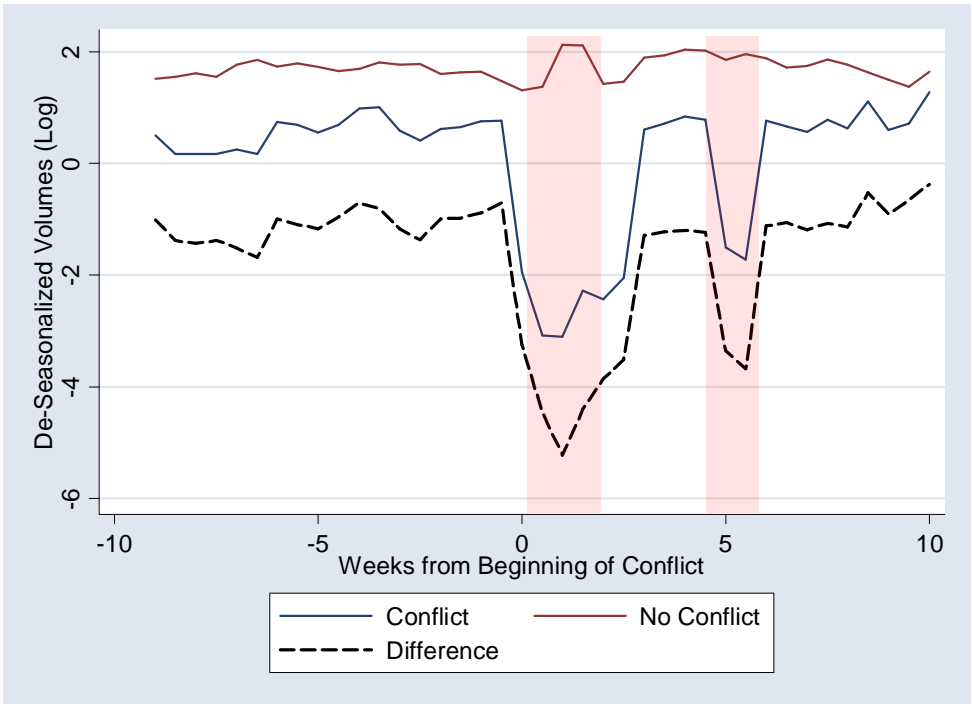
The figure shows the median biweekly residual of a regression that controls for firm specific seasonality and growth patterns in *conflict* and in *non-conflict* locations for the 10 weeks before and 10 weeks after the first outbreak of violence. For data sources, please refer to the online Appendix.

Figure 3: Seasonal Fluctuations in Auction Prices are Predictable
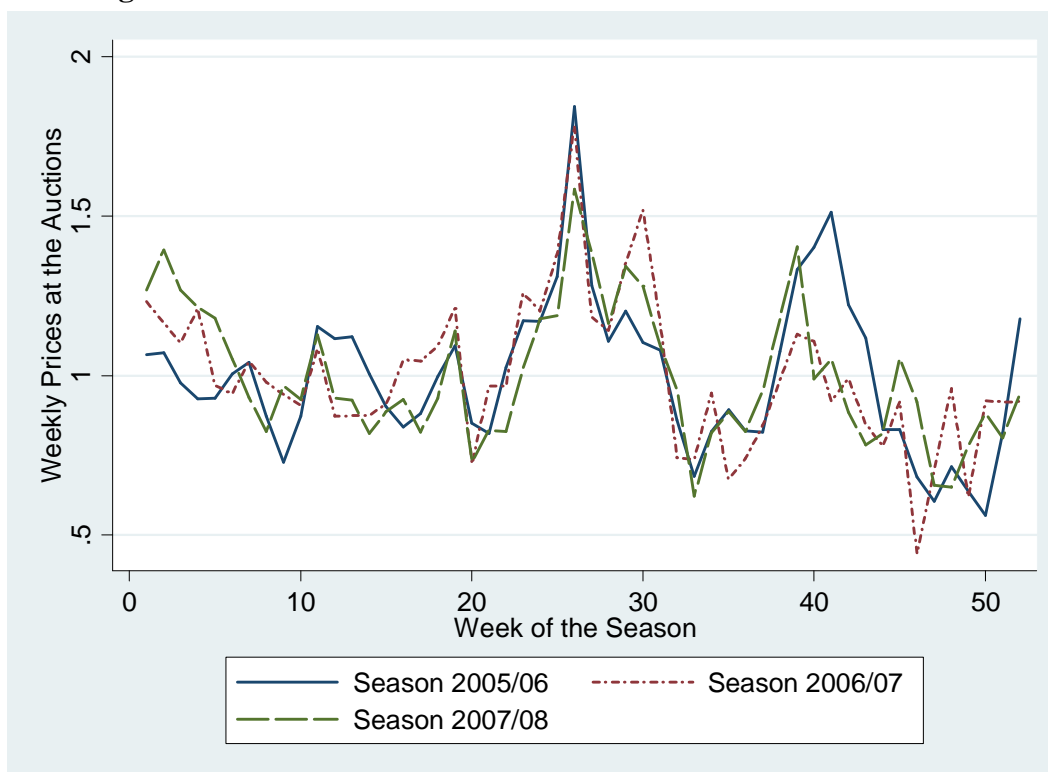
The Figure shows that FOB Prices at the Auctions are highly predictable. A regression of the weekly price at the auction on week and season dummies explains 76% of the variation in prices in the three season preceding the violence period. A season begins in mid-August. For data sources, please refer to the online Appendix.

**Figure 4: Fluctuations in Prices, Direct Relationships vs. Auction**
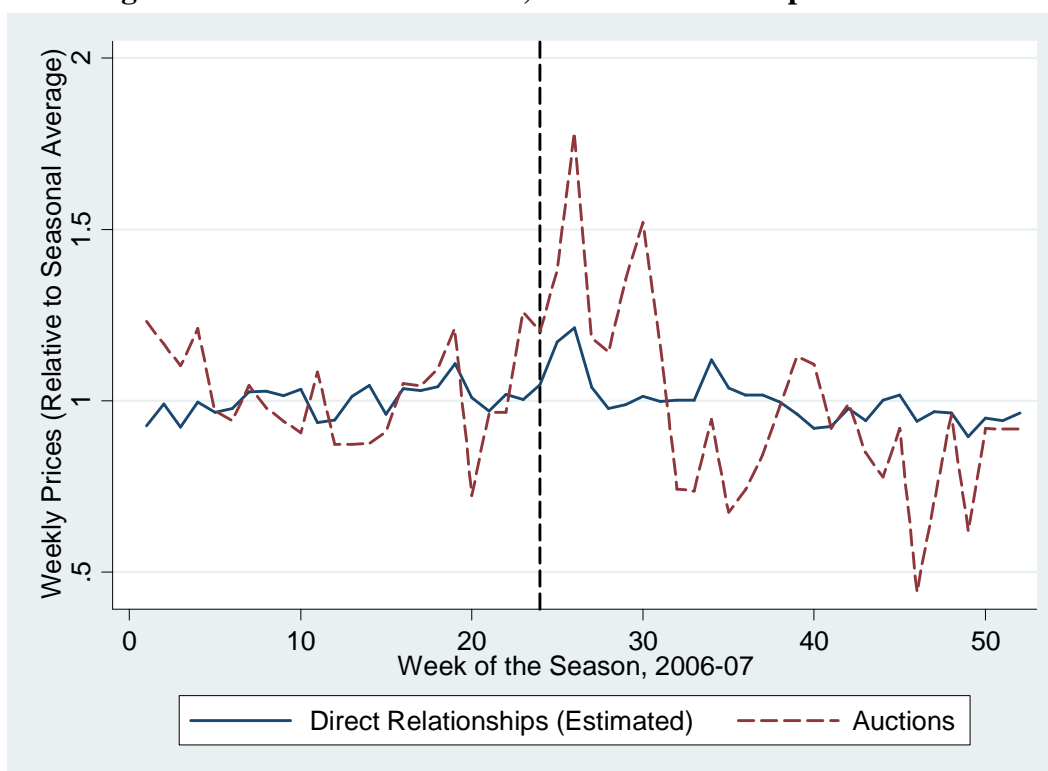
The Figure shows that FOB Prices in direct relationships are more stable than prices at the auctions throughout the season. The Figure shows the weekly variation relative to the season mean of FOB prices in direct relationships and at the Auctions. The FOB prices in direct relationships are obtained as week dummies in a regression of FOB prices on relationship fixed effects on the corresponding season. A season begins in mid-August. For data sources, please refer to the online Appendix.

**Figure 5: Distribution of Highest Temptation Weeks**
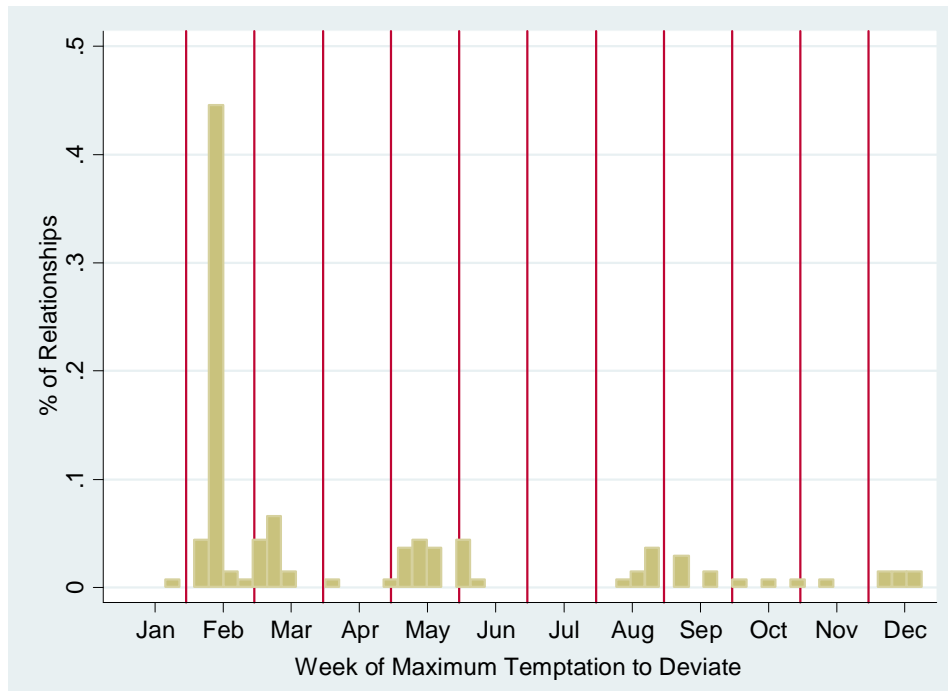
The Figure shows the distribution of the calendar weeks in which the maximum temptation to deviate occur. The sample is given by all the relationships active in the season 2006/07, as in columns 1,3,5,7 of Table 2. The temptation to deviate is the value at the auctions of quantities traded in a relationship in a week. In a given season, the maximum temptation to deviate is given by the highest temptation to deviate during the season. For data sources, please refer to the online Appendix.

Figure 6: Surviving Relationships Afford Higher Aggregate Temptations
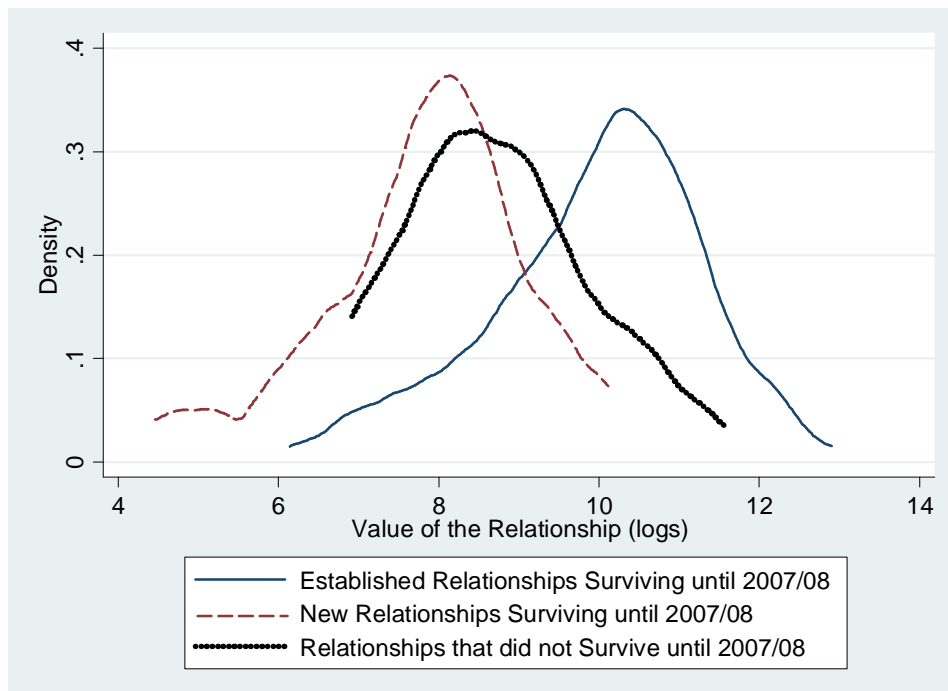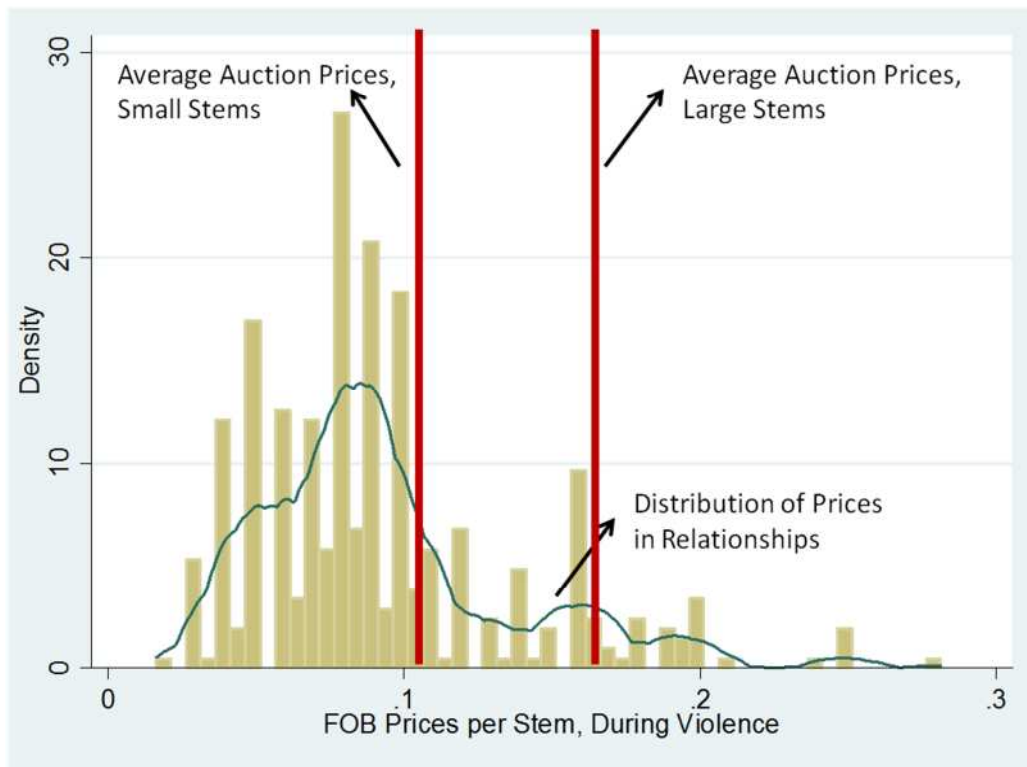

The Figure shows the distribution of the (log of the) value of relationships in the season 2006/07. The value is given by the maximum temptation to deviate. The temptation to deviate is the value at the auctions of quantities traded in a relationship in a week. In a given season, the maximum temptation to deviate is given by the highest temptation to deviate during the season. Among the relationships in our baseline sample, i.e., those active immediately before the violence period, relationships that were already active before 2006/07 are depicted with a straight line, new relationships with a dashed line, and relationships that were active in 2006/07 but did not survive with thicker dots. The Figure shows that relationships with higher values are more likely to survive. The equality of mean (and distribution) between surviving and dying relationships is rejected with 1% confidence interval. New relationships also have lower values. The equality of mean (and distribution) between new and established relationships is rejected with 1% confidence interval. For data sources, please refer to the online Appendix.

Figure 7: Separations Do Not Occur when Auction Prices are High
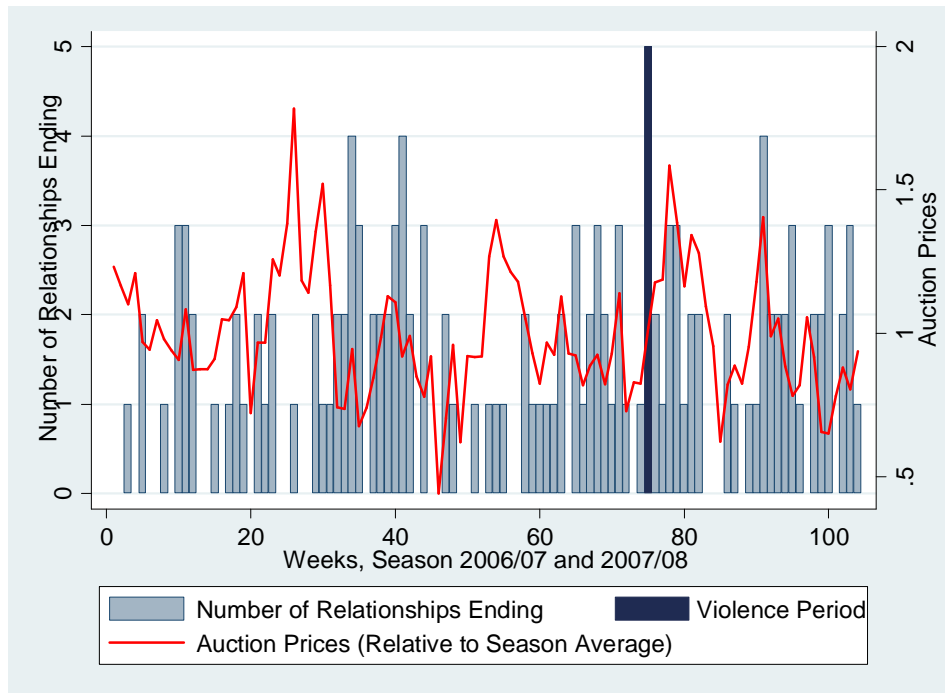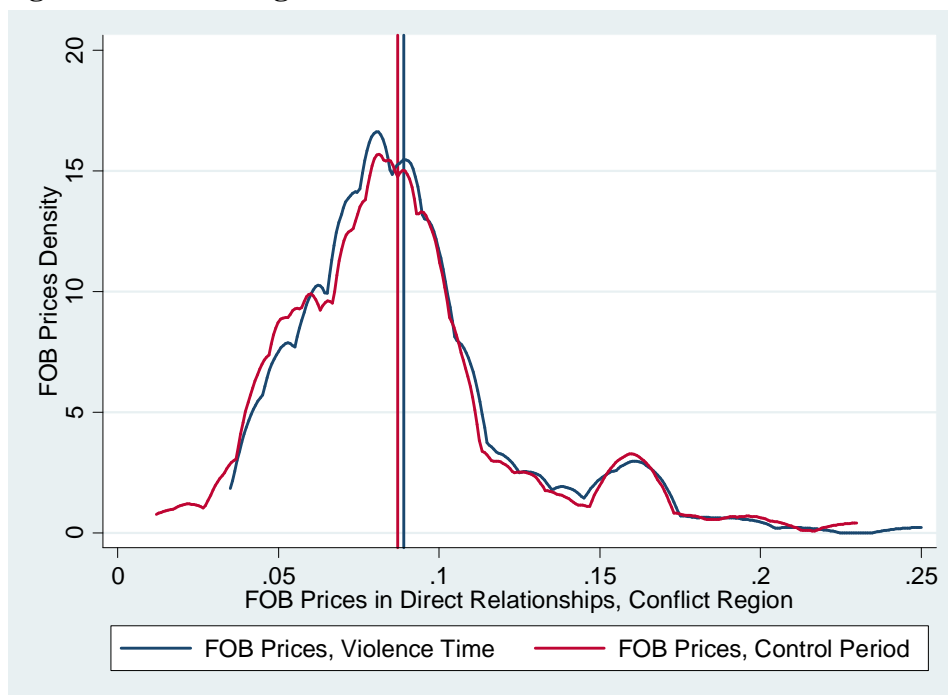

The Figure shows that the number of relationships dying in a given week does not correlate with the price at the Auctions in that week during the two season preceding the violence period. This is consistent with the fact that prices at the auctions are highly predictable. In a regression of the number of relationships dying in a given week that controls for week and season dummies, the coefficient on the violence period is positive and significant. The R-square for the same regression is 0.57. Regardless of whether week dummies are controlled for or not, the level of prices at the auctions does not predict the number of relationships dying. For data sources, please refer to the online Appendix.

Figure A1: FOB Prices at the Time of the Violence: Auctions vs. Direct Relationships

The Figure shows the distribution of average FOB prices per stem in direct relationships at the time of the violence. The two vertical lines show the average prices of small and large stems of roses at the Dutch auctions at the time of the violence. The figure shows that most relationships paid prices lower than at the spot market. (Source: authors calculations from HCDA Data and Auctions Data).

Figure A2: No Renegotiation of FOB Prices at the Time of the Violence

The Figure shows the distribution of average FOB prices per stem in direct relationships at the time of the violence and in the control period, i.e., the ten weeks prior to the violence. The two vertical lines show average FOB prices at the time of the violence and in the control period. The figure shows that prices were not renegotiated at the time of the violence.