Commodity Price Shocks and Civil Conflict: Evidence from Colombia

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How do income shocks affect armed conflict? Theory suggests two opposite effects. If labour is used to appropriate resources violently, higher wages may lower conflict by reducing labour supplied to appropriation. This is the opportunity cost effect. Alternatively, a rise in contestable income may increase violence by raising gains from appropriation. This is the rapacity effect. Our article exploits exogenous price shocks in international commodity markets and a rich dataset on civil war in Colombia to assess how different income shocks affect conflict. We examine changes in the price of agricultural goods (which are labour intensive) as well as natural resources (which are not). We focus on Colombia's two largest exports, coffee and oil. We find that a sharp *fall* in coffee prices during the 1990s lowered wages and increased violence differentially in municipalities cultivating more coffee. This is consistent with the coffee shock inducing an opportunity cost effect. In contrast, a *rise* in oil prices increased both municipal revenue and violence differentially in the oil region. This is consistent with the oil shock inducing a rapacity effect. We also show that this pattern holds in six other agricultural and natural resource sectors, providing evidence that price shocks affect conflict in different directions depending on the type of the commodity.

1. INTRODUCTION

Civil wars have affected more than one-third of the world's developing nations (Lacina and Gleditsch, 2005). Yet little is understood about the channels through which income shocks perpetuate armed conflict. Indeed, the relationship between income and conflict is theoretically ambiguous. On the one hand, a rise in income may reduce conflict by increasing wages and reducing labour supplied to criminal or conflict activity (Becker, 1968; Grossman, 1991). This notion, that wages represent the opportunity cost of fighting, is consistent with previous cross-country evidence that growth reduces the risk of civil war (Collier and Hoeffler, 1998, 2004; Fearon and Laitin, 2003; Miguel *et al.*, 2004).[1] On the other hand, more income means there is more to fight over (Hirshleifer, 1991; Grossman, 1999). Accordingly, a rise in income may

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1. See Sambanis (2002) for a comprehensive review of this literature.

1384

increase conflict by raising the return to predation and promoting rapacity over these resources. This form of predation is held as an explanation for why exporters of oil and other natural resources face a higher probability of experiencing civil war (Fearon, 2005). The existence of two opposing influences, opportunity cost and rapacity, suggests that some income shocks may mitigate conflict, whereas other shocks exacerbate it, depending on the relative strength of the two effects.

In this article, we demonstrate that some types of income shocks increase conflict, whereas others reduce it. We focus on exogenous income shocks induced by movements in world commodity prices, and estimate how these shocks have affected civil war dynamics in Colombia. We employ a unique event-based dataset which records four measures of violence, including guerrilla attacks, paramilitary attacks, clashes and war-related casualties, in over 950 municipalities from 1988 to 2005. Our empirical strategy interacts the exogenous international commodity price with the amount of the commodity produced in each municipality. We find that the price of agricultural commodities (which are labour intensive) are negatively related to conflict: when the price rises, conflict falls differentially in municipalities that produce more of these goods. In contrast, the price of natural resources (which use labour less intensively) are positively related to conflict: when the price rises, conflict rises differentially in municipalities that produce more of these resources.

Much of our analysis focuses on oil and coffee, the two largest Colombian exports for which high-quality data are available.[2] The negative relationship between agricultural price shocks and conflict is evident for the case of coffee: a sharp *drop* in the price of coffee during the 1990s increased violence disproportionately in municipalities cultivating more coffee. Our estimates imply substantial effects: the 68% fall in coffee prices over 1997 to 2003 resulted in 18% more guerrilla attacks, 31% more paramilitary attacks, 22% more clashes, and 14% more casualties in the average coffee municipality, relative to non-coffee areas. We also find that the coffee price fall reduced wages and work hours to a greater degree in the coffee municipalities. Taken together, these results are consistent with an account in which the coffee shock increased violence by lowering the opportunity cost of joining armed activity.

In contrast, we show that a *rise* in oil prices led to a differential increase in conflict in the oil municipalities. The 137% increase in oil prices over 1998 to 2005 led paramilitary attacks to increase by an additional 14% in the average oil producing municipality. The oil shock also increased municipal revenue generated from taxing natural resources, and kidnapping of politicians and leaders. These results are consistent with the oil shock increasing violence by promoting rapacity over contestable resources.

We also extend the analysis to six other major exports (covering eight of Colombia's top 10 exports).[3] We find that the positive relationship between natural resource price shocks and conflict holds for other commodities including coal and gold. In contrast, we find a negative correlation between agricultural price shocks and conflict in the case of sugar, banana, palm and tobacco. These results suggest that the pattern of observed effects do not arise due to idiosyncratic differences between the oil and coffee sectors.

Our findings are consistent with the idea that price shocks generate contradictory pressures on conflict. A price rise may generate greater rents to fight over via a rapacity effect. Alternatively, they may increase wages, raising the opportunity cost of fighting. Since offsetting wage effects will be larger for commodities that use relatively more labour, price increases to labour intensive commodities will reduce conflict, whereas price increases to non-labour intensive goods will

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2. Oil is Colombia's largest export. Coffee was the second largest export in the beginning of the sample period but fell to third place (after coal) in 2000.

3. We are unable to cover two of the top 10 exports (cut flowers and emeralds) since these are differentiated products without a defined international price.

increase conflict. This contrasting effect has been shown theoretically by Dal Bó and Dal Bó (2011).

Our article builds on the current literature in several ways. First, although previous within-country studies have shown a correlation between economic conditions and violence (Deininger, 2003; Barron *et al.*, 2004; and Do and Iyer, 2010), the broad scope of our dataset enables cleaner identification of this effect. By employing municipality fixed effects, we control for time-invariant municipal characteristics that may be correlated with economic conditions and conflict outcomes. In addition, we instrument the cross-sectional production of several commodities that we are not able to measure in the beginning of the sample period, circumventing concerns that the measured quantities have been endogenously determined. For example, we instrument municipal coffee cultivation using rainfall and temperature; coal production using coal reserves; and gold production using historical measures of precious metal mining.

Second, although there is a rich theoretical literature on the relationship between economic conditions and warfare (including Grossman, 1991; Hirshleifer, 1991; Skarpedas, 1992; Grossman and Kim, 1995; Esteban and Ray, 1999; Bates *et al.*, 2002; Fearon, 2008; Chassang and Padró i Miquel, 2009),[4] our article presents micro-empirical evidence consistent with the opportunity cost mechanism by showing that coffee price shocks affect both labour market outcomes and violence. These results are in line with the cross-country analysis of Besley and Persson (2011), which shows that natural disasters are negatively correlated with income per capita and induce greater political violence. Our results are also consistent with Brückner and Ciccone (2010), which demonstrates that negative shocks to export prices increase risk of civil war in countries across Sub-Saharan Africa. However, our analysis differs from this paper in two ways. We firstly exploit international price changes that are driven by supply shocks originating in other nations, which helps ensure that they are exogenous to conflict across Colombian municipalities. In addition, by showing positive effects of natural resource price shocks on conflict, we demonstrate that different types of commodity prices have different effects.[5,6]

The notion that a larger appropriation sector leads to more conflict or crime has been formalized in several key theoretical accounts including the classic crime model of Becker (1968), and the related framework of Dal Bó and Dal Bó (2011), which we adapt in this article. It also forms the crux of theoretical accounts which model conflict technology as a 'contest success function' (Tullock, 1980), and specify how fighting investments by contesting parties translate into winning probabilities. For example, in the seminal paper of Grossman (1991) conflict is proportional to the amount of time devoted by peasants to insurrection or soldiering activities; and in Esteban and Ray (2008), conflict is proportional to the number of militants from both contesting parties who engage in conflict. The idea is that having more combat personnel increases the fighting effort of groups and raises the share of resources dissipated in unproductive conflict activities.

Our examination of the rapacity channel builds on previous work linking natural resources to civil war (Collier and Hoeffler, 2004; Fearon, 2005; Humphreys, 2005; Snyder and Bhavnani, 2005; and Snyder, 2006; see Ross, 2004 for a comprehensive review).[7] Caselli and Coleman

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4. Other theoretical accounts of warfare that do not focus specifically on economic conditions include Hirshleifer (1995), Powell (2004), Esteban and Ray (2008), Chassang and Padró i Miquel (2010), and Yared (2010).

5. Since the completion of our first draft, several other work papers have examined the relationship between conflict and commodity prices, including: Besley and Persson, 2009; Bazzi and Blattman, 2011; De Luca *et al.*, 2012; and Maystadt *et al.*, 2013.

6. Our article is also related to other papers examining the link between economic conditions and illegal activities in non-war contexts, including land invasions in Brazil by Hidalgo *et al.* (2010), and several empirical studies linking wages to participation in criminal activities in the U.S. (Grogger, 1998; Gould *et al.*, 2002).

7. Guidolin and La Ferrara (2007) also highlight the role of resources in conflict with their empirical finding that the end of the Angolan civil war had a negative effect on the market valuation of diamond mining firms.

(2006) additionally theoretically highlight the role of resources in fueling conflict between coalitions whose membership is enforced by ethnicity. More recent work in this area include Besley and Persson (2010), whose theory demonstrates that resource dependence can increase the propensity towards conflict while lowering income and state capacity; Mitra and Ray (2010), who show that income increases of one group trigger greater ethnic violence in India; and Caselli and Michaels (2013) who find that oil windfalls in Brazil increase the incidence of illegal activities by local politicians.

In addition, our article presents direct evidence against several alternative mechanisms. One such account posits that a fall in coffee prices led farmers to plant more coca, and this substitution towards drug crops led to more violence in the coffee region.[8] However, we use satellite data on coca cultivation to demonstrate that the coffee shock did not result in differential coca planting in coffee municipalities. This is important given the findings of Angrist and Kugler (2008), that violent deaths escalated differentially in Colombia's coca departments during the late 1990s. Our analysis replicates the finding that coca promoted war-related casualties at the municipality level,[9] but also shows an independent effect of the other commodity shocks on conflict outcomes while controlling for coca.

Given contention of collusion between paramilitary groups and the state, it is also possible that local governments invite these armed groups into oil areas, sharing revenue with them in exchange for protection services.[10] However, we show that the oil shock does not induce more paramilitary violence in municipalities where local councils are composed of more pro-paramilitary politicians, but does lead to larger increases in paramilitary massacres, suggesting that violence does not reflect direct increases in security provision. Finally, we demonstrate that the increase in attacks cannot be attributed to changes in migration or decreases in government enforcement.

The remainder of the article is organized as follows. Section 2 provides background on the institutional context. Section 3 describes the mechanisms through which commodity shocks can affect conflict outcomes. Section 4 describes the data and the methodology. Section 5 presents the results on conflict, mechanisms, and alternative accounts. Section 6 concludes.

2. INSTITUTIONAL CONTEXT—THE COLOMBIAN CONFLICT

The Colombian civil war started with the launch of a communist insurgency in the 1960s.[11] During the period of our analysis, it involved three sets of actors: left-wing guerrillas, the government and right-wing paramilitaries. The guerrillas are composed of the Armed Revolutionary Forces of Colombia (FARC by its Spanish acronym), estimated to have 16,000–20,000 combatants, and the National Liberation Army (ELN), with approximately 4,000–6,000 fighters. Both groups fight today with the stated aim of overthrowing the government and claim to represent the rural poor by supporting aims such as land redistribution. Despite the stated ideological motivation,

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8. Lind *et al.*, (2010) explore the other direction of causality between drugs and conflict. They show that opium production follows in the wake of conflict events in Afghanistan.

9. In Colombia, approximately 1,000 municipalities are grouped into 32 departments, which in turn are grouped into four major administrative regions. Municipalities are analogous to counties in the U.S., whereas departments are analogous to states.

10. For example, Dube and Naidu (2010) provide evidence suggesting a collusive relationship between the state military and paramilitary groups in some regions of Colombia. Acemoglu *et al.* (2013) also suggest that paramilitaries are able to influence electoral outcomes, highlighting the symbiotic relationship between the state and this armed group.

11. It differs from other civil wars in that there is no polarization along religious, regional, or ethnic divisions, which has been conceptualized as a key predictor of social strife (Esteban and Ray, 1994; Duclos *et al.* 2004, Caselli and Coleman, 2006; and Esteban and Ray, 2006).

the guerrillas are widely regarded as economically motivated, and profit from their involvement in the conflict (Richani, 1997). For example, the FARC is the richest guerrilla in the world, and the two groups together were estimated to have an income of $800 million in 1996 (*ibid*).

The conflict remained low intensity throughout the 1980s, when it effectively served as a Cold War proxy, but escalated sharply during the 1990s, for a number of different reasons, including guerrilla defeat of narcotraffickers, and the emergence of paramilitary groups. Paramilitarism had its roots in anti-insurgent self-defense groups that were organized in the late 1980s by rural landowners and drug barons in response to guerrilla extortion. However, these groups did not emerge as an organized third force with strong regional presence until the mid-1990s. It was only in 1997 that splintered paramilitary factions formed an official coalition called the United Self-Defense Groups of Colombia (AUC by its Spanish acronym), which was estimated to have over 15,000 fighters at its peak over 2001–2003. When the AUC was first formed, some paramilitary factions displayed an ideological motivation in countering the guerrillas, although others were effectively armies for hire, and this heterogeneity persisted throughout the conflict. Paramilitary entry corresponded to a sharp intensification in overall casualties, as these groups intentionally targeted civilians perceived to be allied with the guerrillas (Restrepo *et al.*, 2004). They viewed this approach as pursuing "anti-infrastructure" activity (Aranguren, 2001).

Technically, the conflict was three-sided during the 1990s with all groups fighting one another, although there is extensive evidence of collusion between paramilitary groups and the government military in countering the guerrillas. The extent of this *de facto* collusion varied across groups and regions: given the paramilitary alliance with narcotraffickers and their strategy of violently killing civilians, the government began targeting paramilitary fighters to some extent during the late 1990s (Gutierrez, Sanin and Baron, 2005). Beyond the military alliance, there have also been cases of politician involvement with particular paramilitary groups. These were revealed in the "para-politics" scandal, when several politicians were indicted for accepting illegal assistance in getting elected (through paramilitary coercion of voters or elimination of opponents), in exchange for clemency and other policies favouring former paramilitary combatants (López, 2010; Acemoglu *et al.*, 2013).

In 2003, the AUC declared a partial cease-fire, and some paramilitary blocks agreed to participate in a demobilization program. Although this led to a temporary decrease in paramilitary violence in 2003, the demobilization did not effectively disarm all units, and human rights groups have documented continued paramilitary violence (Human Rights Watch, 2005). In part, this reflects the formation of a new generation of paramilitary groups, as well as renewed violence by members of pre-existing groups (Human Rights Watch, 2010).

Although a variety of factors account for overall dynamics of the Colombian conflict, our article seeks to identify the role of commodity price shocks. Since predation and recruitment are important channels through which conflict responds to economic shocks, we provide background on these factors in the sub-sections below.

2.1. Resources siphoned by armed groups

A central feature of the Colombian conflict is that the armed groups appropriate resources through several avenues. Both the paramilitaries and guerrillas are financed by the cocaine trade, as well as kidnapping, extortion, and predation on public funds. Qualitative evidence suggests that predation is particularly high in regions with natural resources. Armed groups target production directly, siphon royalties, kidnap government officials, and kidnap executives employed in extracting companies to facilitate extortion. Paramilitary predation is documented to be particularly strong in the oil region.

These groups also appropriate government revenue, as audits show that oil and gas royalties are often missing from municipal coffers where the paramilitaries exert influence (Human Rights Watch, 2005). This form of budgetary predation became especially important after a major decentralization in 1991 transferred more fiscal resources to local governments (Sanchez and Palau, 2006). Revenue predation takes places as armed groups are able to extort resources under threat of force. As an example, paramilitary groups in one municipality coerced officials to grant public contracts to particular firms, and extracted 30% of these resources directly from these firms (Semana, 2007). In other cases, paramilitaries have kidnapped and assassinated mayors in the attempt to extract municipal resources (El Tiempo, 2007). Diversion of public funds are also a part of FARC and ELN financing (Richani, 1997).

There is also evidence of direct theft of natural resources. For example, paramilitary groups drill holes in oil pipelines, and sell stolen oil on the black market (U.S.IP, 2004). One journalistic account indicates "Colombia's main oil pipeline...has so many holes in it that it is known as the flute" (McDermott, 2004). In fact, at the height of the AUC's power between 2001 and 2003, an estimated $10 million worth of crude disappeared from Colombia's pipelines (Semana, 2003), underscoring the extent to which this form of theft was prevalent.

2.2.   Wages paid by armed groups

Both the guerrillas and the paramilitaries recruit from the ranks of rural workers, as the insurgency today is concentrated largely in rural areas. The paramilitaries reportedly paid regular wages that exceeded the official minimum wage (Gutierrez, 2006). In addition, a survey of ex-combatants suggests that the need for employment played an important role in decisions to join paramilitary groups (Human Rights Watch, 2005).

Former ELN fighters also indicate that they were paid salaries and given other compensation (Human Rights Watch, 2003). Although FARC typically does not pay regular salaries, some former combatants reported receiving occasional payments. Moreover, all members are given food and clothing, and interviews indicate that this can serve as an impetus for joining the armed group during economic downturns (*ibid*).[12] The recruitment of guerrilla and paramilitary combatants in rural areas suggests that rural workers can opt for employment in these armed groups, and economic conditions can influence the decision to become a fighter.

3. MECHANISMS—COMMODITY PRICES AND CIVIL WAR

To outline the channels through which commodity price shocks affect conflict, we adapt the canonical framework of Becker (1968). Workers choose employment in either a productive sector or a criminal sector, based on whether wages exceed the return to criminal activity. A rise in the return to crime induces more workers to enter the criminal sector, increasing crime, whereas a rise in workers' wages reduces labour supplied to the criminal sector, reducing crime.

The Becker framework can be applied to the civil war context if conflict is conceptualized as a tool for siphoning resources violently from the economy. This is analogous to Grossman (1999) which formalized the idea of civil war as arising from theft. As we detail in the institutional description above, this is particularly appropriate for the Colombian civil war, in which armed groups fight with the aim of appropriating resources. Similar to the crime context, any shock which raises the return to appropriation will increase conflict by increasing labour supplied to the

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12. A survey of ex-paramilitary combatants undertaken by the mayor's office in Medellin also suggests that the need for employment played an important role in decisions to join paramilitary groups (Human Rights Watch, 2005).

conflict sector. This appropriation mechanism is what we label the *rapacity effect*. In addition, any shock which raises wages will reduce conflict by decreasing labour supplied to appropriation activity. This wage mechanism is the *opportunity cost effect*.

In this framework, a rise in commodity prices will generate contradictory pressures. A price increase may raise the return to appropriation by increasing the amount of economic production, a fraction of which is siphoned. On the other hand, a price increase may also raise wages by increasing product demand and hence associated labour demand. Whether wages rise relative to the return to appropriation determines the net effect of prices on conflict. If wages rise relatively more, then conflict will decrease through dominance of the opportunity cost effect; if wages fall relatively, conflict will increase through the dominance of the rapacity effect.

This general framework suggests that price increases of labour intensive goods, where wage effects are relatively large, will reduce conflict. For example, Dal Bó and Dal Bó (2011) use a 2×2 Heckscher–Ohlin international trade model to theoretically demonstrate this effect when one sector is labour intensive and the other is capital intensive, and use a Specific Factors model to show this effect when the two sectors have fixed factors. Their model predicts that a rise in the price of the labour intensive good will reduce the size of the conflict sector, whereas a rise in the price of either the capital intensive good or the fixed factor intensive good will increase it.

The natural resources we analyse, such as oil, are extracted in a capital intensive manner, but also have a large fixed factor component. Therefore we cannot distinguish between the effects of capital intensity versus fixed factor intensity. Instead, we focus on the distinction between whether the good is labour intensive or not. To test the prediction that a rise in the price of labour intensive goods reduces conflict through the opportunity cost effect, we focus on price shocks in the coffee sector, as well as other agricultural commodities. To test whether changes in the price of natural resources increase conflict through the rapacity effect, we focus on price shocks in the oil sector, and other natural resources.

To adapt these predictions to a within-country analysis, which exploits variation in production across regions within a nation, we make the additional assumption that each municipality in Colombia is economically distinct: factor endowments vary, and factor mobility is imperfect across municipalities.[13] This implies that factor returns and the production structure also vary across municipalities (*e.g.*, some places produce coffee more intensively, whereas other places produce oil more intensively).

It is straightforward to test the opportunity cost mechanism since we have a measure of wages, as well as hours worked. To test the rapacity effect, we use the fact that in this institutional context, armed groups appropriate both production and municipal revenue generated by taxing production (as discussed in Section 2). Since revenue is observable at the municipality level, we use this as a measure of potentially contestable resources. In the case of natural resources, a national law establishes a uniform national royalty rate and specifies the amount of revenue received by each municipality based on the value of production in that municipality. Thus the revenue received is proportional to production, which makes it credible to use as a measure of potentially contestable resources.[14]

In summary, this framework generates two sets of testable predictions. First, a rise in the price of agricultural goods such as coffee should increase work hours in the productive sector and increase wages relative to contestable municipal revenue, thus reducing conflict differentially in regions that produce these goods more intensively. Second, an increase in the price of natural

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13. This is a reasonable assumption in the Colombian context. For example, our data suggest that mean municipal migration was 3% annually over this period.

14. In the case of coffee, there is an export tax charged by the National Federation of Coffee Growers (NFCG), a quasi-governmental institution which distributes revenue to coffee producing regions.

resources such as oil should increase municipal resource revenue, but not result in offsetting wage increases, thus increasing conflict differentially in the natural resource region.

4. DATA AND METHODOLOGY

4.1. *Data*

Our data on the Colombian civil war come from the *Conflict Analysis Resource Center* (CERAC). This dataset is event based, and includes more than 21,000 war-related episodes in over 950 Colombian municipalities from 1988 to 2005. It is based on media reports in 25 major newspapers, and supplemented by reports from a network of Catholic priests who describe incidents of political violence in nearly every municipality in the country, including those in remote regions. These additional reports expand the scope of the dataset to locations that would otherwise receive little media coverage. Importantly, the priests are regarded as neutral actors in the conflict, and often used as negotiators between the two sides. This minimizes concerns regarding potential over-reporting of violence perpetrated by one side over another. The events are also cross-checked against several other official sources, including a dataset by the National Police and reports by Human Rights Watch and Amnesty International. Given the large number of sources utilized, the dataset is regarded as comprehensively covering conflict throughout the entire country. The data collection procedure is detailed extensively in the Appendix, and a description can also be found in Restrepo *et al.* (2004).

The CERAC data distinguish between attacks versus clashes. A clash is defined as a direct encounter between two or more groups that results in armed combat. An attack is a unilateral violent event carried out by a single group, in which there is no direct armed combat between two groups. Thus, if one group fires on another group which returns fire, this is classified as a clash. If the targeted group does not fire back, this is classified as an attack.[15] Besides firing upon another group, attacks can also include other types of incidents such as incursions into a village; killing civilians; bombing pipelines, bridges, and other infrastructure targets; destroying police stations or military bases; and ambushing military convoys. CERAC also separately labels attacks that are massacres, which are defined as the intentional killing of four or more civilians in a single event.[16] Intentional killing is distinguished from cases in which civilians deaths arise as a result of another targeted action (such as a bombing an infrastructure or military target). For example, a common type of massacre arises when an armed group enters a village and executes a pre-specified list of villagers perceived to be sympathetic to the opposing side.

The dataset codes each event by date, municipal location, and groups involved, and tracks the associated casualties of civilians and fighters. Thus, we aggregate incidents to the municipality-year level, and employ the annual number of guerrilla attacks, paramilitary attacks, clashes and casualties as the key-dependent variables.[17] We examine paramilitary and guerrilla massacres as additional outcomes.

In considering alternative mechanisms related to changes in government security, we also analyse attacks carried out by the Colombian military. These are rare events that primarily involve

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15. In our dataset, complex cases involving two closely timed events that include clash and attack components have been exclusively classified into one category based on the relative import of each component, as indicated by associated casualties or the scale of destruction involved (see Appendix for more detail).

16. CERAC employs this definition in classifying massacres since it is the one used officially by the Colombian National Police Department.

17. The casualties variable is measured with more noise relative to the other dependent variables, since there is generally more certainty about whether a violent event took place, than the number killed in the event, given that bodies are not always recovered and perpetrators may exaggerate deaths to appear stronger.

aerial bombardments, but can also include cases of anti-narcotics and anti-kidnapping operations. We treat these government attacks as a measure of enforcement rather than another measure of violence as they are likely to arise via different mechanisms relative to violence perpetrated by illegal armed groups. For example, although lower wages may increase military recruitment through the opportunity cost mechanism, region-specific shocks should not induce differential recruitment across municipalities since recruitment occurs at the national level. In addition, the rapacity mechanism is not relevant in this context since the Colombian military is not involved in predation, including theft of either government revenue or natural resources.

In terms of our independent variables, we combine data on commodity intensities from a variety of sources, which are also detailed in the Appendix. For all agricultural commodities, we use measures of the hectares of land used for cultivating that crop in a given year. For example, a coffee census records the amount of land used for growing coffee in each municipality in 1997. We exploit the fact that geographic conditions determine which regions are most suited for cultivating coffee, and instrument this measured coffee intensity using municipal data on rainfall and temperature, which come from the Center for Study of Economic Development (CEDE).[18]

Panel A of Figure 1 maps our coffee measure and shows that Colombia is a good case for comparing conflict dynamics in regions of varying coffee intensity, since cultivation is not isolated to any particular region. In fact, 536 municipalities or approximately 54% of the municipal sample is classified as coffee producing. In 1997, the coffee sector accounted for 30% of rural employment (Fonesca, 2002). Although coffee is not a plantation crop, and is grown largely by smallholders in Colombia, casual agricultural labourers are hired for harvesting purposes (Ortiz, 1999).[19]

We use measures of other agricultural commodities (including sugar, banana, tobacco, and African palm cultivation) from 2005, the earliest year these data are available at the municipal level. Since these cultivation levels may reflect violence levels or price shocks over the sample period, results using these crop intensities are interpreted as correlations, and presented as additional findings in the Supplementary Material. The availability of higher quality coffee data from earlier in the sample period, combined with the availability of an instrument with strong predictive power for coffee intensity, are key reasons why we focus our analysis primarily on coffee.

Our main oil measure is the average barrels of crude oil produced per day in each municipality in 1988, the beginning of the sample period. Panel B of Figure 1 shows the 39 oil producing municipalities in our sample. As a secondary variable, we also use an oil pipeline measure, the length of pipelines used specifically to transport petrol from oil fields to refineries and ports in 2000.[20] However, we again present these as suggestive results in the Supplementary Material owing to potential endogeneity in pipeline location: *e.g.*, over 1988–2000, pipes may have been built in municipalities that are more (or less) likely to experience violence in subsequent years. Figure A.I in the Supplementary Material shows the 146 municipalities with oil pipelines in the sample.

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18. Other studies have used rainfall as instruments in examining conflict. Miguel *et al.* (2004) uses rainfall changes to instrument GDP growth in Sub-Saharan Africa, and Gwande *et al.* (2012) uses rainfall levels to instrument vegetation in analysing Maoist violence in India. See Ciccone (2011) for a discussion of methodological issues regarding various specifications used in estimating the relationship between rainfall and conflict.

19. Colombian coffee has to be hand-picked because it tends to be grown on terraced slopes which makes it difficult to mechanize the harvest. Farmers typically hire workers for up to 5 months during two harvesting seasons. Larger farms also employ landless workers for non-harvest labour throughout the year (Ortiz, 1999).

20. We incorporate pipelines into the analysis both because they tend to be targeted by the armed groups, and because municipalities receive revenue from taxing oil transport.
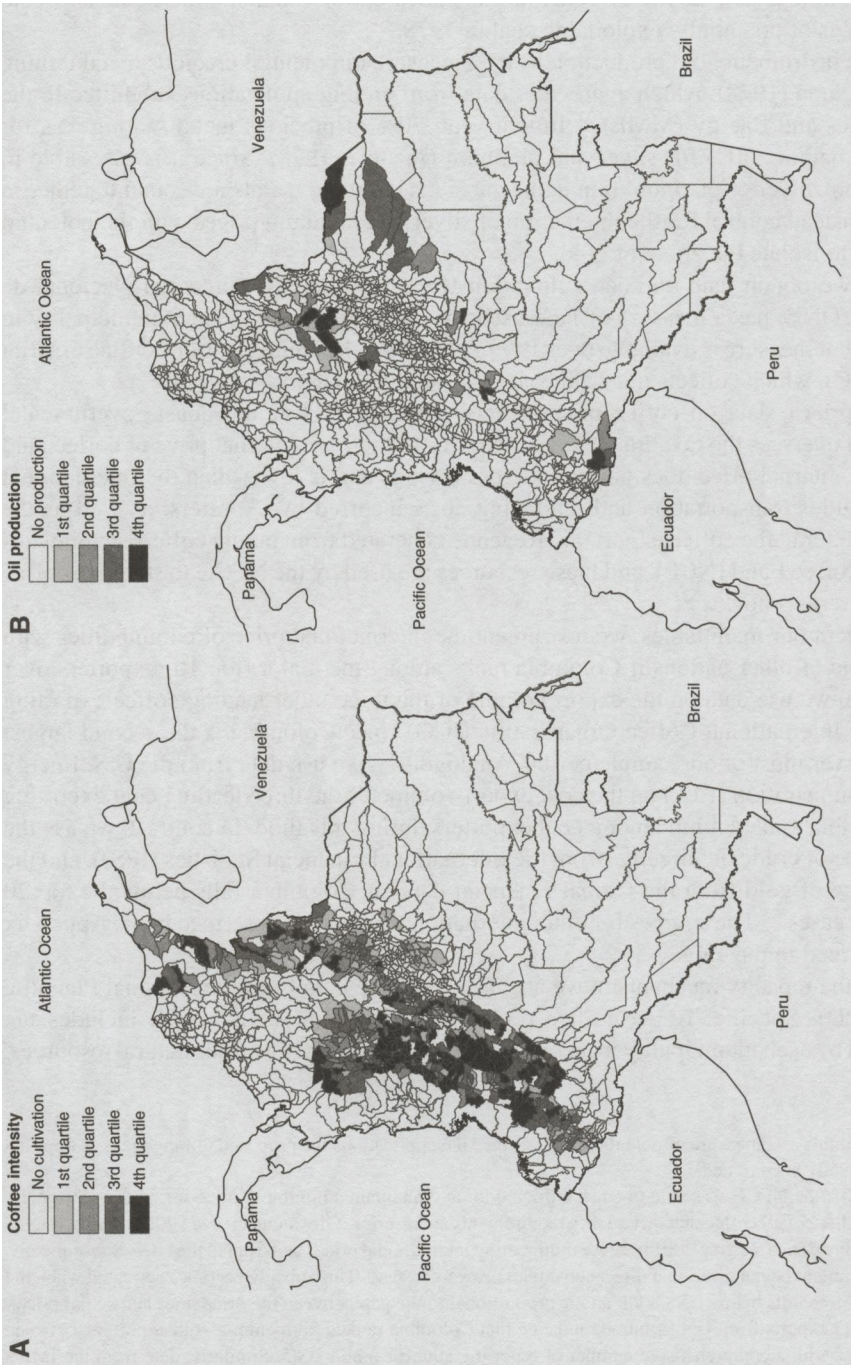
FIGURE 1

Coffee intensity and oil production in Colombia. (A) Coffee intensity; (B) Oil production

Notes: This figure shows coffee intensity and oil production in Colombian municipalities. Coffee intensity is measured as the land used for cultivating coffee (in thousands of hectares) in 1997. Oil production is measured in hundreds of thousands of barrels per day in 1988.

Sources: Shape file from IGAC; coffee data from NFCG; oil data from the Ministry of Mines and Energy.

Our measures of municipal-level coal and gold production are also from later in the sample period, in 2004. Thus, we instrument coal production cross-sectionally with the location of historical coal reserves. Specifically, we use the U.S. Geological Survey's Coal Quality Inventory in Colombia (Tewalt et al., 2006) to generate an indicator for municipalities that had coal sub-basins or fields of potentially exploitable coal in 1978.

Similarly, we instrument gold production using a measure of potential precious metal mining in 1978 from Jacome (1978), which aggregates data from mining applications submitted to the Ministry of Mines and Energy (MME).[21] In that year, 70% of precious metal mining was for gold, and the remaining 30% for silver and platinum (Jacome, 1978). Since it is infeasible to separate gold from silver or platinum mining hectares (as the three metals are found together in the mines), we instead control for the interaction of silver and platinum prices with the potential mining measure to isolate the effect of gold.

In addition, we obtain data on coca cultivation from two sources: Dirección Nacional de Estupefacientes (DNE) has a measure of land used for coca cultivation in each municipality in 1994; an equivalent measure is available over 1999–2005 from the United Nations Office of Drug Control (UNODC), which collects this data based on satellite imagery.

In terms of prices, data on coffee prices comes from the NFCG, the quasi-governmental institution which oversees the taxation of coffee exports and sets the internal price of coffee paid to growers. This internal price does not vary across regions and is lower than the international price which includes transportation and marketing costs incurred by exporters, as well as the 'contribución cafetera,' the coffee export tax. Revenue generated from taxing coffee accumulates in the National Coffee Fund (NCF), and these resources are used by the NFCG to stabilize coffee prices against external shocks.[22]

For all results in our main tables, we instrument the international price of commodities with the export volume of other nations if Colombia ranks among the major (top 10) exporters over this period. Thus, we use data on the export volume of the three other leading coffee exporting nations from the International Coffee Organization (ICO) since Colombia is the second largest coffee exporter over most of our sample period. Analogously, we use data from the U.S. Energy Information Administration (EIA) on the coal export volume of the three leading coal exporting nations as Colombia ranked ninth among coal exporters during this time. In contrast, we use the international price of crude oil directly (from the International Financial Statistics (IFS)), and the international price of gold from the Global Financial data, as Colombia falls below the top 20 exporters in both cases.[23] The sources for other international prices are described in the Appendix and also summarized in the Table A1.

In exploring the rapacity mechanism, we use fiscal revenue data from the National Planning Department (NPD). Specifically, we utilize a capital revenue line-item, which includes tax revenue obtained by each municipality from production and transport of various natural resources.

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21. We interpret this as a measure of potential mining since the applications list proposed mining areas as opposed to areas that have actually been mined.

22. Prior to 2001, the NFCG was able to enact a price floor and maintain a minimum price for coffee growers by guaranteeing the purchase of all coffee that met quality requirements at this price (Giovannucci et al., 2002). However, the price floor had to be abandoned starting 2001 because plummeting international prices bankrupted the NCF. Subsequently, the Colombian government began offering a direct subsidy to growers instead. This subsidy becomes activated when the price of parchment coffee falls below US$.80/lb and is proportional to the gap between the price floor and actual price.

23. Data on gold exports from UN Comtrade indicate that Colombia ranked 28th among gold exporters, between 1995 (the earliest year with a comprehensive number of reporting countries) and 2005. Similarly, data from the IMF's (International Monetary Fund) World Economic Outlook show that Colombia ranked 32nd among oil exporters between 1988 and 2005. Both sources also indicate that Colombia held less than one percent of the world export market of these commodities during these periods.

We analyse the log of capital revenue after adding in a small number (0.001), to account for municipal year observations where the value is 0.

We also use data on political kidnappings from CEDE, which originates from the Observatory of Human Rights of the Vice-Presidency of Colombia. The Observatory data, in turn, are constructed on the basis of reports from the Colombian security agency, the Administrative Department of Security (DAS). Political kidnappings refers to the kidnapping of government officials, political candidates running for office, and other community leaders. The number of such kidnapping incidents, disaggregated by paramilitaries and guerillas are available at the municipality-year level, for the 1988–2004 period.

In examining the opportunity cost mechanism, we use the rural component of the *Encuesta Nacional de Hogares* (ENH), a household survey conducted in 23 of 32 Colombian departments. This enables us to analyse labour market outcomes for employed individuals, including hours worked during the past month, as well as hourly wages for wage and salaried workers. We also utilize other demographic variables such as migration. See the Appendix for more details on this survey.

To consider alternative accounts regarding collusion with paramilitary groups, we define a measure of whether local municipal officials are pro-paramilitary. We use an original event-based dataset collected by Fergusson et al. (2013) which records all news events involving politician accusations of collaborating with paramilitaries over 1997–2011 in the "para-politics" scandal.[24] We designate a political party whose member has been accused of such charges as pro-paramilitary. We then use electoral data from the Registraduría General de la Nación to code the number of years in which the majority of seats in the local council were held by pro-paramilitary parties.

In conducting our analysis, we address the fact that new municipalities were carved out of existing municipalities during our sample period. In particular, 7.8% of Colombian municipalities that existed in 1988 were subsequently divided to create new municipalities. We account for this by aggregating all variables to 1988 boundaries, i.e., to the level of the original municipality. As detailed in the Appendix, our final sample is a balanced panel of 978 municipal units.[25] We also show that our main results hold when we restrict the analysis to the set of municipalities with constant boundaries throughout the sample period.

Table 1 presents the summary statistics of the key variables, whereas Table A.I in the Supplementary Material presents the equivalent statistics of supplementary variables used for appendix tables.

4.2. Methodology

Our empirical strategy follows a *difference-in-differences* estimator by assessing whether changes in commodity prices affect violence disproportionately in municipalities that produce more of these commodities.

In this approach, time variation stems from movements in annual prices. To estimate the impact of the oil shock, we use the international price of oil, which is exogenous to Colombia's

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24. Colombia has a multiparty electoral system and over the past decade the two traditionally strong parties (Liberal and Conservative) have witnessed the detachment of several dissident factions that formed separate parties. Several politicians from a few of these parties have been indicted on collusion-related charges for favouring lenient paramilitary-related legislation in exchange of support in the elections, which is often carried out by illegal means.

25. In cases where the new municipality was carved out of multiple old municipalities, we aggregate the multiple original municipalities, which leads to eight multi-municipal units. The exclusion of these eight units do not affect our main findings. These results are available from the authors upon request.

TABLE 1

Summary statistics of key variables

	Obs.	Mean	Med.	Std. Dev.	Min.	Max.
Panel-level variables						
No. annual guerrilla attacks	17,964	0.490	0	1.502	0	41
No. annual paramilitary attacks	17,964	0.076	0	0.399	0	11
No. annual clashes	17,964	0.473	0	1.344	0	25
No. annual casualties	17,964	1.894	0	6.884	0	292
No. annual government attacks	17,964	0.087	0	0.421	0	14
No. annual paramilitary massacres	17,964	0.047	0	0.291	0	7
No. annual guerilla massacres	17,964	0.011	0	0.122	0	4
No. annual guerrilla political kidnappings, 1988–2004	16,966	0.033	0	0.295	0	20
No. annual paramilitary political kidnappings, 1988–2004	16,966	0.032	0	0.262	0	12
Log real municipal capital revenue, millions of 2006 pesos[a]	11,755	7.058	7.793	2.483	−6.908	11.456
Coca intensity, thousands of hectares, 1994 and 1999–2005	7,984	0.111	0	0.854	0	24.507
Log population, millions	17,964	−4.35	−4.369	0.963	−8.832	−1.357
Municipal-level variables						
Coffee intensity, thousands of hectares, 1997	978	0.832	0.05	1.543	0	10.585
Oil production, hundred thousand barrels/day, 1988	998	0.003	0	0.053	0	1.627
Coal production, thousands of tons, 2004	998	1.870	0	12.749	0	155.518
Coal reserves, indicator, 1978	998	0.319	0	0.466	0	1
Gold production, hundred thousand grams, 2004	998	0.374	0	2.662	0	34.112
Precious metal mining, hectares, 1978	998	583.284	0	3,865.803	0	100,349.4
Cultivated coca, indicator, 1994	998	0.050	0	0.218	0	1
Coca intensity, thousands of hectares, 1994	998	0.071	0	0.582	0	9.081
Ever cultivated coca, indicator, 1994 and 1999–2005	998	0.241	0	0.428	0	1
Rainfall, cm3	998	1,888.327	1,685	1,003.748	160	9200
Temperature, celsius	998	21.392	21.8	4.967	3.9	28.9
Years pro-paramilitary majority over 1994–2005	998	0.761	0	1.418	0	9
Annual-level variables						
Log internal coffee price, thousands of 2006 pesos/lb	18	0.642	0.646	0.247	0.252	0.985
Log int'l price of oil, thousands of 2006 pesos/barrel	18	4.196	4.244	0.384	3.442	4.813
Log int'l coal price, thousands of 2006 pesos/ton	18	−2.164	−2.265	0.265	−2.522	−1.744
Log int'l gold price, millions of 2006 pesos/ounce	18	0.096	0.109	0.297	−0.347	0.619
Log int'l silver price, millions of 2006 pesos/ounce	18	−4.165	−4.232	0.215	−4.502	−3.663
Log int'l platinum price, millions of 2006 pesos/ounce	18	0.382	0.426	0.344	−0.119	0.889
Log coffee exports of top three coffee exporters, millions 60 kg bags	18	3.433	3.356	0.262	3.087	3.845
Log coal exports of top three coal exporters, thousands of short tons	18	12.657	12.671	0.114	12.462	12.862
Individual-level variables						
Log real wage, 1998–2005	26,050	7.273	7.341	0.725	4.649	9.372
Log monthly hours, 1998–2005	57,743	5.119	5.257	0.459	3.178	5.886
Migrant, 2001–2005	33,313	0.031	0	0.174	0	1

Notes: All panel-level and annual-level variables are defined for the 1988–2005 period unless otherwise specified.
[a]Log is taken after adding 0.001 to real capital revenue. The Appendix lists data sources and further details on sample sizes.

production as the country does not rank among leading oil exporters and holds less than one percent of the world oil market. In contrast, Colombia is among the ten largest coffee exporters globally, and its exports, which ranked second during most of our sample period according to ICO data, may have influenced the international price during the period of our analysis. In this case, using the international coffee price directly could bias the estimates. In particular, reverse causality may arise if an intensification of violence in the coffee region lowers coffee production levels, causing the international price to increase. It is worth noting that endogeneity induced by this supply effect would exert an upward bias against the hypothesized negative effect between agricultural price shocks and conflict. To account for potential bias, we instrument the internal coffee price faced by Colombian producers with the coffee export volume of the three other leading coffee exporting nations: Brazil, Vietnam, and Indonesia. This strategy ensures that we capture movements in the coffee price driven by the export supply of other countries.

Our empirical strategy uses cross-sectional variation based on commodity distribution across different municipalities. The main oil variable is a production measure from 1988. This circumvents potential endogeneity concerns both because production is determined by the (exogenous) spatial distribution of oil reserves, and because it is from the first year of the sample period, which means it does not reflect potentially endogenous oil discovery efforts or extraction rates correlated with conflict incidence over the period of the analysis.

In contrast, coffee intensity is measured in 1997, the middle of the sample period, and may therefore reflect violence levels in the beginning of the sample period, as well as past periods of high or low coffee prices. In particular, 1997 is a year in which coffee prices were at their peak. If these high prices caused some municipalities to substitute into coffee production temporarily, this may introduce measurement error, biasing the estimates.[26] Moreover, if the elasticity of substitution into coffee cultivation is correlated with unobserved factors that reduce violence, this could further generate downward bias.[27] To address this concern, we instrument coffee intensity with rainfall and temperature, which captures the latent coffee production capability of a municipality. In countries such as Colombia, Arabica coffee (the variety cultivated there) tends to grow in relatively cool, rainy areas, typically with at least 1800 mm rainfall and temperatures not exceeding 26°C (de Graaff, 1986). Thus, our instrument is a linear interaction in rainfall and temperature.

Our specification can be represented in two stages. The second-stage estimates the effect of commodity shocks on conflict and is given by

$$y_{jrt} = \alpha_j + \beta_t + \delta_r t + \text{Coca}_{jr} t \gamma + (\text{Oil}_{jr} \times \text{OP}_t)\lambda + (\text{Cof}_{jr} \widehat{\times \text{CP}_t})\rho + \mathbf{X}_{jrt}\phi + \varepsilon_{jrt}, \qquad (1)$$

where y_{jrt} are conflict outcomes including the number of guerrilla attacks, paramilitary attacks, clashes or casualties in municipality j, region r and year t; α_j are municipality fixed effects; β_t are year fixed effects; and $\mathbf{X}_{jrt}$ are time-varying controls which always include the natural log of population, to account for the scale effect since the dependent variable is measured as the number of attacks. Oil_{jr} is the oil production level in municipality j and region r during 1988; OP_t is the natural log of the international price of oil in year t; Cof_{jr} is the municipality-level measure of land devoted to coffee production in 1997; and CP_t is the natural log of the internal coffee

26. If production responds to price so that municipalities with lower coffee intensity respond more to high price years, then the measurement error is not of the classical form, and would not necessarily bias the coefficients towards 0.

27. For example, substitution into coffee cultivation may be highest in areas where municipal governments invest in rural infrastructure and security. In this case, high investment regions will be measured as having a higher coffee intensity in 1997 and also be recorded as experiencing a smaller rise in violence during subsequent years.

price in year t.[28] In equation (1), λ captures the differential effect of the oil price on violence in municipalities producing more oil and ρ measures the differential effect of the coffee price on violence in regions cultivating more coffee.[29]

$\delta_r t$ are linear time trends in Colombia's four major regions (Andean, Caribbean, Southeastern, and Pacific). These account for potential omitted variables since commodities may be concentrated in particular regions, and violence may be trending upward in these locations based on other factors such as varying economic growth rates or geographic shifts in the presence of armed groups. For example, oil is concentrated in the Southeastern region, and armed group presence is held to have increased there in the latter part of our sample period, when the government seized control of the Demobilized Zone (DMZ), pushing the FARC eastward towards Venezuela.[30] $Coca_{jr}$ is an indicator that equals 1 if the municipality was cultivating coca in 1994, and $Coca_{jr}t$ are linear time trends in the coca and non-coca municipalities. These trends also mitigate potential omitted variable bias since coca presence may be correlated with commodity presence, and both coca planting and government eradication efforts increased dramatically during the 1990s, either of which may have caused violence to trend upwards in the coca area.[31]

In our specification, the first stage for coffee intensity can be represented as

$$\text{Cof}_{jr} \times \text{CP}_t = \alpha_j + \beta_t + \delta_r t + \text{Coca}_{jr}t\gamma + \sum_{m=0}^{1}\sum_{n=0}^{1}\left(R_{jr}^m \times T_{jr}^n \times \text{FE}_t\right)\theta_{mn} + \mathbf{X}_{jrt}\rho + \mu_{jrt}, \quad (2)$$

where R_{jr}^m is the average annual rainfall of municipality j of region r raised to the power m, T_j^n is the average annual temperature of municipality j raised to the power n; $\theta_{00}=0$; FE_t is the (log) coffee export volume of Vietnam, Brazil, and Indonesia; and $\mathbf{X}_{jrt}$ includes all exogenous explanatory variables in the second stage, including the oil interaction in equation (1).

Since our dependent variable is the number of attacks in levels, and is not normalized by any parameters such as population or land area, we measure municipal exposure to price shocks analogously in levels, using the hectares of land used for cultivating coffee and the oil production level. We measure prices in logs so we can assess its effects in percent terms, but the results are robust to specifying prices, as well as population, in levels.[32]

Although the specification is represented in two stages, the estimation is always undertaken via a one-step procedure. Our main specification uses 2SLS estimation. Since the dependent variables can be conceptualized as a count, in the Supplementary Material, we also present a Poisson instrumental variables approach, which uses GLM estimation specifying that the errors are Poisson distributed and a log link, as well as an iterated re-weighted least squares convergence algorithm.[33] This is an approach recommended by Santos Silva and Tenreyro (2011).[34]

In all specifications, we cluster the standard errors at the department level to control for potential serial correlation over time and across municipalities within a department. This is a

28. Miller and Urdinola (2010) independently and simultaneously developed a similar measure of coffee price shocks in Colombia.

29. We examine the effect of prices in levels versus growth since a growth specification may lead to an excess focus on short-run effects by capturing only year-to-year changes.

30. The DMZ comprises five municipalities in Southern Colombia that the FARC were allowed to administer over 1999–2002. This was a concession by the government of President Andrés Pastrana as a part of peace negotiations.

31. According to our data, coca cultivation more than doubled between 1994 and 2000.

32. These results are not included for brevity but available from the authors upon request.

33. See Hardin et al. (2003) for more detail on this estimation procedure.

34. See also Santos Silva and Tenreyro (2010) for a related discussion on Poisson regressions, and Mullahy (1997), Windmeijer and Santos Silva (1997), and Santos Silva and Tenreyro (2006) for related estimation approaches.
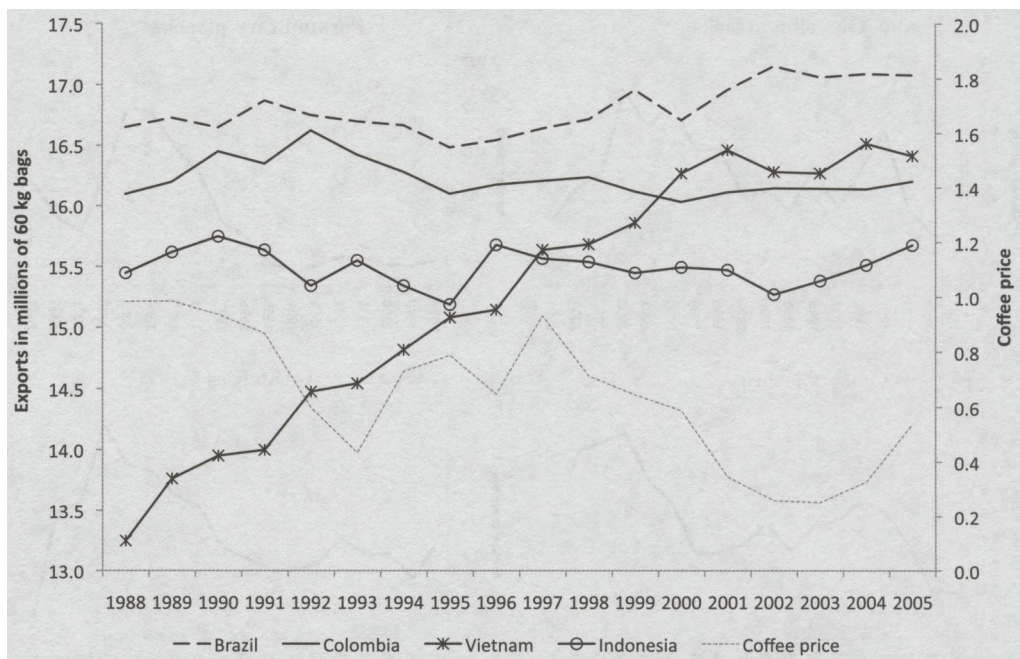
FIGURE 2

The coffee price and exports of main producers

Notes: This figure shows coffee exports (log of millions of 60 kg bags) of the four largest coffee exporters, and the (log) real internal price of coffee in Colombia.

Sources: Coffee export data from the International Coffee Organization and coffee price data from the NFCG.

fairly stringent test since the cross-sectional variation in our key explanatory variables is at the municipal level, and 978 municipalities in our final sample are grouped into 32 departments.

Given our empirical strategy, a subtle form of endogeneity could arise if coffee cultivation decisions in other leading coffee exporting nations were based on differential violence increases in the Colombian coffee region. However, an examination of the factors affecting prices dynamics over the sample period suggests that expansion decisions in other countries were not driven by spatially varying violence in Colombia. Figure 2 shows the internal price of coffee and the coffee exports of Colombia and the three other leading coffee exporting nations. First, the prices fell until 1993 because the system of export quotas negotiated under the World Coffee Organization came to an end in 1989, and all the major producers subsequently expanded their exports. Coffee prices then rose exogenously in 1994 due to an intense frost episode in Brazil which decimated Brazilian coffee crops. Prices remained high from 1994 to 1997, but then plummeted sharply as supply increases from Vietnam and Brazil drove the real international price to a new historic low. The Brazilian expansion occurred because the government promoted planting in frost-free areas after the 1994 crop failure. The harvest of additional output also coincided with a 66% devaluation of the Brazilian currency in 1999 which further boosted exports. The Vietnamese expansion was caused by several factors including World Bank development assistance programs that promoted coffee exports during the mid 1990s (Oxfam, 2002), normalization of trade relations with the U.S. in 1995, and a government led export promotion strategy, including subsidies, which was initiated in 1999 (Nguyen and Grote, 2004). These factors indicate that the expansion decisions which resulted in prices falling were not driven by violence in Colombia. Prices remained low
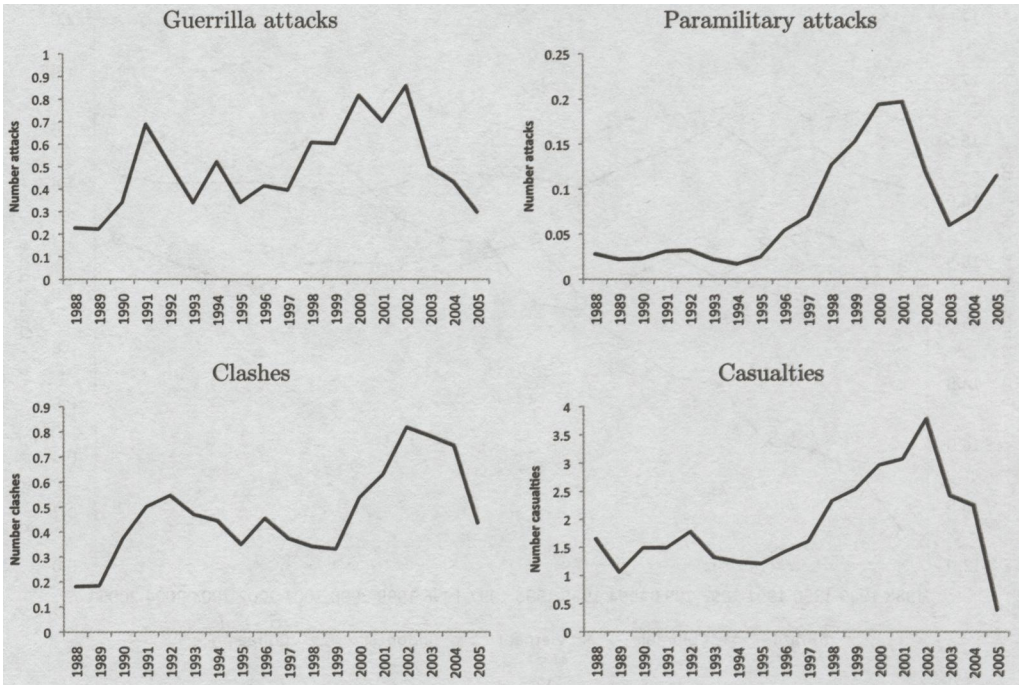
FIGURE 3

Mean violence in Colombian municipalities, 1988–2005

Notes: This figure shows mean violence levels in the sample municipalities.

until 2002, and the 1997–2002 period is referred to as the International Coffee Crisis based on the perceived negative impact of depressed prices on coffee cultivators' livelihoods (ICO, 2003).

To visually examine aggregate conflict dynamics during our sample period, we chart basic trends in our four dependent variables in Figure 3. The figure shows that average guerrilla attacks were high in both the early and late 1990s, which corresponds to the fact that the guerrillas were active throughout this period. In contrast, paramilitary attacks remained low until 1995, which corresponds to the fact that paramilitary groups remained weak and splintered until they began coordinating their activities in the mid-1990s, eventually forming the AUC coalition in 1997 (see Section 2). Casualties also rose concurrently with paramilitary attacks, which is consistent with qualitative accounts of paramilitaries disproportionately targeting civilians. Clashes in the early 1990s primarily reflect fighting between the government and the guerrillas, but also increase during the late 1990s on account of increased fighting between the guerrillas and paramilitaries.

Given differences in the timing of when the armed groups were active, we should expect to observe that the price shocks which induce a guerrilla response increase guerrilla attacks throughout the sample period. In contrast, price shocks which induce a paramilitary response should increase paramilitary attacks after the mid-1990s, when these groups became more active. To visually examine the relationship between the coffee price shock and conflict, Figure 4 overlays the coffee price against mean violence outcomes, distinguishing between coffee and non-coffee municipalities. If the coffee shock relates negatively to conflict, we should observe differential increases in violence in coffee areas when the price of coffee falls. Moreover, to the extent that coffee price changes induce responses by the guerrillas and paramilitaries, divergent effects
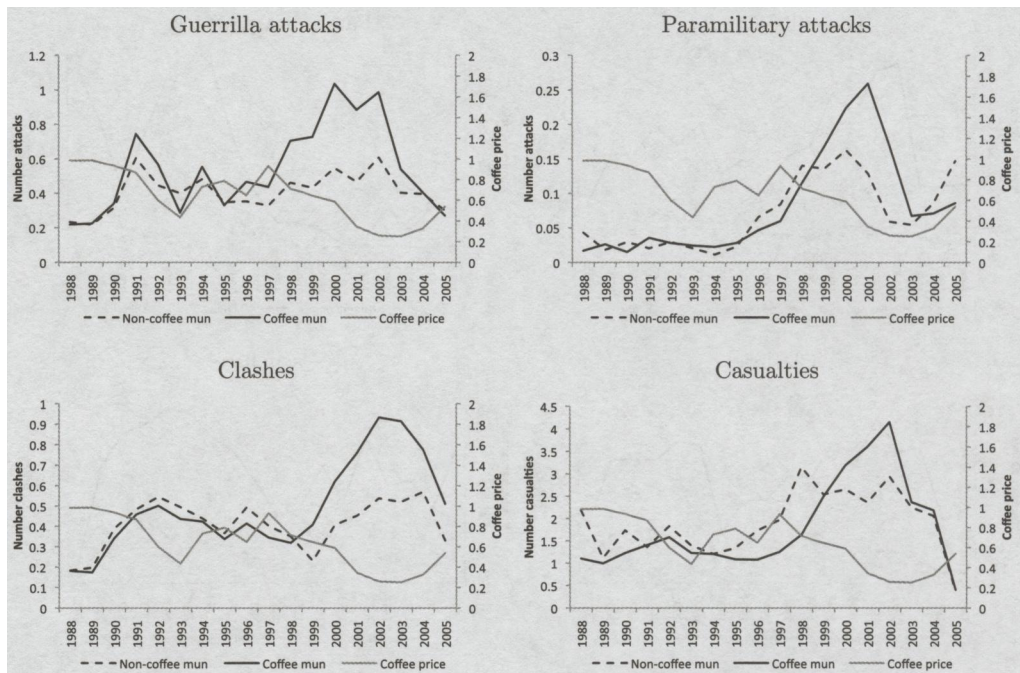
FIGURE 4

The coffee price and mean violence in coffee and non-coffee municipalities

Notes: This figure shows the (log) real internal price of coffee in Colombia, as well as mean violence in municipalities growing coffee in 1997 and mean violence in the non-coffee municipalities.

should be visible for the guerrillas during both the price fall in the early 1990s and the late 1990s, but visible only for the paramilitaries during the late 1990s. These patterns are discernible in the figure. The first major coffee price fall, over 1988–1993, correlates with a bifurcation only in guerrilla attacks across coffee and non-coffee areas.[35] However, during the price fall in 1997, all four dependent variables (including paramilitary attacks) diverge, with mean violence levels higher in coffee areas after 1997. The violence gap also begins closing in 2003, when the coffee price begins its recovery.

To visually examine the relationship between oil prices and violence, Figure 5 shows the price of oil along with mean violence levels in oil producing and non-oil producing areas. Figure A.II in the Supplementary Material shows the equivalent graphs using the broader definition of an oil municipality by including those with oil pipelines. In contrast to the case of coffee, these figures suggest that oil prices induce differential changes in paramilitary attacks, specifically.[36] We should expect to observe a divergence in paramilitary attacks during the oil price increase in the late 1990s, but not in the early 1990s, when overall levels of paramilitary violence were relatively low. This pattern is visible in both Figures 5 and A.II. There is no bifurcation in paramilitary attacks across oil and non-oil municipalities when the oil price is high during the early 1990s. In

35. The effect of the coffee shock on guerrilla attacks between 1988–1993 is statistically significant at the 5% level. This result is not shown for brevity, but is available from the authors upon request.
36. Guerrilla attacks, clashes and casualties tend to be higher in oil areas relative to non-oil areas for most years of the sample period, but do not diverge systematically across oil and non-oil municipalities during years when oil prices are high.
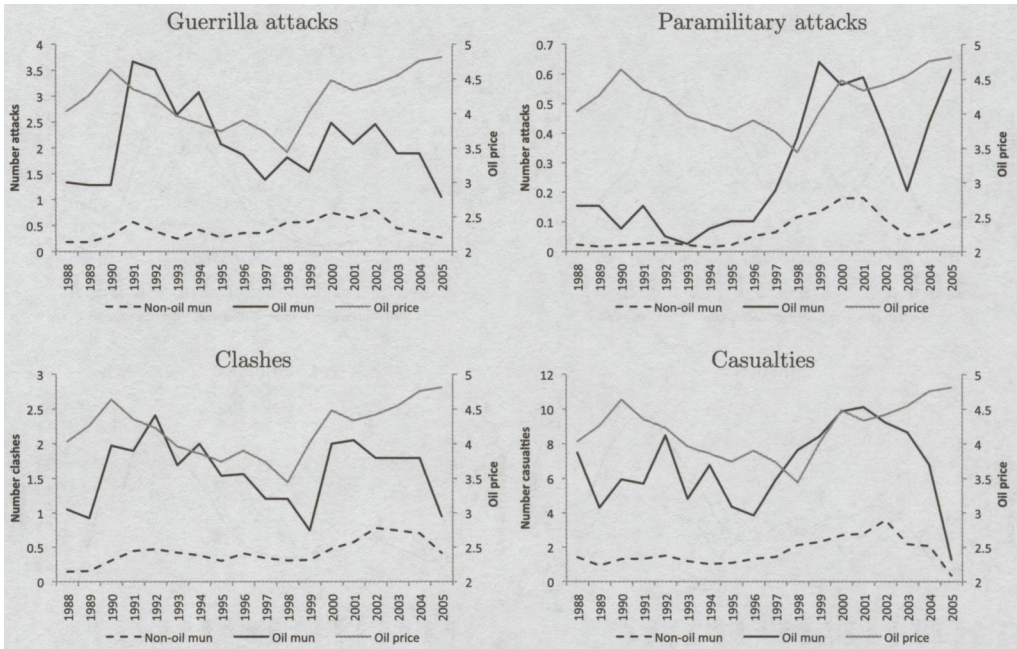
FIGURE 5

The oil price and mean violence in oil and non-oil municipalities

Notes: This figure shows the (log) real international price of oil, as well as mean violence in municipalities producing oil in 1988 and mean violence in the non-oil producing municipalities.

contrast, mean paramilitary attacks are differentially higher in the oil producing areas after 1998, when the oil price is again relatively high.

Overall, these figures seem to suggest that the coffee price shock has a negative relationship to all four violence outcomes, whereas the oil price shock has a positive relationship to paramilitary attacks in particular. However, the graphs presented show raw means, and do not correspond directly to our estimation strategy, since they use indicator variables rather than continuous measures of commodity presence, and do not control for municipality or year fixed effects. In the results section below, we build on this suggestive visual representation with evidence from regression estimates.

5. RESULTS

5.1. *The coffee shock, the oil shock, and conflict*

In this sub-section, we use regression analysis to assess the effect of coffee and oil price shocks on civil war outcomes in Colombia. The equations for the first and second stages are given by (1) and (2), although the estimation is undertaken in one step via 2SLS. The results are presented in Table 2. The coefficients in columns (1)–(4) shows that coffee price shocks have a negative relationship with conflict: when the price of coffee decreases, all four measures of violence increase differentially in municipalities that produce coffee more intensively.[37] These estimates

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37. This negative coefficient might alternatively be interpreted as indicating when prices fell, violence fell, but to a lesser degree in coffee areas. However, our interpretation is favoured by Figure 4, which shows that violence increased after 1997, and differentially so in the coffee region.

TABLE 2
The effect of the coffee and oil shocks on violence

Dependent variables	(1) Guerrilla attacks	(2) Paramilitary attacks	(3) Clashes	(4) Casualties
Coffee int. x log coffee price	−0.611**	−0.160***	−0.712***	−1.828*
	(0.249)	(0.061)	(0.246)	(0.987)
Oil production x log oil price	0.700	0.726***	0.304	1.526
	(1.356)	(0.156)	(0.663)	(2.127)
Observations	17,604	17,604	17,604	17,604

Notes: Standard errors clustered at the department level are shown in parentheses. Variables not shown include municipality fixed effects, year fixed effects, log of population, and linear trends by region and municipalities cultivating coca in 1994. The interaction of the internal coffee price with coffee intensity is instrumented by the interaction of the coffee export volume of Brazil, Vietnam, and Indonesia with rainfall, temperature, and the product of rainfall and temperature.
*** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level

are of statistical and economic significance. To gauge their magnitude, consider the rise in violence associated with the fall in coffee prices from their peak in 1997 to the trough in 2003, when the internal price fell by 0.68 log points. For the average coffee municipality, in which coffee intensity is 1.52 thousand hectares, the coefficients imply that the price fall induced 0.09 more guerrilla attacks, 0.02 more paramilitary attacks, 0.10 more clashes and 0.27 more casualties each year, relative to the non-coffee municipalities. Comparing these increases to their respective means implies increases of 18%, 31%, 22% and 14%, in each of the violence outcomes, respectively. The 0.27 increase in casualties also translates into an additional 1,013 war-related deaths in Colombia's coffee cultivating areas, over the 7-year duration of the international coffee crisis.

Table 2 also shows that the oil price shock exerts the opposite effect on conflict. The positive coefficient on the oil interaction term in column (2) indicates that a rise in oil prices increases paramilitary attacks differentially in areas that produce more oil. To understand the magnitude of the effect, it is useful to recognize that petrol prices rose by 1.37 log points between 1998 and 2005. In the average oil producing municipality, with production levels of 0.083 hundred thousand barrels per day, this price increase translates into 0.08 more attacks over this 8 year period, compared with a municipality without oil. This, in turn, corresponds to 0.01 more attacks per year, representing a 14% differential increase in paramilitary attacks above the mean.

A comparison of the coefficients on the coffee and oil interaction terms in column (2) suggests that the coffee effects are larger: a 10% fall in the price of coffee results in 5% more paramilitary attacks in the mean coffee region, whereas a 10% rise in the price of oil results in 1% more attacks in the average oil producing area.

The first-stage statistics associated with Table 2 also indicate that our instrument set is a strong predictor of coffee intensity. The Kleibergen–Paap *F*-statistic is 15.94, and exceeds the relevant Stock–Yogo critical value. In addition, the test for overidentifying restrictions is not rejected at the 10% level for any of the specifications, which also underscores the validity of the instrumental variables strategy.

Additional results in the Supplementary Material demonstrate the robustness of these results to a number of different samples and specifications. Table A.II shows that the effects holds when we eliminate the sample municipalities affected by a major earthquake in the coffee region in 1999, and when we eliminated municipalities in the DMZ, an area which was under guerrilla control between 1999 and 2002. Given the creation of new municipalities from old municipalities over our sample period (see Appendix), we also show that the estimated effects

are similar when the analysis is restricted to municipalities with constant boundaries over this sample period.[38]

Table A.III additionally shows the robustness of the results to a Poisson instrumental variables specification (which uses GLM estimation specifying a log link and Poisson-distributed errors). The estimates remain statistically significant at conventional levels for all outcomes, with the exception of casualties in the case of coffee shock, where the estimate is marginally insignificant with a p-value of 0.12.

Table A.IV extends our main specification to include the oil pipeline interaction. These results show that paramilitary attacks also increase disproportionately in municipalities with more pipelines when the oil price rises, and that the coefficients on both the coffee and oil production interactions remain unchanged when oil pipeline effects are incorporated.

Overall, these results confirm that the coffee and oil shocks affect conflict in opposite directions, and display asymmetric effects. Although the coffee shock affects all four types of violence outcomes, the oil production (and pipeline) shocks increase paramilitary attacks specifically. We address and interpret this asymmetry explicitly in Section 5.4 below.

5.2. The opportunity cost and rapacity channels

Our framework posits that commodity prices can affect conflict by altering the opportunity cost of armed recruitment, or by increasing contestable revenue, which promotes rapacity over these resources. In this sub-section, we examine whether these channels can be applied to the case of the coffee and oil shocks by examining labour market outcomes, municipal revenue, and kidnappings by armed groups.

To investigate the opportunity cost channel, we analyse whether changes in coffee and oil prices affect labour market outcomes differentially in municipalities producing these commodities more intensively. We analyse wages and work hours since both may respond to price shocks. In the second stage, we estimate:

$$q_{ijrt} = \alpha_j + \beta_t + \delta_r t + \text{Coca}_{jr} t\gamma + (\text{Oil}_{jr} \times \text{OP}_t)\lambda + (\text{Cof}_{jr} \widehat{\times} \text{CP}_t)\rho + \mathbf{Z}_{ijrt}\pi + \omega_{ijrt}, \qquad (3)$$

where q_{ijrt} is either the (log) real wages or (log) monthly hours worked by individual i in municipality j, region r and year t; and $\mathbf{Z}_{ijrt}$ is a vector of individual-level controls including education, age and its square, and indicator variables for gender and marital status. We continue instrumenting coffee intensity in the first stage.

Columns (1) and (2) of Table 3 present these results for 1998–2005, the subset of years for which comparable wage data are available. The estimates indicate that the coffee shock exerts substantially larger effects on both the wages and work hours of rural workers in areas with more coffee cultivation. The coefficients imply that a 1% increase in the real price of coffee increases wages and work hours by 0.56% and 0.43% more, respectively, in the mean coffee municipality, as compared to non-coffee municipalities. The 68% fall in coffee prices over 1997–2003 is thus predicted to have reduced wages by 38% more, and decreased work hours by 30% more during the period of the international coffee crisis. In contrast to these effects, the coefficients on the

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38. We also find that the effects are robust to including additional controls, such as the interaction of the coffee and oil prices with land inequality and an urban indicator, which equals 1 if the population exceeds 10,000 at the beginning of the sample period. These results are available from the authors upon request.

TABLE 3

The opportunity cost and rapacity mechanisms

Dependent variables	(1) Opportunity cost mechanism	(2)	(3) Rapacity mechanism	(4)	(5)
	Log wage	Log hours	Log capital revenue	Paramilitary political kidnappings	Guerrilla political kidnappings
Coffee int. x log coffee price	0.371*	0.286**	−0.787	0.022	−0.060
	(0.217)	(0.125)	(0.698)	(0.014)	(0.060)
Oil production x log oil price	1.230	0.079	0.419**	0.168***	−0.066
	(0.894)	(0.314)	(0.203)	(0.009)	(0.206)
Observations	26,050	57,743	11,559	16,626	16,626
Sample period	1998–2005	1998–2005	1988–2005	1988–2004	1988–2004

Notes: Standard errors clustered at the department level are shown in parentheses. In column (1), the dependent variable is the log of hourly wage, defined as the the individuals' earnings in the past month divided by hours of employment in the past month. In column (2), log hours refers to hours of employment during the past month. Variables not shown in all specifications include municipality fixed effects, year fixed effects, and linear trends by region and municipalities cultivating coca in 1994. Columns (1) and (2) also control for education, age, age squared, and indicators of gender and marital status. Columns (3)–(5) additionally control for log population. The interaction of the internal coffee price with coffee intensity is instrumented by the interaction of the coffee export volume of Brazil, Vietnam, and Indonesia with rainfall, temperature, and the product of rainfall and temperature.
*** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level

oil interaction terms in columns (1) and (2) display insignificant effects on both labour market outcomes.[39]

Next, we examine the rapacity channel by assessing how these price shocks affected local government budgets, which we conceptualize as representing resources that may be targeted for predation. Revenue allocation is linked to oil production in the following way: foreign oil companies operating in Colombia are required to pay the government royalties amounting to 50% of their oil export values, and an explicit revenue sharing agreement divides these royalties across the central, departmental, and municipal governments.[40] The amount given to each municipality is designated to be proportional to municipal production. In the fiscal data, these royalties are codified under a line-item called "capital revenue," which also includes other transfers from the central government (such as co-financing for joint investment projects with the municipal government). To assess whether changes in commodity prices have detectable effects on capital revenue, we estimate equation (1) with this dependent variable.

These results, shown in column (3) of Table 3, indicate that the oil price shock significantly increases capital revenue at the disposal of the municipal government: a 1% rise in the price of oil increases revenue by approximately 0.03% more in the mean producing municipality. Thus the rise in oil prices from 1998 to 2005 is estimated to have increased capital revenue by 5% more in this average municipality.[41]

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39. The coefficients also imply small effects in the average oil producing municipality—i.e., a 1% increase in the oil price predicts a 0.10% relative increase in wages and 0.01% relative increase in work hours, though both effects are statistically insignificant at conventional levels.

40. The government places 80% of the oil royalties into an Oil Stabilization Fund. As codified in Law 141, of the remaining amount, 32% goes to the central government, 47.5% goes to the department, and 12.5% goes to the municipality.

41. Since the fiscal data records the intended municipal allocation of line-items such as capital revenue, we view this variable as an *ex-ante* measure of rents that can be looted, rather than *ex-post* revenue that remains after predation has taken place.

In interpreting the oil shock, we posit that a rise in petrol prices motivates armed groups to escalate activity in oil-rich areas, with the aim of extracting these resources. If this mechanism holds, then we should also observe that the oil shock corresponds to a rise in extortionary activities. We use data on political kidnappings of government officials, political candidates, and other community leaders, to examine this idea. Columns (4) and (5) of Table 3 show that the oil production interaction significantly increases paramilitary kidnappings (by 7% more over 1988–2005 in the average oil municipality), but has no significant effect on guerrilla kidnappings. This one-sided effect, seen only for the paramilitaries, supports the idea that rising violence is linked to rising predation, as the oil shock is found to increase both attacks and kidnappings by paramilitary groups, specifically. Although we are not able to isolate effects on the kidnappings of just elected officials, these results are consistent with anecdotal accounts of armed groups kidnapping mayors as a part of their revenue extraction efforts (see discussion in Section 2).

In summary, the evidence in Sections 5.1 and 5.2 shows that the coffee shock exerts significant effects on wages and work hours, and increases violence perpetrated by all armed groups, but has no significant effect on revenue related to resource royalties, or to political kidnappings. This lines up with the idea that price shocks to labour intensive goods increase violence through the opportunity cost effect. In contrast, the rise in oil prices increases both contestable revenue, as well as paramilitary attacks and kidnappings, without inducing corresponding effects on labour market outcomes. This lines up with the idea that natural resource price shocks affect violence through the rapacity mechanism. In the absence of direct measures of recruitment into armed groups, or looting of public resources, the evidence on potential mechanisms presented here is indirect. However, the pattern of results are consistent with the idea of different commodity shocks affecting conflict via different channels.

5.3. *Alternative accounts*

Next, we consider and present evidence against several alternative explanations of the findings, including changes in migration, government enforcement, and coca cultivation, as well as collusion between government officials and paramilitary groups.

First, it is possible that commodity shocks may induce migration, which raises the concern that changes in the composition of the municipal population may drive the estimated effects. As an example, if changes in oil prices induce the migration of risk-loving individuals who seek employment amidst an oil boom, then this change in workforce composition, rather than rapacity, may increase violence. However, column (1) of Panel A in Table 4 shows that neither commodity shock has a significant effect on migration, and the coefficient on the oil interaction is negative.[42]

It is also possible that the price shocks affect violence through their effect on government enforcement, *e.g.*, by altering resources available for military spending. In particular, if a fall in the coffee price reduced military presence in the coffee municipalities, security lapses may have facilitated a rise in armed group attacks. To explore this hypothesis, we look at government attacks, which we interpret as a proxy for how actively the military fights in a particular area. The negative coefficient in Panel A of column (2) indicates that government military attacks *increased* differentially in the coffee region when coffee prices fell, which is consistent with greater military enforcement.[43] The results also show that the oil shock does not lead to changes

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42. Owing to a change in how migration data were collected in the ENH survey, a comparable migration variable is only available for the 2001–2005 period.

43. As discussed in Section 4.1 we distinguish between attacks by the government military and the illegal armed actors since they are likely to arise from different mechanisms. In particular, since military recruitment occurs at the

TABLE 4
Alternative accounts

	(1)	(2)	(3)	(4)
Panel A: Migration, enforcement and paramilitary protection				
Dependent variables	Migrant	Government attacks	Paramilitary massacres	Guerrilla massacres
Coffee int. × log coffee price	0.144	−0.089**	−0.116**	−0.012
	(0.096)	(0.040)	(0.055)	(0.015)
Oil production × log oil price	−14.381	0.011	0.122**	0.026
	(13.073)	(0.255)	(0.050)	(0.043)
Observations	33,313	17,604	17,604	17,604
Panel B: Political collusion				
Dependent variables	Guerrilla attacks	Paramilitary attacks	Clashes	Casualties
Coffee int. × log coffee price	−0.328**	−0.153***	−0.691***	−1.549**
	(0.152)	(0.036)	(0.241)	(0.751)
Oil production × log oil price	1.004	0.755***	−0.130	1.259
	(1.441)	(0.130)	(0.873)	(2.225)
Years pro-para majority × oil production × log oil price	0.939	1.018	0.834	10.103
	(1.872)	(0.831)	(2.510)	(15.369)
Years pro-para majority × log oil price	0.028	−0.001	0.048*	0.162*
	(0.021)	(0.006)	(0.028)	(0.093)
Observations	11,736	11,736	11,736	11,736

Notes: Standard errors clustered at the department level are shown in parentheses. Variables not shown include municipality fixed effects, year fixed effects, and linear trends by region and municipalities cultivating coca in 1994. Log of population is included as an additional control in all regressions except column (1) of Panel A, in which the dependent variable is an indicator that equals 1 if the individual has resided in the municipality for less than one year. This migrant regression also includes controls for education, age, age squared, and indicators of gender and marital status. In Panel B, years pro-para majority is the number of years between 1994 and 2005 that the majority of the municipal local council was held by politicians from parties whose members were accused of involvement with paramilitary groups. The three-way interaction of years pro-para majority, oil production, and oil price measures whether the oil price shock exerts differential effects in municipalities with more pro-paramilitary politicians. The two-way interaction of years pro-para majority and oil price is included as a control. In all specifications, the interaction of the internal coffee price with coffee intensity is instrumented by the interaction of the coffee export volume of Brazil, Vietnam, and Indonesia with rainfall, temperature, and the product of rainfall and temperature.
*** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level

in government attacks, indicating that a reduction in military presence does not account for the increase in violence in oil areas.

Next, we explore the possibility that the oil effects arise due to collaboration between government officials and paramilitary groups. Under this account, politicians willingly share additional revenue with these armed groups when the value of oil increases budgetary resources. One aspect of this argument posits that local governments essentially outsource security provision to the paramilitaries, in which case it is protection, rather than predation, that leads to greater paramilitary activity in the oil areas. We address this alternative account in two ways. Columns (3) and (4) in Panel A show that the oil shock led to a rise in the number of massacres undertaken by paramilitary groups, without inducing a corresponding effect on massacres by guerrillas. This suggests that paramilitary presence does not, as a general matter, safeguard the population in the oil region.

national level, increases in government attacks after a negative price shock are more likely to reflect increased fighting effort in response to armed group activity, rather than the opportunity cost mechanism.

In addition, if local governments willingly finance paramilitary groups, and this financing induces more paramilitary attacks, then the oil shock should exert larger violence effects in municipalities dominated by pro-paramilitary politicians. To test this hypothesis, we interact the oil price shock with the number of years (between 1994 and 2005) that the majority of the local council was held by politicians from parties accused of ties to paramilitary groups in the para-politics scandal.[44] The three-way interaction term in Panel B shows that there are no differential increases in paramilitary attacks in municipalities where the majority of council legislators came from pro-paramilitary parties. Thus, while there may have been collaboration between some paramilitary groups and some politicians during this period, the rise in paramilitary violence in response to the oil shock does not appear to be driven by this collaboration.

Another alternative account concerns the illicit cultivation of coca. Coca can affect our findings in one of two ways. First, the fall in coffee prices may have led farmers to substitute away from coffee production and into coca production. Since armed groups fight to control proceeds from the drug trade, this could serve as an alternative mechanism through which the price shocks affect violence, beyond the opportunity cost and rapacity channels.[45] To test this hypothesis, we re-estimate equation (1) using time-varying coca-intensity as the outcome variable.[46] These results are shown in Panel A of Table 5. The coefficients in column (1) indicates that neither the coffee nor the oil shock led to a significant rise in coca cultivation. In columns (2)–(5), we also re-estimate our violence outcomes for the subset of years and municipalities for which we have coca data. Generally, the pattern of effects continue to hold within this reduced sub-sample, although the coffee shock effects are no longer statistically significant for guerrilla attacks and casualties, owing to the erosion of 56% of the observations relative to the full sample used for the main results in Table 2.

Second, if coca-intensity is correlated with either oil or coffee production, then any policy shock that leads greater fighting in the coca intensive municipalities may bias our estimates. For example, in 1994, increased air interdiction to curb the transport of coca out of Peru and Bolivia shifted coca cultivation from the other Andean nations into Colombia. Angrist and Kugler (2008) show that this change led to a disproportionate rise in homicides within departments already cultivating coca as of 1994. In addition, in 1999, a U.S.-backed military aid initiative called *Plan Colombia* led to an aggressive military campaign in coca areas, including aerial spraying aimed at eradicating drug crops. If eradication efforts were successful this may have lowered fighting in coca areas. On the other hand, if the policy change resulted in greater military clashes, this may have induced the opposite effects. Although the inclusion of linear trends by coca and non-coca municipalities partly account for these effects, in Panel B of Table 5, we control for the coca effect more flexibly by interacting 1994 coca intensity with year dummy variables. In Panel C, we control for the coca effect differently, by instead removing every municipality that was recorded as cultivating this drug crop in any year of our coca sample. The results are robust to both approaches, indicating that the coffee and oil price shocks exert independent effects on violence, even after accounting for coca in a number of different ways.

In Table A.V of the Supplementary Material, we also estimate effects of the 1994 policy shock on violence directly by adding an interaction of 1994 coca intensity with a post-1994 indicator to our primary specification. The coca shock is found to significantly raise the amount of clashes and casualties, though it does not appear to affect the number of guerrilla and paramilitary attacks.

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44. Data on local council elections are only available for the 1994–2005 period.

45. It is important to address this hypothesis since there has been extensive media coverage claiming that the sharp fall in international coffee prices in the late 1990s led farmers to cultivate more coca in Colombia and other neighbouring countries (Krauss, 2001; Wilson, 2001a,b; Fritsch, 2002).

46. Analogous to coffee intensity, coca intensity is defined on the basis of land used for cultivating coca.

TABLE 5
Accounting for coca

Dependent variables	(1) Coca	(2) Guerrilla attacks	(3) Paramilitary attacks	(4) Clashes	(5) Casualties
Panel A: Testing the coca substitution hypothesis					
Coffee int. × log coffee price	0.072	−0.082	−0.097**	−0.690***	−0.611
	(0.061)	(0.245)	(0.046)	(0.255)	(0.706)
Oil production × log oil price	−0.323	−0.633	0.908***	−0.423	−0.089
	(0.647)	(2.116)	(0.134)	(1.147)	(4.116)
Observations	7,824	7,824	7,824	7,824	7,824
Panel B: Controlling for coca intensity interacted with year effects					
Coffee int. × log coffee price	−	−0.605**	−0.158***	−0.679***	−1.720*
	−	(0.249)	(0.060)	(0.236)	(0.931)
Oil production × log oil price	−	0.700	0.722***	0.247	1.781
	−	(1.361)	(0.153)	(0.671)	(2.053)
Observations		17,604	17,604	17,604	17,604
Panel C: Removing every coca municipality					
Coffee int. × log coffee price	−	−0.349**	−0.132**	−0.314***	−0.667**
	−	(0.139)	(0.052)	(0.100)	(0.324)
Oil production × log oil price	−	0.568	0.630***	0.100	1.258
	−	(1.444)	(0.053)	(0.728)	(1.932)
Observations		13,428	13,428	13,428	13,428

Notes: Standard errors clustered at the department level are shown in parentheses. Variables not shown in all specifications include municipality fixed effects, year fixed effects, log of population, and linear trends by region. The interaction of the internal coffee price with coffee intensity is instrumented by the interaction of the coffee export volume of Brazil, Vietnam, and Indonesia with rainfall, temperature, and the product of rainfall and temperature. The dependent variable in column (2) of Panel A is the amount of coca cultivated in each municipality. The effect of the coffee interaction on this outcome variable indicates whether there is greater substitution towards coca planting in response to coffee price shocks. In this coca regression, the sample period is restricted to the years for which coca data are available: 1994 and 1999–2005. Columns (2)–(5) in Panel A examine the relationship between conflict outcomes and the coffee and oil price shocks for this sub-sample of years. These regressions also control for trends by municipalities cultivating coca in 1994. Panel B includes the interaction of 1994 coca intensity with year dummies as an alternative approach to controlling for coca when examining effects on conflict outcomes. Panel C removes the set of municipalities that were recorded as cultivating coca during any year of the coca sample.
*** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level

This replicates Angrist and Kugler's (2008) finding at the municipal level, and shows the link between coca and political violence explicitly, by using data on civil war-related incidents instead of mortality statistics.

Finally, we address the possibility that spillover effects across the coffee and oil sectors may lead to observed violence effects in Table A.VI of the Supplementary Material. In particular, since the fall in coffee prices occurred simultaneously as the rise in oil prices, it is possible that the fall in coffee workers' wages led to their recruitment into armed groups for the explicit purpose of predating on oil rents. In this sense, a fall in coffee prices may be driving the increase in violence in the oil region. Since this type of spillover is likely to be largest when coffee and oil production are in close proximity of one another, we present evidence against this account by showing that the results are robust to: eliminating municipalities that have both coffee cultivation and oil production; eliminating oil municipalities that are spatially contiguous with or neighbour coffee municipalities; and conversely, eliminating coffee municipalities that neighbour coffee.

In sum, the evidence presented here suggests that the coffee and oil shocks do not affect violence through a number of plausible alternative channels, including changes in migration, enforcement, paramilitary collusion with officials, the planting of coca, and cross-sector spillovers.

5.4. *Interpretation of asymmetric effects*

Our results show asymmetric effects, with the coffee shock increasing both guerrilla and paramilitary violence, and the oil shock increasing only paramilitary violence. We posit that this asymmetry reflects the geographic concentration of oil production, which reduces the likelihood that multiple armed groups operate in these areas. Moreover, the paramilitary groups originated from oil areas which positioned them to dominate these municipalities. As shown in Figure A.III of the Supplementary Material, two leading paramilitary groups emerged from the Magdalena Medio and Córdoba regions, which have oil production and pipelines. In contrast, FARC originated from the Southern departments of Cauca and Tolima, and ELN from the department of Santander, which are coffee producing areas but do not have oil.

It is important to note that the Magdalena Medio and Córdoba regions gave rise to paramilitary groups reasons unrelated to oil. Both were major cattle ranching and drug crop production areas during the early 1980s, when guerrilla extortion led the ranchers and drug lords to create self-defense groups which were precursors to paramilitary groups (Cubides, 1997). In the Magdalena Medio, the ranchers formed an alliance with narcotraffickers, and marijuana and cocaine (rather than oil rents) were their primary source of revenue (Gutierrez and Baron, 2005).[47] In Córdoba, two brothers of the Castaño family formed an anti-insurgency group in 1983, when their father, a cattle rancher, was kidnapped and killed by the FARC. Upon formation, it was financed by illegal drug trafficking, voluntary contributions from landowners, and also extortion of small businesses, but not oil (Cubides, 1997). This group began working with other neighbouring paramilitary organizations and ultimately united with the Magdalena Medio paramilitaries to form the AUC, with one brother (Carlos Castaño) serving as the AUC's first official leader.

Once the paramilitaries expunged the guerrillas from the oil region, oil producing municipalities became paramilitary strongholds.[48] In contrast, the geographic spread of agricultural commodities such as coffee increased the likelihood that both types of armed groups would be proximate to and operate out of the coffee areas. For example, 1988 oil production took place in 39 sample municipalities, and 90% of it was concentrated in just 12 municipalities. However, 1997 coffee cultivation took place in 536 municipalities, and 90 of the land used for coffee cultivation was spread out over 275 municipalities. In this sense, geographic differences in the armed groups' place of emergence interact with the relative geographic concentration of oil in accounting for the asymmetric manner in which the coffee and oil price shocks affect violence.

This explanation suggests that similar asymmetric effects should be observed for price shocks to other agricultural commodities and natural resources, a hypothesis we examine directly in the section below.

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47. In fact, the two leaders of the early rendition of the Puerto Boyacá paramilitaries were Henry Perez, a noted cattle rancher, and Gonzalo Rodriguez Gacha, a drug trafficker (Gutierrez and Baron, 2005).

48. A greater government military presence in the oil region also made it relatively difficult for the guerrillas to subsequently move into the regions with oil pipelines, since the government forces target the guerrillas to a greater degree than they target the paramilitaries. However, it is important to note that any tacit collusion of the military and paramilitary in terms of differential targeting of guerrillas differs from the hypothesis that local governments hire paramilitary groups directly to outsource security in the oil region. This hypothesis is an important alternative explanation of the mechanism behind our findings, which we address and present evidence against in Section 5.3.

5.5. *Other commodity price shocks and conflict*

In this sub-section, we examine the extent to which our findings for the coffee and oil shocks hold in the case of other commodities. We select these other goods based on three criteria: the commodity must be a major export, have a defined international price, and be produced in a reasonable number of treatment municipalities. (Further details are available in the Appendix).

These criteria yield two additional natural resources: coal and gold. In both cases, municipal-level production data are only available from the end of the sample period (2004). Since these production levels may be endogenously determined, we instrument gold production cross-sectionally with a measure of potential precious metal mining area from 1978. Specifically, the instrument interacts the 1978 mining area with the international gold price. Since the mines also contain silver and platinum, we control for mining area interacted with the international prices of silver and platinum, which helps ensure that the instrument isolates the effects of the gold shock. We also instrument coal production cross-sectionally with an indicator of whether the municipality had coal sub-basins in 1978, which analogously represents potentially exploitable coal mining prior to our sample period. Since Colombia is a major coal exporter during this time, we also have to address potential endogeneity in using the international price. Thus, we instrument the interaction of coal production and international price with the interaction of the coal sub-basin indicator and the export volume of the top 3 coal exporting nations.

Table 6 presents these results. The Kleibergen–Paap F-statistic associated with this table is 11.486, which again exceeds the Stock Yogo critical value. In addition, the Angrist–Pischke F-statistics for the coal and gold interactions are 20.83 and 48.84, respectively, ruling out concerns regarding weak identification of the individual regressors. As shown in Table 6, the coefficients on these interaction terms demonstrate that the positive relationship between natural resource price shocks and violence generalize beyond oil, and hold in the case of these other two commodities. The results also display a clear pattern in terms of attacks increasing by one group: the oil shock continues to induce greater paramilitary attacks but has no significant effect on guerrilla attacks, whereas both the coal and gold shocks increase guerrilla attacks, but have no significant effect on paramilitary attacks. The coal interaction additionally increases clashes and casualties (though the gold and oil shocks do not). This suggests that increased attacks by one side can have an ambiguous effects on the more aggregate conflict measures.

TABLE 6

The effect of other natural resource price shocks on violence

Dependent variables	(1) Guerrilla attacks	(2) Paramilitary attacks	(3) Clashes	(4) Casualties
Oil production × log oil price	0.689	0.723***	0.253	1.514
	(1.355)	(0.149)	(0.654)	(2.031)
Coal production × log coal price	0.128*	0.014	0.145**	0.392*
	(0.069)	(0.011)	(0.062)	(0.236)
Gold production × log gold price	0.143**	−0.027	0.026	−0.234
	(0.068)	(0.028)	(0.058)	(0.461)
Observations	17,964	17,964	17,964	17,964

Notes: Standard errors clustered at the department level are shown in parentheses. Variables not shown include municipality fixed effects, year fixed effects, log of population, and linear trends by region and municipalities cultivating coca in 1994. The interaction of coal production and coal price is instrumented by the interaction of a dummy indicating that the municipality has coal sub-basins in 1978 and the coal export volume world's three leading coal exporting nations (which excludes Colombia). The interaction of gold production and price is instrumented by the interaction of 1978 precious metal mining area interacted with the international gold price. All specifications also control for the interactions of 1978 precious metal mining area with the international prices of silver and platinum.
*** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level

Since the majority of coal and gold production takes place in relatively few municipalities (8 and 15, respectively), this reinforces the idea that increased violence by one armed group arises when there is a relatively high geographic concentration of the commodity. It also highlights the potential concern that particular armed groups may operate in particular regions as an endogenous response to the production of these commodities. However, two points counter this concern in the context of our study. First, the time-invariant association between particular armed groups and regions where commodities are concentrated are essentially absorbed as municipality fixed effects in our empirical strategy, which identifies effects on violence based on changes in international prices over time. Second, qualitative accounts of guerrilla entry into the coal and gold region highlight that FARC and ELN came to dominate these areas due to several idiosyncrasies, including geographic proximity of the groups to the resources, as well as their entry into the areas prior to paramilitary emergence.

The coal region came to be a dominated by the ELN, which originated in the department of Santander in 1964. Coal mining started in Colombia nearly two decades later in the 1980s, which precludes the possibility that ELN chose the location of its base as an endogenous response to this resource. However, coal production was concentrated in a belt proximate to Santander, which facilitated the group's subsequent predation in the area. In fact, during our sample period, the four major coal producing departments—Norte de Santander, Antioquia, Boyacá, and Cundinamarca—all surrounded Santander. As reported by Kline (1999) ELN was earning approximately 12.8 million in revenue annually from the coal regions. However, coal was not a major source of revenue for the FARC, indicating that proximity to base matters for expansion into particular geographic territories with particular natural resources.

The guerrillas came to achieve dominance in the gold municipalities prior to the time when the paramilitary groups had emerged on a widespread scale or become an organized force. FARC moved into the Antioquia gold region as early as the 1970s and the Bolivar gold region in the early 1980s, as a part of a massive geographical expansion which led to a doubling of fronts over this period (Echandia, 1997). By 1991, FARC and ELN were earning up to 9.6 million and 10.8 million in gold revenue, respectively (Kline, 1999). Once these groups established control in the gold region, it increased the cost and difficulty of paramilitaries operating in these areas. The advantage of moving first is reflected in continued guerrilla domination of the gold region. Even as of 2011, FARC reportedly controlled up to 15 gold mines in the department of Bolívar alone, mining gold illegally in some areas, while extorting payments from small-scale miners in others (The Economist, 2011). Notably, anecdotal accounts posit that the extent of illegal mining increased with the spike in gold prices in 2010 and 2011 (*ibid*).

To what extent can the positive effects of natural resource price shocks on violence perpetrated by one group be contrasted to violence effects in the case of other agricultural goods? In Table A.VII in the Supplementary Material, we examine effects with four other agricultural goods: bananas, sugar, African palm, and tobacco.[49] In the absence of strong instruments predicting these crop production levels, which are measured from the end of the sample period (in 2005), we interpret these effects as correlations. However, the results again display a clear pattern: they show a negative relationship between agricultural price shocks and conflict, with price increases inducing a differential fall in violence among municipalities that cultivate these crops more

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49. We conceptualize coca differently from these other agricultural commodities because it is an illicit good, and contracting to produce coca for an illegal armed group is analogous to employment in the illegal criminal sector rather than a legal sector. Because violence is required for contract enforcement in illicit markets, a rise in the price of coca may lead to greater predation and violence through this channel, even though it is an agricultural good. In addition, it is challenging to identify the effect of coca price shocks in the Colombian context, since it is the leading producer of cocaine in the world and prices are not plausibly exogenous to its production.

intensively. In addition, the coefficients generally indicate violence increases by both sides, with attacks by paramilitaries and guerrillas increasing in response to a price fall.[50]

Taken together, this pattern of results suggests that the asymmetric effect of natural resource prices on armed group attacks do not reflect idiosyncratic features specific to the coffee and oil regions. In addition, the results suggest the opposite effects of agricultural versus natural resource price shocks on conflict generalize beyond the coffee and oil sectors.

6. CONCLUSION

This article has examined how different types of commodity shocks affect civil war outcomes. Using detailed conflict data in 978 Colombian municipalities over 18 years, we document that price shocks to labour intensive agricultural goods and natural resources affect political violence in opposite directions. We demonstrate that a *fall* in the price of coffee increases violence differentially in regions that cultivate coffee more intensively, and find similar patterns with other labour intensive agricultural crops including sugar, banana, tobacco, and palm. In contrast, a *rise* in the price of natural resources including oil, coal, and gold intensifies attacks in regions that produce more of these goods.

According to our results, different commodity shocks affect violence dynamics through different channels. We find that the fall in coffee prices disproportionately reduces the wages and work hours of rural workers in coffee municipalities. This is consistent with the coffee shock inducing an opportunity cost effect, whereby violence rises as income shocks lower the opportunity cost of joining armed groups. We also find that oil price booms increase local government revenue generated by taxing natural resources and promote political kidnappings in the oil region. These results are consistent with the oil price shock inducing a rapacity effect, whereby armed groups target the oil region with the aim of extorting these rents. Although this evidence on mechanisms is indirect, we are also able to address and rule out a number of alternative accounts: we show that the effects cannot be attributed to rising drug crop cultivation, or decreases in government enforcement. In addition, municipalities with more pro-paramilitary politicians do not display larger effects, which counters the argument that they are driven by explicit revenue sharing or officials hiring paramilitary groups to provide security in the oil region.

Our analysis points to several policy implications. First, the findings suggest that price stabilization schemes which place a floor on the price of labour intensive commodities can help mitigate violence in the wake of price shocks. Second, since natural resource revenue is found to promote rapacity, improved monitoring may prevent these funds from fuelling conflict. Finally, since funds leak through local governments, fiscal structure may interact with price shocks in affecting conflict outcomes. For example, price shocks to natural resources may invite greater predation when fiscal decentralization transfers more revenue to lower levels of government. How a commodity's production characteristics interact with local political institutions in promoting armed conflict should be an avenue for future study.

APPENDIX

A. DATA APPENDIX

A.1. *CERAC conflict data*

Our analysis uses the 2006 version of the conflict dataset from the CERAC, a Bogota-based think tank. This dataset contains over 21,000 events from the Colombian civil war, covering the period 1988–2005. The main source of the

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50. The exception is the palm shock, where the coefficient is (insignificant) positive in the case of guerilla attacks.

CERAC data are conflict events listed in periodicals published by two Colombian NGOs, the Center for Research and Popular Education/Peace Program (CINEP) and Justicia y Paz. These periodicals, in turn, are based on two sources: reports of political violence and human rights abuses that appear in 25 printed media outlets with local and national coverage, and a broad network of partner NGOs and priests from the Catholic church with representation in almost every Colombian municipality, who report on conflict episodes to CINEP. The reliance on a large number of media sources as well as the priests residing in remote areas leads to the inclusion of every part of the Colombian territory: violence events are reported in over 950 Colombian municipalities during this 18-year period.

CERAC constructs the dataset by coding CINEP's event list. It proceeds in several stages. First, the research team screens out violent events that are deemed unrelated to the civil conflict.[51] This ensures that the data only include war-related actions that are carried out by one of the politically motivated armed groups or the government military. Second, researchers take the universe of all large events (that are associated with double-digit casualties), as well as a random sample of smaller events, and check them against the electronic archives of the leading Colombian news paper, El Tiempo. This verifies that events have been reported accurately in the original periodicals (and coded correctly by the research team). Third, CERAC cross-checks the events against other sources, including a dataset of the National Police and reports from international organizations such as Human Rights Watch and Amnesty International. It incorporates events from these other sources, without double-counting, to verify that the dataset is comprehensive.

Each event is coded in terms of date; location at the municipality level; and group involved, which includes the categories of FARC, ELN, other guerrilla, paramilitary, and government military.[52] For each event, it is also possible to generate counts of casualties by civilians and the groups involved. Finally, each event is classified by type of action, either an attack or a clash. Based on this coding, we aggregate the number of guerrilla attacks, paramilitary attacks, clashes and casualties to the municipality-year level and use these as the four main dependent variables in the analysis.

A clash is defined as a direct encounter between two or more groups that results in armed combat. An attack is a unilateral violent event carried out by a single group, in which there is no direct armed combat between two groups. In cases of events that involve one group firing upon another, the distinction is based on whether the event is contested, or remains uncontested. Thus, if one group fires on another group, and there is no return of fire by the targeted group, this is classified as an attack. In contrast, when one group targets another group which returns fire, it is classified as a clash. In some instances, a sequence of events may involve two or more closely timed actions that include both attacks and clashes. For example, an armed group may ambush an army convoy (an attack), and this may be subsequently followed by an exchange of fire with government soldiers (a clash). In these complex cases, CERAC determines which action it is primary based on the relative import of the two sub-events, and the attacks and clashes variables we use are based on the exclusive placement of an event into a single category. In the convoy example, if no solider dies during the ambush before the army re-positions itself and returns fire, the attack component is deemed to be of lesser importance, and the event is classified as a clash. Conversely, if a number of soldiers die in the ambush it is classified as an attack. Given potential complexities in classification, we assess effects on both attacks and clashes throughout our analysis.

Attacks by the armed groups can also include other types of events besides those that involve firing on another group, such as: incursions into a village; bombing pipelines, bridges, telecommunications towers, or other types of infrastructure; launching explosives towards police stations and army bases; and setting off mine explosions. In addition, the data include government attacks, which are rare events that primarily involve aerial bombardments. However, they also include some cases of anti-narcotics and anti-kidnapping operations that remain uncontested.

The raw, original data also include brief descriptions of each event. We access these descriptions and provide examples below to convey the richness of the information used to construct the dataset, and to add further clarification on the attacks versus clashes distinction.[53]

Three examples of clashes from the dataset are:

(1) March 13, 2003. Department: Cundinamarca—Municipality: Gutiérrez

One guerrilla from Front 51 of FARC-EP died during combat against troops from the Counterinsurgency Battalion "River Heroes" from the National Army. The events occurred in Vereda La Preciosa.

(2) January 24, 2004. Department: Nariño—Municipality: La Llanada

After members of FARC-EP entered the municipality there was a combat with the National Police in La Tola, near the cemetery of the town. In the midst of these events a civilian was killed and many houses resulted damaged. Seven policemen were injured.

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51. The majority of discarded events involve non-conflict-related crimes, including property crime, and incidents of domestic violence.

52. The other guerrilla category includes smaller groups, several of which demobilized over the sample period, such as the Popular Liberation Army (EPL), the Quintin Lame Armed Movement, M19, The People's Revolutionary Army (ERP), and others.

53. We translate the events which are originally recorded in Spanish.

(3) April 24, 2000. Department: Casanare—Municipality: Paz de Ariporo

During a combat between guerrillas of Front 28 from FARC-EP and paramilitaries from the Autodefensas del Casanare, 16 guerrillas, and 12 paramilitaries died.

Three examples of attacks are:

(4) April 1, 2000. Department: Cesar—Municipality: El Paso

Using dynamite, the guerrillas blew up two stages of the railroad that is used to transport coal from the Drummond mines to the sea harbours of the Atlantic coast, during the early morning.

(5) January 12, 2004. Department: Antioquia—Municipality: Anza

Guerrillas from Front 34 of FARC-EP threw an explosive at a group of AUC paramilitaries, killing five and injuring seven of them. The event occurred in a public establishment located in the main square of the corregimiento Guintar, during the night.

(6) December 24, 1999. Department: Valle—Municipality: Tulua

Between 30 and 40 heavily armed AUC paramilitaries arrived in the zone of Altaflor, located between Tulua and Bugalagrande in the afternoon. Holding a list, they pulled five peasants out of their houses and executed them.

CERAC coders also explicitly label attacks that are massacres. A massacre is defined as the intentional killing of four or more civilians by a single perpetrator in a single event.[54] Coders are instructed to distinguish intentional killing from cases of civilian deaths that arise as a consequence of other objectives. For example, if civilians die while the guerrillas attack the police (analogous to a situation in event (2) above), this would not be coded as a massacre. However, if one of the armed groups enter a village and kill four or more civilians (as in event (6) above), this would be coded as a massacre. We use this label to additionally generate annual counts of paramilitary and guerrilla massacres.

A.2. Data sources for commodities and international prices

We use commodity data from a number of different sources. Data on hectares of land used for coffee cultivation comes from the 1997 Coffee Census, a nation-wide enumeration of coffee growers conducted by the *NFCG,* over the 1993–1997 period. Measures of land used for cultivating sugar, banana, tobacco, and African palm in 2005 (used for results in the Supplementary Material), come from the Agricultural Ministry. These figures are estimates produced by technical assistance experts in the municipal government.

Data on 1988 oil production come from the MME. The same source provides data on the length of oil pipelines in the year 2000 (used for Supplementary Material results).

Measures of municipal coal and gold production in 2004 come from another government institution, el Instituto Colombiano de Geología y Minería (Ingeominas). We use maps from the U.S. Geological Survey's Coal Quality Inventory in Colombia (Tewalt *et al.,* 2006) to generate an indicator for which municipalities have sub-basins or, fields of potentially exploitable coal in 1978. Data based on mining license applications submitted to the MME are used to measure potentially exploitable precious metal mining as of 1978. In particular, individuals seeking permission to mine gold, silver, and platinum (which are found together in the same mines) list the proposed mining area in their applications, and these areas are aggregated to the municipal level, and reported by the Sociedad Geográficas de Colombia (in Jacome, 1978).

The internal price of coffee and the export volume of the other leading coffee exporting nations comes from the NFCG and International Coffee Organization, respectively. The international price of oil is from the IFS. The export volume of the three other leading coal exporters comes from the U.S. EIA (EIA). The international price of coal, gold, and tobacco come from the Global Financial Data. The international prices of sugar, bananas, and African palm are from the IMF. Table A1 provides a summary of sources, along with the sample size of key variables.

A.3. Sample size at the municipal level

In creating the panel datatset that combines the CERAC conflict data with the commodities data, we create a balanced panel of municipal year observations. Because the CERAC data are comprehensive in coverage of conflict events throughout the country, we ensure that we include municipalities that have never experienced an attack during the sample period by coding them with zeroes. This requires us to account for the fact that 7.5% of the 1,036 Colombian municipalities extant at the start of the sample period (1988) subsequently split to give rise to new municipalities, resulting in a total of 1,118 municipalities by 2005. We do so by aggregating new and old municipalities to their original 1988 boundaries, *i.e.*, to the level of the original municipality. This aggregation enables us to analyse violence events in a constant geographic unit

54. CERAC uses this definition because it is the official one set by the Colombian National Police Department.

TABLE A1
Sample size and sources

	Sample period	Sample municipalities	Source
Panel-level variables			
No. annual guerrilla attacks	1988–2005	998	CERAC
No. annual paramilitary attacks	1988–2005	998	CERAC
No. annual clashes	1988–2005	998	CERAC
No. annual casualties	1988–2005	998	CERAC
No. annual government attacks	1988–2005	998	CERAC
No. annual paramilitary massacres	1988–2005	998	CERAC
No. annual guerilla massacres	1988–2005	998	CERAC
No. annual guerrilla political kidnappings	1988–2004	998	CEDE-observatory
No. annual paramilitary political kidnappings	1988–2004	998	CEDE-observatory
Log real municipal capital revenue	1988–2005	983	NPD
Coca intensity	1994, 1999–2005	998	DNE, UNODC
Log population	1988–2005	998	DANE

	Year	Sample municipalities	Source
Municipal-level variables:			
Coffee intensity	1997	978	NFCG
Oil production	1988	998	MME
Length of oil pipelines	2000	998	MME
Coal production	2004	998	Ingeominas
Coal reserves indicator	1978	998	USGS
Gold production	2004	998	Ingeominas
Precious metal mining	1978	998	Jacome (1978)
Cultivated coca in 1994 indicator	1994	998	DNE
Coca intensity	1994	998	DNE
Ever cultivated coca indicator	any year of 1994, 1999–2005	998	DNE, UNODC
Sugar intensity	2005	998	Ag. Ministry
Tobacco intensity	2005	998	Ag. Ministry
African palm intensity	2005	998	Ag. Ministry
Banana intensity	2005	998	Ag. Ministry
Rainfall	1995	998	CEDE
Temperature	1995	998	CEDE
Years pro-paramilitary majority	over 1994–2005	998	Fergusson *et al.* (2013)

	Sample period		Source
Annual-level variables			
Log internal coffee price	1988–2005	–	NFCG
Log coffee exports of top 3 coffee exporters	1988–2005	–	ICO
Log int'l price of oil	1988–2005	–	IFS
Log int'l coal price	1988–2005	–	IMF
Log coal exports of top 3 coal exporters	1988–2005	–	US EIA
Log int'l gold price	1988–2005	–	GFD
Log int's silver price	1988–2005	–	GFD
Log int'l platinum price	1988–2005	–	GFD
Log int'l tobacco price	1988–2005	–	GFD
Log int'l palm price	1988–2005	–	IMF
Log int'l banana price	1988–2005	–	IMF
Log int'l sugar price	1988–2005	–	IMF

(Continued)

TABLE A1
continued

	Sample period	Sample Individuals	Source
Individual-level variables			
Log real wages	1998–2005	26,050	DANE (ENH)
Log monthly hours	1998–2005	57,743	DANE (ENH)
Migrant	2001-2005	33,313	DANE (ENH)

Notes: CERAC, Conflict Analysis Resource Center; Ag. Ministry, Ministry of Agriculture; DNE, National Department of Drugs; UNODC, United Nations Office of Drug Control; CEDE, Center for the Studies of Economic Development; CEDE-observatory, CEDE data that originates from the Observatory of Human Rights of the Vice-Presidency of Colombia; NFCG, National Federation of Coffee Growers; MME, Ministry of Mines and Energy; Ingeominas, A government agency in charge of mining; USGS, U.S. Geological Survey; ICO, International Coffee Organization; IFS, International Financial Statistics; IMF, International Monetary Fund; US EIA, U.S. Energy Information Administration; GFD, Global Financial Data; DANE, Colombian statistical agency; ENH, Encuesta Nacional de Hogares. The ENH is not a panel and the number of individuals in the sample varies across years.
The individual sample listed above refers to working-age individuals (between 14 and 60) that appear in our sample. See Section A.4 in the Appendix for further details.

over time. It is also important given that the time-invariant commodity measures (such as oil production in 1988) tell us the total quantity of the commodity present in the original municipality, rather than its distribution across the new and old portions of the municipality after its division.

Since 16 of the new municipalities were formed out of multiple original municipalities existing in 1988, in these cases, we aggregate multiple original municipalities to create a constant unit over which the dependent and independent variables can be tracked. This leads to the creation of some municipal units that are actually a composite of multiple original municipalities. There are seven such composite units in our final sample.

Because the insurgency is concentrated in rural areas, and conflict dynamics vary substantially in the urban metropolitan areas, we eliminate the 22 largest municipal units from the analysis, defined as those whose population, on average, exceeded 250,000 over the sample period. In addition, 20 municipalities missing coffee data from the 1997 Coffee Census and an additional 3 municipalities missing rainfall and temperature data yield a final sample of 978 municipal units utilized for the study.

A.4.   ENH household survey data

We use household survey data from the rural component of the *ENH*, which is called the *Encuesta Continua de Hogares* after 2001. The survey is carried out by Departamento Administrativo Nacional de Estadistica (DANE), and collects data on a representative sample of 23 departments in the 4 regions of Colombia.

The survey identifies the rural population using the following criteria:

(1) The population of the city where the municipal government is located if the city has fewer than 10,000 residents.

(2) The population of the city where the municipal government is located if the city has more than 10,000 residents and also meets one of the following other conditions: (a) the percentage of the city's residents does not exceed 50% of the population in the entire municipality; (b) the percentage of housing units without basic services (such as water and electricity) exceeds 20%; or (c) the percentage of the active population engaged in agricultural activities exceeds 50%.

(3) All persons living in towns with fewer than 10,000 inhabitants.

(4) All persons not living in either cities or towns.

To align the survey and conflict analysis, we also exclude the large municipalities with average population exceeding 250,000 over 1988–2005 from the survey sample. We utilize the employment module of the survey, which gathers repeated cross-sectional data on labour market outcomes among employed individuals. Data on hours worked is collected for all employed persons, and we use (log) monthly hours as one of our dependent variables. We also use earnings data for wage and salaried workers to generate (log) hourly wages by dividing monthly earnings by monthly hours. This earnings data are collected in a manner comparable across years for the 1988–2005 period.[55] We trim out the top and bottom 1%

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55. The ENH survey was conducted in 1996 and 1997 with a similar sampling methodology to latter years. However, the rural earnings measures are not directly comparable to remaining years since in-kind earnings was not collected in these 2 years.

outliers for both dependent variables, and conduct the analysis using individuals who are of the official working age in Colombia, *i.e.*, those between the ages of 14 and 60.

We also utilize the migration module of the ENH data, which is collected over 2001–2005, to generate an indicator of migration that is comparable across years. In particular, a survey question asks how long the respondent has resided in the municipality, and a response of less than 1 year is coded as indicating that the individual migrated to the municipality during that year.

A.5. *Selecting agricultural and natural resource sectors*

Although our main results focus on coffee and oil, we choose additional sectors according to three criteria. First, the commodity must be one of Colombia's five largest agricultural exports after coffee or one of the five largest natural resource exports after oil. For agriculture, this criteria yields: cut flowers, sugar, bananas, African palm, and tobacco. For natural resources, it yields: coal, iron ore, nickel, emeralds, and gold.

Second, the commodity must have a defined international price. This eliminates cut flowers and emeralds, since different varieties of flowers and emeralds have different international prices. Moreover, Colombia is one of the world's only major emerald producers, which means that the international price cannot be taken as plausibly exogenous to Colombia's production.

Third, there must be sufficient variation in the spatial distribution of production to enable a reasonable set of control and treatment municipalities. This eliminates iron ore and nickel, since in both cases, there is a single mine in Colombia that produces each, which would imply one treatment municipality against over 970 control municipalities.

Taken together, these three criteria together yield two additional natural resources: coal and gold, and four additional agricultural goods: bananas, sugar, African palm, and tobacco.

Supplementary Data

Supplementary data are available at *Review of Economic Studies* online.

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