Civil Conflict and Firm Performance

Evidence from Côte d'Ivoire

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Abstract

This paper investigates the impact of political instability and civil conflict on firms. It studies the unrest in Cote d'Ivoire that began in 2000, using a census of all registered firms for the years 1998–2003. The analysis uses structural estimates of the production function and exploits spatial variations in conflict intensity to derive the cost of conflict on firms in terms of productivity loss. The results indicate that the conflict led to an average 16–23 percent drop in firm total factor productivity and

the decline is 5–10 percentage points larger for firms that are owned by or employing foreigners. These results are consistent with anecdotal evidence of increasing violent attacks and looting of foreigners and their businesses during the conflict. The results suggest increases in operating costs is a possible channel driving this impact. Finally, the paper investigates whether firms responded by hiring fewer foreign workers and finds evidence supporting this hypothesis.

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Civil Conflict and Firm Performance: Evidence from Côte d'Ivoire

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1 Introduction

More than a quarter of the world's population lives in countries affected by instability and violent conflicts, many recurrent events (World Bank 2011). Previous studies have shown the devastating consequences of war and conflict on various human capital outcomes such as health and education; however, less is known about how the private sector is affected and how firms adapt during such situations, primarily due to a lack of data. Nonetheless, understanding these effects is important for at least two reasons: (i) the private sector is identified as an important engine of growth for developing countries; and (ii) reconstruction policies require the allocation of scarce resources. By understanding the impact of conflict on the private sector, resources can be appropriately allocated to improve the prospects for recovery.

This paper fills a gap in the literature by studying the impact of conflict on firms in the context of Côte d'Ivoire. Côte d'Ivoire presents an interesting case study since it has a relatively large private sector,¹ with systematic collection of information on registered firms since the 1970s. Economic fluctuations and power struggles characterize the early 1990s, but prior to experiencing its first coup d'état on Christmas Eve 1999, most observers still considered serious political violence to be unlikely in a country that had enjoyed an uninterrupted 30-year period of political stability. The 1999 coup marks the beginning for an episode of social unrest and eventually a Civil War in 2002. At the center of Côte d'Ivoire's crises were issues of ethnicity and nationality, fueled by political tactics exploiting discontent between its southern populations and the large migrant populations from neighboring countries.

Our analysis makes use of detailed financial and employment data from the census of formal firms for the years 1998-2003. We document that starting in 2000, firms enter at a decreasing rate and exit at an increasing rate. Aggregate employment also decreases. Moreover, average output is 20-40% lower than in the pre-conflict period. These patterns coincide with the surge of violence starting in 2000. However, this period of violence in Côte d'Ivoire is also coupled with major macroeconomic shocks, including large swings in commodity prices and a collapse of foreign aid.² As a result, even though these conflict events are largely unanticipated, it is not possible to identify the common macro component of the conflict impact with the data at hand.

The paper focuses on disentangling the non-macro component of the conflict impact associated with certain firm characteristics. In particular, we test whether firms owned by or employing foreigners were impacted disproportionately. We aim to identify (i) the magnitude and heterogeneity in the costs of conflict associated with firm ownership and employment; (ii) potential transmission mechanisms of these heterogeneous effects; and (iii) how firms respond to conflict intensity. The focus on foreign ownership/employment is motivated by anecdotal evidence which suggests increasing anti-foreigner

¹In Côte d'Ivoire, the formal private sector accounts for 60% of GDP (Berthelemy and Bourguignon 1996).

²Cocoa prices - Côte d'Ivoire most important export - dropped substantially from 1998-2000 before rebounding in 2002 and 2003 (The Economist 2003). Much of the country's foreign aid was suspended in 2000 as the World Bank, IMF, and EU withdrew support to Côte d'Ivoire in response to the 1999 coup (The Economist 2000).

sentiments during this period led to disproportional attacks and looting targeting foreigners and foreign businesses.

Given the absence of data on the direct costs and losses due to violence and conflict, we propose a 2-step approach to infer the magnitude of these losses from the available data. In the first step, we estimate production functions following Olley and Pakes (1996) and Akerberg, Caves and Frazer (2006) to correct for endogeneity of input use and firm exit. We then use parameter estimates from the production functions to recover a measure of firm total factor productivity (TFP). Since TFP is essentially a residual that contains any information not captured by observed inputs, output losses that firms incur due to violence and conflict will be reflected in this variable. In the second step, we regress the estimated TFP on measures of foreign ownership, foreign employment and conflict. To test whether foreign firms are impacted differently, we interact foreign ownership/employment with conflict variables, exploiting the fact that the coup in 1999 came as an unanticipated shock so the following civil unrest is exogenous to individual firms. To proxy for conflict, we use both a period dummy and an intensity variable which makes use of the geographical variations in conflict pattern and detailed information on firm location.

The results indicate that foreign owned firms and firms employing foreigners have higher productivity on average but that this advantage over domestic firms was reduced by the conflict. Having at least one foreign employee is associated with an extra 9.7% reduction in firm's measure of TFP - or a 9.7% decline in output holding other inputs constant - during the conflict period. Foreign ownership does not appear have an effect until 2003, when it is associated with a 18.8% decline in TFP. In the specifications that rely on conflict intensity, we find an increase of one standard deviation in the conflict rate reduces TFP by 10-11% on average and each additional percentage point increase in the share of foreign employees increases the conflict impact on TFP by about one percentage point. In aggregate, the implied annual impact of conflict on firm's TFP from different specifications ranges from 16-23%. These effects are qualitatively similar when we used a modified Akerberg, Caves and Frazer's procedure to control for simultaneity between productivity shocks and the choice of foreign employment, along similar lines of Van Biesebroeck (2005) and De Loecker (2007). The results are also robust to alternative definitions of industry and different specifications of the production functions to allow for changes in expected investment returns and factor prices over time.

We investigate possible channels of impact, and find that industry concentration and export orientation have no significant impact on TFP, suggesting the conflict had no effect on firms' ability to charge mark-ups. On the other hand, TFP decreases significantly for firms in import oriented industries, indicating rising cost of imported inputs might be a channel of impact. Finally, we find evidence supporting a simple model of labor adjustment in which firms reduce the shares of foreign workers at any given relative wage to compensate for their negative effect on productivity.

The contribution of our paper is three-fold. First, we utilize a unique dataset which covers all formal private sector firms in the economy, both before and during the conflict. Hence our analysis

is representative of all formal firms and is longitudinal, unlike most existing research on firms and conflict which is often limited by cross section and/or survey data. Second, by measuring the impact on productivity, our methodology enables us to overcome data restrictions to estimate the conflict's economic costs. Since all regressions control for firm and industry-specific time effects and other observable characteristics, our estimated impact is net of any common macroeconomic trends or shocks and likely represents the lower bound impact of the conflict. Finally, the question of an asymmetric impact on foreigners is important since foreign investment plays a crucial role in Côte d'Ivoire³ and other developing countries. Moreover, if firms are affected because of their identity, it implies the conflict creates an additional distortion to the reallocation of resources, further lowering potential aggregate output.

The remainder of the paper is organized as follows: Section 2 describes Côte d'Ivoire's institutional background in more detail and motivates our hypotheses. Section 3 discusses the related literature on conflict and productivity. Section 4 presents a brief conceptual framework and our empirical strategy. Section 5 describes the data and preliminary analysis and section 6 presents the econometric results, including a discussion on firms' responses in terms of labor composition. Section 7 concludes.

2 Background

Côte d'Ivoire's first coup d'état on Christmas Eve 1999 marked the beginning of a violent episode and eventually a civil war that divided the country along north and south lines (see figure 1 for a summary of events). Initially staged by middle-rank military officers as a response to low wages in the military, the coup came as a complete surprise. A report by the BBC (2000a) noted:

The people of this city had never experienced a coup d'état before, ... hundreds of local people were standing frozen on the pavements, staring at the soldiers in complete disbelief.

Before this event, Côte d'Ivoire had been a much more stable country. Despite having some 60 ethno-language groups and 25% of the population made up of immigrants, it managed to maintain economic growth and political stability for more than 30 years after independence. While a policy of "Ivoirite" - which sought to redefine who constitutes "true" Ivorians - had increased social tension during the mid 1990s, the economy was showing signs of improvements after a devaluation package in 1994.

The 1999 coup greatly increased political uncertainty (The Economist 2002). Robert Guei, the coup's leader, initially promised to step down after cleaning up the toxic political environment created by his predecessor's "Ivoirite" policy. Instead, he decided to run for president only a few months later and further enforced the same policy that requires both parents of any presidential

³For example, French investment constitutes 25% of total capital invested in Ivorian firms (World Market Research Center 2004) while 55% of tax revenues in Cote d'Ivoire comes from French companies (BBC 2004).

candidate to be Ivorian citizens (Kohler 2003). This excluded Alassane Ouatarra, a candidate originally from the North, from running. The general election in October 2000 threw the country into chaos. Laurent Gbagbo, the opposition candidate, won but disputed results set off widespread violent clashes among Guei and Gbagbo's supporters. Legislative elections held later in December also saw unprecedented violence by pro-Gbagbo youth and militias attacked northerners and immigrants for their supposed support for Ouatarra's party (McGovern 2011, Marshall-Fratani 2006).

Gbagbo ran on an anti-French and anti-foreigners political platform. The latent nationalism of his party became state policy and resulted in widened mistrust and deepening ethnic and regional divisions within the country (Marshall-Fratani 2006, Kohler 2003). On September 19, 2002, military troops originating from the North, mutinied and attacked major cities throughout the country, claiming control over the northern region and establishing Bouake (the second largest city in Côte d'Ivoire) as its base. During 2003-2004, violence escalated. Massacres of civilians took place especially in the South West and many presumed northerners in Abidjan neighborhoods were arrested and killed (McGovern 2011). Actions by the international community also provided an excuse for the pro-Gbagbo "Young Patriots" to stage violent riots and attacks against West Africans, French and other foreigners.

While most fighting ended in 2004, the country was effectively split between north and south by a "confidence zone" - set up by international peace keeping forces - between the rebels and government forces (United Nations 2009). The reconciliation process was not abided by and elections originally set for 2005 were pushed back several times until late 2010. The 2005-2010 was described as a "no war, no peace" situation characterized by uncertainty, severe disruptions of services and widespread small armed conflicts (McGovern 2011).

Figure 2 maps the conflict rate by department for the period before and after 2000 which shows a clear increase in the overall conflict intensity in the later period. While social tension had increased in the country, the consensus among observers is that violence at the scale witnessed in the 2000 elections and the election outcomes were largely unanticipated before 2000.⁴ Thus it seems reasonable to assume that prior to the 1999 coup, the turn of events leading to the election crisis and the civil war in 2002 were unexpected to most individuals and firms. Based on this, we argue that the conflict starting in 2000 was an exogenous shock.

3 Related literature

Our research contributes to the empirical literature on the economic consequences of violence and civil conflicts. Until recently, this literature has largely been dominated by cross-country and cross-

⁴The Economist (1998) for example, assesses Mr Gbagbo as "unlikely ever to come to power". An investment guide published in 1999 asserts that "Historically, private investment has not been targeted" and "As the 2000 elections approach, further disturbances are likely but serious violence has not characterized Ivorian political life in the past and is not expected to do so in the foreseeable future" (Africa-Asia Business Forum: http://www.aabf.org/cote_divoire_inv_guide.htm)

region analyses. Not surprisingly, past research often finds civil wars and political crises to have a negative economic cost, particularly in the short run. For example, Cerra and Saxena (2008) estimate that on average, output contracts by 18% immediately following civil wars in a cross section of 190 countries. Abadie and Gardeazabal (2003) study terrorist activities in the Basque country and find a 10 percent gap between GDP per capita in Basque and a comparable “synthetic” region.

Though informative, macroeconomic studies by nature are unable to address heterogeneity associated with individual conflicts and the differential impact of conflict on different groups within a country/region. More studies are now adding evidence at the micro level, but due to data constraints, most of this research focuses on analyses at the household level and on human capital outcomes such as health and education attainment.⁵ Studies on the links between firms’ output and conflicts remain scarce.

Early papers on firm outcomes use stock market returns to get around data limitations. For example, Abadie and Gardeazabal (2003) analyze how the cease-fire declared by the Basque terrorist organization ETA in 1998-1999 affects the returns of firms operating in the Basque Country relative to other firms. They find that the truce announcement led to excess returns of firms operating in the region while its end led to a small negative impact on their returns, suggesting a negative impact of terrorism on expected investment returns. Similarly, Guidolin and La Ferrara (2007) study the market’s response by diamond mining firms to the sudden end of the Angolan civil war in 2002. In contrast to Abadie and Gardeazabal, they find that diamond companies with concessions in Angola saw a drop of seven percentage points in market returns compared to otherwise similar firms that held no concessions there. The intuition is that conflicts can be beneficial or harmful to businesses depending on the institutional arrangements where they operate. In Angola, conflicts might have been beneficial to incumbent diamond firms because they helped deter entry and make profitable unofficial dealings easier.

One concern with the above approach is that stock market data are typically not available in countries impacted by civil wars. More recently, Collier and Duponchel (2010) use survey data to investigate some channels through which conflicts can affect firm performance in the context of Sierra Leone’s civil war. They propose that one channel in which wars can have persistent post-conflict effects on firms is through technical regress and loss of workers’ skills. The prediction is supported by the result that 5 years after the war ends, firms were more likely to report willingness to pay for staff training in those areas most affected by the conflict, indicating a shortage of skilled labor. A lack of more detailed data prevents Collier and Duponchel from confirming this result since it is not possible to determine the substitutability between labor and capital at the firm level. Moreover, they only have data after the war so they do not have a “control” period. Hence, there are concerns with omitted unobserved factors as high intensity regions might have intrinsic characteristics that make them more prone to conflicts *and* also affect the operating environments of firms. Collier

⁵See Blattman and Miguel (2010) for a broader literature survey.

and Duponchel (2010) use distance to Monrovia (Liberia) to instrument for conflict intensity but distance is a problematic instrument because it can also directly affect output and productivity.

One approach is to find an exogenous event. Ksoll et al. (2010) examine the impact of unexpected violence during the 2007 Kenyan general election on exports by flower firms. The advantage of this paper is a cleaner identification strategy since violence shocks were unexpected and did not equally affect all regions where the firms were located. Thus Ksoll et al. are able to construct appropriate counterfactuals and estimate the reduced form impact of violence on exports more reliably. They find that violence in this period leads to a 38% drop in export volumes. Detailed survey data allow them to further develop and estimate a structural model with endogenous labor supply. Simulations results show a 16% increase in operating cost if firms were to induce workers to work overtime to compensate for workers' absence caused by fear of violence.

The external validity of these results is unclear. Ksoll et al.'s work is based on a small sample size and it focuses on a highly specialized industry which is likely very different from the rest of the economy. The only paper we are aware of that uses census data is Camacho and Rodriguez (2010). These authors use instrumental variables approaches in models with fixed effects to assess the impact of armed conflicts on the exit of manufacturing firms in Colombia. They find that a one standard deviation increase in the number of attacks (by region) results in a 5.2 percentage point increase in the firms' exit rate. Exit mechanisms however, are left unexplored in the paper.

To the best of our knowledge, our paper is the first to study the evolution of firms' productivity in a conflict context. As such, it also contributes to the growing literature that examines productivity growth in developing countries. A paper closely related to our research is Hallward-Dreameier and Rijkers (2011), who study the relationship between firm survival and productivity before and after the 1997 financial crisis in Indonesia and find an attenuated impact of productivity on firms' exit during the crisis. Among other explanations, Hallward-Dreameier and Rijkers suggest that regime change and political connectedness might be determinants of this attenuation, based on the premise that firms affiliated with the Suharto regime might have been hurt disproportionately and were more productive before the crisis. However, firms might have appeared productive as a result of connectedness or as a result of real technical efficiency. Hallward-Dreameier and Rijkers mention but do not attempt to disentangle these two possible effects.

4 Methodology

There are various mechanisms through which conflict could impact individual firms. The most obvious channel is through its effect on both factors of production, capital and labor: buildings and machinery might be damaged or stolen, people might die, get injured, migrate out of fear of violence or simply unable to show up at work. Destruction of capital and labor, if on a sufficiently large scale, will likely alter both their marginal product and marginal cost.

In addition, other factors might lead to changes in their relative prices. Uncertainty in conflict situations might reduce the relative attractiveness of domestic investments leading to capital outflows, driving up the cost of capital. Inter-regional migration might either increase or decrease labor supply and consequently prices in a particular location. If there are severe disruptions in any factors of production, firms may find it optimal to change their technology altogether.⁶

Even if capital, labor and technology do not change, conflict likely causes output/efficiency loss due to looting of output, bribe extortion or because businesses have to stop operating when there is a high risk of violence. Further, destruction of infrastructure and supply disruptions of intermediate inputs such as materials, electricity and other utilities can drive up the operating costs. There is anecdotal evidence of these effects in Côte d’Ivoire⁷. Firms’ operating costs might also increase because they have to pay for “non-productive” inputs for security purposes to protect their output and investments.⁸

Another channel of impact is through demand effects. Conflict is often associated with reduced consumption due to reduced income. There are also potential changes in preferences. In the context of Côte d’Ivoire for example, anecdotal evidence suggests that some customers might divert their consumption away from foreign owned firms.

All these effects imply that the expected returns of investments may decrease. As a result, firms might reduce investments in both physical and human capital. Moreover, beyond these direct effects, conflict will likely increase uncertainty in terms of how demand will change and how much violence will happen in the future, leading to changes in investment dynamics.⁹ Firms with bleak current and future prospects may opt out of the market. Heterogeneity in opportunity costs and all the effects discussed above will determine how the responses differ across firm owners. In fact, foreigners were reportedly leaving Côte d’Ivoire or looking to move their businesses elsewhere after the 1999 coup (BBC 2000b).

Quantifying and disentangling all these transmission channels is difficult, particularly without direct data on output/input losses or prices. We will present evidence in section 5 which suggests destruction of capital and labor is not severe. Our analysis employs a production function framework that uses available data on output and firm’s use of capital, labor and material inputs¹⁰ to

⁶These effects have been documented empirically. Imai and Weinstein (2000) argue that reduced private investment by a process of portfolio substitution is a primarily channel through which war affects economic growth and find supporting evidence in cross-country data. Collier and Duponchel (2010) suggest firms in Sierra Leon switched to using inferior technology after the war due to severe shortages of skilled labor.

⁷Africa Research Bulletin (2001 and 2003) reports widespread looting and property destruction targeting businesses owned by West Africans and other foreigners after both the 1999 and 2002 coups.

⁸Cross-country enterprise surveys find that the costs of security technology and services represented 13 percent of sales in Senegal, South Africa, Tanzania, and Uganda, and 6 percent in Kenya (World Bank 2011).

⁹Bloom (2009) finds that uncertainty reduces investments because firms take a “wait and see” approach. Further, Bloom et al. (2007) note that the partial irreversibility of investment and fixed costs of hiring and firing influence the timing of actions and response to shocks. They find that firms with adjustment costs is much less responsive to demand shocks than firms not subject to the costs.

¹⁰It is also possible that firms might fudge their accounting figures to avoid extortion from the government. Without a secondary data source, we cannot identify this effect.

infer the reduced form net impact of several other mechanisms discussed above. Specifically, we use an estimate of TFP to capture the effect of output loss, “wasted” inputs and demand changes, by modeling their impact as an output distortion. Our estimation procedure does not identify the effects of input prices, and investment and exit dynamics, but allows for them under a number of simplification assumptions. Below, we present a brief conceptual framework of our approach. The sections follow will discuss our empirical strategy in more details.

4.1 Conceptual framework

Assume that firm i at time t produces according to a Cobb-Douglas technology. Without any distortions, for a vector of inputs $X_{it} = (X_{1it}, \dots, X_{kit})$ used, the amount of output is: $Y_{it} = e^{A_{it}} F(X_{it}) = e^{A_{it}} X_{1it}^{\alpha_1} \dots X_{kit}^{\alpha_k}$, where A_{it} is the technical efficiency term and Y_{it} denotes output. Suppose that because of the conflict, part of the firm’s output is stolen and/or it has to halt operations for some fraction of the time, so that the realized output is only a fraction of potential output $\gamma_{it} Y_{it}$. Further assume that not all *observed* inputs are productive because for example, (i) a part of them is used for security purposes, or (ii) they are imperfect substitutes of the inputs normally used. Let λ_{kit} be the proportion of input X_{kit} that is actually used towards production. The net effect of all these factors is equivalent to the firm facing an output distortion $e^{\tau_{it}}$, where $\tau_{it} = \ln(\gamma_{it} \lambda_{1it}^{\alpha_1} \dots \lambda_{kit}^{\alpha_k}) < 0$, so that the realized output becomes: $\tilde{Y}_{it} = e^{\tau_{it}} Y_{it} = e^{A_{it} + \tau_{it}} F(X_{it})$.

Increases in the absolute magnitude of τ_{it} reduce the output produced. Therefore given the *observed* (or recorded) inputs, the measured TFP, which we define as $\tilde{Y}_{it}/F(X_{it})$, would be lower than the firm’s underlying technical efficiency. Effectively, τ_{it} is a reduced form impact measure that captures the overall effects of output loss and “wasted” inputs through the channels discussed above. Additionally, if output is measured in monetary terms, as in our empirical implementation, changes in the TFP term would also contain price (demand) effects. We expect the absolute value of τ_{it} to increase with the intensity of the conflict. Because firms might be exposed to violence differently, τ_{it} is allowed to be firm-specific.

In the context of Côte d’Ivoire, our conjecture is that as the conflict intensifies, firms owned by foreigners or employing more foreign employees face greater distortions because identity, in particular citizenship and nationality, is an issue at the heart of the conflict. A larger distortion will correspond to a larger observed decline in TFP. Formally, we want to test the following hypotheses:

$$\frac{\partial \tau_{it}}{\partial \text{conflict}_{it}} < 0 \quad (1)$$

$$\left| \frac{\partial \tau_{it}}{\partial \text{conflict}_{it}} \right|_{\text{foreign}} > \left| \frac{\partial \tau_{it}}{\partial \text{conflict}_{it}} \right|_{\text{domestic}} \quad (2)$$

where conflict_{it} is a variable that proxies for conflict intensity. Since A_{it} and τ_{it} are unobserved, getting unbiased estimates of TFP first depends on the ability to estimate $F(X_{it})$ consistently. If firms anticipate ω_{it} and τ_{it} and incorporate them in their investment, input purchase, and exit decisions

then we need a framework that can allow for such possibilities. Therefore, our empirical strategy involves two steps. First, we follow Akerberg, Caves and Frazer (ACF, 2006) to structurally estimate a production function. After getting consistent estimates of the production function parameters, we can recover a productivity measure. As explained above, this productivity term will measure technical efficiency as well as any residual factors that cannot be controlled for by observable inputs. In the second step, we regress the estimated productivity term on firm ownership, foreign employment and its interaction with time and conflict intensity, and other control variables to test hypotheses (1) and (2).

4.2 Productivity estimation

Assuming the production function is a Cobb-Douglas function in capital K_{it} and labor L_{it} , we estimate its log transformation:

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + \omega_{it} + \eta_{it} \quad (3)$$

where $\omega_{it} = A_{it} + \tau_{it}$, lower case letters denote logs and the error term η_{it} captures unanticipated shocks to output and measurement errors. In this framework, we can estimate the TFP term if β_k and β_l are known. OLS estimation of β_k and β_l , however, runs into an obvious simultaneity problem since high productivity firms may also use more inputs.

ACF (2006) address this endogeneity problem by taking a structural approach in which an inverted function of the intermediate input demand is used to control for productivity.¹¹ The underlying structure is based on a model that derives industry equilibrium with heterogeneous firms. In the model, firms maximize a discounted sum of current and future profits, which are governed by exogenous productivity shocks that follow a first-order Markov process. Formally, the productivity process can be described as: $p(\omega_{t+1}|\{\omega_\tau\}_{\tau=0}^t, I_t) = p(\omega_{t+1}|\omega_t)$. Hence, current productivity can be written as a function of last period's productivity and a white noise error:

$$\omega_t = E[\omega_{it}|\omega_{it-1}] + \xi_{it} \quad (4)$$

There are two crucial timing assumptions in the ACF estimation approach. First, capital is treated as a dynamic input. That is, investment i_{it} takes place one period before the new capital can be used in the next period: $k_{it+1} = (1 - \delta)k_{it} + i_{it}$. Second, labor, unlike intermediate inputs, is allowed to be a not fully variable input. It is decided at time $t - b$ ($0 < b < 1$) when only part of the current productivity shock has been observed by the firm and before intermediate inputs are chosen.¹² Suppose productivity also evolves as a first-order Markov process between the $(t - 1, t - b)$

¹¹It is related to the approaches originated by Olley and Pakes (1996) and Levinson and Petrin (2003) but includes additional timing assumptions to address collinearity issues.

¹²In the context of our research, it is a reasonable assumption since formal firms in Côte d'Ivoire are subject to the Labor Code. According to the Bureau of International Affairs (1999), those employed in the formal sector are

and $(t - b, t)$ sub-periods then l_{it} would be correlated to ω_{it} through ω_{it-b} .

The only fully variable input is intermediate inputs m_{it} . Because it is chosen after both capital and labor, and after current productivity is observed, the material input demand m_{it} can be written as: $m_{it} = m_t(k_{it}, l_{it}, \omega_{it})$. ACF use the insight that m_{it} can be proven to be strictly increasing in ω_{it} under quite general assumptions. Therefore an inverted input function, proxied by a semiparametric function of capital, labor and materials, can be used to control for productivity: $\omega_{it} = m_t^{-1}(k_{it}, m_{it}, l_{it})$. Equation (3) then becomes:¹³

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + m_t^{-1}(k_{it}, m_{it}, l_{it}) + \eta_{it} \quad (5)$$

Neither β_k or β_l can be separately identified from the above equation because the function $m_t^{-1}(\cdot)$ also contains k_{it} and l_{it} as its arguments. It is however possible to recover an estimate $\hat{\phi}_{it}$ where $\phi_{it} = y_{it} - \eta_{it}$. This term will prove to be useful in the moment conditions identifying β_k and β_l .

Recall that the timing assumptions above imply that *current* capital and *past* labor are decided before the current productivity is observed. Consequently, they are both uncorrelated with the error term ξ_{it} in equation (4). Hence, the two following moment conditions can be used to identify β_k and β_l :

$$E[\xi_{it} \cdot \begin{pmatrix} k_{it} \\ l_{it-1} \end{pmatrix}] = 0 \quad (6)$$

To operationalize these two moment conditions, we need to be able to write ξ_{it} as a function of the parameters and known quantities. From equations (3) and (5), we have: $\omega_{it} = \phi_{it} - \beta_k k_{it} - \beta_l l_{it}$. Since current productivity only depends on its last period's value, we can approximate $E[\omega_{it} | \omega_{it-1}]$ as another semiparametric function $g(\omega_{it-1})$. For any set of initial values (β_k^*, β_l^*) ,¹⁴ ω_{it} and ξ_{it} can be expressed as follow: $\hat{\phi}_{it} - \beta_k^* k_{it} - \beta_l^* l_{it} = g(\hat{\phi}_{it-1} - \beta_k^* k_{it-1} - \beta_l^* l_{it-1}) + \xi_{it}$. This expression can be used to form the sample analog of the moment conditions in equation (6) and estimate β_k and β_l . In the empirical estimations, we use third-order polynomials to approximate both $m^{-1}(\cdot)$ and $g(\cdot)$.

In addition to endogeneity of inputs, we face a selection bias problem in unbalanced panel data if the probability of exiting the market at any given productivity shock is correlated with inputs. This is the case if, for example, capital intensive firms are more likely to stay following a bad productivity shock. To account for this problem, we also estimate the production functions following Olley and Pakes (OP, 1996), which involves estimating an exit equation in past capital and investment and using the predicted exit probabilities to control for selection.¹⁵ Nevertheless, ACF is our

generally protected against arbitrary discharge from employment.

¹³Note that we do not have m_{it} as an input in this equation thus y_{it} can be interpreted as value-added output. Alternatively, we can estimate a production function in revenue to recover coefficients on intermediate inputs. Since increasing the number of unknown parameters put additional requirements on sample size, we choose to estimate value-added production functions to use our data more efficiently.

¹⁴We use OLS estimates as initial values in the estimations.

¹⁵OP's methodology uses the inverted investment demand instead of intermediate inputs to control for productivity:

preferred method for three reasons. First, the ACF method is robust to labor adjustment costs and firm-specific labor and capital price shocks.¹⁶ Second, investment is often lumpy, especially in a developing country context such as Côte d’Ivoire, so the monotonicity condition between investment and productivity in the OP procedure might not be satisfied. Third, past studies often find negligible impact of controlling for sample selection on estimated TFP. This is the case in our study, as discussed in section 6.1.

Our empirical work assumes that 1) there is a common production function (in value added) for firms in the same 2-digit industry; and that 2) the same functional form holds for the entire sample period. Both assumptions are necessitated by sample size limitations. Assumption 2 is justified by the fact that physical capital was not destroyed to a large extent since the most intense fighting during the civil strife happened outside of the capital city, and the majority of firms (86%) are located in the capital. Moreover, given the short sample period, it is reasonable to assume that firms might not have had the time to change their technology. As discussed above, changes in expected returns and uncertainty during the conflict can affect investment and exit dynamics.

To allow for changes in the material input demand (capital investment and exit responses in the OP approach), we control for year fixed effects, so our estimation procedure is robust to yearly shifts in material (investment) and exit functions. After recovering the input coefficients β_k and β_l , we calculate the log of measured TFP as:

$$\hat{\omega}_{it} = y_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_l l_{it} \quad (7)$$

4.3 Heterogeneous impact of conflict

We can think of the estimated TFP from equation (7) as containing an underlying technical efficiency index A_{it} and a distortion term τ_{it} , $\hat{\omega}_{it} = A_{it} + \tau_{it}$, which cannot be measured separately unless one is prepared to introduce some additional structure. We test for the hypotheses in (1) and (2) in the regression:

$$\hat{\omega}_{it} = \alpha_0 + \alpha_1 \text{Foreign}_{it} + \alpha_2 \text{Foreign}_{it} \times \text{after} + W_{it} \alpha_3 + \mu_i + \mu_{jt} + \mu_{rt} + \varepsilon_{it} \quad (8)$$

where i , j , and r references a firm, an industry and a region respectively, and year is indexed by t .

Here, *after* is a dummy variable denoting the conflict period, which equals one if $t \geq 2000$. *Foreign_{it}* indicates whether the firm is classified as “foreign”. We consider two alternative definitions, namely 1) whether the firm is foreign owned, and 2) whether it employs any foreign employees. These two

$\omega_{it} = i_t^{-1}(k_{it}, i_{it})$. Because we only observe firms that survive, the correct expression for the g function which approximates the deterministic portion of ω_{it} should be $g[\omega_{it-1}, Pr(\chi_{it} = 1)]$ where $\chi_{it} = 1$ indicates survival. The selection correction is based on an exit rule, which states that firms exit when productivity falls below a threshold so: $Pr(\chi_{it} = 1 | I_{it-1}) = Pr[\omega_{it} \geq \underline{\omega}_{it}(k_{it}) | \omega_{it-1}] = \varphi(k_{it-1}, i_{it-1})$. This probability can be estimated using a probit function and the predicted values $\hat{P}_{it}$ will be controlled for in the function g above.

¹⁶Since the material input demand function includes both capital and labor, any price shocks in capital and labor will be reflected in this demand function

variables pick up inherent differences in efficiency between foreign and domestic firms, regardless of conflict-induced shocks.

Our variable of interest is thus the interaction term between foreign status and the conflict dummy. A negative and significant α_2 would suggest that foreign firms were impacted disproportionately by the increased conflicts since 2000. Our identification assumption is, conditional on observables, firms have comparable levels and trends in technical efficiency A_{it} so the variations in $\hat{\omega}_{it}$ during the conflict can be solely attributed as the effect of the firm's foreign status on the distortion τ_{it} .

We include a set of fixed effects to control for unobserved heterogeneity that could be confounding with foreign ownership/employment. First, firm fixed effects μ_i capture all time-invariant unobserved effects correlated to foreign status and help mitigate the problem with firms charging different mark-ups which will be reflected in the productivity term (Pavcnik 2002). By including firm-level fixed effects, α_2 is effectively identified from firms that experience a change in their foreign status during the conflict. Second, industry-specific time effects μ_{jt} capture all events during the sample period that affect all firms within a given industry equally. Foreign firms may be representative disproportionately in certain industries and some industries may have been affected more heavily by the conflict or by other macroeconomic shocks. Including these fixed effects avoids incorrectly attributing industry effects to foreign status. Another advantage of including industry-specific time effects is they can help capture the effect of measurement errors in the industry level deflators used in the empirical part (Amiti and Konings 2007). We also include region-specific time fixed effects μ_{rt} to control for shocks overtime that affect productivity in all industries but may vary across regions. This is important if there are spatial correlations in conflict patterns.

Vector W_{it} includes measures of firm size - log of total assets, a dummy indicating whether the firm is above the median employment level and its interaction with time. These measures of firm size address three issues: (i) firm size might affect productivity; and (ii) if financial frictions are present, large firms might weather shocks better than smaller firms and (iii) if firms are richer (have more assets), they are more likely to be looted regardless of identity. We also include a dummy variable indicating whether the firm's age is above the sample median, plus its interaction with time to control for the possibility that older firms are more productive and are affected differently during the conflict. If foreign ownership and employment are correlated with firm size and age, then not controlling for these variables creates potential bias.

In an alternate specification, we use another set of variables to assess the effects of civil strife:

$$\hat{\omega}_{it} = \delta_1 Foreign_{it} + \delta_2 conflict_{it} + \delta_3 Foreign_{it} \times conflict_{it} + \delta_4 W_{jit} + \mu_i + \mu_{jt} + \mu_{rt} + \varepsilon_{it} \quad (9)$$

Here, foreign employment - $Foreign_{it}$ - is measured by two variables, namely (i) the percentage of all foreign employees, and (ii) French West African and other nationalities out of total employment. The $conflict_{it}$ variable measures the number of armed conflicts per 100,000 inhabitants by the department where the firm is located (see section 5.1 and the data appendix). As argued in section

3, we can consider conflict intensity to be exogenous to the individual firms.¹⁷ The interaction between conflict and foreign allows us to see if firms which employ more foreign workers fare worse in situations of violence. Similarly to equation (8), we include the same set of fixed effects and size in terms of total assets interacted with time. Testing the hypotheses in (1) and (2) is equivalent to testing $\delta_2 < 0$ and $\delta_3 < 0$.

In all specifications, we cluster the standard errors at the firm level.¹⁸ In the last specification, we use bootstrap standard errors, allowing for clustering, to account for heteroskedasticity since we also have a generated variable on the right hand side of the regression.

4.4 Endogenous foreign employment choices

A potential problem with above specifications is that foreign employment and ownership might be endogenous since firms might make decisions about employing foreigners/changing ownership after observing their productivity. If having foreign workers during the conflict results in a negative impact on production, we might expect firms to respond by reducing their shares of foreign employees. However, we can observe less hiring of foreigners without a negative effect of foreign employment on production if for example, foreigners were leaving the country, driving up their relative wages. In this section, we outline an empirical test for such adjustment and discuss corrections for the potential bias in the production function estimations above.

Our empirical test is based on a simple model linking wages and labor returns. We assume that the share of foreign employees, denoted as ρ_{it} , has an impact on production in the form of an output distortion so that (log) productivity is the sum of technical efficiency A_{it} and a function $h_t(\rho_{it})$: $\omega_{it} = A_{it} + h_t(\rho_{it})$. The model implies that the optimal choice of ρ_{it} is decreasing with its marginal product, conditional on a relative wage ratio.¹⁹ This prediction gives an empirical specification of the form:

$$\rho_{it} = \gamma_0^i + \gamma_1 \frac{1}{1 - w_{it}^f/w_{it}^d} + \gamma_{2t} + \eta_{it} \quad (10)$$

where w_{it}^f and w_{it}^d denote the wage rates of foreign and domestic workers respectively. Here, γ_{2t} is a dummy variable indicating the conflict period. The hypothesis is $\gamma_{2t} < 0$, that is the share of foreign employees is decreasing with the conflict. We control for firm-level fixed effects to account for any differences in the return of labor at the industry level and other unobserved heterogeneity.

If there is evidence of firms adjusting their labor composition, the production function estimations will need to be adjusted accordingly. The reason is that both the ACF and OP estimation procedures relies on the assumption that the TFP term depends on its past value and an error term that is

¹⁷The total number of firms which changed their locations during the conflict is 30, representing a negligible percentage of all firms in our data.

¹⁸We also allow for clustering at the geographical level of the conflict variables (following Moulton (1990)) but the resulted standard errors are smaller, possibly due to the unbalanced distribution of firms in our data. Therefore, we report standard errors clustered at the firm level to be conservative.

¹⁹Model set up available upon request.

uncorrelated with current capital stock (see equation (6)). If $\omega_{it} = A_{it} + h_t(\rho_{it})$ as in the model setup above and, for example, firms with more foreigners are more capital intensive, then the coefficient estimate on capital in the production function will be biased.²⁰

To check whether our results are affected by this bias, we use the ACF approach and include the percentage foreign employees, ρ_{it} , directly in the proxy function for TFP: $\omega_{it} = m_t^{-1}(k_{it}, m_{it}, l_{it}, \rho_{it})$. Intuitively, it means that firms take into account the impact of foreign employment on production and thus the material input demand function is also a function of ρ_{it} in addition to other inputs. We assume productivity still evolves according to a first order Markov process so: $\hat{\omega}_{it} = g(A_{it-1}) + h_t(\rho_{it}) + \xi_{it}$. Effectively we model the impact of foreign employment directly into the production function and not through the unobserved component of productivity. In practice, because this estimation procedure is much more data demanding, we assume that h_t is linear and only allow $h_t(\cdot)$ to change once with a dummy variable indicating the starting of the conflict. The effect of ρ_{it} over time is estimated directly from the production function through $h_t(\rho_{it})$. See Appendix A for more details on the exact estimation procedure.

5 Data

Our analysis is based on firm-level data from the Registrar of Companies for the Modern Enterprise Sectors, collected by Côte d'Ivoire's National Statistics Institute (INS), covering the universe of registered, formal modern enterprises for 1998-2003.²¹ The unit of observation is the firm. Almost all firms in Côte d'Ivoire are single-establishment firms. The data set covers manufacturing, agriculture, trade and services firms.

The Registrar of Companies collects information upon incorporation including physical location, sector classification at the 3-digit industry level, and shareholdings for all shareholders. The INS requires all registered companies to submit annual filings with detailed financial and employment information including total wages, employee skill level, taxes paid, sales, and fixed assets, which are reported under the West African accounting system standards, *Etats Financiers Normalises du Systeme Comptable Ouest Africain* (SYSCOA). These firms, which operate in the formal economy, pay a range of taxes, benefit from bank finance and technical assistance, and are characterized as having more educated owners (Goedhuys and Sleuwaegen 2002, OECD 2004).

The structure of the data is an unbalanced panel. We define exit as a permanent exit from the data (We do not consider temporary lapses in reporting as exits). Entry can be defined unambiguously since we know the year when the firm starts operating. The reporting requirement constitutes an

²⁰To see this, consider equation (5) above. The error term η_{it} and consequently ϕ_{it} will contain information on ρ_{it} if it is not included in the proxy function m_t^{-1} . As a result, the error term ξ_{it} calculated using $\hat{\phi}_{it}$ will contain information on ρ_{it} . Therefore, the first moment conditions in (6) will not be satisfied if capital is correlated to foreign employment. For a more formal discussion of the problem, see Appendix A.

²¹Our panel is shorter than the typical sample length in the TFP literature. However, it is longer than most panels available in Sub-Saharan context. For example, Frazer (2007) uses a 4 year panel while Soderbom et al. (2006) and Van Biesebroeck (2005) both have a panel length of 3.

important advantage of our data since entry and exit from the data implies real entry and exit, unlike data from other countries which usually require a certain employment or revenue threshold to be included in the data.

Table 1 displays information about the composition of the sample. The full sample includes 7010 firms there are missing values and potential outliers. For the production function estimations, we exclude the top and bottom one percent of the distribution of output and inputs.²² As a result, we are left with 4161 unique firms or 11810 firm-year observations. Table 2 shows the distribution of firms by panel length. In general there are a larger number of missing values in the earlier years, but all possible panel length (1-6) are well represented in our data. As mentioned, we estimate separate production functions for 2-digit industries when possible. However, since the sample size is limited for some industries, we also need to pool several industries and estimate the same production function for these industries.²³ Table B.1 in Appendix B reports the resulting number of firms by industry.

We augment the INS data with population estimates from Côte d’Ivoire’s 1998 Census, GIS data on administrative boundaries and conflict data from the Armed Conflict Location and Event Data (ACLED, Raleigh et al 2012). The conflict rate variable is calculated as the number of armed conflicts²⁴ as reported per year by department, per 100,000 inhabitants. Population data is taken from the 1998 Census. The conflict rate ranges between 0 to 8.04 and the mean conflict rate is 1.28 for all firms in the sample. The average rate of conflicts targeting foreigners increase from 0.63 to 2.38 after 2000. Figure 3 maps the distribution of firms in the sample in two periods.²⁵ It shows that firms’ concentration has somewhat changed over time but the majority of firms still concentrated in Abidjan both before and during the crisis.

5.1 The firms

Summary statistics of the variables of interest are reported in Table 3, including summary statistics for the sub-sample used to estimate the production functions, which excludes observations whose monetary values are in the first and ninety-ninth percentiles of the full sample. All monetary variables, including sales, value added and material costs are deflated using the corresponding industry deflators taken from the INS, where the industry classification is similar to the US 2-digit SIC classification. The use of industry-specific deflators helps limit the problem of product/input quality

²²The results are very similar if we instead drop observations with abnormal (one-percent tails) year-to-year growth in output and inputs.

²³We base our pooling on the similarity of the industries i.e. if they have similar capital labor ratios. Nevertheless, we need to drop some industries with a very small number of firms and no obvious similar grouping. These are electric and water utilities, ores and minerals, and petroleum industries. We further exclude financial services and government, education and health services since they are potentially very different from the rest of the industries.

²⁴We include five types of events reported by ACLED: Battle-Government regains territory, Battle-No change of territory, Battle-Rebels overtake territory, Riots/Protests and Violence against civilians.

²⁵Since the coded location data was collected upon in-corporation, the data might not be accurate if the firm has relocated. When the registered location does not match a firm’s physical address, we use the city and department information from the address to recode the firm’s location.

or markup differences across industries being incorporated in prices. Investment and capital are deflated using an economy-wide deflator due to a lack of more detailed information. Recent papers have raised concerns that using monetary values instead of physical output amount confounds productivity with mark-ups if there is still considerable heterogeneity in market power within industries (see for example, Foster et al. 2012). In the absence of data on firm-level prices or other information to infer mark-ups, our estimated TFP will have to be interpreted as containing price effects.

Sample means and medians show a typical skewed distribution with mostly small firms and few very large firms.²⁶ A quick glance at some key characteristics suggest that the quality of our data is reasonable. The average firm size, at 56 employees, is close to estimates from other countries in the region. For example, Soderbom and Teal (2004) estimate the average size of Ghanaian manufacturing firms to be 67 employees. The measure of labor productivity, sales per employee, is at around 80,000 USD. This figure is comparable to China and Indonesia (see Bloom et al 2010).

We use information on shareholding, which is available for the sub-period 1999-2003, to construct ownership variables for the firms. We observe nationality and share values held by all shareholders in the firm but not their identity. We define ownership of the firm as the nationality category with the largest total share. We distinguish between Ivorian, French West African, French and other foreign ownership to understand the differences in firm characteristics by ownership. However, in what follows, we only distinguish between Ivorian and foreign ownership since we do not hold any *a priori* hypotheses on the differences between different types of foreign firms (except for French West African firms, which at any rate constitute a very small share of the sample). Summary statistics of firms by ownership over the years are reported in Table 4 and 6.

As shown in panels A and C of table 4, foreign owned firms in all years represent a significant proportion of all firms in both the original sample and the sample used to estimate TFP. At the same time, there are considerable changes of ownership over the crisis years. By the end of the sample period, the percentage of Ivorian firms has increased by almost 10% compared to the beginning of the sample period, picking up the decline in French ownership. The distribution of ownership in a balanced sample shown in panel B of table 4 suggests that part of the changes are caused by entry and exit. This is confirmed in table 5 which shows that the majority of changes in ownership happens in 2000. Table 6 compares the characteristics of firms by ownership. Given their large percentage and significantly larger size, both in terms of employment and total assets, foreign, and especially French, businesses clearly play an important role in Côte d'Ivoire's economy.

5.2 Firm entry and exit

Figure 4 shows aggregate trends in firm's entry, exit and employment growth. Entry and exit rates average over the entire study period at 11.7% and 25.2% respectively. Both entry and exit rates

²⁶Compared to the typical distribution of firm size in developed countries however, the formal sector in Côte d'Ivoire exhibits a relatively smaller percentage of small firms and a greater percentage of large firms - similar to findings from other developing countries (Klapper and Richmond 2010).

show a clear break after 2000. Exit rate increases from around 23% in 1998-1999 to around 27% in the 2000-2002 period. Entry rate shows an even bigger gap between the two periods, from around 15% in 1998-1999 to 9-10% in the later years. Aggregate employment also contracts from a net job creation of about 10000 workers in 1999²⁷ to a net loss of about 18000 jobs in 2000 and decreases further in 2002 and 2003.

As shown in figure 5, foreign and Ivorian-owned firms have similar entry and exit rates in 1999 but diverging trends of increasing exits among domestic firms and decreasing entry among foreign firms starting in 2000. One possible explanation is that foreign firms weather shocks better than domestic firms and thus are more likely to stay in business. However, because foreigners have higher opportunity costs of establishing businesses in the country given the conflict, they are less likely to enter. Figures 6 and 7 show that the spike in exit rates since 2000 is also accompanied by an increase in the average size and age of exiting firms. Given the common finding in the literature that larger and older firms are more productive, this trend suggests that more productive firms might be exiting during the conflict.

These figures indicate a highly volatile economy comparing to entry-exit rates of firms in other countries. It is difficult to find census data for other economies with comparable income level but estimates from surveys in other sub-Saharan countries indicate lower annual firm exit rates. For example, Soderbom et al. (2006) find that the attrition rate for a sample of firms from Ghana, Kenya and Tanzania averages 6% between 1993 and 1999. Shiferaw (2009) reports annual exit rates from the manufacturing census in Ethiopia, whose income per capita is about one third the level of Côte d'Ivoire, to be 16% in the 1996-2002 period. In general, coinciding with the surge of violence, the formal sector starts to show signs of contraction in 2000 as evidenced by decreased overall employment, increased exit and decreased entry.

5.3 Output

Figure 8, panel A plots the simple trend in firms' output - measure as log of value added - over time (the base level in 1998 has been normalized to zero). It shows a sharp decline in average output, which is 38-56% lower in 2000-2003 compared to 1998-1999, the pre-conflict period. In panels B and C, we plot the coefficient estimates γ_{2t} from the following regression:

$$y_{it} = \gamma_0 + \gamma_1 Foreign_{it} + \sum_t \gamma_{2t} Foreign_{it} \times D_t + \mu_i + \mu_{jt} + \varepsilon_{it} \quad (11)$$

where y_{it} denotes log value added, $Foreign_{it}$ denotes foreign ownership/employment and D_t are year dummies. The coefficients γ_{2t} tell us the percentage differentials between firms with/without foreign ownership and employment over time, conditional on firm fixed effects μ_i and industry-specific year effects μ_{jt} . The results show that output has been reduced by more than 20% for firms

²⁷The size of the total workforce in Côte d'Ivoire in the industrial sector is half a million (Bureau of International Affairs 1999).

with foreign employees relative to other firms beginning in 2000. The relative decline is the largest (35%) in 2003. Foreign owned firms' output has also decreased more than their Ivorian counterparts but the difference is not significant until 2003.

Figure 9 shows the distributions of log capital and log capital/labor ratio for the two periods before and during conflict. It shows that the distribution of capital has shifted somewhat to the left during the conflict but the reduction does not reflect a situation of severe destruction. The distribution of capital/labor ratios has also decreased but not to a large extent.²⁸ These observations lend support to our assumption that firms did not change their technology during the conflict.

The observed trends in value added suggest that output of foreign firms has dropped significantly more than non-foreign firms during the conflict. In the next section, we present regression results using structural estimates of TFP in light of the conceptual framework in section 4.1 to get at the causal impact of foreign ownership/employment and conflict on firms' production.

6 Results

6.1 Productivity evolution

Coefficient estimates of the (value-added) production function using the ACF and OP approaches are displayed in Table B.2, Appendix B.²⁹ Using these estimates, we plot the average firm-level log TFP and labor productivity (sales per employee) in figure 10. ACF and OP productivity estimates follow each other closely, suggesting that exit bias does not affect much the estimated TFP. Both estimates suggest that average TFP has dropped substantially in the conflict period. More specifically, productivity decreases by 12% and 18% in 2000 and 2001 respectively before rebounding slightly in 2002. Firm productivity in 2003 remains at 10% lower than the 1998-1999 average. Since Côte d'Ivoire's economy is heavily dependent on cocoa and coffee exports, the rebound in 2002 and 2003 might be partly due to a significant increase in their prices in the international markets.

The trend in labor productivity is qualitatively similar. The trends in TFP and labor productivity estimates match the pattern of average value added closely. In fact, a simple regression of firm-level year to year changes in value added on changes in TFP suggests that more than 80% of the changes in value added can be explained by TFP changes. Given this result, TFP appears to be an important channel through which firms' output is impacted by this conflict.

²⁸The statistics for the Kolmogorov-Smirnov tests of the equality of distributions are -0.1041 and -0.1298 for log capital and log capital/labor ratio respectively. The null hypothesis of equal distributions before and after 2000 is rejected at 0.001 significance level for both variables.

²⁹Since the coefficient estimates on unskilled labor for group 3 (canned and food preparations, beverages and ice cream, and other food products) and the capital coefficient for group 5 (wood industries) are negative using the ACF and OP approaches respectively, we omit firms in these two groups from our subsequent analyses.

6.2 Heterogeneous effects

The previous section provides some evidence that firm productivity has generally declined since 2000, after the start of Côte d’Ivoire’s political turmoil. We now explore whether the productivity decline is heterogeneous with respect to a firm’s identity during conflict times. Given that the results using OP and ACF estimates of TFP are very similar, we will only report regression results using the ACF estimates in the main tables.

Table 7 reports regression results from the estimating equation (8) which investigates the impact of foreign ownership/employment on TFP during the conflict period. Columns 1 and 2 report the results with foreign ownership while columns 3 and 4 report the results with foreign employment. The pre-conflict period is 1998-1999 but the base year is 1999 in columns 1 and 2 because ownership information is missing for 1998. Consistent with our hypothesis, the effect of foreign ownership and employment during the conflict period is negative in all specifications, but insignificant in columns 1 and 2. This could be due to the fact that most foreign owners are French and other European nationals and violent attacks against them did not intensify until 2003.

Turning to foreign employment, having at least one foreign employee has a significant and larger effect on TFP. This is consistent with the fact that most foreign employees are French West Africans and violence against them started in 2000. The coefficient estimate of the interaction term in column 3 implies that conflict reduces TFP of firms with foreign workers by more than 20% compared to firms with no foreign workers. This effect is identified from within-firm TFP and foreign employment variations, controlling for yearly shocks common among firms within industries and regions. When further controlling for age and size interacted with time in column 4, the estimated impact reduces to 9.7%. Given the functional form of the production function, this TFP impact translates to an annual impact of around 10% of total value added output.³⁰

The coefficient estimates on size in terms of assets also have expected signs. In all specifications, total assets have significantly positive effect on TFP, consistent with results elsewhere that larger firms are in general more productive (see, for example, Sorderbom 2006). Conditional on assets however, the results in columns 1 and 3 suggest that size in terms of employment and age have a negative impact on TFP. These results seem to be driven by the differential impact of conflict on older and larger firms. When controlling for the interactions of size and age with the conflict dummy in columns 2 and 4, the levels of size and age are no longer significant. Since firm size can affect various factors such as financial constraints and mark-ups, which can be captured in our TFP estimates, it is possible for the estimated TFP of large firms to decrease more during the conflict if these factors are changing differently for small and large firms. There is however no clear theories for why age should drive the magnitude of the the impact of conflict on firms conditional on size.

³⁰Or approximately 6% of GDP since the formal sector’s contribution to GDP is estimated to be 60% (Berthelemy and Bourguignon 1996). Due to missing data on value added and industry price indices, we cannot accurately match Berthelemy and Bourguignon’s estimates using our data. If we exclude all observations with negative reported value added and summing up nominal value added across firms, the aggregate value added of all firms in our data corresponds to roughly 30% of nominal GDP.

A possible explanation is that older firms are also more “visible” and thus are more likely to be the target of attacks.

In addition to the above before-after specification, we estimate and graph the effect of foreign ownership/employment in each year, $\tilde{\alpha}_{2t}$ where $t = 1998 \dots 2003$, using the model:

$$\hat{\omega}_{it} = \tilde{\alpha}_1 Foreign_{it} + \sum_t \tilde{\alpha}_{2t} Foreign_{it} \times D_t + W_{it}\alpha_3 + \mu_i + \mu_{jt} + \mu_{rt} + \varepsilon_{it} \quad (12)$$

These graphs permit a visual and statistical test for the year-specific effects of foreign ownership/employment on TFP. In these graphs, the value $\tilde{\alpha}_{2t}$ where $t = 1998/1999$ represents a reference category set to zero (as ownership information is not available in 1998). The results are presented in figure 11. The impact pattern of foreign ownership/employment on TFP mirrors the pattern of value added found in figure 8. Figure 11A shows that the before-after specification above masks the significant effect of foreign ownership in 2003, when anti-French sentiments became prevalent. The result suggests that having foreign ownership in 2003 reduces firm’s TFP by 18.8% on average. Conflict further reduces TFP of firms with foreign workers by 14.3% in 2000 and 17.4% in 2003, respectively, relative to firms which only hired domestic workers. Figure 11B also shows an insignificant effect of foreign employment in 1999 compared to the base year, justifying the parallel trend assumption for identification in the before-after specification above.

The results so far provide evidence on how productivity changes with foreign ownership and employment over time, which is suggestive that the turmoil in 2000 and 2003 has a negative impact on foreign firms. However, it is not possible to identify the overall effect of conflict on all firms given the time variation related to conflict will be succumbed into the year fixed effects. To identify this effect, we exploit geographical variations in conflict intensity and estimate equation (9). The results are presented in Table 8. Conflict intensity is a significant determinant of productivity in all specifications. An increase of one violent attack per 100,000 inhabitants reduces TFP by 10-11%, which translates to a aggregate annual impact of around 13% compared to the counterfactual of no violent attacks.³¹ This is comparable to the cross-region results in Abadie and Gardeazabal (2003) but lower than the cross-country estimate of 18% in Cerra and Saxena (2008).

Column 1 presents the results when we control for foreign employment as a dummy variable and interact it with conflict intensity. The coefficient estimate suggests that on average the impact of violent attacks on firms are 41.6% higher in magnitude if they have foreign workers. The results are qualitatively similar in column 2 where we control for the interactions between the shares of foreign employees and conflict intensity to allow for the effect of conflict on firms to vary with the degree of foreign employment that they have. When French West Africans and employees of other foreign nationalities are controlled for separately in column 3, only the interaction with French West Africans shows a significant impact. Most likely, this is due to the the small percentage of non-French West African employees in the sample. The results in column 3 suggest that having an

³¹We estimate this aggregate impact by summing up the predicted firm level TFP had the conflict rate variable is zero, and compare it to the observed aggregate TFP.

extra percent of French West African workers increases the (negative) impact of violent conflict by almost one percentage point. In aggregate, this effect corresponds to a 7% reduction in TFP over the sample period.

6.3 Channels of impact and robustness checks

This section presents results from several tests to disentangle the potential mechanisms through which conflict affects TFP and other robustness checks. Table 9 reports results on channels of impact. Specifically, we consider demand effects and effects on operating costs. Table 10 includes results from a set of robustness checks in various sub-samples.

As noted above, our TFP measure likely picks up changes in mark-ups (see section 5.1). Hence, the result that TFP of foreign firms are decreasing more than domestic firms might be driven by changes in both efficiency and demand. Since income as a whole for the population was decreasing, it is likely that domestic demand for goods and services produced by the formal sector was also falling. Therefore, firms that export part of their products might fare better than those depend solely on the domestic market. On the other hand, it is possible that trade in general and exporting firms suffer from instability. We test for which effect is stronger by interacting an indicator of export orientation with foreign employment and the conflict dummy in the before-after regression in equation (8). Since we do not have trade data at the firm level, we use aggregate data from the INS to calculate an industry export orientation index before the conflict.³² The coefficient estimates on the variables of interest are reported in table 9, column 1. The interaction between foreign employment and the conflict dummy is still significant and of similar magnitude while the coefficients on export interacting with conflict and foreign employment are insignificant, suggesting exporting has no net effect on all firms.

Another possibility is that firms with different market power would see different changes in profits which is reflected in TFP. To test whether this channel is operating, we control for an indicator that equals one for firms belonging to a highly concentrated industry at the beginning of the sample period (1998). An industry is defined as high concentration when its Herfindahl index - defined as the sum of squared market shares in value added - is larger than 1.4, or approximately in the seventy-fifth percentile of the sample. We then control for this variable in an analogous way as the export orientation variable before. The results are in column 2. The concentration dummy interacted with foreign employment and conflict is insignificant, suggesting that productivity loss for foreign firms are present in both high and low concentration industries.

Another channel through which trade may affect firms is if they use imported inputs, which might

³²We calculate the share of exports over total output at two-digit industry level in 1999 since we only have aggregate data from the INS for two years 1999 and 2004. In principle, we can use trade data from other sources such as COMTRADE to calculate export and import shares at the ISIC 4-digit level and for all years. However, this approach does not work because we were unable to match the industry indicator for more than 60% of the firms in our data with the COMTRADE data. Approximately half of the industries (in terms of number of firms) do not export in 1999 so we define export orientation as a dummy variable indicating non-zero exports at the industry level.

become more costly with the conflict. Column 3 displays results of whether firms in import oriented industry are impacted differently. The import indicator is calculated in the same way as the export indicator above. The coefficient on its interaction with the conflict dummy is negative and significant, indicating this cost channel might be at play. The coefficient on the interactions with foreign employment and conflict is not significant however. Thus increasing cost of imported inputs does not appear to be a channel through which foreign firms were affected more by the conflict.

As discussed before, conflict might lead to destruction of infrastructure such as roads, causing firms with higher transportation cost to incur disproportionately higher operating cost.³³ Column 4 presents a test of this channel, using the share of transportation cost over total sales at the firm level. The result suggests no significant impact of transportation cost however, even though the signs of the interaction terms are as expected. We also control for lagged instead of current transportation cost to mitigate endogeneity concerns and did not find a different result.

One concern with the previous results is that they could be affected by sample selection bias given we have to drop a larger number of firms from earlier years due to missing data. The sample selection issue is driven by that fact that we have to fill in missing sector information for a large number of firms in 1998 and 1999 using data from earlier/later years. As a result, firms that survive only one period are more likely to be excluded. An ideal test would be to drop firms that exit after one period, which would require dropping firms with a panel length of one. However, exit is not known in the last year of data (2003) so such procedure implies a lower likelihood of being included in 2003. To overcome this problem, we reestimate all of the specifications above using a sample where firms' age is larger than one. This test effectively excludes firms that survives one period with the caveat that inferences are only for firms that are age 2 and above. The results are presented in column 1 of table 10. The coefficient estimates are largely similar of significance and magnitude as before, suggesting that sample selection is not driving our earlier results. Lastly, columns 2-5 report results from the regressions in equation (9) on the sub samples stratified by size and age to account for the possibility that percentage foreign employees might affect firms of different size and age very differently. The coefficients on the interactions between conflict intensity and shares of foreign workers are qualitatively similar but only significant for smaller and older firms.

6.4 Do firms adjust the shares of foreign workers?

Do firms respond to conflict pressure by hiring fewer foreign workers and adjusting their workforce? Table (11) presents summary statistics which show that there is significantly less hiring of foreign employees in general during the conflict, consistent with our prediction. Table 12 present further econometric evidence from equation (10). In practice, we estimate this equation using the share of French West African employees as ρ_t since they make up the vast majority of foreign workers and

³³Moreover, this channel may be more important for foreign firms. In Côte d'Ivoire, anecdotal evidence suggests that unrest in the country has led to an increase in the number of checkpoints on the roads, and consequently an increase in the solicitation of bribes at these checkpoints. Furthermore, foreigners are often discriminated and demanded higher bribes.

they are mostly unskilled workers so the results are less likely to be confounded by skill level.

The results in column 1 and 2 are as predicted. That is, for firms with positive foreign employment, the share of foreign employees is decreasing with the conflict, after controlling for the relative wage of foreigners over Ivorians. To control for the possibility that labor adjustment cost might affect how quickly firms can change the share of foreign workers, we add lagged employment size and its squared terms and interactions with time. The results are reported in column 2. The negative coefficient on the interaction between size and conflict dummy indicates that bigger firms might be slower to adjust but the effect is imprecisely estimated. Coefficient estimates of the wage and conflict variables are qualitatively unchanged, suggesting our prediction holds up after (partially) accounting for adjustment cost. Another important caveat is we assume firms to be maximizing profits in the model and thus have not taken into account the firm's owner's taste for employing Ivorian versus foreign workers.³⁴ To the extent that larger firms might be more likely to behave as profit maximizers, the results that larger firms are slower to adjust might also be driven by a taste-based effect.

We have found suggestive evidence of firms adjusting the shares of foreign employment downward to mitigate the conflict impact. Tables 13 and 14 report results from the production function estimations where such adjustment is taken into account. Effectively, the share of foreign workers is modeled as an additional (potentially negative) input in the production function and its effect on productivity is estimated directly in one step. As before, we define the start of the conflict as $t \geq 2000$ and allow percentage foreign employees to have a different before and after effect on production. Since the production function estimations are at the industry level, the effect of foreign employment interacted with the conflict dummy is also allowed to be industry specific. We find negative and significant effects for the interaction term in five industries³⁵ and no significant impact on other industries. The results for these industries where we find a significant effect are reported in table 13. Using these coefficient estimates, the aggregate cost of having foreign workers during the conflict is estimated to be 5.4% of total output.

Next, we run the same production function estimations on sub samples of industries stratified by size to allow technology to be different for small and large firms and to make the percentage foreign employees more comparable across firms of similar size. Because of data limitations, this exercise can be done only for industries with sufficiently numerous observations. The results are reported in table 14. Here, we only find evidence of negative impact of foreign employment and conflict for firms in the Transport and communications and Commerce sectors and for larger firms in the Chemical, rubber products and building materials sector. Lack of statistical power might be responsible for the absence of impact in some industries but in general, these results confirm the findings in the earlier sections that foreign firms were impacted more by the conflict.

³⁴Taste could also be changing with the conflict. If it does not change over time then fixed effects can control for such concern.

³⁵Mechanical and electrical products, Construction and maintenance, Transport and communications, Rental and management of buildings, and Commerce)

7 Conclusion

Using firm-level data from Côte d’Ivoire, this paper has examined the heterogeneous impacts of political instability and violent conflict on firms in terms of efficiency loss. Our approach relies on a measure of firm TFP derived from structural estimates of the production function parameters. We argue that under fairly general structural assumptions, this TFP term contains the reduced form impact of several channels through which conflict might have affected firms, including (i) output loss due to looting and extortion, (ii) increasing shares of unproductive inputs for security purposes or due to idle capacity, and (iii) demand changes.

We find that the conflict reduces firm TFP substantially and having foreign ownership/employment magnifies the impact of conflict. The results are qualitatively similar when we control for endogeneity of foreign employment using instrumental variables or using an alternative procedure to estimate production functions. These results suggest that the nature of the conflict, which spurred increasing anti-foreigner sentiments, creates distortions that disproportionately affect foreign firms. In response, we find evidence of firms employing fewer foreigners to mitigate the conflict impact.

Given the importance of foreigners in general and of foreign investment in Côte d’Ivoire, our results suggest that recovery effort would have to entail restoring confidence in the state’s commitment and ability to protect the interests of foreign investments and employees. Moreover, increasing hostility and discrimination towards foreigners, as signaled by economic impacts, might further exacerbate the country’s already eroding social cohesion. Blattman and Miguel (2010) argue that if the costs are borne unequally across groups, conflict itself could intensify inequality and social discord, hence further aggravating factors that feed into the risk of conflict reoccurrence. In a society with a history of strong presence of immigrants and long standing social disparity between the north and the south like Côte d’Ivoire, this concern might prove to be important. Just before the Civil War started in 2002, a survey in major cities by PEW Global Attitudes Project found that 78% of the survey respondents rate “ethnic conflict” as a big problem facing the country. Indeed, the civil war that erupted the following year confirms that view.

Our research is also of relevance for other contexts because the type of conflict studied in Côte d’Ivoire - characterized by “low-intensity” but repeated cycle of unrest - has become common in many other developing countries. Understanding how the private sector is affected and adapts in these “no war no peace” situations is critical in understanding the role of instability in underdevelopment in a large part of the world. While this paper focuses on the specific conflict in Côte d’Ivoire and the negative implications it has for foreigners, our approach provides a useful framework to analyze conflicts/shocks in other contexts, which frequently impose asymmetric costs on different groups in the population.

A limitation with our data is that we do not observe directly the type and magnitude of losses that firms incurred due to the conflict. We have used several firm and industry characteristics to investigate potential mechanisms through which the conflict might have affected TFP. We find

evidence consistent with a story of increasing cost of imported inputs as a channel of impact and no evidence of demand effects driving the results. Nevertheless, we cannot rule out any mechanisms with certainty. This is an area for future research.

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Figures

Figure 1: Major political and conflict events

Figure 2: Conflict intensity by department

Note: conflict rate is calculated as the number of armed conflicts, divided by the total population by department

Figure 3: Firm distribution

Figure 4: Rate of entering and exiting firms and aggregate net job creation

Figure 5: Entry and exit rate by ownership

Figure 6: Average size of entering and exiting firms

Figure 7: Average age of exiting firms

Figure 8: Trend in average value added over time

A: Average value added over time, where 1998's level has been normalized to 0.

B: Impact of foreign ownership on value added over time, relative to 1999.

C: Impact of having foreign employees on value added, relative to 1998.

Coefficients from regression (11) are plotted in B and C. The dotted lines represent 95% CI, where all s.e are clustered at the firm level

Figure 9: Distribution of capital and capital/labor ratio before-after 2000

Note: Log capital and log (capital/labor) are plotted in the first and second panels respectively

Figure 10: Trend in un-weighted aggregate TFP index

Figure 11: Yearly effects of foreign ownership/employment on TFP

A: Impact of foreign ownership on TFP over time, where 1999's level has been normalized to 0.
 B: Impact of foreign employment on TFP over time, where 1998's level has been normalized to 0.
 Coefficients from regression (4) are plotted in A and B. The dotted lines represent 95% CI, where all s.e are clustered at the firm level

Tables

Table 1: Panel information

Year	Number of firms with missing			No of firms with valid values for K, L, value added
	Capital	Labor	Value-added	
1998	345	331	922	1,879
1999	294	482	889	1,789
2000	274	462	693	2,078
2001	277	451	656	2,037
2002	224	358	608	1,941
2003	140	278	585	2,086
Total				11,810

Table 2: Panel length

Number of years in data	Number of firms
1	1,733
2	1,728
3	1,953
4	1,816
5	2,180
6	2,400

Table 3: Summary statistics

Variable	Obs	Median	Mean	Std. Dev.	Min	Max
<i>Foreign ownership/employment:</i>						
Foreign ownership	10811	1.00	0.53	0.50	0.000	1.00
% foreign employees	16348	1.94	15.96	23.76	0.000	100.00
% foreign employees (if > 0)	8473	25.00	30.78	25.15	0.021	100.00
% French West Africans (FWA)	16348	0.00	12.62	21.27	0.000	100.00
% other foreign employees	16348	0.00	3.33	10.27	0.000	100.00
<i>Production function variables (full sample):</i>						
Value added	17317	31.39	266.06	840.93	-410.718	9538.21
Capital	18437	23.73	402.90	1505.21	0.000	18026.10
Skilled labor	16409	3.00	19.63	88.52	0.000	2923.00
Unskilled labor	16409	4.00	44.07	245.50	0.000	10395.00
Total employees	16409	10.00	63.70	289.77	0.000	11019.00
Investment	18345	2.00	75.71	276.36	0.000	3348.71
Materials	17468	86.78	1037.25	3613.16	0.000	42397.08
<i>Production function variables (after cleaning*):</i>						
Value added	11810	61.40	331.06	862.26	0.004	9525.39
Capital	11810	32.23	384.53	1310.81	0.001	17965.25
Skilled labor	11810	4.00	16.59	54.06	0.000	1650.00
Unskilled labor	11810	6.00	38.96	145.81	0.000	5443.00
Investment	11716	4.63	77.41	262.10	0.000	3312.97
Materials	11699	154.31	1199.72	3722.53	0.000	42397.08
<i>Conflict variables (by department):</i>						
Conflict rate, overall	18771	0.67	1.28	1.02	0.000	8.04
Conflict rate, FWA	18771	0.99	1.43	1.60	0.000	10.95
Conflict rate, other foreigners	18771	5.06	11.35	16.43	0.000	330.03
<i>Other firm characteristics:</i>						
Total assets	16939	146.27	2318.00	12802.64	0.008	455305.38
Sales	16044	247.41	1834.04	5743.94	1.820	60890.87
Sales per employee	14503	23.44	77.41	325.69	0.007	14201.23
Age of the firm in years	18436	6.00	10.32	11.34	1.000	104.00

Notes:

1. Monetary values are in constant 000's 1996 USD.
2. *The clean sample includes obs used in the production function estimations, where all obs in the one-percent tails of any monetary input/output variables are dropped.
3. Conflict rate is the number of armed conflicts divided by total population by department

Table 4: Percentage of firms by ownership

	Year	Ivorian	FWA	French	Foreign - other	Total
A: All obs with ownership information						
	1999	45.05	3.59	29.77	21.59	1283
	2000	45.63	3.40	29.97	20.99	2382
	2001	42.71	3.50	31.52	22.28	2002
	2002	45.23	3.83	28.36	22.59	2116
	2003	53.10	3.50	22.95	20.44	3028
	Total	47.04	3.55	27.95	21.46	10811
B: Balanced sample with ownership information						
	1999	43.69	3.47	29.80	23.03	547
	2000	39.44	3.28	37.74	19.55	885
	2001	34.74	3.13	39.42	22.72	832
	2002	35.66	3.37	38.55	22.41	830
	2003	40.36	3.10	34.40	22.14	1224
	Total	38.61	3.24	36.27	21.89	4318
C: TFP sample with ownership information						
	1999	42.18	2.83	31.27	23.72	742
	2000	45.66	3.32	32.06	18.97	1566
	2001	41.67	3.38	32.96	22.00	1332
	2002	42.98	3.51	31.25	22.26	1424
	2003	52.70	3.43	24.76	19.11	2072
	Total	46.06	3.35	29.86	20.73	7136

Table 5: Transition rate in/out of foreign status

	Year (t)				
	1999	2000	2001	2002	2003
Foreign employment:					
Total share of switchers	0.118	0.136	0.147	0.133	0.128
Zero in $t - 1$, positive in t	0.058	0.065	0.076	0.071	0.071
Positive in $t - 1$, zero in t	0.060	0.071	0.070	0.062	0.057
Foreign ownership:					
Total share of switchers		0.398	0.068	0.051	0.065
Zero in $t - 1$, positive in t		0.174	0.034	0.025	0.027
Positive in $t - 1$, zero in t		0.224	0.034	0.026	0.037

Table 6: Firm characteristics differentials between foreign owned and Ivorian firms

Variable	Means	Relative differences*			N	R^2
	Ivorian	FWA	French	Foreign-other		
Number of firms	4615	346	2733	2110	9804	
<i>Characteristics:</i>						
Log of total assets	5.669	0.667***	0.619***	0.217*	9804	0.202
Employment	86.343	22.591*	25.306*	-1.735	9417	0.13
Percentage skilled labor	44.12	5.434**	3.721***	-5.819***	9230	0.088
Percentage Ivorian workers	85.798	-9.925***	-9.861***	-10.324***	9273	0.153
Percentage FWA workers	11.629	7.513***	6.962***	5.773***	9273	0.161
Percentage foreign workers	13.905	9.689***	9.831***	9.821***	9273	0.156
Log of wage	14.39	0.417***	0.439***	0.016	9377	0.072
Log of staff cost	17.116	0.461***	0.609***	-0.057	9775	0.441
Log (VA/L)	2.234	0.359***	0.409***	0.11	8369	0.116
Log(K/L)	1.343	0.261**	0.088	-0.132	9146	0.107
Investment/lagged total assets	0.1	0.004	-0.003	0.006	6712	0.038
Receivables/sales	0.257	0.031*	0.039***	-0.016	9224	0.103
Payables/sales	0.763	0.01	-0.034	0.014	8853	0.069

Notes:

* Coefficients from OLS regressions, controlling for year, industry & size FEs (in equations without $\ln(\text{total assets})/\text{employment}$ on the LHS)

Table 7: TFP and foreign ownership/employment over time - full sample

Dependent variable: $\ln(TFP_{it})$	ACF estimates			
	(1)	(2)	(3)	(4)
Foreign ownership	0.0426 (0.0655)	0.0418 (0.0642)		
Foreign ownership $\times$ after	-0.0744 (0.0808)	-0.0716 (0.0788)		
Foreign employment			0.0961* (0.0505)	0.0170 (0.0506)
Foreign employment $\times$ after			-0.203*** (0.0483)	-0.0971** (0.0487)
Ln(total asset)	0.259*** (0.0915)	0.296*** (0.0909)	0.214*** (0.0712)	0.245*** (0.0711)
Ln(total asset) squared	0.00296 (0.00921)	-0.00103 (0.00919)	0.00624 (0.00731)	0.00267 (0.00728)
Size above median	-0.272*** (0.0487)	-0.00437 (0.0898)	-0.201*** (0.0385)	-0.0824 (0.0525)
Age above median	-0.0427 (0.0523)	0.0423 (0.0709)	-0.0868** (0.0419)	0.0390 (0.0472)
Size $\times$ after		-0.304*** (0.0881)		-0.179*** (0.0503)
Age $\times$ after		-0.108* (0.0645)		-0.228*** (0.0468)
Firms FE	Yes	Yes	Yes	Yes
Industry $\times$ year FE	Yes	Yes	Yes	Yes
Region $\times$ year FE	Yes	Yes	Yes	Yes
Constant	0.661 (0.404)	0.894** (0.363)	0.824*** (0.187)	0.666*** (0.188)
Observations	6344	6344	10204	10204
R-squared	0.140	0.145	0.132	0.139
Number of firm_id	3106	3106	4084	4084

Notes:

1. after indicates the conflict period 2000-2003

2. Clustered standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 8: Impact of conflict and foreign employment on TFP - full sample

Dependent variable: $\ln(TFP_{it})$	ACF estimates		
	(1)	(2)	(3)
Conflict rate	-0.107* (0.0551)	-0.116** (0.0547)	-0.118** (0.0547)
Foreign employment	-0.00727 (0.0489)		
Foreign employment $\times$ conflict rate	-0.0463** (0.0191)		
Percentage foreign employees		0.000100 (0.000953)	
% foreign employees $\times$ conflict rate		-0.000638* (0.000387)	
% FWA employees			0.000842 (0.00105)
% other foreign employees			-0.00253 (0.00172)
% FWA employees $\times$ conflict rate			-0.000936** (0.000439)
% other foreign employees * conflict rate			0.000501 (0.000799)
Firms FE	Yes	Yes	Yes
Industry $\times$ year FE	Yes	Yes	Yes
Region $\times$ year FE	Yes	Yes	Yes
Total assets $\times$ year FE	Yes	Yes	Yes
Constant	0.300* (0.170)	0.295* (0.168)	0.290* (0.169)
Observations	10287	10287	10287
R-squared	0.133	0.132	0.132
Number of firm_id	4107	4107	4107

Clustered standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Channels

Dependent variable: $\ln(TFP)_{it}$	Demand		Cost	
	Exporting (1)	Concentration (2)	Importing (3)	Transport (4)
Foreign employment $\times$ after	-0.117** (0.0578)	-0.101** (0.0508)	-0.105* (0.0558)	-0.0979* (0.0513)
Export oriented $\times$ after	-0.445 (0.288)			
Export oriented $\times$ foreign emp $\times$ after	0.0472 (0.0731)			
High concentration $\times$ after		-0.324 (0.300)		
High concentration $\times$ foreign emp $\times$ after		0.0265 (0.103)		
Import oriented $\times$ after			-0.565** (0.230)	
Import oriented $\times$ foreign emp $\times$ after			0.0446 (0.0722)	
Transportation cost $\times$ after				-0.770 (0.559)
Transportation cost $\times$ foreign emp $\times$ after				-0.329 (0.661)

Notes: specifications 1-4 include controls as in columns 2 and 4 of Table 7

1. Clustered standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

2. Export and import orientation are industry dummies indicating positive export/import in 1999.

3. High concentration indicates industries with above median Herfindahl index in 1998.

4. Transportation cost: transportation cost/sales, measured at the firm level.

Table 10: Robustness checks in sub-samples

	Age>1	Sample: below median		Sample: above median	
		Size	Age	Size	Age
		(2)	(3)	(4)	(5)
Spec: before-after					
Foreign ownership×after	-0.0457 (0.0758)				
Foreign emp×after	-0.0965* (0.0502)				
Observations	9415				
Spec: conflict intensity					
% FWA emp ×conflict rate	-0.000883** (0.000427)	-0.00152** (0.000686)	-0.000582 (0.000793)	-0.000551 (0.000588)	-0.000968** (0.000491)
% other foreign emp ×conflict rate	0.000368 (0.000812)	7.84e-05 (0.00125)	0.000621 (0.000926)	0.00123 (0.00104)	-0.000234 (0.00119)
Observations	9500	4899	4958	5388	5412

Clustered standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 11: Trends in skill and nationality composition

	Mean		Difference relative to 1998			
	1998	1999	2000	2001	2002	2003
% FWA employees	14.87	-0.918**	-1.782***	-2.667***	-3.924***	-4.267***
% other foreign employees	3.65	-0.334	0.32	0.0363	-0.279	-1.659***
% skilled employees	40.91	-0.369	0.166	1.438	2.281**	3.575***

Clustered standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 12: Labor adjustments

Dependent variable	Share of foreigners over all employees		
	(1)	(2)	(3)
After 2000	-0.0178*** (0.00403)	-0.0179*** (0.00402)	-0.0143*** (0.00502)
Wage ratio (firm level)		-0.000974*** (0.000299)	-0.00122*** (0.000375)
Size (lagged employment/1000)1			-0.00862 (0.0416)
Size × after			-0.0291 (0.0211)
Size ²			-0.00141 (0.00480)
Size ² × after			0.00273 (0.00261)
Constant	0.283*** (0.00250)	0.287*** (0.00281)	0.287*** (0.00529)
Firm FE	Yes	Yes	Yes
Observations	4412	4412	2764
R-squared	0.010	0.014	0.019
Number of firms	2035	2035	1381

Notes: all regressions are run on a sample of firms with wage data

1. Clustered standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

2. Foreign implies French West African (FWA) in all specifications.

3. Wage ratio: calculated as $\text{average wage}_{\text{Ivorian}} / (\text{wage}_{\text{Ivorian}} - \text{wage}_{\text{foreign}})$.

Table 13: Effect of foreign employment on productivity (endogenous foreign employment)

Industry group	Mec. & electrical products	Construction & maintenance	Transport & communications	Rental & mgmt. of buildings	Commerce
% foreign employees	0.00905	0.00558*	0.0129**	0.00752**	0.00184**
% foreign emp×after	-0.00612**	-0.00494**	-0.00814*	-0.00400**	-0.00241***
After 2000	-0.405	-0.523	-0.102	-0.339	-0.281***

Clustered bootstrap standard errors *** p<0.01, ** p<0.05, * p<0.1. Foreign denotes % foreign employees.

Table 14: Effect of foreign employment on productivity (endogenous foreign employment), by size

Industry group	Size	6		10		11		13		14	
		small	large	small	large	small	large	small	large	small	large
% foreign employees		0.0117	0.00975	0.0172	-0.00158	0.0219***	0.00912*	-0.000523	-0.00221	0.00214	0.00267*
% foreign emp×after		-0.0233	-0.0340*	-0.0111	-0.00410	-0.0116*	-0.0131**	-0.00111	0.00145	-0.00234**	-0.00264**
After 2000		0.305	0.306	-0.237	-1.030	0.463	0.206	-0.342**	-0.187	-0.307**	-0.299***

Notes:

1. Clustered bootstrap standard errors *** p<0.01, ** p<0.05, * p<0.1. Foreign denotes % foreign employees.
2. Size is measured in terms of employment. Small: below sample median. Large: above sample median (by industry)
3. Industry groups: 6 - Chemicals, rubber products, glass and building materials, 10- Construction and maintenance, 11- Transport and communications, 13- Other services, 14 - Commerce

A Empirical model with an endogenous productivity process

This sections sets up a simple model of the firm's profit maximizing problem to illustrate endogeneity issues with foreign employment and explains an estimating procedure based on ACF (2006) using materials to proxy for productivity to correct for this problem. We omit the issue of attrition bias for simplicity, but it can be reintroduced with an additional step that predicts exits using past investment (at the expense of being more data intensive).

Assume the firm's production is given by function of capital, labor, material inputs and an efficiency index:

$$y_{it} = e^{A_{it}} f(k_{it}, l_{it}, m_{it})$$

Let $e^{\tau_{it}}$ be a time-varying parameter that reflects an output distortion faced by the firm so that the firm's realized output is only $e^{\tau_{it}} y_{it}$ where $\tau_{it} < 0$.³⁶ Under our hypothesis that this distortion is increasing over time during the conflict for firms employing foreigners, denoting some measure of foreign employment as ρ_{it} , we can write τ_{it} as a time indexed function: $\tau_{it} = h_t(\rho_{it})$.

We maintain the assumptions that (i) the "real" productivity index A_{it} follows a first order Markov process so that $A_{it} = E(A_{it}|A_{it-1}) + \xi_{it}$, and (ii) the timing of investment is such that it takes one full period to form working capital so current level of capital stock is uncorrelated to the current productivity shocks. Allowing for input prices to change with whether firms employ foreigners and normalizing output price, the firm's profit in any period t can be written as:³⁷

$$\pi(k_{it}, l_{it}, m_{it}, \rho_{it}, A_{it}) = e^{\omega_{it}} f(k_{it}, l_{it}, m_{it}) - c(k_{it}, l_{it}, m_{it}, \rho_{it})$$

where $\omega_{it} = A_{it} + h_t(\rho_{it})$

It can be shown that under general assumptions, the material input demand is a functions of the state variables A_{it} and k_{it} and it is strictly increasing in the productivity parameter. We follow ACF (2006) to assume that labor decisions are made after the productivity shocks are completely realized but before decisions on purchasing materials so that the firm solves a sequential problem and chooses labor composition first.³⁸ Then:

$$m_{it} = m_t(k_{it}, A_{it}, l_{it}, \rho_{it})$$

Because of strict monotonicity, we can invert the material input demand function to get

$$A_{it} = m_t^{-1}(k_{it}, m_{it}, l_{it}, \rho_{it}) \tag{A-1}$$

Assuming a Cobb-Douglas functional form, we can rewrite the (log) value added production function

³⁶As discussed in the Methodology section, this distortion could arise if some firms (i) had their output expropriated, stolen, taxed more heavily or (ii) were forced to close operations more often.

³⁷In the empirical estimation, we only have value and not quantity data thus the distinction is irrelevant. Consequently, the differences in estimated productivity can also reflect how firms' product demand over time were affected differently

³⁸What this means is labor does not have to be a perfectly variable input as needed in the OP estimation procedure. Thus we can accommodate the case where labor and its composition (in terms of foreign/domestic workers) are serially correlated. Moreover, this estimation procedure is consistent with firm-specific capital and labor price shocks since they will simply be reflected in the material input demand function. This is an important advantage since in the context of a developing country like Côte d'Ivoire, it is likely that there are frictions in the labor and capital markets which result in different input prices across firms.

as:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + A_{it} + h_t(\rho_{it}) + \varepsilon_{it} \quad (\text{A-2})$$

$$= \beta_0 + \phi_t(k_{it}, m_{it}, l_{it}, \rho_{it}) + \varepsilon_{it} \quad (\text{A-3})$$

In our implementation, we approximate for ϕ_t semi-parametrically by a third order polynomial. There is a time index t in m_t and ϕ_t because of our hypothesis that the impact of being a foreign firm changes overtime with conflict intensity. Accordingly, the empirical estimation of the above equation has to allow for this possibility. Due to data constraints, we allow ϕ_t to change only once by including a dummy variable indicating the start of the conflict and its interactions with all other terms in the function ϕ_t . It is consistent with assuming that $h_t(\rho_{it}) = h^1(\rho_{it})$ before the conflict and $h_t(\rho_{it}) = h^2(\rho_{it})$ during the conflict.

The first step in the estimation involves estimating equation (A-3) to get predicted values for ϕ_t . If we have some initial values for β_k , β_l and $h_t(\rho_{it})$ then we can get a predicted value of the productivity term:

$$\tilde{A}_{it} = \hat{\phi}_t - \beta_k^* k_{it} - \beta_l^* l_{it} - h_t^*(\rho_{it})$$

Based on the assumption of the productivity process, we can get an estimate of the unexpected shocks ξ_{it} in the productivity process by regressing $\tilde{A}_{it}$ on a function of $\tilde{A}_{it-1}$:

$$\hat{\xi}_{it} = \hat{\phi}_t - \beta_k^* k_{it} - \beta_l^* l_{it} - h_t^*(\rho_{it}) - g(\hat{\phi}_{t-1} - \beta_k^* k_{it-1} - \beta_l^* l_{it-1} - h_{t-1}^*(\rho_{it-1}))$$

We approximate for g by a second order polynomial and use the following moment conditions to estimate β_k , β_l and the parameters in $h_t(\rho_{it})$:

$$E(\xi_{it} | k_{it}, l_{it-1}, \rho_{it-1}, m_{it-1}, k_{it-1}) = 0 \quad (\text{A-4})$$

From equations (A-3) and (A-4), it can be seen that if ρ_{it} is not included in the proxy function ϕ_t , the estimated $\hat{\xi}_{it}$ would still contain information on ρ_{it} . Therefore if the choices of foreign employees are correlated with labor or capital then we will get biased estimates using these moment conditions.

If $h_t(\rho_{it})$ contains a large number of parameters, it would require more moment conditions for identification and a large sample size to get precise estimates. Given our data constraints, we assume that

$$h_t(\rho_{it}) = \gamma_0 \rho_{it} + \gamma_1 \rho_{it} \times \text{after} + \gamma_2 \text{after} + \eta_{it}$$

where *after* is a dummy indicating the conflict period and η_{it} is a random noise unknown to the firm.

B Data appendix

B.1 Construction of variables used in TFP estimation

For the production function estimation, we need measures of output, inputs and investment. Except for labor input, all other variables are taken from the balance sheet information and measured in monetary values.

Labor: is measured as the total number of permanent employees. The employment information from the data allows us to distinguish between technical and unskilled employees and thus the ability to estimate separate coefficients on skilled and unskilled labor in the production function.

Capital and investment: Capital is proxied for by total fixed assets in book values in US dollars and investment is total acquisition of tangible and intangible fixed assets. With this definition, there are 10719 firm-year observations, or 70% of the sample, reporting positive investment. Both capital stock and investment are observed every year in the data. Therefore, we can also calculate investment or capital using the perpetually inventory method: $I_{it} = K_{it+1} - (1 - \delta)K_{it}$ where δ is the depreciation rate. De Loecker (2007) argues that this method is preferred when reported investment is not accurate. However, the lack of data on depreciation rates at the industry level makes this method also prone to measurement errors. Moreover, using a 15% depreciation rate for all firms, the number of firm-year observations with positive investment account for less than one third of the sample. Therefore the reported investment will be used in the estimation.

Output: we estimate the production function using the reported value added as a measure of output (implicitly imposing a separability assumption in the production functions).

Materials: are defined as total cost of intermediate inputs and other good purchases. Since both value added and materials are reported in the data, we reestimate value added - gross output less intermediate inputs and other purchases - as a robustness check as inaccuracies (in terms of reporting errors) are common. The two measures are highly correlated thus only results using reported value-added are included in the paper.

Industry classification and industry-specific deflators: Due to a revision in the industry classification in 1998, many firms in the data in 1998 and 1999 have missing sector information. To fill in this information, one can use sector information available in later years. This procedure implies a bias that firms that exited before 1999 are less likely to have sector information. To deal with this problem, we augmented the data with sector information from earlier years³⁹. Because of inconsistent sector categorization, we reconcile the sector variable by using a harmonized classification that groups some industries from the old and new systems. Consequently, some industry deflators need to be recalculated. We calculate the new deflators by adding the monetary values (production, value-added or intermediate goods) of the newly formed industries both in real and nominal terms and take the ratios of these two terms.

B.2 Constructing ownership variables

Recall that we define ownership by the nationality of the firm's largest shareholder. Since for more than 95% of the sample, the largest total share of shareholders of the same nationality is also larger than 50%, this definition almost coincides with ownership definition often found elsewhere in the corporate finance literature. Because the data were entered manually, there are significant number of typos which resulted in duplicate entries and inflated values (in cases when decimal places were entered wrongly). We fix the typos when possible using the rule that individual shares have to sum up to approximately 100 (i.e. dropping the duplicated entries and divide the values by an appropriate number) and drop the firms when there are no obvious way to fix the values. Another caveat with using this information is that data are not available in 1998 and are missing for a large

³⁹We have identification and employment data for firms prior to 1998, but financial information was not available. This procedure still implies that firms that entered and exited in 1998 are more likely to have missing sector information. However, the TFP estimation is not affected by this because we need at least 2 periods of data for each firm

number of firms in later years.

B.3 Conflict data

We use the Armed Conflict Location and Event Data (ACLED, Raleigh 2010)⁴⁰ to construct the conflict rate variables. This database tracks politically driven events in unstable and warring states therefore does not include crime violence. The database was compiled from various sources including news articles, books and humanitarian workers accounts of conflict events with the exact date, and by longitude and latitude. The longitude and latitude information allows us to merge the conflict data with GIS data on Côte d'Ivoire administrative boundaries to locate any conflict in the respective administrative unit.

The data also have detailed notes on the actors and targets of each conflict, which allows us to categorize conflicts into ones that targeted the general population, northerners, West Africans and other foreigners. This information enables the calculation of specific conflict rates by segments of the population, which can be a proxy for the differential risks faced by firm owners and employees of different nationalities⁴¹.

⁴⁰Available at <http://www.acleddata.com/>

⁴¹Northerners and West Africans were grouped together because such distinction is not possible in the firm and census data and because anecdotal accounts of discrimination suggest that they faced similar discrimination pressure

Appendix tables

Table B.1: Industries and industry groupings

Industry	Group	Description	Median $\ln(K/L)$	Proportion of firms with foreign Ownership Employment		Number of firms by Industry Group	
2	1	Agriculture for industry and ex- port	0.71	0.55	0.91	224	338
3		Forestry and logging	1.47	0.55	0.91	58	
4		Fishery products	1.13	0.42	0.77	56	
6	2	Grain and flour products	0.95	0.35	0.56	235	272
9		Oilseed industry	1.71	0.10	0.84	37	
7	3	Canned and food preparations	1.79	0.59	0.77	53	169
8		Beverages and ice cream	2.58	0.47	0.89	27	
10		Other food products	2.13	0.55	0.66	89	
11	4	Textiles	2.14	0.53	0.84	103	177
12		Leather and footwear	1.36	0.85	0.70	74	
13	5	Wood industries	1.36	0.74	0.84	411	411
15	6	Chemicals	1.83	0.67	0.77	190	476
16		Rubber Products	2.25	0.70	0.85	225	
17		Building materials, glass	1.75	0.81	0.84	61	
19	7	Transport equipment	0.28	0.71	0.72	186	186
20	8	Mechanical and electrical prod- ucts	1.37	0.61	0.69	388	388
21	9	Other manufacturing	1.22	0.48	0.68	394	394
23	10	Construction and Maintenance	0.56	0.52	0.56	884	884
24	11	Transport and communications	1.58	0.49	0.64	808	808
25	12	Rental and management of buildings	2.10	0.61	0.66	261	261
26	13	Other services	1.00	0.48	0.49	1961	1961
27	14	Commerce	0.91	0.54	0.47	4919	4919

Table B.2: Production function coefficient estimates

Industry group	OP			ACF		
	capital	skilled L	unskilled L	capital	skilled L	unskilled L
1	0.339**	0.277***	0.228***	0.195**	0.336***	0.255***
2	0.345**	0.292***	0.245***	0.218**	0.319***	0.291***
3	0.331	0.550***	-0.0242	0.314	0.0168	-0.159
4	0.435**	0.350***	0.238***	0.292	0.297*	0.354**
5	-0.159	0.318***	0.336***	0.128	0.276***	0.268**
6	0.306*	0.398***	0.188***	0.328*	0.468***	0.205***
7	0.280***	0.482***	0.430***	0.258***	0.418***	0.399***
8	0.295***	0.670***	0.275***	0.206*	0.607***	0.205***
9	0.260	0.469***	0.273***	0.253**	0.277**	0.229*
10	0.279***	0.401***	0.268***	0.296***	0.442***	0.253***
11	0.319***	0.369***	0.216***	0.285***	0.116	0.128*
12	0.176	0.523***	0.348***	0.216**	0.732***	0.326***
13	0.279***	0.535***	0.240***	0.303***	0.556***	0.226***
14	0.144***	0.498***	0.301***	0.174***	0.505***	0.248***

Clustered bootstrap standard errors *** p<0.01, ** p<0.05, * p<0.1

Table B.3: Correlation coefficients of productivity estimates

	Labor pro- ductivity	OP TFP	ACF TFP
Labor productivity	1		
OP TFP	0.9515*	1	
ACF TFP	0.8341*	0.8064*	1

Note: * indicates significance at 5% level