Aid, Trade and Post-War Recovery of the Rwandan Coffee Sector

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Abstract

We study post-war recovery in Rwanda, focusing on the coffee sector. First, we find that the role played by the rise in international coffee prices largely outweighed the one played by domestic policies. Second, we reveal the legacy of armed conflict, by analyzing how the recovery of the coffee sector varied sub-nationally. In 1999 – five years after the peak of the violence – we observe a significant investment gap in highly violence-affected regions. By 2009 the gap is however closed. We argue that the catching up was fostered by positive externalities generated by high-profile public investments in the coffee sector.

Keywords: Africa, Rwanda, coffee, conflict, war overhang, catch up.

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1. Introduction

In this study we look at the evolution of the Rwandan coffee sector over the period 1999-2009. During this period, Rwanda's real GDP per capita grew at an average annual rate of 4.3%, the double of the sub-Saharan African average (World Bank, 2011). The economic growth resulted in a 60% increase in the real GDP per capita in ten years and was accompanied with improvements in other measures of economic development; life expectancy increased from 44.2 in 1999 to 54.7 in 2009, and the primary completion rate more than doubled over the same period, from 30% to 68%. Trends in rural growth and poverty indicators are also encouraging, indicating a 5% average annual growth in the rural sector and a fall in rural headcount poverty from 61.9% to 48.7% over the period 2005/6 - 2010/11 (Republic of Rwanda, 2012).

This stunning progress came unexpectedly. In 1999, Rwanda was picking up the pieces of the 1991-94 civil war, the 1994 genocide, and the 1994-98 (counter-)insurgency. Approximately 800,000 Tutsi and moderate Hutu were killed in the genocide; and tens of thousands died in the civil war, by revenge killings or during (counter-)insurgency operations. In 1999, millions of refugees who just returned from camps across the border with DR Congo and Tanzania needed to be resettled; in the Northwest of the country a rural guerrilla warfare was disrupting the economy; hundreds of thousands of prisoners were waiting to be trialed; and millions of ordinary people needed to recover from the serious mental and material setback of the war (Des Forges, 1999; Verpoorten, 2012a). In addition, the structural factors that were said to have triggered the violence, including ethnic polarization and land scarcity, were still in place (Verpoorten, 2012b).

Under these circumstances, observers expected Rwanda to experience at best slow economic recovery and possibly slide back into violence. The rationale for this pessimistic expectation is laid out in the best-selling book *The Bottom Billion*, in which Paul Collier argues that approximately 60 countries, with a total population of about one billion, are stuck at the bottom of the world's income distribution because of self-enforcing mechanisms of poor economic performance (Collier, 2007). Rwanda qualifies for at least two of Collier's poverty traps: civil war and being landlocked surrounded by conflict-prone poor economies, so-called "bad neighbors". However, things turned out differently. In fact, Paul Collier himself called Rwanda's recovery "*deeply impressive*".[1]

How did Rwanda escape its "bottom billion" status? Some have argued that Rwanda's post-war success story is rooted in the combination of massive foreign aid and technical assistance as well as a complete redesign of the economy by a developmental authoritarian state (Booth and Golooba-Mutebi, 2012). As such, the Rwandan government has invested heavily in the promotion of private-sector development by improving public infrastructure and the business environment, and

by stimulating human capital accumulation through investments in health and education (Basinga et al., 2010). In addition, in order to directly improve the lives of millions of peasants, both the Rwandan government and international donors have focused on boosting agricultural productivity, among others by promoting high value agricultural commodities and liberalizing the two most important agricultural export sectors of coffee and tea (Republic of Rwanda, 2000).

There are however two important, yet largely unanswered questions. First, what is the actual role that domestic policies played in stimulating the impressive growth experienced by the country? Second, is the recovery process shared equally across high and low conflict-intensity regions? It is against the background of these two broad questions that we study the coffee sector in Rwanda. First, we examine the relative role of domestic policy measures, compared to external factors (the international coffee price) in explaining the extraordinary post-war recovery of the Rwandan coffee sector. Second, we perform a detailed analysis of the spatial pattern of the sector's transformation across low and high conflict intensity regions.

Although one economic sector cannot be taken as representative for the entire economy, learning about the coffee sector is interesting, both in itself and for gaining insights into the broader development processes in Rwanda. First of all, the coffee sector is economically very relevant for the country. With an estimated 500,000 coffee farmers, its development has a potentially large effect on rural incomes, employment and poverty reduction; and - being an important source of export revenues[2] - it plays a key role in determining the structural trade balance of the country. Second, the sector's liberalization and its transformation from a supplier of ordinary coffee to a player in the market of specialty coffee fits in the country's broader aim to free up markets and specialize in high value agricultural commodities. Third, the turnaround of the Rwandan coffee sector is widely perceived as a success story, on pair with the impressive national growth figures. Finally, a more practical reason for our focus on the coffee sector is the availability of unique data from nationwide coffee censuses (1999, 2003 and 2009)[3] as well as data on the instalment and performance of coffee washing stations[4], allowing us to trace coffee investments through time and across space.

Regarding our first research question on the determinants of the turnaround in Rwanda's coffee sector, we demonstrate that the spectacular 346% rise of coffee export earnings over the period 2003-2011 is mainly driven by world market prices for coffee. Increases in the quantity and quality of coffee produced played only a secondary role. Thus, while the repositioning of the Rwandan coffee sector from a supplier of ordinary coffee to a player in the market of specialty coffee has been often presented as the vehicle for higher prices received by coffee farmers

(Boudreaux, 2011; Chunan-Pole and Angwafo, 2011), our findings indicate that its importance is dwarfed by the steep international coffee price rise.

With respect to our second research question, we find that post-war investments in the coffee sector vary with conflict intensity, with farmers in heavily affected regions planting less new trees and maintaining existing trees less well up to several years after the conflict (in 1999 and 2003). This finding is in line with the *war overhang effect*, which - as described in Collier (1999) - results from the "bad news" of civil war raising perceived uncertainty of future returns on assets, thus discouraging investments. It is also in line with a small number of existing micro-empirical studies that show that violence affects households' behavior and production decisions, often constraining rural households to subsistence farming (e.g. Brück, 2006; González and Lopez, 2007). Other studies on Rwanda have shown evidence of gaps between low and high conflict intensity areas in terms of household consumption, cattle stock, and educational attainment (Serneels and Verpoorten, 2014; Verpoorten, 2009; Akresh and de Walque, 2011). As these studies look at a single data point shortly after the end of conflict, little is known, however, on the evolution over time of these gaps: are they closing or widening? Our analysis of the 2009 coffee census data shows that 15 years after the peak of violence, coffee tree investment was similar across low and high conflict intensity areas, marking the end of the micro-level war overhang effect and indicating that the armed conflict has not caused local poverty traps in coffee investments.[5] We will argue that donors and the Rwandan government played an important role in the closing of the gap, by undertaking large and highly visible investments in the coffee sector, which helped restoring confidence in coffee production, especially in areas highly affected by the violence. Thus, while these investments were less successful than forecasted in boosting the production of specialty coffee, the externalities they generated played an important role in the overall recovery of the coffee sector.

The rest of the paper is organized as follows. Section 2 dissects the national success story, evaluating the relative role of policies and international coffee prices in the post-war revival of the coffee sector. Section 3 descends to a more disaggregated level, focusing on the subnational variation of coffee tree investment, and how it may relate to the spatial pattern of conflict intensity. We present an empirical framework for estimating this relationship, for which results are presented in Section 4. Section 5 concludes.

2. A success story: background and determinants

2.1 Rise and fall of the coffee sector, 1904-2000

Coffee was introduced in Rwanda in 1904 by German missionaries. To assure its contribution to government revenue, its cultivation was made compulsory in 1933 by the Belgian rulers; and in 1963 the post-colonial government issued a law that prohibited the uprooting of coffee trees. These coercive measures were complemented with a set of positive stimuli, including the free distribution of seeds and fertilizers and the guaranteeing of stable prices (Tardif-Douglin et al., 1996). The coffee was purchased by a government agency called OCIR-CAFE and sold on the international market through RWANDEX and ETIRU, two companies in which the government held a high capital share.

This system worked relatively well until the end of the eighties, when the collapse of the International Coffee Agreement made an end to the worldwide quota system, resulting in a steep fall of coffee prices and a soaring deficit of Rwanda's coffee marketing board.[6] Following these events, a liberalization policy was introduced in Rwanda. In 1995, the export market was opened to other exporters besides RWANDEX and ETIRU; and in 1998, OCIR-CAFE stopped fixing producer prices (Tardif-Douglin et al., 1996). While this liberalization policy released farmers from the obligation to produce coffee, it exposed them to fluctuations in world market price and forced them to rely on private input and output markets. The coffee sector inevitably was also affected by the civil war and genocide in the nineties, as trees were left unattended and access to input and output markets was severely constrained.

The combination of the fall in international coffee prices, the liberalization policy and violent conflict led to a dramatic drop in coffee production. In addition, the quality of the coffee produced was low, resulting in prices below the international reference price, which in turn were keeping low the producers' incentives to invest their limited resources in coffee production. As a result, farmers uprooted the trees replacing them with food crops and plantations were neglected as the efforts involved in harvesting did not seem warranted (Loveridge et al., 2003).

2.2 Putting the sector back on track

As a response to the steady decline in production, in quality and in export earnings and in view of the recognized potential contribution of the coffee sector to the economy, the Rwandan government embarked on a strategy of stimulating the production of specialty coffee, a niche product that fetches a higher and more stable price on the world market. The stimuli included the access to credit for coffee investors and export tax exemptions for high quality coffee (Murezeki et al, 2014). International donors actively supported the government providing funding, technical assistance and training for the distribution of seedlings and the installation of coffee washing stations, and helping with the launch of an international marketing campaign for Rwandan coffee (USAID, 2006).

The most impressive and visible aspect of these efforts is the multiplication of coffee washing stations, which increased in number from 2 to 213 in the period 2002 to 2012. One of the most important consequences of these investments has been the reduction in the average distance from a coffee farm to the closest station. This reduced distance has allowed for a shorter time between harvesting and processing coffee beans, crucial for preserving the quality of the beans. The cost of fully washing coffee are, however, high. It is therefore only rewarding to undertake such process when the final product can enjoy a special premium price on the market, i.e. the premium for specialty coffee.

This is not always the case: the distinction between semi- and fully-washed coffee does not mirror the difference between ordinary and specialty coffee. There is no single definition of specialty coffee. The Specialty Coffee Association of America, for instance, simply defines it as coffee that is "*notably good and has a distinctive character in the cup*". In order to obtain such result, it is necessary that all actors involved in the coffee value chain (from the farmer until the retail shop) adhere to the highest quality standards. At the farm level, this implies a careful selection of coffee cherries, excluding defective, immature and overripe cherries, as well as cherries with the infamous potato-taste. In addition, marketing is an essential part of the specialty coffee business, because specialty coffee not only refers to the quality of the product, but also to the manner in which it is positioned in the market, highlighting origin, social and environmental certifications. Because of these characteristics, specialty coffee is sometimes referred to as "relationship coffee", requiring an investment in long-term relations with the specialized coffee brokers who buy on behalf of high-end coffee roasters such as Starbucks, Green Mountain Coffee, Intelligentsia and Wholefoods. The importance of the marketing aspect is well summarized by USAID, when it states that "*purchases [of specialty coffee] by importer, roaster, retailer and consumer are dictated more by perceptions of quality and back story rather than on price*" (USAID 2006, p. 18).

An example of a true success story is the Maraba washing station. Built in 2002 with the support of USAID, it is now managed by a farmer cooperative counting over 1,000 members. The origin of every coffee bean that reaches the station is recorded, the nearby laboratory is then used to test its quality, a double register is used to track the provenance of each lot, and farmers receive credits based on the quantity and quality of the beans they provide. Maraba coffee is internationally recognized, having been awarded with the prestigious Cup of Excellence in 2008.

In fact, in the past years, Rwanda has won several awards. On the occasions of winning coffee cupping competitions and new contracts signed, e.g. with Starbucks, popular media have reported on Rwanda's success story.[7] The sector also received praise from donors. For instance, it is included as an example of a success story in the World Bank publication *Yes Africa Can*. In this

publication, the success is mostly attributed to the reforms, in particular the liberalization of the sector and the focus on specialty coffee (Chunan-Poleand and Angwafo, 2011). Maybe most noteworthy, the transformation is recognized as a success story by one of the world's most well-known aid skeptics, Bill Easterly. Pointing to the role of financial and technical assistance in the revival of the sector, Easterly and Reshef (2010) state that "*Rwanda's coffee quality upgrade was a foreign aid success despite the usual poor record of aid*" (p. 4).

2.3 Qualifying the success

The recovery of the Rwandan coffee sector is largely advertised as a success story of government and donor interventions. Looking closer at the data, however, both the success and its attribution to policy need to be qualified.

The World Bank publication *Yes Africa Can* reports that the average export price of Rwandan green coffee increased from $1.60 to $3.10 between 2003 and 2008, but it fails to mention that the world market price for coffee rose from $1.41 to $3.06 over the same period.[8] Thus, while prices for Rwandan coffee increased by 94%, the international reference price increased by 117%, which puts the role of the reforms and the promotion of specialty coffee in a different perspective.

Likewise, the recovery of Rwandan coffee export earnings from its 2003 low is driven by international coffee prices. Coffee export earnings, which stood at $58 million in 1991, had plummeted to $15 million in 2003, but almost entirely recovered by 2011, amounting to $52 million; thus increasing by 346% over the period 2003-11. But, over the same period, the world market price for coffee increased by 427%, while Rwandan coffee production grew by 39%. Admittedly, 39% production growth over an 8-year period is a good performance for an agricultural commodity, but - in terms of explaining the rise of export earnings - it is dwarfed by the steep international coffee price rise. These facts are illustrated in Figure 1, which depicts the series for export earnings, exported quantity and the international coffee price, after normalizing each of the series taking 2003 as a base year.

— Figure 1 about here —

One of the reasons for the small role of specialty coffee in the recovery of export earnings lies in the incomplete transformation of the sector. Despite the rapid multiplication of washing stations, the production of fully washed coffee has remained far below targeted production and still is very modest. This is illustrated in Figure 2, which displays production figures for Rwandan coffee for the years 1980-2011.

— Figure 2 about here —

Overall, the figure shows a strongly decreasing production after the liberalization of the coffee sector in the early nineties and a sharp drop in 1994, at the peak of the violence. In the years following the genocide, production levels increased, but stayed far below what they were in the heydays of the eighties. The dotted line indicates the production of fully washed coffee, which entered the market in 2002. Ten years later, its market share reached approximately 20%, which is quite an achievement, but less than half of the target set in 2002. Thus, most of Rwandan coffee still was not fully washed and received no price premium.

The relatively low share of fully washed coffee can be traced to the large heterogeneity in the performance of the washing stations. Guariso et al. (2012) show that there is a wide variation in capacity use, with some washing station not being operational (capacity used equaling 0), others running at full capacity (100%), and an average capacity use of only 29% in 2008. Moreover even in the segment of fully washed Rwandan coffee not all coffee qualified as specialty coffee and received the mark-up that goes with it. Looking at the price paid for coffee lots, Guariso and coauthors find that by 2007 the average price for Rwandan fully-washed coffee was slightly above $3/kg (compared to $2/kg for ordinary coffee), but the distribution of prices was very skewed, with some lots of fully washed coffee sold at $2/kg and others sold at prices above 8$/kg. The very different prices paid for fully-washed coffee align with the large variation in the quality of fully-washed coffee produced.

In sum, while the liberalization of the sector has allowed farmers to benefit from increasing world market prices and the promotion of specialty coffee may have incited farmers to invest in coffee trees, the recovery of export earnings was almost entirely due to an increase in world market prices. The home-grown success story of the Rwandan coffee sector appears therefore largely driven by a few success stories that are hardly representative for the sector. Whether the heterogeneous performance of the Rwandan coffee sector relates to conflict exposure is the subject of the next section.

3. Subnational variation: the legacy of conflict?

We hypothesize that part of the within-country spatial variation of investments in the coffee sector relates to the spatial variation in conflict exposure. In this section we lay out the conceptual framework and our empirical strategy for testing this hypothesis.

3.1 Conceptual framework

In theory, the impact of conflict on post-war investment in the coffee sector in Rwanda may be positive or negative.

Two main mechanisms could explain a positive impact. First, there may be a "peace dividend". In the words of Collier (1999, p. 157): "*If a country immiserises itself through civil war it will have an enhanced post-war growth rate by virtue of its poverty*". The peace dividend follows the logic of neo-classical convergence according to which post-war growth is explained by high returns to heavily depleted production factors (Barro and Sala-i-Martin, 2004). It is also in line with what Organski and Kugler (1977) termed "The Phoenix factor", to describe the rapid rise from the ashes of post-war economies, in which innovations easily find their way. In the case of coffee production, farmers may have been more willing to invest in new and more productive tree varieties if their old coffee trees had been damaged till the point they could not be regenerated. Second, there may be a donor effect, as the donor community might have especially focused its efforts to promote (specialty) coffee in war-affected regions.

There is also a set of different mechanisms that could explain a negative impact of conflict on coffee tree investment. First, conflict-affected regions may be characterized by a "war overhang" effect. This is caused by the fact that the occurrence of conflict is "bad news" and while the news of current peace is good, the expected risk of bad news does not fully revert to its pre-war level (Collier, 1999). This pessimistic outlook on the future might lead individuals in war-affected areas to be more reluctant to engage in investments that are not easily reversible. Second, the capacity to invest may be affected. If war results in a drop in income, then - in the absence of perfect credit markets - total investment may be lower. Or, catch-up takes time to materialize as some production factors, such as human capital (e.g. the knowledge to produce coffee), may be slow to recover.

There are several other channels through which conflict may affect the investment in coffee, by changing its relative attractiveness compared to other crops. These channels relate to five distinctive characteristics of coffee production. First, coffee is a tree crop, requiring a rather large initial sunk cost and with a long gestation period, yielding income only 4 to 5 years after planting. Second, coffee prices tend to fluctuate a lot, causing further uncertainty about future returns. Third, unlike many typical subsistence crops such as manioc, coffee trees need specialized inputs, e.g. the appropriate type and quantity of fertilizer and pesticides. Fourth, coffee is a cash crop that needs to be exchanged on the market and its return therefore depends on the state of road networks, as well as on social networks and trust that may reduce transaction costs. Finally, coffee tree planting and uprooting are traditionally reserved for men. Because of these five characteristics, any conflict-induced shocks to expectations about the future, time and risk preferences, land tenure security,

market and road infrastructure, social capital, the labor market and the relative endowment of male labor may affect the relative profitability of coffee, thus inducing a reallocation in the investment portfolio of the households.

While with the limited data at our disposal we cannot distinguish between these various mechanisms, we can test whether the impact of conflict on coffee tree investment was on average positive or negative at different points in time after the end of massive violence. In addition, we will probe into the donor effect, studying whether government and donor investments in the coffee sector correlate with conflict intensity and with the evolution in coffee tree investments.

3.2 Econometric equation

We investigate the impact of conflict intensity on the recovery path of the coffee sector through a multivariate analysis. Our regression analysis is based on the following empirical model:

$$Y_{s,t} = \alpha_0 + \alpha_1 C_s + \Omega X_s + \Phi T_s + \mu_p + \varepsilon_{s,t} \qquad (1)$$

The dependent variable *Y* represents the outcome of interest - farm investment in new coffee trees, maintenance of coffee trees, or the instalment of a washing station - in year t . The subscript s indicates our unit of analysis, the administrative sector. The explanatory variable of interest is conflict intensity *C*; ε is the error term.

Simply regressing our dependent variable *Y* on the conflict measure *C* would run into problems. First, there may be reversed causality, with conflict intensity depending on pre-war coffee growing, e.g. as a result of rents stemming from coffee production. Second, there may be omitted factors that are related both to coffee and conflict, for instance pre-war income: regions where soil is more suitable for growing coffee may have been more wealthy, with better infrastructures, and this, in turn, may have directly affected the intensity of the violence.

We deal with these issues in three ways. First, we include province fixed effects μ_p to control for unobserved time-invariant province-level characteristics. Second, we include the vectors ***X*** and ***T*** to capture pre-war coffee growing conditions; ***X*** includes sector-level covariates that may explain coffee investment, while ***T*** includes proxies for pre-war investment in coffee trees (detailed below). Finally, we run a falsification test showing that conflict intensity does not relate to the number of trees planted prior to the genocide, conditional on the controls ***X*** and the province fixed effects.

3.3 Data

The outcome variables, Y

The Rwandan government organized three coffee census rounds in 1999, 2003 and 2009, covering all coffee-producing administrative sectors of the country. The 1999 and 2009 datasets provide detailed information on the number of coffee trees in several age groups; the 2003 dataset provides instead a rough categorization of the level of tree maintenance at the sector level. The quality of these data – at least for what concerns the 2009 census round - has been recently validated by Mukashema et al (2014), who showed that there is a very high correlation (0.92) between the coffee areas defined in this census and the mapping of coffee obtained through an innovative Bayesian network model applied to high-definition images of Rwanda.

We use the coffee census data to construct the three following sector-level variables: number of newly planted (less than 3 years old) coffee trees in 1999; share of trees that are maintained very well, well and badly in 2003[9]; and number of newly planted coffee trees in 2009. Panel A of Table 1 reports the summary statistics of these variables. In 1999 there were on average just 44 newly planted trees per km^2, compared to 1,015 in 2009, indicating a sharp increase in investments in new trees.[10] In 2003, the broad categories for maintenance indicate that one third of the trees were very well maintained, while almost 21% fell in the category of "bad maintenance".

— Table 1 about here —

Figure 3 displays the spatial pattern of coffee tree investment. In Panels A and C darker shaded sectors indicate a higher density of young trees in 1999 and 2009, respectively. In Panel B, darker shaded sectors indicate a higher share of very well maintained trees in 2003. The patterns clearly indicate large heterogeneity in coffee tree investments as well as a substantial increase in coffee tree investments between 1999 and 2009.

— Figure 3 about here —

One important caveat of the analysis is that the unit of observation is not the same across the three datasets because the 2006 administrative reform reduced the number of sectors from 1,536 to 416. Hence, the 1999 and 2003 datasets refer to the smaller pre-reform sectors, while the 2009 dataset considers the larger post-reform ones. Since the coverage of pre- and post-reform administrative sectors is different across the census rounds, we estimate our empirical model separately for the different rounds. In a robustness check we will show that our results are robust to restricting the estimation to the overlapping observations between the census rounds, i.e. to those post-reform sectors for which all corresponding pre-reform sectors were covered in 1999.

Explanatory variable of interest, C

Conflict intensity *C* can be measured in several ways. The Rwandan conflict cycle of the nineties included civil war, genocide, reprisal killings, (counter)insurgency (i.e. rural guerilla warfare) and a major refugee crisis (Verpoorten, 2012a). The genocide against Tutsi took by far the largest death toll and has been fairly well documented. Several proxies for genocide intensity exist, such as the pre-genocide share of Tutsi in a commune[11], the share of alleged genocide perpetrators in a sector, and an index of genocide excess mortality derived from two waves of population census data and data from the transitional justice system. The other forms of violence are less well documented.

Several criteria weigh when choosing among the available conflict measures: straightforwardness, reliability, exogeneity (not related to coffee production besides through the conflict channel), completeness (capturing the most important form(s) of violence), and fineness (available at commune or sector level instead of the more aggregate province level). None of the available measures stands out on all of these criteria. Therefore, for our main analysis we make the rather arbitrary choice of using the 1991 commune-level share of Tutsi in the population, which is a fairly straightforward measure to capture genocide intensity. In Appendix we show that our results are confirmed whenever using any other of seven possible alternative conflict intensity measures.

*Control variables, **X** and **T***

The vector ***X*** consists of several sector-level covariates likely associated to the suitability of the sector for coffee growing. These variables capture soil and climatic characteristics, access to market and infrastructures, and land availability. More specifically, the covariates - summarized in Panel C of Table 1 - are: average sector elevation and standard deviation in elevation (to control for soil ruggedness); average 1983-1998 sector-level yearly rainfall and average rainfall during the harvest season (March- May); sector-level estimates of potential coffee yields[12]; number of coffee mills installed in the sector by 1960; distance from each sector centroid to the closest main road, to the closest main city and to the country border; 1991 population and total sector area.

In order to better control for pre-war investments in coffee trees in the sector (***T***), we rely on information contained in the 1999 coffee census, which gives the sector-level number of coffee trees in the categories 3-10 years, 10-30 years and more than 30 years. All these trees - with the exception of a small fraction aged 3 to 10[13] - were planted before the genocide and therefore provide information about the pre-conflict situation.[14]

Conditional on the inclusion of these controls, we can interpret the relation between *C* and *Y* as causal, provided that sectors within the same province, with similar soil and climatic conditions,

similar rainfall, access to infrastructure (including coffee mills in 1960), size and population, and similar numbers of coffee trees older than 3 years in 1999 would have experienced similar levels of coffee investments in the absence of violence.

4. The impact of conflict: Regression Results

4.1 Coffee tree investment and maintenance

Table 2 reports our main results. In the first three columns we look at early post-war coffee tree investment as captured by the (log of the) number of coffee trees that are younger than 3 years in 1999. In the first column we simply control for province fixed effects and cluster the standard errors at the commune level. The estimated coefficient of the conflict variable α_1 is negative and significant at 5% and indicates that one percentage point more Tutsi in the population in 1991 is associated with 8.4 percent less young trees in 1999 - the average being 540 young trees per sector.

— Table 2 about here —

In column (2) we control for the sector-specific covariates included in the vector $\boldsymbol{X}$. The absolute value of the estimated coefficient slightly decreases to 7.7 percent, but it is now more precisely estimated and becomes significant at the 1% level. In column (3) we add the vector $\boldsymbol{T}$, i.e. the controls for older trees. While significantly increasing the explanatory power of our empirical model and the precision of the estimates, the coefficient of interest remains very stable at 8.1 percent. The coefficients on the covariates included in $\boldsymbol{T}$ are all positive and highly significant, indicating that, shortly after the genocide, new investment in coffee trees were relatively more likely in sectors with a history of coffee production.

In columns (4) and (5) we look at coffee tree maintenance as reported in the 2003 data. We consider the sector-level proportion of very well maintained trees as the outcome variable in our empirical model. Column (4) considers the specification with the covariates $\boldsymbol{X}$, while column (5) also includes $\boldsymbol{T}$. The estimated coefficient on our conflict proxy is highly significant and indicates that a one percentage point increase in the share of Tutsi in 1991 decreases the proportion of trees that are very well maintained in 2003 by 0.7 percentage points, corresponding to a decrease of about 2% compared to the mean. Thus, even nine years after the peak of violence, areas more severely affected by the genocide were significantly lagging behind in terms of tree maintenance.

Finally, in columns (6) and (7) we focus on the 2009 coffee census. The two columns replicate columns (2) and (3) but now considering trees aged less than 3 in 2009 as the outcome variable, and with all controls re-computed at the level of the larger post-reform sectors. Results no

longer show any significant difference between high- and low- conflict intensity areas in the number of newly planted coffee trees. If anything, the coefficient of conflict intensity is now positive. These results indicate a catch-up process fifteen years after the conflict.

4.2 Falsification test and Robustness checks

The results reported in the first three columns of Table 2 suggest that in 1999 - five years after the genocide - investments in new coffee trees and the maintenance of existing trees lagged behind in sectors with relatively high genocide intensity. Lacking a true counterfactual, our claim that the observed relation is causal heavily relies on the quality of the control variables included in the vectors $\boldsymbol{X}$ and $\boldsymbol{T}$. If the control variables do not sufficiently account for sector-level characteristics that correlate both with coffee production and conflict, our results may be driven by omitted factors. To check for this possibility, we exploit the information on the different age cohorts of trees and run a falsification test. In this test, we regress the number of trees that were planted in the pre-war period (i.e. the *old* trees aged 3-10, 11-30 and over 30 in 1999) on our conflict measures. Table 3 shows the result of this falsification test, using the same controls as in column (2) of Table 2.[15] The Table clearly indicates that conflict intensity is negatively related only to trees aged 0 to 3 in 1999, not to trees in the older age groups. This makes us confident that omitted variable bias is not a major issue.[16]

— Table 3 about here —

So far we considered the 1991 share of Tutsi living in the commune as our measure of conflict intensity. In tables A1 to A5 in the Online Appendix we introduce seven alternative conflict intensity measures and we show that our findings are confirmed when using any of these alternative measures.[17] Overall these results confirm that areas more affected by the violence were lagging behind in coffee tree investments five years after the end of the genocide, but no longer after fifteen years.

In a final robustness check, we tackle the issue of the 2006 administrative reform, which obscures our key comparison between the 1999 and 2009 results. To verify whether the different results across these two rounds stem from their coverage of different administrative units, we restrict our sample to the 164 sectors in the 2009 census for which the corresponding pre-reform sectors were fully included in the 1999 census. Results are reported in Table 4. The first two columns of the table show that our conclusion for 1999 remains the same: areas more affected by the genocide display a significantly lower number of young trees in 1999. This holds both when we

use pre-reform sector boundaries (column (1), N=613), and post-reform boundaries (column (2), N=164).[18] In column (3) we report the 2009 results for the subsample of 164 sectors, which confirm our previous finding: by 2009 there no longer is any significant difference related to past conflict intensity.

— Table 4 about here —

4.3 The role of investments in washing stations

What can explain the closing of the gap in coffee tree investments? Section 3.1 put forward some possible mechanisms related to coffee investment decisions in the aftermath of war. This section looks into one of these mechanisms that may explain the closing of the gap - namely the donor effect. More specifically, we will investigate whether the instalment of coffee washing stations helped curbing the war overhang effect. [19]

The rapid rise in the number of washing stations in the period since 2001 was the most visible achievement of the government- and donor-led efforts to put the coffee sector back on track.[20] We start by checking whether these stations were strategically located in more (or less) conflict-affected areas. In order to do so, we run a set of regressions that are based on the same empirical specification that we used so far, but as a dependent variable we now take the number of washing stations in the sector. The number of stations are obtained from the coffee division of NAEB and are available for the years 2002, 2003, 2005, 2007 and 2008. Columns (1) to (5) of Table 5 report the regression results for these various years. They clearly indicate that, after controlling for our $\boldsymbol{X}$ and $\boldsymbol{T}$ covariates, the location of washing stations across sectors does not depend on past conflict intensity.

— Table 5 about here —

Furthermore, columns (6) to (10) of Table 5 show that the placement of washing stations was also unrelated to the level of investments in new coffee trees in the immediate post-conflict period (trees younger than 3 years in 1999). Thus, new coffee washing stations were right from the start equally distributed across the coffee producing sectors, regardless of conflict exposure and baseline investment in trees.[21]

Could this invariant instalment have triggered subsequent tree investment? Particular about the coffee washing stations is their great visibility and the fact that they provide an

opportunity for coffee farmers to meet each other, and with buyers. In theory, these characteristics could stimulate coffee tree investment, as they signal a serious commitment to coffee production on the part of the government and foster networking of coffee growers. This theoretical prediction is however not supported by the data. Regressing the change in coffee tree investments over the period 1999-2009, defined as the difference of (the log of the) investments in coffee trees between the two census rounds, on the washing stations installed by 2007, we do not find any significant effect of washing station instalment (see column (2) of Table 6).[22]

The average effect that we have just estimated might however hide important heterogeneity. Very concretely, good news (and social interaction) may have a larger effect in areas where investments were set back by bad news (and mistrust). This is consistent with our empirical result in column (3) of Table 6. The positive and significant coefficient on the interaction term between washing station instalment and conflict intensity indicates that the instalment of a washing station had a significant positive impact in those sectors where the genocide was more intense.[23] More specifically, the coefficients in column (3) indicate that for a sector with a 1991 share of Tutsi equal to 10 percent (roughly coinciding with the 75th percentile of the distribution in our sample), having a coffee washing station installed by 2007 is associated with a 25% increase in investment in new coffee trees over the period 1999-2009, compared to a sector with the same 1991 share of Tutsi that hosts no washing station.[24] Thus, even though the washing stations did not lead to the expected growth of specialty coffee production (as discussed in Section 2.3), their rapid multiplication helped countering the war overhang effect, encouraging farmers in high-conflict intensity areas to invest in coffee trees (and thus allowing them to benefit from the surge in international coffee prices).

— Table 6 about here —

In sum, the catching up process of investments in new trees materialized somewhere between 1999 and 2009, and thus coincided with the explosion in investments in new coffee washing stations. These investments were equally distributed across the coffee producing sectors, regardless of conflict exposure and baseline investment in trees. We hypothesize that this large-scale high-profile indiscriminate investment was particularly effective in spurring new investments in coffee trees in those areas that were more severely hit by the violence and where the "war overhang" effect was more severe; and – although we cannot rule out alternative explanations - we find support for this in the data. Our interpretation is also supported by Elder et al (2012), who find, among other things, that washing stations in Rwanda were particularly successful in stimulating interactions among coffee growers, increasing their level of trust and social capital.

5. Conclusion

At the end of the nineties Rwanda was recovering from a horrific genocide, several other forms of violence and a massive refugee crisis. There were many reasons to be pessimistic about Rwanda's future, and expect poverty and conflict to reinforce each other. Yet, in the decade 1999-2009 Rwanda experienced impressive economic growth and development. Some observers attribute the unexpected success to decisive policymaking and leadership in Rwanda (Booth and Golooba-Mutebi, 2012). Others, analyzing the recovery path using subnational data, point to a mechanism of catch-up, i.e. growth seen as a recovery from a post-war low to a (new) steady state growth path (Serneels and Verpoorten, 2014).

In this paper we studied the Rwandan post-war recovery through the lens of the coffee sector. The post-war recovery of the coffee sector is largely perceived as a success story, and its success is attributed to donor and government policies that freed up markets and enabled the sector to reposition itself as a supplier of specialty coffee. We set out to answer two questions: (1) To what extent can the recovery of the coffee sector be attributed to donor and government policies? (2) To what extent is the recovery path affected by conflict?

Regarding the first question, we showed that the increases in coffee export revenue and producer prices are mostly driven by increases in the international price of coffee. Admittedly, without the liberalization policy that exposed farmers to world market prices for coffee, much of the international price rise would not have been transmitted to farmers. On the other hand, should the world market prices have decreased, producer prices would have decreased as well. The liberalization policy thus contributed to the recovery of the sector, but conditional on a windfall increase in international coffee prices.

Several commentators have remained silent on this crucial conditionality. Instead, they have attributed the sector's success to policies promoting its liberalization and especially its repositioning from a supplier of ordinary coffee to a supplier of specialty coffee. We showed that, although coffee washing stations have multiplied at an impressive rate, the share of fully-washed coffee has remained far below target. These findings underline the need for critically evaluating the data and numbers, and call for caution whenever applauding the transformation of the sector: it remains very uncertain if and how the sector can cope in a climate of declining coffee prices, and what the consequences will be on small-scale coffee farmers. The findings also contribute to the debate on the relative importance of domestic policies versus external factors in explaining the recent African economic growth (see for instance Ghura, 1995). They give some support to the strand of the

literature that questions the robustness of the recent growth spurt, qualifying it as being mostly driven by high commodity prices rather than by real structural reforms (Arbache and Page, 2010).

Regarding the second research question, we showed that the recovery path of the coffee sector is affected by conflict. Our results indicate that investments in new coffee trees and maintenance of existing trees were lagging behind in conflict areas, up to four and nine years after the end of massive violence. Thus, even though national growth figures recovered quickly and impressively once peace was restored, when analyzing coffee investments at the subnational level we find indications of a war overhang effect that lingered on for at least a decade. However, in line with what Miguel and Roland (2011) find in the context of Vietnam, we find that the conflict has not led to long-lasting local poverty traps. Fifteen years down the road there are clear signs of catch-up: by 2009, farmers in heavily affected areas invested no less in new trees compared to farmers in less affected areas.

We mentioned different mechanisms that could explain this time-path of recovery. While we did not have the data to estimate the contribution of each one of them, we explored more in detail the donor effect hypothesis. We did not find any evidence that donors especially targeted conflict-affected regions by awarding them with more washing stations and, when considering the full sample, we found no indication of any positive relationship between the presence of washing stations and the evolution of coffee tree investments over the 1999-2009 period. Washing station instalment, however, does relate positively to the evolution of coffee tree investment in areas more severely affected by the violence. This finding is consistent with the "bad news"/"good news" hypothesis: the increased uncertainty about the future following the "bad news" of violence caused an initial gap in coffee investments; which was later counteracted by the promotion of highly visible investments in the coffee sector and by renewed interactions among coffee producers, which carried the "good news" of a new favorable economic and social climate for coffee production.

Thus, while the promotion of specialty coffee may not have contributed directly to the rise in coffee revenue and to the post-war micro-level catch-up process, it may have done so indirectly by affecting expectations and/or human relations and thereby farm investments in coffee trees, enabling farmers to profit from the rise in the international coffee prices. Although this aligns well with recent research on the role of washing stations in building trust in Rwanda (Boudreaux , 2011; Elder et al, 2012), the bad news/good news hypothesis needs further investigation. If proven to be true, it would imply that the signaling function of policies in post-war settings is crucially important to counter a war overhang effect.

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[1] Paul Collier spoke these words at a high-profile gathering in Kigali, at the occasion of the release of the third Integrated Household Living Conditions Survey (EICV3). A Roaring Economic Engine, 21 February 2012 (The Independent, http://allafrica.com/stories/201202220765.html. Last accessed: August 2014).

[2] According to the UN COMTRADE database (http://comtrade.un.org/db/) in 2011 coffee accounted for 18% of the total exports of Rwanda.

[3] As it will be detailed in the following chapters, the definition of census better applies to the 1999 and 2009 datasets, which records the number and age of all coffee trees planted in the country. The 2003 dataset only contains information on the sector-level quality of the maintenance of the trees, indicating the share of very well, well and poorly maintained trees.

[4] Coffee washing stations are facilities that use spring water to remove the fruity pulp from the coffee cherries, separating out the beans that are then dried and stored for marketing. The process is semi-automated, and allows for several quality control methods to be employed to sort the coffee into various grades.

[5] This finding is in line with the results obtained by Miguel and Roland (2011), who considered sub-regional variation in the U.S. bombing intensity of Vietnam, finding no long term impact on a number of different outcomes.

[6] The International Coffee Agreement signed in 1983 established a system of exporting quotas to secure price stability within ranges agreed annually by exporting and importing members.

[7] One of many examples is the article by L. Fraser titled Coffee, and Hope, Grow in Rwanda, New York Times, August 6, 2006. Available at http://www.nytimes.com/2006/08/06/business/yourmoney/06coffee.html?_r=1. Last accessed: August 2014.

[8] The New York price index for Arabica coffee is commonly considered the international reference price for coffee.

[9] No specification of the criteria on which the categorization is based is available. It is however likely to take into account practices such as pruning, mulching, unweeding and the usage of pesticides, as these measures were (individually) included in the 1999 census.

[10] The values are computed by taking from the table the average number of trees per sector (540 and 53,050, respectively for 1999 and 2009) and dividing it by the average size of the sector (12.41 and 52.29 km^2, respectively).

[11] Commune indicates the administrative level above the sector. There were 154 Communes in Rwanda before the administrative reform.

[12] We proxy potential yield with the yield of very well maintained trees in the 2003 census. For sectors with missing data we spatially extrapolate potential coffee yield on the basis of a spatial weighting matrix, including the 5 nearest neighbours.

[13] We repeated all estimations excluding the category 3-10 years from the controls and results remained qualitatively unchanged (results available on requests from the authors).

[14] Coffee trees may have been uprooted during the conflict, or in the immediate post-war years. In this case, the number of trees older than 3 years as recorded in the 1999 census would be an underestimation of the true number of trees that were planted before the conflict. If more trees were uprooted in the more affected areas, the underestimation would be related to conflict intensity and thus affect our coefficient of interest. There is some anecdotal evidence that perpetrators uprooted coffee trees during the conflict, but there is no indication that this occurred on a large scale. In fact, in some cases the local administration explicitly established that all the crops standing on the field of the people killed were to

belong to the commune and were to be protected by the people of the sector in which they were located (Des Forges, 1999). An additional piece of evidence is provided by our robustness test reported in table 3, which shows that genocide intensity is unrelated to the number of old trees recorded in the 1999 census (and if anything, there is a positive association).

[15] Table 3 as well as all the following tables only displays the coefficient of interest. The full tables can be found in the Online Appendix.

[16] As we are proxing conflict intensity with the 1991 share of Tutsi, this result also indirectly confirms that coffee cultivation was not an ethnic-specific activity, thus excluding that we are simply picking up an "ethnic effect" of the genocide. This will be further confirmed by the following check, reported in the Online Appendix, where we rely on alternative conflict measures.

[17] More specifically, results show that the estimated coefficients for five out of seven conflict intensity variables are negative and significant for the 1999 census, four out seven are negative and significant for the 2003 census and none of them is negative and significant for the 2009 census.

[18] All the controls are re-computed according to the different boundaries.

[19] We also tried testing for alternative potential mechanisms, merging the coffee census data with data from the 1991 and 2002 population census rounds as well as with the 1999 Integrated Household Living Conditions Survey (EICV1). In this way we could generate the commune-level gender ratio (to proxy labor endowment), shares of immigrants and returnees (to proxy for land tenure security) and the share of villages having access to a local daily or weekly market (to proxy for market access). We denote these proxies by the vector $W_{s,t}$. Whenever including $W_{s,t}$ in the main regressions, the conflict intensity coefficient remains virtually unaffected. Furthermore, the estimated coefficient on $W_{s,t}$ is mostly statistically undistinguishable from zero. These results indicate that $W_{s,t}$ does not capture the channels through which conflict affect coffee tree investment. It is however also possible that the variables we included in the vector $W_{s,t}$ are poor proxies for the channels we want to investigate. In the absence of better data, we therefore decided to leave this analysis out of the paper.

[20] While there are today also a large number of privately owned washing stations in Rwanda, donors (especially USAID) and the Rwandan government initiated the wave of investments in the coffee sector (for more details, see Schilling and McConnell (2006) and USAID (2006)). Other efforts included investments in seeds development, agricultural extension practices, the stimulation of cooperatives, and the sponsorship of international partnerships with large coffee traders.

[21] This is in line with Schilling and McConnell (2006), who describe a model for the placement of the washing stations in Rwanda. The criteria for the choice of location included the suitability of the region to coffee growing, the presence of good transportation roads, the presence of plentiful clean water, the absence of other washing stations in the same service area, the availability of land for the construction of the station, and the absence of a national park in the nearby area.

[22] We consider the presence of washing stations in 2007 because the dependent variables considers coffee trees younger than 3 years by 2009, which were therefore planted from 2007 onwards. Using the presence of washing stations in 2008 delivers in any case qualitatively similar results.

[23] When considering the alternative proxies for violence intensity, in four out of seven cases the interaction terms remains positive at significant (at least) at 10% level. Results not reported but available on request from the authors.

[24] This effect has been obtained by computing (exp(-0.639 + 0.086*10)-1)%. The coefficients indicate that the positive effect of the washing station appears for sectors with a 1991 share of Tutsi equal to 7.4% or above (0.639/0.086). The average change in (the log of) investments in coffee trees in the sample is equal to 6.89.