

Responsiveness and Firm-led Disease Prevention: Three Cases from the 2014 Ebola Epidemic in Liberia

Byron Carson*

Abstract

During the recent Ebola epidemic, large agricultural and industrial firms in Liberia helped to lower the prevalence rate of Ebola, despite the lack of functioning governmental public health services. Firestone, Sime Darby, and ArcelorMittal are three instances of firm-led Ebola prevention whereby the private goals of owners, managers, and workers aligned with the social goal of Ebola prevention. The phenomenon of firm-led Ebola prevention, however, is contrary to standard public health approaches to Ebola and underexplored in the economics of epidemiology. This paper develops three conditions under which firms respond to epidemiological disasters, provide prevention, and lower prevalence rates. First, firms have well-defined and enforceable property rights. Second, labor is relatively scarce. Third, there are few public health alternatives. The aforementioned firms each held well-defined property rights and few public health alternatives, while Firestone faced a relatively abundant supply of labor. These conditions and experiences from Liberia suggest private actors can be a significant source of preventing in epidemiological disasters and the welfare consequences of epidemics may be overstated.

Keywords: Liberia, Ebola, firm-led prevention, public goods, public health, incentives

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* Email: bcarson2@gmu.edu. Address: Department of Economics, George Mason University, MS 3G4, Fairfax, VA 22030, USA.

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1 Introduction

The 2014-2015 Ebola epidemic is a unique opportunity to illustrate how firms in the private sector respond to severe epidemiological disasters.¹ It is well known that firms can help to provide goods and services related to public health, especially if an infectious disease is known or is endemic. For example, Fishback (1992), Troesken (2015), and Carson (2016) discuss how private sector firms provided sanitation, water filtration, and anti-malaria campaigns, respectively, in the United States during the late 19th and early 20th centuries. In sub-Saharan Africa, businesses have helped to prevent malaria in Ghana and South Africa (Ebama and Urbach, 2011), and in Zimbabwe and Zambia (Watson, 1953; Utzinger et al, 2001). Firms have even provided a variety of services to care for and treat HIV patients, as well as prevent its spread (Honke, 2013; Kranz, 2013; Muller-Debus, 2013; Rosen and Simon, 2003; Thauer, 2013; and Yassi et al, 2013). With Ebola, however, no one knew the full extent of the epidemic, and there was less time to prepare. Past outbreaks of Ebola are numerous, but they have been smaller and easy to contain when compared to the recent epidemic (Chippaux, 2014; Peters and LeDuc, 1999; and Shears and O’Dempsey, 2015). Understanding the private sector’s response to epidemiological disasters complements the economic approach to epidemiology and our knowledge of public health systems.

This paper provides an economic based explanation as to why large industrial and agricultural firms in Liberia responded to the Ebola epidemic. The Firestone Natural Rubber Company, the Sime Darby Plantation Liberia, and ArcelorMittal, some of Liberia’s largest employers, altered their organizational structures and production processes to mitigate the spread

¹ According to the World Health Organization, Liberia accounted for about 42 per cent of the deaths (4,808) and 20 per cent of the confirmed cases (3,157) (see, Tseng and Chan, 2015, for an overview of the epidemic).

of Ebola. They reported seventy-two, zero, and one confirmed cases, respectively, whereas the number of confirmed cases in the seven counties where they operated ranged from a low of 20 (Gbarpolu) to a high of 400 (Margibi), with an average of 138. These firms valued Ebola prevention to maintain the health and productivity of their workers, their dependents, and members of the local community, and especially because they held well-defined and enforced property rights, they faced a relatively scarce supply of labor, and there were few public health alternatives.

Analyzing why and how these firms helped to prevent Ebola makes three contributions to the economic and public health literature studying infectious diseases (Laxminarayan and Malani, 2011; Philipson, 2000; and Roberts, 2006). First, it extends the notion of prevalence elastic behavior (Philipson and Posner, 1993; 1995), to human behavior within a firm.

Prevalence elastic behavior is the way in which people respond to changes in the prevalence of an infectious disease; for example, as the prevalence of HIV increases, people are less likely to engage in potentially infectious behavior like unprotected sex or the use of unhygienic needles. While most studies of prevalence elasticity focus on changes in the consumption of potentially infectious behavior, e.g., the consumption of vaccines (Goldstein et al, 1996; and Oster, 2016), and the variety of HIV/AIDS related behaviors (Kremer, 1996; Oster, 2012; Greenwood et al, 2016), the way in which people respond to infectious diseases through a firm is underexplored. Yet, prevalence elastic behavior through the firm, or firm-led disease prevention, was an important response to the epidemic in some parts of Liberia, which deserves explanation.

Second, firm-led Ebola prevention complements our understanding of when private and public incentives align to resolve collective action problems associated with infectious diseases. That is, whenever people prevent the spread of an infectious disease, they emit external effects

and cause the well-known free rider problem (Gersovitz and Hammer, 2003; Tullock, 1969). Resolving externality problems of infectious diseases is particularly problematic for uncoordinated private actors. However, Adam Smith noted long ago that private actors can partially mitigate external effects when profit opportunities encourage them to do so. Historical, theoretical, and experimental analyses on the private provision of public goods support Smith's insight (Anderson and Hill, 2004; Beito et al, 2009; Bogart, 2005; Brubaker, 1975; Coase, 1974; Cheung, 1973; Cornes and Sandler, 1996; Demsetz, 1970; Foldvary, 1994; Harrison and Hirshleifer, 1989; Klein, 1990; and Smith, 1980). If firms partially internalize prevention externalities but are ignored in standard welfare analyses of epidemics, the social consequences will be overstated.

Third, cases of firm-led Ebola prevention also address the public health literature on the economic, political, and social foundations of Ebola. While the literature points to a number of underlying factors, firms are either ignored as a means of prevention or believed to exacerbate the epidemic.² Poverty, for example, is a driver of the epidemic, especially in communities throughout Montserrado, Liberia, where people may be less educated or more likely to live in overcrowded spaces (Fallah et al, 2015). Abramowitz et al (2015) and Salmon et al (2015) analyze local community responses to the epidemic. Tambo (2014) focuses on humanitarian responses that could help prevent future outbreaks. These theories consider important aspects of the Ebola epidemic, but none consider the role private firms play in prevention or how profit encourages preventative behavior.

² For recent scholarship on the sociological, cultural, and behavioral factors of Ebola, see Alexander et al (2015) and Manguvo and Mafuvadze (2015). Richards et al (2015) describes social pathways that influenced the spread of Ebola in Sierra Leone. On the inability of national public health systems to combat Ebola, see Regmi et al (2015). On Ebola as a global health threat, see Kalra et al (2015). On the social and political determinants of epidemiological models – for Ebola and H1N1 – and how they form narratives of disease, as well as particular policy approaches, see Leach and Scoones (2013).

If private firms are considered in the public health literature, they are assumed to be non-existent or facilitators of disease. Bowles et al (2015) shows that many firms in Liberia, especially in the automotive, construction, food and beverage, and restaurant industries, as well as many firms in Monrovia, responded to the epidemic by closing down. These firms, typically small businesses with less than ten employees, faced a temporary decline in revenue and could not have afforded a meaningful prevention campaign. Some larger firms walked away too; Wilkinson and Leach (2014) dismiss the private sector's response to Ebola based on the exit of larger firms like London Mining and British Airways.

Furthermore, private firms are believed to contribute to the spread of Ebola. Richards et al (2015) describes how historical and modern trade routes, among other social factors, correlate with Ebola in Sierra Leone. Wallace et al (2014) suggest firms like Firestone and Sime Darby, as well as business-oriented government policies, exploit and encroach upon forestlands; yet, they acknowledge the complex political economy factors that influence the interactions between a nation's economic interests and its agroecology. Leach (2015) suggests that long term economic and political structures of violence cause inequality, environmental problems, and conflict. For example, local populations around ArcelorMittal fail to develop inclusive political and economic institutions, as well as public health institutions, because of the company's pursuit of profit (Allouche, 2015; Leach, 2015). These authors argue private enterprise is an underlying means of transmission, which facilitated the spread of Ebola throughout west Africa. On the contrary, this paper focuses on the incentives firms have to halt the transmission of Ebola. That is, while firms can be an underlying cause of epidemics, they can also be an underlying means of prevention. Delineating the conditions under which firms serve the latter function develops our understanding of complex public health systems.

The paper proceeds as follows. Section II develops the theoretical argument explaining why firms facilitate disease prevention amongst owners, managers, workers, and local populations. Section III describes the methodology and case selection. Section IV analyzes whether or not Firestone, Sime Darby, and ArcelorMittal meet the conditions of firm-led disease prevention in Liberia. Section V details how Firestone, Sime Darby, and ArcelorMittal responded to the Ebola epidemic. Section VI concludes.

2 Responsiveness and Firm-led Disease Prevention

Preventing the spread of a contagious disease emits a positive externality because people are automatically better off through a lower probability of infection. Therefore, an uncoordinated group of people suffer from a collective action problem, whereby people free-ride off of the preventive actions of others. Over time, this leaves an uncoordinated group of people with too little prevention, which facilitates disease transmission.

Resolving this problem requires a mechanism to alter the payout schedule people face, which will punish free-riding or reward prevention. Philipson and Posner (1993) develop an epidemiological model based on individual behavior, whereby people respond to changes in prevalence by altering their consumption of an infectious or preventive behavior. For example, unprotected sex and the use of unhygienic needles are the main individual-level behaviors that increase the probability of becoming infected with HIV. The consumption of these behaviors is expected to decline as the prevalence of HIV increases. While they may not resolve the collective action problem completely, they mitigate its severity by the extent to which people respond to changes in prevalence.

People can also respond to changes in prevalence by leveraging the financial resources and organizational capacity of a firm. The owner or manager of a firm can purchase medical supplies, employ doctors, and hire relevant public health specialists to coordinate a prevention campaign. Firms also have the ability to restrict entry into and enforce rules throughout worksites, which can contain or prevent the spread of disease. For example, a firm can select for healthy people during its hiring process or it can require the use of facemasks, among other precautions. Such policies alter the incentives potential and actual workers face and lowers prevalence rates.

The owners, managers, and workers of a firm all face incentives to cooperate with a firm-led prevention campaign. The owner is a residual claimant of the firm and faces financial incentives to provide prevention, to the extent the value of a firm depends on a healthy workforce. Healthier workers are more productive, take less sick leave, and are less likely to die. Providing prevention requires the help of many people, which suggests the owner of a firm must contract with subordinates and workers.³ In this way, a firm coordinates disease prevention by punishing infectious behavior or rewarding preventative behavior.

With this definition of firm-led disease prevention, there are two preconditions that clarify the relevant behavior and focus attention on relevant cases, i.e., firms that value staying in business and value preventing the spread of disease.⁴ The first precondition is that firms expect to remain profitable. If the owners and managers of a firm expect to close down, they are less interested in responding to the spread of disease. Their prevalence *inelastic* behavior is driven by market and firm-level conditions unrelated to changes in prevalence rates. For example, this

³ Barzel (1997) develops an economic analysis of property rights and exchanging those rights, as it pertains to forming larger, more complex production plans.

⁴ These conditions are self-explanatory, are assumed to hold in the following cases, and are not explicitly discussed.

describes London Mining and African Minerals, iron producers in Sierra Leone, which faced a declining price of iron, rising debt, increasing interest payments, and production setbacks (Ficene, 2014; Guthrie, 2014; Armstrong, 2014; Wilson and Hume, 2014; Wilson, 2014a).⁵

The second precondition is that the marginal benefit of prevention – to a firm – is greater than the marginal cost of prevention. This precondition focuses attention on firms that value prevention, as opposed to those who don't. Both kinds of firms are responses to changes in prevalence rates, but only the former kind of firms are useful for illustrating how firms provide prevention. The larger a firm's workforce is and the more susceptible that workforce is, the more benefit a firm will retain from prevention. Similarly, there are economies of scale in providing prevention, which may discourage smaller firms from prevention; smaller firms in Liberia, for example, shutdown during the Ebola epidemic (Bowles et al, 2015).⁶ When this precondition does not hold, prevalence *elastic* behavior may have a negligible influence on prevalence rates. For illustrative purposes, these preconditions suggest that relevant firms include firms that expect to stay in business, firms with larger workforces, and firms with workers who face a higher probability of infection.

Given firms satisfy the preconditions above, three primary conditions help to explain why they provide disease prevention. The following conditions are significant factors that influence when firms provide prevention; but there are surely other factors.⁷ First, firm-led disease prevention is more likely the more property rights are defined and protected. Well-defined and

⁵ According to Google Finance, the stock prices for both companies show a downward trend, which began years before the Ebola epidemic.

⁶ Ninety-six per cent of Liberian businesses employ less than fifty workers (Musinamwana and Togba, 2014).

⁷ Parametric insurance and risk analysis, for example, may facilitate firm-led prevention. As participants of the *Global Health Risk Framework* workshop on pandemic financing suggest, however, insurance was not an option prior to the 2014 epidemic because it was wholly unexpected and clear triggers may not have been available; neither buyers nor sellers valued insuring against the Ebola epidemic (Buckley and Pittluck, 2016).

properly-enforced systems of property rights are known to give people incentives to innovate and make long-term plans (North, 1990; and Troesken, 2015). The more an owner of a firm holds property rights over future profit and the longer they plan to stay in business, the more she cares for workers and will ensure their health and safety.

Second, firm-led disease prevention is more likely as workers become relatively scarce. A competitive firm must offer higher real wages to attract relatively scarce workers. Disease prevention can be part of a worker's real wage. Workers become relatively scarce as the labor market becomes more competitive or if there are fewer workers available. For example, as transaction and transportation costs decline, workers become more mobile and may learn of more opportunities for employment. Fishback (1992) shows that in isolated areas of the United States, coal mining companies provided sanitation services to attract workers and maintain employment.

Third, firm-led prevention is more likely as there are fewer public health alternatives, e.g., individual responses, local and state level governments, and international humanitarian organizations. For example, firm-led HIV prevention in South Africa can be attributed to the inability of its governments to respond appropriately to the growing HIV epidemic (Borzel and Thauer, 2013). Similarly, if everyone scrupulously washed their hands in bleach, there would be less demand for firm-led prevention. When these alternatives are available and effective, there is little value in implementing a firm-specific campaign to provide similar services.

These effects may occur simultaneously and may magnify or counteract each other. A firm may be located in a country where property rights are enforced and where there are relatively few workers. Both could explain an instance of firm-led prevention. However, a firm may benefit from well-defined property rights but have a relatively abundant pool of workers.

The context and particulars of each case influence the extent to which these conditions hold and whether or not they are strong factors in explaining firm-led disease prevention.

3 Case Selection and Methodology

Ebola is an infectious disease spread primarily through contact with infected people, which suggests it is an appropriate disease to study prevalence-elastic behavior. The recent Ebola epidemic suggests relevant cases include firm-led prevention in Liberia, Sierra Leone, and Guinea. According to the Ebola Private Sector Mobilization Group (EPSMG) and the UN-Business Action Hub (UNBAH), forty-two firms responded to the epidemic and had operations in Liberia, Sierra Leone, and Guinea prior to the epidemic.⁸ Eighteen of these operations, about 42.8 per cent of the total, were in Liberia; fifteen were in Sierra Leone, 35.7 per cent; and nine were in Guinea, 21.4 per cent. That most of these operations were in Liberia suggests that studying firms in Liberia illuminates firm-led responses in general. Firestone, Sime Darby, and ArcelorMittal illustrate how larger firms with susceptible workforces respond to Ebola and help to prevent its spread.

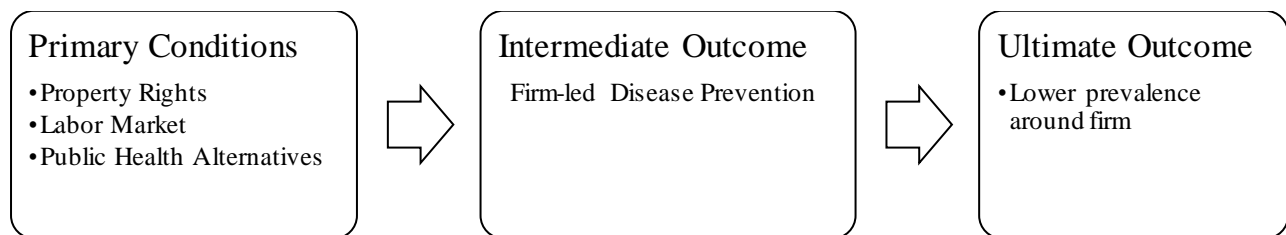
Selection bias is a relevant concern, especially for qualitative research in health economics (Coast et al, 2004). Indeed, selection issues apply to all of the studies on the relationship between firms and infectious diseases. The focus on Firestone, Sime Darby, and ArcelorMittal may misrepresent the way in which firms throughout Liberia and western Africa responded to the epidemic. As the focus is on how Liberian firms responded to Ebola, cases in

⁸ While the lists show 120 firms that responded to the epidemic, they are not a perfect representation of larger firms. Many of the firms are not engaged in commercial activities in western Africa. Furthermore, there are cases of firm-led prevention not on the lists, like Firestone and Sime Darby. The former is available online at <https://www.epsmg.com/media/6214/epsmg-briefing-note-11-december-2014.pdf>, whereas the latter is available online at https://business.un.org/en/documents/business_action_pledge_signatories.

Sierra Leone and Guinea are not directly relevant. While most Liberian firms are small and medium sized, they are not likely to satisfy the preconditions of firm-led disease prevention. There are larger firms that could satisfy the preconditions, which indicates they are relevant for analysis.⁹

To partially mitigate these concerns, and to provide a consistent framework for analysis, a firm-level logic model establishes internal validity by matching the conditions of firm-led disease prevention with observable characteristics of a firm (adapted from Yin, 2013). The replication of this logic provides further validation. Contrasting replication logic with sampling logic, Yin (2013: 47) states that: “...replication logic is analogous to that used in multiple experiments...” Figure 1 depicts the model.

Figure 1. Logic Model of Firm-led Disease Prevention



When the preconditions, mentioned above, and *primary conditions* hold – so that firm-led disease prevention is valuable – the owner or manager of a firm implements a prevention campaign, the *intermediate outcome*, which lowers prevalence around the firm, the *ultimate outcome*.

⁹ Indeed, the 2013 and 2016 *Building Markets* reports on Liberia suggest there are about 70 large enterprises (Bruins, 2013; Bickel, 2016). Such a list would likely include Aureus Mining, Bollore Africa at Umarco, Chevron, Equatorial Palm Oil, Golden Veroleum, Hummingbird Resources Limited, RLJ Companies, Tawana Resources, Vedanta (Sesa Sterlite), and Western Cluster Limited.

4 Analysis

4.1 Property Rights

Differences in the underlying property rights available to private actors in Liberia is a contributing factor as to why some helped to prevent Ebola and why others did not. Throughout the Twentieth century, indigenous Liberians relied on traditional or customary property rights to protect their lands and settle disputes. George Dalton (1963) suggests conflict stems from the exclusion of non-elites from the political process, which keeps harmful rules in place. Stickler and Huntington (2015) suggest that many Liberians believe tribal leaders own a majority of community property; they fear encroachment from their neighbors or cannot clearly define boundaries; and they do not have the ability to sell property or even use it as collateral.¹⁰

These disputes were compounded during and after the Liberian Civil Wars by conflicts between owners of land who were displaced and people who claimed their land while the owners were away. Through field work studying how people acquire property rights over forests, Liz Wily (2007) suggests that conflict in Liberia leaves individuals and communities in a situation where they rarely know if they will retain the value of their property or if it will be granted to other interested parties. The difficulty of finding and understanding relevant laws also contributes to the complexity. People have even sold their lands to multiple parties as they know the threat of prosecution is negligible (Unruh, 2009). Additionally, the Liberian state also often grants rights over forests and community lands to other parties because they are considered in the public domain (Stevens, 2014; Wily 2011; and Joireman and Yoder, 2016).

¹⁰ Experimental results from two counties in Liberia, Margibi and Montserrado, suggest that people with stronger kinship ties are more likely to pay to hide their wealth, indicating how kinship networks may dissuade economic activity (Beekman et al, 2015).

Despite some efforts to reform, namely the Community Rights Law with Respect to Forest Lands (2009), a Land Rights Policy (USAID, 2013), and other commissions from which community ownership is given more of a legal standing, property rights are still uncertain (Johnson-Sirleaf, 2007; Wily, 2011). In 2006, the national government cancelled all timber concessions, and significant taxes were assessed on these concessions, a thirty per cent land rental fee to the community and a separate thirty per cent fee to the county (Unruh, 2009). Unruh (2009:427) suggests that because of these unresolved conflicts, "...the resulting insecurity of claim, residence, food supply, and investments (small and large) is high." Corriveau-Bourque (2010) suggests that missing a court date is a common way of disrupting the legal process, which increases the time and opportunity costs of resolving disputes. Given the prevalence of conflict and legal disputes – Corriveau-Bourque (2010) suggests conflict is a ubiquitous part of life in Liberia – formal means of justice are too costly for most people. Some people may take initial steps to secure property rights or remedy conflict, but most do not complete the complex process.

As a result, few Liberians are willing to engage in long-term investment.¹¹ For example, investment in irrigation and fencing is consistently minimal (Stickler and Huntington, 2015). Lofa, Nimba, and Bomi counties were once prominent agricultural and commercial areas, but they have not been revitalized since the civil war. In Lofa, inhabitants became small-scale farmers of peppers, peanuts, and bittaball – a local spice (Corriveau-Bourque, 2010). In Nimba, Mandingo traders, who had dealt with diamonds, gold, and petroleum, remained in exile after the wars (Rincon, 2010). Hilson and Bockstael (2012) suggest that current mining regulations and licensure laws deter many from mining in Bomi. The significant costs of reclaiming and defining – or in some cases defending – rights over land and other resources deters many from developing

¹¹ Experimental evidence from Liberia also indicates corruption is a relevant factor that discourages economic activity, especially for communities around Monrovia (Beekman et al, 2013).

larger means of production and forming trading networks. Thus, individuals throughout Liberia face smaller incentives to seek profit, which would encourage the provision of healthcare and disease prevention for workers and local communities.

Larger firms, however, are likely to enter into concession agreements with the Liberian government.¹² Firms like Firestone, Sime Darby Plantation Liberia (SDPL), and ArcelorMittal (AML), can enter into concession agreements with the Liberian government, which involves the exchange of ownership rights over land and resources for tax revenue (AML, 2007; Firestone, 2008; SDPL, 2009). Dating back to at least the nineteenth century (Stevens, 2014), these agreements encourage owners and managers to invest and innovate. In particular, they grant the firms authority to provide police services and stipulate the provision of public health services like clean water and sanitation, as well as primary medical care to their workers. Firestone and its predecessors have had an agreement with the Liberian government since 1926, which was renewed and modified in 2005 and 2008, respectively, and will expire in 2041. Sime Darby has operated on its concession land since 1981. Its concession was renewed in 2009 and will expire around 2070. ArcelorMittal signed a concession agreement in 2005 and renewed it in 2006, which will expire in 2031.

With these assurances from the Liberian government, the owners and managers face incentives to invest in their respective production processes, which includes the health and wellbeing of their workers, families, and local populations. For example, Firestone has long faced incentives to provide education and medical services for local populations (Dalton, 1963). Since 1926 when Firestone obtained its concession agreement, the company implemented a massive land-clearing project to search for alternative sources of natural rubber, built 21 schools,

¹² Casavant and Musinamwana (2014) provide a list of firms with exploration and mineral rights in Liberia.

4 churches, 23 playing fields, 7 community centers, 3 electric power stations, 2 radio stations, 2 hospitals, and almost 700 miles of usable road (Church, 1969). SDPL does not have a similar history of providing social services, most likely because of its relatively recent operations in Liberia, which also coincided with the Liberian civil wars, 1989-2003.

In terms of the 2014 epidemic, these incentives encouraged firm leaders to be aware of local problems and take steps to alleviate them. All of these firms were aware of the Ebola outbreak and monitored its spread throughout the spring, summer, and fall of 2014. Alan Knight, General Manager of Corporate Responsibility with ArcelorMittal, suggests the concessions give managers and owners a long-term perspective, from which they are motivated to care for their workers (Personal Interview, May 17, 2016).¹³ Furthermore, long-term relationships between firm leaders, workers, and local communities encourages cooperation (Taylor, 1987). Such relationships develop norms of trust, increase the cost of failing to cooperate, and encourage the production of local public goods like disease prevention. The decades-long relationships in Firestone and Sime Darby, and the developing relationships in ArcelorMittal, provide some explanation as to why they valued Ebola prevention. If these firms had failed to respond, the value of the firm would have declined due to productivity losses, higher employment and training costs, and the loss of trust within their local communities.

According to the 2015 Afrobarometer survey, 44 per cent of people who worked in the private sector knew a close friend or relative infected with Ebola (about 62 people); and 39 per cent of private sector employees knew a close friend or relative who died from Ebola (about 54 people). For people employed by government, however, 57 per cent knew a close friend or relative who was infected with Ebola (about 31 people), and 50 per cent knew someone who died

¹³ See also, Knight's testimony to the Senate Foreign Relations Committee, Subcommittee on Africa and Global Health, April 7, 2016, available online: www.foreign.senate.gov/imo/media/doc/040716_Knight_Testimony.pdf.

(about 28 people). This difference suggests that private employers face incentives to care for their workers, which may be diminished in the public sector.

4.2 Labor Market

There are two reasons to expect Firestone, Sime Darby, and ArcelorMittal face incentives to provide disease prevention due to the relative scarcity of labor. First, available employment data suggests the labor pool is shrinking. Since 2010, Liberia's net migration rate has declined, which suggests more people are leaving the country. The United States State Department issued an Investment Climate report on Liberia (2015: 21), which argues that one of the biggest operational hindrances foreign companies face is the difficulty of finding skilled labor. Liberians are also more likely to work in the formal sector in and around urban areas (Lindberg, 2014; Bonaparte, 1979). In rural areas, where the three firms operate, 75 per cent of the available population remains in the informal sector, mainly as self-employed traders or as farmers (Richiardi, 2015). Agriculture employed about 48 per cent of Liberia's workforce in 2007 and 47 per cent in 2010. About half of the population now lives in urban areas, an increase from 36 per cent since the early 1980s. For example, Monrovia is the country's largest city with around 1.2 million people and comprises about 30 per cent of the total population, as well as 56 per cent of the urban population. To the extent there are fewer workers available to hire in and around rural areas where the firms operate, they are more likely to offer a higher real wage to maintain employment.

Second, Liberian workers are becoming more mobile and knowledgeable about opportunities in the labor market. There are numerous means of transportation, from which people can move throughout the country. Liberia has 580 km of coastline and about 10,000 km

of mostly unpaved roads. According to the 2015 Afrobarometer survey in Liberia, about 94 per cent of the respondents live within walking distance to paid transportation services, which include busses, taxis, and mopeds (Question EA_FAC_G). The ports of Monrovia, Buchanan, Greenville, and Harper are significant economic centers and facilitate the movement of goods and workers. There is also a developing road network that connects major urban areas like Monrovia with local towns. Firms are finding the creation of roads and improving existing ones increasingly profitable. Rail transportation also complements this network. These transportation networks lower transaction costs associated with moving, increase a person's outside employment opportunities, and encourage firms to offer higher real wages.

Improved communication networks lower search costs too. According to the World Bank, less than 75 per cent of the population had a mobile phone subscription in 2014, an increase from 8 per cent in 2006.¹⁴ The largest jumps in subscriptions rates occurred between 2009 and 2010, from 28 per cent to 40 per cent, and between 2013 and 2014, from 59 per cent to 73 per cent. The 2015 Afrobarometer survey in Liberia suggests that 77.62 per cent of respondents own a mobile phone (Question 91d). This source of communication is even more important given fixed-line telephone systems were destroyed during the civil wars (Best et al, 2010). Best et al (2010) suggests that for every one mobile phone subscription, there are five users. There are also four active mobile phone providers, which produce some of the lowest rates in West Africa. In interviews, Best et al found that Liberians, rural and urban, rely on their phones for contacting clients and learning about differences in prices. The World Bank estimates that the number of Internet users increased, from less than 1 per cent in 2007 to over 5 per cent in 2014, and the number of fixed broadband subscriptions has increased from 524 in 2012 to about

¹⁴ The World Bank defines this variable as subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology.

6,000 in 2014.¹⁵ The 2015 Afrobarometer survey suggests that while most Liberians do not use the internet regularly, about 13.6 per cent of respondents use the internet every day (Question 92b). This is an increase from 2.6 per cent (2012 Afrobarometer in Liberia, Question 91b). With access to more information, it is easier to learn about which firms offer higher real wages. Lower transactions costs and search costs incentivize firms to offer a higher real wage, which includes disease prevention, in order to maintain a productive workforce. These factors suggest that firms in the agricultural and manufacturing sectors, like Firestone, Sime Darby, and ArcelorMittal, find it difficult to employ skilled workers.

There are also reasons to expect that incentives to provide prevention will be different for firms in the agricultural than firms in the mining sector. That is, agricultural firms are likely to hire different kinds of workers than those in the mining sector, primarily because of differences in skills required in mining operations. Given the overall lack of semi-skilled and skilled labor in Liberia – about fifty-six per cent of the labor force aged fifteen and over never attended school or failed to finish primary school – mining firms should be more likely to provide disease prevention. This condition is not likely to influence rubber concessions, for example, because they hire mainly domestic workers (Bruins, 2013). The lack of semi-skilled and skilled labor is particularly problematic for the mining industry. Line cutters, for example, must have basic literacy and math skills. Furthermore, firms in the mining industry are significantly larger employers than firms in agriculture, which suggests they have interests in maintaining health and productivity. For example, carpentry and welding firms are smaller firms directly employed by mining firms for various projects. There are also a variety of semi-skilled opportunities, e.g.,

¹⁵ The World Bank defines the former as the percentage of people who have used the Internet from any location in the last twelve months. The latter are fixed subscriptions to high-speed access to the public Internet, at downstream speeds equal to, or greater than, 256 kbit/s.

electrical, plumbing, mason, information, that mining companies contract with others (Casavant and Musinamwana, 2014).

4.3 Public Health Alternatives

Alternative providers of Ebola prevention include the Liberian government, local county governments, and prominent NGOs. According to the Fund for Peace's Failed States Index, the Liberian government has increasingly become one of the world's worst governments between 2008 and 2014, based on demographic pressures, problems related to refugees and internally displaced persons, the lack of public services, and external interventions. Ten-year trends for demographic pressures and public services have also worsened.

Liberian public health has been poor since the late 1970's since its economic decline (Varpilah et al, 2011) and especially since its civil wars.¹⁶ According to Petit et al (2013: 43):

During the conflict most government owned health facilities had stopped functioning unless they received international assistance through humanitarian NGOs or faith-based organizations. In the period following the peace agreement of 2003 these same organizations managed approximately 80% of all the health facilities in Liberia and managed to expand health service delivery, in particular to areas that had been most affected by the war and were home to many refugees and internally displaced people. However, due to the limited government leadership and absence of a uniform policy in this period, these expanded services were fragmented and skewed in coverage.

While there were 3,526 healthcare workers in 1988, the conflict reduced this sector by 60 per cent to 1,396 employees by 1998 (Ali et al, 2015). By 2005, Liberia's health sector depended on more than \$80 million of international humanitarian aid (Varpilah et al, 2011; MOHSW, 2011). From 2006 to 2013, per capita health spending increased from \$3.3 to 17.2, representing between 8.4 to 11.5 per cent of the federal budget (MOHSW, 2014: 55-56). Recently, the Ministry of

¹⁶ The Liberian civil war killed 3.068 out of every 100 people between 1991 and 1997, and is likely to have long-lasting public health effects, especially on children and maternal mortality (Ghobarah et al, 2004; and Kruk et al, 2010).

Health and Social Welfare has helped to improve public health (Varpilah et al, 2011). Maternal health also improved between 2007 and 2011, despite regional variations (Luginaah et al, 2016).

Regarding the epidemic in 2014, healthcare facilities and workers were particularly burdened. In April 2014, health workers refused to work unless provided with personal protective equipment (Hinshaw, 2014; Butler, 2014). A government hospital in Monrovia shut down during the epidemic's peak because health workers were ill-equipped to prevent themselves from infection and patients were afraid to enter. The President of Liberia declared a state of emergency and even implored the United States government to help provide humanitarian assistance (Paye-Layleh, 2014; Cooper, 2014). By December 31, 2014, 370 health workers had been infected; 192 of these survived (MOHSW, 2014).

At the county level, services ranged from non-existent to adequate and responsive. For instance, in Grand Gedeh, Grand Kru, River Gee, and Maryland – counties with only a handful of Ebola cases – there were only six doctors throughout the four counties prior to the epidemic; three remained at the time of evaluation (Forrester et al, 2014). Furthermore, nurses failed to show up for work, and many members of hospital staff had not been paid in three months; healthcare workers that remained rarely had adequate medical supplies. While an Ebola emergency task force had been established in all of the counties, none of them had enough resources or the necessary training to provide prevention (Forrester et al, 2014). A similar situation was the case for people in Grand Cape Mount, Grand Bassa, Rivercess, and Sinoe counties (Summers et al, 2014). Grand Bassa, however, was the only county among these that had a trained team to investigate Ebola cases and perform contact tracing. Improper burials were

common, and only two ambulances were in operation throughout these counties (Summers et al, 2014).¹⁷

Yet, public health services were more adequate in some counties. Regarding the public health response in Montserrado, Nyenswah et al (2014: 4) suggest that: “The medical and humanitarian response to Ebola in Liberia...have been augmented by an intense and pervasive program by government and partners...” The Bomi County Community Health Department, for example, began to monitor the epidemic soon after it was first reported and began to support a 12-bed isolation ward; a second and larger isolation ward was also opened in October 2014 (Logan et al, 2014). Furthermore, the public health response in Lofa county – one of the most affected counties –included an Ebola Treatment Unit (ETU), as well as educational and support programs (Sharma et al, 2014).

Hundreds of international humanitarian aid organizations helped support prevention efforts in Liberia.¹⁸ The World Health Organization provided financial assistance, medical training, about 460 public health experts, field laboratories, response teams, logistical support, and research initiatives (WHO, 2015). The UN Mission in Liberia, the UN Mission for Ebola Emergency Response, and the UN Development Programme also helped to finance healthcare workers and provide contact surveillance throughout the affected areas.

Until September 2014, however, Doctors Without Borders (MSF) was the leading humanitarian organization responding to the epidemic in West Africa (WHO, 2014). The group provided hospital care for about 85 per cent of Ebola patients throughout the affected regions; it helped to care for about one third of the confirmed cases. In Liberia, MSF helped the anti-Ebola

¹⁷ Experimental evidence from rural Liberia suggests that the corruption of local political authorities discourages contributions to public goods (Beeckman et al, 2014).

¹⁸ Since the civil wars, NGO’s and faith-based organizations helped to provide over 400 medical institutions, comprised of 12 public hospitals, 32 public health centers, 189 public clinics, 10 private hospitals, 10 private health centers, and 167 private clinics (Ali et al, 2015; Varpilah et al, 2011).

efforts in all of the counties where the firms above are located.¹⁹ MSF established a small isolation unit in Margibi County, where Firestone is located, supported it with public health experts, and helped to train local health staff. The aid organization tasked a team of sixteen to help the response in Grand Bassa County, where AML is located. Finally, MSF supported twenty-three clinics in the counties of Montserrado and Grand Cape Mount, of which, Sime Darby is located in the latter (MSF, 2015a; 2015b; 2015c).

While Liberian governments were unable to entirely respond to the epidemic, there were a variety of local governmental and non-governmental organizations that did. The presence of adequate public health services in Bomi and the presence of MSF in throughout Liberia indicates Firestone, Sime Darby, and ArcelorMittal were less likely to respond to the epidemic. The small presence of MSF in those counties and its focus on other countries, however, suggests the leaders of the firms valued firm-specific prevention measures. Due to inadequate public health services, firm leaders provided relatively private prevention campaigns, specifically for their workers and local communities, which helped to lower the prevalence rate of Ebola.

5 Firm-led Ebola Prevention in Liberia

5.1 The Firestone Natural Rubber Company

The Firestone Natural Rubber Company of Liberia – located in Margibi County – helped to prevent Ebola within its district during the 2014 epidemic. In an interview with Jason Beaubien (2014), Ed Garcia, the managing director of Firestone Liberia, suggests the company repurposed its entire management structure to deal with the outbreak. According to the CDC's *Morbidity and Mortality Weekly Report*:

¹⁹ MSF has also been a major source of healthcare in Liberia since 1990.

Firestone implemented administrative and environmental modifications to convert an outpatient health clinic separated from the main hospital to meet the infection control standards of an Ebola treatment unit (ETU) following guidance developed by Médecins Sans Frontières. The facility can house 23 patients, including those separated as having confirmed, probable, or suspected Ebola. By April 9, Firestone had completed the construction and certification of its ETU (Reaves et al, 2015: 961).

Patients who were suspected of being infected, like people who shared a house with a confirmed patient, were encouraged to voluntarily enter quarantine in the ETU and in converted schools for twenty-one days. Voluntary quarantine was encouraged for employees and non-employees (Arwady et al, 2014).

Firestone was able to prevent people from entering parts of the district. For example, after health care workers (HCW) experienced high-risk exposures to Ebola in August, Firestone imposed screening and triage rules:

Firestone established a single, gated access point to the hospital compound that included a screening station staffed by trained HCWs. Screening included temperature readings with noncontact infrared thermometers and verbal responses to a questionnaire about Ebola signs and symptoms irrespective of history of contact with an Ebola patient. Patients with suspected Ebola were sent to the ETU. From August 1 to September 23, three patients were sent to the ETU with suspected Ebola following this screening protocol; one of the three had confirmed Ebola (Reaves et al, 2015: 962).

The report also describes how suspected patients were sorted again based on their condition:

‘Additional triage was conducted to prioritize patients who required hospitalization but were not suspected of having Ebola based on their signs and symptoms. Patients who had some signs or symptoms of Ebola but not those meeting the national Ebola case definition were isolated in a single, dedicated room’ (*ibid*: 962). With this sorting mechanism in place, suspected patients were isolated and taken out of the general population. Firestone took preventative steps and more – infected patients who survived quarantine were reintegrated into the community through a program which helped educate people about the disease and signaled that the survivors were healthy (Arwady et al, 2014).

Among the twenty thousand person work force, and the Firestone District's total population, of 69 to 80 thousand people, only seventy-two confirmed cases were reported and eighteen of these patients survived – as of 24 October 2014. This represents a cumulative incidence of .09 percent, whereas Margibi County, where the Firestone District is located, is reported to have a cumulative incidence of .23 percent (Reaves et al, 2014). Between 1 August and 1 November, 2014, thirty-three Ebola patients died (30 were confirmed), and twenty-two confirmed patients survived and were released following stringent symptom-resolution and testing procedures. Overall, thirteen of the twenty-two survivors were Firestone employees or dependents; six were retiree dependents; and three had no connection to Firestone (Arwady et al, 2014).

5.2 Sime Darby Plantation

The Sime Darby Plantation of Liberia (SDPL) – mainly located in Grand Cape Mount, Bomi, Bong, and Gbarpolu counties – helped to prevent Ebola as well. Despite some operational delays in its response, no deaths were reported amongst its workforce of 2,881 (Toweh, 2014; Mokhtar, 2014). The lack of Ebola throughout SDPL stands in contrast to the prevalence of Ebola in its affiliated counties. In a patient database, the WHO reports ninety-six confirmed cases in Grand Cape Mount between 28 July, 2014 and 15 Feb., 2015; 132 confirmed cases in Bomi county between 16 June and 1 Feb., 2015; 149 confirmed cases in Bong county between 30 June and 23 Nov., 2014, and twenty confirmed cases in Gbarpolu between 11 Aug to 23 Nov.

Working with local communities, civil society organizations, and county health organizations, SDPL helped to provide medical equipment, food, and relevant sanitation supplies. Regarding its response to the Ebola epidemic in Liberia, SDPL's website states:

Immediate disaster response was mooted to create Ebola-free workplaces to control the spread of the virus. All estate grounds in Grand Cape Mount and Bomi counties were equipped with necessary personal protective equipment and implemented control measures. Employees and their families were educated on the outbreak, stressing on hygiene and sanitation as well as importance of medical attention. Regular awareness trainings were also conducted with the national Ebola health teams. As a result of the continuous education, no employee or their families living within Sime Darby estates was infected during the outbreak. Sime Darby's clinics on its estates continued to operate and provide medical service to not only its employees but its surrounding communities. Together with the Health Ministry, healthcare was extended despite issues of overcrowding facilities and shortage of medical personnel (SDPL, 2016).

In a press release issued on October 24, Roslin Azmy Hassan, head of SDPL operations, said, ‘Social mobilization efforts like door to door campaigns, are vital to create greater awareness on the virus. SDPL hopes the partnership will overcome some of the challenges faced through greater collaborative efforts with affected communities. SDPL will continue to work with local players including the authorities and the Government of Liberia in their efforts to contain the outbreak’ (SDPL, 2014a).

Sime Darby was particularly helpful in the preventative efforts associated with the villages of Sinje, PAC, and Zodua. SDPL Social Program Manager, Toushi Itoka, said, ‘We were aware of the challenges faced by women, children, and the elderly. We were the only people they could turn to at that time – so we were there for them, as always’ (Front Page Africa, 2015). Sime Darby sent medical supplies, fuel, and other sanitation supplies. Sime Darby donated over 700 bags of rice, thermometers, hand washing stations, and chlorine. According to Gabriel Logan, head of the Bomi County Hospital, the Sime Darby clinic was the only referral clinic left open in Bomi. Sime Darby also broadcasted radio messages in three languages to help inform people about how the disease spread and ways to prevent it.

Sime Darby also provided humanitarian assistance throughout Liberia. Over five million latex gloves were donated to the Liberian government through a consortium between Sime Darby, the Malaysian government, and other Malaysian companies (SDPL, 2014b). Dr

Gwenigale, Liberia's Health and Social Welfare Minister said, 'These donations are timely and good for us because the demand for PPEs is too high' (Kennedy, 2014). Matthew Flomo, the Deputy Health Minister for Administration suggested the gloves will be used across Liberia's fifteen counties to help prevent Ebola. In conjunction with the International Federation of Red Cross and Red Crescent Societies (IFRC) and the Liberian Red Cross (LRC), SDPL helped to finance awareness campaigns which reached over 400,000 people in Liberia. Their work included contact tracing, the extension of healthcare and diagnosis facilities, training SDPL workers, community engagement, and psychosocial support (Front Page Africa, 2015; SDPL, 2014a; 2014b).

5.3 ArcelorMittal Liberia

ArcelorMittal (AML) reported one death during the epidemic throughout its operations in Grand Bassa and Nimba counties. A patient database of the WHO reports fifty-eight confirmed cases in Grand Bassa county, between 7 July 2014 and 25 January 2015. There were 114 confirmed cases in Nimba county, between 30 June and 2 Nov. ArcelorMittal took a number of actions to help prevent the spread of Ebola and spent over one and a half million dollars between April and November on prevention (Patrick, 2014).²⁰ While it halted new projects during the epidemic, it continued its operations in Yekepa and Buchanan. Bill Scotting, Chief Executive of AML, said:

Clearly the priority for Liberia and other affected countries right now is to contain and ultimately stop this current outbreak of Ebola. We are providing full support to the government in this regard and taking every precaution to protect all of our employees on the ground in Liberia. ArcelorMittal has made a long-term commitment to Liberia and we will maintain this commitment. While the recent developments are very concerning, at present we believe that the emergency procedures and other measures developed and currently in place at all ArcelorMittal

²⁰ AML originally allocated three million dollars for the Ebola effort.

sites in Liberia make it possible to continue our phase 1 operations. (AML Press Release, 8 August 2014)

AML's Health and Safety Department organized a discussion and awareness session on 4 April 2014 – well before the epidemic had begun (AML Press Release, 9 April 2014). Professor Adriano Duse, a tropical disease specialist led the discussion and answered questions about Ebola.²¹ AML also ordered 500 sets of personal protective equipment to be used by the medical staff of AML, International SOS, Firestone, other clinics, and the government hospitals of Sanniquellie and Buchanan. Thermoflash scanners were used to monitor the temperatures of employees and visitors at entry points in all of AML's locations.²²

In Nimba County, AML provided the health department with its first Ebola treatment unit, which was capable of holding sixty beds. AML renovated a former eye clinic at the Ganta United Methodist Hospital in order to build an Ebola holding center. AML also constructed an Ebola treatment unit in Sanniquellie at the Harley Hospital in Nimba. Buckets, mattresses and chlorine were also provided by AML (AML Press Release, 16 September 2014).

AML launched an Ebola Contact Tracing and Surveillance program with the help of AFRICARE in the middle of September, 2014. The goal of this project, manned by around 150 people and intended to last until December 2014, was to provide tracking and monitoring services for local communities in Nimba and Grand Bassa counties. Marcus Wleh, AML's Corporate Responsibility and Government Affairs Manager, said that the project is a 'community based project that builds on local structures to address the critical gaps in contact tracing and surveillance' (AML Press Release, 30 September 2014). The manager of AML operations in

²¹ Professor Duse also visited a hospital in the Firestone District.

²² Denis Foulds, manager of AML port operations at Buchanan, suggested employees at the port are probably safer than people living in the city (Vittozzi, 2014.)

Liberia, Ronnie Addy, also suggested the project will help to increase the participation of local communities in the fight against Ebola.

Other means of prevention include the continued employment of Dr. Monia Sayah, an infectious disease expert (AML Press Release, 19 September 2014); the repair and donation of two ambulances to the Liberian government (AML Press Release, 24 September 2014); and the site preparation for an Ebola treatment unit, built by the United States military (AML Press Release, 30 October 2014). AML was also instrumental in organizing the Ebola Private Sector Mobilization Group, which brought together a number of private and public groups for the purposes of preventing the spread of Ebola (AML Press Release, 17 and 22 Oct. 2014).

6 Conclusion

Experiences from three large firms in Liberia suggest different reasons for responsiveness. Contributing factors are the property rights all of the firms faced, as well as the lack of public health alternatives. The relative abundance of labor, however, is the condition with that discouraged Firestone and Sime Darby from prevention, but not ArcelorMittal. In terms of production costs, the Ebola epidemic posed less of a shock for agricultural firms like Firestone and Sime Darby because they could more easily replace workers who became infected or died. Due to ArcelorMittal's production process requiring semi-skilled and skilled labor not readily available in Liberia, ArcelorMittal was more responsive to the epidemic along this margin. These conditions and experiences have the following implications.

First, lengthening the duration of concession agreements encourages firms to be responsive to outbreaks. Firestone, Sime Darby, and ArcelorMittal expect to hold ownership and production rights for about the next three, six, and two decades, respectively. These are strong

incentives to develop production plans, maintain the health of workers, and be cognizant of potential epidemiological disasters. Lengthening existing concession agreements and allowing smaller firms to have similar agreements will give firms in the private sector stronger incentives to respond. Furthermore, reforming the bureaucratic administration of property rights and land tenure in Liberia, so that more people have access to defined property rights, is an alternative way to give private actors incentives to invest and, when necessary, prevent infectious diseases.

Second, behavioral models of epidemiology should consider how people use firms and related private organizations to facilitate disease prevention. If firm-led disease prevention is not considered, models are likely to misrepresent how some people can respond to changes in prevalence rates and are likely to make overly pessimistic predictions. Similarly, the welfare consequences associated with externalities may be overstated, especially when considering how managers and workers internalize the benefits of prevention. That is, instead of an epidemiological disaster acting upon unresponsive actors and imposing a variety of costs, some actors may be able to perceive the threat, have incentives to mitigate the threat, and take steps to prevent those costs. While market imperfections may still exist, they are less severe because of the variety of ways in which people responded to the epidemic, particularly because they responded through organizations like the firm.

Finally, firms can be an alternative pathway to provide public goods that may not be provided otherwise. Given Liberia's dysfunctional public health system, Firestone, Sime Darby, and ArcelorMittal helped to prevent many from becoming infected with Ebola. If people live in countries with weak public health services, they may use firms to provide prevention, channel relevant public health experts, and create common knowledge of how prevention is accomplished in practice. Larger firms also have the ability to finance a prevention campaign or

develop better instruments to insure against disasters. Furthermore, firms are doubly important to the extent they alleviate poverty (Fallah et al, 2015) and ease the transition from Ebola patient to Ebola survivor, both of which are important public health goals.

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