Donations for Refugee Crises: In-kind Versus Cash Assistance

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Problem definition: Six million refugees have been living in camps in 2021 due to multiple armed conflicts worldwide. Regulations often impede refugees' integration into host countries; thus, refugees have to seek help from humanitarian organizations (HOs). HOs traditionally provide in-kind (e.g. food) assistance and now offer cash (monetary assistance) that refugees can spend at local retail stores. However, cash assistance can be exploited by local retailers' market power, which challenges HOs' mission of helping refugees while doing no harm to host communities. ***Practical Relevance***: Completely informed by field research in three refugee camps in northwestern Greece, we analyze the trade-off between in-kind and cash assistance from the perspective of an HO. We propose two cash assistance policies, implementable by a partnership between the HO and the local government, to curb the retailer's market power and ensure that the refugees, the local residents, and the retailer are better off than if only in-kind assistance is provided. ***Methodology***: We use field research to define our research setting and support our main modeling assumptions and parameters. Then, we use a game-theoretical model to analyze the interactions among multiple stakeholders in an ecosystem consisting of an HO, refugees, a monopolistic retailer, local residents, and a local government. ***Results***: We demonstrate the effectiveness of our proposed cash assistance policies that benefit refugees and local residents while ensuring the retailer's profitability. In particular, a price-dependent cash assistance (PDCA) policy aligns the incentives between the retailer and the HO-government partnership. This new policy for cash assistance acts as a lever for the retailer to voluntarily set desirable prices, which benefit both refugees and their host community. ***Managerial Implications***: We provide tools and implementable policies that guide HOs to improve their budget allocation between in-kind and cash assistance for refugees living in areas where local market power exists. Moreover, we clearly outline the roles of HOs and the local government in a partnership for cash assistance to refugees.

Key words: humanitarian operations, refugees, cash assistance, in-kind assistance, game theory

1. Introduction

Six million refugees have been living in camps in 2021 due to multiple armed conflicts worldwide (UNHCR 2021). For decades, humanitarian organizations (HOs) have provided food, hygiene, and shelter items (*in-kind assistance*) to help beneficiaries—in particular refugees. In 2014, in-kind assistance accounted for 94% of the $25 billion of humanitarian assistance worldwide; the remaining 6% was money (*cash assistance*) provided to the beneficiaries (High Level Panel on Humanitarian Cash Transfers 2015). However, cash (and voucher) assistance increased to 18% in 2019 (Jódar Vidal et al. 2020). Specifically, the United Nations High Commissioner for Refugees (UNHCR) provided cash assistance to more than 100 countries in 2019 compared to 33 countries in 2015 (UNHCR 2019), and the World Food Programme (WFP) injected $2.1 billion of cash assistance into the economies of 67 countries in 2020 (WFP 2021). The increasing use of cash assistance motivates our research in this paper.

We study humanitarian assistance—cash and in-kind—to refugees and asylum seekers, hereafter refugees, who live in camps and are not authorized to work in their host country. Host countries often block refugees' integration into host communities through strict regulations. On the right to work, "*almost half* [of the 145] *states parties* [to the 1951 Refugee Convention] *declaring reservations—often in full, and even states that grant the right to work usually impose some conditions or reservations. The same limitations apply to many of the 48 states that are not party to the Convention*" (Zetter and Ruaudel 2016). A typical limitation to work is the requirement that applicants must receive the official refugee status, which can take years[1] due to long bureaucratic processes or missing documentation. Meanwhile, HOs are tasked with providing assistance to refugees in the transient status until they obtain the official refugee status and work visas or can safely return to their home countries.

There are several reasons why cash assistance has increased in recent years. First, an acceleration in economic growth in many developing countries has improved the availability of goods in local markets, thus eliminating supply constraints (WFP 2019). Second, cash assistance allows refugees to buy their preferred goods at local stores, which helps refugees not only meet their individual needs but also restore their dignity. Third, unfortunately, host communities often perceive refugees as a burden and sometimes meet them with hostility to the extent that UNHCR explicitly recommends that HOs and local governments should ensure that refugee camps "do no harm" to all parties involved. Cash assistance is expected to bring economic benefits to the host communities, thereby promoting peaceful relations between refugees and host communities. However, the use of cash

[1] Lutheran Immigration and Refugee Service: www.lirs.org/refugees-asylum-seekers-migrants-whats-the-difference

assistance requires careful examination of its impact on both refugees and host communities.

Although refugees would like the power and flexibility of purchasing goods to meet their own needs, retail prices are higher than the wholesale prices that HOs pay for in-kind assistance. Thus, although cash assistance benefits local retailers, it reduces the amount of goods received by refugees. Such a trade-off can be managed by weighing the benefits to the refugees with the profit of local retailers. However, this trade-off is entangled with market factors.

Local retailers often enjoy monopolistic market power that complicates the trade-off between cash and in-kind assistance. Although it is well understood how a monopolistic retailer facing local residents' demand would price goods to maximize profit, it is less understood how the same retailer facing both the local residents and refugees with cash assistance would exercise its market power. In the absence of supply constraints, an increase in the total demand does not automatically lead to an increase in the monopoly price. HOs must get a better understanding of local retailers' decisions. This motivates our first research question: Facing a hybrid demand from local residents and refugees, how would a retailer price its goods?

In practice, evidence suggests that retailers raise prices in response to cash assistance to refugees, but supply constraints and market power are entangled. A case in point is the inflated prices due to the cash assistance provided by Save the Children to beneficiaries in Swaziland and by Action Against Hunger to beneficiaries in Uganda (Devereux and Jere 2008, Creti 2010). Price inflation hurts local residents and results in an even lower quantity of goods received by refugees. Equally concerned about price increase, UNHCR (2015) recommends that in-kind assistance is needed "*where increased demand on markets will cause inflation.*" This paper originates from our field research in Greece (detailed in Section 3), where supply of goods is not an issue, and investigates how a monopolistic retailer may price goods in response to the refugees' demand due to the cash assistance.

With the understanding of how the retailer's market power impacts the welfare of refugees and local residents, HOs should reexamine the trade-offs between in-kind and cash assistance. Therefore, we pose the second question from an HO's perspective: How should an HO allocate its budget between in-kind and cash assistance to help refugees, anticipating the retailer's pricing behavior?

Given that the retailer's objective of maximizing profit is not aligned with the HO's objective of supporting refugees, the retailer's market power is likely to lead to undesirable outcomes. Because the HO is not in a position to regulate the market, our third question is: How can an HO-government partnership mitigate the retailer's market power and improve the social welfare? There are many possible ways to mitigate market power, but we are interested in finding a solution that maximizes social welfare while doing no harm to all parties—refugees, the retailer, and local residents. Fur-

thermore, we are especially interested in solutions that can align the retailer's incentive with the HO-government partnership rather than imposing regulatory restrictions.

The government is interested in partnering with the HO because it is in the best interest of the government to assist refugees while also enhancing the host community (retailer and local residents) through cash assistance (Campbell 2014, Jódar Vidal et al. 2020). The government must maintain a delicate balance in the co-existence of refugees and the host community; if this balance is lost, local residents could turn hostile towards refugees and HOs (Berg et al. 2013). Therefore, a cross-sector partnership between the HO and the government is crucial, and it aligns with the 17th goal of the United Nations Sustainable Development Goals: "Partnerships for the Goals" (United Nations 2015). Through exploring ways to align incentives and answering the above research questions, we identify the role that the government should play.

Due to the scarce literature on cash assistance to refugees, we conducted field research in three refugee camps in rural areas of northwestern Greece. These host communities typically have a single retailer. Our data consists of 30 interviews, observations during weekly meetings of HOs, and organizational documents of all stakeholders—HOs, refugees, retailers, local residents, and the government. The data collected during our field research serve to develop in-depth insights about these stakeholders and their interactions and pinpoint the most pressing issues regarding the introduction of cash assistance.

Informed by our field research, we build a game-theoretic model to capture the interactions in the real-world refugee assistance program: The HO first allocates a fixed budget between cash and in-kind assistance, followed by a monopolistic retailer setting market prices, and finally a heterogeneous population of refugees making purchase decisions with limited cash from the cash assistance. We find that cash assistance can increase refugees' utility by allowing them to purchase goods according to their individual needs, but the profit-maximizing retailer would exploit the cash assistance, hurting both refugees and local residents. Furthermore, our analysis reveals the severity of the harm. The reduction in the refugees' utility alone already exceeds the retailer's profit from selling to the refugees. Compared to the situation before refugees' arrival, the retailer's profit from selling to the local residents declines, while the local residents' surplus also shrinks. Therefore, the retailer's market power in response to the cash assistance is detrimental to refugees and their host community, and it is best for the HO not to provide cash assistance only to be exploited by the retailer's market power.

The second part of our theoretical analysis explores cash assistance policies to curb the retailer's market power and improve social welfare in a general setting with multiple goods and heterogeneous refugee preferences. The first policy we consider is a price index cap (PIC), under which the retailer

can adjust its prices of the essential goods as long as a price index does not exceed a cap. To minimize government intervention on prices, we propose a second policy as an innovative way to achieve the social-welfare maximizing solution. This new method is the price-dependent cash assistance (PDCA) policy. Under this policy, the amount of cash assistance HOs provide to refugees is no longer predetermined. It is dependent on a retail price index, thereby changing the retailer's incentives. Both policies enable the HO-government partnership to help refugees while doing no harm or even bringing economic benefits to both the retailer and residents in the host community. We provide theoretical foundation for constructing the price indices for both PIC and PDCA policies.

Our proposed policies could make an important impact on how HOs roll out cash assistance programs. Currently, HOs tend to only collect information upfront about the host communities to decide cash versus in-kind assistance. This paper recommends that HOs also consider market dynamics in order to proactively drive these dynamics in favor of all stakeholders. Currently, HOs share information with the retailer about their cash assistance plans to improve the experience of refugees and host communities. This paper recommends the HOs implement a price-dependent cash assistance policy as a lever to align the incentive of the retailer with the goal of the HO-government partnership. This new policy for cash assistance provides three functions simultaneously: supporting the refugees, incentivizing the retailer to set desirable retail prices, and benefiting the host community, thereby sustaining the co-existence of refugees and their host community in an ecosystem.

2. Literature Review

The 1951 Refugee Convention defines a refugee as "*someone who is unable or unwilling to return to their country of origin owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group, or political opinion.*" (UNHCR 2010). Extant operations management literature on refugee assistance is scarce. Ergun et al. (2014) investigate how information technologies can facilitate coordination of HOs regarding the last-mile distribution of goods at a refugee camp after the 2010 Haiti earthquake. Sahinyazan et al. (2021) consider three types of assistance distribution: in-kind, cash, and vouchers. Their multi-objective optimization model balances improvement in the nutrition of refugees, contribution to the local economy, and cost for the HO. They assume that refugees spend the cash assistance locally and that such expenditure would not affect local prices. In contrast, we explore the case when the introduction of cash assistance to refugees leads the retailer to exercise its market power, inflating retail prices after the refugees' arrival, thereby hurting both refugees and local residents. To the best of our knowledge, this paper is the first to develop a framework that captures the key interactions among the parties involved in refugee assistance and introduce policies for cash assistance in humanitarian settings.

Our work also contributes to the literature on partnerships and incentive alignment in humanitarian settings. Using an epidemic model, Arifoğlu and Tang (2021) study the interactions of a social planner, a profit-maximizing flu vaccine manufacturer who experiences uncertain yield in vaccine production, and a continuum of individuals who make self-interested vaccination decisions. Sodhi and Tang (2014) investigate frequent disruptions of supply chains of Asian retailers due to floods. They show that a partnership among retailers benefits the consumers and the retailers because it reduces the expected supply-disruption period. Arora and Subramanian (2019) model the interactions between a nonprofit procuring organs and a hospital securing donors. A social planner maximizes the benefit delivered to organ recipients and other patients. The authors show that properly designed contracts can address the misalignment among the players and ensure that neither the nonprofit nor the hospital are worse off. de Zegher et al. (2019) build an analytical model of a buyer who can source either directly from a specific supplier or through a commodity market comprised of multiple suppliers. The authors design the appropriate incentive schemes for the buyer to adopt sustainable technology. In our paper, an HO-government partnership uses cash assistance policies to restore the distorted incentive due to the introduction of cash assistance. To the best of our knowledge, our study is the first attempt to provide concrete policies for a cross-sector partnership to ensure that refugees' needs are met while neither the retailer nor the local residents are worse off.

Our work is also related to research on nonprofit operations, which addresses unique challenges that nonprofits face when managing their operations. Berenguer and Shen (2019) review the nonprofit operations literature and discuss that nonprofits have complex sets of stakeholders, which need to be taken into account in order to produce socially responsible research. Korpeoglu et al. (2020) analyze the entry conditions for a nonprofit with a social mission in a market consisting of utility-maximizing consumers and a profit-maximizing retailer. Karaer et al. (2017) investigate the conditions under which a buyer should invest in supplier development with the help of a tool developed by a nonprofit, which improves visibility in the supply chain. Feng and Shanthikumar (2017) point out that extant literature on nonprofit operations analyzes the implications of in-kind assistance primarily and that HOs should consider cash assistance as well. Besiou and Van Wassenhove (2020) add that providing cash assistance "empowers local markets as well as beneficiaries." We examine the nonprofit operations of an HO that manages both in-kind and cash assistance for refugees. Our research analyzes the impact of cash assistance on market dynamics and proposes policies under which all stakeholders can benefit from cash assistance.

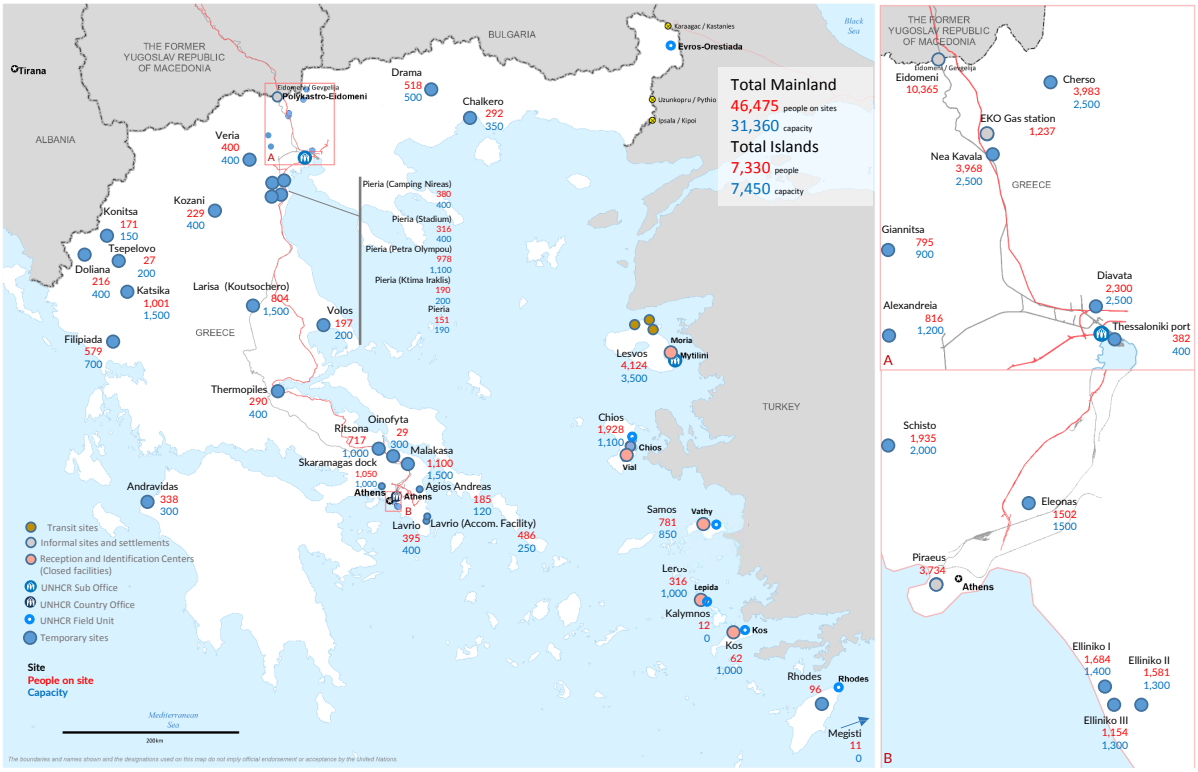
In summary, our work contributes to the extant literature by (i) conducting field research to inform modeling and analysis of refugee assistance policies, (ii) analyzing the interactions among

refugees' needs-driven purchasing decisions, retailers' profit-maximizing behavior, and HOs' mission of helping refugees without harming host communities, and (iii) providing new ways in which HOs can partner with local governments to curb retailers' market power and avoid price inflation, which is the main deterrent of cash assistance in humanitarian settings.

3. Field Research on a Humanitarian Assistance System

HOs, refugees, local retailers, and local residents form the system under our study. To motivate our analysis, we describe this system that is informed by our field research in three refugee camps in northwestern Greece (Epirus). We visited refugee camps on the mainland (Doliana, Filippiada, Konitsa) where the refugee population remains stable over long periods of time (Figure 1). The Greek government created these camps in 2016 to accommodate some of the 45,500 refugees stranded in the Greek islands, such as Lesvos, Chios, and Kos (The Vima Team 2019). These camps were not the refugees' entry points into Greece, which allowed the managing HOs to plan for their arrival. In this setting, refugees are not allowed to work because of regulations such as the Dublin Regulation No. 604/2013 and Greek law that requires a work visa for foreigners, which could only be obtained after the refugees have been formally admitted into Greece or another European country.

Figure 1: (Color online) Map of refugee camps in Greece (April 17, 2016)



Source: United Nations High Commissioner for Refugees

We collected and stored the data in a comparable way following a research protocol, as outlined by Eisenhardt (1989). To limit bias in our data, we chose interviewees from management and field teams, who bring diverse perspectives for helping refugees with in-kind and cash assistance (following Eisenhardt and Graebner 2007). We asked open-ended questions because we aimed to obtain detailed information, including feelings, attitudes, and understanding of the subject by the interviewees (following Eisenhardt et al. 2016). Our open-ended questioning protocol reduced framing and recall bias, leading to an improved accuracy in retrospective accounts, as outlined by Miller et al. (1997).

Our data are approximately 11,000 words in length and can be obtained from the authors upon request. In detail, these data include transcripts and field notes from 30 semi-structured interviews, observations during meetings of HOs, and formal organizational documents of all key stakeholders—HOs (Mercy Corps, Oxfam, Doctors Without Borders, Doctors of the World, Arsis, and Terre des Hommes), refugees, local residents, and the government (Greek local authorities).

Our analysis of the first set of transcripts revealed that retailers were critical stakeholders in this ecosystem. For our second round of interviews, we interviewed the three retailers in close proximity to each camp and a regional supplier for these retailers. This iterative process is common in qualitative research (Bansal and Corley 2012). Table 1 shows the location, time, organization and position of all interviewees. Next, we use interview quotes to describe HOs' drivers and operations related to each assistance type: in-kind and cash.

To tailor the in-kind assistance to the refugee population in each camp, HOs assess all aspects of daily life (i.e. food, water, sanitation, clothing, and hygiene). Thus, it is reasonable to assume that refugees' preferences are public knowledge. "*Assessing refugees' needs lasted about two months after their arrival in March* [2016]*... We held hour-long focus groups, interviews with individuals of different genders, nationalities, and age groups... We used UNHCR and government databases as well*

Table 1: Summary of interviews: organizations, number of interviews, location (D for Doliana, I for Ioannina, F for Filippiada, K for Konitsa), year, and interviewees' positions

Organization	#	Location and time	Positions of interviewees
Mercy Corps	3	I (2016), D (2016), F (2016)	Manager, Coordinator, Volunteer
Doctors of the World	2	K (2016), F (2017)	Nurse, Pathologist
Doctors Without Borders	3	I (2017), K (2016), K (2016)	Psychologist, Manager, Volunteer
Oxfam	4	F (2017), I (2017), K (2017), F (2016)	Coordinator, Manager, Officer, Volunteer
Arsis	2	I (2017), K (2017)	Manager, Volunteer
Terre des Hommes	2	D (2016), D (2017)	Educator, Volunteer
Local UNHCR office	2	I (2017), F (2017)	Coordinator, Volunteer
Refugee community	3	D (2016), K (2016), F (2017)	Yazidis' Representative, Women's Group, Leader
Greek authorities	4	I (2016), F (2016), K (2016), I (2017)	Manager, Manager, Army Officer, Police Officer
Retailers	3	K (2019), F (2019), D (2019)	Owner, Owner, Owner
Supplier	2	I (2019)	Owner, Manager

as collaborated with HOs, such as the Women's Refugee Commission that targets gender inequality, to make sure we have a comprehensive view of refugees' needs" (interview with M. Kapelle at Oxfam; see Table 1). Each HO was responsible for meeting a certain set of needs of refugees through in-kind assistance. Consequently, HOs managed their budget independently.

HOs informed retailers in advance about the upcoming demand increase. "*To ensure that transactions would run smoothly, we visited the closest grocery shop to each site and gave the vendors details about the cash assistance we* [Mercy Corps] *aimed to provide to refugees*" (interview with H. Awad at Mercy Corps 2017; see Table 1). These communications allowed retailers to anticipate the demand increase and avoid stockouts as a result of refugee demand.

Moreover, HOs expected two effects of cash assistance on refugees: giving refugees the power of choice and enhancing their relationship to local communities. "*Each of the three host communities consists of a rural, small, homogeneous Greek population, especially in terms of language, income, and religion. Therefore, we expect that local residents will receive the refugee families with some tolerance if the refugees' arrival coincides with money infused into local markets*" (interview with H. Awad at Mercy Corps 2017; see Table 1).

To confirm that local retailers faced an increased demand after the refugees' arrival, we interviewed a regional supplier. All three retailers that were close to refugee camps used the same supplier, who noted that "*Order quantities for produce from Doliana, Konitsa, and Filippiada have almost tripled since the end of August* [2016]. *Orders for hygiene items and other basic necessities have doubled during the same period*" (interview with supplier G. Papadopoulos at Papadopoulos S.A.; see Table 1). Therefore, the issue of demand increase that we model occurs in refugee operations. Furthermore, the same supplier confirmed that "*Since the arrival of the HOs in Epirus, first Oxfam and later Arsis, have purchased goods (produce, meat, hygiene products, etc.) from us, which were provided as in-kind assistance to refugees in the area*" (interview with supplier S. Papadopoulos at Papadopoulos S.A. 2019; see Table 1).

In summary, our field research revealed that (i) refugees' preferences are known to the HO; (ii) each monopolistic retailer has complete information about refugees' profiles and the HO's budget allocation decisions; and (iii) retailers and the HO purchase from the same regional supplier, so they are charged the same wholesale prices for the same goods. Next, we construct and analyze a model that respects our main observations from the field research.

4. The Humanitarian Assistance Model

We consider a situation where an HO helps refugees after their relocation to a refugee camp close to a host community. The HO manages a refugee assistance program with a certain budget and plans

to spend that budget on two types of aid: in-kind and cash assistance. In this section, we model the interactions among the stakeholders—HO, refugees, local retailer, and local residents—and how these interactions would change under our proposed policies, which would be set by an HO-government partnership.

4.1 Sequence of Decisions

Let B denote the total budget for the HO's refugee assistance program. The HO decides that refugees will receive a fraction $k \in [0, 1]$ of the budget in cash, and the HO will use the remaining budget, $(1 - k)B$, to purchase n kinds of essential goods that satisfy basic needs (e.g., staples, baby food, water, toothbrushes, toilet paper) from external suppliers at unit cost $\mathbf{c} = [\, c_1, \ldots, c_n \,]^\intercal$. The purchase quantities, denoted by $\mathbf{g} = [\, g_1, \ldots, g_n \,]^\intercal$, are constrained by the budget: $\mathbf{c}^\intercal \mathbf{g} \leq (1 - k)B$. The HO's assistance decision can be summarized as $(k, \mathbf{g})$ ('k' for cash, 'g' for goods). This decision does not change throughout the duration of donors' funding cycle (e.g., one year) because setting up in-kind and/or cash assistance requires considerable effort. Once decided, the HO distributes the cash and in-kind assistance equally among refugees.

Before distributing cash assistance, the HO connects with the local retailer to help the retailer anticipate the refugees' demand. The HO typically informs the retailer about the number of refugees, what in-kind assistance is provided to them ($\mathbf{g}$), what goods they need to purchase, and how much cash assistance they will receive (kB). It is reasonable to assume that the refugees bring almost no cash from their home country (even if they brought some, based on our interviews, most refugees spent their savings during their long, and often dangerous, trip to reach a safe place); thus, kB accurately estimates the amount of cash that the refugees will have.

The retailer sells the same set of essential goods as the HO can purchase from the external suppliers. (The retailer may sell many more non-essential goods that refugees are unlikely to purchase; thus, we do not include them in the model.) With the knowledge about the local residents' demand and the HO's help on understanding the refugees' potential demand, the retailer determines the retail prices, $\mathbf{p} = [\, p_1, \ldots, p_n \,]^\intercal$, for n kinds of essential goods that are for sale to both the refugees and the local residents.

In summary, three sequential moves take place: First, the HO decides cash assistance in the amount of kB and in-kind assistance of n goods in the quantities of $\mathbf{g}$; second, the retailer informed about the refugees' potential demand sets the retail price $\mathbf{p}$; finally, the refugees purchase goods based on their individual preferences. Next, we detail these moves in the reverse order, starting from the refugees.

4.2 Refugees

There are N refugees in the assistance program. (The camps we visited were not the entry points and managed a stable number of refugees, which is an important factor for the HO to consider for cash assistance.) We assume that an individual refugee's utility function is $u(\mathbf{x}, \boldsymbol{\theta})$, which is increasing and concave in $\mathbf{x} = [\, x_1, \ldots, x_n \,]^\intercal$, where x_i is the consumption of good i and $\boldsymbol{\theta}$ is a vector of parameters that are heterogeneous across refugees, with refugee j's parameters denoted as $\boldsymbol{\theta}_j$, for $j = 1, \ldots, N$. We assume that the HO knows the form of the utility function and the distribution of $\boldsymbol{\theta}$ but does not know each individual's $\boldsymbol{\theta}$. Thus, the HO distributes the assistance equally among all refugees. Refugee j receives $\mathbf{g}/N$ units of in-kind goods and cash assistance kB/N and decides to purchase $\mathbf{q}_j = [\, q_{j1}, \ldots, q_{jn} \,]^\intercal$ units of goods at retail price $\mathbf{p}$ to maximize the individual utility:

$$U(\mathbf{p}, k, \mathbf{g}, \boldsymbol{\theta}_j) \;:= \max_{\mathbf{q}_j} \; \{u(\mathbf{g}/N + \mathbf{q}_j, \boldsymbol{\theta}_j) \mid \mathbf{q}_j \geq 0, \; \mathbf{p}^\intercal \mathbf{q}_j \leq kB/N\}, \tag{1}$$

where $U(\mathbf{p}, k, \mathbf{g}, \boldsymbol{\theta}_j)$ denotes refugee j's maximum utility under the HO's assistance decision $(k, \mathbf{g})$ and the retailer's pricing decision $\mathbf{p}$. Since the utility $u(\mathbf{x}, \boldsymbol{\theta}_j)$ is the refugee's valuation of consumption $\mathbf{x}$, $U(\mathbf{p}, k, \mathbf{g}, \boldsymbol{\theta}_j)$ is measured in monetary units.

Note that the refugee's decision in (1) does not involve saving money for future use. This is because the budget B is limited; hence, the cash assistance is insufficient for saving. During our field research, when we asked refugees if the HO's monthly cash assistance is enough for meeting their needs, they reported that they usually ran out of money by the middle of the month and relied on in-kind assistance for the rest of the month.

For ease of exposition, we assume that $u(\mathbf{x}, \boldsymbol{\theta})$ is strictly concave in $\mathbf{x}$ for any $\boldsymbol{\theta}$, implying that refugees' problem in (1) has a unique optimal solution for any given $(\mathbf{p}, k, \mathbf{g})$. We denote this unique maximizer by $\mathbf{q}^*(\mathbf{p}, k, \mathbf{g}, \boldsymbol{\theta}_j)$, which is refugee j's demand function under given humanitarian assistance $(k, \mathbf{g})$. The aggregate demand function is

$$\mathbf{Q}(\mathbf{p}, k, \mathbf{g}) = \sum_{j=1}^{N} \mathbf{q}^*(\mathbf{p}, k, \mathbf{g}, \boldsymbol{\theta}_j) = N\mathbb{E}[\mathbf{q}^*(\mathbf{p}, k, \mathbf{g}, \boldsymbol{\theta})], \tag{2}$$

where the expectation is taken on $\boldsymbol{\theta}$, and the last equality holds because the expected individual demand is equal to the population average demand. Knowing the utility function and the distribution of $\boldsymbol{\theta}$, the HO is able to compute the aggregate demand function $\mathbf{Q}(\mathbf{p}, k, \mathbf{g})$ and inform the retailer.

Before the cash assistance program emerged, the refugees were separated from the local economy and the HO aimed to maximize the refugees' aggregate utility by deciding in-kind assistance:

$$U_0 \;:=\; \max_{\mathbf{g}} \; \{N\mathbb{E}[u(\mathbf{g}/N, \boldsymbol{\theta})] \mid \mathbf{g} \geq 0, \quad \mathbf{c}^\intercal \mathbf{g} \leq B\}. \tag{3}$$

We regard U_0, the maximum utility under in-kind assistance only, as a benchmark in our analysis.

4.3 Host Community

The host community consists of the retailer and local residents. We assume a single retailer in the community because it is representative of the market conditions of the host communities we visited in Greece. The rural communities in Epirus, which Greek authorities chose to host refugees, are isolated. In each rural community, a single retailer typically sells all goods to refugees and local residents. Moreover, refugees have limited access to transportation to visit the closest urban center. For example, the camp in the Doliana village hosting 405 refugees in December 2017 is 21 miles from the closest town; the camp nearby Filippiada hosting 693 refugees is 34 miles from the closest town. More information about these communities can be found in Section 3.

The local residents' demand for n goods are denoted by $\mathbf{D}(\mathbf{p})$. Before the refugees' arrival, facing the local residents' demand $\mathbf{D}(\mathbf{p})$, the retailer purchases goods from external suppliers at unit cost $\mathbf{c}$ and sets prices $\mathbf{p}$ to maximize its profit $\pi_0(\mathbf{p}) := (\mathbf{p} - \mathbf{c})^\intercal \mathbf{D}(\mathbf{p})$. Let $\mathbf{p}_0 = [\, p_{01}, \ldots, p_{0n} \,]^\intercal$ be the optimal prices and Π_0 be the maximum profit on n goods, determined by the standard monopoly pricing problem:

$$\Pi_0 := \pi_0(\mathbf{p}_0) = \max_{\mathbf{p}} \{\, \pi_0(\mathbf{p}) \,\}, \tag{4}$$

where we assume the retailer and the HO share the same suppliers with cost $\mathbf{c}$. This is common for the host communities in countries with well-developed wholesale markets like Greece. In those countries, the HO typically buys in-kind goods from the same national suppliers as the retailer because it is more expensive for the HO to use international suppliers due to transportation, insurance, and possible customs costs. In our interviews, we found that at least two of the HOs were purchasing goods from the same wholesaler as the retailers.

In our model, we also assume that the wholesale prices of n goods remain at $\mathbf{c}$ before and after refugees' arrival. This is because the refugees' demand is small compared to the regional or national demand, although it is comparable to the demand of the local residents in the host communities. From our interview with a national supplier, there was no evidence that the wholesale prices changed after the refugees' arrival. According to the supplier, "*we sell goods to most retailers and big hotel chains in Epirus, including a few of the Ionian Islands. The increase of demand from a handful of retailers since March did not affect our pricing strategy*" (interview with supplier S. Papadopoulos at Papadopoulos S.A. 2019; see Table 1). The retailers we interviewed also confirmed that their purchasing prices remained the same.

As discussed in Section 4.1, the HO fully informs the retailer about the assistance to the refugees

and their demand function $\mathbf{Q}(\mathbf{p}, k, \mathbf{g})$. In reality, we do not expect the HO or retailer to solve the economic model in (1) to find the refugees' demand function, but because the same amount of cash assistance is distributed to the refugees every month, the retailer will have a pretty good understanding of the refugees' demand. Our interviews confirm that the retailers were able to recognize the products and quantities refugees buy regularly. Therefore, after the refugees' arrival, the retailer's profit under set price $\mathbf{p}$ is expected to be

$$\Pi(\mathbf{p}, k, \mathbf{g}) := \pi_r(\mathbf{p}, k, \mathbf{g}) + \pi_0(\mathbf{p}), \tag{5}$$

where $\pi_r(\mathbf{p}, k, \mathbf{g}) := (\mathbf{p} - \mathbf{c})^\intercal \mathbf{Q}(\mathbf{p}, k, \mathbf{g})$ and $\pi_0(\mathbf{p}) = (\mathbf{p} - \mathbf{c})^\intercal \mathbf{D}(\mathbf{p})$ are the profit from selling to the refugees and local residents, respectively. The retailer decides $\mathbf{p}$ to maximize the combined profit:

$$\max_{\mathbf{p}} \{ \Pi(\mathbf{p}, k, \mathbf{g}) \}. \tag{6}$$

Let $\mathbf{p}^\dagger(k, \mathbf{g})$ be an optimal solution to (6), which is the retailer's best response to the HO's assistance decision $(k, \mathbf{g})$.[2] Because $\mathbf{p}^\dagger(k, \mathbf{g})$ tends to be in between $\mathbf{p}_0$ in (4) and the price that maximizes $\pi_r(\mathbf{p}, k, \mathbf{g})$, it is unclear, a priori, whether the retailer would set $\mathbf{p}^\dagger(k, \mathbf{g})$ to be above or below $\mathbf{p}_0$.

In the host community, we also measure the local residents' surplus derived from n goods and denote it as $C(\mathbf{p})$. This consumer surplus function is derived from the demand function $\mathbf{D}(\mathbf{p})$ using standard economic methods.

4.4 HO's Budget Allocation Decisions

Through working with the local retailer, the HO becomes fully informed about the local community. The HO is tasked to use the budget B to assist refugees. As discussed in Section 1, in-kind assistance is procured at wholesale cost $\mathbf{c}$, while the cash assistance provides refugees with spending flexibility, brings economic benefits to the host community, and hopefully eases tension between the refugees and the host community. We formulate the HO's problem as maximizing the refugees' utility by choosing the right mix of in-kind and cash assistance:

$$\max_{(k,\mathbf{g})} \quad N\mathbb{E}[U(\mathbf{p}, k, \mathbf{g}, \boldsymbol{\theta})] \tag{7}$$

$$\text{s.t.} \quad k \in [0, 1], \ \mathbf{g} \geq 0,$$

$$\mathbf{p} = \mathbf{p}^\dagger(k, \mathbf{g}), \tag{8}$$

$$\mathbf{c}^\intercal \mathbf{g} \leq (1 - k)B, \tag{9}$$

[2] Under most common demand functions of local residents and refugees, the set of $(k, \mathbf{g})$ for which the optimal solution to (6) is nonunique has a measure of zero (see the proof of Proposition 2). Therefore, when the solution is nonunique, setting $\mathbf{p}^\dagger(k, \mathbf{g})$ as one of the optimal prices will not affect how HO decides the refugee assistance program parameters $(k, \mathbf{g})$.

where the condition in (8) reflects that the HO anticipates the retailer's response to the assistance allocation $(k, \mathbf{g})$, and the budget constraint in (9) links k and $\mathbf{g}$ (note that at the optimum, the inequality holds as equality, as it is optimal to spend the entire budget).

The HO's optimization problem in (7)-(9) formally summarizes the HO's trade-off. The HO must consider how its assistance decision $(k, \mathbf{g})$ may affect the retailer's pricing decision through (8), which in turn affects the refugees' utility. If the HO provides the refugees with only in-kind assistance and no cash ($k = 0$), the refugees will not have the flexibility of buying goods according to their individual preferences. When some budget is allocated to cash assistance, it will immediately benefit the retailer even if the retail price remains unchanged. However, the retailer may change the retail price, which impacts both the refugees and local residents.

We will analyze the model (7)-(9) in Section 5; here, we preview a key takeaway: If the HO offers cash assistance, the retailer will raise prices, hurting both refugees and local residents. Since the HO aims to help refugees, it is in the HO's best interest to ensure that refugees are welcomed by the host community, but the retailer's market power prevents the cash assistance from achieving its intended benefit to local residents. For a cash assistance program to benefit all parties involved, the HO needs to form a partnership with the local government, as we describe next.

4.5 HO-Government Partnership

As discussed in Section 1, the government is interested in forming a partnership with the HO because the government wants to achieve the intended benefits of cash assistance to the host community. Therefore, the HO-government partnership aims to improve the welfare of all parties through cash assistance. To that end, the partnership needs to consider policies to curb the retailer's market power, because such market power will hurt both refugees and local residents.

Before designing any policy intervention, we first consider a social-welfare maximization problem that is aligned with the partnership's objective:

$$\max_{(\mathbf{p},k,\mathbf{g})} \quad \Pi(\mathbf{p}, k, \mathbf{g}) + C(\mathbf{p}) + w_{\text{P}}\, N\mathbb{E}\big[U(\mathbf{p}, k, \mathbf{g}, \boldsymbol{\theta})\big], \tag{10}$$

$$\text{s.t.} \quad k \in [0, 1], \quad \mathbf{g} \geq 0, \quad \mathbf{c}^{\intercal}\mathbf{g} \leq (1 - k)B, \tag{11}$$

$$\Pi(\mathbf{p}, k, \mathbf{g}) \geq \Pi_0, \quad C(\mathbf{p}) \geq C(\mathbf{p}_0), \quad N\mathbb{E}\big[U(\mathbf{p}, k, \mathbf{g}, \boldsymbol{\theta})\big] \geq U_0, \tag{12}$$

where w_{P} is the weight of the refugees' utility agreed upon by the HO-government partnership, and the lower bounds, Π_0, $C(\mathbf{p}_0)$, and U_0, are determined by (3)-(4). The constraints in (12) ensure that none of the parties will be worse off than if the HO provides in-kind assistance only.

We do not include the national suppliers' profits in the objective in (10) because the focus of

this study is the refugees and their host community. In (10), the transfer payment from the local residents to the retailer, $\mathbf{p}^\intercal \mathbf{D}(\mathbf{p})$, cancels out as expected (it appears in both $\Pi(\mathbf{p}, k, \mathbf{g})$ and $C(\mathbf{p})$). However, the payment from the refugees to the retailer is counted as a gain in the welfare because the refugees' money is entirely from cash assistance.

Denote the solution to (10)-(12) by $(\mathbf{p}^*, k^*, \mathbf{g}^*)$. This is the socially optimal solution, and this is what the HO-government partnership tries to achieve. In practice, although the HO can decide the budget allocation exactly at $(k^*, \mathbf{g}^*)$, implementing price maintenance at $\mathbf{p}^*$ can be difficult, especially because price maintenance can be perceived as against the market economy. Nevertheless, the optimal solution to (10)-(12) reveals a social-welfare maximizing solution (with the constraint that no party is worse off), providing the partnership with a target for using other policies.

Next, we propose two policies to induce the retailer to choose $\mathbf{p}^*$. Both are based on creating a price index of n goods:

$$p_{\mathbf{v}} \equiv \mathbf{p}^\intercal \mathbf{v}, \tag{13}$$

where $\mathbf{v} = [\, v_1, \ldots, v_n \,]^\intercal$ contains the coefficients (or weights, but they do not need to sum up to one) used to calculate the price index. In practice, a price index in the form of (13) would be an easy, useful way for the government to measure the retail price of essential goods.

4.5.1 Price Index Cap (PIC)

The first approach is to impose a cap on the price index of n goods. The retailer has the flexibility in adjusting prices as long as the price index $p_{\mathbf{v}}$ does not exceed the cap.

Below, we formulate the problem of designing the price index cap more generally, in that we aim to achieve any given feasible solution $(\mathbf{p}^\odot, k^\odot, \mathbf{g}^\odot)$ that satisfies (11) and (12). This generalization is useful in practice because the target $(\mathbf{p}^\odot, k^\odot, \mathbf{g}^\odot)$ could be influenced by various stakeholders and, thus, different from the theoretical optimal solution $(\mathbf{p}^*, k^*, \mathbf{g}^*)$. For example, the target solution may slightly sacrifice the total welfare but achieve strict inequalities in (12), i.e., all parties—refugees, retailer, and local residents—are strictly better off compared to the benchmark case of no cash assistance. For another example, cash assistance can offer intangible value to the refugees in terms of empowerment and dignity; therefore, the target cash assistance $k^\odot$ can be adjusted upward.

As before, the budget allocation $(k^\odot, \mathbf{g}^\odot)$ can be decided by the HO. Thus, the HO-government partnership's policy design problem is to choose price index coefficients, denoted as $\mathbf{v}^{\mathsf{PIC}}$, and a price index cap, denoted as $\overline{p}$, such that

$$\mathbf{p}^\odot \in \arg\max_{\mathbf{p}} \left\{ \Pi(\mathbf{p}, k^\odot, \mathbf{g}^\odot) \;\middle|\; \mathbf{p}^\intercal \mathbf{v}^{\mathsf{PIC}} \leq \overline{p} \right\}. \tag{14}$$

4.5.2 Price-Dependent Cash Assistance (PDCA)

Although the price index cap does not maintain individual prices, it can still be perceived as a price regulation. To achieve (or get close to) the social-welfare maximizing solution without using price regulation, we propose a new policy, which we call *price-dependent cash assistance* (PDCA). As the name suggests, the amount of cash assistance depends on a retail price index. If the retail price index is too high, the partnership will offer less cash assistance to the refugees, thus curbing the retailer's sales. We aim to investigate whether there exists a PDCA policy that is able to induce the social-welfare maximizing solution without imposing any price restrictions.

The PDCA policy design problem is to design a price index with certain weights, denoted as $\mathbf{v}^{\mathsf{PDCA}}$, and a function $k(p_{\mathbf{v}}) \in [0,1]$ that specifies the cash assistance fraction k for every value of the price index, so that it is the retailer's best interest to choose the target price $\mathbf{p}^{\odot}$. In the PDCA scheme, in-kind assistance $\mathbf{g}$ must vary with k to balance the budget, i.e., $\mathbf{c}^{\intercal}\mathbf{g} = (1-k)B$. Since $\mathbf{c}^{\intercal}\mathbf{g}^{\odot} = (1-k^{\odot})B$, we can set $\mathbf{g} = \mathbf{g}^{\odot}(1-k)/(1-k^{\odot})$ to balance the budget. Then, the retailer's profit depends on the assistance only through k, and we can define

$$\widetilde{\pi}_r(\mathbf{p}, k) := \pi_r\Big(\mathbf{p}, k, \frac{\mathbf{g}^{\odot}(1-k)}{1-k^{\odot}}\Big). \tag{15}$$

The retailer has complete freedom to set prices, but a properly designed PDCA policy (i.e., proper $\mathbf{v}^{\mathsf{PDCA}}$ and $k(p_{\mathbf{v}})$) would steer the retailer to choose $\mathbf{p}^{\odot}$. That is,

$$\mathbf{p}^{\odot} \in \arg\max_{\mathbf{p}} \{\, \widetilde{\pi}_r(\mathbf{p}, k(\mathbf{p}^{\intercal}\mathbf{v}^{\mathsf{PDCA}})) + \pi_0(\mathbf{p}) \,\}, \tag{16}$$

$$k^{\odot} = k(\mathbf{p}^{\odot\intercal}\mathbf{v}^{\mathsf{PDCA}}). \tag{17}$$

To implement a PDCA policy, the HO first announces such a policy to the retailer, and the retailer is free to choose any retail prices upon refugees' arrival. Once the chosen prices are verified and the price index is calculated, the HO distributes the cash assistance to the refugees (by direct deposit to refugees' debit cards) and, importantly, the retailer must commit to the chosen retail prices for the period that the cash will be spent. Because the PDCA policy involves the HO's commitment to the policy and the retailer's commitment to the prices, the government should play a role here to ensure the commitments are followed so that the intended benefits can be achieved. In contrast to the price index cap policy where the government has to restrict pricing freedom, the government's role in the PDCA policy is facilitating communication and monitoring implementation.

Note that if the retailer tries to game the PDCA policy by stocking out the essential goods included in calculating the price index, the refugees (who are provided a list of goods that the retailer should offer) could bring this issue to the HO's attention. The HO-government partnership

would then hold the retailer accountable.

5. In-kind Versus Cash Assistance without HO-Government Partnership

In this section, we study the HO's problem of budget allocation between in-kind and cash assistance, as formulated in (7)-(9), anticipating the retailer's pricing decision in (6). For ease of exposition, we assume the local residents' demands are independent across n goods, and thus we can measure the consumer surplus as $C(\mathbf{p}) := \sum_{i=1}^{n} \left[\int_0^{D_i(p_i)} D_i^{-1}(x)dx - p_i D_i(p_i) \right]$, where $D_i(p_i)$ is the demand function for good i.

Throughout this section, we focus on the case of symmetric goods, where n goods have the same unit cost and demand function, the HO provides the same quantity of in-kind assistance for all goods, and the refugees' aggregate demand function is symmetric in n goods (individual refugee's demand function is not necessarily symmetric). Analyzing this special case allows us to capture the key trade-offs of the retailer's and HO's decisions as well as the interactions among them. Specifically, we have $c_i = c$, $p_i = p$, $g = ng_i$ for all $i = 1, \ldots, n$; we write $D(p)$ as the aggregate demand for n symmetric goods.

With $(1-k)B$ allocated for in-kind assistance, the HO will buy $g = (1-k)B/c$ units of goods for refugees. Because the quantity of in-kind assistance, g, is uniquely determined by k, we will express the HO's budget allocation decision simply as k instead of (k, g) throughout this section.

With cash assistance kB, the refugees purchase from the retailer $Q(p, k) = kB/p$ units of goods, which cost the retailer kBc/p. Then, the retailer's profit from selling to the refugees (the first profit component in (5)) can be written as $\pi_r(p, k) = kB(1 - c/p)$.

Throughout our analysis, we assume that the in-kind assistance to refugees is worth more than its cost, as formally stated below.

Assumption 1 *Let* $u_{\boldsymbol{\theta}}(x) := \max_{\mathbf{x}} \{u(\mathbf{x}, \boldsymbol{\theta}) : \mathbf{x} \geq \mathbf{0}, \mathbf{1}^\intercal \mathbf{x} \leq x\}$. *For any* $\boldsymbol{\theta}$, *we assume that* $w_{\text{P}} u'_{\boldsymbol{\theta}}(B/(Nc)) > c$, *or equivalently,* $w_{\text{P}} u'_{\boldsymbol{\theta}}(x) > c$, $\forall x \in [0, B/(Nc)]$.

In most humanitarian assistance cases, the budget is limited and the refugees are always in need of essential goods. Thus, the HO-government partnership should always find it worthwhile to provide in-kind assistance at unit cost c. Therefore, $w_{\text{P}} u'_{\boldsymbol{\theta}}(x) > c$, for all $x \in [0, B/(Nc)]$, where $B/(Nc)$ is the maximum quantity that the refugee receives, which justifies Assumption 1. The two ways of stating Assumption 1 are equivalent because $u_{\boldsymbol{\theta}}(x)$ is concave in x.

For analytical convenience, we also impose a mild assumption on the local residents' demand function.

Assumption 2 $D(p)$ *is continuously differentiable and* $D'(p) \leq 0$ *for all* $p \in (c, p_{\max})$, *where* $p_{\max}$ *is*

such that $D(p_{\max}) = 0$. *The retailer's profit before refugees' arrival,* $\pi_0(p) = (p-c)D(p)$, *is unimodal in* p *with the unique maximizer* $p = p_0$.

We proceed with analyzing the sequential game. In the second-stage of the game, under given budget allocation k, the retailer chooses p to maximize the objective in (5), which reduces to

$$\Pi(p,k) = \pi_r(p,k) + \pi_0(p) = kB\Big(1 - \frac{c}{p}\Big) + (p-c)D(p). \tag{18}$$

We intuitively describe the retailer's trade-off captured by (18). Knowing that the refugees will spend all their cash to buy goods (hence kB becomes the revenue), the retailer has an incentive to raise the price to reduce the quantity sold to refugees (hence reducing the procurement cost). On the other hand, raising the price above the original monopoly price, p_0, leads to loss of profit from the local residents. The following proposition formally states the relationship between the optimal retail price $p^\dagger(k)$ and first-stage decision k. All proofs are in the appendix.

Proposition 1 *Suppose the HO provides cash assistance to refugees (i.e.,* $k > 0$*) with no cash assistance policy, and the retailer responds by setting the retail price at* $p^\dagger(k)$. *Then,*
(i) $p^\dagger(k) > p_0$, *i.e., the retailer raises the price above the original monopoly price* p_0*;*
(ii) As the retailer raises the price, the loss in the weighted aggregate refugees' utility exceeds the increase in profit from refugees: $-w_{\text{P}} N \partial \mathbb{E}[U(p,k,\boldsymbol{\theta})]/\partial p > \partial \pi_r(p,k)/\partial p$*;*
(iii) $p^\dagger(k)$ *strictly increases in* k, *i.e., a larger cash assistance leads to a higher retail price; furthermore, if* $\pi_0(p)$ *is concave in* p, *then the inverse function of* $p^\dagger(k)$ *is*

$$k^e(p) = -\frac{\pi_0'(p)p^2}{Bc}, \qquad p \in [p_0, p^e_{\max}], \tag{19}$$

where $k^e(p^e_{\max}) = 1$.

Proposition 1 characterizes the retailer's pricing decision under all possible budget allocations. Part (i) confirms that, in the absence of a cash assistance policy, the cash assistance to the refugees leads to an unintended consequence that the retail price will increase above the original retail price (used before the refugees' arrival), which hurts local residents. Part (ii) reveals that the retail price increase does more harm to the refugees' utility than it benefits the retailer's profit. Note that the price increase also hurts local residents. Part (iii) implies the retailer's response has a one-to-one correspondence with the budget allocation decision; therefore, this relationship is invertible. Further, if $\pi_0(p)$ is concave, the inverted relation $k^e(p)$ is an explicit continuous function in (19). Note that $k^e(p)$ is not the budget decision in response to p, but in anticipation of p.

In the first-stage of the game, the HO decides the budget allocation k in anticipation of retailer

setting price at $p^\dagger(k)$. Then, the HO's problem in (7)-(9) can be written as

$$\max_{k\in[0,1]} N\mathbb{E}\big[U(p^\dagger(k),k,\boldsymbol{\theta})\big]. \tag{20}$$

Because the response function $p^\dagger(k)$ strictly increases in k (Proposition 1(iii)), it is differentiable almost everywhere (Lebesgue's Theorem). Using this fact and Assumption 2, we can prove how the refugees' utility in (20), the retailer's profit, and local residents' surplus change in k, which leads to the following proposition.

Proposition 2 *(i) As k increases, the profit from selling to the refugees, $\pi_r(p^\dagger(k),k)$, strictly increases, but the refugees' utility, $N\mathbb{E}\big[U(p^\dagger(k),k,\boldsymbol{\theta})\big]$ may increase or decrease:*

- *(a) When k is small so that some refugees purchase only their preferred goods, their individual utility as well as the aggregate utility, $N\mathbb{E}\big[U(p^\dagger(k),k,\boldsymbol{\theta})\big]$, may increase in k;*
- *(b) When k is large (in-kind assistance is small) so that every refugee needs to purchase all n goods, the weighted aggregate refugees' utility, $w_{\text{P}}N\mathbb{E}\big[U(p^\dagger(k),k,\boldsymbol{\theta})\big]$, decreases in k faster than the increase in the retailer's profit.*

(ii) As k increases, the profit from selling to the local residents, $\pi_0(p^\dagger(k))$, decreases, but the total retail profit strictly increases, while the local residents' surplus $C(p^\dagger(k))$ strictly decreases.

Proposition 2 formally characterizes the impact of cash assistance on each stakeholder in the ecosystem. Without cash assistance, the refugees are effectively separated from the host community. Cash assistance is expected to not only benefit the refugees by allowing them to purchase goods according their individual preferences, but also allow their spending to benefit the host community. However, the retailer's pricing strategy only benefits the retailer, while hurting both the refugees and local residents. Surprisingly, under the retailer's monopoly pricing, if k is large, the decline in the refugees' utility alone already exceeds the increase in the profit from selling to the refugees. The retailer actually loses profit from selling to the local residents, whose surplus also shrinks. The composite effect of the retailer's market power in response to cash assistance is, therefore, detrimental to the ecosystem. Consequently, although a positive cash assistance may be optimal for (20) due to the value of spending flexibility to the refugees, such flexibility is already negatively impacted by the retailer's market power, and the local residents become strictly worse off. Thus, to avoid increasing the tension between the refugees and local residents, it is best for the HO not to provide cash assistance only to be exploited by the market power.

We note that the reason for the retailer to raise prices is not because of the increased demand (the retailer is assumed to have unlimited supply) but because of the retailer's incentive to reap the

entire cash assistance while selling a lower quantity of higher-priced goods to refugees. Our analysis highlights such motive and explains the observed price hikes in reality. In the rest of the paper, we explore ways to curb the retailer's market power.

6. Strengthening Refugee Assistance through an HO-Government Partnership

In this section, we analyze how the HO-government partnership can improve social welfare by strengthening the cash and in-kind assistance with the price index cap (PIC) policy or the price-dependent cash assistance (PDCA) policy introduced in Section 4.5. Throughout this section, we assume the HO-government partnership wishes to offer cash assistance $k^{\odot}B$ and in-kind assistance $\mathbf{g}^{\odot}$ and aims to induce the retailer to choose prices $\mathbf{p}^{\odot}$.

6.1 Price Index Cap

We first design the price index cap intervention by the HO-government partnership, as formulated in Section 4.5.1.

Proposition 3 *The HO-government partnership should compute the price index using weights*

$$\mathbf{v}^{\mathsf{PIC}} := \left[\frac{\partial \Pi(\mathbf{p}^{\odot}, k^{\odot}, \mathbf{g}^{\odot})}{\partial p_1}, \ldots, \frac{\partial \Pi(\mathbf{p}^{\odot}, k^{\odot}, \mathbf{g}^{\odot})}{\partial p_n}\right]^{\mathsf{T}}, \tag{21}$$

and set the price index cap to be $\overline{p} = \mathbf{p}^{\odot\mathsf{T}}\mathbf{v}^{\mathsf{PIC}}$. *Then, the retailer would maximize its profit by pricing* n *goods at* $\mathbf{p}^{\odot}$, *i.e.,* (14) *is satisfied.*

Proposition 3 prescribes that the prices should be weighted by the retailer's marginal profit with respect to each price, evaluated at the target solution $(\mathbf{p}^{\odot}, k^{\odot}, \mathbf{g}^{\odot})$. Under this price index cap policy, the retailer would adjust its prices to $\mathbf{p}^{\odot}$, and the corresponding marginal profit is exactly $\mathbf{v}^{\mathsf{PIC}}$.

6.2 Price-Dependent Cash Assistance

In this section, we analyze the price-dependent cash assistance (PDCA) policy, as introduced in Section 4.5.2. Under such a scheme, the retailer can no longer take the cash assistance as given. Instead, the HO presents the retailer with a cash assistance plan that is dependent on retail prices. To counteract the retailer's incentive to raise prices, this cash assistance plan will provide an incentive for the retailer to reduce prices. Intuitively, such an incentive can be created if the HO commits to raising the cash assistance for lower retail prices set by the retailer.

Proposition 4 *The HO-government partnership should compute the price index using weights*

$$\mathbf{v}^{\mathsf{PDCA}} := \left[\frac{\partial \Pi(\mathbf{p}^{\odot}, k^{\odot}, \mathbf{g}^{\odot})}{\partial p_1}, \ldots, \frac{\partial \Pi(\mathbf{p}^{\odot}, k^{\odot}, \mathbf{g}^{\odot})}{\partial p_n}\right]^{\mathsf{T}}, \tag{22}$$

and set the cash assistance fraction to be

$$k(p_{\mathbf{v}}) = \min\{(a + sp_{\mathbf{v}})^+, 1\}, \qquad s = -\left(\frac{\partial \widetilde{\pi}_r(\mathbf{p}^\odot, k^\odot)}{\partial k}\right)^{-1}, \qquad a = k^\odot - s\,\mathbf{p}^{\odot\mathsf{T}}\mathbf{v}^{\mathsf{PDCA}}, \tag{23}$$

and set the in-kind assistance to be

$$\mathbf{g}(p_{\mathbf{v}}) = \frac{\mathbf{g}^\odot(1 - k(p_{\mathbf{v}}))}{1 - k^\odot}. \tag{24}$$

Then, the retailer would maximize its profit by pricing n goods at $\mathbf{p}^\odot$, i.e., (16) is satisfied. The resulting assistance is $(k^\odot, \mathbf{g}^\odot)$.

It is interesting to see that $\mathbf{v}^{\mathsf{PDCA}}$ in (22) is exactly the same as $\mathbf{v}^{\mathsf{PIC}}$ in (21). The first policy caps the weighted price, while the second policy modifies the profit of the retailer using the weighted price. Both policy designs intend to curb the retailer's market power. Intuitively, if raising the price of a good yields a higher marginal profit for the retailers, that price should receive a higher weight in calculating the price index. This intuition holds for both policy designs.

The result in (23) shows that the price sensitivity of the cash assistance, s, should be inversely related to the marginal profit of cash assistance to the retailer. This can be intuitively understood as follows. If the retailer raises price p_i from $p_i^\odot$ to $p_i^\odot + \delta$ ($\delta > 0$ is small), the direct effect of this price change on the profit is $\delta \cdot \partial\Pi(\mathbf{p}^\odot, k^\odot, \mathbf{g}^\odot)/\partial p_i$. It also increases the price index $p_{\mathbf{v}}$ by $\delta v_i^{\mathsf{PDCA}}$, resulting in a drop of cash assistance fraction k by $|\delta v_i^{\mathsf{PDCA}} s|$. Since the marginal benefit of cash assistance fraction to the retailer is exactly $|s^{-1}|$, the price change of δ indirectly reduces the profit (through reduced k) by $\delta v_i^{\mathsf{PDCA}}$, which cancels out with the positive direct effect.

Under the PDCA policy, the retailer can choose to use the original monopoly price to earn profit Π_0. If the target solution $(\mathbf{p}^\odot, k^\odot, \mathbf{g}^\odot)$ results in a retailer's profit of Π_0 as well, then the retailer is theoretically indifferent, but practically may be unwilling to choose $\mathbf{p}^\odot$. In such a case, the HO can offer a slightly higher cash assistance. Note that our theory can induce any target solution.

More importantly, Proposition 4 generalizes the cash assistance into an incentive scheme. The cash assistance now provides three functions simultaneously: to support the refugees, to incentivize the retailer to set desirable retail prices, and to benefit the local community (both the retailer and local residents).

6.3 Case of Symmetric Goods

For the case of symmetric goods (defined at the beginning of Section 5), the social-welfare maximisation problem in (10)-(12) can be equivalently written as

$$\max_{(p,k)} \; kB\Big(1 - \frac{c}{p}\Big) + \pi_0(p) + C(p) + w_{\mathrm{P}}\, N\mathbb{E}[U(p, k, \boldsymbol{\theta})], \tag{25}$$

$$\text{s.t.} \quad kB\Big(1-\frac{c}{p}\Big)+\pi_0(p)\geq \Pi_0, \quad C(p)\geq C(p_0), \quad N\mathbb{E}[U(p,k,\boldsymbol{\theta})]\geq U_0. \tag{26}$$

The constraint $C(p)\geq C(p_0)$ in (26) requires that the solution to (25)-(26) satisfies $p^*\leq p_0$. Note that p^* is also the optimal price cap to be used because Proposition 1 shows that the retailer has an incentive to raise the price above p_0. (The price index cap is equivalent to a price cap under the symmetric goods assumption.) In the next proposition, we analyze the property of the optimal cash assistance as a function of the price cap.

Proposition 5 *Suppose the HO-government partnership implements a retail price cap $\overline{p}\in(c,p_0]$. Then,*

(i) Corresponding to the given $\overline{p}$, the optimal cash assistance fraction is

$$k^*(\overline{p})=\frac{\Pi_0-\pi_0(\overline{p})}{B(1-c/\overline{p})}.$$

(ii) $k^*(\overline{p})$ strictly decreases in $\overline{p}$; the price cap $\overline{p}$ must be in the range $[p_{\min},p_0]$, where $p_{\min}\in(c,p_0)$ and satisfies $k^*(p_{\min})=1$.

(iii) When the price cap $\overline{p}$ decreases from p_0 and the cash assistance $k^*(\overline{p})$ increases accordingly, the retailer earns a constant profit Π_0, the local residents' surplus increases (convexly), whereas the refugees' utility may increase or decrease.

Proposition 5 reveals that, in the price cap policy, the retail price is capped to limit the retailer's profit margin, but the HO-government partnership allocates enough cash assistance to the refugees who will buy from the retailer and allows the retailer to earn the same profit as before. Consistent with our intuition, parts (ii) and (iii) find that a more stringent (lower) price cap needs to be implemented with more cash assistance to ensure the retailer is not made worse off. (To maximize the social welfare, we keep the retailer's profit at Π_0, but in practice, it would be reasonable to allow the retailer to earn a profit higher than Π_0.)

One might expect that a more stringent price cap would limit more of the retailer's market power, hence improving the social welfare. However, Proposition 5 (iii) shows that a lower price cap benefits local residents but may hurt refugees. This is because a more stringent cap and the corresponding larger cash assistance imply that the refugees receive less in-kind assistance and purchase more goods from the retailer at price $\overline{p}>c$. Thus, the refugees gain more spending flexibility but receive a reduced total quantity of goods. Therefore, a more stringent price cap is not necessarily desirable; the partnership must trade off the benefits to local residents with the impact on refugees to make the best decision.

The optimal price cap and the associated cash assistance also depend on the weight w_{P}. If the

HO-government partnership places a higher weight on the local residents, then a more aggressive cash assistance policy (a lower price cap) will be used, benefiting local residents but not necessarily refugees (for example, refugees may achieve only U_0). On the other hand, if the partnership places a higher weight on refugees, then a lower cash assistance should be used to allow refugees to gain spending flexibility but not lose too much in the total quantity of goods received.

Finally, we demonstrate a PDCA policy for the setting with symmetric goods. Let $k(p)$ denote the fraction of budget used for cash assistance if the retailer commits price p. The retailer takes $k(p)$ into account and maximizes its profit: $\max_p \; k(p)B\Big(1-\frac{c}{p}\Big)+\pi_0(p)$. Applying Proposition 4 to the symmetric goods setting, the slope coefficient of $k(p)$ can be written as $S(p^\odot, k^\odot) = v^{\mathsf{PDCA}} s = -\frac{\partial \Pi}{\partial p} \Big/ \frac{\partial \widetilde{\pi}_r}{\partial k}$. Specifically, the PDCA scheme in Proposition 4 becomes

$$k(p) = \min\left\{\Big(k^\odot + S(p^\odot, k^\odot)(p-p^\odot)\Big)^+, 1\right\}, \qquad S(p^\odot, k^\odot) = -\frac{\frac{k^\odot c}{{p^\odot}^2} + \frac{\pi_0'(p^\odot)}{B}}{1-\frac{c}{p^\odot}}. \tag{27}$$

Note that the slope coefficient $S(p^\odot, k^\odot)$ increases in $p^\odot$ and decreases in $k^\odot$. Intuitively, a steeper (more negative) slope of the PDCA scheme is required if the HO wants to either induce the retailer to choose a lower target price $p^\odot$ or provide more cash assistance without changing the retail price. The slope coefficient $S(p^\odot, k^\odot)$ can be connected to Proposition 5 when the retailer's profit under $(p^\odot, k^\odot)$ is Π_0. The symmetric goods assumption leads to $\frac{\partial \widetilde{\pi}_r}{\partial k} = \frac{\partial \Pi}{\partial k}$. Then, $S(p^\odot, k^\odot) = -\frac{\partial \Pi}{\partial p} \Big/ \frac{\partial \Pi}{\partial k}$, which is the slope of the implicit function defined by $\Pi(p,k) = \Pi_0$. On the other hand, in Proposition 5 (i)-(ii), the optimal cash assistance under a given price cap $\overline{p}$ is $k^*(\overline{p})$, which holds the retailer's profit at Π_0. Thus, the slope of $k^*(\overline{p})$ is exactly the slope in (27), i.e., $S(p^\odot, k^\odot) = k^{*\prime}(p^\odot)$.

Furthermore, as long as the retail price p is such that $k(p) \in (0,1)$, $k(p)$ is linear in p and it can be readily seen that the retailer's profit from refugees, $k(p)B(1-\frac{c}{p})$, is strictly concave in p. If $\pi_0(p)$ is also concave, then we can be sure that the PDCA policy derived from the first-order conditions in Proposition 4 indeed incentivizes the retailer to choose the target price $p^\odot$, so the resulting total profit will be at least Π_0 under any feasible target solution. On the other hand, if the retailer chooses such a high price that $k(p) = 0$, then no budget will be allocated to cash assistance and the retailer's profit reduces to $\pi_0(p)$, the pre-refugee-arrival level. Similarly, if the retailer chooses such a low price that $k(p) = 1$, the retailer's profit is $B(1-\frac{c}{p}) + \pi_0(p)$.

Therefore, over the entire price region, the retailer profit is piecewise concave, and $p = p^\odot$ is an optimal retail price; it is the unique optimal price if $\pi_r(p^\odot, k^\odot) + \pi_0(p^\odot) > \Pi_0$.

7. Numerical Analysis

The goal of this section is to calibrate our model for a typical host community for refugees in Greece, such as the one in Doliana, and demonstrate how one can apply the theoretical results in the previous sections to a realistic setting to manage the tradeoff between in-kind and cash assistance better.

7.1 Parameters Selection

We use various data sources—primary data from our field research and secondary data from academic literature and organizational reports of HOs—to set up our numerical analysis. Below we present our choice of the refugees' utility, an estimate for the overall budget of an HO, and the local demands.

For ease of illustration and computation, we consider two essential goods categories (food and hygiene products). We use a Cobb-Douglas utility function $u(x_1, x_2, \theta) = a\, x_1^{\theta} x_2^{1-\theta}$, where the individual preference parameter θ is uniformly distributed over $[0, 1]$. Cobb-Douglas utility function allows a closed-form solution to an individual refugee's consumption choice problem in (1),[3] which facilitates the analysis of the sequential decisions in (6)-(12). In our numerical procedure, we let θ take ten discrete values, $0.05, 0.15, \ldots, 0.95$, each having a probability of 0.1, and set the multiplier $a = 50$, which ensures that in-kind assistance to refugees is worth more than its cost (c_1 and c_2 are discussed shortly).

To estimate the HO's budget for in-kind and cash assistance, we use public data from two HOs. At the time of our field research, one HO provided only cash assistance, and the other one provided only in-kind assistance. For the in-kind assistance, the HO allocated 500,000€ monthly to goods (food and non-food) for about 6,000 refugees (Matis 2017), which is about 2.8€ per refugee per day. For the cash assistance, the HO reported 340€ in monthly funds for cash assistance to a family of refugees in Greece (Glasgow 2018), which results in about 2.7€ per refugee per day (based on 4.2 people per family, suggested by our interviews with M. Kapelle at Oxfam; see Table 1). Since the assistance provided to refugees by either HO was relatively low, we consider a budget that is the sum of the assistance from both HOs, i.e., we assume the budget allows for 2.8€ + 2.7€ = 5.5€ per refugee per day. Based on our field research, the average camp population in northwestern Greece was about 660 refugees. Consequently, the total annual budget for assistance to an average camp is about 1.3 million euros.

We use a 1:3 ratio of refugees to local residents to stay close to the actual size of the three rural towns from our field research (interview with A. Zioga at Oxfam; see Table 1). Therefore, for all

[3] With $u(x_1, x_2, \theta) = a\, x_1^{\theta} x_2^{1-\theta}$, the explicit solution to (1) is: $q_1 = \min\left\{kB/p_1,\ \left(\theta(kB + p_1 g_1 + p_2 g_2)/p_1 - g_1\right)^+\right\}/N$ and $q_2 = \min\left\{kB/p_2,\ \left((1-\theta)(kB + p_1 g_1 + p_2 g_2)/p_2 - g_2\right)^+\right\}/N$.

our numerical results, we use a refugee population of 660 people and a local resident population of 2,000 people. Since the retailers we interviewed could not provide us with detailed data on their demand from local residents, we opt for reasonable assumption of annual demand functions $D_i(p_i) = 100,000(20 - p_i)$, $i = 1, 2$, with wholesale prices $c_1 = 10$€/kg and $c_2 = 13$€/kg. Under monopoly prices, these demands translate to an annual spending of 13.3 million €, about ten times the amount of the humanitarian assistance provided to refugees.

Throughout the numerical analysis, we assume that the weight of the refugees' utility used in the HO-government partnership's objective in (10) is $w_{\text{P}} = 1$. A case in point is a local HO with strong ties to the local community forming an HO-government partnership that aims to provide benefits to everyone involved.

7.2 Impact of Cash Assistance and Proposed Policies for HO-Government Partnership

For the humanitarian assistance setting described in Section 7.1, we first examine the situation with the retailer's market power uncontrolled (when HO acting alone). Then, we study the impact of our proposed cash assistance policies (under the HO-government partnership).

Without the help from the government, when the HO provides cash assistance to refugees, the retailer raises retail prices above the original monopoly prices, as shown by the dashed curves in Figure 2(a). Before the refugees' arrival, the retailer's monopoly prices are $\mathbf{p}_0 = (15.0, 16.5)$€/kg. After the refugees' arrival, with the increase in cash assistance, the retailer increases both prices. Consistent with Proposition 1, the larger the amount of cash assistance for the refugees, the more it induces price inflation.

Figure 3(a) shows how each stakeholder's welfare changes as the HO increases its budget allocated to cash assistance. As expected, when cash assistance increases, the retailer generates more profit from the refugees (dashed blue curve), and the refugees' utility (dashed red curve) increases first and peaks at $k = 0.24$, driven by the value of cash assistance in meeting their individual needs. However, as k increases further, the refugees' utility decreases and, when $k > 0.54$, it decreases faster than the increase in the retailer's profit from selling to the refugees and the retailer's total profit (seen using the three horizontal dotted lines), which is in line with Proposition 2. Furthermore, we observe that the magnitude of the negative impact of market power is severe: It primarily affects refugees, but hurts local residents (dash-dotted curve) as well. (The refugees' utility exceeds the local residents' surplus because the refugees' survival solely depends on the in-kind assistance. Therefore, they value the goods much more than the local residents.) Note that Propositions 1 and 2 rely on the symmetric goods assumption, but the qualitative insights remain valid for the asymmetric good case studied here.

Figure 2: (Color online) Impact of the proposed HO-government policies on the retail price and social welfare

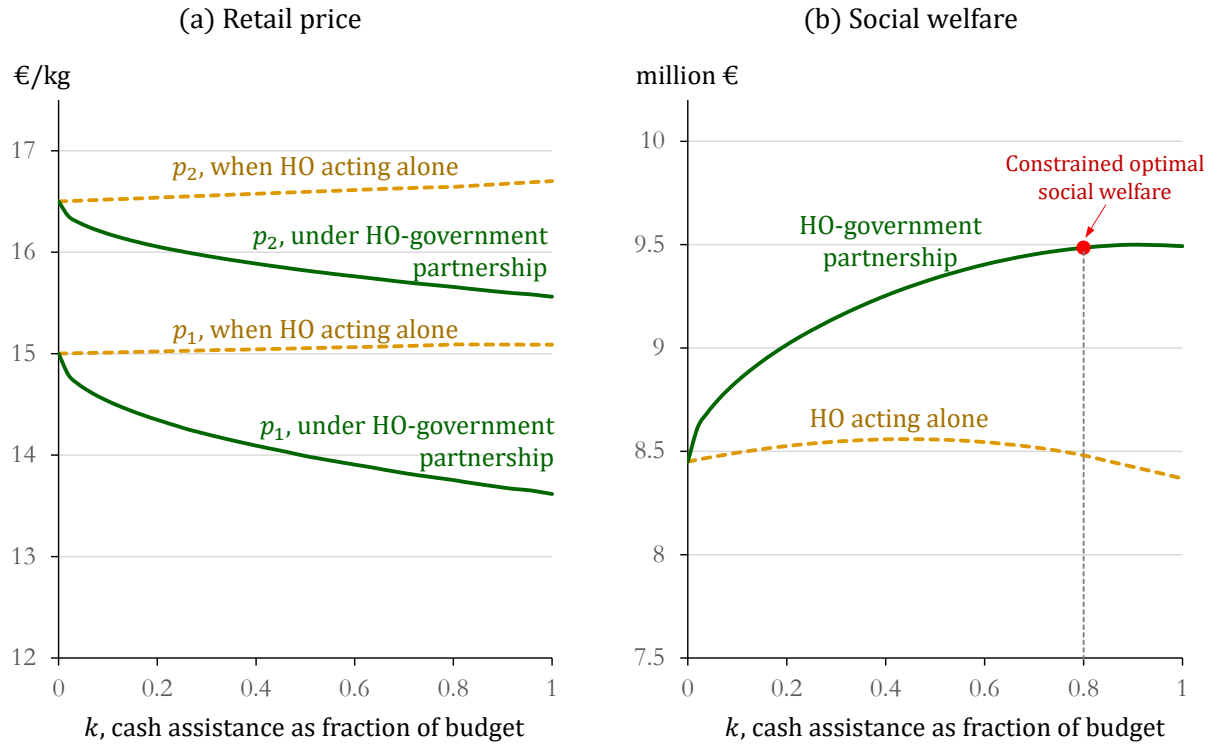
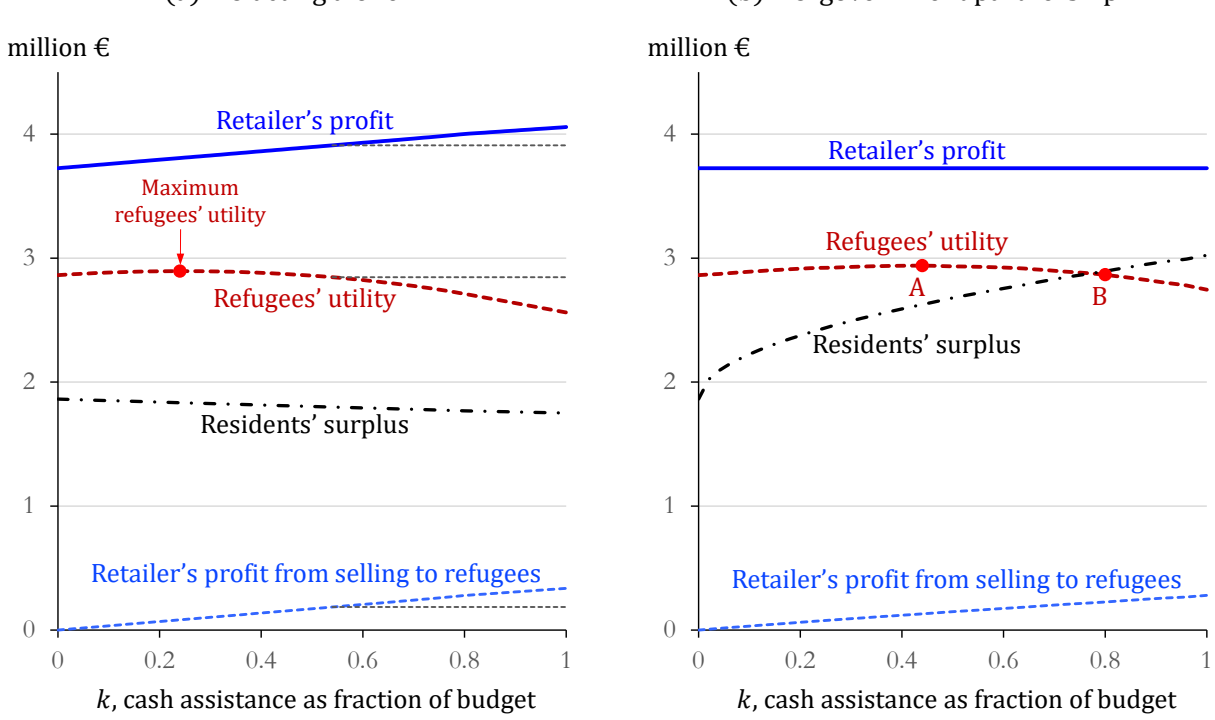


Figure 3: (Color online) Stakeholders' welfare under various amounts of cash assistance



Overall, although the HO's intention of using cash assistance might be to benefit both the refugees and the host community, it turns out that the retailer reaps most of the benefits at the cost of local residents and refugees. The social welfare as shown by the dashed curve in Figure 2(b) first increases in k, driven by the benefit of cash to the retailer and refugees, but declines afterward due to the retailer exercising its market power. Note that any amount of cash assistance makes the local residents worse off. Therefore, when the HO acts alone to provide cash assistance to refugees, it cannot ensure that the assistance "does no harm" to local residents.

To rectify the negative impact of the market power, we next study the impact of our proposed cash assistance policies (PIC and PDCA) that the HO-government partnership can implement to maximize the combined welfare of all parties without hurting anyone involved.

Under either the PIC or PDCA policy, the retailer will price both goods below the original price $\mathbf{p}_0$ (solid curves in Figure 2(a)). This is in stark contrast to the case of the HO acting alone. Specifically, when the HO allocates $k = 80\%$ of budget to cash assistance, the retailer is willing (and actually chooses under PDCA) to drop the price by 8.3% and 5.1%, respectively, from the original retail price $\mathbf{p}_0$.

Figure 3(b) reveals how either the PIC or PDCA policy affects each party's welfare. The retailer's profit is kept at Π_0 (solid flat line) because either policy keeps its market power in check. As the cash assistance increases, the declining retail price improves the local residents' surplus (dash-dotted curve); meanwhile, the refugees' utility increases slightly faster and decreases slower than if the HO acts alone in Figure 3(a). The utility falls despite the price drop because more cash assistance results in more goods being purchased at retail prices, which are higher than the wholesale prices for procuring in-kind assistance. Refugees' utility is maximized at $k = 0.44$ (point A in Figure 3(b)), which is about 2.7% higher than the original utility under only in-kind assistance. If we increase k to 0.8 (point B), the social welfare keeps increasing thanks to the substantial gain in the local residents' surplus, while the refugees' utility drops to the same level as that under all in-kind assistance. Therefore, $k = 0.8$ is the constrained optimal cash assistance fraction that the HO-government partnership can use to allocate the budget. In reality, the partnership can choose other target prices and assistance level, $(\mathbf{p}^{\odot}, k^{\odot}, \mathbf{g}^{\odot})$, to bring strictly positive benefit to each party, as discussed in Section 6.

Another important observation from Figure 3(b) is that a properly designed cash assistance policy leads to significant gains for local residents. Our analysis provides a great opportunity for the HO to showcase formally to governments and donors that cash assistance can provide economic benefits to local residents, thereby easing tensions between refugees and their host communities. The

benefit of cash assistance to refugees appears to be smaller than that to local residents, but that is because more cash assistance for refugees must come with less in-kind assistance (the budget is fixed), whereas cash spent by refugees is a net gain for the host community.

Finally, we present the construction of the price index and the specification of the PDCA policy. Using the results from Propositions 3 and 4, we can compute the weights (note that $\mathbf{v}^{\mathsf{PIC}} = \mathbf{v}^{\mathsf{PDCA}}$) to construct the price index. For this example, if the HO-government partnership targets to implement the constrained optimal solution responding to $k = 0.8$, we can find that $\mathbf{v} = (0.276, 0.199)$ million. We normalize the weights to $\mathbf{v} = (0.581, 0.419)$. That is, the price index is calculated as

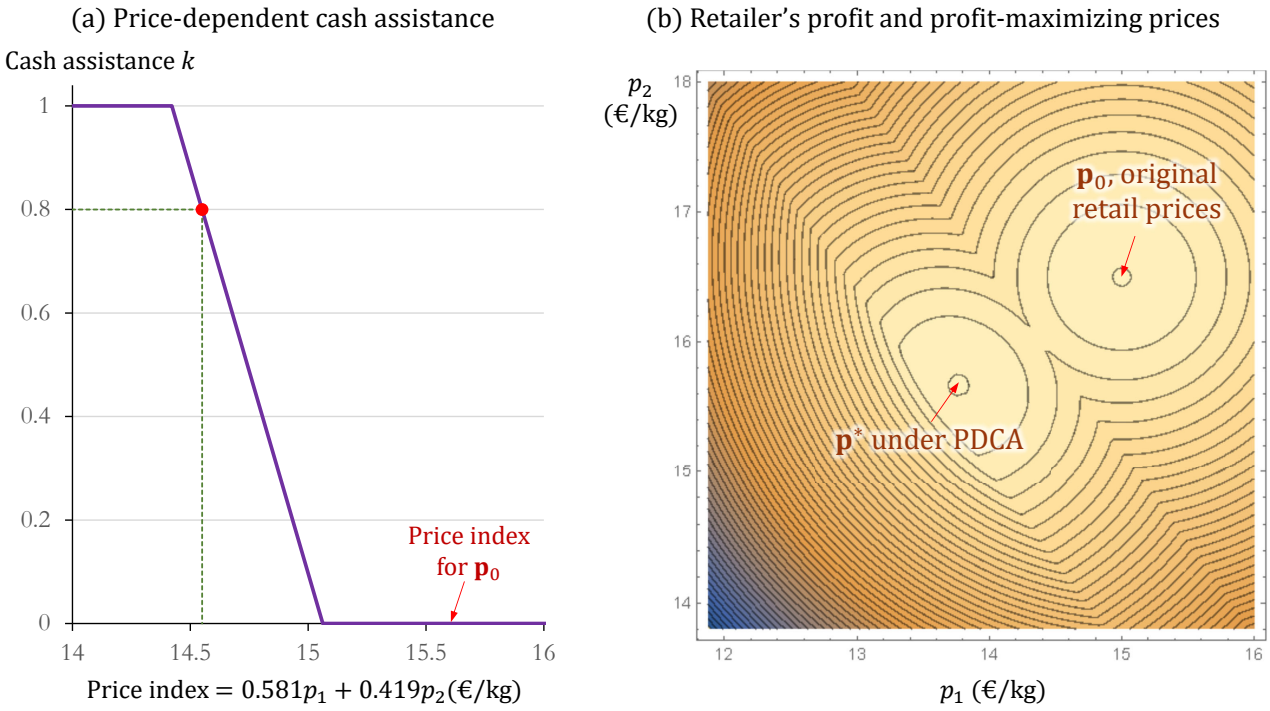
$$p_{\mathbf{v}} = 0.581\, p_1 + 0.419\, p_2.$$

The corresponding PDCA policy given by Proposition 4 is

$$k(p_{\mathbf{v}}) = \min\{(23.54 - 1.56p_{\mathbf{v}})^+, 1\}, \tag{28}$$

which is shown in Figure 4(a). Under the PDCA policy, the contours of the retailer's profit as a function of the two prices are plotted in Figure 4(b).

Figure 4: (Color online) Price-dependent cash assistance and the retailer's response



As shown in Figure 4, the price index for the original monopoly prices $\mathbf{p}_0$ is 15.63€/kg. The PDCA policy aims to incentivize the retailer to lower the price index. In this PDCA scheme, if the price index exceeds 15.06€/kg, no cash assistance will be provided. Below that point, for every

0.1€/kg drop in the price index, the cash assistance amount will increase by 15.6% of the total budget (suggested by the coefficient of $p_{\mathbf{v}}$ in (28)). This incentive reshapes the retailer's profit function so that the retailer's profit is maximized at $\mathbf{p}^* = (13.75, 15.66)$€/kg with a lower price index 14.55€/kg. These are the exact (constrained) social-welfare-maximizing prices found in Figure 2.

The corresponding cash assistance according to PDCA will be $k = 80\%$ of the total budget. The advantage of this policy is that it induces the retailer to set a price desirable for both the retailer itself and social welfare without imposing any price restrictions. In this example, we keep the retailer's profit the same under PDCA as the original profit, i.e., the retailer's profit in Figure 4(b) has two maximizers, but in practice, it would be reasonable to allow the retailer to earn a strictly higher profit. Proposition 4 establishes the theory for achieving any win-win-win solution.

8. Conclusions and Final Remarks

In the last 150 years, HOs have become experts in assisting beneficiaries via in-kind assistance. Recently, cash assistance has gained remarkable traction as an effective type of aid because it also benefits local economies. To avoid price inflation, however, HOs have implemented their cash assistance programs mostly in competitive markets. An unresolved challenge facing HOs is to provide cash assistance to their beneficiaries when local retailers have market power. Here lies the topic of this paper and is an important problem because there are many communities that not only host refugee camps but also deal with retailers' market power.

Focused on the setting of refugee crises, we conducted field research in northwestern Greece, which included visits to three refugee camps as well semi-structured interviews with different stakeholders. Our qualitative field data allowed us to support our analytical assumptions with evidence from practice. Building on our field research, we developed a game-theoretic model that captures the strategic interactions between the stakeholders involved in the ecosystem: HOs, refugees, local retailers, and local residents. Then, we calibrated the model using parameters with realistic values to illustrate our analytical insights.

Our analysis reveals that cash assistance is a double-edged sword: If an HO provides cash assistance without considering the retailer's market power, the HO will inadvertently harm the refugees and local residents. This issue justifies HOs' general policy of avoiding cash assistance in monopolistic markets. However, coordinating with the local government, HOs can extend cash assistance to settings with market power. We propose a partnership between HOs and the local government that effectively curbs the retailer's market power. We recommend the partnership adopt a price-dependent cash assistance policy that restores the distorted incentive due to the introduction of cash assistance and achieve a win-win-win solution, where refugees gain the power of meeting their

individual needs in a dignified way, the retailer sells more products (and makes at least the same profit as before), while local residents enjoy lower prices. Our numerical analysis also indicates that there are material economic benefits to local residents due to cash injection. Therefore, our research designs operational tools for HOs to persuade local governments to recognize the economic benefits of welcoming refugees into their communities.

Our modeling assumptions are general enough to capture settings in which the influx of refugees—or other beneficiaries of humanitarian aid—can affect local (monopolistic) retailer prices. An example with similar market conditions is each of the three Aegean islands of Greece: Kos, Chios, and Lesvos. In these islands, monopolistic markets are present since transportation from one side of the island to the other is limited, especially in winter. The refugee to local resident population ratio is similar in magnitude to the one we used in our numerical analysis. Another example is in South Africa, a country with a highly concentrated retail market, in which more than 500,000 refugees have fled from Burundi, the Democratic Republic of the Congo, and Rwanda (Robinson 2018, Deloitte 2015).

According to Besiou and Van Wassenhove (2020), it is the researchers' responsibility to close the loop between theory and practice and "*translate results and insights into practical recommendations that are relatively easy to implement.*" Thus, to increase the visibility of our research to practice, we shared our findings with HOs in charge of managing refugee camps. In 2019, we presented our preliminary findings to the Middle East Area Operations Manager of Mercy Corps—an international HO that distributed cash assistance in Epirus and the Greek islands in 2016 and 2017. The manager commented that after providing cash assistance to the refugees for six months, the HO realized that the retailer's market power had a detrimental effect on refugees' purchasing power. He added that the HO decided against allocating all its budget to in-kind assistance due to the *absence* of refugees' empowerment. Thus, the cash assistance policies we propose seem to be a promising tool for HOs to improve their cash assistance programs while controlling retailers' market power. We also discussed our results with a representative of the task force of the Cash Learning Partnership, a collaborative international network of humanitarian stakeholders actively engaged in the critical areas of policy, practice, and research related to cash assistance. According to the representative, the task force recognizes that the government is an important stakeholder that HOs cannot overlook when providing cash assistance. However, the communication between HOs and local governments is merely informational. By delving into the specifics of such a partnership and demonstrating its benefits for all stakeholders, our research offers tools and implementable policies that HO-government partnerships can utilize to create benefits for all their stakeholders.

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Online Appendix for *Donations for Refugee Crises: In-kind Versus Cash Assistance*

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Proof of Proposition 1: *(i)* For any $k \in (0,1]$ and any price $\widetilde{p} \in (c, p_0)$, we have

$$\begin{aligned}\Pi(\widetilde{p},k) &= kB\Big(1-\frac{c}{\widetilde{p}}\Big)+(\widetilde{p}-c)D(\widetilde{p})\\ &< kB\Big(1-\frac{c}{p_0}\Big)+(p_0-c)D(p_0) \;=\; \Pi(p_0,k),\end{aligned}$$

where the inequality follows from $\widetilde{p} < p_0$ and $(\widetilde{p}-c)D(\widetilde{p}) < (p_0-c)D(p_0)$ since p_0 maximizes $(p-c)D(p)$. Therefore, $\widetilde{p} \in (c, p_0)$ cannot be a maximizer of $\Pi(p,k)$. Next, Assumption 2 implies that the derivative of $(p-c)D(p)$ with respect to p is zero at $p = p_0$. Thus,

$$\frac{\partial \Pi(p_0,k)}{\partial p} = \frac{kBc}{p_0^2} > 0,$$

which implies that p_0 cannot be a maximizer of $\Pi(p,k)$, either. Therefore, any $p \in (c, p_0]$ is not optimal for the retailer; the optimal price must satisfy $p^\dagger(k) > p_0$.

(ii) Under the symmetric goods assumption (see the beginning of Section 5), an individual refugee's problem in (1) can be written as

$$U(p,k,\boldsymbol{\theta}) \;:= \max_{\mathbf{q}} \Big\{ u\Big(\frac{(1-k)B}{cNn}\mathbf{1}+\mathbf{q},\boldsymbol{\theta}\Big) \;\Big|\; \mathbf{q}\geq 0,\; \mathbf{1}^\intercal\mathbf{q} \leq \frac{kB}{Np}\Big\}.$$

The Lagrangian is

$$\mathcal{L}(\mathbf{q},\lambda,\boldsymbol{\eta},p,k,\boldsymbol{\theta}) = u\Big(\frac{(1-k)B}{cNn}\mathbf{1}+\mathbf{q},\boldsymbol{\theta}\Big)+\lambda\Big(\frac{kB}{Np}-\mathbf{1}^\intercal\mathbf{q}\Big)+\sum_{i=1}^{n}\eta_i q_i.$$

The first-order condition with respect to q_i is $\dfrac{\partial u}{\partial x_i} - \lambda + \eta_i = 0$. Since $k > 0$, there exists some j such that $q_j > 0$ in the optimal solution, implying $\eta_j = 0$ (complementary slackness) and

$$\lambda = \frac{\partial u}{\partial x_j} = u'_{\boldsymbol{\theta}}(x) > \frac{c}{w_{\text{P}}}, \qquad \text{for some } x \in [0, B/(Nc)], \tag{A.1}$$

where $u_{\boldsymbol{\theta}}(x) = \max\limits_{\mathbf{x}}\{u(\mathbf{x},\boldsymbol{\theta}) : \mathbf{x}\geq \mathbf{0},\, \mathbf{1}^\intercal\mathbf{x} \leq x\}$ and $u'_{\boldsymbol{\theta}}(x) > c/w_{\text{P}}$ follow from Assumption 1.

Using the envelope theorem and $\lambda > c$ from (A.1), we have

$$\frac{\partial U(p,k,\boldsymbol{\theta})}{\partial p} = -\frac{kB\lambda}{Np^2} < -\frac{kBc}{w_{\text{P}}Np^2}. \tag{A.2}$$

Since the retailer's profit from refugees is $\pi_r(p,k) = kB(1-c/p)$, we have

$$\frac{\partial \pi_r(p,k)}{\partial p} = \frac{kBc}{p^2}. \tag{A.3}$$

Combining (A.2) and (A.3), we have

$$-w_{\text{P}}N\frac{\partial \mathbb{E}[U(p,k,\boldsymbol{\theta})]}{\partial p} > \frac{\partial \pi_r(p,k)}{\partial p}.$$

(iii) Let $k_1 < k_2$ and consider any price $\widetilde{p} \in (c, p^\dagger(k_1))$. We have

$$\begin{aligned}
\Pi(\widetilde{p}, k_2) &= k_2 B\Big(1 - \frac{c}{\widetilde{p}}\Big) + (\widetilde{p} - c)D(\widetilde{p}) \\
&= (k_2 - k_1)B\Big(1 - \frac{c}{\widetilde{p}}\Big) + \Pi(\widetilde{p}, k_1) \\
&< (k_2 - k_1)B\Big(1 - \frac{c}{p^\dagger(k_1)}\Big) + \Pi(p^\dagger(k_1), k_1) \\
&= k_2 B\Big(1 - \frac{c}{p^\dagger(k_1)}\Big) + (p^\dagger(k_1) - c)D(p^\dagger(k_1)) \;=\; \Pi(p^\dagger(k_1), k_2),
\end{aligned} \tag{A.4}$$

where the inequality follows from $\widetilde{p} < p^\dagger(k_1)$, $k_1 < k_2$, and the fact that $p^\dagger(k_1)$ maximizes $\Pi(p, k_1)$. Therefore, $\widetilde{p} \in (c, p^\dagger(k_1))$ cannot be a maximizer of $\Pi(p, k_2)$. Next, note that $\dfrac{\partial \Pi(p^\dagger(k_1), k_1)}{\partial p} = 0$. Evaluating the derivative of (A.4) at $p = p^\dagger(k_1)$, we have

$$\frac{\partial \Pi(p^\dagger(k_1), k_2)}{\partial p} = \frac{(k_2 - k_1)Bc}{(p^\dagger(k_1))^2} > 0,$$

which implies that $p^\dagger(k_1)$ cannot be a maximizer of $\Pi(p, k_2)$, either. Therefore, the retailer's optimal price must satisfy $p^\dagger(k_2) > p^\dagger(k_1)$. This proves that $p^\dagger(k)$ strictly increases in k.

If $\pi_0(p)$ is concave in p, then the retailer's profit $\Pi(p, k)$ is strictly concave in p and thus the retail price $p^\dagger(k)$ can be uniquely determined by the first-order condition $\dfrac{\partial \Pi}{\partial p} = \dfrac{kBc}{p^2} + \pi_0'(p) = 0$. Thus, for given k, $p^\dagger(k)$ is the unique solution to $k = -\dfrac{\pi_0'(p)p^2}{Bc}$. Therefore, to induce a retail price p, the budget decision k should be $k^e(p) = -\dfrac{\pi_0'(p)p^2}{Bc}$ as in (19), which strictly increases in p for $p \geq p_0$. Clearly, to induce $p = p_0$, the HO should set $k^e(p_0) = 0$. Price $p < p_0$ cannot be induced, due to part (i). The largest inducible price $p^e_{\max}$ satisfies $k^e(p^e_{\max}) = 1$. ∎

Proof of Proposition 2: *(i)* The monotonicity in Proposition 1 (iii) implies that the response function $p^\dagger(k)$ is almost everywhere differentiable because monotone functions on a line are almost everywhere differentiable. We now show that $p^\dagger(k)$ is differentiable at a given k if and only if $p^\dagger(k)$ is the unique optimal response to k.

Recall that $p^\dagger(k)$ is a solution to $\max\limits_p \big\{ kB\Big(1 - \dfrac{c}{p}\Big) + \pi_0(p)\big\}$. For a given $\widehat{k}$, if $p^\dagger(\widehat{k})$ is the unique maximizer, then it is determined by the first-order condition $\widehat{k} = -\dfrac{\pi_0'(p)p^2}{Bc}$. The right side is differentiable in p (Assumption 2). Therefore, the inverse function $p^\dagger(k)$ is differentiable at $k = \widehat{k}$.

For a given $\widehat{k}$, suppose there exist multiple maximizers. (Recall that $p^\dagger(\widehat{k})$ is defined to be one of the maximizers; see the definition after (6).) Because $p^\dagger(k)$ strictly increases in k (Proposition 1 (iii)), $p^\dagger(k)$ with $k < \widehat{k}$ must be less than the smallest maximizer, and $p^\dagger(k)$ with $k > \widehat{k}$ must be greater

than the largest maximizer. That is, $p^\dagger(k)$ is not differentiable at $k = \widehat{k}$ and the nature of the non-differentiability is a jump.

Therefore, $p^\dagger(k)$ is strictly increasing and almost everywhere differentiable in k, with jumps only at points where the retailer's optimal response is not unique.

Below, we consider all the differentiable points of $p^\dagger(k)$ first, and then consider the jumps. The profit from selling to the refugees is $\pi_r(p,k) = kB(1-c/p)$. Thus,

$$\frac{d\pi_r(p^\dagger(k),k)}{dk} = \frac{\partial \pi_r(p^\dagger(k),k)}{\partial p} p^{\dagger\prime}(k) + \frac{\partial \pi_r(p^\dagger(k),k)}{\partial k} = \frac{kBc}{(p^{\dagger\prime}(k))^2} p^{\dagger\prime}(k) + B\Big(1 - \frac{c}{p^\dagger(k)}\Big) > 0. \quad \text{(A.5)}$$

Under the symmetric goods assumption, for a given k, the in-kind budget $(1-k)B$ are equally allocated to n goods, so that each refugee receives $\frac{(1-k)B}{cNn}$ units of good i, and the retailer sets n prices at $p^\dagger(k)$. Incorporating the in-kind assistance and the retailer's optimal response, we can write an individual refugee's utility in (1) as a function of k:

$$U_{\boldsymbol{\theta}}(k) \;:= \max_{\mathbf{q}} \left\{ u\Big(\frac{(1-k)B}{cNn}\mathbf{1} + \mathbf{q}, \boldsymbol{\theta}\Big) \;\Big|\; \mathbf{q} \geq 0,\; \mathbf{1}^\intercal \mathbf{q} \leq \frac{kB}{Np^\dagger(k)} \right\}. \quad \text{(A.6)}$$

The Lagrangian is

$$\mathcal{L}(\mathbf{q}, \lambda, \boldsymbol{\eta}, k, \boldsymbol{\theta}) = u\Big(\frac{(1-k)B}{cNn}\mathbf{1} + \mathbf{q}, \boldsymbol{\theta}\Big) + \lambda\Big(\frac{kB}{Np^\dagger(k)} - \mathbf{1}^\intercal \mathbf{q}\Big) + \sum_{i=1}^n \eta_i q_i. \quad \text{(A.7)}$$

An individual refugee's purchase decision satisfies the KKT conditions:

$$\frac{\partial u}{\partial x_i} = \lambda - \eta_i, \qquad i = 1, \ldots, n, \quad \text{(A.8)}$$

$$\lambda \geq 0, \qquad \frac{kB}{Np^\dagger(k)} \geq \mathbf{1}^\intercal \mathbf{q}, \qquad \lambda\Big(\frac{kB}{Np^\dagger(k)} - \mathbf{1}^\intercal \mathbf{q}\Big) = 0, \quad \text{(A.9)}$$

$$\eta_i \geq 0, \qquad q_i \geq 0, \qquad \eta_i q_i = 0, \qquad i = 1, \ldots, n. \quad \text{(A.10)}$$

Using the envelope theorem, the refugee's utility changes in k as follows:

$$\begin{aligned}
\frac{dU_{\boldsymbol{\theta}}(k)}{dk} &= \Big(\sum_{i=1}^n -\frac{\partial u}{\partial x_i}\frac{B}{cNn}\Big) + \lambda \frac{B}{N}\frac{p^\dagger(k) - kp^{\dagger\prime}(k)}{(p^\dagger(k))^2} \\
&= \Big(\sum_{i=1}^n \eta_i \frac{B}{cNn}\Big) - \frac{\lambda B}{cN} + \frac{\lambda}{N}\Big(\frac{B}{p^\dagger(k)} - \frac{kBp^{\dagger\prime}(k)}{(p^\dagger(k))^2}\Big) \\
&= \frac{B\mathbf{1}^\intercal \boldsymbol{\eta}}{cNn} - \frac{\lambda}{cN}\Big(\frac{kBc\,p^{\dagger\prime}(k)}{(p^{\dagger\prime}(k))^2} + B\Big(1 - \frac{c}{p^\dagger(k)}\Big)\Big) \\
&= \frac{B\mathbf{1}^\intercal \boldsymbol{\eta}}{cNn} - \frac{\lambda}{cN}\frac{d\pi_r(p^\dagger(k),k)}{dk}, \qquad \text{(A.11)}
\end{aligned}$$

where the last equality in (A.11) follows from (A.5). The expression in (A.11) suggests that $dU_{\boldsymbol{\theta}}(k)/dk$ can be positive only if $\eta_i > 0$ for some good i, implying that the corresponding $q_i = 0$ (complementary slackness in (A.10)), i.e., the refugee does not purchase all the goods, which happens when cash assistance amount is small and the amount of in-kind assistance for some goods exceed

the needs of the refugee. This proves statement (i-a).

When k is large (i.e., amount of in-kind assistance is small) so that every refugee needs to purchase all n goods, we have $\eta_i = 0$ (complementary slackness) for all $i = 1, \ldots, n$, and (A.11) becomes

$$\frac{dU_{\boldsymbol{\theta}}(k)}{dk} = -\frac{\lambda}{cN}\frac{d\pi_r(p^\dagger(k), k)}{dk},$$

which, together with $\lambda > c/w_{\text{P}}$ in (A.1) and (A.5), implies that

$$-w_{\text{P}} N \frac{d(\mathbb{E}[U_{\boldsymbol{\theta}}(k)])}{dk} \geq \frac{d\pi_r(p^\dagger(k), k)}{dk}.$$

Therefore, at all the differentiable points of $p^\dagger(k)$, the weighted aggregate refugees' utility decreases in k faster than the increase in the retailer's profit.

Next, we show that when $p^\dagger(k)$ jumps, the decrease in the refugees' utility still exceeds the increase in the retailer's profit. Suppose $p^\dagger(k)$ jumps at $k = \widehat{k}$ with $\lim_{k \uparrow \widehat{k}^-} p^\dagger(k) = p_1 < p_2 = \lim_{k \downarrow \widehat{k}^+} p^\dagger(k)$. Fixing $k = \widehat{k}$, we consider the refugee's utility as a function of the retail price p:

$$U_{\boldsymbol{\theta}}(p) \ := \max_{\mathbf{q}} \left\{ u\left(\frac{(1-\widehat{k})B}{cNn}\mathbf{1} + \mathbf{q}, \boldsymbol{\theta} \right) \,\middle|\, \mathbf{q} \geq 0,\ \mathbf{1}^\intercal \mathbf{q} \leq \frac{\widehat{k}B}{Np} \right\}. \tag{A.12}$$

The Lagrangian is similar to (A.7). Using the envelope theorem, we have

$$\frac{dU_{\boldsymbol{\theta}}(p)}{dp} = -\frac{\lambda \widehat{k} B}{Np^2}.$$

On the other hand, the profit from refugees, $\pi_r(p) = \widehat{k}B(1 - c/p)$, implies $\frac{d\pi_r(p)}{dp} = \frac{\widehat{k}Bc}{p^2}$. This, together with $\lambda > c/w_{\text{P}}$ in (A.1), implies

$$-w_{\text{P}} N \frac{d(\mathbb{E}[U_{\boldsymbol{\theta}}(p)])}{dp} \geq \frac{d\pi_r(p)}{dp} > 0.$$

Therefore, when $p^\dagger(k)$ jumps from p_1 to p_2, the decrease in the weighted aggregate refugees' utility, $w_{\text{P}} N(\mathbb{E}[U_{\boldsymbol{\theta}}(p_1)] - \mathbb{E}[U_{\boldsymbol{\theta}}(p_2)])$, exceeds the increase in the retailer's profit from refugees, $\pi_r(p_2) - \pi_r(p_1)$.

Combining the results for all the differentiable points and the jump points of $p^\dagger(k)$ proves that the weighted aggregate refugees' utility decreases in k faster than the increase in the retailer's profit from refugees, $\pi_r(p^\dagger(k), k)$. Part (ii) shows that the profit from selling to the local residents decreases in k. Thus, the weighted aggregate refugees' utility decreases in k faster than the increase in the retailer's total profit, $\Pi(p^\dagger(k), k)$.

(ii) Proposition 1 shows that the retail price $p^\dagger(k) \geq p_0$ and strictly increases in k. Since $\pi_0(p)$ is unimodal with maximizer at p_0 (Assumption 2), $\pi_0(p)$ decreases in p for $p \geq p_0$. Thus, $\pi_0(p^\dagger(k))$ decreases in k.

When k increases, if the retailer keeps the same retail price, its profit will already strictly increase due to an increased profit from the refugees; optimizing the price will further increase its profit. Thus,

the retailer's total profit $\pi_r(p^\dagger(k),k)+\pi_0(p^\dagger(k))$ strictly increases in k.

The local residents' surplus $C(p)=\int_0^{D(p)} D^{-1}(x)dx - pD(p)$ strictly decreases in p because $C'(p)=-D(p)<0$. ∎

Proof of Proposition 3: Similar to the discussion on the uniqueness of the optimal solution to (6) (see footnote 2 in the paper), under most common demand functions of local residents and refugees, the optimal solution to (14) can be uniquely determined by the retailer's first-order (KKT) conditions:

$$\frac{\partial \Pi(\mathbf{p},k^\odot,\mathbf{g}^\odot)}{\partial p_i}=\lambda v_i^{\mathsf{PIC}},\quad i=1,\ldots,n,$$
$$\lambda\geq 0,\qquad \overline{p}\geq \mathbf{p}^\intercal\mathbf{v}^{\mathsf{PIC}}\qquad \lambda(\overline{p}-\mathbf{p}^\intercal\mathbf{v}^{\mathsf{PIC}})=0.$$

Clearly, $\mathbf{p}=\mathbf{p}^\odot$ and $\lambda^\odot=1$ satisfy the KKT conditions. ∎

Proof of Proposition 4: First, note that if the retailer chooses $\mathbf{p}^\odot$, the assistance is

$$k(\mathbf{p}^{\odot\intercal}\mathbf{v}^{\mathsf{PDCA}})=\min\{(k^\odot-s\,\mathbf{p}^{\odot\intercal}\mathbf{v}^{\mathsf{PDCA}}+s\,\mathbf{p}^{\odot\intercal}\mathbf{v}^{\mathsf{PDCA}})^+,1\}=k^\odot,$$
$$\mathbf{g}(\mathbf{p}^{\odot\intercal}\mathbf{v}^{\mathsf{PDCA}})=\frac{\mathbf{g}^\odot(1-k(\mathbf{p}^{\odot\intercal}\mathbf{v}^{\mathsf{PDCA}}))}{1-k^\odot}=\mathbf{g}^\odot.$$

Thus, when the retail price $\mathbf{p}$ deviates from $\mathbf{p}^\odot$ within a range, $k(p_{\mathbf{v}})$ varies linearly with $\mathbf{p}$. Similar to the discussion on the uniqueness of the optimal solution to (6) (see footnote 2 of the paper), under most common demand functions of local residents and refugees, the optimal solution to (16) can be uniquely determined by the retailer's first-order condition:

$$\frac{\partial\widetilde{\pi}_r(\mathbf{p},k(\mathbf{p}^\intercal\mathbf{v}^{\mathsf{PDCA}}))}{\partial p_i}+\frac{\partial\widetilde{\pi}_r(\mathbf{p},k(\mathbf{p}^\intercal\mathbf{v}^{\mathsf{PDCA}}))}{\partial k}sv_i^{\mathsf{PDCA}}+\frac{\partial\pi_0(\mathbf{p})}{\partial p_i}=0. \tag{A.13}$$

We now verify that $\mathbf{p}=\mathbf{p}^\odot$ satisfies the condition in (A.13). To see this, note that under $\mathbf{p}=\mathbf{p}^\odot$, we have $k(\mathbf{p}^{\odot\intercal}\mathbf{v}^{\mathsf{PDCA}})=k^\odot$ and the above equation becomes

$$\frac{\partial\widetilde{\pi}_r(\mathbf{p}^\odot,k^\odot)}{\partial p_i}-v_i^{\mathsf{PDCA}}+\frac{\partial\pi_0(\mathbf{p}^\odot)}{\partial p_i}=0,$$

which indeed holds because v_i^{PDCA} is defined in (22) as

$$v_i^{\mathsf{PDCA}}=\frac{\partial\Pi(\mathbf{p}^\odot,k^\odot,\mathbf{g}^\odot)}{\partial p_i}=\frac{\partial\pi_r(\mathbf{p}^\odot,k^\odot,\mathbf{g}^\odot)}{\partial p_i}+\frac{\partial\pi_0(\mathbf{p}^\odot)}{\partial p_i},$$

and note that $\frac{\partial\pi_r(\mathbf{p}^\odot,k^\odot,\mathbf{g}^\odot)}{\partial p_i}=\frac{\partial\widetilde{\pi}_r(\mathbf{p}^\odot,k^\odot)}{\partial p_i}$ by (15). Therefore, $\mathbf{p}=\mathbf{p}^\odot$ satisfies (A.13). ∎

Proof of Proposition 5: *(i)* Using the result in Proposition 1(ii), for any given k, the weighted refugees' utility decreases in p faster than the increase in the profit from refugees $kB(1-c/p)$. In addition, the profit from the local residents and the residents' surplus combined, $\pi_0(p)+C(p)$, always decreases in p. Thus, the objective in (25) decreases in p for any given k. Therefore, for any given

k, the price that maximizes social welfare should be set as low as possible, i.e., it leaves the retailer with a profit of Π_0. In other words, $\overline{p}$ should satisfy $kB(1-c/\overline{p})+\pi_0(\overline{p})=\Pi_0$. Therefore, for given $\overline{p}\in(c,p_0]$, the corresponding optimal cash assistance is

$$k^*(\overline{p})=\frac{\Pi_0-\pi_0(\overline{p})}{B(1-c/\overline{p})},$$

under which the retailer earns Π_0.

(ii) From Assumption 2, $\pi_0(\overline{p})$ increases in $\overline{p}$ for $\overline{p}\in(c,p_0]$, and thus the numerator of $k^*(\overline{p})$ decreases in $\overline{p}$, while the denominator strictly increases in $\overline{p}$. Therefore, $k^*(\overline{p})$ strictly decreases in $\overline{p}$. Clearly, $k^*(p_0)=0$ since $\pi_0(p_0)=\Pi_0$, and $k^*(\overline{p})\to\infty$ as $\overline{p}\to c^+$. Therefore, there exists $p_{\min}\in(c,p_0)$ such that $k^*(p_{\min})=1$.

(iii) The retailer earns a constant profit Π_0, as shown in part (i). The local residents' surplus $C(\overline{p})=\int_0^{D(\overline{p})}D^{-1}(x)dx-\overline{p}D(\overline{p})$ decreases in $\overline{p}$, because $C'(\overline{p})=-D(\overline{p})<0$. Furthermore, $C(\overline{p})$ is convex in $\overline{p}$, as $C''(\overline{p})=-D'(\overline{p})\geq 0$.

On the other hand, the combined amount of goods from in-kind assistance and refugees' purchase using cash assistance is

$$\frac{(1-k^*(\overline{p}))B}{c}+\frac{k^*(\overline{p})B}{\overline{p}}=\frac{B-k^*(\overline{p})B(1-c/\overline{p})}{c}=\frac{B-\pi_r(\overline{p},k^*(\overline{p}))}{c}=\frac{B-\Pi_0+\pi_0(\overline{p})}{c},$$

which increases in $\overline{p}$ for $\overline{p}\in[p_{\min},p_0]$. If all refugees were homogeneous (identical $\boldsymbol{\theta}$), more goods would imply a higher utility, and thus the refugees' utility increases in $\overline{p}$. Of course, since refugees have heterogeneous preferences, more in-kind assistance means less purchasing flexibility, and thus the refugees' utility may decrease in $\overline{p}$. ∎