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Cash-Based Interventions to Enhance Dignity in Persistent Humanitarian Refugee Crises: A System Dynamics Approach

Fahimeh Allahi , Saeed Taheri , Ramez Kian , and Ehsan Sabet

Abstract—**Cash-based interventions (CBIs) as one form of aid have recently received substantial interest from humanitarian organizations in persistent humanitarian crises. This article proposes a system dynamics (SD) approach to study the CBIs' impact factors on all aspects of the beneficiaries' dignity in longstanding refugee crises, such as the case of Syrian refugees in Turkey. Reviewing the humanitarian management literature, we first develop a set of holistic causal loops to better understand the building boxes of refugees' dignity and their interactions. Then, an SD model is proposed and calibrated by field data from humanitarian organizations. The result of CBI amount sensitivity and payment time periods shows that CBIs are significantly more effective in diminishing child labor rates and to improve in health and accommodation service reception by the refugees in short terms, but to be as much effective in longer terms, humanitarian organizations must be more directly contribute to service capacity-building activities that are strategies by the hosting governments and supported by the international bodies, such as EU and UN. Otherwise, long-term or enhanced CBI supports can only lead to accelerated service capacity saturation and thus put extra pressure on already strained services and cause tensions between hosting and refugee communities.**

Index Terms—**Cash-based interventions (CBIs), causal loop model, decision making framework, humanitarian relief, system dynamics (SD).**

I. CASH-BASED INTERVENTIONS (CBIs) IN HUMANITARIAN AID

NATURAL and man-made disasters have increasingly caused famine, illnesses, fatalities, homelessness, economic loss, and human misery around the world [1]–[3]. A disaster is defined as "a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the ability of a community or society to cope using its own resources" [4]. Since 1990, more than 200 million people have been affected by the direct consequences of natural and man-made disasters, which have become one of the most significant problems of human life [5]–[7]. Currently, among the most man-made disaster-affected regions in the world are the Middle East and North Africa with continuous wars in Iraq, Libya, Syria, and Yemen. This has caused the largest scale of contemporary emigration, including inner displacement of people as well as refugees to other countries. Syria has seen more than 5 million people leave their homeland since the start of the civil war in the country in 2011. Many Syrians sought refuge in neighboring countries, and now over 3.6 million are living in Turkey [8], turning Turkey into the country with the greatest number of refugees in the world [9].

It is essential to help victims immediately after the occurrence of a disaster in various ways [10], [11], such as in-kind assistance or by supporting the affected places to reduce the impacts of disasters and initiating the improvement of operational skills to face the emergency situation better [4], [12]. The main purpose of humanitarian agencies is to save lives, alleviate poverty and vulnerability in the longer term, and preserve human dignity [13]. Over the past century, humanitarian support has been provided by means of in-kind products and services. However, such in-kind assistance may not always be the most proper response [14], [15], in particular, when the immediate needs are met and the sudden disaster is stabilized. Developing countries and donors are increasingly interested in moving away from in-kind assistance and replacing it with alternative transfer modalities, such as CBIs. These are considered more cost-effective for all parties and more enabling for the beneficiaries to supply and consume a wider range of foods or goods than what would be otherwise distributed by in-kind programs [13], [16], [17]. The field data show, with an access to CBIs, beneficiaries more frequently buy food and in a greater quantity and variety [18]. Thus, it increases their access to fresh products, improves their dietary diversity, and often saves them money as well.

CBIs are modes of transferring direct financial aid (either through cash or vouchers) to beneficiaries and are known to improve beneficiaries' livelihood and to generate feelings of hope and a sense of security [19]. CBIs can be classified into four categories; unconditional cash transfers, conditional cash

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interventions, vouchers (cash or commodity), and microcredits [20]. Most of these means have been implemented by aid organizations for many years. For instance, in the 1990s, UNHCR distributed a considerable amount of cash to over 3.5 million beneficiaries in Central America and Afghanistan, and by 2011, over 35% of humanitarian agencies were using CBIs [15].

CBIs enhance beneficiaries' dignity by giving the freedom of choice, and hence provide them with a higher level of satisfaction and well-being [21]. In fact, one could argue that as CBIs have become a major part of humanitarian aid around the world, the well-being of beneficiaries have improved in both developed and developing countries [13], [17].

The narratives of CBIs have recently been reviewed [15], and "dignity" has been named as the most significant impact of CBIs in long-term and persistent refugee crises [12]. Dignity can be described as the ability to identify and satisfy one's needs in a prioritized way [22]. The essential and critical building factors of dignity can be described as access to health, social security, and safety, access to education, and access to basic needs (food and accommodation) and enhanced spending choices to exercise "coping strategies," such as selling assets, taking on debts, taking degrading jobs, and child labor [23]–[27]. In this article, we categorize these elements into three pillars of dignity, namely overall health and social security, education, and improved coping strategy. Because CBIs are increasingly becoming a common mode of aid transfer for humanitarian organizations, there is a need to better understand CBI effects on the key components of refugees' dignity and humanitarian operations [20], [28]–[30], and the impact mechanism of CBIs on the building elements of dignity [31]. Such an analysis is particularly needed at the initiation phase of CBI programs [32]. Hence, this article aims to address this need, first by understanding dignity and its building elements, by investigating the interaction dynamics between these building elements, by assessing the impact of CBIs in changing such interactions, and finally by offering a system dynamics (SD) simulation model verified with a series field data, as a future guideline for CBI schemes. This is the first time such a model has been developed for a better understanding of CBI impact on refugees' overall dignity.

We have explored both academic and organizational reports to address and classify impact factors in humanitarian crises. We also contribute to the literature by forming a holistic causal relation between the factors identified, which forms a basis for an SD model. To the best of our knowledge, our article is the first research project that uses a quantitative SD model verified and validated with real data for different factors related to the refugee crisis. Our validated model is then used to forecast the future situation and depict the trend of stock values, which might be the KPIs in a bigger picture for policy makers in humanitarian organizations.

The rest of this article is organized as follows. Section II presents findings on the aforementioned factors within the existing body of the literature. Section III will analyze the subfactors by causal loop models to see the relations and interactions between them. The impacts of CBIs will also be displayed by SD in Section IV. A numerical study to verify and validate our proposed SD model is also presented. Finally, Section V concludes this article .

II. SD in Humanitarian Aid

SD is a simulation methodology, initially developed by J. W. Forrester in 1958 at the Massachusetts Institute of Technology, Revetria *et al.* [33] featured the multiloop characteristics of the feedback systems in human life. An SD model can be demonstrated graphically by utilizing a mix of simulation modeling to improve comprehension [34]–[36]. SD tools are required to build macromodels and are specified by differential equations [37]. Such simulation models can be used as powerful decision support systems, due to their high ability to generate detailed components and their complex relations to assess the various alternatives [38].

The application of SD has recently been reviewed in crisis management and humanitarian aid [12]. In two separate studies Cassettari *et al.* [39] and Cooke [40] presented an SD model to study an emergency impact on hospital operations and management. The methodology represented an opportunity to model different phenomena in humanitarian aid to support managers in designing more effective policy interventions in the long run. In another study, human behavior during a flood crisis was modeled by SD to evaluate the effectiveness of various flood emergency management systems [41]. Lately, several efforts have been proposed to analyze the use of systems dynamics in humanitarian emergencies [42], [43]. The proposed methods represent an opportunity to model different phenomena in humanitarian aid to support managers to design more effective policy interventions in the long run.

In a more recent study in the domain of humanitarian supply chain management, an SD model was used to model distribution of critical supplies during relief procedures in case of a hurricane event to understand relief supply required in accommodation and points of distribution [44]. A similar study [45] suggested an SD model for the transfer of food items during a disaster and developed a decision framework on how to allocate budgets in emergencies. Although SD models in humanitarian aid have been increasingly exploited in recent studies, none of the existing studies has managed to implement a holistic set of parameters to gauge and model beneficiaries' dignity and well-being in a persistent and long-term refugee crisis, as directly targeted by this article.

In this article, we use SD approach to simulate CBI impact on refugees' dignity and its building elements. CBIs for refugees are by nature systemic and complex, influencing many interconnected subsystems (e.g., level of refugee health), which can be demonstrated by causal loop diagrams (CLDs) to systemically demonstrate and interpret the dynamic complexity. CLDs are essential tools and visual qualitative models for interpreting the feedback structure of systems by employing feedback loops to show links between the variables that define a system [46]. They have long been employed in academic studies and frequently applied in organizations to quickly capture assumptions about the causes of dynamics [34]. The consequences of relations

between the variables can be further simulated via the model to evaluate and enhance the perception of this complex system.

III. CBIs IMPACT ON DIGNITY

Reviewing crisis management and humanitarian aid literature, this section studies the building boxes of dignity, as categorized in Section I, in three main groups of coping strategy, health and social security, and education. The interaction between factors is extensively reviewed and the impact of CBIs on such interactions is discussed. A CLD will be developed as a result of this section, as the discussion progresses. We first discuss the elements of dignity in the following order: first the impact on coping strategies, then the impact on health and social security, and last the impact on education.

A. Impact on Coping Strategies

Regrettably, the longer the civil war lasts in Syria, the more refugees exhaust their saving resources and assets, leading to more debts and poverty [9]. One study shows that 80% of Syrian refugees in Turkey are living under the poverty line while housing expenses are constantly rising [47]. Food and rent account for 75% of the average household expenditure, leaving refugees with no choice but to exercise a wide range of coping strategies [48]. Coping strategies are the decisions made by beneficiaries to overcome the existing and mainly financial problems in emergency situations or at refugee camps. Such decisions may involve using emergency savings, selling assets, incurring debts, exploitative or degrading employment, and child labor [49]. CBIs enhance dignity by enabling beneficiaries to fulfill their own high-priority needs with less reliance on exercising their coping strategies [15]. The main elements of the coping strategies are discussed below and summarized in Table I.

Reportedly, the total debt of CBI recipients is lower than for those who receive no cash interventions [29], [50]. Moreover, studies show that one-third of cash recipients often pay off some of their debts to avoid accumulating and increasing debt [27].

Recent field research [21] has shown that CBIs have provided a majority of beneficiaries with an option of living outside refugee camps in the city areas with relatively high living costs, thus providing them with an opportunity to better blend with the hosting culture, find jobs, and thus better contribute to their own and the hosting community. CBIs play a critical role in affording accommodation in urban areas for the beneficiaries and, therefore, have indirect positive effects on the mental well-being of many recipients. With regard to the Syrian refugees in Turkey, data show over 90% of beneficiaries reported that CBIs enabled them to pay rent in urban areas, and 40% reported CBIs supported them in moving to better accommodation [47].

Another study [11] shows that 47% of households that receive CBIs are even able to save part of the cash transfer, which increases their resilience and reduces their reliance on coping strategies. Field research in [51] and [52] find evidence that CBI receivers are more likely to generate more income and hence have a higher total income as well. As a result of the increased total income, beneficiaries are more likely to afford dietary diversity, which improves their physical and mental well-being [21], [48], [50].

Poverty is the main cause for increasing the amount of child labor in refugee households, which is a significant measure in persistent refugee crisis [53]. Reports [54] show the effectiveness of CBIs in enabling refugees to better utilize their cash resources that often reduces child-labor rates and instead increases child school attendance. Moreover, CBI narratives work permits by the hosting governments enable adult refugees to legally work that not only contributes to the local economy, but also prevents them from exercising their coping strategies and engaging in black market or antisocial activities [15], [29], [55].

1) CLD of CBIs Impact on Coping Strategies: The CLD illustrated in Fig. 1 shows feedback loops focusing on relationships amongst the major elements of the coping strategies. The figure shows seven basic structure loops; positive causal links (in blue) and negative causal links (in red) create different positive (reinforcing—"R") and negative (balancing—"B") feedback loops. The balancing loop B1 indicates that with more income, refugees stop sending their children to work, thus reducing the amount of child labor [21]. Moreover, the exogenous number of issued work permit factor, shown within the reinforcing loop R1, demonstrates the impact of a work permit along with the CBIs program on the legal employment of beneficiaries [15]. This in turn generates more income and lessens the chance of taking a degrading job in a black market [27], [60]. In addition, as shown in loop B2, an increase in the total income can lead to an increase of the total assets [52]. An increase in the total income as a part of total assets also leads to a reduction in debt, whereas borrowing money provides extra assets [48], as shown in loop B3. Moreover, the more beneficiaries are enabled to pay their debt, the less poverty they may face and, thus, less child labor may occur [50]. Beneficiaries with higher assets are more likely to save more and similarly more saving by increased purchasing power is correlated to the total asset growth of recipients [26], which is reflected in loop R2. Furthermore, Bailey *et al.* [29] and Creti [66] declared that the more income beneficiaries receive, the more they can spend because of enhanced purchasing power, which results in the improvement of saving and assets, leading to overcoming poverty and the less amount of child labor, which is shown in loop B4.

As shown in loop R3, lower debts preserve the total assets that beneficiaries possess, and protects beneficiaries against the risk of remaining in poverty longer, which in turn results in a reduced need to exercise different coping strategies, such as cashing available assets or withdrawing children from school.

B. Impact on Health and Social Security

Access to healthcare services is a basic human right that humanitarian organizations aim to provide [26], [70]. Field research on the Syrian refugee crisis in Turkey [52] reports that approximately 60% of all financial support by humanitarian agencies aims at ensuring primary assistance to refugees, which in particular means supporting them in their food and healthcare requirements.

TABLE I
OVERVIEW OF THE IMPACT FACTORS FOR COPING STRATEGIES

No.	Impact factors	Contribution to coping strategies	Sources	Interactions	Sources
1.1	Anti-social expenditure	Using cash for anti-social purposes; spending it on non-essential items like alcohol, drugs and cigarettes	[28], [51], [56]–[60]	Reducing of expenditure on foods which cause less dietary diversity, threatening physical and mental health, leading to more violence and reducing total assets	[30], [56], [61]
1.2	Amount of child labor	Earning money by working of children in school age which is a negative coping strategy used by beneficiaries because of the main cause of their poverty	[20], [48], [49], [51], [53], [62], [63]	Generating more income by receiving cash, preventing implementing a negative coping strategy like child labor and causing increasing of children's attendance at school, Similarly, more number of employed beneficiaries, reduces sending children to work	[15], [48], [64], [65]
1.3	Savings	Obtaining more savings such as gold and bank accounts can be secure for beneficiaries by CBIs	[11], [29], [49], [56] [62]	Expanding purchasing power and high amount of assets from CBIs, cause raise of savings and as a result increase of assets again	[26]
1.4	Debt	An alternative way to cover substantial expenses of refugees' lives when they cannot provide their basic needs and cash assistance facilitating recipients to repay their debt	[27], [49], [50], [61]	Total high expenditure leading to a nominal increase in debt and a growth in poverty. An improvement in assets by CBIs, leading to lower debt which improves mental health level	[27], [50]
1.5	Number of employed Syrian refugees	Putting more effort into finding work by CBIs than those in comparable households not receiving grants; more successful in finding jobs in markets and self-employ with CBIs	[15], [62], [66]	Leading to high education level by CBIs, healthier body to increase chance of employment in market or causes self-employment which reduces the amount of child-labor and generates more income	[60], [67]
1.6	Number of employed Syrian refugees in black market	Engaging in high-risk, informal, underpaid, illegal or socially degrading jobs such as cleaning jobs and sales of food rations, producing a feeling of being at risk of exploitation by landlords and lack of accessibility to trusted legal jobs for refugees	[50], [54]	Issuing of work permit for beneficiaries and increasing of income from CBIs, cause reducing employment in black markets and enhancing taking secure jobs	[60]
1.7	Household expenditure	Enabling households to have a higher expenditure on household items, household size, rent and utilities by CBIs	[11], [21], [48], [54]	Improvement of purchasing power by CBIs, enable beneficiaries to spend more on house-related items with owning accommodation, lessening household cost	[50]

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TABLE I
CONTINUED.

No.	Impact factors	Contribution to coping strategies	Sources	Interactions	Sources
1.8	Poverty line	Lack of money, assets and food security, reduction of access to accommodation and being in debt	[11], [20], [29], [48], [51], [62], [64], [68], [50]	Enabling payment of debt and having more assets by CBIs, reducing poverty to not face continuous food shortages and lack of accommodation	[50]
1.9	Purchasing power	The larger the payment by CBIs program, the more likely this will be spent on assets, household and health expenditure and in some cases spending on anti-social items	[29], [50], [59], [66]	Higher income affects rise in purchasing power and results in improvement of spending money on health, household items, anti-social expenditure and more savings	[29], [56]
1.10	Number of self accommo-dated	Owning one's accommoda-tion, better living conditions, supporting not paying rent and having a permanent house, can be obtained with CBIs for beneficiaries who usually live in insecure settlements with poorly built defectively pre-served housing	[14], [15], [47], [50]	By owning accommodation, accessing better hygiene facili-ties and adequate water which reduces household's expendi-ture	[47]
1.11	Total assets	considered as durable and pro-ductive assets, total income and savings	[48], [49], [50], [63]	Enhancing of household's abil-ity to save more and less debt by CBIs, leading to improve-ment of total assets which re-duces poverty	[50], [61]
1.12	Total income	Referring to injected cash from CBI program and wages earned from employment by beneficiaries who had insuffi-cient financial reserves to pur-chase supplies before	[11], [20], [29], [48]–[52], [54], [59], [60]	Higher incomes are expected to enhance beneficiaries pur-chasing power, spending more cash on various meals to have more dietary diversity, reduc-ing the amount of child labor, supporting recipients to own accommodation and intending to spend further on education	[26], [48], [52]
1.13	Number of is-sued Work permit	Facilitating the issuance of work permits with CBI, grant-ing strategic inclusion of Syr-ian refugees into workforce	[27], [69]	Recipients with work permit, employed much more in mar-kets and less taking a degrad-ing job in a black market	[9], [27]

Healthcare and social security needs are categorized in eight measures of access to healthcare service: access to water and sanitation facilities, availability of health services, dietary di-versity, health expenditure, general or physical health, mental health, and violence [26]. These are defined and described in Table II. CBIs have been reportedly described as one of the most effective means of enhancing refugees' access to healthcare services they need most [20]. The high costs of healthcare is one of the most commonly reported hindering factors for refugees not to seek healthcare services [70]. Fur-thermore, CBIs are reported to positively impact food security, nutrition status, and access to clean water and hygiene facil-ities, which all enhance the general health of refugees [29]. Reviving CBIs often plays a significant role in affording daily meals [20] and dietary diversity [29]. As discussed before, CBIs reduce violence in refugee communities and hence improve the

mental health of the community in general, and in particular, for the women who experienced different kinds of abuse due to the absence of cash resources and increased poverty in their community [30].

1) CLD of CBIs Impact on Health and Social Security: Fig. 2 demonstrates the effects of CBIs on health and social security and behavior, and their interactions with the elements of coping strategies. The causal interconnections corresponding to these two subsystems are specified with green and blue colors, re-spectively. CBIs empower beneficiaries to be more employed and earn more income, thus improve the chance of dietary diversity and overall health [50], [71] (loop R4). Enhanced overall health state of refugees positively affects their well-being and reduces stress levels to refine mental health level [47] (loop R6). This can reduce the level of violence and antisocial activities [79] (loop R7), which in turn saves refugees money,

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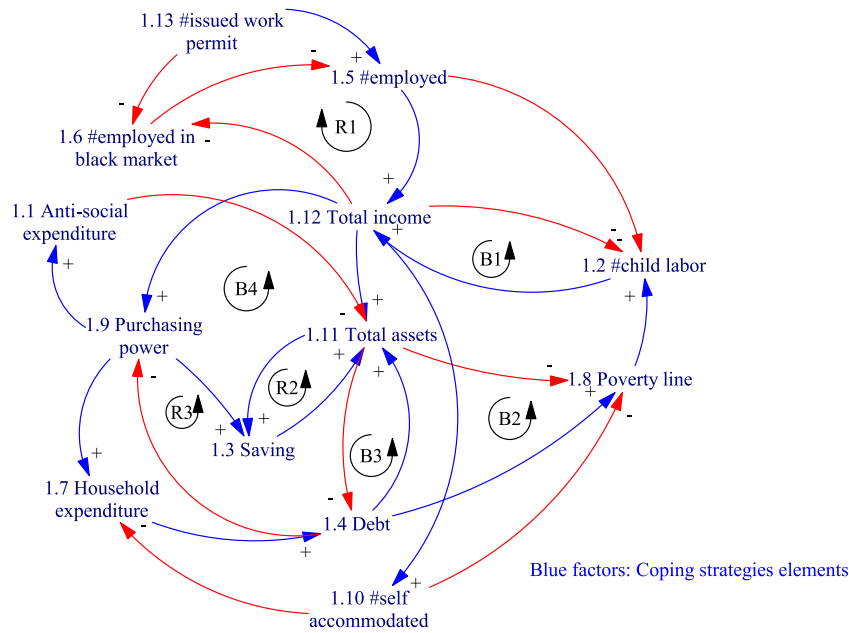
Fig. 1.   CLD of coping strategies (R: Reinforcing loop and B: Balancing loop).
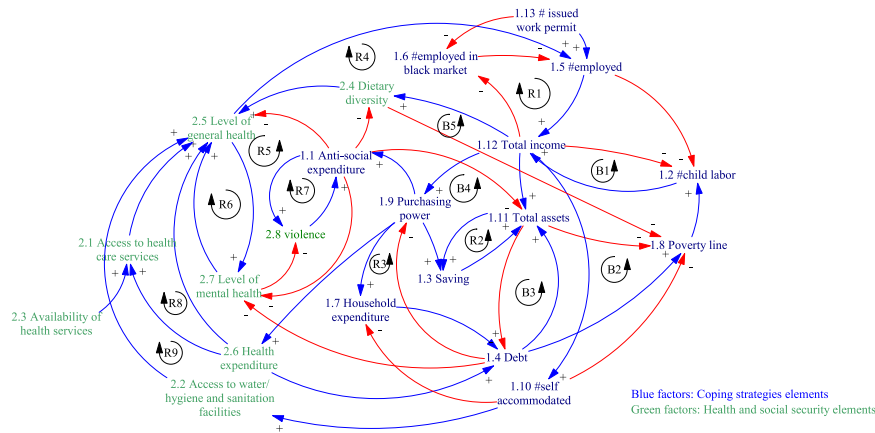
Fig. 2.   CLD of coping strategies and health and social security (R: Reinforcing loop and B: Balancing loop).

increases the level of saving, and reinforces the health loop (loop R5). Moreover, recipients of CBIs show an increase in their total expenditure, and particularly in their health expenditure [50]. In addition, increased health expenditure is associated with improvement of access to health services and, thus, enhanced overall health of the beneficiaries [61]. The interconnections between level of general health, number of employed refugees, total income, and purchasing power are shown in loop R8, which emphasizes the positive effect of CBIs on the health status of refugees.

Refugees with access to improved self-accommodation have better access to adequate water and sanitation facilities and are healthier [73]. Hence, in the positive loop R9, the relations of health, employment, income, and self-accommodation declare an important outcome of CBIs on the accommodation for refugees.

C. Impact on Education

General studies of low-income communities highlight that households have on average 2–3 children of school age (5–17 years old), although more than half of these children often do not attend school [50]. More than half of all Syrian refugees are under the age of 18, with over 75% not enrolled in any school in Turkey [9]. CBIs help to reduce the number of children missing school by covering a large proportion of their education costs [47] and their transportation costs [61]. Moreover, covering the cost of attending schools, CBIs are reported to enhance the children's education level by up to 40% [74]. In addition, UNHCR in Turkey initiated a CBI program to incentivize primary and secondary school enrollment and retention [9], [48]. Outcomes of CBI evaluations to this end have been widely positive, showing considerable improvements in school enrollment rates as well as a decreased rate of child labor [62].

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TABLE II
OVERVIEW OF IMPACT FACTORS FOR HEALTH AND SOCIAL SECURITY

No	Impact factors	Contribution to health	Sources	Interactions	Sources
2.1	Access to healthcare services	Access to health care by providing necessary funds to pay for the service and related expenses for refugees who require ongoing medical care	[20], [29], [47], [51], [64], [71]	Relating to general health and health care expenditure; availability of health care services can increase access to health services	[71]
2.2	Access to water/ hygiene and sanitation facilities	Lack of appropriate accommodation, reduced access to adequate water and sanitation facilities; enabling refugees to have safe access to water of sufficient quality and quantity by CBIs, improving sanitation and hygiene	[51], [72]	Improvement of accommodation and living conditions of beneficiaries, bringing about more access to adequate water and sanitation facilities to be healthier	[73], [74]
2.3	Availability of health services	An exogenous factor which ensures the availability of these services, provides access to healthcare services	[9]	Providing basic health services, improving health status of refugees (the key role for primary health); the better the quality and availability of health services, the more success for CBIs	[9]
2.4	Dietary Diversity	Defined as an indicator of the food quality, constructed from the sum of unique food stuffs consumed in a specified period of time; improvement of meals both in terms of size and quality; consuming fresher and healthier foods; improving refugees' diet variety	[20], [21], [28], [29], [49], [50], [51], [56], [75]	Increasing total income of refugees by CBI programs, associated with a raise in dietary diversity; however, spending money on anti- social purposes has a negative effect on food security	[50], [71]
2.5	Level of general health	Referring to general medical and reproductive health; improving health status in refugees can be provided by CBIs	[74], [76]	Healthier refugees, more likely to be employed; enabling beneficiaries to spend more on health care related items to be healthier by CBIs; accessing to better water, hygiene facilities and healthcare services lead to improvement of their health status	[48], [52], [71]

In other research, the World Food Program reported 38% of cash recipients spent cash on education costs for their children [20]. All the impact factors regarding the education are summarized in Table III.

1) CLD of CBIs Impact on Education: Fig. 3 illustrates the final CLD of this article, which combines the interactions of the coping strategies, health and social security, with those of refugees' education, which all together covers refugees' dignity, as discussed earlier.

In this final CLD, a total of 16 interconnected key feedback loops are suggested, of which 14 are those from previous sections (coping strategies and health and social security). The education elements have been highlighted in red. Two positive and negative feedback loops labeled as R10 and B6 represent the effects of

school attendance on employment and of access to education services on total income, respectively.

Loop R10 illustrates the positive impact of education on the employ ability of refugees, learning skill, and hosting country's language [48]. In a crises situation and with no CBI support, households often send their children to work to support the family by earning some extra income, which can be reversed by increased total household income, pushing more children to schools [20], [49], [63]. Lower child labor rate often means more school attendance and thus improved education level, and consequently more employment rates in the legal market over a longer time [53] (see R10 loop). Loop B6 demonstrates the impact of total household income on education expenditure and consequently on children's school attendance.

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TABLE II
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No	Impact factors	Contribution to health	Sources	Interactions	Sources
2.6	Health expenditure	Spending money on medical centers, medicines and medical expenses; applied in CBI programs by more than half of beneficiaries	[20], [29], [48], [51], [61], [64]	Having more income from CBIs, aim to spend more on improving health outcomes and accessing better medical centers; high health expenses lead to more debt	[48], [52]
2.7	Level of mental health	Referring to stress, major depression, generalized anxiety, panic attacks, adjustment disorder, and somatization of refugees which reduced by CBIs, cause improvement in their psychological well-being	[20], [47], [50], [77]	More mental problems affect refugee's physical health; spending money on negative impacts such as anti- social expenditure and debt reducing refugee's mental health status and cause intra-house violence	[30], [47], [61]
2.8	Violence	Referring to physical, sexual and psychological violence occurring in the families of beneficiaries, including battering, sexual exploitation, sexual abuse of children in the household, marital violation, non-spousal violence and violence related to exploitation	[78], [60]	Anti-social expenditure contributes to more violence in the household and also leads to poorer mental health in recipients	[30]

Some field research shows 38% of refugees who received CBIs spend more money on the education costs for their kids [47], [61].

In the following section, a stock and flow simulation model is provided, and numerical verification and validation are presented.

IV. QUANTITATIVE ANALYSIS: STOCK AND FLOW SIMULATION MODEL

In this section, a simulation structure of the CLDs described in the previous section is presented. The quantified stock and flow diagrams of the above discussed CBI CLDs are created using Vensim software [80]. As the quantified SD modeling requires specification of the major flows and stocks in the system, the major factors in the causal model were used in the simulation development.

The impact of CBIs on different factors of dignity is simulated, whereas seven main stock variables related to Syrian refugees are considered: Net incomes for the refugees population (in US dollars); total antisocial expenditures by the refugees population (in US dollars); number of employed refugees; amount of child labor; number of refugees receiving health services; number of refugees receiving educational services; and number of self-accommodated refugees.

The quantitative model is designed around the concept of "Net Income" of Syrian refugees as a direct factor influencing refugees dignity in their hosting country, Turkey. "Net income" is modeled as a stock whose value increases based on the inflow of money (money making rate) and decreases based on the outflow of money (money spending rate). Income sources of Syrian refugees comprise the following.

1) The total CBIs paid by the government and the organizations, which is modeled as a constant and total "CBI" and currently sums up to US$320 per year per eligible family member [81].
2) Salaries in case of formal or informal employments in Turkey.
3) Other sources of income, including cashing the savings and assets, debts, and bank loans.

Since there is no reliable source of data for the other sources of income, they are all aggregated as a constant "Other sources" into the variable "Money making rate." If the net income of Syrian refugees is less than the poverty line in Turkey, they will exercise their coping strategies. Due to data scarcity, amount of child labor is the only coping strategy that is quantitatively modeled in this article. As long as the net income of beneficiaries is below the poverty line, the number of child labor increases based on a first-degree stock and flow model, and the child labor income contributes to the beneficiaries' net income. The way refugees tend to spend money is modeled as follows (the Money Spending Rate). In general, beneficiaries will first spend money to cover their essential needs. If their net income is above the poverty line, then the surplus of money will be spent on their secondary needs, including accommodation, education, and health service, which are all modeled as first-order stocks and flows. In addition, part of the money will also cover beneficiaries' antisocial expenditure (mainly buying tobacco [82]). The amount of money spent on these different needs are determined by indices in the model, whose numerical values will be defined during the calibration of the model and through finding the best fit between the model outcomes and the available time-series data, similar to other studies [83].

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TABLE III
OVERVIEW OF IMPACT FACTORS FOR EDUCATION

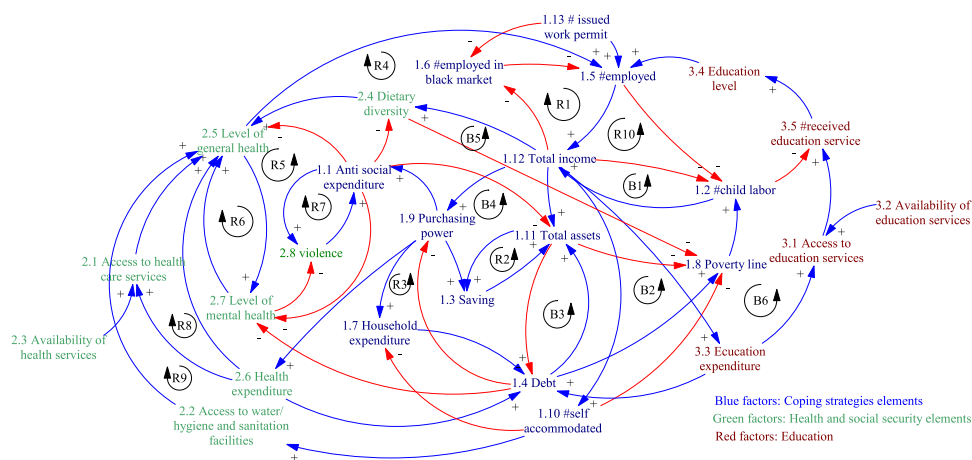| No	Impact factors	Contribution to education	Sources	Interactions	Sources
3.1	Access to education services	By providing necessary funds to pay for this service and related expenses to contribute to refugees who require access to ongoing education service	[20], [29], [60], [71]	Improving in access to schools, leads to a reduction in the number of children missing school and ultimately become child labor	[20], [29], [51]
3.2	Availability of education services	An exogenous factor which ensure the availability of education services, provides access to them	[9]	Providing schools and learning centers to promote the education level of refugees (The key role for primary education); the better quality and availability of education services, the more success of CBIs programs	[9]
3.3	Education expenditure	Spending money on school enrollment and educational purposes (more than one third of beneficiaries)	[47], [61]	Spending on education reflecting children improved access to school	[47]
3.4	Education level	An academic performance; more than half of CBIs recipients announce improvement of their academic knowledge	[21], [47], [67]	By providing training programs for refugees in CBIs and improving of the educational level, employed better in the market	[21], [67]
3.5	Number of received education service	lower withdrawal of children from education, leads to reduction in the number of children missing school (60% of beneficiaries in CBIs program)	[20], [50], [51], [60], [62]	Enabling a huge number of recipients' children to leave the workforce and return to school through CBIs program	[50]

Fig. 3. CLD of coping strategies, health and social security, and education (R: Reinforcing loop and B: Balancing loop).

Fig. 4.   Overview of the stock-flow model structure related to coping strategies, health and social security, and education factors.

Although an increase in beneficiaries' total net income provides them with an access to health, education, and accommodation, constant increase in this figure does not result in unlimited increase in such services and, thus, in the total beneficiaries' dignity, due to the limited capacity of these services in the hosting country. The available capacity and total investment in the service infrastructures will not be able to cover a sharp rise in the demand for education, accommodation and health services in Turkey arising from the population increase of Syrian refugees, along with national rising requirements.

These limits are modeled using "`availability`" constants in the model whose approximate values are extracted from available data. Exceeding the limits might lead money toward antisocial expenditure and is an issue that needs to be addressed in CBI plans. The equations to calculate the number of beneficiaries whom receive educational services are as follows. The model overview is illustrated in Fig. 4, and its variables and full equations are provided in Table VIII of Appendix A.

A. Model Verification and Related Data

The model is validated using different structural and behavioral validity tests [84]. Comparing the quantitative model with the causal loop model, which is developed based on the extensive literature review, shows that important concepts and structures are endogenous to the model, and the structure is consistent with the relevant descriptive knowledge of the model. The model also passes the dimensional consistency and extreme condition analysis tests. The model calibration estimates the values of different indices to best fit the real time-series data related to Syrian refugees in Turkey in a time horizon of six years (2012–2018), which are presented in Tables IV and V.

TABLE IV
INPUT PARAMETERS: VALUES AND UNITS

No.	Variable	Value	Units	References
1	Poverty line	239.25	Dollar/Person /Year	[85]
2	Accommodation cost	567	Dollar/Person /Year	[54], [81]
3	Amount of cash for eligible Syrian refugee	319	Dollar/Person /Year	[81]
4	Average wage of Syrian refugee	2250	Dollar/Person /Year	[85]
5	Health cost	294	Dollar/Person /Year	[81], [86]
6	Education cost	180	Dollar/Person /Year	[81]
7	Food cost	444	Dollar/Person /Year	[81]
8	Employment percentage	0.84	Dmnl*	[85]
9	Health service availability to Syrian refugee population	0.86	Dmnl	[87]
10	Accommodation availability to Syrian refugee population	0.82	Dmnl	[85]

Note: *Dmnl=Dimensionless

The data used are continuous, and the six-year period is selected based on availability of the real data.

According to Oliva [95], the model calibration is based on the numerical optimization, which minimizes the difference between model output and real data using the best estimation of the model parameters. For this purpose, similar to Parvan *et al.* [83], a payoff function as a linear combination of differences between data and model for the number of children doing child labor (CL), number of refugees employed (EM), number of self-accommodated refugees (SA), number of refugees received health services (HS), and number of refugees received educational services (ES) is defined and minimized. Fig. 5 illustrates a component of the payoff function, whereas (1) represents the

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TABLE V
HISTORICAL DATA FOR THE IDENTIFIED IMPACT FACTORS

No.	Impact Name	Data series							Units	Resources
		2012	2013	2014	2015	2016	2017	2018		
1	Child labor wage	$354	$345	$372	$432	$536	$663	$852	Dollar/ person/year	[88]
2	Number of children doing child labor	0	19,225	59,587	94,845	125,000	150,051	170,000	Person	[89]
3	Number of employed Syrian working-age refugees	3,990	133,992	363,659	693,000	1,122,000	1,650,644	2,278,967	Person	[81], [90], [91]
4	Number of Syrian refugees looking for jobs	78,674	296,797	860,105	1,326,881	1,491,755	1,814,846	1,919,854	Person	[8]
5	Number of work permit issued to Syrian refugees	26,632	30,881	35,808	41,519	48,142	56,024	65,000	Person/Year	[85]
6	Number of Syrian refugees' access to health care services	0	0	224,000	960,000	2,178,000	2,595,664	3,013,328	Person	[81], [87], [92]
7	Availability of education services to Syrian refugee population	0.3267	0.4017	0.4767	0.55	0.63	0.7	0.7767	Dmnl	[93]
8	Number of Syrian children who received educational services	0	0	130,000	511,259	710,489	872,536	1,109,453	Person	[86], [93], [94]
9	Number of Syrian refugees in Turkey	9,500	148,441	559,994	1,622,839	2,503,549	2,854,968	3,424,237	Person	[86], [93]
10	Number of Syrian children in Turkey	4000	74,220	279,997	811,419	1,138,992	1,239,866	1,746,160	Person	[86], [93]
11	Number of Syrian refugees with own accommodation	0	0	503,000	1,135,990	1,897,890	2,637,704	3,355,432	Person	[86], [92], [91]

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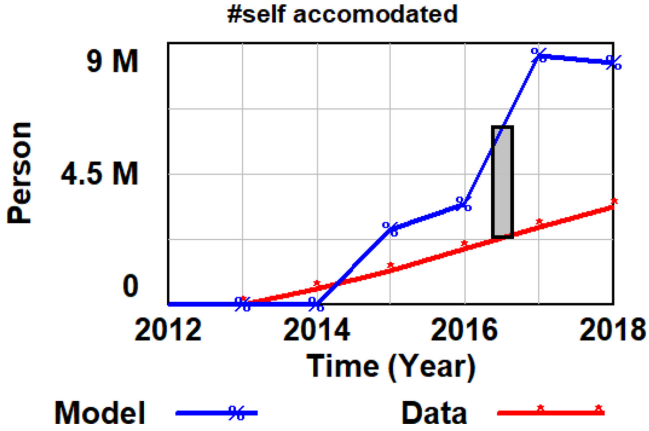IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT

Fig. 5. Sample component of calibration payoff function; the gray area between the model and data lines represents the quantity we aim to minimize.

TABLE VI
WEIGHT VALUES FOR CALIBRATION

Weights	Values
W_{CL}	0.2
W_{EM}	0.2
W_{SA}	0.2
W_{HS}	0.2
W_{ES}	0.2

payoff function for the model that includes the sum of squared percentage error for the aforementioned parameters. Once the errors of different parameters are normalized into percentages, they could be added together using their corresponding weights, which is symbolized by (W). The values of weights, as listed in Table VI, are set so that all parameters are scaled to be of the same order of magnitude

$$
\begin{aligned}
\text{Payoff} \\
= \frac{1}{\text{Time Step}} &\left\{ W_{\text{CL}} \int \left(\frac{\text{CL}_m(t) - \text{CL}_d(t)}{\text{CL}_m(t) + \text{CL}_d(t)} \right)^2 .dt \right. \\
&+ W_{\text{EM}} \int \left(\frac{\text{EM}_m(t) - \text{EM}_d(t)}{\text{EM}_m(t) + \text{EM}_d(t)} \right)^2 .dt \\
&+ W_{\text{SA}} \int \left(\frac{\text{SA}_m(t) - \text{SA}_d(t)}{\text{SA}_m(t) + \text{SA}_d(t)} \right)^2 .dt \\
&+ W_{\text{HS}} \int \left(\frac{\text{HS}_m(t) - \text{HS}_d(t)}{\text{HS}_m(t) + \text{HS}_d(t)} \right)^2 .dt \\
&\left. + W_{\text{ES}} \int \left(\frac{\text{ES}_m(t) - \text{ES}_d(t)}{\text{ES}_m(t) + \text{ES}_d(t)} \right)^2 .dt \right\}. \quad (1)
\end{aligned}
$$

The optimization is conducted using Vensim's built-in Powell conjugate search algorithm (see [96]) using different combinations of weight values and start points in the parameter space. Through this iterative process, Vensim repeatedly runs the model using a set of parameter values sent by its optimizer, and after each run, the payoff value is sent back to the optimizer, where it is compared with the previous runs. The stopping criterion is 1000 iterations, among which the best fit between the model outcomes

TABLE VII
ADJUSTING PARAMETERS VALUE BASED ON THE CALIBRATION MODEL

Indices	Estimated values
Child labor index	0.21370
Accom. Exp. index index	0.885972
Anti-S Exp. index	0.446101
Health Exp. index	0.408864
Edu. Exp. index	0.148135

and the real data are evolved. Table VII lists the estimated values of different indices, and Fig. 6 illustrates the best fit for selected variables in the calibrated model.

V. CONCLUSION

To study the impact of different levels of CBI paid to beneficiaries on the impact factors, we have examined a $\pm 100\%$ CBI variation and the results are illustrated in Fig. 8 of Appendix B in which different colors corresponding to each confidence level. According to these graphs, all stocks except the number of employed refugees are sensitive to the changes in the CBI level where the trends of the variables change with almost a linear multiplier offset for each factor. As shown in Fig. 8(a), CBIs only contribute up to 20% of beneficiaries' total income, and thus they often seek and secure formal or informal jobs and sources of income to support themselves and their family, regardless the CBIs they receive. Hence, the employment factor has been formulated independent of CBI level, as shown in Fig. 8(c). In addition, some differences in the magnitude of sensitivity between different variables are observed. For instance, the confidence intervals are narrower initially for net income [see Fig. 8(a)], antisocial expenditure [see Fig. 8(b)], child labor [see Fig. 8(d)], and education service [see Fig. 8(f)], and then get wider in the longer term. Considering the long-term importance of education in refugees dignity and its contribution to the hosting community in a long run persistent crisis, this result should raise a red flag to policy makers. In contrast, health service [see Fig. 8(e)] and self-accommodation [see Fig. 8(g)] are more sensitive to CBI changes in the short term, whereas become less sensitive in the longer term, which might be due to the infrastructure and resource capacity consideration of the hosting society. Based on the historical data, the model includes a linear growth of investment in infrastructure, proportional to the population of inflow refugees, and therefore, the number of refugees who receive health service or are self-accommodated are still restricted by the capacity for these services over time. As a result, these stock variables are saturated in the long term and behave less sensitive to the CBI level. In addition, the S-shaped trend of these variables is due to the dominance of the balancing loop corresponding to the capacity limits over the reinforcing loops over time.

Fig. 7 shows the current amount of CBI ($320/Person/Year) with two other extreme scenarios of no CBI and 100% increase in CBI to study the impact of different amounts of CBIs on the building boxes of the beneficiaries' dignity. According to Fig. 7(b), doubling the amount of CBI increases antisocial expenditure by above 15% and paying no CBI decreases it roughly 20%. Although it shows the negative impact of CBIs, it indicates
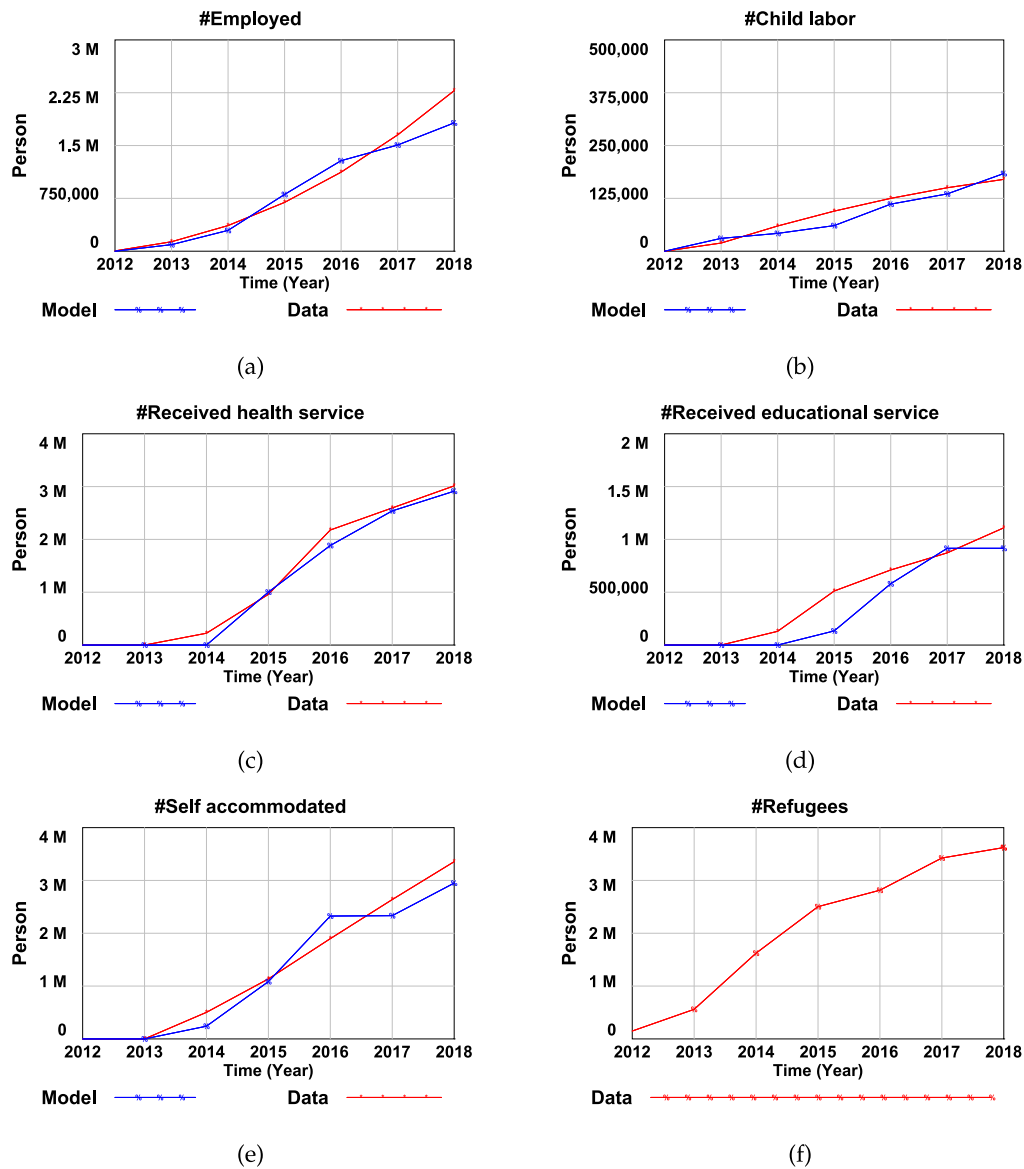
Fig. 6. (a)–(e) Stock variables in terms of the population of Syrian refugees in Turkey with the "Person" unit, used for calibration with real data. (f) Population of Syrian refugees in Turkey (real data).

a diminishing growth rate of antisocial expenditures by increase of CBI support. Fig. 7(d) also shows a diminishing growth rate of child labor by increasing CBI amount. The absolute growth, however, is done to the constant intake of refugees to the country, as shown in Fig. 6(f).

The results of CBI change on service reception by refugees [see Fig. 7(c)–(e)] show that an increase in CBI programs in short and medium terms have significant impacts on such services and especially on accommodation and health services, and thus can empower them to avoid exercising their negative coping strategies, such as debt, selling valuable assets, and child labor. However, such impacts are less significant in long term if the service infrastructures are not well developed and in a balance with the increasing demand from the inflow of refugees. In such situations, an increase in CBI programs and a loner-term schemes can only lead to a quicker saturation of service capacities, which in turn may cause competition over

resources, such as accommodations, and thus lead to enhanced local inflation. Moreover, the result of Fig. 7 shows that the amount of CBI currently paid to the refugees ($320/Person/Year) is well balanced with the increasing demand of growing refugee population on the limited and slow-growing service capacity in the country. As shown in Fig. 7(c) and (e), 100% increase in CBI can lead to an early capacity saturation and extra pressure on already stretched service infrastructures.

This article showed that CBI, in moderate amounts, can be well effective in short and midterms after refugees are settled in a host country, but in for longer term, CBI can only be as effective when well-balanced capacity-building programs are in place and constant investments are made in the service infrastructures. This is in line with what Turkish government as the hosting authority has raised and sought in the last few years and after the mass Syrian refuge situation [97], [98]. These strategic and enabling investments are often overlooked

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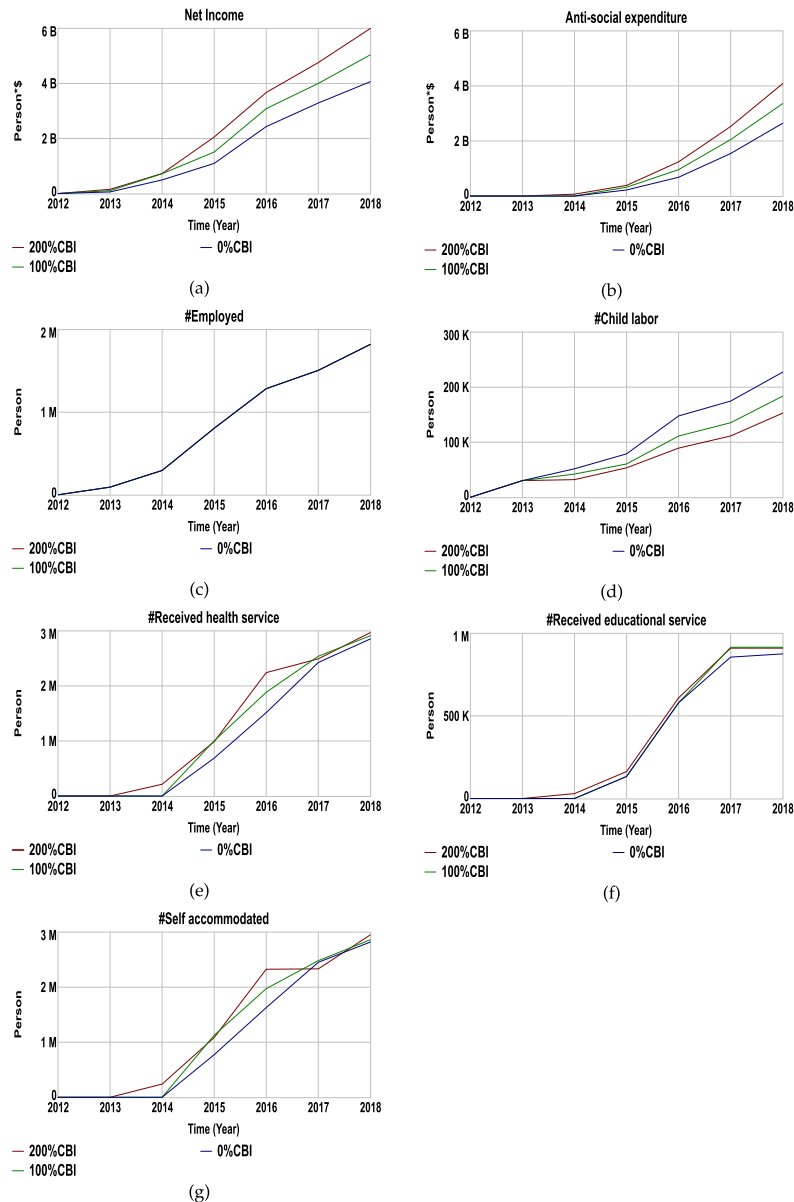

Fig. 7.   A 100% and 200% of CBI sensitivity analysis on the stock variables: (a) and (b) in terms of accumulated money over refugee's population, (c)–(g) in terms of number of Syrian refugees.

by humanitarian organizations, due their different priorities and missions. Such investments are mostly considered at national government planning as well as UN and EU support schemes, such as the recent 500 million donation by the European Union to Turkey for the educational infrastructure and school capacity-building in 2016 [98]. Besides the direct impact of high strains on service capacities on refugees, according to International Crisis Group, intercommunal violence between host communities and Syrian refugees increased threefold in the second half of 2017 compared to the same period in 2016, due to socioeconomic inequality driven by high unemployment and limited service capacities caused by constant and significant inflow of refugees to the country [99]. Although several NGOs are working out ways to ease such tensions [100], their focus is yet on providing supports to beneficiaries, rather than aiming for the root cause. Capacity-building investments in persistent refugee crisis

although often required more resources and planning can improve and sustain refugees dignity in all aspects, and ease tensions and facilitate better integration with the hosting community. Thus, a more active and direct capacity-building roles by the humanitarian organizations can enhance the effectiveness and sustainability of their CBI programs in longer terms. As discussed in [101] and [102], humanitarian aid may have significant economic impacts. Potential negative impacts, such as local inflation are due to local competition over resources, such as accommodation. However, this article is highly limited to the availability of the real data for the validation, and as such, the impact of CBIs on local and national inflation have been over viewed. Further studies can address this impact and complete the model. Another direction of research is to encompass the investigation of the effect of mixed CBI and in-kind strategies.

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APPENDIX A
TABLE VIII
MAIN VARIABLES AND EQUATION: S = STOCK, F = FLOW, AND A = AUXILIARY

| #	Type	Variable Name	Unit	Equations
1	S	Anti-social expenditure	Person.Dollar	$\int$ *AS Exp rate.dt* + 0.0
2	S	Child labor	Person	$\int$ *Child labor rate-Child labor reduction rate.dt* + 0.0
3	S	Employed	Person	$\int$ *Informal Emp rate+ Formal Emp rate.dt* + 0.0
4	S	Net Income	Person.Dollar	$\int$ *Money making rate-Money spending rate.dt* + *Initial money*
5	S	PO child labor stock	Dmnl	$\int$ *(ZIDZ((("#Child labor-data"-Child labor)^2),(("#Child labor-data"^{2})+(Child labor^2))))/TIME STEP.dt* + 0.0
6	S	PO Employed	Dmnl	$\int$ *(ZIDZ((("#Employed-data"-Employed)^2),(("#Employed-data"^{2})+(Employed^2))))/TIME STEP.dt* + 0.0
7	S	PO Received Edu service	Dmnl	$\int$ *(ZIDZ((("#Received edu service-data"-Received educational service)^2),(("#Received edu service-data"^{2})+(Received educational service^2))))/TIME STEP.dt* + 0.0
8	S	PO Received health service.	Dmnl	$\int$ *(ZIDZ((("#Received health service-data"-Received health service)^2),(("#Received health service-data"^{2})+(Received health service^2))))/TIME STEP.dt* + 0.0
9	S	PO Self Accommodated.	Dmnl	$\int$ *(ZIDZ((("#Self-Accommodated-data"-Self Accommodated)^2),(("#Self-Accommodated-data"^{2})+(Self Accommodated^2))))/TIME STEP.dt* + 0.0
10	S	PO stock.	Dmnl	$\int$ *PO/TIME STEP.dt* + 0.0
11	S	Received educational service.	Person	$\int$ *Edu service rate.dt* + 0.0
12	S	Received health service.	Person	$\int$ *Health service rate.dt* + 0.0
13	S	Self Accommodated	Person	$\int$ *Self accom rate.dt* + 0.0
14	F	AS Exp rate	Person.Dollar/Year	*IF THEN ELSE(Net Income>Income threshold,(1-(Received educational service/"#Refugees")) * "Anti-S Exp index" * Net Income/TIME STEP, 0)*
15	F	Child labor rate	Person/Year	*Income threshold/ Net Income * ("#Child refugee"-Child labor) * Child labor index/TIME STEP*
16	F	Child labor reduction rate	Person/Year	*IF THEN ELSE(Child labor>0, MIN(Child labor/TIME STEP, Edu service rate) * Child labor index, 0)*
17	F	Edu service rate	Person/Year	*MIN((Edu Service Availability*#Child Refugees),(Education expenditure/Edu cost) * Edu service avail index)/TIME STEP*
18	F	Formal Emp rate	Person/Year	*#Work Permit*
19	F	Health service rate	Person/Year	*MIN((Health service availability*#Refugees),(health expenditure/health cost) * health service avail index)/TIME STEP*
20	F	Informal Emp rate	Person/Year	*Employment percentage * ("#Job seeker"-Employed)/TIME STEP*
21	F	Money making rate	Person.Dollar/Year	*(("#Refugees" * CBI)+("#Refugees" * Other sources)+(Employed * Average Wage)+(Child labor * Child avg Wage))/TIME STEP*
22	F	Money spending rate	Person.Dollar/Year	*(Accommodation expenditure+ "Anti-social expenditure"+ Education expenditure+ health expenditure+ Food cost * "#Refugees")/TIME STEP*
23	F	Self accom rate	Person/Year	*MIN((Accommodation availability*#Refugees),(Accommodation expenditure/Accommodation cost) * Accommodation avail index)/TIME STEP*
24	A	Accommodation avail index	Dmnl	*MAX(0,1-(Self Accommodated/(Accommodation availability * "#Refugees")))*
25	A	Accommodation expenditure	Person.Dollar	*IF THEN ELSE(Net Income>Income threshold, (Net Income-"Anti-social expenditure") * Accom Exp index, 0)*
26	A	Edu service avail Index	Dmnl	*MAX(0,1-(Received educational service/(Edu service availability * "#Child refugee")))*
27	A	Education expenditure	Person.Dollar	*IF THEN ELSE(Net Income>Income threshold,(Net Income-"Anti-social expenditure") * Edu Exp index, 0)*
28	A	Health expenditure	Person.Dollar	*IF THEN ELSE(Net Income>Income threshold, (Net Income-"Anti-social expenditure") * Health Exp index, 0)*
29	A	Health service avail Index	Dmnl	*MAX(0,1-(Received health service/(health service availability * "#Refugees")))*
30	A	Income threshold	Person.Dollar	*#Refugees * Poverty line*
31	A	PO	Dmnl	*CL weight * PO Child labor stock+ Em weight * PO Employed+ ES weight * PO Received Edu service+ HS weight * PO Received health service+ SA weight * PO Self Accommodated*
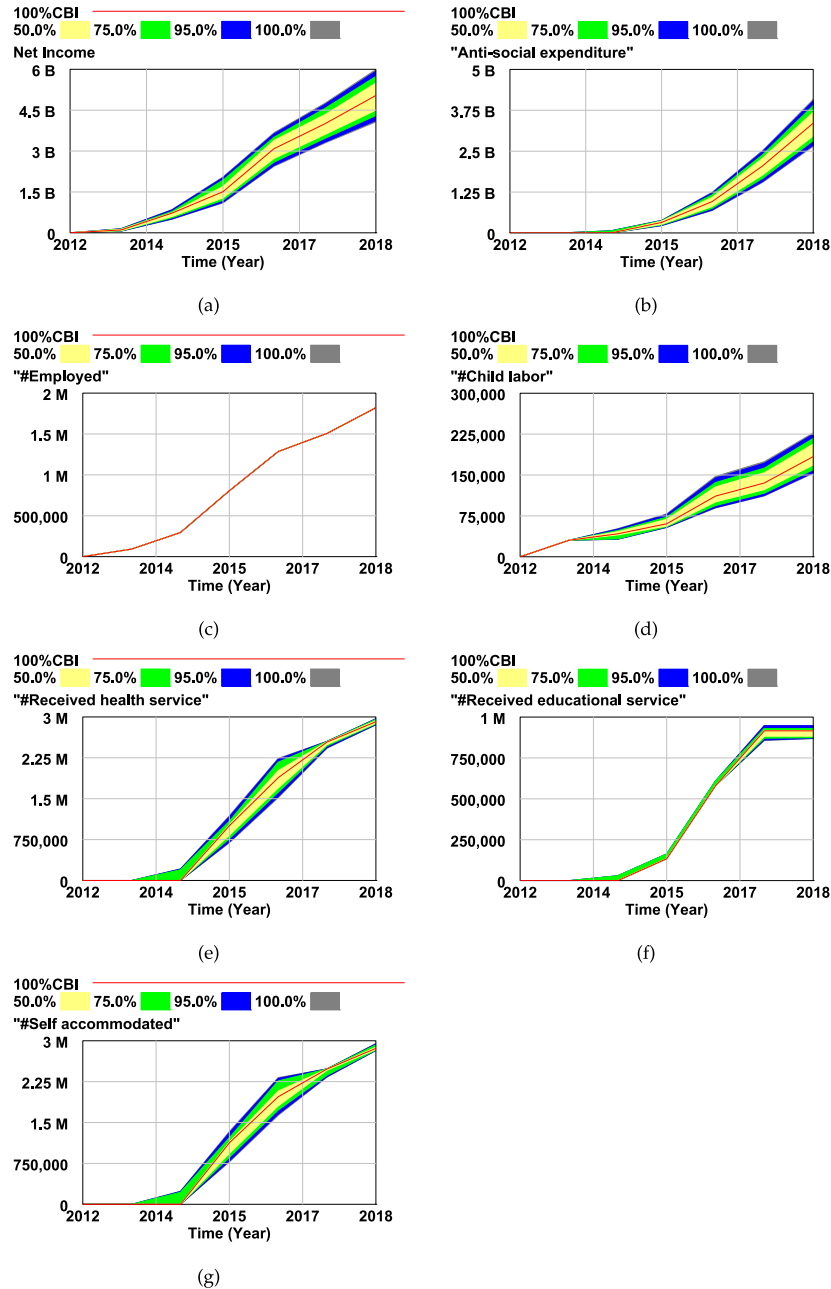
Fig. 8.   A sensitivity analysis on CBIs amounts in the interval basis of [−100, +100%] on the stock variables: (a) and (b) in terms of accumulated money over refugee's population, (c)–(g) in terms of number of Syrian refugees.

Appendix B

See Fig. 8.

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