Growth in Syria:
Losses from the War and Potential Recovery in the Aftermath

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Abstract

This paper addresses three questions: 1) what would have been the growth and income trajectory of Syria in the absence of war; 2) given the war, what explains the reduction in economic growth; and 3) what potential growth scenarios for Syria there could be in the aftermath of war. Conflict impact estimates point to negative GDP growth of -12% on average over 2011–18, with output contracting to about one-third of the 2010 level. In post-conflict simulation scenarios, the growth drivers are affected by the assumed levels of reconstruction assistance, repatriation of refugees, and productivity improvements associated with three political settlement outcomes: a baseline (Sochi-plus) moderate scenario, an optimistic (robust political settlement) scenario, and a pessimistic (de facto balance of power) scenario. Respectively for these scenarios, GDP per capita average growth in the next two decades is projected to be 6.1%, 8.2%, or 3.1%, assuming a final and stable resolution of the conflict.

Keywords: War, conflict, reconstruction, growth, factors of production, Syria

JEL Codes: D74, F51, 011, 040, 053

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1. Introduction

This paper addresses three questions. First, what would have been the growth and income trajectory of Syria in the absence of war. Second, given the war, what explains the reduction in economic growth in terms of growth drivers - physical capital, demographics and the labor force, human capital, and total factor productivity. And, third, what potential growth scenarios for Syria there could be in the aftermath of war given various assumptions on key growth drivers. Post-conflict, these growth drivers will be affected by the levels of reconstruction assistance and repatriation of refugees, driven, in turn, by potential political settlement outcomes. To obtain plausible quantitative answers to these three questions, the paper uses an extension of the World Bank Long Term Growth Model (LTGM) that accounts for the role of fundamental growth drivers in a clear and straightforward way. The paper builds on data and insights by academic researchers and international organizations, such as the United Nations and the World Bank.

The scale and intensity of the violence and destruction associated with the civil war that engulfed the Syrian Arab Republic since 2011 have very few parallels in recent history. The Syrian Observatory for Human Rights (SOHR) estimates the total death toll (from 15 March 2011 to 15 March 2019) at a staggering number of 570,000 (2.7% of Syria's population in 2010). The United Nations Economic and Social Commission for Western Asia (UN-ESCWA) - which conducted an elaborate sectoral analysis of the economic cost of the Syrian civil war - puts the cumulative destruction of the physical capital stock by end of 2017 at almost USD 120 billion (ESCWA 2018), two times the GDP level in 2010 and about five times the GDP level some seven years into the conflict. And, in terms of the cost to the overall economy, World Bank (2017) estimates that, from 2011 until the end of 2016, the cumulative losses in gross domestic product (GDP) reached a whopping USD 226 billion, about four times the Syrian GDP in 2010. These assessments broadly cohere with calculations of the country's night-light intensity by Ceylan and Tumen (2018) and Li et al. (2017), with the latter suggesting that by 2017, Syria had lost about 80% of its city night light.

Moreover, in addition to the massive death and destruction, this war has also created an unprecedented number of refugees and internally displaced persons. According to the United Nations High Commissioner for Refugees (UNHCR), there are about 5.6 million registered refugees from Syria in neighboring countries (26% of the population in 2010). However, accounting for unregistered refugees in just the three countries of Egypt, Jordan, and Lebanon would raise the aggregate number to more than 7 million, around a third of Syria's population in 2010 (UNHCR 2019). Adding these numbers to the roughly 6.3 million internally displaced persons in Syria, we have almost two-thirds of the 21 million Syrian citizens who have been forced out of their homes. To appreciate the global impact of the Syrian refugees and displaced crisis, it suffices to note that the former accounts for more than 23% of the total number of refugees worldwide, while the latter is estimated at 20% of the total number of global internally displaced persons.

The losses incurred by Syria are great, but it is not false hope to look toward recovery and further strengthening of the country's socio-economic fundamentals beyond its pre-war situation. Chen, Loayza and Reynal-Querol (2008) conduct a comprehensive evaluation of the aftermath of civil war using event-study analysis across 41 countries over 1960-2003. They show that recovery to pre-conflict levels and further improvements are possible for a country afflicted by war when lasting peace is achieved. Other studies focusing on World War II (WWII) indicate countries returned to their pre-war trends 15 to 20 years post-war (Organski and Kugler 1977, 1980); and that countries suffering large negative output shocks grew systemically faster during the subsequent decades due to reconstruction dynamics (Milionis and Vonyo 2015). Because of the massive destruction of the factors of production in Syria at a scale more common in inter-state wars than civil conflicts, the lessons from the post-WWII reconstruction of Europe and insights from modern growth theory could be useful in assessing the post-conflict growth potential for Syria. Jánossy (1969) postulates that fast growth during reconstruction is not only the result of higher returns to physical capital accumulation (which diminish as capital grows in relation to output) but also depends on structural factors like the reorganization of economic activity and the reallocation of production factors. One of the key lessons

from the experience of post-WWII growth in the European countries and Japan, for example, was that the rapid growth impact of the massive re-building of physical capital was made possible, not only by the Marshall Plan resources, but also by the relatively limited war time depreciation of the human capital base and technological potential (Smolny 2000).

The implication of the above for the post-conflict economic reconstruction agenda for Syria is that the restoration of human capital should be accorded the highest priority. And this should be alongside the rebuilding of physical capital which will unavoidably be a key component of the agenda. Further, attention also needs to be paid to other factors contributing to total factor productivity (TFP), including institutions and market efficiency.

However, the prospects for mobilizing meaningful multi-year financing for reconstruction and development and for achieving a critical mass of voluntary refugee returns would hinge on the nature of the ultimate political settlement of the conflict. A lopsided political settlement may deter refugees, with strong lingering uncertainty about security and economic prospects, to return. Some of the main impediments hindering repatriation include the dispossession of refugees' homes and mandatory military conscription for men of age. Therefore, and despite the "invitation" for refugees to return home and the refugee camps being set up within Syria, it is not surprising that only a few thousands returned in 2017, mostly motivated by push factors in the recipient countries. Indeed, this very limited response did not mark the opening of the flood gates for massive repatriation in the following years (POMEPS 2018).

Moreover, the volume of the funding required for reconstruction has been estimated from USD 250 billion by the United Nations (UN), more than 10 times the estimated GDP in 2018, to as high as USD1 trillion (POMEPS 2018), by far more than could be provided by Syrian allies. Thus, a genuine reconstruction plan for Syria would best be served by robust support from the wider international community, who have indicated a preference for a more robust political settlement (Elbadawi et al. 2019). The international community can provide some reconstruction aid that would support and

encourage the return of refugees, infrastructure investment, and policy reform. This includes aid for geographically dispersed economic reconstruction (such as, rebuilding infrastructure and access to health and education) and institutional reform (including security, property rights, and access to justice) that benefit various segments of the population fairly (Yahya and Kassir 2017). Djankov and Reynal-Querol (2010) find that both per capita income and civil war are jointly determined by idiosyncratic country-specific phenomena, some of particular relevance to Syria, such as sectarian and ethnic polarization. Consequently, policies are needed to rectify structural problems that make countries and specifically Syria more prone to conflict.

Subscribing to the context discussed above, this paper uses the World Bank Long-Term Growth Model - Public Capital Extension (LTGM-PC) by Devadas and Pennings (2019) to simulate a counterfactual of no conflict scenario (in Section 2), to estimate the impact of conflict (in Section 3), and to assess the potential post-conflict growth for Syria (in Section 4). The after-war projections are carried out for three political settlement scenarios: a baseline moderate scenario (Sochi-plus, mainly operated by Iran, Russia, and Turkey, with some involvement from the United Nations); a high optimistic scenario (robust political settlement, brokered by the United Nations); and a pessimistic scenario (de facto balance of power).

The LTGM-PC has been developed from another World Bank tool, the Long-Term Growth Model (LTGM) (Loayza and Pennings 2018; Hevia and Loayza 2012). In the Standard LTGM, which follows the Solow-Swan growth model, the production function is the traditional Cobb-Douglas specification with aggregate capital and effective labor as imperfect complements. There, public and private capital have the same effect on output. The LTGM-PC extends the Standard LTGM by separating total capital stock into private and public portions, with the former adjusted for quality, while retaining other features of the LTGM including other growth drivers (demographics and the labor force, human capital, and TFP). The LTGM-PC can be used to analyze the effect of an increase in

the quantity or quality of public investment on growth; and to compare the effects of public investment and private investment (see Appendix 1 for details).

In the LTGM-PC, the effect of an increase in either the quantity or quality of public investment and the full dynamic growth path depends on country-specific factors, such as the scarcity of public capital (relative to GDP). The model also allows for the fact that the public capital stock might be of low-quality construction, which is a practical concern in many developing countries. It contains a new infrastructure efficiency index (IEI) that combines quality indicators for power, roads, and water, as a cardinal measure of the quality of public capital in each country. The LTGM-PC draws extensively on the empirical literature to guide its choice of other parameters, the most important of which is the elasticity of output to public capital, and publicly available databases to calculate key variables. We run all our simulations using the LTGM-PC Excel-based toolkit.

Our paper complements earlier modeling work by World Bank (2017), the most comprehensive study to date on the Syrian toll of war, in four ways. One, it provides a straightforward and transparent analysis of how GDP evolves based on projections for the growth drivers. World Bank (2017) uses a dynamic general equilibrium model to simulate the effects of the conflict through three channels – physical capital destruction, casualties, and economic disorganization; with the last calculated as a residual based on estimated GDP losses. Two, data-wise, we use estimates of physical damage across all types of capital whereas World Bank (2017) determines destruction in their simulations based on physical damage assessments in the housing sector. Three, with a greater certainty of the end of conflict, we focus on growth scenarios in the aftermath of war, rather than mostly assessing conflict impact based on different end-time scenarios. Four, we also attempt to provide a more up-to-date assessment of the impact from the conflict, that is until the end of 2018.

Under the counterfactual simulation, our baseline projection shows average real GDP growth of 5.3% per annum over 2011-2018 which would have led to real GDP rising from USD 60 billion in 2010 to USD 91 billion and real GDP per capita rising from USD 2,857 to USD 3,774 by 2018. In contrast,

our simulations of the impact of conflict point to negative annual GDP growth of -12% on average (across all three scenarios, central, lower and upper estimate projections) over 2011-2018, resulting in a GDP level of USD 22 billion in 2018 which is only 24% of the counterfactual GDP level in 2018. Comparing the conflict versus no conflict simulations suggest a cumulative loss in GDP potential of about USD 300 billion over 2011-2018. About 64% of the average negative GDP growth from 2011 to 2018 under the conflict simulation is due to physical capital destruction. Physical capital destruction reflects the compounded effects of large outright damages, low new investments, and a falling output base that is adversely affected by all growth drivers. Demographics and labor account for about 15%, human capital 7%, and TFP 13% of negative GDP growth on average over the conflict years (2011-2018).

In our post-conflict simulations, we assume that the three political settlement scenarios are associated with different levels of reconstruction assistance and different degrees of voluntary mobility of refugees. These in turn affect key drivers of growth: public and private investment and the labor force. We also make different assumptions for human capital growth and TFP growth across the three scenarios. Depending on the scenarios, our simulation results suggest that it would take between 10 and 20 years for Syria to reach its pre-conflict GDP level and between 10 and 30 years to recover its pre-conflict GDP per capita level (both at 2010 constant prices). If there were to be an unsanctioned and misguided "forced" repatriation of refugees, this would result in significantly lower GDP per capita compared to the voluntary mobility case. Under voluntary return, labor would adjust gradually to capital reconstruction, thus keeping labor productivity from falling.

2. Syria Pre-Conflict Developments and Projections

Real GDP growth averaged about 4.7% over 2001-2010 (Figure 1(a)). [1] Just prior to the conflict, IMF projected robust near-term growth: an average of 5.0% over 2011-2016 (Figure 1(b)). This section builds a calibration for a no-conflict scenario using the LTGM-PC, based on pre-conflict developments

and projections (where available) in the key growth drivers - physical investment, demographics and the labor force, human capital and TFP.

2.1. Growth drivers

In terms of physical investment**,** the investment-to-output ratio, I/Y (gross fixed capital formation (GFCF), as a percentage of GDP) averaged about 21.5% over the seven-year period, 2001-2007. For gross capital formation (GCF), which includes inventories, as a percentage of GDP, the IMF data showed an average of 23.1% over 2001-2010 (Figure 2(a)). Pre-conflict projection data meanwhile suggested a lower average of 21.8% for GCF (% of GDP), albeit with a projected rise of about 3 percentage points over 2011-2016 (Figure 2(b)).

The growth rates of total population and the working-age population share averaged 2.5% and 0.8% respectively over 2001-2010 based on latest UN estimates (United Nations 2017) - Figure 3(a). As a gauge of projections prior to the conflict, United Nations (2011) indicated average growth rates for these two variables of 1.7% and 1.0% respectively over 2011-2020 and 1.5% and 0.3% over 2021-2030 compared to 2.5% and 0.5% over 2001-2010 (Figure 3(b)).

The labor force participation rate (LFPR) had been moderating, declining from 54.5% in 1995 to 44.9% in 2010, with an average growth over 2001-2010 of -1.5% (Figure 4(a)). This phenomenon occurred despite relatively strong economic growth, distinguishing Syria from other countries – no other Middle East and North Africa (MENA) economy had a similar rate of decline in the LFPR over the same period, except Yemen. Nasser and Mehchy (2012) note that a sizeable portion of the economically active population that went out of the labor force in the 2000s consisted of women in the agriculture sector (affected by the drought and higher fuel prices in the second half of the 2000s), and workers becoming students. Early in the conflict, International Labour Organization (ILO)-modelled estimates suggested a stabilizing participation rate after 2010 (Figure 4(b)), though some caution needs to be exercised in taking this at face value given uncertainty surrounding the underlying data.[2]

Human capital growth in Penn World Tables (PWT) 9 (Feenstra, Inklaar, and Timmer 2015), which uses Cohen, Soto and Leker (CSL) data (Cohen and Soto 2007; Cohen and Leker 2014) for the average years of schooling of the population aged 25 and above, averaged 1.0% for the 10 years up to 2010.[3] Figure 5(a) shows average years of schooling based on select age groups under both CSL and Barro and Lee (BL) measures. Barro and Lee (2015) projections indicate a continued rise in the average years of schooling absent conflict, for the population aged 15-64: 1.6 years over 2011-2030. Figure 5(b) shows human capital growth, based on the schooling years under CSL and BL measures. While fluctuations and differences are obvious decade to decade, there is consistency in a long-term average of approximately 1.5%.

TFP growth, averaged 1.4% over 2001-2010 based on calculations by The Conference Board (2018). Our own estimations following the methodology in Kim and Loayza (2019) also suggest an average growth rate of 1.4% for the same period.[4] See Figure 6.

2.2. Simulation of what would have happened in the absence of conflict

Table 1 details the baseline calibration of the LTGM-PC, comprising key parameters and initial conditions (panels A and B), and the central projected paths of key growth drivers over 2011-2030 (panel C). Key parameters and initial conditions either take their 2010 values or are calibrated. In particular, we calibrate the initial capital-to-output ratio, K_0/Y_0 at 2.560 assuming steady-state properties and based on 30-year averages of the investment-to-GDP share (22%), GDP growth (4.1%), and aggregate depreciation rate (4.5% in PWT 8.1). Taking this approach at least provides us with some basis of setting an initial K_0/Y_0 that is in between the PWT values for 2010 (2.384 based on PWT 9 and 2.632 based on PWT 8.1), especially since the PWT 9 value puts Syria on the border of the 75th percentile of lowest capital-to-output, K/Y ratios, and is below the respective averages of lower-middle-income countries, low-income countries as well as MENA countries.

We also consider lower and upper estimates based on adjustments to some of the central projections for growth drivers - Table 2 displays these calibrations. Notes to Tables 1 and 2 explain the calibrations.

Figure 7 shows the trajectory for the level and growth of GDP in Syria based on the calibrations. The baseline assumptions are consistent with a long-term GDP growth average of close to 5.0%. Average real GDP growth of 5.3% over 2011-2018 in the absence of conflict would have led to real GDP rising from USD 60 billion in 2010 to USD 91 billion, and real GDP per capita rising from USD 2,857 to USD 3,774 by 2018 (upper estimate: GDP of USD95.3 billion and GDP per capita of USD 3,997 in 2018; lower estimate: GDP of USD87.6 billion and GDP per capita of USD 3,649 in 2018).

3. Impact from Conflict

This section provides a simulation of how the different growth drivers account for the loss in GDP growth over 2011-2018. The purpose of this simulation is to provide an up-to-date and holistic analysis of what happened to GDP potential based on its underlying drivers. Such an analysis complements other work done, for example, by the UN-ESCWA and the World Bank, which have documented overall GDP loss by sector and expenditure components. Furthermore, the analysis in this section is a necessary step towards establishing as best as possible, the initial conditions post-conflict, an important precursor to simulations for the reconstruction period.

3.1. How were the drivers of growth affected by the conflict?

3.1.1 Physical capital stock and investment

We use estimates of physical capital stock damage by the UN-ESCWA which appear to be the most comprehensive and up-to-date data so far. ESCWA (2018) puts the destruction of capital across various economic sectors, including public and private capital, at USD 119.7 billion by the end 2017. As pockets of fighting continued in Syria in 2018, we build in further damages of USD 7 billion to total USD 126.7 billion in 2018 (more than five times the GDP level in 2018). See Appendix 2 for details.

World Bank (2017) estimates a decline in private investment as a share of GDP (I^P/Y) from 12% in 2010 to 4% in 2015, and for the public investment-to-GDP ratio (I^G/Y) – a decline from 9% in 2010 to 1% in 2015. ESCWA (2018) sees a smaller decline from 12% to 9% for private investment as a share of GDP (averages for 2006-2010 and 2011-2016 respectively) and from 10% to 7% for public investment as a share of GDP. In our simulations, we use the World Bank estimates for our central projections, assuming I^P/Y and I^G/Y remain stable at 4% and 1% respectively over 2016-2018. We then consider the ESCWA estimates as an upper estimate to our projections.

A deterioration in the efficiency of public investment is a likely concern. No Syria-specific value of the Infrastructure Efficiency Index (IEI) (Devadas and Pennings 2019) is available. As a proxy for Syria's pre-conflict efficiency of new public investment, we use the lower-middle-income (LMI) average of 0.734 and build in a decline to the low-income (LI) group average of 0.570 by 2017 (at which point the World Bank's income classification of Syria switches from LMI to LI).

3.1.2 Demographics and the labor force

United Nations (2017) indicate negative average annual population growth of -1.7% over 2011-2018, (from 21 million people in 2010 to 18.3 million in 2018), and for the working age-to-population share, negative average annual growth of -0.09%. From mid-2010 to mid-2020, estimated deaths are higher at 1,036,445 (5.6% of the average population over 2010-2020) compared with 657,131(3.5% of the average population over 2000-2010) the previous decade. Net emigration is tallied at 5,397,896 (25% of population in 2010). The latter considers refugee numbers from the UN Refugee Agency (UNHCR) populations of concern data up to March 2017.

The above numbers might understate fatalities and migrants. The cumulative number of fatalities from the war is hard to ascertain. SOHR data puts Syrian fatalities at 494,892 over March 2011 – 10 December 2018, [5] higher than what is suggested by UN population statistics. The UNHCR populations of concern data shows that compared to 2016, total registered Syrian refugees and asylum-seekers increased in 2017 by 746,811 (Figure 8(a)). While the equivalent 2018 data is not

available, from data on refugees in selected neighboring countries, we note that when compared to 2017, refugees had increased by 184,398 to 5,663,675 in 2018, around one third of the remaining population in Syria in 2018 (patterned bars in Figure 8(a)). Based on this, the UN population statistics may be understating refugees by about 900,000. However, if we discount the 1 million refugees born in exile supposedly included in the UNCHR data, then the under-representation of population "loss" in the UN population statistics due to the use of outdated UNHCR data disappears.

Of greater concern then is that the UN population statistics likely do not include non-registered Syrians in neighboring countries, for which estimates vary but tend to go up to more than a million (see for instance, Vignal (2018) and World Bank (2019)). UNDP and UNHCR (2019) put the difference between estimated total Syrians and registered Syrian refugees at about 1.6 million in December 2018. The difference is wholly accounted for by Egypt, Jordan and Lebanon.

Consequently, as a lower estimate to population growth, we calculate an added decline in the Syrian population of 1.8 million, building in additional conflict deaths of 200,000, and unregistered Syrian migrants of 1.6 million. This would reduce the 2018 population from 18.3 million to 16.5 million giving a negative average growth of -3.0% over 2011-2018.

May 2018 ILO-modelled estimates shows the overall LFPR at 43.0% in 2018, giving an average negative growth of -0.5% over 2011-2018. World Bank (2019) shows 2017 LFPRs for men and women above 15 years of age at 79.1% and 11.9% respectively versus 73.0% and 13.0% in 2010. We use the ILO estimates in our central projection, and for a possible upper estimate, consider an increment in the LFPR by 2018 based on the changes in participation rates reported in World Bank (2019).

3.1.3 Human capital

Human capital would have been affected by (i) the interruption of schooling of the younger population, who represent future entrants into the labor force; and (ii) migration and fatalities which alter the distribution of years of schooling among the remaining population.

According to the Syrian Center for Policy Research (SCPR 2016), almost half (45.2%) of all basic education school-age children residing within the country were not attending school by 2014-2015. They estimate a decline of 1.5 in the average years of schooling for population aged 15 and above, based on these non-attendance rates, from 6.8 in 2010 to 5.3 years in 2015.

We provide alternative calculations to assess the impact from the interruption of schooling as well as migration and fatalities on the national average of years of schooling. To do this, we use forward extrapolations, with the following assumptions:[6]

- for age groups, $a = 3{:}\,25-29$ to $a = 10{:}\,60-64$, the educational attainment (average schooling years), s, of gender g (either men, m or women, f) in age group, a, at time, t, is the same as that of the age group five years younger at time, $t-5$, as we assume these groups have completed their education, i.e.,

$$s_{g,t}^{a} = s_{g,t-5}^{a-1} \tag{1}$$

- for age groups, $a = 1{:}\,15-19$ and $a = 2{:}\,20-24$, who are still in school, we use the attainment in $t-5$ for the same group a, adjusted to account for changes in enrollment ratios, $\Delta enroll_{g,j,t}^{a}$[7] for age group a in education level j (primary, secondary and tertiary; incomplete and complete) during the transition period from $t-5$ to t, i.e.

$$s_{g,t}^{a} = s_{g,t-5}^{a} + \sum_{j} \Delta enroll_{g,j,t}^{a}\, Dur_{j,t-5}^{a} \tag{2}$$

Dur is the corresponding duration system of education level j, which we assume to be unchanged.

Average total years of schooling for each age group s_t^a is then a composite of the respective average years of schooling of men (m) and women (f) in that group:

$$s_t^a = s_{f,t}^a \times \frac{Pop_{f,t}^a}{Pop_t^a} + s_{m,t}^a \times \frac{Pop_{m,t}^a}{Pop_t^a} \tag{3}$$

where Pop_t^a is population in age group a at time t.

Finally, we derive average total years of schooling for the population aged 15-64:

$$s_t = \sum_{a=1}^{10} s_t^a \times \frac{Pop_t^a}{Pop_t^{(15-64)}} \quad (4)$$

where $Pop_t^{(15-64)}$ is the total population aged 15-64 at time t.

Primary and secondary net enrollment rates stood at 93% and 67% respectively in 2010 (UNESCO Institute for Statistics (UIS)).[8] Last available data from UIS indicates that these rates declined to 63% and 46% respectively in 2013, with the secondary enrollment rate stable at 45% in 2018 (UNICEF 2018). For our projection of average years of schooling for the still-in-school groups using equation (2), we let the 2010 primary and secondary enrollment rates decline to 75% and 45% respectively by 2015 for both girls and boys, keeping them steady thereafter.[9] Regarding tertiary education, UIS data rather surprisingly suggests an increment of about 10 percentage points in the gross enrollment rate during the conflict from 26% in 2010.[10] We build in this increment over 2010-2015, applying the same enrollment rate for men and women, and keep it unchanged thereafter. Primary school duration is assumed to be 6 years (6-11 years), secondary school, 6 years (12-17 years), and university 4 years (18-21 years). Appendix 3 provides further details on how we arrive at the average years of schooling in 2018.

Our approach constrains changes to the national average of schooling years to arise from shifts in the distribution of the total population by age and gender, and in enrollment ratios. Because we use past composite values of average years of schooling, we do not consider changes in completion rates. This approach also does not consider other types of heterogeneity in educational attainment, for instance, that depend on the socioeconomic status or geographical origination of migrants and conflict victims. Verme et al. (2016) find that Syrian refugees in Jordan and Lebanon in fact tend to have slightly lower levels of educational attainment than pre-conflict Syrians.

To obtain human capital growth, we continue to use the same method and returns to education as in PWT 9. For the central projection using UN population statistics, we find that average years of schooling would have declined by 1.467 years for the population aged 15-64 with human capital contracting by an annual average growth of -2.59% over 2011-2015 and -0.56% over 2016-2018 respectively. With the additional decline of 1.8 million in the Syrian population for the lower estimate, average years of schooling declines only marginally more - by 1.499 years.

3.1.4 TFP

The key element that feeds into the model of TFP growth in Kim and Loayza (2019) is an overall index of TFP determinants, the determinants being education, infrastructure, innovation, institutions, and market efficiency. The composite index stood at 30.33 for Syria in 2010 on a scale between 1 and 100. We estimate the trajectory of this index over 2011-2018 by calibrating its subcomponents.

For the education index, we calculate a decline that is proportionate to our estimates of the fall in average years of schooling of the working-age population. For the infrastructure index, we build in a decline that is proportionate to the relative total light in Syria over time estimated by Li et al. (2017). For the institutions index, the estimation is based on the Worldwide Governance Indicators (WGI) across six dimensions (Kaufmann, Kraay and Mastruzzi 2010). For the innovation and market efficiency indices, we assume that these evolve proportionately to a weighted average of the indices for infrastructure and institutions.

This gives an overall TFP determinant index of 15.98 in 2018, almost half the 2010 level. The associated average annual TFP growth over 2011-2018 is -1.6%. Further details are provided in Appendix 4.

3.2. Simulation of the impact from the conflict

Table 3 details the baseline calibrations of conditions during the conflict years 2011-2018, following the discussion in Section 3.1. Regarding the public and private capital to output ratios, K^G/Y and

K^P/Y, the simulated ratios inclusive of damage in Table 3, panel B, use calculations described below to reflect the damage to capital stocks:

— Each period's initial K^G/Y and K^P/Y are reduced by lowering K^j (for $j = G, P$) by the amount of the monetary value of physical damage (with Y held constant). Damage during a period (year) affects capital and initial capital-to-output ratios for the next period.

Initial conflict capital-to-output ratios, $\frac{K_{c,0}^j}{Y_0} = \frac{K_{c,2011}^j}{Y_{2011}}$

where $K_{c,2011}^j$ is capital adjusted for damage, D_{2011}^j.

Then, $\frac{K_{c,2011}^j}{Y_{2011}} = \frac{K_{2010}^j}{Y_{2010}} \times \frac{1+g_{k_c^j,2011}}{1+g_{y,2011}}$

where K_{2010}^j is based on $\frac{K_{2010}^j}{Y_{2010}}$ of 1.152 and 1.408 respectively for public and private capital, and Y_{2010} = USD 60.043 billion;

growth in adjusted capital per worker, $1 + g_{k_c^j,2011} = \frac{(1-\delta^j)\left(1-d_{2011}^j\right) + \frac{I_{2010}^j/Y_{2010}}{K_{2010}^j/Y_{2010}}}{(1+g_{\varrho,2011})(1+g_{\omega,2011})(1+g_{N,2011})}$

(5)

where $d_{2011}^j = \frac{D_{2011}^j}{K_{2010}^j}$, the proportion of capital damaged in 2011.

and growth in output per worker,

$$1 + g_{y,2011} = [(1+\Gamma_{2011})^{(1-\zeta)\phi}](1+g_{A,2011})(1+g_{\theta,2011})^{\phi}(1+g_{k_c^G,2011})^{\phi}(1+g_{k_c^P,2011})^{1-\beta-\zeta\phi}(1+g_{h,2011})^{\beta}$$

$$\text{with } 1+\Gamma_{2011} = (1+g_{\varrho,2011})(1+g_{\omega,2011})(1+g_{N,2011})$$

(6)

— The process is repeated for periods 2012-2018. Damages to K_t^j are apportioned across the conflict period based on the estimates discussed in Section 3.1.1. Damages are apportioned between public and private capital based on their relative cumulative shares as at end 2015, made available by ESCWA. We assume the same shares for each time t (that is, 40% of damages are attributable to public capital, 60% private capital).

Under the central projection, both K^G/Y and K^P/Y are lower in 2018 (1.029 and 0.708 respectively) compared with 2010 (1.152 and 1.408 respectively), but more so in the latter case, since the damage value for private capital is higher. In the lower and upper estimate scenarios for selected growth drivers (Table 4), the K/Y ratios in 2018 are slightly higher than in the central projection but remain lower than the 2010 levels.

Figure 9(a) - 9(b) shows the outcomes of simulations for GDP level and growth over the conflict years given the calibrations in Tables 3 and 4. Our simulations of the impact from the conflict across the three scenarios (central, lower and upper estimate projections) from 2011-2018 indicate that the depletion of factors of production alone may account for about 87% of the negative GDP growth on average, and further, that about 64% of the average negative growth is due to physical capital destruction. Demographics and labor account for about 15%, human capital 7%, and TFP 13% of GDP growth on average over the conflict years.

The decrease in physical capital reflects the compounded effects of large outright damages, low net investment rate, and a falling output base (which is adversely affected by all growth drivers). The prominent effective losses due to physical capital destruction are worsened by the lack of investment. This echoes the observation by World Bank (2017) that capital destruction itself might have relatively subdued effects in a well-functioning economy, as in the aftermath of a natural disaster; but in the case of conflicts, the fall in investments due to disruptions in economic organization reinforces the adverse effects from physical capital damages. Having said that, our estimate of physical capital decrease is greater than the estimate in World Bank (2017) because of methodological reasons:

we take into account the monetary value of physical capital destroyed (as reported by ESCWA (2018)), as well as depreciation and gross investment, directly in the calculation of the capital stock; while World Bank (2017) assumes that the resulting capital stock keeps the same proportion with respect to the initial capital stock as the stock of housing does. Consequently, World Bank (2017) find that the impact of capital destruction on GDP growth is not as immense. They find that in a scenario with only capital damage, GDP only decreased by -3.5% from the pre-conflict GDP level in the sixth year of conflict, compared to the -65.2% decrease in the scenario where all shocks including casualty and economic disorganization were included. The impact for growth when there is only casualty is comparable to the capital stock damage case at -3.9%. Economic disorganization has the biggest impact with GDP decreasing by -59.8% from the pre-conflict level on the sixth year of conflict. Overall, notwithstanding the differences in the relative importance of factors, the cumulative GDP loss is similar at USD 226 billion over 2011-2016 (in 2010 prices), almost four times the GDP level in 2010.

Comparisons against the no-conflict scenario suggest a cumulative loss in GDP potential of between USD289 and USD300 billion over 2011-2018 (Figure 10(a)). Our estimates point to a continued loss in 2017-2018 because of the damage to physical capital and negative TFP growth. This varies somewhat from ESCWA (2018) and others like Devarajan and Mottaghi (2017), Gobat and Kostial (2016) and World Bank (2017), all of which point to a trough in *actual* GDP contraction around 2012-2013. ESCWA (2018) estimates average GDP growth of -10% over 2011-2017, with growth turning positive in 2017. ESCWA also projects a GDP level of USD 27 billion in 2017 against a no conflict counterfactual of USD 86 billion. Our estimates seem to mimic these results, pointing to a GDP growth of -12% on average over 2011-2018 (across all three scenarios under the conflict simulation), with an average GDP level of USD 22 billion in 2018 (against a no-conflict scenario of USD 91 billion). Per capita GDP is estimated at USD 1,154 in 2018 under the central projection (upper estimate: USD 1,381; lower estimate: USD 1,200).

4. Growth Scenarios Post-Conflict

This section discusses potential growth scenarios for Syria in the aftermath of war, exploring how long it would take for Syria to reach its pre-conflict level of development under various assumptions for the growth drivers.

Experiences of other countries in the Middle East suggest that longer-lasting conflicts would entail longer recovery periods. Sab (2014) notes that it took Lebanon 20 years to reach its pre-war GDP level (after the Lebanon Civil War from April 13, 1975 – October 13, 1990), Kuwait, seven years (Gulf War from August 2, 1990 – February 28, 1991), and Iraq, one year only (2003 Invasion of Iraq from March 19-May 1, 2003). Lebanon lost 70% of its GDP level while Kuwait 55% and Iraq 35% during their respective wars. Gobat and Kostial (2016) note that under the hypothetical assumption of reconstruction starting in 2018 and the Syrian economy growing at about 4.5%, it would take the country about 20 years to reach its pre-conflict real GDP level. ESCWA (2018) puts Syria's real GDP at about USD 27 billion in 2017 – some 55% below the 2010 level and close to the level in the early 1990s. Our central projection of Syria's potential GDP level in Section 3, at USD 21.2 billion in 2018, is 65% below the GDP level in 2010, close to the loss experienced by Lebanon.

To analyze the growth outlook in Syria, we consider a voluntary mobility case within which our projections for the growth drivers are guided by three plausible political settlement/security outcomes (baseline/moderate, optimistic, and pessimistic). These settings are associated with varying levels of reconstruction assistance, which influences the voluntary mobility of refugees residing in neighboring countries. The amount of reconstruction funds directly affects public and private investment, while refugee returns affect the labor force size. We also build in variation in human capital growth based on different assumptions for enrollment rates and vary the projections for TFP growth across the three scenarios.

We also look at a second broad case of forced repatriation of refugees. Forced repatriation would contravene UN principles that care for the safety and welfare of refugees,[11] but it may be instigated by local and international voices eager for a quick resolution of the refugee issue.[12] Under

a forced repatriation scenario, all refugees in neighboring countries are assumed to return to Syria, regardless of the type of political settlement and associated reconstruction amounts. Therefore, in this case, refugee returns are assumed to be disconnected from the size of the reconstruction program. We thus have six scenarios in total – three for each of the two different broad cases of voluntary mobility and forced repatriation, respectively. These are summarized in Table 5. We discuss the projections for the growth drivers in Section 4.1 and present the resulting simulations for Syria's growth over the next 30 years in Section 4.2.

4.1 Prospective developments in growth drivers

4.1.1 Physical investment

The reconstruction and expansion of Syria's physical capital will largely depend on the extent of foreign funds made available since its self-financing capacity is likely to be limited, especially in the near term. equation (7), a slight variant of the saving/investment - balance of payments accounting identity, links $\frac{I_t}{Y_t}$ to the inflow of foreign funds.

$$\frac{S_t}{Y_t} = \frac{I_t}{Y_t} + \frac{CAB_t}{Y_t} \quad \text{where } CAB_t = TB_t + IB_t = -NCT_t - \Delta NFL_t \qquad (7)$$

(Note: S_t = saving *excluding* net current transfers, CAB_t = current account balance *excluding* net current transfers, TB_t = trade balance, IB_t = income balance, NCT_t = net current transfers, ΔNFL_t = change in net foreign liabilities.)

External financing may take the form of (non-debt creating) aid and grants (higher NCT_t) or direct investment and loans (higher foreign liabilities, thus increasing ΔNFL_t). If the foreign funds lead to an equivalent amount being spent on tradables (for example, the imports of capital goods), the current account will be in deficit, ceteris paribus. If the foreign funds do not lead to the purchase of tradables, the current account will be in balance, ceteris paribus (see Elbadawi, Kaltani and Schmidt-Hebbel (2008) for related discussion on how the utilization of aid monies affects current account

balances and exchange rates). In our simulations, $\frac{CAB_t}{Y_t} = -\frac{\Delta FF_t}{Y_t}$ where $NCT_t + \Delta NFL_t = \Delta FF_t$, the inflow of foreign funds. So, there is a corresponding amount being spent on tradables. This gives us equation (8). ΔFF_t varies across the three post-conflict scenarios as described in Table 5: beginning 2019, USD 12.5 billion per year over a 20-year period under the optimistic scenario; USD 7 billion per year over a 20-year period under the baseline scenario; and USD 3 billion per year over a 10-year period under the pessimistic scenario. Even distribution of foreign funds over the 20-year and 10-year period is assumed following the reasoning in the ESCWA (2017) report. On the one hand, the country's absorptive capacity of investment will progressively increase over time. On the other hand, national sources are able to provide larger investment funding as the economy recovers. A stable provision of foreign funds alongside rising domestically-funded investment is consistent with this paper's assumed investment rates with respect to GDP which are not excessively high in comparison to other post-conflict recovery experiences.

$$\frac{I_t}{Y_t} = \frac{S_t}{Y_t} + \frac{\Delta FF_t}{Y_t} \tag{8}$$

If we assume $\frac{I_t}{Y_t}$ of 5% (as per the central projection of our conflict simulation), and $\frac{CAB_t}{Y_t}$ of around -30%[13] at the end of the conflict, this would give us $\frac{S_t}{Y_t}$ of approximately -25%. This is about 50 percentage points below Syria's pre-conflict long-term average: 23%.[14] For the post-conflict pessimistic scenario, we calibrate the transition for Syria's $\frac{S_t}{Y_t}$ by 50 percentage points to 25%, in eight years, based on the experience of Lebanon. Lebanon was subject to persistent political instability during its recovery. External assistance specific to its reconstruction program was limited, though it did receive large capital inflows attracted by high interest rates that enabled it to run current account deficits. For the optimistic scenario, we assume that Syria's saving ratio increases by 60 percentage points to 35% in five years, following the timeline and change experienced by Kuwait as it recovered to its pre-conflict saving-to-GDP level. Resource-rich, high-income Kuwait made a strong recovery after the sharp decline as its oil production capacity was quickly restored amid a comprehensive

economic recovery and reconstruction program (Sab 2014). For the moderate scenario, we take an average of the projections for $\frac{S_t}{Y_t}$ under the other two scenarios. See Appendix 5 for further details.

Of projected $\frac{I_t}{Y_t}$, we continue to assume a public investment share of 40%. This is consistent with the estimated relative shares of destruction between public and private capital. We keep new public investment efficiency unchanged at 0.570 under the pessimistic scenario and assume a rise from 0.570 to 0.734 by 2038 under the baseline. For the optimistic scenario, we assume a rise to the average IEI for the upper-middle-income (UMI) group of 0.769 by 2038.

4.1.2 Demographics and the labor force

Registered Syrian refugees in neighboring countries numbered 5,663,675 at the end of 2018 (Figure 8). World Bank (2019) finds that the key drivers of potential voluntary refugee returns are security and infrastructure services in the home country. On this basis, we link voluntary returns to the reconstruction bill, in that a more optimistic political settlement scenario is associated with greater security and more reconstruction funds being made available. The amount of available funds in turn determines the amount of infrastructure that can be built. Hence, to calculate the baseline and pessimistic scenarios of voluntary mobility (or refugee returns), we use the ratio of reconstruction funds to the optimistic scenario in the first 10 years in each case.

According to UNHCR (2018) survey, 76% of refugees (4.3 million people) intend to return to Syria one day. This rate of return is also consistent with United Nations population projections. We assume that this is the rate of returnees under the optimistic scenario, with trajectory based on United Nations data, where the majority of returns occur in the first 10 years. Following this, we assume average population growth of 2.5% over 2019-2038 with the data building in net migration into Syria of 4.21 million over 2020-2035. Of this total, 66% return over 2020-2025 (about 556,000 on average per year), 29% over 2025-2030 (about 240,000 per year) and 5% over 2030-2035 (about 46,000 per year).[15]

Given that in the optimistic scenario reconstruction funds amount to USD 125 billion (for the first 10 years) and the return rate stands at 76%; for the moderate scenario of USD 70 billion, this would imply a return rate of 43%. Similarly, compared to the optimistic scenario, for a pessimistic scenario of USD 30 billion, this would imply a return rate of 18%. Following this, in the moderate and pessimistic scenarios of the voluntary mobility case (43% and 18% return rates respectively), we calculate average population growth rates of 2.2% and 1.9% respectively over 2019-2038. For the forced repatriation case (100% return rate), we obtain an average population growth rate of 2.7% over 2019-2038.

4.1.3 Human capital

We follow the same approach as in Section 3.1.3. Changes in the average years of schooling are estimated based on shifts in the population (including the return of refugees) and improvements in enrollment rates. Where we reduce (voluntary mobility case – moderate and pessimistic scenarios) or increase refugee returns (forced repatriation case) compared to the UN statistics (voluntary mobility case – optimistic scenario), we apportion the adjustment to different age groups based on the UNHCR profile of the age distribution of refugees.

Destroyed/non-functioning schools lead to low enrollment rates (World Bank 2019). Further, displaced families will likely be hindered in their attempts to access education services. Since the prospects for reconstruction are relatively weak under the pessimistic scenario, we assume primary and secondary enrollment rates only return to pre-conflict levels (93% and 67% respectively) by 2038, while the tertiary enrollment rate rises to 50% (from 36%) by that time. This timeline from the given initial levels is roughly in line with the trajectory of estimations/projections of enrollment ratios for developing countries in Barro and Lee (2015) (see their Chapter 3, Figure 3.5) and is longer than what Syria historically took to reach those rates.[16] We further assume that by 2048 enrollment rates reach 100%, 80% and 60% respectively at the primary, secondary and tertiary levels. For the optimistic scenario, we assume primary and secondary enrollment rates reach pre-conflict levels in half the time,

that is, by 2028, and by 2038, 100% and 80% respectively. For the tertiary enrollment rate, we assume it rises to 50% by 2028 (also in half the time compared to the pessimistic scenario) and 60% by 2038. By 2048, we assume enrollment rates reach 90% and 70% respectively at the secondary and tertiary levels. With these calculations we obtain years of schooling of 8.449 and 6.991 respectively by 2038 in the optimistic and pessimistic scenarios of the voluntary mobility case. The projected years of schooling in 2038 under the pessimistic scenario is roughly the same as the pre-conflict value of 7.080. For the moderate scenario, we take an average of years of schooling under the other two scenarios, which gives a value of 7.718 by 2038.

Using the above, average annual growth in human capital is 1.3% under the optimistic scenario and 0.9% in the pessimistic scenario over 2019-2048. The human capital growth under the moderate scenario is a simple average of the growth rates under the other two scenarios. The average years of schooling and human capital growth rates remain similar in the scenarios of the forced repatriation case compared to the voluntary mobility case as there is little change in the population distribution by age groups.

4.1.4 TFP

We assume a gradual rebuilding of the overall TFP determinants index. Under the optimistic scenario, we increase this index from 15.98 in 2018 to 35.42 by 2028 and 75.76 by 2048 based on the trajectory of the Republic of Korea's index over the 30-year period, 1985-2014. Korea is the best performer in the sample of countries used in Kim and Loayza (2019). This gives average annual TFP growth of 1.4% over 2019-2048 under the optimistic scenario, a rate which implies about 10 years to rebuild TFP to pre-conflict levels. For the pessimistic scenario, we repeat the exercise but based on the index of the United Arab Emirates (UAE), the best performer among MENA countries. This would imply an increase in Syria's index to only 21.72 by 2028 (still below pre-conflict level) and 32.74 by 2048. The corresponding average annual TFP growth over 2019-2048 for the pessimistic scenario would be 0.3%. For the moderate scenario, we assume TFP growth rates that are the average of the rates under the

optimistic and pessimistic scenarios which brings to an average annual TFP growth of 0.9% over the same time period.

4.2 Simulation of the post-conflict growth outlook

We keep the constant parameters (labor share and depreciation rates) unchanged from the values in the earlier simulations. Default initial conditions as of 2018 (GDP level, GDP per capita level, and K/Y ratios) are drawn from the outcomes of the central projection in Section 3. Table 6 details the projections of growth drivers post-conflict based on the discussion in Section 4.1. Based on the experience of other conflict countries, investment-to-GDP ratios are tied to foreign funding and a gradual recovery in national savings. Other cases of post-conflict recovery also suggest high overall investment rates, for example in the range of 30 to 35% in Lebanon in the 1990s and about 40% in Kuwait following its one-year conflict (Sab 2014).

Under the moderate scenario of the voluntary mobility case, I/Y averages about 43% and 39% over 2019-2028 and 2029-2038; and, at 23% and 25%, respectively, under the pessimistic scenario. The pessimistic rate is consistent with the pre-conflict investment rate in Syria. The investment shares are exceptionally high under the optimistic scenario, averaging 63% and 46% respectively in the next two decades.

4.2.1. Post-conflict GDP projections across the different scenarios under voluntary mobility

Under the moderate scenario of the voluntary mobility case, average GDP growth is 8.4% over 2019-2038 (Figure 11(a)). As can be observed from the top right of Figure 11(b), with the inflow of reconstruction funds, the main growth driver over the 20-year period is capital accumulation. As I/Y reverts to something close to pre-conflict trends especially after the 20-year annual inflow of reconstruction funds, the contribution from human capital growth and TFP are just as relevant as

physical capital growth. In this scenario, Syria reaches its pre-conflict GDP level by 2031, and its pre-conflict GDP per capita level by 2033, thus losing about two decades.

In the optimistic scenario, average GDP growth is 10.9% over 2019-2038, with exceptionally high investments, and stronger contributions from other growth drivers relative to the moderate scenario (Figure 11(a) and Figure 11(b), bottom left). Even so, it would take Syria 9 years, that is by 2027, to surpass its 2010 GDP level and 11 years to surpass its pre-conflict GDP per capita. In the pessimistic scenario, GDP growth averages 5.1% across the next two decades, only slightly higher than pre-conflict levels, amid limited reconstruction funds from external sources (see Figure 11(b), bottom right, for the difference in growth drivers vis-à-vis the moderate scenario). In this case, it would take Syria at least 22 years to surpass its pre-conflict GDP level and almost 29 years to meet its GDP per capita level. This finding echoes the simulation in World Bank (2017) where under the assumption that the conflict ends in its sixth year (2017), with investment recovering but remaining below its pre-conflict level, Syria's GDP remains below its pre-conflict level even 20 years after the conflict.

4.2.2. Comparing between voluntary mobility and forced repatriation

On one hand, the higher population growth from the forced repatriation contributes to higher GDP growth rates, particularly over the time the influx of refugees is expected, and a progressively higher level of GDP given these growth rates (Figure 12, left). This is a somewhat sanguine perspective, based on the assumption that there are no changes to other factors of production, particularly demographic ratios, labor force participation rates, and human capital characteristics.

On the other hand (and most importantly), regarding GDP per capita, growth rates under the forced repatriation case are lower over the refugee influx period (Figure 12, right). For instance, at the height of repatriation, in the moderate scenario GDP per capita growth is lower by 1 percentage point when compared to voluntary mobility. Growth rates recover thereafter. However, GDP per capita levels remain lower in the forced repatriation case than the voluntary mobility case for the entire period under our review. In the moderate scenario, GDP per capita level is on average lower by USD

76 (at 2010 constant prices) over 2019-2048. This is because of lower physical capital in per worker terms, which reduces labor productivity and output per capita relative to the voluntary mobility case. Of all the scenarios, it is the optimistic case where forced repatriation is the least adverse – as refugees already want to return given relatively good conditions for growth.

4.2.3. How long would it take Syria to reach higher income group thresholds?

Prior to the conflict, Syria's GNI per capita based on the World Bank Atlas Methodology (USD 1,840 as of 2007) placed it in the LMI category, and at a level that was about half the then UMI threshold.

In Figure 13, we show that at the tail-end of the conflict (using 2018 as a reference point), Syria appears to have fallen just below the LMI threshold. While once again surpassing this threshold is very likely in the next few years, it would possibly take 18 and 26 years under the optimistic and moderate scenarios respectively to breach the UMI threshold, and beyond 2050 for the pessimistic scenario. In contrast, in the counterfactual of no conflict, Syria might have passed this level in about six years, that is by 2024. This means that from 2010, while it could have taken Syria 14 years to become an UMI country, it may now take about double, or even triple that time.

5. Conclusion

In this paper, we use the Long-Term Growth Model - Public Capital Extension (LTGM-PC) to answer three questions pertaining to Syria's economic growth in the aftermath of its civil conflict: What might have been the counterfactual of no conflict? What was the impact of the conflict? And what are the possible growth paths given different scenarios post-conflict?

Our simulations of the conflict impact suggest an average GDP growth of -12% over 2011-2018, with GDP declining to almost one-third the pre-conflict level. Cumulatively, the loss in GDP amounted to about USD 300 billion when compared against the counterfactual. These results are broadly in line with findings in other studies. An added insight is that we identify how the different growth drivers might have contributed to the decline in GDP. Close to two-thirds of the average

negative GDP growth throughout the conflict years is due to physical capital destruction, followed by destruction in labor (15%), TFP (13%), and human capital (7%). This breakdown sets the stage for the analysis of Syria's post-conflict GDP potential which depends on the projected evolution of these growth drivers.

The post-conflict outlook for the growth drivers depend on the political settlement outcome which directly affects the availability of reconstruction funds and the voluntary mobility of refugees. Voluntary mobility would not only be preferable on humanitarian grounds but also on economic terms. The political settlement scenario will also affect human capital and productivity growth rates.

In the voluntary mobility case, under our moderate scenario (partial political settlement with strong guarantees for micro-security and property rights), the average GDP per capita growth over 2019-2038 is 6.1%, assuming a final and stable resolution of the conflict. With the inflow of reconstruction funds amounting to USD 140 billion spread over 20 years, the main growth driver over the 20-year period is physical capital accumulation amid average investment-to-output of about 41%. As investment-to-output reverts to a lower level especially after the assumed 20-year annual inflow of reconstruction funds, the contributions from human capital and TFP growth are just as relevant as physical capital growth. Syria reaches its 2010 GDP per capita level by 2033, implying two "lost" decades from conflict.

Under the optimistic scenario (robust political settlement), with exceptionally high investment-to-output of over 60% in the first decade (2019-2029), it would still take Syria about one decade to surpass its 2010 GDP per capita level. Under the pessimistic scenario of limited guarantees for micro-security and property rights, low reconstruction funds of USD 30 billion (1.5 times the GDP level in 2018), and investment-to-output close to the pre-conflict average, Syria's GDP per capita reaches its pre-conflict level in about three decades. Respectively for the optimistic and pessimistic scenarios, projected average GDP per capita growth rates over the next two decades (2019-2029 and 2030-2039) are 8.2% and 3.1%.

While the reconstruction and expansion of physical infrastructure is essential, the importance of strengthening human capital and the factors underlying TFP growth cannot be overstated. We have only accounted for population and enrollment effects on human capital growth. However, the quality of education and health will also likely be impeding factors that would have to be addressed in Syria's quest for growth.

Endnotes

[1] World Development Indicators (WDI) data for Syria is available up to 2007. For 2008-2010, we use data on GDP growth from the World Bank's internal macroeconomic and fiscal model (MFMod), November 2017 vintage. See Burns et al. (2019) for more information on the model.

[2] ILO-modeled estimates are based on projections for GDP-related variables and population structure. The 2013 estimates draw on the IMF WEO April 2013 and United Nations (2013). However, the IMF stopped publishing projections for Syria effective 2012, and ILO uses the regional median growth to extrapolate GDP growth for Syria.

[3] See the documentation, "Human Capital in PWT 9.0". (https://www.rug.nl/ggdc/docs/human_capital_in_pwt_90.pdf).

[4] TFP is measured by growth accounting. Syria data for output, physical capital, human capital, and employed persons are from PWT 9. Labor share is proxied by the average for four relatively conflict-free middle-income MENA economies (Djibouti, Jordan, Morocco and Tunisia).

[5] Source: http://www.syriahr.com/en/?p=108723.

[6] The nomenclature follows Barro and Lee (2013, 2015).

[7] We base the enrollment adjustment factor formula on Barro and Lee (2013) (their Table A.2).

[8] Source: http://uis.unesco.org/country/SY

[9] We use a simple average calculation to obtain the 2015 primary enrollment rate based on a net enrollment rate for school-age children of 60% (UNICEF 2016) and secondary enrollment rate of 45%. Net enrollment rate

for school-age age children appears to have been relatively stable after 2015, amounting to 61% in 2018 (World Bank 2019).

[10] Milton (2019) discusses how Syria's higher education system survived quantity wise, despite general expectations that higher education suffers relatively more during conflict, but that quality had been eroded and political control over campuses increased.

[11] The UN principle of non-refoulement, codified in Article 33 of the 1951 UN Refugee Convention, requires that "no contracting state shall expel or return a refugee in any manner whatsoever to the frontiers of territories where his life or freedom would be threatened."

[12] The limitations that the UN non-refoulement principle places on repatriation is frequently resented by states. Host countries are often impatient to see uninvited refugees leave. Countries of origin are sometimes impatient to see them return and signal the end of conflict. Moreover, donor states are eager to bring an end to the long-term refugee assistance programs that they fund.

[13] This is based on the 2017 estimate of the trade balance share of GDP by ESCWA (2018).

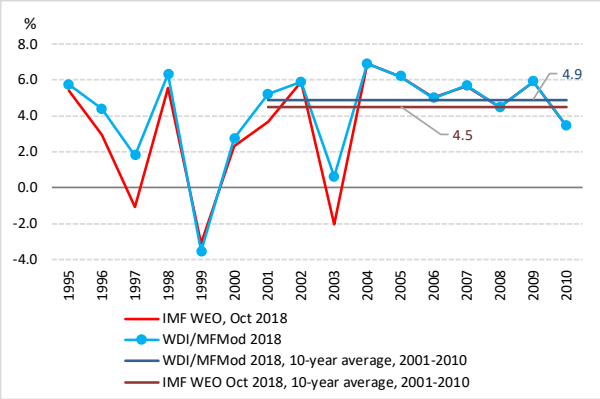
[14] 20-year average, 1991-2010 (WEO data).

[15] From our calculations using details in the UN population statistics, this is in addition to about 112,000 returnees from mid-2019 to mid-2020, giving a total of 4.3 million returnees, or 76% of registered refugees residing in neighboring countries over 2019-2035.

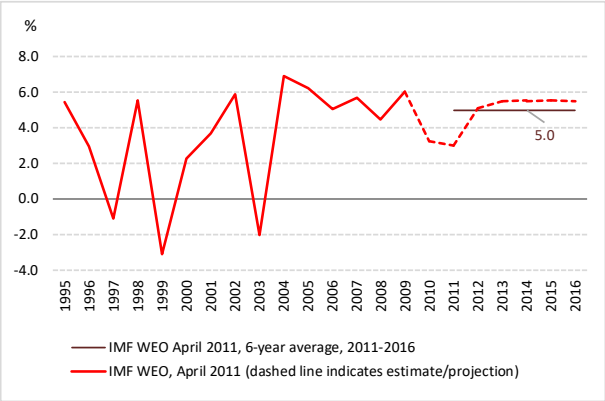
[16] UIS: the net primary enrollment rate rose from 81.9% in 1973 to 94.8% in 1987 while the net secondary enrollment rate increased from 39.3% in 2000 to 66.9% in 2010.

Figure 1: Pre-Conflict Real GDP Growth and Projection

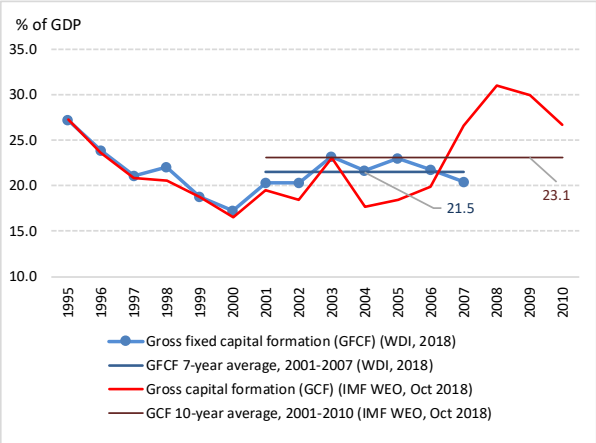
(a) September/October 2018 Vintage



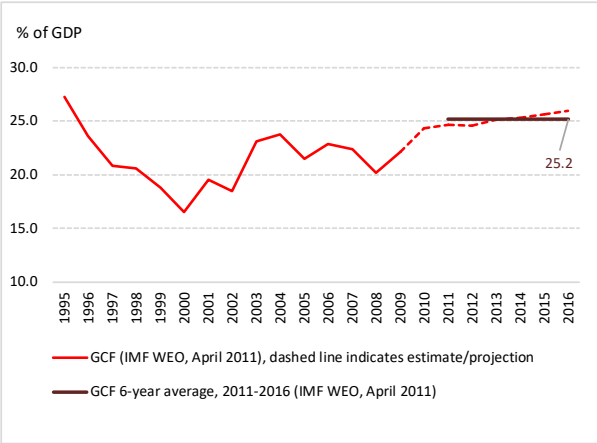
(b) April 2011 Vintage



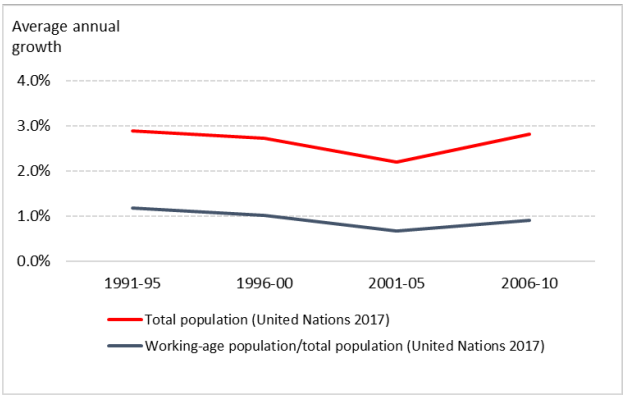
(a) September/October 2018 Vintage



(b) April 2011 Vintage



(a) 2017 Vintage



(b) 2011 and 2013 Vintage

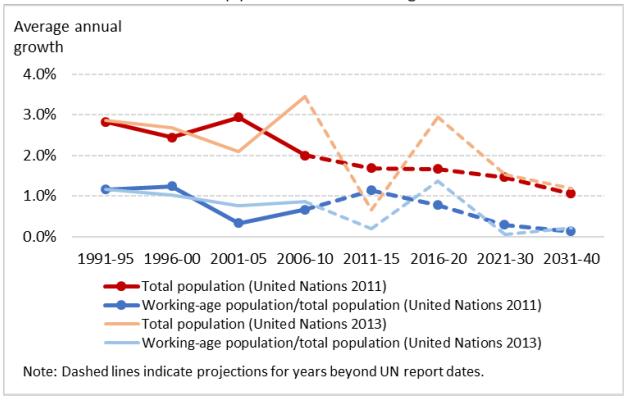
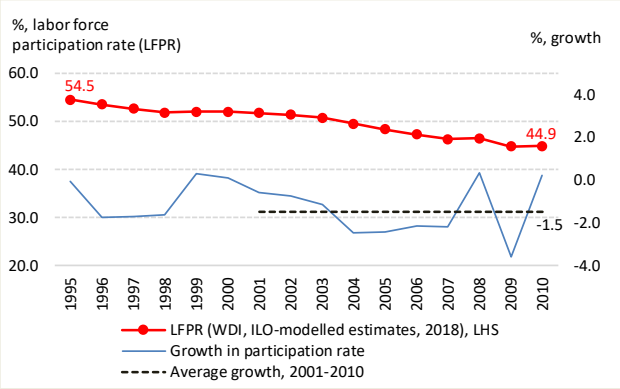
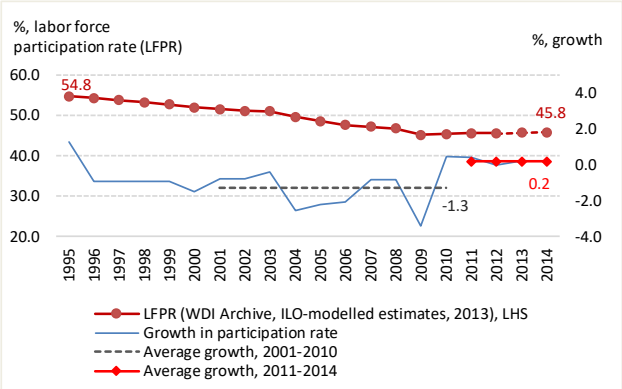


Figure 4: Pre-Conflict Labor Force Participation Rate and Projection

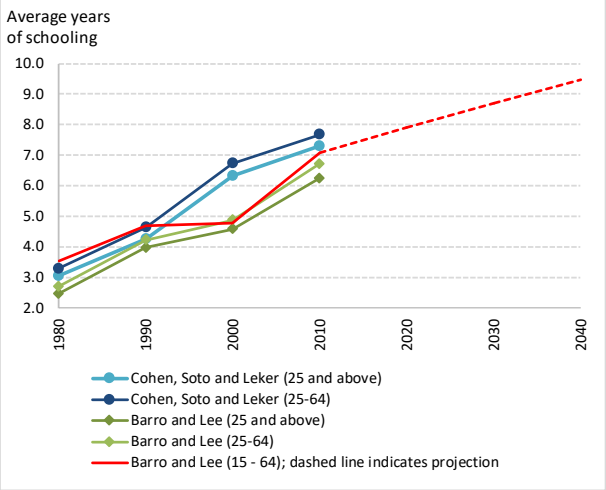
(a) 2018 Vintage



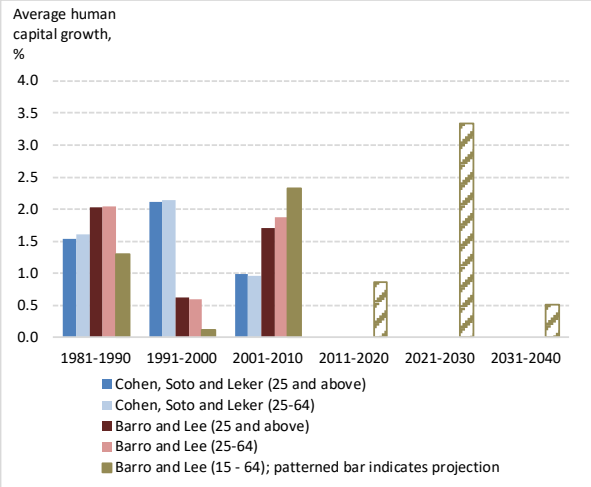
(b) 2013 Vintage



(a) Average years of schooling



(b) Human capital growth



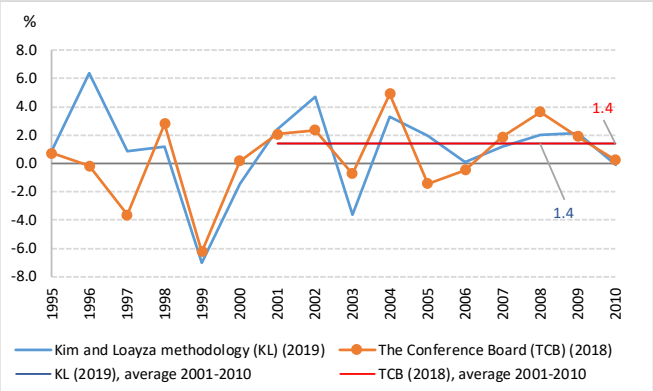
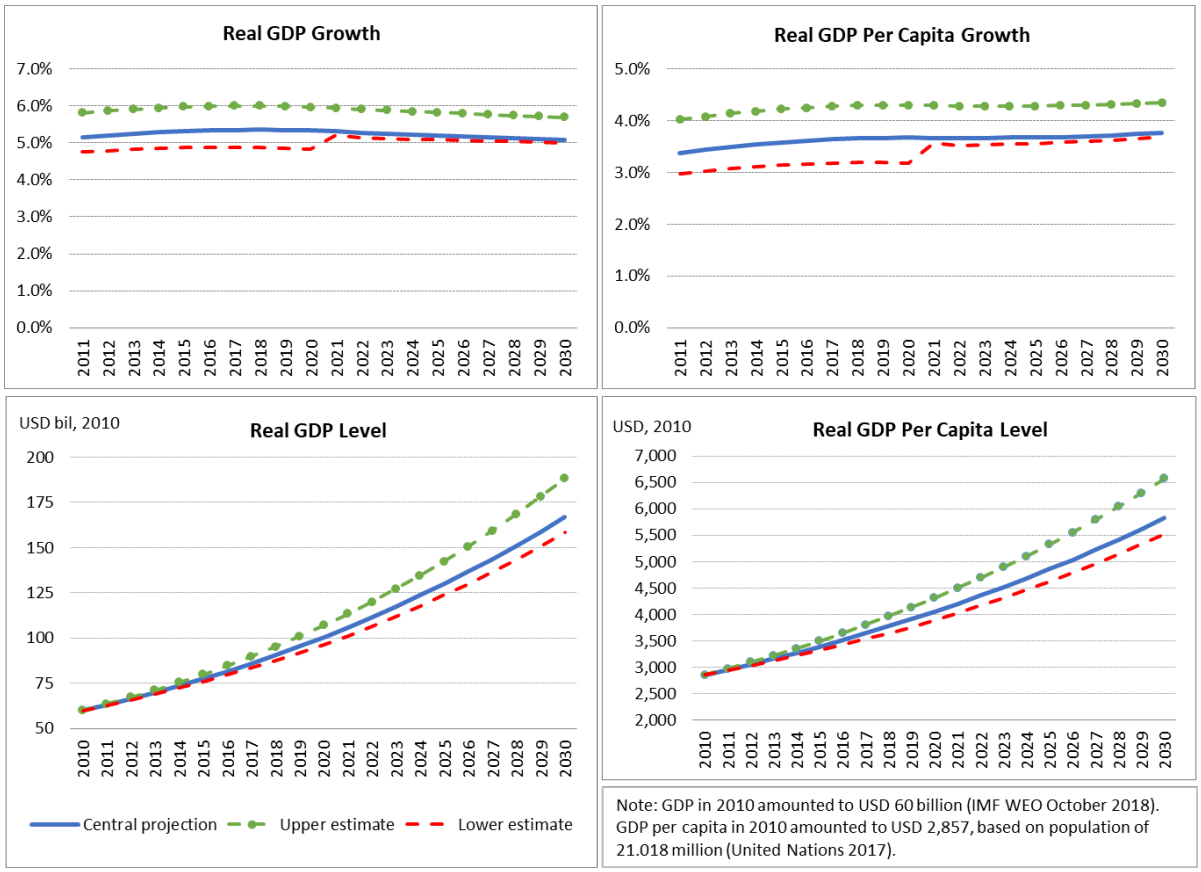
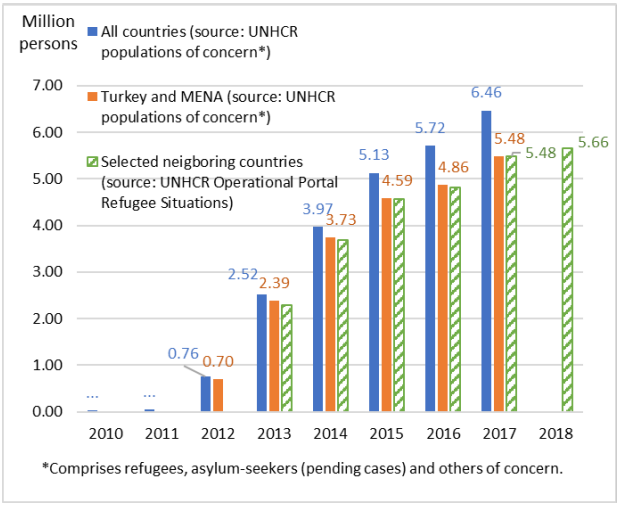


Figure 7: No-Conflict Simulation for GDP in Syria



Note: GDP in 2010 amounted to USD 60 billion (IMF WEO October 2018). GDP per capita in 2010 amounted to USD 2,857, based on population of 21.018 million (United Nations 2017).

(a) Total Syrian Refugees and Asylum-Seekers



(b) Profile of Syrian Refugees in Selected Neigboring Countries

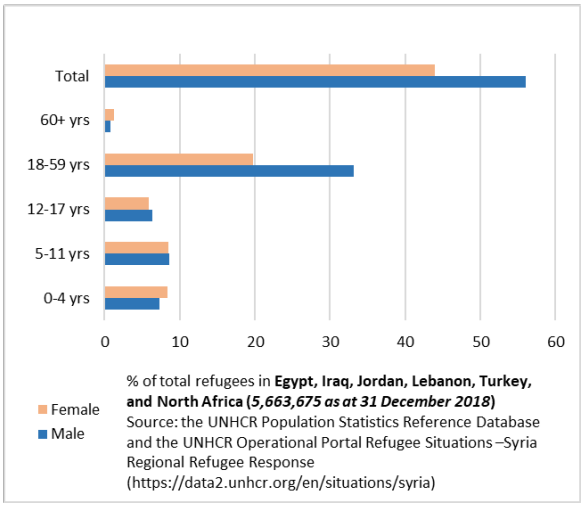


Figure 9(a): Conflict Years Calibration for GDP in Syria

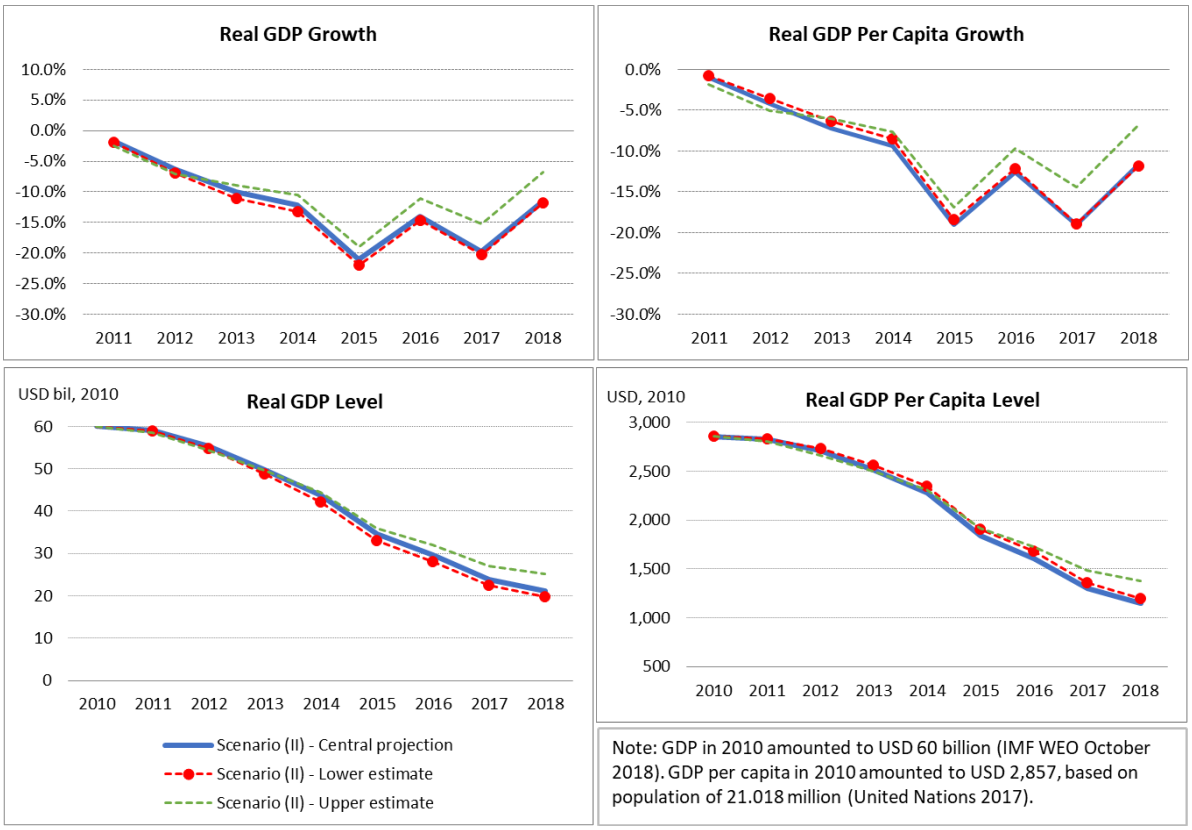


Figure 9(b): Average Impact of Different Growth Drivers on GDP during the Conflict (across Central, Lower and Upper Estimate Projections)

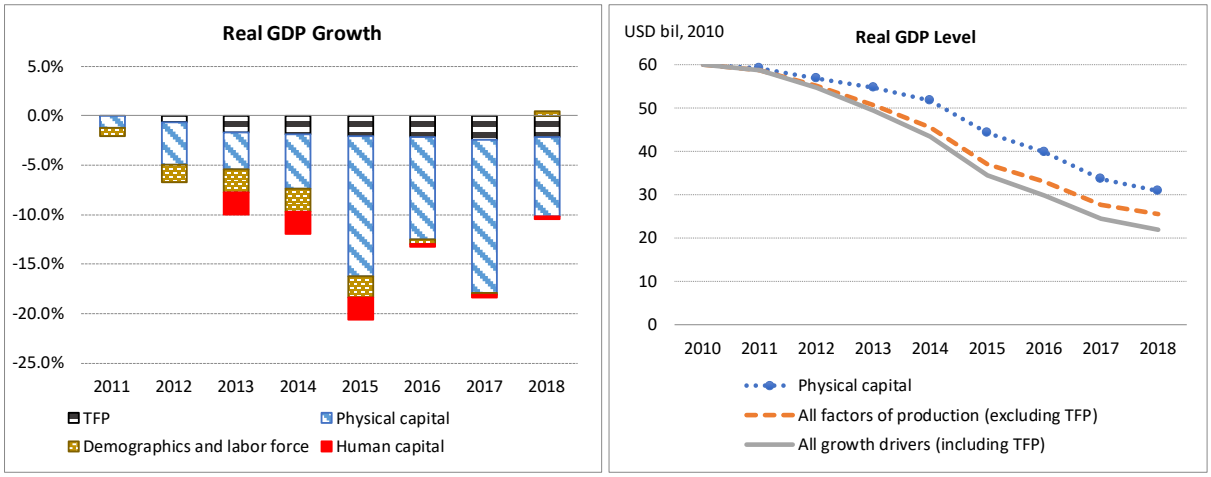


Figure 10: GDP Loss based on the Conflict Simulation Compared Against the Counterfactual of No Conflict

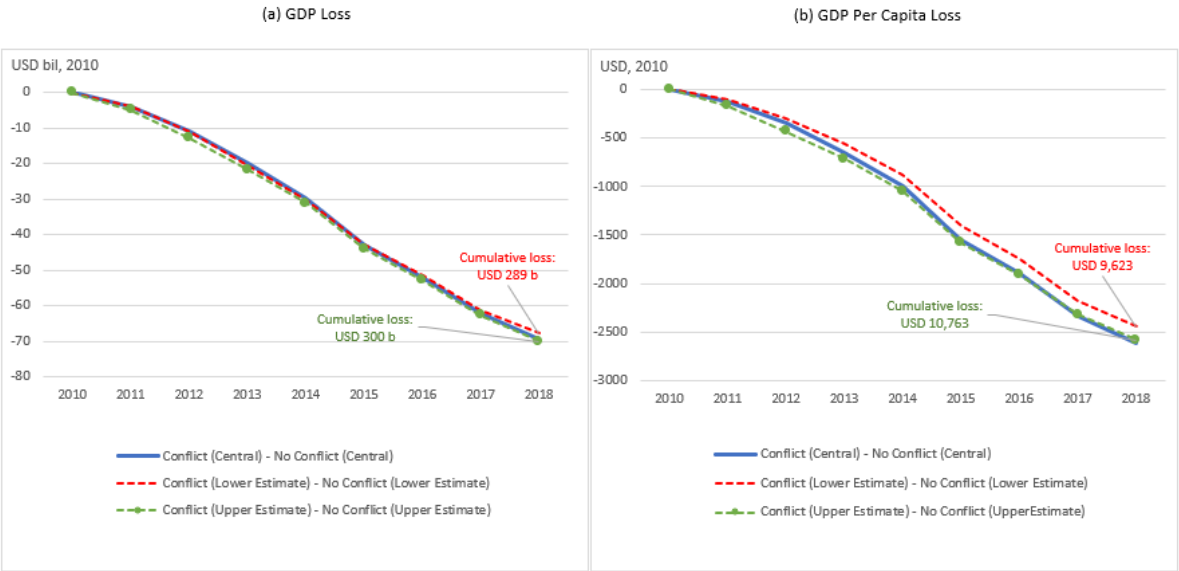


Figure 11 (a): Post-Conflict Simulation of GDP in Syria - Scenarios under the Voluntary Mobility Case

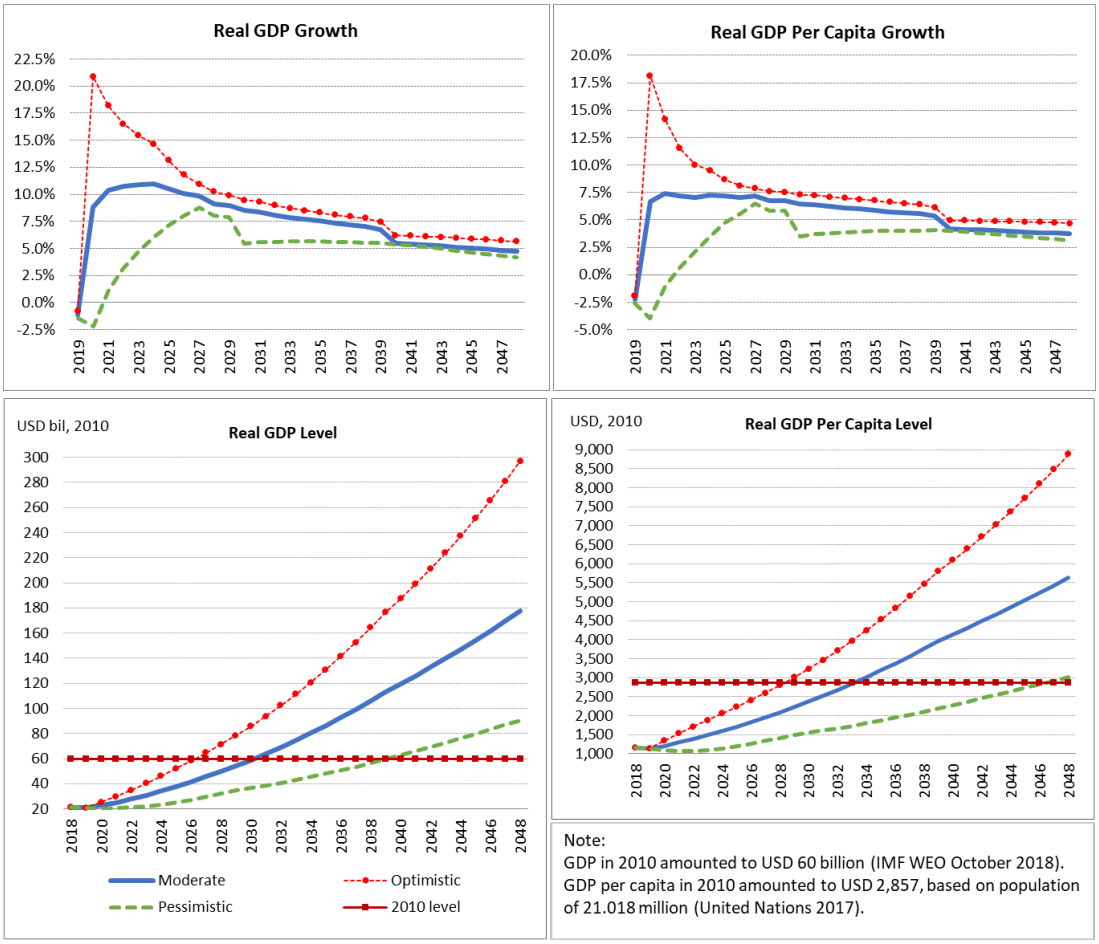


Figure 11 (b): Impact of Different Growth Drivers under the Voluntary Mobility Case

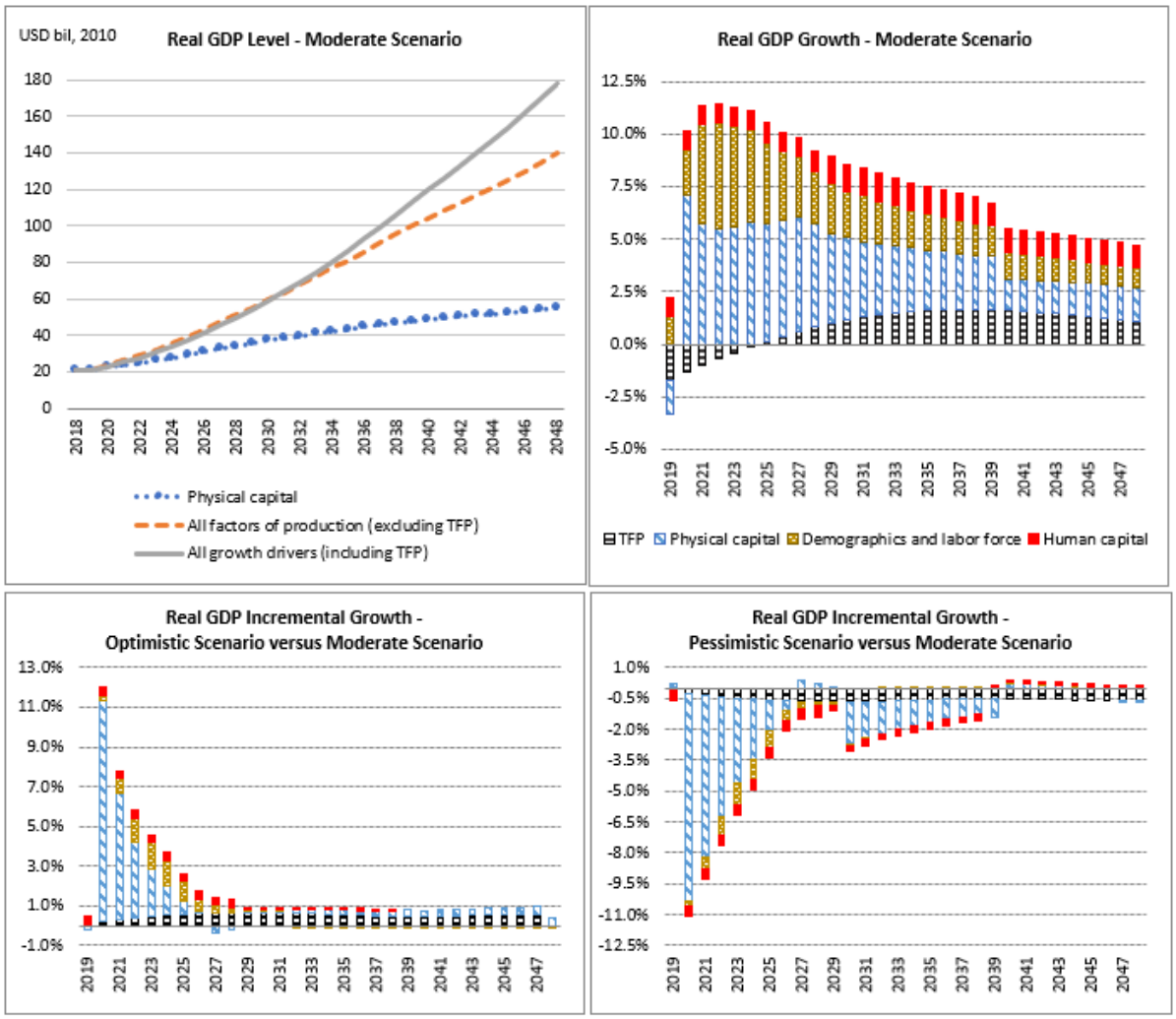
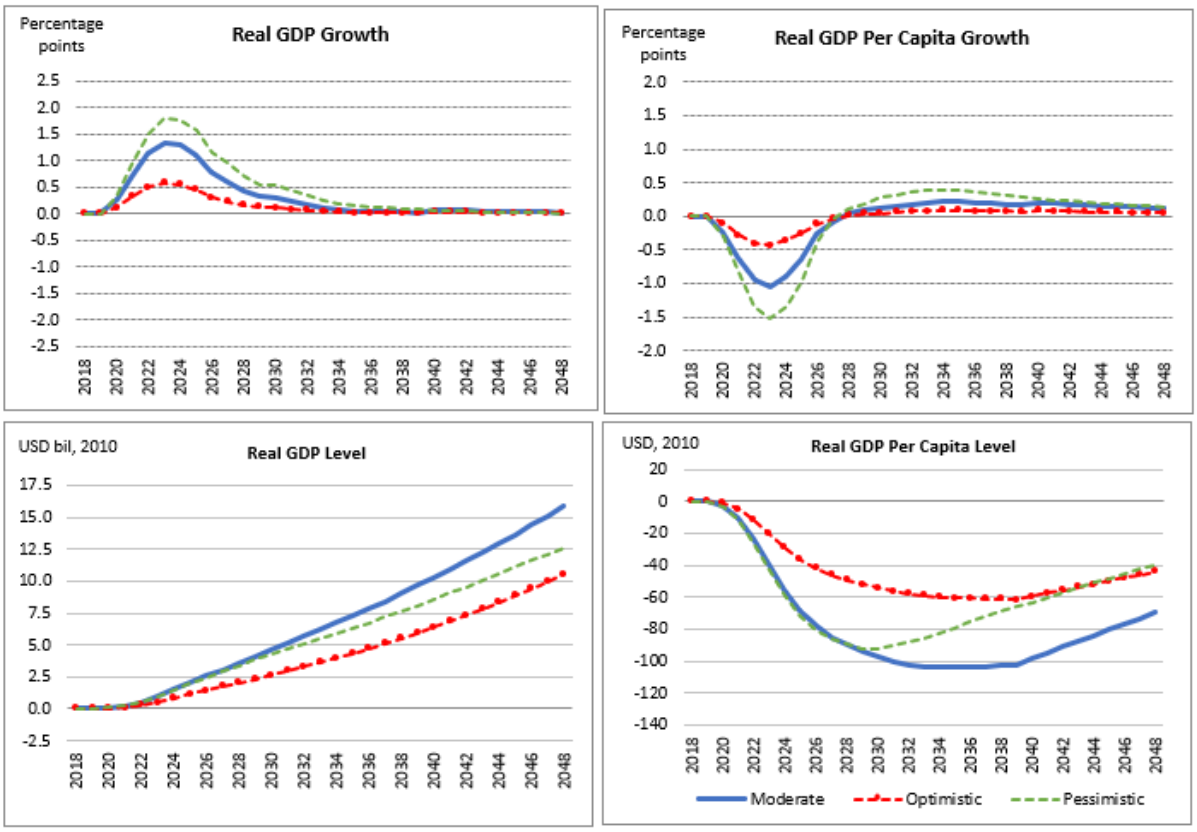


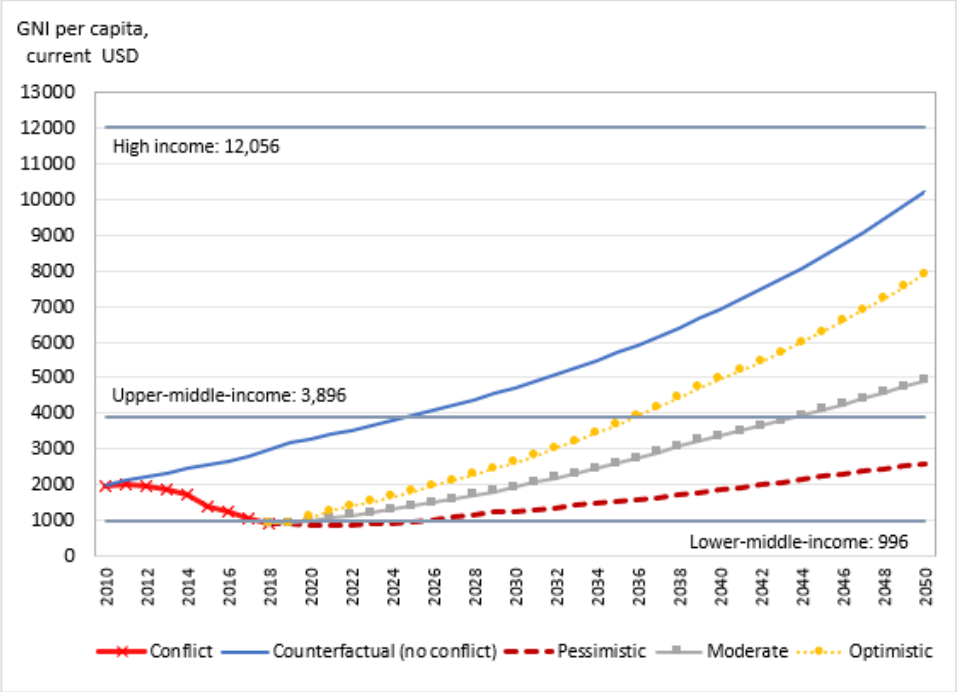
Figure 12: Post-Conflict Simulation of GDP in Syria –

Incremental/Decremental Effect of Forced Repatriation versus Voluntary Mobility



Note:
Each scenario reflects the difference that is calculated as forced repatriation case - voluntary mobility case.

Figure 13: Distance to Higher Income Group Thresholds based on GNI Per Capita



Notes:
GNI per capita based on the World Bank Atlas Methodology for Syria is only avaible up to 2007. We impute future values based on actual GDP per capita growth up to 2010 (at 2010 prices), our projections for GDP per capita growth over the conflict and post conflict periods (both also at 2010 prices). We account for inflation up to 2019 based on US inflation rates.
On using GDP growth rates to proxy GNI growth rates, our calculations based on pre-conflict data suggest the the growth rates of GDP per capita in current USD and GNI per capita based on the Atlas Methodology on average are quite close (e.g. 1998 - 2007: 7 percent versus 8 percent; 1993-2007: 5 percent versus 4 percent).
The post-conflict scenarios (pessimistic, moderate and optimistic) reflect the voluntary mobility case.

Table 1: No-Conflict Baseline Simulation -
Values for Parameters, Initial Conditions and Projected Variables

Parameter/Variable*	Note	Input value: 2010/ Calibrated	Average, Pre-Conflict	Average, 2011-30
A. Constant Parameters				
Labor share β	*(1)*	0.520		
Aggregate capital depreciation rate δ	*(2)*	0.048		
Public capital depreciation rate δ^G	*(2)*	0.031		
Private capital depreciation rate δ^P	*(3)*	0.062		
B. Initial Conditions				
Initial capital-to-output ratio K_0/Y_0	*(4)*	2.560		
Public capital share of total capital K^G/K	*(5)*	0.450		
Initial public capital-to-output ratio K_0^G/Y_0	*(6)*	1.152		
Initial private capital-to-output ratio K_0^P/Y_0	*(6)*	1.408		
C. Projected Variables, Central Path (2010/11— 30)				
Investment-to-output ratio I/Y	*(7)*		0.215	
Public investment-to-output ratio I^G/Y	*(7)*		0.086	
Private investment-to-output ratio I^P/Y	*(7)*		0.129	
Human capital growth g_h	*(8)*		0.010	
TFP growth g_A	*(9)*		0.014	
Population growth rate g_N	*(10)*			0.016
Working age-to-population share, growth g_ω	*(10)*			0.006
Labor force participation rate, growth g_ϱ	*(11)*		0.000	

*Multiply by 100 to obtain parameter/variable values in percent share or growth terms (%).

(1) PWT 9. Average of 2010 values for Djibouti, Jordan, Morocco and Tunisia.

(2) δ is PWT 8.1 data for Syria. δ^G is the PWT 9 depreciation rate for non-residential structures.

(3) δ^P is derived as the residual from a weighted average calculation of δ based on δ^G and K^G/K.

(4) Calibrated based on long-term averages of I/Y, GDP growth and δ. In steady-state, output grows at the same rate as capital stock, which allows us to write, $K/Y = I/Y/(g_Y + \delta)$ where g_Y is average output growth. We use: 30-year averages of I/Y (22%), g_Y (4.1%), and δ (4.5%).

(5) Calibrated based on average shares for lower-middle income countries and oil-based economies (fuel exports/total merchandise exports ≥ 30%). K^G/K data is from the IMF FAD Investment and Capital Stock Database 2017.

(6) K_0^G/Y_0 and K_0^P/Y_0 are derived by applying K^G/K to K_0/Y_0.

(7) Gross fixed capital formation (% of GDP), average for 2001-2007 from WDI. Public investment share assumed at 40% based on World Bank (2017) and IMF (2010).

(8) PWT 9. Average growth rate, 2001-2010.

(9) Authors' estimate. Average growth rate, 2001-2010.

(10) United Nations (2011).

(11) Based on the stabilizing participation rate observed in the 2013 ILO-modelled estimates.

Table 2: No-Conflict Simulation –
Upper and Lower Estimates for Projected Variables

Variable	Note	Input value
Lower estimate on projected variables (average, 2011-2030)		
Labor force participation rate, growth g_{ϱ}	*(1)*	-0.003
Upper estimate on projected variables (average, 2010/11-2030)		
Investment-to-output ratio I/Y	*(2)*	0.235
Public investment-to-output ratio I^G/Y	*(2)*	0.094
Private investment-to-output ratio I^P/Y	*(2)*	0.141
Human capital growth g_h	*(3)*	0.015

*Multiply by 100 to obtain parameter/variable values in percent share or growth terms (%).

(1) May 2018 ILO-modelled estimates.

(2) I/Y is based on IMF data suggesting higher GCF (% of GDP) after 2010. Public investment share of total investment unchanged at 40%.

(3) Long-term average. See Section 2.1.

Table 3: Simulation of Syria's Conflict Years (2011-2018)

Parameter/Variable	Note	2010	Average 2011-18	2018
A. Constant Parameters				
Labor share β	*(1)*		0.520	
Aggregate capital depreciation rate δ	*(1)*		0.048	
Public capital depreciation rate δ^G	*(1)*		0.031	
Private capital depreciation rate δ^P	*(1)*		0.062	
B. Capital-to-Output (K/Y) Ratios				
Initial public capital-to-output ratio K_0^G/Y_0	*(1)*	1.152		
Simulated K_c^G/Y (with damage)	*(2)*		1.141	1.029
Initial private capital-to-output ratio K_0^P/Y_0	*(1)*	1.408		
Simulated K_c^P/Y (with damage)	*(2)*		1.144	0.708
C. Projected Variables, Central Path (2011-2018)				
Public investment-to-output ratio I^G/Y	*(3)*	0.090	0.025	0.010
Private investment-to-output ratio I^P/Y	*(3)*	0.120	0.064	0.040
Efficiency of new public investment θ^N	*(4)*	0.734	0.632	0.570
Human capital growth g_h	*(5)*		-0.018	-0.006
TFP growth g_A	*(6)*		-0.016	-0.022
Population growth rate g_N	*(7)*		-0.017	0.001
Working age-to-population share, growth g_ω	*(7)*		-0.001	0.011
Labor force participation rate, growth, g_ϱ	*(8)*		-0.005	-0.008

*Multiply by 100 to obtain parameter/variable values in percent share or growth terms (%).

(1) Unchanged from Table 1.

(2) See Sections 3.1.1 and 3.2.

(3) Based on World Bank (2017).

(4) Average IEI for LMI countries for 2010 which is assumed to gradually decline to the average IEI for LI countries by 2017.

(5) See Section 3.1.3. Since the fall in enrollment rates and the exodus of Syrians occurs noticeably from 2013, we keep the human capital unchanged from 2010 to 2012, such that the contraction mainly occurs over 2013-2015: average growth of -4.28% (average growth, 2016-2018: 0.56%).

(6) See Section 3.1.4.

(7) Based on United Nations (2017).

(8) May 2018 ILO-modelled estimates.

Table 4: Simulation of Syria's Conflict Years (2011-2018)
– Lower and Upper Estimates and Impact on Capital-to-Output Ratios

Variable	Note	Average 2011-18	2018
A. Lower Estimate			
Population growth g_N	*(1)*	-0.030	0.000
Human capital growth g_h	*(2)*	-0.019	-0.006
Capital-to-Output (K/Y) Ratios (with Damage)			
Simulated K_c^G/Y		1.180	1.091
Simulated K_c^P/Y		1.175	0.737
B. Upper Estimate			
Public investment-to-output ratio I^G/Y	*(3)*	0.070	0.070
Private investment-to-output ratio I^P/Y	*(3)*	0.090	0.090
Labor force participation rate, growth, g_ϱ	*(4)*	0.007	0.006
Capital-to-Output (K/Y) Ratios (with Damage)			
Simulated K_c^G/Y		1.133	1.127
Simulated K_c^P/Y		1.139	0.784

*Multiply by 100 to obtain parameter/variable values in percentage share or growth terms (%).

(1) See Section 2.2.

(2) See Section 3.1.3. As in the central projection, we keep the human capital index unchanged from 2010 to 2012, such that the contraction mainly occurs over 2013-2015: average growth of -4.37% (average growth, 2016-2018: 0.57%).

(3) Based on ESCWA (2018).

(4) Based on World Bank (2019).

Table 5: Key Factors in the Post-Conflict Scenarios for Growth Drivers

Broad Case	Factor	Baseline (Moderate)	High (Optimistic)	Low (Pessimistic)
Voluntary mobility OR Forced repatriation	Security	Partial political settlement with strong guarantees for micro-security and property rights.	Robust political settlement.	Political settlement largely reflects de-facto balance of power, with limited guarantees for micro-security and property rights.
	Reconstruction program	USD 140 billion (average of the high and low scenarios), spread evenly over a 20-year period.	Large. USD 250 billion to meet UN-estimated reconstruction bill, spread evenly over a 20-year period.	Limited. USD 30 billion, largely relying on China, Iran and Russia, and spread evenly over a 10-year period.
Voluntary mobility	Refugee returns	Of total refugees in neighboring countries, 43% return rate based on the ratio of reconstruction funds in the first 10 years (moderate versus high scenario).	76% rate of refugee returns from neighboring countries, based on the UNHCR (2018) survey of refugees intending to return to Syria one day.	Of total refugees in neighboring countries, 18% return rate based on the ratio of reconstruction funds in the first 10 years (low versus high scenario).
Forced repatriation	Refugee returns	100% return rate, of refugees in neighboring countries.		
Refugee returns follow the same time pattern (United Nations 2017) across the three scenarios, rising to peak around 2023-2024, and gradually moderating thereafter World Bank (2019) finds that refugee mobilization tends to be lower, the lower are security and infrastructure services.				

Table 6: Simulation for Post-Conflict Syria – Projected Variables

Parameter/Variable*	Note	2018	Scenario								
			Optimistic			Moderate			Pessimistic		
			Average								
			2019-2028	2029-2038	2039-2048	2019-2028	2029-2038	2039-2048	2019-2028	2029-2038	2039-2048
Public investment-to-output ratio I^G/Y	*(1)*										
- voluntary mobility case		0.010	0.251	0.185	0.140	0.170	0.157	0.120	0.091	0.100	0.100
- forced repatriation case			0.250	0.183	0.140	0.168	0.155	0.120	0.088	0.100	0.100
Private investment-to-output ratio I^P/Y	*(1)*										
- voluntary mobility case		0.040	0.376	0.277	0.210	0.255	0.236	0.180	0.136	0.150	0.150
- forced repatriation case			0.374	0.275	0.210	0.252	0.232	0.180	0.133	0.150	0.150
Efficiency of new public investment θ^N	*(2)*	0.570	0.625	0.724	0.769	0.615	0.697	0.734	0.570	0.570	0.570
Human capital growth g_h	*(3)*		0.013	0.014	0.011	0.009	0.013	0.011	0.004	0.010	0.012
TFP growth g_A	*(4)*		0.001	0.021	0.020	-0.003	0.015	0.014	-0.009	0.009	0.009
Population growth rate g_N	*(5)*										
- voluntary mobility case			0.034	0.017	0.011	0.027	0.017	0.011	0.021	0.017	0.012
- forced repatriation case			0.039	0.016	0.010	0.039	0.016	0.010	0.039	0.016	0.010
Working age-to-population share, growth g_ω	*(6)*		0.009	0.002	0.000	0.009	0.002	0.000	0.009	0.002	0.000
Labor force participation rate, growth g_ϱ	*(7)*		-0.001	0.000	0.000	-0.001	0.000	0.000	-0.001	0.000	0.000

*Multiply by 100 to obtain parameter/variable values in percent share or growth terms (%).

(1) The 2018 values are from the central projection under conflict. See Section 4.1.1 for details on the scenarios.

(2) The 2018 value is from the central projection under conflict. See Section 4.1.1 for details of the scenarios.

(3) See Section 4.1.3.

(4) See Section 4.1.4.

(5) See Section 4.1.2.

(6) United Nations (2017).

(7) May 2018 ILO-modelled estimates up to 2030, held constant thereafter.

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SUPPLEMENTARY MATERIAL

APPENDIX 1- A MODEL OF LONG-TERM GROWTH WITH PUBLIC CAPITAL

Underlying the simulations in this paper is the following model, reproduced here in an abridged manner from Devadas and Pennings (2019). All the simulations are run using the Excel-based toolkit constructed based on this model.

4.1 The production function

We assume a Cobb-Douglas specification, where the public and private capital stocks have unitary elasticity of substitution. The following production function at time, t:

$$Y_t = A_t\, S_t (K_t^P)^{1-\beta} (h_t L_t)^{\beta} \tag{1}$$

Each firm takes technology (TFP), A_t and public services S_t as given, that is, these are externalities to the firm. K_t^P is the private capital stock, $h_t L_t$ is effective labor, which can be further decomposed into h_t , human capital per worker and L_t, the number of workers. $1-\beta$ and β are private capital and labor income shares. Next, we consider the following specification for public services S_t:

$$S_t = \left[\frac{G_t}{K_t^{P\zeta}}\right]^{\phi} \tag{2A}$$

$G_t$is the efficient physical public capital stock – the public capital that is actually used in production. ζ captures whether public capital is subject to congestion (or not). ϕ is the *usefulness* of public capital (more technically the elasticity of output to efficient public capital).

$$G_t = \theta_t K_t^{Gm} \tag{2B}$$

Due to corruption, mismanagement or pork-barreling, only a fraction $\theta_t \leq 1$ of measured public capital is useful for production. The measured capital stock K_t^{Gm} is what is recorded in international statistical databases, constructed using the perpetual inventory method. θ_t is the average *efficiency/quality* of the public capital stock. Equations (1), (2A) and (2B) can be written in a more conventional production function as:

$$Y_t = A_t (\theta_t K_t^{Gm})^{\phi} (K_t^P)^{1-\beta-\zeta\phi} (h_t L_t)^{\beta} \tag{3}$$

<u>Population and labor force growth</u>

Equation (3) can be translated into per worker terms by dividing both sides by L_t:

$$y_t \equiv \frac{Y_t}{L_t} = A\left[\theta_t (L_t)^{1-\zeta} k_t^{Gm}\right]^{\phi} (k_t^P)^{1-\beta-\zeta\phi} {h_t}^{\beta} \tag{4}$$

where y_t is output per worker and k_t^P is private capital per worker and k_t^{Gm} is measured public capital per worker (note the lower case). $L_t = \varrho_t \omega_t N_t$, where N_t is total population, ω_t is the working age-population ratio and ϱ_t is the labor participation rate (labor force-to-working age population ratio). The above equation can then be used to calculate growth rates of output per worker from t to $t+1$:

$$\frac{y_{t+1}}{y_t} = \left[\frac{\omega_{t+1}}{\omega_t}\frac{\varrho_{t+1}}{\varrho_t}\frac{N_{t+1}}{N_t}\right]^{(1-\zeta)\phi} \left[\frac{A_{t+1}}{A_t}\right] \left[\frac{\theta_{t+1}}{\theta_t}\right]^{\phi} \left[\frac{k_{t+1}^{Gm}}{k_t^{Gm}}\right]^{\phi} \left[\frac{k_{t+1}^{P}}{k_t^{P}}\right]^{1-\beta-\zeta\phi} \left[\frac{h_{t+1}}{h_t}\right]^{\beta} \tag{5}$$

Equation (5) can be rewritten in terms of growth rates from t to $t+1$:

$$1+g_{y,t+1}=[(1+\Gamma_{t+1})^{(1-\zeta)\phi}](1+g_{A,t+1})(1+g_{\theta,t+1})^{\phi}(1+g_{k^{Gm},t+1})^{\phi}(1+g_{k^{P},t+1})^{1-\beta-\zeta\phi}(1+g_{h,t+1})^{\beta} \quad (6)$$

where the growth rate of a variable x from t to $t+1$ is denoted by $g_{x,t+1}$, and Γ is the growth rate of the number of workers:

$$1+\Gamma_{t+1}=(1+g_{\varrho,t+1})(1+g_{\omega,t+1})(1+g_{N,t+1}) \quad (7)$$

$1+\Gamma_{t+1}$ drops out from equation (6) in the congestion default ($\zeta=1$).

To obtain output per capita, y_t^{PC} from equation (4), $y_t^{PC}\equiv\frac{Y_t}{N_t}=\frac{Y_t}{L_t}\varrho_t\omega_t$. Rewriting this equation in terms of growth rates:

$$1+g_{y,t+1}^{PC}=(1+g_{y,t+1})(1+g_{\varrho,t+1})(1+g_{\omega,t+1}) \quad (8)$$

To obtain output growth, we multiply (8) with population growth:

$$1+g_{Y,t+1}=(1+g_{y,t+1}^{PC})(1+g_{N,t+1}) \quad (9)$$

4.2 Public and private capital accumulation, and changes in the efficiency/quality of public capital

The *measured* quantity of public capital (as in international statistical databases) accumulates according to a standard capital accumulation identity, with the next period's stock coming from the previous period's undepreciated stock, $(1-\delta^G)K_t^{Gm}$ (where δ^G is the public capital depreciation rate) and new public investment, I_t^G.

$$K_{t+1}^{Gm}=(1-\delta^G)K_t^{Gm}+I_t^G \quad (10)$$

The gross growth rate of measured public capital (not per worker) is:

$$K_{t+1}^{Gm}/K_t^{Gm}=(1-\delta^G)+\frac{I_t^G/Y_t}{K_t^{Gm}/Y_t} \quad (11)$$

The growth rate of measured public capital *per worker,* which enters equation (6), is:

$$1+g_{k^{Gm},t+1}\equiv\frac{K_{t+1}^{Gm}}{K_t^{Gm}}/\frac{L_{t+1}}{L_t}=\frac{(1-\delta^G)+\frac{I_t^G/Y_t}{K_t^{Gm}/Y_t}}{(1+g_{\varrho,t+1})(1+g_{\omega,t+1})(1+g_{N,t+1})} \quad (12)$$

The stock of efficiency-adjusted public capital (which is actually used in production) evolves based on the previous period's efficiency-adjusted undepreciated stock and efficiency-adjusted new investment $\theta_t^N I_t^G$.

$$G_{t+1}=(1-\delta^G)G_t+\theta_t^N I_t^G \quad (13A)$$

θ_t is the average efficiency of existing public capital (rather than the efficiency of new investment). Substituting $G_t=\theta_t K_t^{Gm}$ into Equation 13A and rearranging as 13B, one can see the θ_{t+1} evolves as a weighted average of the quality of existing public capital θ_t, and the quality of new investment θ_t^N.

$$\theta_{t+1}=\theta_t\frac{(1-\delta^G)K_t^{Gm}}{(1-\delta^G)K_t^{Gm}+I_t^G}+\theta_t^N\frac{I_t^G}{(1-\delta^G)K_t^{Gm}+I_t^G} \quad (13B)$$

As such, the quality/efficiency of the stock of public capital only changes when the quality of new investment projects is different from that of the existing public capital stock: $\theta_t^N\neq\theta_t$. Using equation (13B), the growth in quality which enters equation (6) can be written as follows:

$$1 + g_{\theta,t+1} \equiv \frac{\theta_{t+1}}{\theta_t} = \left[(1-\delta^G) + \frac{\theta_t^N}{\theta_t}\frac{I_t^G/Y_t}{K_t^{Gm}/Y_t}\right]/(K_{t+1}^{Gm}/K_t^{Gm}) \tag{14}$$

The quantity of private capital follows the same accumulation process as public capital. But with δ^P as the private capital depreciation rate, and I_t^P as private investment. The growth rate of private capital per worker is as follows:

$$1 + g_{k^P,t+1} = \frac{(1-\delta^P)+\frac{I_t^P/Y_t}{K_t^P/Y_t}}{(1+g_{\varrho,t+1})(1+g_{\omega,t+1})(1+g_{N,t+1})} \tag{15}$$

4.3 Analysis of the drivers of growth

To better understand and simplify the analysis of the drivers of growth, we take a log-linear approximation of equation (6). Specifically, equations (12), (14) and (15) are substituted into equation (6). Then, taking logs and using the approximation $\ln(1+g) \approx g$ (for small g) we arrive at the following:

$$g_{y,t+1}^{PC} \approx g_{A,t+1} + \beta\left(g_{\varrho,t+1} + g_{\omega,t+1} + g_{h,t+1}\right) - (1-\beta)(g_{N,t+1}) + \phi\left[\theta_t^N \frac{I_t^G/Y_t}{\theta_t K_t^{Gm}/Y_t} - \delta^G\right]$$
$$+(1-\beta-\zeta\phi)\left(\frac{I_t^P/Y_t}{K_t^P/Y_t} - \delta^P\right) \tag{16}$$

4.4 Implementation

The future growth rates of the labor participation rate ($g_{\varrho,t+1}$), the working age-population ratio ($g_{\omega,t+1}$), population ($g_{N,t+1}$) and pure TFP ($g_{A,t+1}$), are exogenously determined. The growth rate of measured public capital per worker ($g_{k^{Gm},t+1}$) which is given by equation (12), using the growth rate of the public capital stock (equation (11)) as an intermediate step. Private capital per worker growth ($g_{k^P,t+1}$) is as given by equation (15). The growth rate of the efficiency of public capital ($g_{\theta,t+1}$) as given by equation (14) using the growth rate of the public capital stock (equation (11)) as an intermediate step.

Finally, the model is closed by updating public capital-to-output using equation (17) and the private capital-to-output ratio using equation (18) (with the growth rates in per-worker terms):

$$\frac{K_{t+1}^{Gm}}{Y_{t+1}} = \frac{K_t^G}{Y_t}\frac{(1+g_{k^{Gm},t+1})}{1+g_{y,t+1}} \tag{17}$$

$$\frac{K_{t+1}^P}{Y_{t+1}} = \frac{K_t^P}{Y_t}\frac{(1+g_{k^P,t+1})}{1+g_{y,t+1}} \tag{18}$$

APPENDIX 2 - ESTIMATED PHYSICAL CAPITAL DAMAGE DURING CONFLICT

Notes:

Data on physical damage and conflict intensity from 2011 to 2017 is sourced from ESCWA (2018). The conflict intensity index is based on damage reports; estimated number of casualties; and the geographical size and spread of military operations as well as the volume of assets deployed, and the intensity of weapons used.

*Authors' calculations where the conflict intensity index is assumed to take the 2017 value of 25 in the first quarter and an average of the 2011 and 2012 index values (2 and 6 respectively) in the other three quarters. Given the calculated average conflict intensity index for 2018 of 9.25, we then derive an estimate of physical damage that is proportionate to the 2017 estimate of physical damage of USD 18.5 billion.

APPENDIX 3 - PROJECTION OF AVERAGE YEARS OF SCHOOLING DURING CONFLICT

	A		B		C		D		E		F		G	
	Average years of schooling by age group								Population ('000)					
Age group	2010 (from Barro and Lee)		Projected 2015[1]		Projected 2020[1]		Interpolated 2018[5]		Population 2010 (UN 2017)		Population 2018 (UN 2017)		Population 2018 (adjusted)[6]	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
1: 15-19	7.48	7.49	2.52 [2]	2.53 [2]	2.52 [4]	2.53 [4]	2.52	2.53	1078	1135	1071	1133	1009	1050
2: 20-24	7.84	8.26	4.48 [3]	4.90 [3]	4.48 [4]	4.90 [4]	4.48	4.90	1072	1106	820	897	752	760
3: 25-29	7.15	7.52	7.84	8.26	4.48	4.90	5.82	6.24	1001	1006	583	653	521	532
4: 30-34	6.82	7.46	7.15	7.52	7.84	8.26	7.56	7.96	813	803	578	604	527	504
5: 35-39	6.20	7.83	6.82	7.46	7.15	7.52	7.02	7.50	625	612	569	552	530	472
6: 40-44	6.20	7.84	6.20	7.83	6.82	7.46	6.57	7.61	511	501	480	453	447	388
7: 45-49	4.64	7.76	6.20	7.84	6.20	7.83	6.20	7.83	431	426	400	375	373	320
8: 50-54	4.64	7.81	4.64	7.76	6.20	7.84	5.58	7.81	335	332	361	335	339	291
9: 55-59	2.81	6.89	4.64	7.81	4.64	7.76	4.64	7.78	263	257	309	285	293	250
10: 60-64	2.60	6.47	2.81	6.89	4.64	7.81	3.91	7.44	168	173	244	220	236	209

Using the respective average years of schooling for females and males in each age group, we can calculate the average total years of schooling for each age group, $S_a^y = S_{f,a}^y \times \frac{Pop_{f,a}^l}{Pop_a^l} + S_{m,a}^y \times \frac{Pop_{m,a}^l}{Pop_a^l}$

Then, the average total years of schooling for population aged 15-64, $S^y = \sum_{a=1}^{10} S_a^y \times \frac{Pop_a^l}{Pop_{(15-64)}^l}$

where a = age group; Pop is population; y = A, or D. l = E if y=A and F or G if y = D. f = female, m =male.

This would give us average total years of schooling for population aged 15-64 of 7.080 in 2010 (based on columns A and E), 5.612 in 2018 (based on columns D and F) or 5.581 in 2018 (based on columns D and G).

Notes:

[1] For age groups 25-29 and upwards, the respective average years of schooling of females and males in the age group five years younger at *t-5* is assumed, that is $s_t^a = s_{t-5}^{a-1}$.

[2] Using $s_t^a = s_{t-5}^a + \Delta enroll_{j,t}^a Dur_{j,t-5}^a$, the second element on the right-hand side, the enrollment adjustment factor, is calculated as ((-0.18+0.22)*6)+((-0.22-0.10)*12)+((-0.18+0.22)*3)+((-0.22-0.10)*9)+(0.10*14). The first to fifth terms are for the following education levels: primary, secondary, incomplete primary, incomplete secondary, incomplete tertiary.
This is based on the formula in Table A.2 in Barro and Lee (2013) which we reproduce at the end of this page for reference.
-0.18 is the change in primary enrollment rate, 6 is the duration of primary education, -0.22 is the change in the secondary enrollment rate, 12 is the duration of primary + secondary education, 3 is incomplete primary education, 9 is incomplete secondary education, 0.10 is the change in the tertiary enrollment rate, and 14 is the duration of incomplete tertiary education.
We exclude an adjustment for "no education" as this term would drop out since the corresponding duration is zero.

[3] The enrollment adjustment factor is calculated as
((-0.18+0.22)*6)+((-0.22-0.10)*12)+((-0.18+0.22)*3)+((-0.22-0.10)*9)+(0.10*14)+(0.10*16)
where 16 is the duration of primary + secondary + tertiary education.

[4] Average years of schooling of the same group in the previous period is assumed.

[5] Linearly interpolated based on the 2015 and 2020 projections for average years of schooling (from columns B and C).

[6] UN 2017 data adjusted for a larger number of migrants and fatalities. See the discussion in Section 2.2 of the main paper.

Barro and Lee (2013), Table A.2.

Enrollment adjustment factor for age groups, 15–19 and 20–24.

Level	Forward extrapolation
No education	$-(enroll_{pri,t}^a - enroll_{pri,t-5}^a)$
Primary	$(enroll_{pri,t}^a - enroll_{pri,t-5}^a) - (enroll_{sec,t}^a - enroll_{sec,t-5}^a)$
Secondary	$(enroll_{sec,t}^a - enroll_{sec,t-5}^a) - (enroll_{ter,t}^a - enroll_{ter,t-5}^a)$
Tertiary	$(enroll_{ter,t}^a - enroll_{ter,t-5}^a)$

Note: $enroll_{j,t}^a$ is the enrollment rate for age group a in level j at time t.

APPENDIX 4 - PROJECTION OF TFP GROWTH DURING CONFLICT

Table A4.1 Variables Used in Projections of Selected Determinant Sub-Indices of the TFP Overall Determinant Index

Variable/ Year	Infrastructure	Education	Governance					
	Relative total city light (%)[1]	Schooling (average years)[2]	Voice and accountability	Control of corruption	Government effectiveness	Political stability and absence of violence	Regulatory quality	Rule of law
			(composite indicator)[3]					
2010	100	7.08	-1.70	-1.13	-0.61	-0.81	-0.90	-0.59
2011	70	7.08	-1.81	-1.09	-0.50	-2.01	-0.95	-0.78
2012	40	7.08	-1.84	-1.21	-1.15	-2.68	-1.53	-1.13
2013	33	6.65	-1.83	-1.26	-1.40	-2.68	-1.55	-1.41
2014	22	6.21	-1.88	-1.55	-1.40	-2.75	-1.69	-1.36
2015	18	5.78	-1.92	-1.55	-1.59	-2.97	-1.64	-1.42
2016	21	5.71	-1.99	-1.57	-1.83	-2.92	-1.67	-1.99
2017	21	5.65	-1.97	-1.56	-1.79	-2.63	-1.83	-2.09
2018	21	5.58	-1.97	-1.56	-1.79	-2.63	-1.83	-2.09

[1] Data from Li et al. (2017) is for March of each of year (2010-2016) and January 2017 and pertains to Syria as a whole. We assume that the 2017 level continues to prevail in 2018.

[2] Authors' calculations.

[3] Worldwide Governance Indicators (WGI) (Kaufmann, Kraay and Mastruzzi (2010), updated to 2017). We assume the 2017 values continue to prevail in 2018.

Table A4.2 TFP Overall Determinant Index and Its Sub-Indices

Year	Sub-indices of the TFP overall determinant index					TFP overall determinant index	
	(A) Innovation[1]	(B) Education[2]	(C) Market Efficiency[1]	(D) Infrastructure[3]	(E) Institutions[4]	(F) Composite Index[5]	(G) Rescaled Composite Index[6]
2010	-0.352	-0.247	-0.317	0.308	-0.877	-0.641	30.33
2011	-0.564	-0.247	-0.507	0.215	-1.102	-0.960	26.88
2012	-0.899	-0.247	-0.808	0.123	-1.517	-1.466	21.40
2013	-0.983	-0.263	-0.884	0.102	-1.623	-1.600	19.96
2014	-1.062	-0.281	-0.955	0.068	-1.708	-1.727	18.58
2015	-1.121	-0.302	-1.008	0.055	-1.785	-1.826	17.51
2016	-1.218	-0.306	-1.095	0.065	-1.945	-1.974	15.90
2017	-1.212	-0.310	-1.089	0.065	-1.934	-1.965	16.00
2018	-1.212	-0.313	-1.089	0.065	-1.934	-1.967	15.98

[1] From 2011, values are calibrated to evolve proportionately to a weighted average of the insfrastructure and institutions sub-indices. The weights are based on the cofficients calculated by Kim and Loayza (2019), normalized to sum to one. Weighted average (D+E) = 0.52*(D) + 0.48*(E).

[2] From 2011, values are calibrated to evolve proportionately to the average years of schooling.

[3] From 2011, values are calibrated to evolve proportionately to relative total city light.

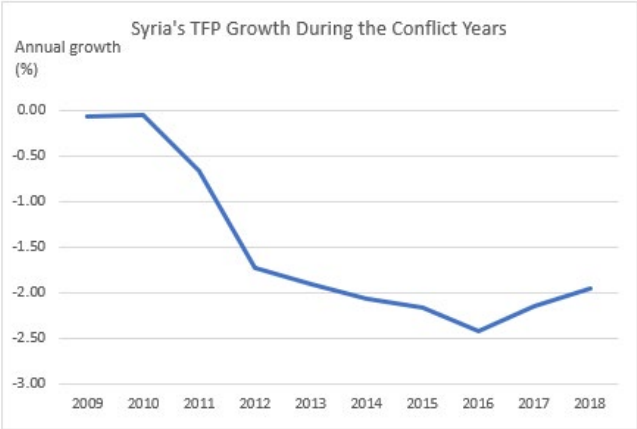
[4] The composite institutions sub-index is calculated using the six indicators in the WGI, based on the methodology and coefficients/weights derived in Kim and Loayza (2019).

[5] The overall determinants index is calculated using the methodology and coefficients/weights derived in Kim and Loayza (2019). (F) = 0.43*(A) + 0.44*(B) + 0.46*(C) + 0.47*(D) + 0.43*(E).

[6] The overall determinants index is rescaled with the following transformation, as in Kim and Loayza (2019): (composite index (F) for Syria at time t - lowest index)/(highest index-lowest index)*(100-1)+1. The highest and lowest indices are the best and worse values across countries across the three decades, 1985-2014.

APPENDIX 4 - PROJECTION OF TFP GROWTH DURING CONFLICT (CONT'D)

Graph A4.1: Projected TFP Growth for Syria based on the TFP Overall Determinant Index



Notes:

TFP growth is calculated using the following equation based on Kim and Loayza (2019), where $Index$ is the TFP Overall Determinant Index, and TFP is the level of TFP in index form, with 2011 normalized to one.

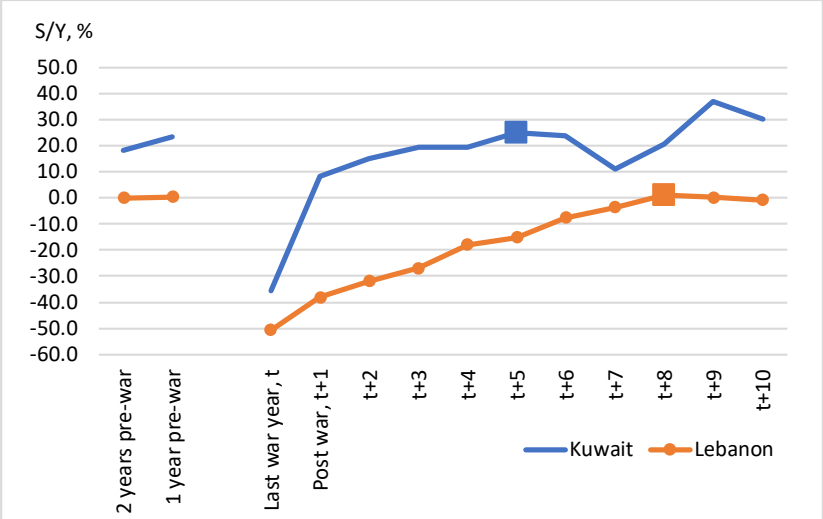
$$TFP\ growth_{(t,t-1)} = -0.180 + 0.050[\ln(Index_{t-1}) - \ln(Index_{t-2})] - 0.099\ [\ln(TFP_{t-1}) - \ln(TFP_{t-2})]$$

For the initial year, 2011, a 15-year average, [(t-1) - (t-16)]/15, is used for the change in the index and TFP level.

APPENDIX 5 – POST-CONFLICT SCENARIOS FOR SYRIA'S SAVING-TO-OUTPUT

We refer to the experiences of Kuwait and Lebanon to establish the transition path for Syria's saving-to-output, S/Y in terms of the change and time to recovery. Kuwait is used to guide the optimistic scenario and Lebanon, the pessimistic scenario. The moderate scenario reflects the average of the values under the other two scenarios.

Graph A5.1: Saving-to-Output in Kuwait and Lebanon



Source: Authors' calculations based on Sab (2014) and World Development Indicators (WDI).
S/Y= GFCF/Y + (X/Y-M/Y), where GFCF = gross fixed capital formation, X=exports of goods and services and M = imports of goods and services. We focus on the domestic savings ratio rather than the gross national savings ratio to better gauge domestic production capacity.
Square markers are where we assume each country's S/Y recovers to its pre-war level.

Graph A5.2: Saving-to-Output Scenarios for Syria