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Working Paper No. 1340

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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 in terms physical capital, labor force, human capital, and productivity; and 3) what potential growth scenarios for Syria there could be in the aftermath of war. Estimates of the impact of conflict point to negative gross domestic product (GDP) growth of -12 percent on average over 2011–18, resulting in a GDP contraction 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 plausible 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 percent, assuming that a final and stable resolution of the conflict is achieved.

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

JEL Classifications: D74, F51, 011, 040, 053.

1. Introduction

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. The United Nations Economic and Social Commission for Western Asia (ESCWA 2018) - which conducted an elaborate sectoral analysis of the economic cost of the Syrian civil war - puts the destruction of the physical capital stock by end of 2017 at almost USD 120 billion. And, in terms of the cost to the overall economy, the World Bank (2017b) 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 seem to broadly cohere with the 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 percent 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 (IDPs). According to the United Nations High Commissioner for Refugees (UNHCR), there are about 5.6 million registered refugees from Syria in neighboring countries. 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 (UNHCR, 2019). Adding these numbers to the about 6.3 million IDPs 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 IDPs crisis, it suffices to note that the former accounts for more than 23 percent of the total number of refugees worldwide, while the percentage of the latter is estimated at 20 percent of the total number of IDPs in the world.

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 relatively 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 insight from modern growth theory could be useful in assessing the post-conflict growth potential for Syria. Janossy (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 - with almost two-thirds of its population internally displaced or living as refugees in foreign countries - 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 repatriation of refugees 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 at USD 250 billion by the United Nations 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 (ERF 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 (rebuilding infrastructure, access to health and education, etc.) and institutional reform (including security, property rights, and access to justice) that benefit various segments of the population fairly (Yahya 2017). Djankov and Reynal-Querol (2010) find that both per capita income and civil war are jointly determined by country-specific phenomena, such as colonial history. Consequently, policies are needed to rectify structural problems that make countries 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) - see Appendix 1 for details - 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 (Sochi-plus, mainly operated by Iran, Russia, and Turkey, with some involvement from the United Nations) moderate scenario; a high (robust political settlement, brokered by the United Nations) scenario; and a pessimistic (de facto balance of power) scenario. The LTGM-PC builds on the Solow-Swan growth model, and is evolved from another World Bank tool, the Long-Term Growth Model (LTGM) (Loayza and Pennings 2018; Hevia and Loayza 2012). The LTGM-PC splits the accumulation of aggregate capital into public and private portions, while retaining other features of the LTGM including other growth drivers (demographics and the labor force, human capital, and total factor productivity). We run all our simulations using the LTGM-PC Excel-based toolkit.

Our paper complements earlier modeling work by World Bank (2017b) in four ways. One, it provides a straightforward and transparent analysis of how GDP evolves based on projections for the growth drivers. World Bank (2017b) 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 (2017b) 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 (that is, if war had not occurred), our baseline projection shows average real GDP growth of 5.3 percent 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 percent on average over 2011-2018, resulting in a GDP level of USD 23.2 billion in 2018. Comparing the conflict versus no conflict simulations suggest a cumulative loss in GDP potential of about USD 300 billion over 2011-2018. The depletion of factors of production alone may account for about 87 percent of the negative GDP growth on average, and further, about 64 percent of the average negative growth 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 percent, human capital 7 percent, and total factor productivity 13 percent of negative GDP growth on average over the conflict years.

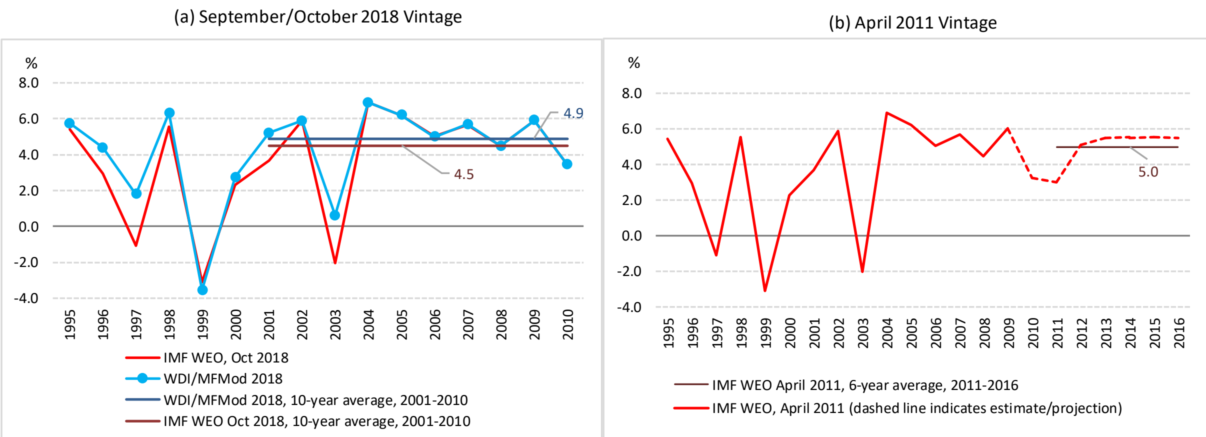
In our post-conflict simulations, we assume that the three political settlement scenarios are associated with different levels of reconstruction assistance and different degrees of voluntary mobility of refugees. These in turn affect key drivers of growth: public and private investment, and the labor 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 reach its 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

This section focuses on building a calibration using the LTGM-PC for a no-conflict scenario based on developments and projections prior to the conflict. Recent data indicate that average real GDP growth in Syria was around 4.7% over 2001-2010 (Figure 1(a)). World Bank's World

Development Indicators (WDI)[4] data suggest an average growth of 4.9% over 2001-2010, while IMF World Economic Outlook (WEO), points to 4.5%, over the same period.[5] Just prior to the conflict, projections for near-term growth were still robust: an average of 5.6% over 2011-2012 in the World Bank Global Economic Prospects (GEP), January 2011[6]; and an average of 5.0% over 2011-2016 in the IMF WEO, April 2011 edition[7] - see figure 1(b). In the following subsection we look at pre-conflict trends and projections (where available) for key growth drivers (physical investment, demographics and the labor force, human capital and total factor productivity).

Figure 1: Pre-Conflict Real GDP Growth and Projection

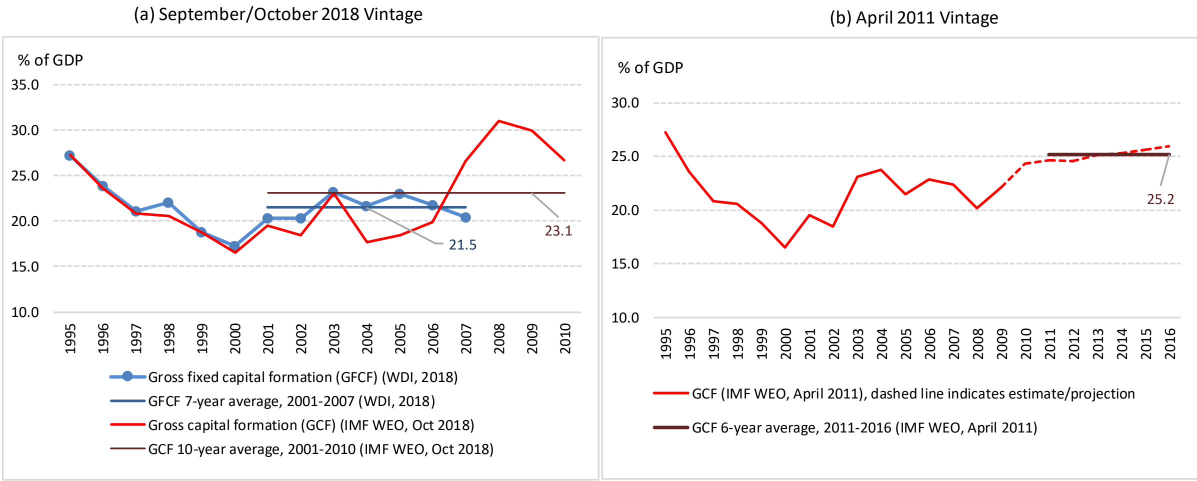


2.1. Growth drivers

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 7-year period, 2001-2007 (Figure 2(a), blue line with marker).[8] For gross capital formation (GCF), which includes inventories, as a percentage of GDP, the IMF WEO October 2018 showed an average of 23.1% over 2001-2010 (Figure 2(a) red line). Pre-conflict data (IMF WEO April 2011) 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)). Of total I/Y, how much exactly can be attributed to public investment (I^G/Y) is uncertain - 40% seems plausible based on reported figures.[9]

[4] WDI data for Syria are publicly available only up to 2007. We supplement these data for the last three years up to 2010 with data on GDP growth from the World Bank's internal macroeconomic model (MFMod), November 2017 vintage, which is consistent with the IMF WEO October 2018 data.
[5] WDI: GDP is at market prices, 2010 USD. IMF WEO: GDP is at market prices, 2000 local currency.
[6] Source: http://documents.worldbank.org/curated/en/293851468162862428/Global-economic-prospects-January-2011-navigating-strong-currents. GDP growth of 5.0% for 2010 is an estimate. No GEP projections for Syria are available beyond the January 2011 publication. GDP is at market prices, 2005 USD.
[7] Source: https://www.imf.org/external/pubs/ft/weo/2011/01/weodata/index.aspx.
[8] MFMod numbers suggest a slightly lower average of 20.5% over the same period (and 20.1% over 2001-2010).
[9] World Bank (2017b) reports I^G/Y of 9% and private fixed capital formation-to-output, I^P/Y of 12% in 2010 giving a public investment share of total investment of 43%. Data in IMF (2010) indicate an average share of 38% over 2005-2008, based on gross capital formation-to-output averaging 21.8%. Calculations using the IMF FAD Investment and Capital Stock Database 2017 suggest an average share of 47% over 2001-2010, but the average value for total investment-to-output at 6% is relatively low compared to the other reported values.

Figure 2: Pre-Conflict Investment and Projection



Demographics and the labor force. 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 United Nations (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), dashed lines with markers).[10]

The labor force participation rate (LFPR)[11] meanwhile, had been on a moderating trend, declining from 54.5% in 1995 (Male: 84.3%; Female: 24.4%) to 44.9% in 2010 (Male: 75.6%; Female: 14.0%), with an average growth over 2001-2010 of -1.5% (Male: -0.9%; Female: -3.9%) (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 rural areas, and workers becoming students. Women in the agriculture sector became jobless with the drought and higher fuel prices in the second half of the 2000s, and were unable to find other work, thus returning to domestic services in their homes. In the case of the increase in students, this was partly affected by the easing of entry into universities, and the development of the financial sector (entry of private banks and insurance companies) that required high-skilled workers. It is not clear though, if the developments cited in relation to student enrollment were expected to have a long-term impact on the LFPR. Early in the conflict, International Labour Organization (ILO)-modelled estimates and projections 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.[12]

[10] This is based on the medium fertility variant – "…considered the most likely future scenario and that is widely used by the literature" (Barro and Lee 2015). This variant has "normal" fertility, mortality and migration rates.

[11] Percentage of total population aged 15-64.

[12] Labor force participation rates for 2013-2014 are projections. ILO-modeled estimates and projections are based on estimates and projections for GDP-related variables and population structure. The 2013 estimates and projections 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.

Figure 3: Pre-Conflict Population Growth Rate and Projection

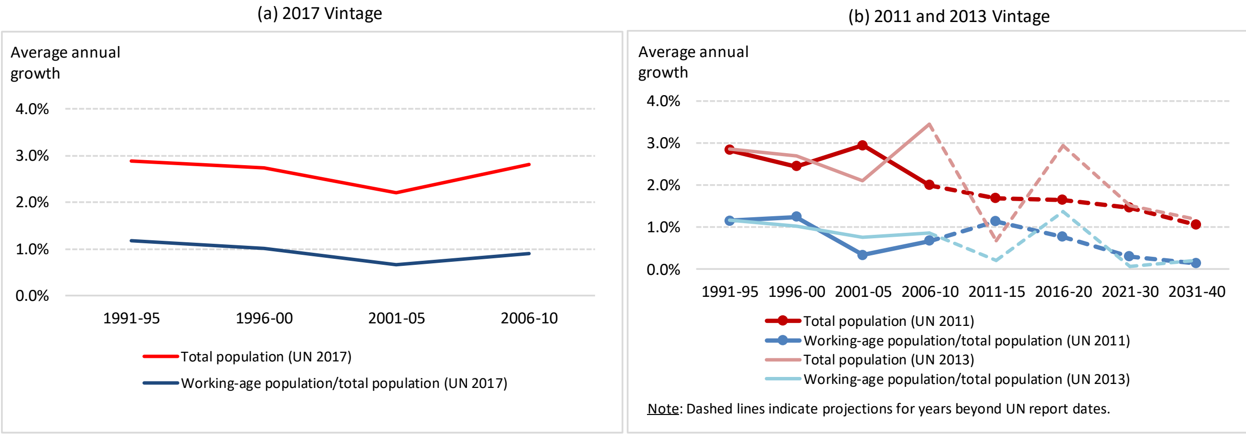
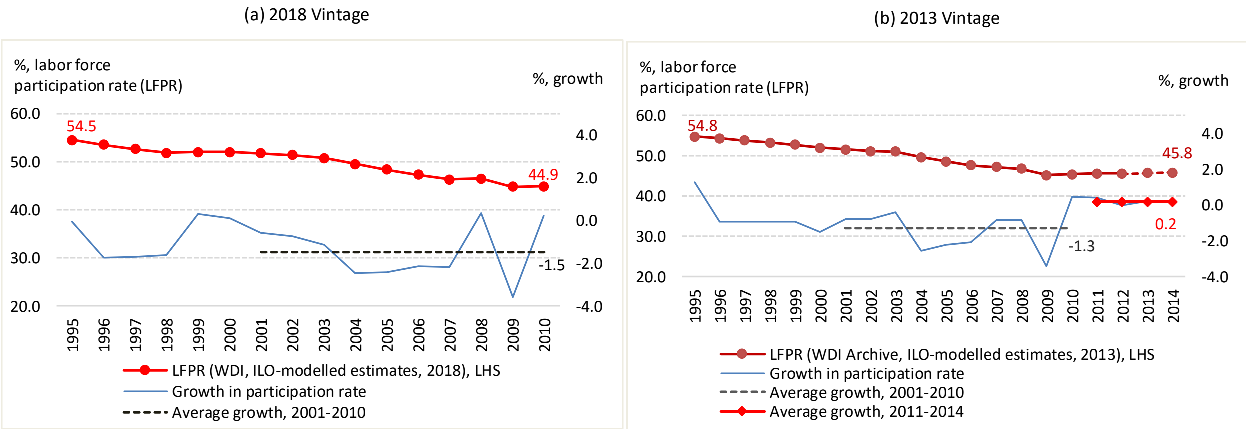


Figure 4: Pre-Conflict Labor Force Participation Rate and Projection



Human capital growth, based on Penn World Tables (PWT) 9, which for Syria, uses Cohen, Soto and Leker (CSL) data for the average years of schooling of the population aged 25 and above (Cohen and Soto 2007; Cohen and Leker 2014), averaged 1.0% for the 10 years up to 2010.[13, 14] 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:[15] 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%.

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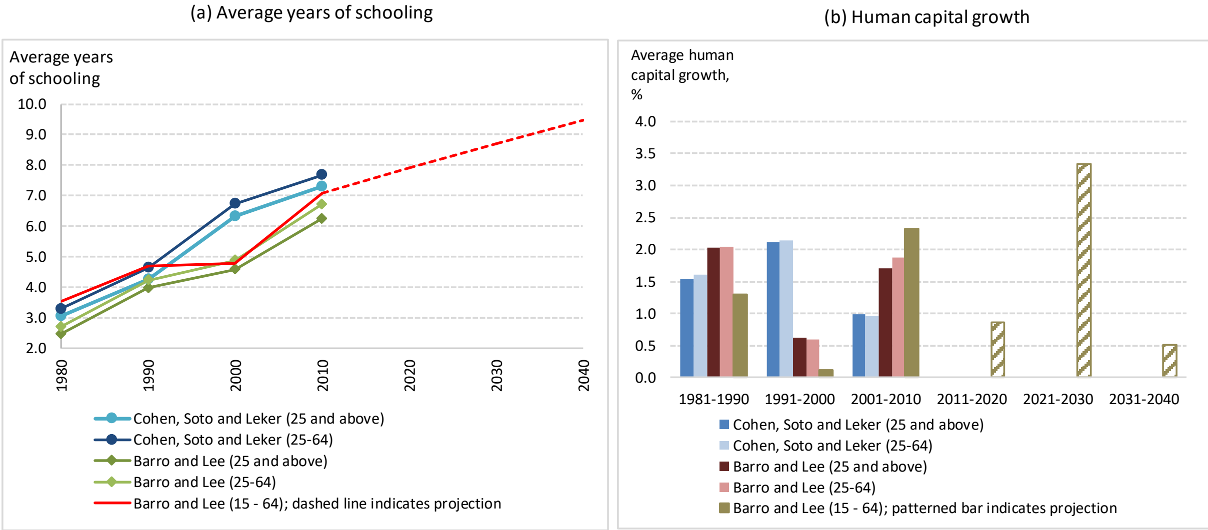
[13] See the documentation, "Human Capital in PWT 9.0" (https://www.rug.nl/ggdc/productivity/pwt/). Human capital, $h = e^{\Phi(s)}$, where s is average schooling years. $\Phi(s)$= 0.134 · s if s ≤ 4, $\Phi(s)$=0.134 · 4+0.101 · (s − 4) if 4 < s ≤ 8, $\Phi(s)$= 0.134 · 4+0.101 · 4+0.068 · (s − 8) if s>8 (based on Caselli (2005) and Hall and Jones (1999)). For the first four years of education, a rate of return of 13.4 percent is assumed, corresponding to the average, reported by Psacharopoulos (1994) for Sub-Saharan Africa. For the next four years 10.1 percent is assumed, the average for the world. For education beyond the eighth year the OECD value, 6.8 percent is assumed.

[14] Using PWT 8.1 data points to a human capital growth rate 0.5% over 2001-2010, but this is based on a previous version of Barro and Lee data (version 1.3, which has since been updated).

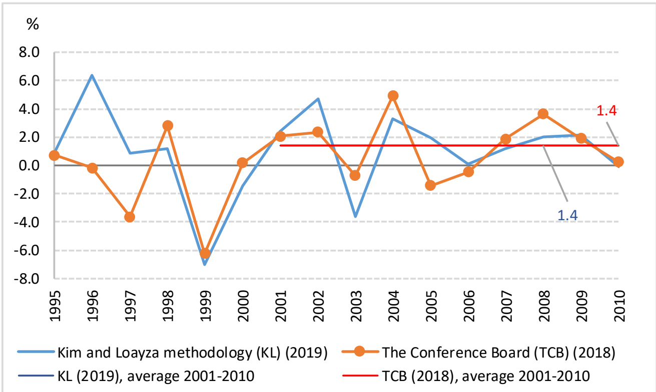
[15] Barro and Lee (2015) do not appear to capture the population loss in Syria from the conflict, as they use projections from United Nations (2013).

Figure 5: Pre-Conflict Human Capital and Projection



Total factor productivity (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.[16] See figure 6.

Figure 6: Pre-Conflict Total Factor Productivity (TFP) Growth



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

Table 1 details the baseline calibration of the LTGM-PC for simulation under the no-conflict scenario. 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 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. We discuss the baseline assumptions in sub-sections 2.2.1 - 2.2.2 below. Sub-section 2.2.3 considers upper and lower estimates for the calibration.

[16] TFP is measured using growth accounting based on the standard Solow-Swan growth model with human capital. Syria data for output, physical capital, human capital, and employed persons are taken from Penn World Tables (PWT) 9. Labor share is proxied by the average for four relatively conflict-free middle-income Middle East and North Africa (MENA) economies (Djibouti, Jordan, Morocco and Tunisia).

2.2.1. Key parameters and initial conditions

Key parameters and initial conditions (panels A and B of Table 1) either take their 2010 values or are calibrated. In panel A of Table 1, Syria's share of labor income of 0.520 is proxied by the 2010 average value for relatively conflict-free middle-income MENA economies from PWT 9. This value is close to the average for lower-middle income (LMI) countries (0.510), as well as "oil-based" middle-income economies with fuel exports amounting to less than 60% of their merchandise exports (0.540). The Conference Board (2018) also uses a similar value of 0.500. We calibrate the depreciation rate for aggregate capital to 4.8%, which is the PWT 8.1 data point for 2010 (PWT 9 gives a value of 5.5% for the same year). Generally, for Syria, PWT data suggests a relatively low share of structures (compared to other forms of physical capital) and hence a high depreciation rate, one that is above the MENA and LMI averages. So, we choose the lower of the two PWT depreciation values given the possibility of measurement error. The public capital depreciation rate of 3.1% follows the PWT 9 depreciation rate for non-residential structures. Calculated as a residual, the private capital depreciation rate of 6.2% appears reasonable, consistent with the average of private capital depreciation rates for low- and middle-income countries used in the IMF FAD Investment and Capital Stock Database 2017.[17]

In panel B of Table 1, we calibrate the initial capital-to-output ratio, K_0/Y_0 at 2.560 assuming steady-state properties[18] and based on 30-year averages of the investment-to-GDP share (22%), GDP growth (4.1%),[19] 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 K/Y ratios, and is below the respective averages of LMI countries, low-income countries as well as MENA countries.[20]

Using the IMF FAD Investment and Capital Stock Database 2017 to calculate the shares of public and private capital shows that the share of public capital (K^G/K) is relatively high in Syria, accounting for 0.610 of total capital. This is higher than the average for LMI countries of 0.399, but closer to the average for oil-based economies in the Middle-East and North Africa (MENA) region, 0.506. Still, Syria appears to have the highest ratio among oil-based economies that have fuel exports accounting for less than 60% of exports (for which, the average is 0.397).[21] Taking all this into account, we use a "mid-point" public capital share of 0.450 for our simulations.

2.2.2. Central projections

The central projected paths of key growth drivers over 2011-2030 (panel C, Table 1) are based on:

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[17] 4.25% for low-income countries and 8.30% for middle-income countries as of 2015.

[18] In steady-state/equilibrium, output grows at the same rate as capital stock, which allows us to write, $\frac{K}{Y} = (\frac{I}{Y})/(g_y + \delta)$ where g_y is average output growth and δ the depreciation rate.

[19] Investment-to-GDP and GDP growth are averages of WDI and WEO data (1981-2007 and 1981-2010 respectively).

[20] Our calibrated value is also closer to what the calculated K/Y would be based on MFMod data (2.498).

[21] Based on data from the IMF database for K^G/K in 2010, and World Bank income and region classifications for the same year. Oil-based economies are defined as those with fuel exports at least 30% of total merchandise exports (using WDI data).

(i) average I/Y over 2001-2007 of 21.5% (from WDI), and public investment share of total investment of 40%;
(ii) average growth rates over 2001-2010 for TFP of1.4% (according to The Conference Board 2018 and our own calculations following Kim and Loayza 2018) and human capital of 1.0% (following PWT 9);
(iii)United Nations (2011) projections for growth rates of total population of 1.6% and of the working-age population share of 0.6% (as discussed in Section 1.1); and
(iv)zero growth in the LFPR (i.e. the 2010 participation rate level is maintained) given some signs of stabilization (and possible increase) from the 2013 ILO-modelled estimations and projections.

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

Parameter/Variable*	Note	Input value: 2010/ Calibrated	Input value: Average, Pre-Conflict	Input value: 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 (%).

Note (source and calculation):

(1) Penn World Tables (PWT) 9: share of labor compensation in GDP at current national prices. There is no data for Syria. As a proxy, we use the 2010 average for four relatively conflict-free middle-income MENA economies (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 value based on long-term averages of investment-to-output, GDP growth and the aggregate capital depreciation rate. See the discussion in Section 2.2.1.

(5) Calibrated based on average shares for lower-middle income countries and oil-based economies. See the discussion in Section 2.2.1.

(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 1998-2007 from WDI. Public investment share assumed at 40% based on World Bank (2017b) and IMF (2010).

(8) PWT 9: index of human capital per person based on years of schooling (Cohen and Soto 2007; Cohen and Leker 2014) and returns to education (Psacharopoulos 1994). Average growth rate, 2001-2010.

(9) The Conference Board (2017)/our own estimates using Kim and Loayza (2019). Average growth rate, 2001-2010.
(10) United Nations (2011).
Zero growth is assumed based on the stabilizing/marginally increasing participation rate observed in the 2013 ILO-modelled estimates and projections.

2.2.3. Lower and upper estimates of projections

Lower and upper estimates are set based on adjustments to some of the projected variables in panel C of Table 1. Table 2 displays these calibrations – which are those projections that are different from the central projections in panel C of Table 1.

- For the lower estimate, we introduce a decline in the LPFR based on the latest ILO-modelled estimates and projections that in turn draw on the most recent UN population estimates and regional GDP growth.[22] Other possible alternatives for this, though probably less satisfactory, are to: (i) assume the same decline in the participation rate as in the previous decade, but this would have likely been an unsustainable path; or (ii) use an earlier average growth, namely for 1991-2000 (-0.6%), which would be quite arbitrary.
- For the upper estimate, we use a higher I/Y of 23.5% since the IMF data presented in Section 2.1 indicates roughly a 2 ppt increase in average gross capital formation (from 23.1% over 2001-2010 to 25.2% over 2011-2016) and we assume the same for gross *fixed* capital formation. We also use a higher long-term average growth rate of 1.5% for human capital based on both CSL and BL data.

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

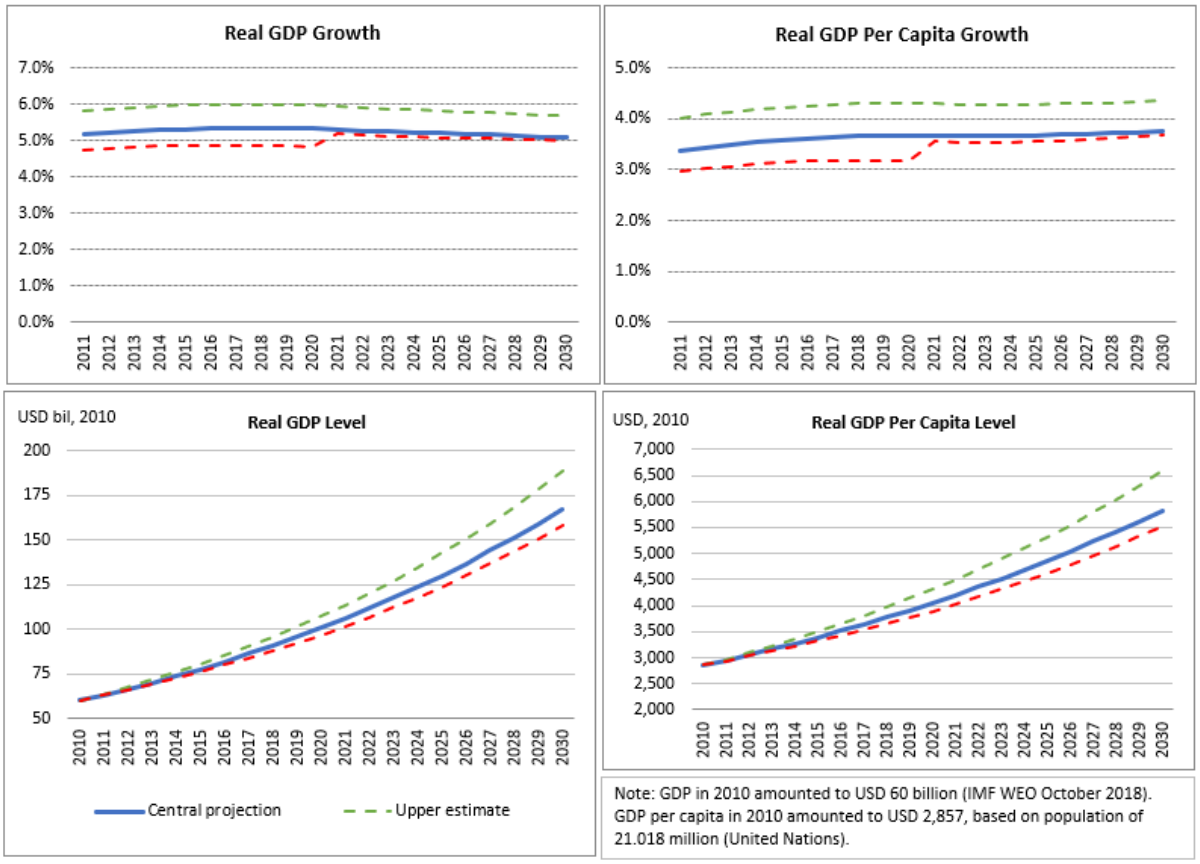
Variable	Note	Input value
Lower estimate on projected variables (average, 2011-2030)		
Labor force participation rate, growth g_ϱ	*(1)*	-0.003
Upper estimate on projected variables (average, 2010/11-2030)		
Investment-to-output ratio I/Y	*(2)*	0.235
Public investment-to-output ratio I^G/Y	*(2)*	0.094
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 (%).
Note (see Section 2.1 for further discussion):
(1) Calculated using female and male LFPRs from ILO-modelled estimates and projections, May 2018. We carry out linear interpolation for annual values based on the ILO-reported values of series end points (2010 and 2030) and turning points (2020-21 for the male participation rate) so that trends are smoothened. Female and male shares of working-age population, from United Nations (2017) are kept unchanged at 2010 levels.
(2) I/Y is based on IMF estimations suggesting higher GCF (% of GDP) after 2010. The assumption of public investment share of total investment of 40% as used in the central projection is maintained.
Long-term average based on calculations using both Cohen, Soto and Leker; and Barro and Lee average years of schooling data respectively. See figure 4(a)-(b).

Figure 7 shows the trajectory for the level and growth of GDP in Syria based on the central calibrations in Table 1 and the calibrations for the upper and lower estimates from Table 2. Note that the lower estimate shows a slight upward trajectory – this is because of the ILO-modelled estimates and projections, which show the LFPR for men gradually rising from 2021 onwards, after declining in the previous decade.

[22] The estimates and projections do not fully account for the conflict. UN projections of population decline are captured but not GDP growth developments. See footnote 10 for further details.

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).

3. Impact from Conflict

This section provides a simulation of how the different growth drivers, introduced in the previous section, account for the loss in GDP level and growth over 2011-2018. The purpose of this simulation is to provide an up-to-date, factual 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 United Nations Economic and Social Commission for Western Asia (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

The estimates of physical capital stock damage by the UN-ESCWA appear to be the most comprehensive and up-to-date data so far, and we use these in our simulations. ESCWA (2016) puts the destruction of capital across various economic sectors, including public and private capital, at USD 89.9 billion over 2011-2015. ESCWA (2018) updates this to USD 101.2 billion and USD 119.7 billion by the end of 2016 and 2017 respectively. 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.[23] We assume that the conflict intensity index in the first three months of 2018 is at the 2017 level as estimated by the ESCWA, but then improves to somewhere between the 2011-2012 level. Given the calculated average conflict intensity index for the year, we then derive an estimate of physical damage that is proportionate to the 2017 estimate of physical damage of USD 18.5 billion (see Appendix 2).[24] Such an assumption of improvement in conflict intensity is not inconsistent with the dread factor[25] in World Bank (2019), which reached new heights in 2017, continuing into the first quarter of 2018 before appearing to taper off to around the 2012 level by May 2018, the last data point. We also consider that the SOHR notes that a record low 20,000 lives were lost in 2018, and that big data (conflict-related events) collated and analyzed by the Global Data on Events, Location and Tone (GDELT) project suggests that conflict intensity in 2018 was lower than in 2011.

World Bank (2017b, in their Figure 2.9) 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. On the other hand, 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 capital, we use the LMI average of 0.734, and build in a decline in the efficiency of public investment 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

In terms of Syria's total population, UN population statistics (United Nations 2017)[26] indicate negative average annual growth of -1.7% over 2011-2018, with the population declining from 21 million in 2010 to 18.3 million in 2018. UN statistics also indicate for the working age-to-population share, negative average annual growth of -0.09% over 2011-2018. The projections capture developments during the conflict. From mid-2010 to mid-2020, estimated deaths are higher at 1,036,445 compared with 657,131 the previous decade[27] and reflect the rise in the

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[23] In terms of other sources of data on physical damage, SCPR (2016) estimates total capital stock at 2010 prices to be down by 57% at end 2015 compared with 2010, but with no details of the breakdown of damages. World Bank (2017a), in a detailed but narrower assessment, estimates the damage to housing and infrastructure for six cities in the range of USD9.6 – USD11.1 billion at pre-conflict prices, over 2011 – February 2017. The housing damages are extrapolated to eight governorates and used in the model-based simulations of physical destruction effects on GDP in World Bank (2017b).

[24] We use the most recent year's value of physical damage as opposed to some longer-term average measure, as the former would best reflect possible further damages given that much of Syria's physical capital would have been destroyed by 2017/2018.

[25] Shown graphically, this is an aggregate measure of the number of conflict events based on tank, artillery and air strikes of light, medium and heavy incidence levels.

[26] Medium fertility variant.

[27] 607,685 on average per decade over mid-1980 to mid-2010.

proportion of male deaths (68% versus 32% for women). Further, net migration abroad is also higher at 5,397,896 over mid-2010 to mid-2020. This considers refugee numbers based on the UN Refugee Agency (UNHCR) populations of concern data up to March 2017 and builds in refugee returns over 2020-2035. [28]

There is a possibility though that the above numbers might still understate fatalities and migrants. The cumulative number of fatalities from the war is hard to ascertain. A source currently relied upon, the Syrian Observatory for Human Rights (SOHR) puts the death toll at 560,000 (civilians and combatants) over March 2011 – 10 December 2018 (with 367,965 documented victims). Netting off foreign combatants of 65,108, we would get a total of 494,892 Syrian fatalities.[29] This is higher than what the UN population statistics suggest in terms of conflict-related deaths – 303,451, based on our calculations when we take the difference of average deaths between 2011-2020 and 2001-2010 (multiplied by eight years).

The UNHCR populations of concern data show 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 are not available, from the UNHCR Regional Refugee and Resilience Plan database specifically on refugees in selected neighboring countries - Egypt, Iraq, Jordan, Lebanon, Turkey and North Africa,[30] we note that when compared to 2017, refugees had increased by 184,398 to 5,663,675 in 2018 (patterned bars in figure 8(a), with the age and gender profile of these refugees shown in figure 8(b)). Based on this, the UN population statistics may be understating refugee movement by about 900,000. But if we discount the 1 million refugees born in displacement/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.[31] Perhaps 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[32] 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 possible lower estimate to population growth estimates, 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

[28] The UNHCR data available up to 2016 indicate a change of 5,688,897 in the number of refugees, asylum-seekers (pending cases) and others of concern based on the 2010 and 2016 stock positions. UN data on the international migrant stock for 2017, show net migration for Syria of 5,784,696 over 2011-2017 (2017 stock compared against 2010 stock).

[29] Source: http://www.syriahr.com/en/?p=108723. Civilian casualties totaled 111,330 (22.5% of the 494,892 total Syrian casualties), and were mostly adult males (70.1%), as 20,819 were children under 18 (18.7%) and 13,084 were women over 18 (11.8%).

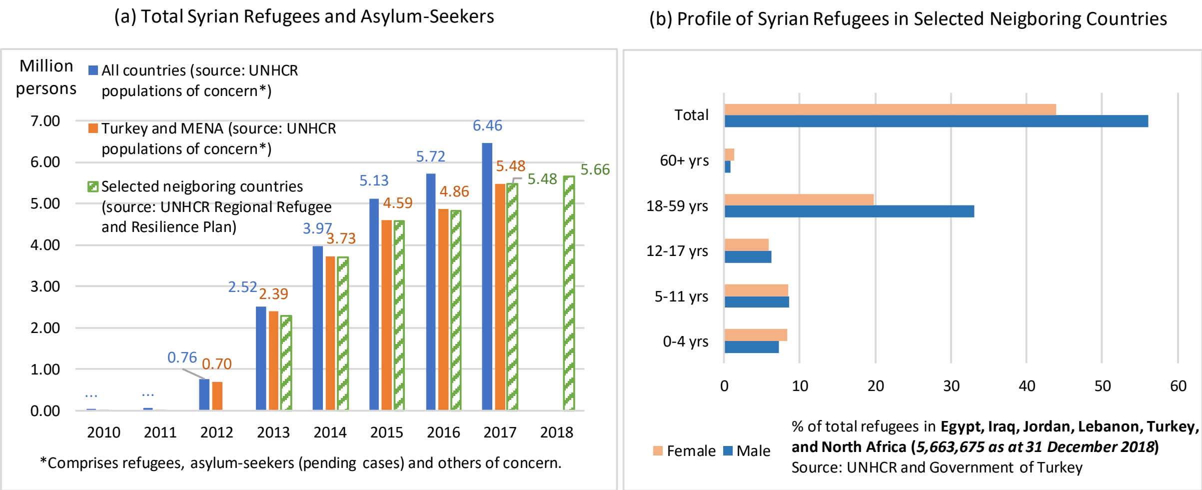
[30] Syria Regional Refugee Response. https://data2.unhcr.org/en/situations/syria

[31] https://www.unhcr.org/refugeebrief/the-refugee-brief-11-december-2018/

[32] Total estimated number of Syrians are government estimates which include registered Syrian refugees, unregistered Syrian refugees and Syrians residing in host countries under alternative frameworks.

population from 18.3 million to 16.5 million giving a negative average growth of -3.0% over 2011-2018.[33]

Figure 8: UNHCR Registered Syrian Refugees and Asylum-Seekers



ILO (2018) projects the overall LFPR at 43.0% in 2018 (female at 12.5% and male at 73.0%) down from 44.9% in 2010 (female at 14% and male at 75.6%), giving an average negative growth of -0.5% over 2011-2018 (female LFPR growth at -1.4% and male at -0.4%). Data in World Bank (2017b) suggest the LFPR in 2015 stood at 47.2%, somewhat higher than the 2010 level of 44.6%.[34] World Bank (2019) meanwhile shows latest/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 of men and women 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/existing labor force.

Regarding the **interruption of schooling**, according to SCPR (2016), almost half (45.2%) of all basic education school-age children residing within the country were not attending school

[33] UN population statistics suggest that births remained relatively high at 4,339,946 over mid-2010 to mid-2020 (about 434,000 births/year) versus 5,275,028 the previous decade (about 528,000 births/year). Some news reports (for example: http://english.alarabiya.net/en/variety/2015/11/17/Births-in-Syria-down-more-than-50-since-war-media.html) suggest that births have fallen substantially, but absent more sources of concrete analysis, we do not make any adjustments to birth rates. Further, World Bank (2019) notes that adolescent fertility rates have only dropped to 40 per 1,000 women aged 15-19 in 2016 compared to 45 in 2010, amid child marriages as a conflict coping mechanism.

[34] Though this LFPR increase contrasts with the ILO estimate of a decline, data in World Bank (2017b) suggests a sharp increase in the unemployment rate from 8.6% in 2010 to 52.9% in 2015. ILO estimates, on the other hand, point to a more moderate increase in the unemployment rate to 14.9% in 2018 (14.7% in 2015).

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.[35]

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:[36]

- 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.,

$$s_{g,t}^{a} = s_{g,t-5}^{a-1}$$
$$= \sum_j h_{g,j,t-5}^{a-1}\, Dur_{j,t-5}^{a-1} \qquad (1)$$

  where $h_{g,j}^{a}$ is the proportion of either men or women ($g = m$ or f) in age group a, that have attained education level j (primary, secondary and tertiary; incomplete and complete) and Dur is the corresponding duration system, both of which we assume to be unchanged;

- 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, $\Delta enroll_{g,j,t}^{a}$[37] for age group a in level j during the transition period from $t - 5$ to t, i.e.

$$s_{g,t}^{a} = \sum_j (\, h_{g,j,t-5}^{a} + \Delta enroll_{g,j,t}^{a})\, Dur_{j,t-5}^{a}$$
$$= \sum_j \left(h_{g,j,t-5}^{a} Dur_{j,t-5}^{a} + \Delta enroll_{g,j,t}^{a} Dur_{j,t-5}^{a}\right)$$
$$= s_{g,t-5}^{a} + \sum_j \Delta enroll_{g,j,t}^{a}\, Dur_{j,t-5}^{a} \qquad (2)$$

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:

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

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:

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

[35] The same contraction rate in enrollment for basic education is assumed for secondary and tertiary education.
[36] The nomenclature draws on Barro and Lee (2013, 2015).
[37] We base the enrollment adjustment factor formula on Barro and Lee (2013) (their Table A.2).

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

World Bank (2019) indicates that the net enrollment rate for school-age children (5-17 years) declined from 82% in 2010 to 61% in 2018. The sharpest decrease in the enrollment rate for school-age children appears to have occurred in the 2012/13 school year, with the enrollment rate rising slightly thereafter from 55% in 2013 to 60% in 2015 (UNICEF 2016, 2018a). Primary and secondary net enrollment rates stood at 93% and 67% respectively in 2010. Last available data from UNESCO UIS indicates that these rates were down to 63% and 46% respectively in 2013, with the secondary enrollment rate stable at 45% in 2018 (UNICEF 2018b). For our projection of average years of schooling for the still-in-school groups using equation (2), we let primary and secondary enrollment rates decline from 93% and 67% in 2010 to 75% and 45% respectively by 2015 for both girls and boys, keeping them steady thereafter.[38] Regarding tertiary education, UNESCO UIS data on the average gross enrollment rate over 2011-2016 rather surprisingly suggest an increment of about 10 percentage points during the conflict period compared with the 2010 rate of 26%.[39] 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). In Appendix 3, we provide further details on how we arrive at the average years of schooling in 2018.

By using the above methodology, we constrain 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 (that is, we are assuming completion rates are unchanged). This approach also does not consider other types of heterogeneity in educational attainment, for instance, that may depend on the socioeconomic status or geographical origination of migrants and conflict victims. Verme et al. (2016), focusing on the profile of refugees in Jordan and Lebanon, find that Syrian refugees in fact tend to have slightly lower levels of educational attainment than pre-conflict Syrians.[40]

To obtain human capital growth, we continue to assume the same calculations as in PWT 9 for the returns to education. Our calculations for the central projection using UN population statistics suggest 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. When we consider the additional decline of 1.8 million in the Syrian population discussed in the previous section, average years of schooling declines only marginally more, that is by 1.499 years. If we split this decline over

[38] 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% and secondary enrollment rate of 45%. Taking together the data reported by UNICEF (UNICEF 2016, UNICEF 2018a) and the World Bank (World Bank 2019), net enrollment of school-age children averaged about 84% over 2010-2012, 60% over 2013-2015, and 61.3% over 2016-2018.

[39] See Milton (2019) for a discussion of 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.

[40] Educational attainment for pre-conflict Syrians five years and older (2007): 83 percent with primary education and below, 9.5 percent with secondary education and 7.2 percent with tertiary education. Syrian refugees five years and older (2014): 83.6 percent with primary education and below, 11.4 percent with secondary education and 5.1 percent with tertiary education (Jordan); 86.7 percent with primary education and below, 8 percent with secondary education and 5.3 percent with tertiary education (Lebanon).

time following the proportions in the first case, we obtain annual average growth rates in human capital of -2.64% over 2011-2015 and -0.57% over 2016-2018 respectively.

3.1.4. TFP

The Conference Board estimates an average TFP growth of -9.5% over 2011-2017 (from a low of -22.9% in 2012 rising to 2.8% in 2017). However, while the loss of TFP would be an important driver of loss in GDP potential, it could be that this high number reflects an underestimation of the destruction of physical and human capital.

Thus, as an alternative to The Conference Board's calculations of TFP growth, we utilize Kim and Loayza's (2019) model of determining TFP growth. The key element that feeds into this model 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 the fall in average years of schooling of the working-age population. Given that enrollment rates fall, and the exodus of Syrians increases noticeably only from 2013, we keep the average schooling years unchanged from 2010 to 2012, instead interpolating a decline over 2013-2018, based on our calculations of average years of schooling for 2015 and 2018 respectively. 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 source data originally used by Kim and Loayza (2019) - the Worldwide Governance Indicators (WGI) across six dimensions (Kaufmann, Kraay and Mastruzzi 2010) updated to 2017. 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%.[41] Further details of our calculations 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 uses calculations as 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, $\frac{K^j_{c,0}}{Y_0} = \frac{K^j_{c,2011}}{Y_{2011}}$
  where $K^j_{c,2011}$ is capital adjusted for damage, D^j_{2011}.

[41] As an exercise to gauge the room for underestimation of the contraction in TFP growth, we run the Kim and Loayza (2019) model with the assumption that the overall index of TFP determinants for Syria declines linearly from 30.33 to the minimum 1 by 2018. This would give us an average annual growth of -3 percent over 2011-2018, only 1.4 percentage points lower than our current projection of the average growth rate.

Then, $\frac{K^j_{c,2011}}{Y_{2011}} = \frac{K^j_{2010}}{Y_{2010}} \times \frac{1+g_{k^j_c,2011}}{1+g_{y,2011}}$

where K^j_{2010} is based on $\frac{K^j_{2010}}{Y_{2010}}$ 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, $1 + g_{k^j_c,2011} = \frac{(1-\delta^j)\left(1-d^j_{2011}\right) + \frac{I^j_{2010}/Y_{2010}}{K^j_{2010}/Y_{2010}}}{(1+g_{\varrho,2011})(1+g_{\omega,2011})(1+g_{N,2011})}$

(5)

where $d^j_{2011} = \frac{D^j_{2011}}{K^j_{2010}}$, the proportion of capital damaged in 2011.

and growth in output per worker,

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

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

(6)

- The process is repeated for periods 2012-2018. Damages to K^j_t are apportioned across the conflict period based on the 2011-2017 annual estimates from ESCWA (2018) while we build in USD 7 billion for 2018 as discussed in Section 2.1.1. Damages are apportioned between public and private capital based on their relative cumulative shares of damages as at end 2015, made available by ESCWA. We assume the same shares for each time t (that is, 40 percent of damages are attributable to public capital, 60 percent to private capital).

In Table 3, panel C, we present information on the central paths of projected variables based on the previous discussions. 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 for the former, since the damage for public capital was valued at less than for private capital.

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 (%).
Note (source and calculation):
(1) Unchanged from Table 1. See Table 1 for further details on source and computation.
(2) Calculations follow the discussion in Sections 3.1.1 and 3.2.
(3) Based on World Bank (2017b). Their estimates of 1% and 4% for I^G/Y and I^P/Y respectively in 2015 are also assumed for 2016-2018 in our simulations.
(4) Based on the average IEI for LMI countries for 2010 which is assumed to gradually decline to 0.570 (the average IEI for LI countries) by 2018.
(5) See Section 3.1.3. Given that enrollment rates fall, and the exodus of Syrians increases noticeably only from 2013, we keep the index of human capital unchanged from 2010 to 2012, such that the contraction mainly occurs over 2013-2015 with average growth of -4.28% (average growth over 2016-2018: 0.56%).
(6) TFP growth is calibrated using the empirical methodology in Kim and Loayza (2019). See Section 3.1.4.
(7) Based on United Nations (2017).
(8) Female and male LFPRs are based on ILO-modelled estimates, May 2018 (ILOSTAT). Female and male shares of the working-age population follow United Nations (2017).

In Table 4, we show the lower and upper estimate outcomes for capital-to-output ratios when we consider (i) lower population growth and the associated human capital growth for this population trend; and (ii) higher on average investment-to-output ratios and a higher LFPR. Other variables remain unchanged from their central paths in the simulations. For both the lower and upper estimate scenarios, the K/Y ratios in 2018 are slightly higher than in the central projections but remain lower than the 2010 levels.

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_Q	*(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) Based on a further downward adjustment to the UN population statistics to reflect higher migration and fatalities than the central projection. See Section 2.2. Population changes over 2011-2018 are calibrated such that they follow the trend in the UN population statistics but with steeper slopes.

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

(3) Investment-to-output ratios are based on ESCWA (2018) estimates. See Section 3.1.1.

(4) Calculated based on the growth in LFPRs for men and women above 15 years of age over 2010-2018 reported in World Bank (2019). Female and male shares of the working-age population follow United Nations (2017).

Figures 9(a) - 9(b) show the outcomes of simulations for GDP level and growth over the conflict years given the calibrations in Table 3 and Table 4. Our simulations across the three scenarios (central, lower and upper estimate projections) indicate that the depletion of factors of production alone may account for about 87 percent of the negative GDP growth on average, and further, that about 64 percent of the average negative growth is due to physical capital destruction. Demographics and labor account for about 15 percent, human capital 7 percent, and TFP 13 percent 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 sufficient investment. This echoes the observation by World Bank (2017b) 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 (2017b) 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 (2017b) assumes that the resulting capital stock keeps the same proportion with respect to the initial capital stock as the stock of housing does.

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

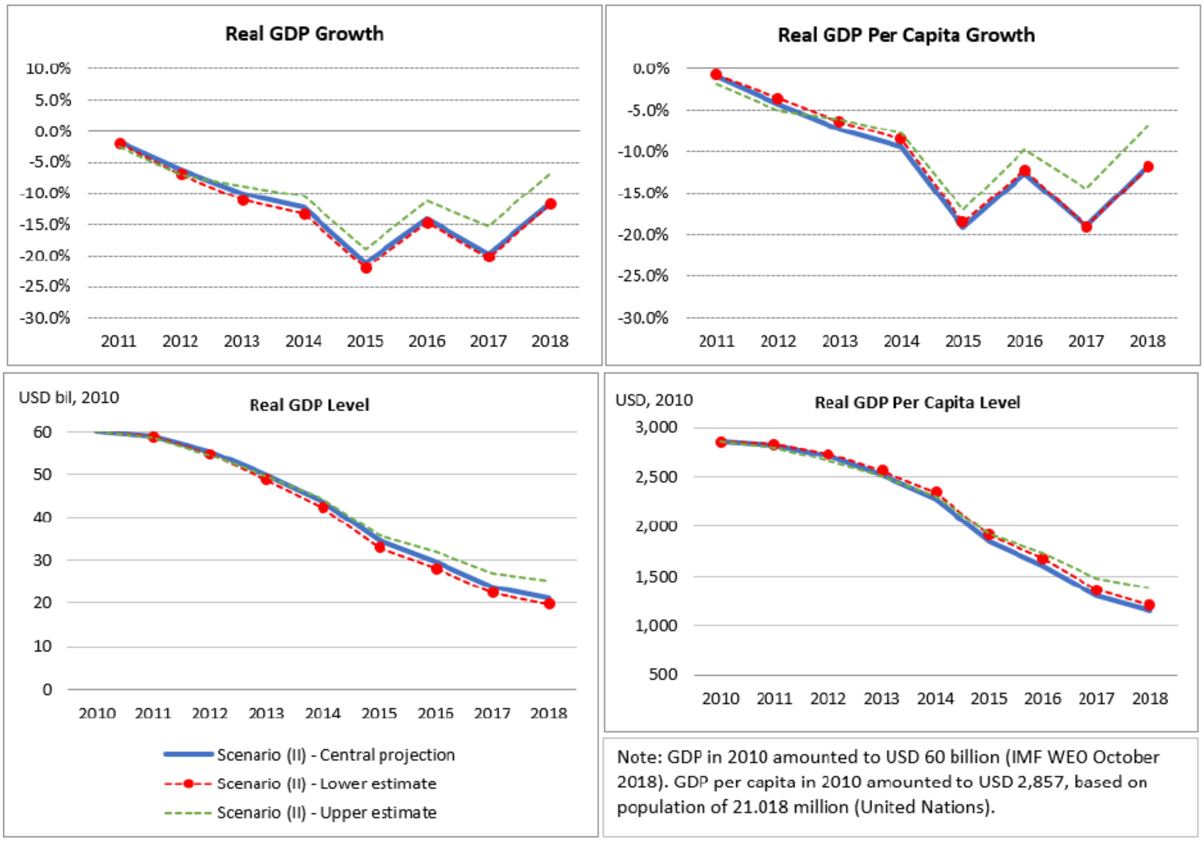
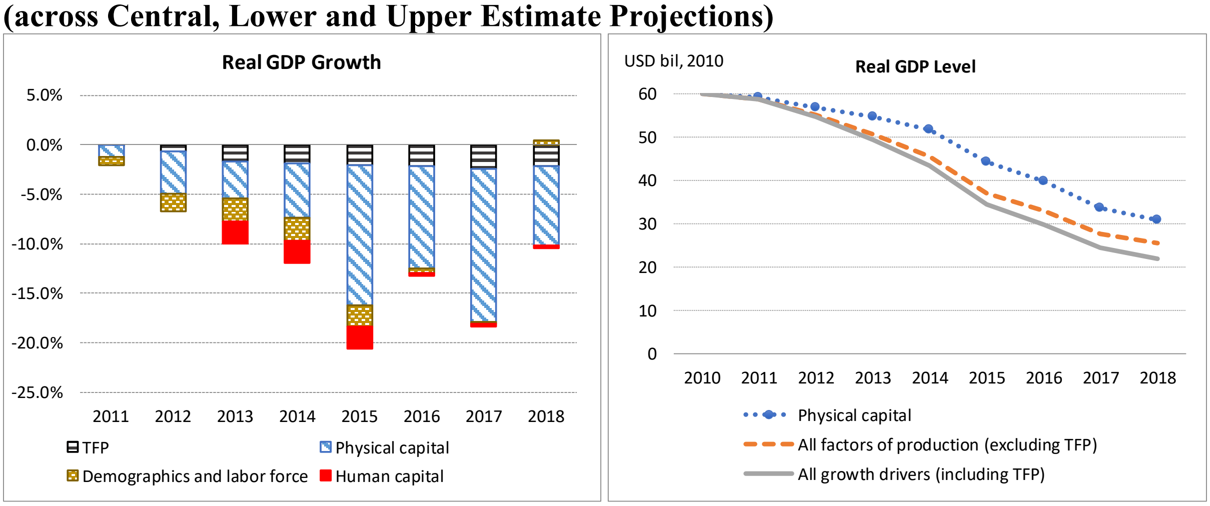
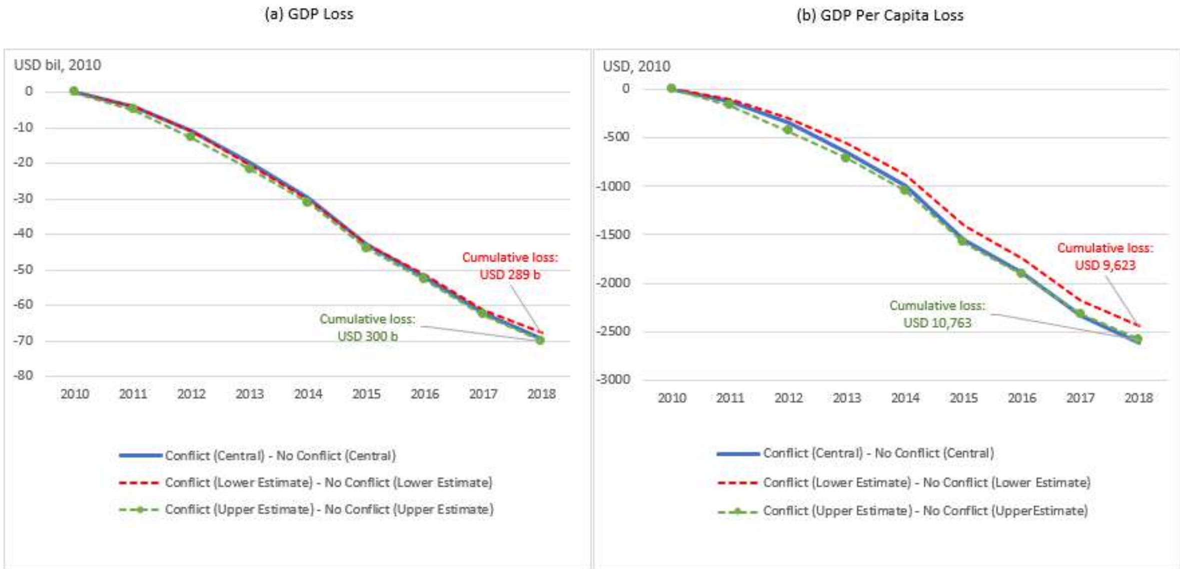


Figure 9(b): Average Impact of Different Growth Drivers on GDP during the Conflict (across Central, Lower and Upper Estimate Projections)



The projections under conflict versus the no-conflict scenario suggest a cumulative loss in GDP potential of between USD289 and USD300 billion over 2011-2018 (see 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 (2017b), 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 loss in potential GDP growth of -12% on average over 2011-2018, with an average GDP level of USD 23.2 billion in 2018 (against a no-conflict scenario of USD 91 billion).

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



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 and the number of "lost decades" under various assumptions for the growth drivers.

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	A substantial reconstruction program of USD 140 billion (average of the high and low scenarios), spread evenly over a 20-year period.	A large reconstruction program amounting to USD 250 billion to meet UN-estimated reconstruction bill, spread evenly over a 20-year period.	Limited reconstruction program of 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 percent return rate based on the ratio of reconstruction funds in the first 10 years (moderate versus high scenario).	76 percent 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 percent return rate based on the ratio of reconstruction funds in the first 10 years (low versus high scenario).
Forced repatriation	Refugee returns	100 percent return rate, of refugees in neighboring countries.		

Notes: Under the voluntary mobility case, refugee returns follow the same time pattern 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.

Experiences of other countries in the Middle-East suggest that longer-lasting conflicts would entail a longer recovery period. 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).[42] Lebanon lost 70 percent of its GDP level while Kuwait 55 percent and Iraq 35 percent 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 percent, 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 percent 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 percent below the GDP level in 2010, close to the loss experienced by Lebanon.

To analyze the outlook for growth in Syria, we first consider a voluntary mobility case within which our projections for the growth drivers are guided by three plausible political

[42] Sab (2014) highlights that while the 2002 invasion of Iraq did not last long, Iraq had experienced low-grade civil war for much of the 2000s until the summer/fall of 2009.

settlement/security outcomes (baseline/moderate, optimistic, and pessimistic). These settings are associated with varying levels of reconstruction assistance, which in turn influences the voluntary mobility of refugees residing in neighboring countries.[43] With regard to linkages to the drivers of growth, the amount of reconstruction funds directly affects public and private investment.

Refugee returns, meanwhile, affect the size of the labor force. 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 then 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,[44] but it may be instigated by local and international voices eager for a quick resolution of the refugee issue.[45] Under forced repatriation, refugee returns are disconnected from the size of the reconstruction program, and instead, a "full" rate of refugee returns is assumed across the three scenarios. We thus have six scenarios in total – three for each of the two different broad cases (voluntary mobility and forced repatriation respectively). These are summarized in Table 5. We discuss the projections for the growth drivers in detail in Section 4.1 below. Then, we 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. We use Equation (7), a slight variant of the saving/investment - balance of payments accounting identity, to link $\frac{I_t}{Y_t}$ to the inflow of foreign funds.[46]

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

(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.)

In Equation (7), external financing may take the form of (non-debt creating) aid and grants (which enter as higher NCT_t) or direct investment and loans (which result in an increase in

[43] World Bank (2019) finds that pull factors, of which two prominent ones are security and infrastructure, have unambiguous effects on return behavior, in contrast to push factors in countries of asylum which have mixed implications.

[44] 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."

[45] 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.

[46] The standard identity has net current transfers as a component of the current account balance.

foreign liabilities, thus increasing ΔNFL_t).[47] 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.[48] If the foreign funds do not lead to the purchase of tradables, the current account will be in balance, ceteris paribus (see for instance 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, which leads to 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.

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

Regarding $\frac{S_t}{Y_t}$, if we assume $\frac{I_t}{Y_t}$ of 5 percent (as per the central projection of our conflict simulation), and $\frac{CAB_t}{Y_t}$ of around -30 percent at the end of the conflict, this would give us $\frac{S_t}{Y_t}$ of approximately -25 percent.[49] This is about 50 percentage points below Syria's pre-conflict long-term average: 23 percent (20-year average over 1991-2010 based on WEO data). For the post-conflict pessimistic scenario, we calibrate the transition for Syria's $\frac{S_t}{Y_t}$ by 50 percentage points to 25 percent, in eight years, based on the experience of Lebanon. Lebanon was subject to persistent political instability during its recovery, and 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 percent 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.[50] 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.

Once we have the projection for $\frac{I_t}{Y_t}$ for each scenario, we then split it between public and private investment by continuing to assume that 40 percent of total investment is public, following pre-conflict trends. This is consistent with the estimated relative shares of destruction between public and private capital during the conflict. In terms of the efficiency of new public investment, we keep efficiency unchanged at 0.570 under the pessimistic scenario and assume

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[47] This would be the "first leg" before the money is spent and both will have counter entries reflected as an increase in foreign assets.
[48] In either instance of financing spent on imports – transfers or loans - the trade deficit is the same, though the current account deficit *including* transfers, will differ.
[49] This is based on the 2017 estimate of the trade balance share of GDP by ESCWA (2018).
[50] See Sab (2014) for discussion on the conflict and recovery stories of Kuwait and Lebanon.

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 group of 0.769 by 2038.

4.1.2. Demographics and the labor force

As shown in figure 8, registered Syrian refugees in neighboring countries numbered 5,663,675 at the end of 2018. A survey by UNCHR (2018) of a sample of 4,283 Syrian refugees in neighboring countries indicated that 76 percent intend to return to Syria one day. In the optimistic scenario of the voluntary mobility case, if we assume a 76 percent return rate, this would amount to 4.3 million returnees. We use the UN population statistics (United Nations 2017), which projects an average population growth of 2.5% over 2019-2038 and builds in net migration into Syria of 4.21 million over 2020-2035. Of this total, 66 percent return over 2020-2025 (about 556,000 on average per year), 29 percent over 2025-2030 (about 240,000 per year) and 5 percent over 2030-2035 (about 46,000 per year).[51,52]

For the moderate and pessimistic scenarios in the voluntary mobility case, we assume refugee return rates of 43 percent and 18 percent respectively based on the ratio of reconstruction-related average funding per year in the first 10 years post conflict. For both these moderate and pessimistic scenarios, we still assume a similar time path as the optimistic scenario – with refugee returns rising to peak around 2023-2024, and gradually moderating thereafter. Consequently, we obtain average population growth rates of 2.2 percent and 1.9 percent respectively over 2019-2038 for the moderate and pessimistic scenarios. For all three scenarios in the forced repatriation case, we adjust the return rate to 100 percent (but keep the pattern of returns unchanged over time), thus giving us an average population growth rate of 2.7 percent over 2019-2038.

We continue to draw on United Nations (2017) for projections of the working-age population share, and ILO (2018) for LFPR projections – the latter is available until 2030, and so we keep the values thereafter stable at the 2030 level. The same working-age population share and LFPR time series are used across all scenarios.

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.

School destruction and/or non-functioning schools are the key reasons for 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 percent respectively) by 2038, while the tertiary enrollment rate rises

[51] In the UN population statistics, the net migration numbers are reported for the five-year period between the middle of the respective bracketing years (for example, from mid-2020 to mid-2025).
[52] From our calculations based on average births and deaths in the UN population statistics, this is in addition to about 112,000 inward migrants from mid-2019 to mid-2020, which gives us a total of 4.3 million returnees, or 76 percent of registered refugees residing in neighboring countries over 2019-2035.

to 50 percent (from 36 percent) 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.[53] We further assume that by 2048 enrollment rates reach 100, 80 and 60 percent 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 percent and 80 percent respectively. For the tertiary enrollment rate, we assume it rises to 50 percent by 2028 (also in half the time compared to the pessimistic scenario) and 60 percent by 2038. By 2048, we assume enrollment rates reach 90 and 70 percent 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, we obtain an average annual growth rate in human capital of 1.3 percent over 2019-2048 under the optimistic scenario (1.3 percent over 2019-2028, 1.4 percent over 2029-2038, and 1.1 percent over 2039-2048). For the pessimistic scenario, average annual growth amounts to 0.9 percent. That is, 0.4 percent over 2019-2028, 1.0 percent over 2029-2038, and 1.2 percent over 2039-2048.[54] The human capital growth rate 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

Using the Kim and Loayza (2019) empirical model, we assume a gradual rebuilding of the TFP determinants index which was estimated at 15.98 in 2018. Under the optimistic scenario, we increase this index 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 percent over 2019-2048 (0.1 percent over 2019-2028, 2.1 percent over 2029-2038, and 2.0 percent over 2039-2048).

For the pessimistic scenario, we repeat the exercise but based on index of the United Arab Emirates (UAE), the best performer for the sub-sample of 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 would be 0.3 percent (-0.9 percent over 2019-2028, 0.9 percent over 2029-2048). For the moderate scenario, we assume TFP growth rates that are the average of the rates under the optimistic and pessimistic scenarios.

[53] UNESCO UIS data for Syria indicate that the net primary enrollment rate rose from 81.9 percent in 1973 to 94.8 percent in 1987 (approximately 15 years) while the net secondary enrollment rate increased from 39.3 percent in 2000 to 66.9 percent in 2010 (approximately 10 years).

[54] The slightly faster human capital growth rate in 2039-2048 compared with the optimistic scenario is mainly because of there still being room for improvement in the primary enrollment rate in the pessimistic scenario.

4.2. Simulation of the post-conflict growth outlook

For the simulations in this section, we keep the constant parameters (labor share and depreciation rates) unchanged from the values used in the pre-conflict and conflict projections. 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 calibrations and projections of growth drivers post conflict based on the discussion in Section 4.1. Under the baseline/moderate scenario of the voluntary mobility case, I/Y averages about 43 percent and 39 percent over 2019-2028 and 2029-2038; and, at 23 percent and 25 percent, respectively, under the pessimistic scenario. The investment shares are exceptionally high under the optimistic scenario, averaging 63 percent and 46 percent respectively in the first and second decades; but are closer to pre-conflict levels. The investment-to-output ratios only differ slightly in the forced repatriation case, at most 1 percentage point in the first decade.

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

The results of our simulations for Syria's post-conflict GDP in the different scenarios under the voluntary mobility case are shown in figure 11(a). Under the baseline/moderate scenario, average GDP growth is 8.4 percent over 2019-2038. As can be observed from the top right of figure 11(b), with the inflow or 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 percent over 2019-2038 reaching a peak of 20.9 percent in 2022 with exceptionally high investments, and stronger contributions from other growth drivers relative to the moderate scenario (see figure 11(a) and figure 11(b), bottom left). Even with this strong performance, 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 percent 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 pass its pre-conflict GDP level and almost 29 years to meet its GDP per capita level. This finding echoes the simulation in World Bank (2017b) 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.

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 (%).

Notes (source and calculation):

(1) The 2018 values are from the central projection under conflict. Values under the scenarios are derived using the saving-investment-external financing accounting identity, based on assumptions on reconstruction funds and the saving-to-output ratio. See Section 4.1.1.

(2) The 2018 value is from the central projection under conflict. A gradual rise from low-income efficiency to lower-middle-income efficiency and upper-middle-middle efficiency are assumed under the moderate and optimistic scenarios respectively. Efficiency is unchanged at the low-income level under the pessimistic scenario.

(3) Average years of schooling by age groups are projected based on assumptions on enrollment rates (with the moderate scenario as a simple average of the optimistic and pessimistic scenario). Overall average years of schooling is based on population projections across the scenarios. See Section 4.1.3.

(4) Based on the Kim and Loayza (2019) model, assuming the TFP overall determinants index follows a similar trajectory as that of Korea (over 1985-2014) under the optimistic scenario, and the UAE under the pessimistic scenario. TFP growth under the moderate scenario is a simple average of the values under the other two scenarios. See Section 4.1.4.

(5) The optimistic scenario under the voluntary mobility case is based directly on projections from United Nations (2017). For other scenarios, the UN projections are adjusted to reflect higher or lower refugee returns. See Section 4.1.2.

(6) United Nations (2017).

(7) Based on ILO projections up to 2030 of the labor force participation rates, held constant thereafter.

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

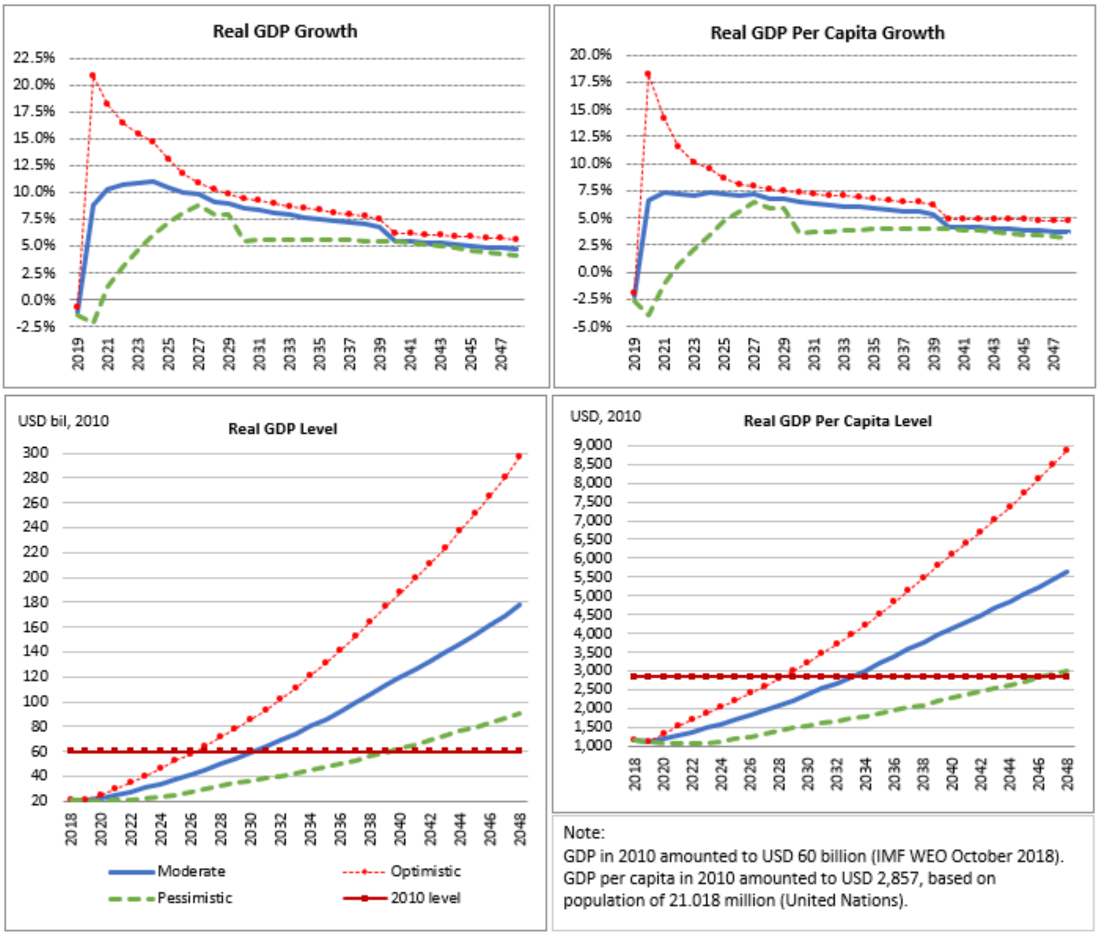
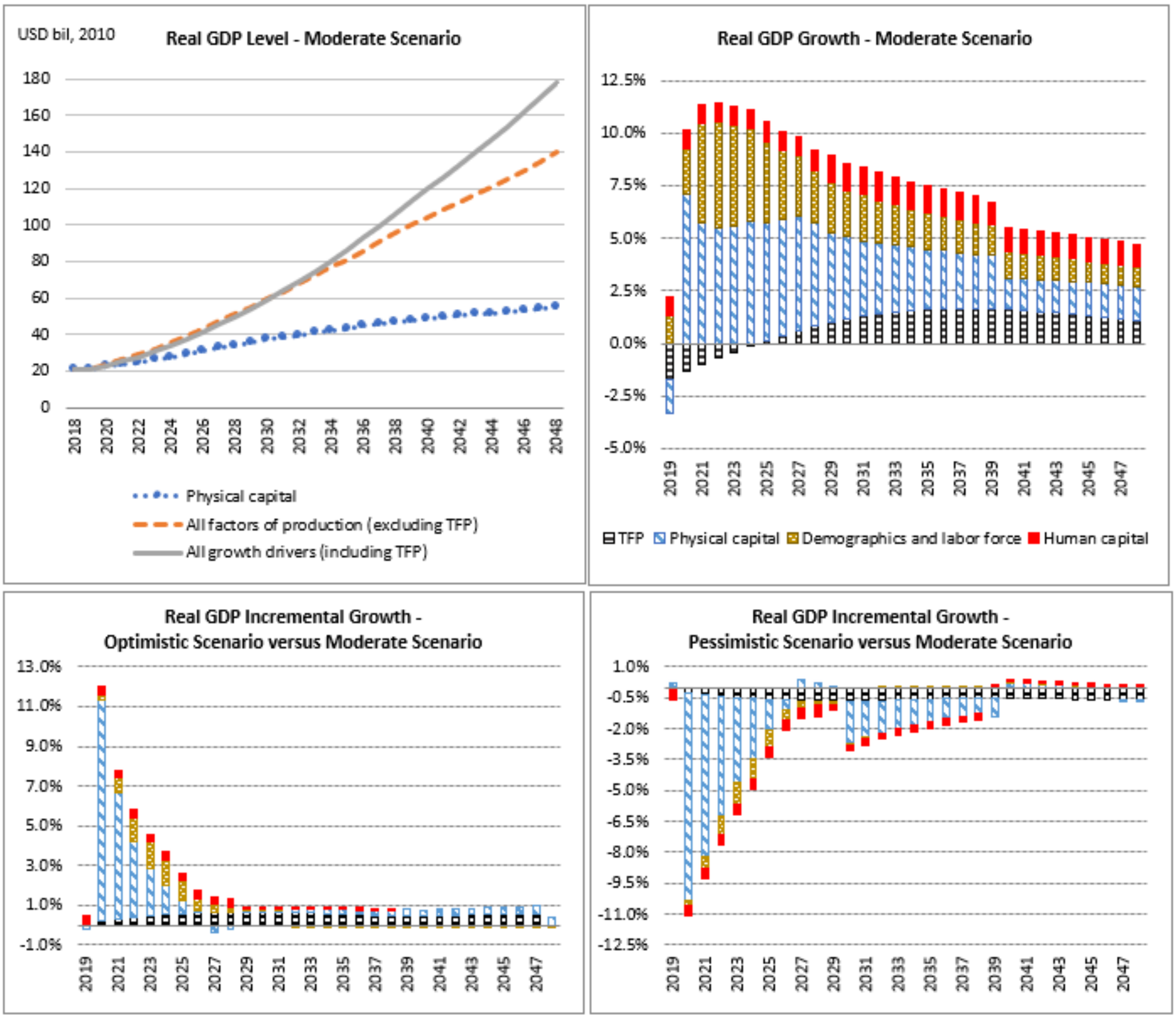


Figure 11 (b): Impact of Different Growth Drivers under the Voluntary Mobility Case

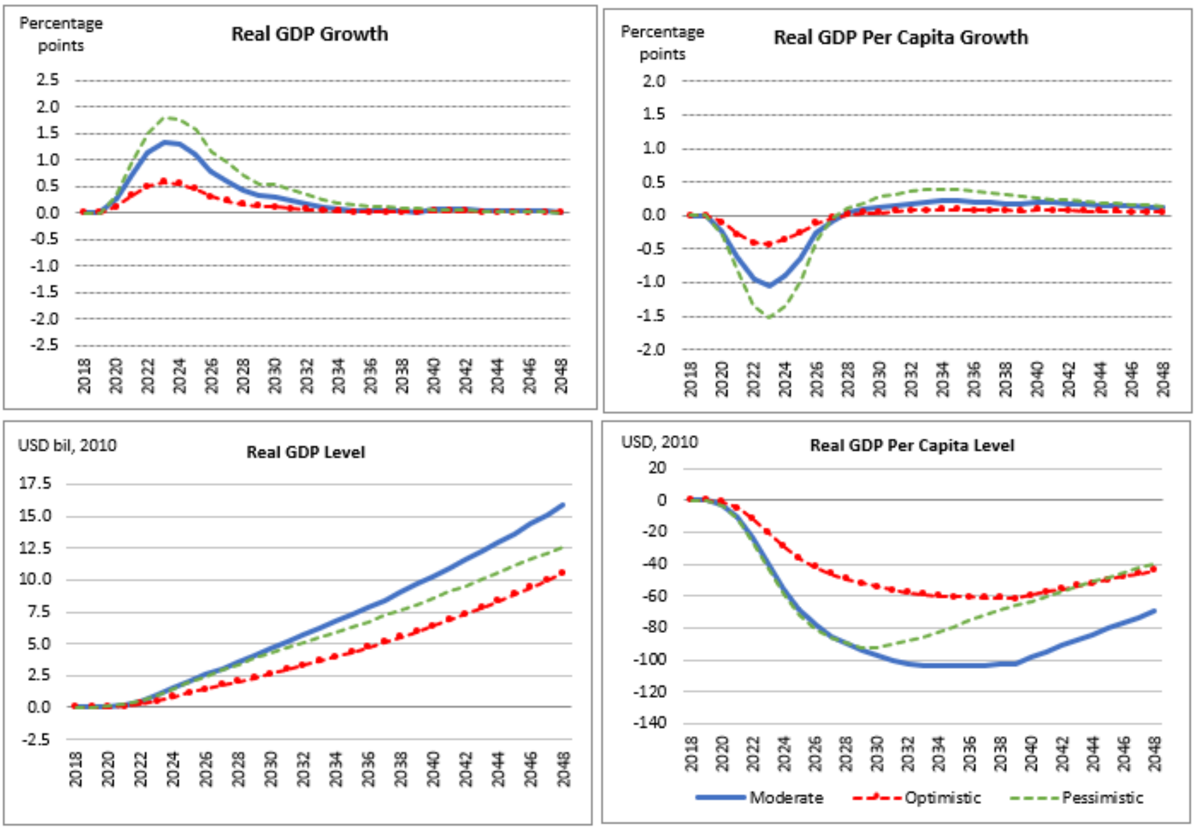


4.2.2. Comparing between voluntary mobility and forced repatriation

In figure12, we present the incremental/decremental growth and level effect for GDP and GDP per capita of the forced repatriation case against the voluntary mobility case. On one hand, in terms of GDP, 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. 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. For instance, at the height of repatriation, in the moderate scenario, GDP per capita growth is lower by 1 percentage point. Growth rates recover thereafter. However, GDP per capita levels remain lower 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.

Figure 12: Post-Conflict Simulation of GDP in Syria – Incremental/Decremental Effect of Forced Repatriation versus Voluntary Mobility



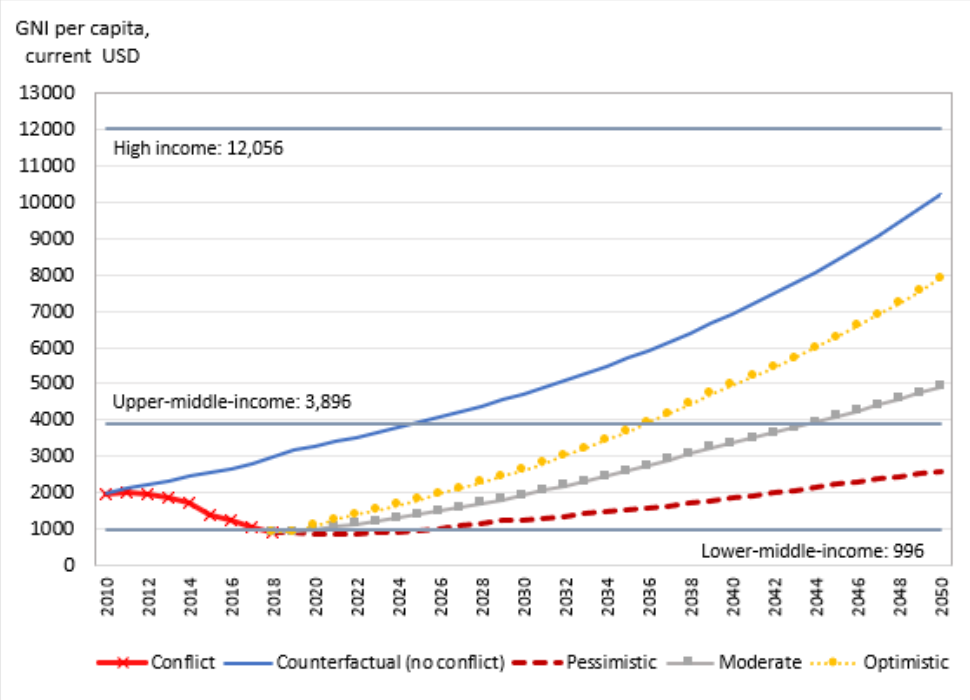
Note:
Each scenario reflects the difference that is calculated as forced repatriation case - voluntary mobility case.

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 lower-middle-income category, and at a level that was about half the then upper-middle-income threshold. In Figure 13, we illustrate possible trajectories for Syria's GNI per capita with conflict and thereafter across the three different post-conflict rebuilding scenarios under the voluntary mobility case. We also show what might have transpired in the absence of conflict.

At the tail-end of the conflict (using 2018 as a reference point), Syria appears to have fallen just below the lower-middle-income 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 upper-middle-income 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 upper-middle-income country, it may now take about double, or even triple that time.

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.

5. Summary and 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 impact of the conflict suggest an average GDP growth of -12% over 2011-2018, with the level of GDP declining to almost one-third the pre-conflict level. Cumulatively, the loss in GDP amounted to about USD 300 billion when the conflict simulations are compared against the counterfactual. These results are broadly in line with findings in other studies. An added insight from what we do is that we identify how the different growth drivers comprising physical capital, demographics and the labor force, human capital, and TFP might have contributed to the decline in GDP. Our simulations indicate that the depletion of factors of production alone may account for about 87 percent of the negative GDP growth on average, and further, that about 64 percent of the average negative growth is due to physical capital destruction. Demographics and labor may have accounted for about 15 percent, human capital 7 percent, and TFP 13 percent of GDP growth on average over the conflict years. This breakdown of factors is important as it 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 in turn, 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 significantly human capital growth and productivity growth.

Focusing on the voluntary mobility case, under our moderate scenario of partial political settlement with strong guarantees for micro-security and property rights, the average GDP growth and GDP per capita growth are 8.4 percent and 6.1 percent respectively over 2019-2038, assuming that a final and stable resolution of the conflict is achieved. 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 investment-to-output of about 41 percent on average. 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. In this scenario, Syria reaches its pre-conflict/2010 GDP level by 2031, and its pre-conflict GDP per capita level by 2033, implying two "lost" decades from conflict.

Under the optimistic scenario of robust political settlement, with exceptionally high investment-to-output of over 60 percent in the first decade, it would still take Syria about one decade to surpass its 2010 GDP and GDP per capita levels. Under the pessimistic scenario of limited guarantees for micro-security and property rights, reconstruction funds amounting to only USD 30 billion, and investment-to-output close to the pre-conflict average, it would take Syria at least two decades to meet its pre-conflict GDP level and close to three to surpass its pre-conflict GDP per capita. Respectively for the optimistic and pessimistic scenarios, the average GDP per capita growth rate over the next two decades is projected to be 8.2 or 3.1 percent.

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. In this paper, we have only accounted for population and enrollment effects on human capital growth. However, the quality of education and health (as illustrated in the World Bank's human capital index) will also likely be impeding factors that would have to be addressed in Syria's quest for growth.

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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:

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

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:

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

$G_t$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).

$$G_t = \theta_t K_t^{Gm} \quad (2B)$$

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:

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

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

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

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

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 $t+1$:

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

(5)

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

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

(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:

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

(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:

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

(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:

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

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:

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

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:

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

4.4. Implementation

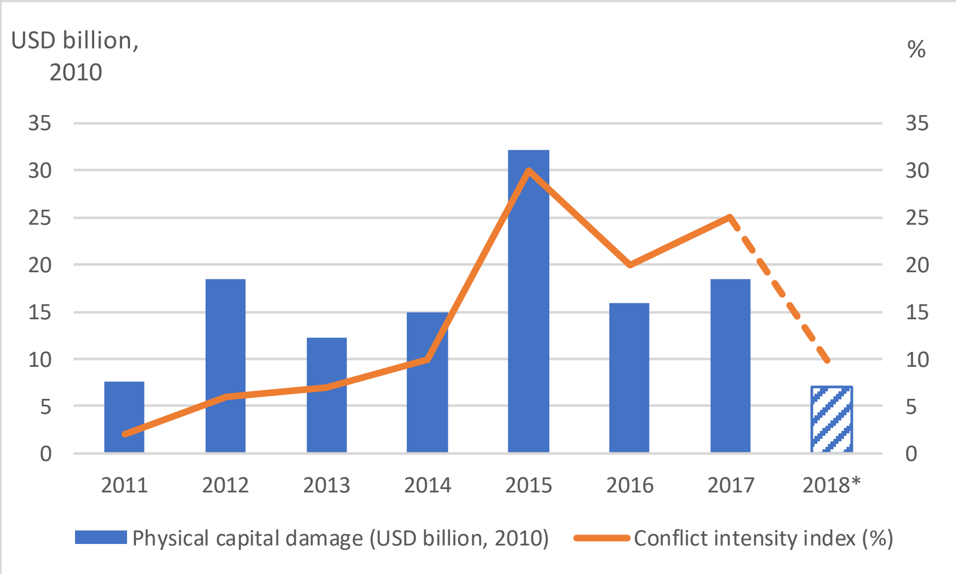
The future growth rates of the labor participation rate ($g_{Q,t+1}$), the working age-population ratio ($g_{\omega,t+1}$), population ($g_{N,t+1}$) and pure TFP ($g_{A,t+1}$), are exogenously determined. The growth rate of measured public capital per worker ($g_{k^{Gm},t+1}$) which is given by equation (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	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]	
group	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.

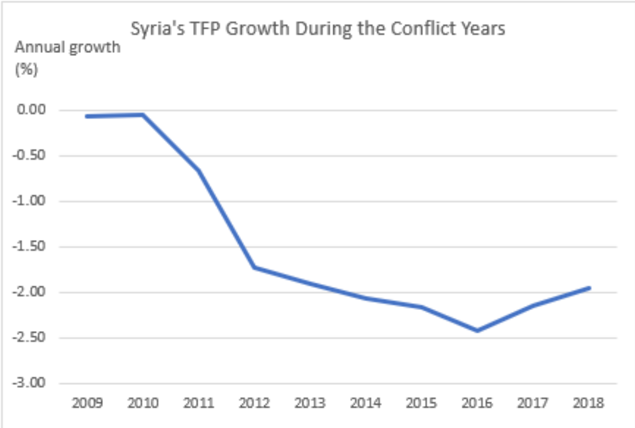
[4] The composite institutions sub-index is calculated using the six indicators in the WGI, based on the methodology and coefficients/weights derived in Kim and Loayza (2019).

[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)

Figure 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.

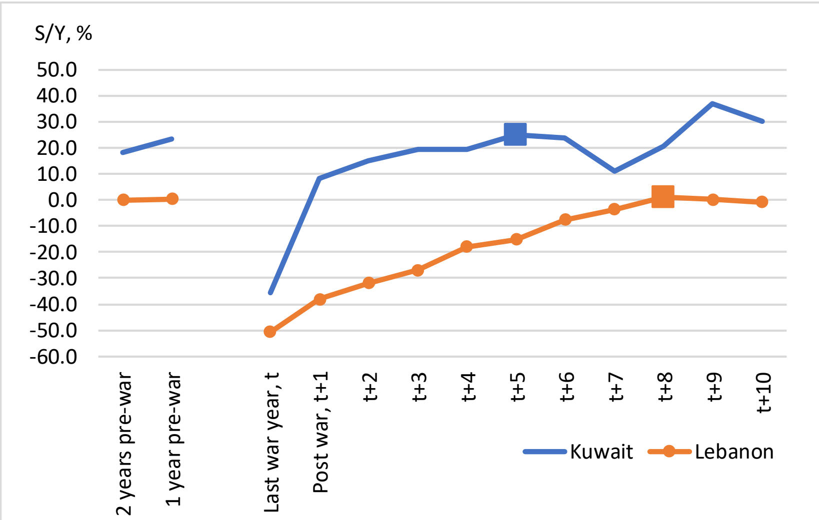
$$TFP\ growth_{(t,t-1)} = -0.180 + 0.050[\ln(Index_{t-1}) - \ln(Index_{t-2})] - 0.099\ [\ln(TFP_{t-1}) - \ln(TFP_{t-2})]$$

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.

Figure 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.

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