Trade Liberalization and Income Distribution: A CGE Model for Jordan*

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Abstract

The Association Agreement between Jordan and the EU entered into force in 2002. It provides a gradual reduction of import duties on EU products over a period of twelve years. In this paper we investigate the economic implications of induced trade liberalization on aggregate economic performance as well as effects on welfare and income distribution of heterogenous households. This is done by introducing heterogenous households into a standard neoclassical dynamic computable general equilibrium model. Thereby individual households' tax rate, wage rate, initial endowment of assets, transfers from government and abroad, as well as individual preferences, are calibrated by data from a household survey.

JEL classification: C68, F11, I32, D31

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1 Introduction

The Association Agreement (AA) between Jordan and the European Union (EU) was signed in 1997 and is part of a larger program, the Euro-Mediterranean Partnership that involves through a network of bilateral relations the EU and countries in the Middle East and North Africa (MENA) region. The AA between Jordan and the EU replaced the 1997 Cooperation Agreement, and entered into force in May 2002. It reduces and eliminates, over a 12-year period, custom duties and charges on importing most EU industrial products to Jordan. Duties on EU agricultural and food products are only partially eliminated.

Trade liberalization in the form of a preferential trade agreement with the EU is expected to provide benefits for Jordan in terms of lower import prices of investment and consumption goods that bring about higher consumer welfare. However, trade liberalization reduces government revenue due to reduced import tariff duties. Therefore, a possible resulting drop in government transfers could make results ambiguous, particulary for households which rely heavily on transfers. In addition, low income households can probably not exploit the benefits of increased incentives for investment and will therefore have problems utilizing the full potential of trade liberalization. Moreover, special attention should be given to poverty in Jordan, since this is a potentially important determinant in the Middle-East conflict.

In our model we asses the question of how trade liberalization affects heterogeneous households in a dynamic neoclassical Computable General Equilibrium (CGE) framework. More specifically, the model at hand builds on previous work done by Feraboli et al. (2003), who implement a dynamic CGE model characterized by the assumption of one representative consumer as used by Ramsey, Cass and Koopmans (see Ramsey, 1928, Cass, 1965 and Koopmans, 1965). We augment their dynamic CGE model by introducing heterogeneous households. In detail, we disaggregate households into six

different groups ranked by their disposable income. Within each group a representative consumer maximizes the sum of discounted utility according to his or her own budget constraint. Household groups' individual tax rate, wage rate, initial endowment of assets, transfers from government and abroad, as well as preferences concerning the consumption basket are calibrated by data from a household survey. Moreover, different households' time preferences are also calibrated from survey data.

The model is implemented by means of the mathematical software Gauss and by employing the relaxation algorithm proposed by Trimborn et al. (2006). This allows for simulation exercises regardless of the dimension of the state space. Our simulation results indicate changes in per-capita level of welfare in Jordan between -0.03% and 0.19%, providing evidence that trade liberalization has indeed a different impact across heterogeneous households. More precisely, low income households gain even slightly more from trade liberalization in terms of welfare, since they can overcome losses in transfers by an increasing wage income due to aggregate capital accumulation. However, income inequality increases, since high income households can exploit the benefits of increased incentives for investment. This results in higher capital income and, therefore, a widening income gap. Remarkably, the behavior of aggregate variables is qualitatively consistent with previous work done by Feraboli et al. (2003).[1]

In the context of General Equilibrium modelling several studies have been conducted to assess aspects of income distribution and poverty (see Reimer, 2002, and Winters et al., 2004, for a survey). We build on the strand of the literature, which embeds the disaggregated household groups within the CGE model (e.g. Bourguignon et al., 1992, Gibson, 2002).[2] This

[1] Previous work by Hosoe (2001) on Jordan's trade liberalization implements a static model with one representative household. Simulation results suggest average welfare gains of 0.44%.

[2] Other studies of this strand are e.g. Löfgren (1999), Decaluwé et al. (1999), Cogneau and Robilliard (2000), Cockburn (2001), and Harrison et al. (2002).

approach guarantees that the model is internally consistent, i.e. behavioral changes at the household level can transmit back into the macroeconomic solution. Moreover, these models exhibit additional channels, which can potentially influence income distribution, e.g. inflation, human capital accumulation, or labor market distortions. We extend the existing studies by relaxing the assumption of an exogenous saving rate. To our knowledge, this study is the first approach analyzing income distribution in a dynamic General Equilibrium framework with utility maximizing agents as used by Ramsey, Cass and Koopmans (see Ramsey, 1928, Cass, 1965 and Koopmans, 1965). On the other hand, theoretical contributions analyze the effects of implementing heterogeneous consumers into a neoclassical framework (see e.g. Chatterjee, 1994 or Caselli and Ventura, 2000). By imposing restrictions on the utility maximizing agents it is guaranteed that the sum of all households behave as if it were a single household. This is of analytical convenience, since it is possible to analyze a model with one representative consumer in a first step and calculate the effects on heterogenous households in a second step. However, the restrictions on the utility maximizing agents imposed by this strand of the literature are not fulfilled in our model and would be neglected by the available survey data. Therefore, in our approach the behavior of disaggregated variables influences aggregate variables.

This paper is structured as follows: In Section 2, we describe the EU-Jordan Association Agreement, in Section 3, we explain the model briefly, in Section 4, we present the calibration process and explain the numerical solution method, in Section 5, we analyze and discuss the simulations, and in Section 6 we draw the main conclusions.

2 The EU-Jordan Association agreement

The relations between Jordan and the European Union are governed by the Euro-Mediterranean Partnership, which is implemented through the EU-

Jordan Association Agreement and the regional dimension of the Barcelona Process. The EU-Jordan Association Agreement is part of the bilateral track of the Euro-Mediterranean Partnership. The aims of the Agreement are to provide a framework for the political dialogue, to establish progressive liberalization of trade in goods, services, and capital, to improve living and employment conditions, to promote regional cooperation and economic and political stability, and to foster the development of economic and social relations between the parties. The final aim is the creation of a free trade area between the EU and Jordan over a period of 12 years, in conformity with the provisions of the General Agreement on Tariffs and Trade (GATT).

The Euro-Mediterranean Partnership was launched at the 1995 Barcelona Conference between the European Union and its 12 original Mediterranean Partners.[3] This Partnership governs the policy of the EU towards the Mediterranean region. It comprises two complementary tracks, the bilateral agenda and the regional agenda. The framework for the bilateral agenda is the Association Agreement. The regional agenda is implemented through a number of regional working groups on a range of policy issues including trade, customs cooperation, and industrial cooperation.

The EU-Jordan Association Agreement was signed in 1997 and entered into force at the beginning of 2002. This agreement provides the gradual reduction of import duties on imports of EU industrial and agricultural products into Jordan over a period of twelve years. Table 1 shows the pre-AA import duty rates and the tariff reduction schedule of the Association Agreement for the eight good sectors.[4]

The establishment and the promotion of cross-border cooperation with the Mediterranean Partners will also be an important element of future

[3]The 12 original partners are: Israel, Morocco, Algeria, Tunisia, Egypt, Jordan, the Palestinian Authority, Lebanon, Syria, Turkey, Cyprus and Malta. Two of them, Cyprus and Malta, joined the EU in 2004. Libya has observer status since 1999.

[4]The sectors are Agriculture, Mining, Food, Textiles, Papers, Chemicals, Minerals, and Others.

Table 1: Tariff reduction schedule of the AA

Year	Agric.	Mining	Food	Text.	Paper	Chemic.	Miner.	Other
Pre-AA	17.0%	9.4%	29.2%	14.1%	13.2%	2.8%	12.2%	12.2%
2002	17.0%	5.6%	29.2%	8.5%	7.9%	1.7%	7.3%	7.3%
2003	17.0%	5.0%	29.2%	7.5%	7.0%	1.5%	6.5%	6.5%
2004	17.0%	4.4%	29.2%	6.6%	6.2%	1.3%	5.7%	5.7%
2005	17.0%	3.8%	29.2%	5.7%	5.3%	1.1%	4.9%	4.9%
2006	15.3%	2.8%	26.3%	4.2%	4.0%	0.8%	3.7%	3.7%
2007	13.6%	2.5%	23.4%	3.8%	3.5%	0.8%	3.3%	3.3%
2008	11.9%	2.2%	20.4%	3.3%	3.1%	0.7%	2.9%	2.9%
2009	10.2%	1.9%	17.5%	2.8%	2.6%	0.6%	2.4%	2.4%
2010	8.5%	1.6%	14.6%	2.4%	2.2%	0.5%	2.0%	2.0%
2011	8.5%	1.3%	14.6%	1.9%	1.8%	0.4%	1.6%	1.6%
2012	8.5%	0.9%	14.6%	1.4%	1.3%	0.3%	1.2%	1.2%
2013	8.5%	0.6%	14.6%	0.9%	0.9%	0.2%	0.8%	0.8%
2014	8.5%	0.0%	14.6%	0.0%	0.0%	0.0%	0.0%	0.0%

regional integration. Jordan is already at the core of the main integration process in the region. It is a member of the Mediterranean Arab Free Trade Area, the so-called "Agadir" agreement, which was signed in May of 2001 with Egypt, Morocco, and Tunisia. Jordan has also signed bilateral FTAs with several countries in the MENA regions, and is a member of the Great Arab Free Trade Area (GAFTA), with 13 other countries, which are members of the Arab League. After joining the World Trade Organization (WTO) in April 2000, Jordan signed FTAs with the United States in October 2000, and with the European Free Trade Association (EFTA) in June 2001 in an effort to more trade liberalization.

Trade liberalization in the form of the Association Agreement with the EU is expected to provide benefits for Jordan in terms of lower consumption and investment prices, that bring about a rise in welfare. Investment demand plays a key role in the process of trade liberalization, and is potentially important to the dynamic behavior of output over the long-run. Since lower investment prices create incentives for investment, the capital stock is expected to rise over the long-run. On the other hand, trade liber-

alization has an unpleasant effect for the Jordanian government. There is a clear loss in government revenue, due to foregone import tariff duties. Such an impact is likely to be particularly strong for Jordan, where government revenue relies heavily on custom duties[5].

The policy implications for Jordan suggest, therefore, that the government should accompany the trade liberalization process with appropriate economic measures in order to counteract the adverse effects on government revenue due to the reduction in custom duties. Such measures should involve a reform and modernization of the tax system and broadening of the tax base as well as a reduction in government expenditure (see Lucke 2001). In recent years, the government has undertaken a reform of the tax system. As measures of fiscal reform, the Jordanian government has replaced the General Sales Tax (GST), introduced in 1994, with a sales tax in 2000, which is similar to a Value-Added Tax (VAT). The government has also undertaken an income tax reform in 2001.

However, trade liberalization had not started before 2002 and the expected significant drop in government revenues will likely force government expenditure to decrease. This potential decrease in government expenditure could comprise a reduction of government consumption and will probably include a reduction of government transfer payments. Since the poorest households rely heavily on these transfer payments, it is likely that trade liberalization will affect different households asymmetrically.

3 The Model

We model the Jordanian economy as a dynamic small open economy, building on the model of Feraboli et al. (2003). For each of six different household groups, a representative consumer maximizes discounted intertemporal util-

[5]Import duties from EU trade in Jordan in the period 1994-96 averaged 12% of total tax revenue and 2% of GDP, total import duties averaged more than one-third of total tax revenue and about 6% of GDP (Abed, 1998).

ity subject to a budget constraint. In the domestic economy there are nine production sectors, eight of which are producing goods and one produces services. Aggregate private consumption, government consumption, and aggregate investment are Cobb-Douglas composites of nine different sectoral outputs, which, in turn, are Armington (1969) composites of domestically produced and imported goods. Firms produce nine different commodities using a Leontief production technology between sectoral goods and a value-added factor, which is a CES composite of capital and different kinds of labor. Total output can be sold domestically or exported according to a CET specification. The Government raises taxes and collects import tariffs. Government revenues are spent for a fixed amount of government consumption as well as for transfers to households.

The domestic economy accepts the world price as given in international markets. Perfect competition and full employment are assumed in all sectors. Production factors are perfectly mobile across sectors.

In the following, we focus on the main mathematical equations. The remainder of the equations used in the model is delegated to the appendix.

Households

The problem of each representative infinitely-lived household, i, is to maximize discounted intertemporal utility

$$\int_0^\infty \log\left(C_i\right) e^{-\rho_i t} dt \qquad i = 1, \ldots, 6$$

subject to

$$\dot{K}_i = \frac{YD_i - P_C C_i}{P_I} - \delta K_i$$
$$K_i\left(0\right) = K_{i,0}$$

where C_i, Y_i, K_i are consumption, disposable income, and capital of household i, respectively. Each representative household discounts future utility with discount rate ρ_i, which is specific to each household group.

Disposable income of each household group is given by

$$YD_i = (1 - \tau_i)(w_i L_i + r K_i + GT_i + FT_i)$$

whereby w_i, L_i, K_i, GT_i and FT_i denote the individual wage rate, labor endowment, and capital endowment of household i, as well as government and foreign transfers to household i, respectively. The interest rate r is identical for each household since capital is a homogenous good. Each household pays a different income tax τ_i depending on its household group.

Firms

Sectoral output in the domestic economy is determined by a two-stage production process, which exhibits at the top tier a Leontief (or fixed-proportions) specification between intermediate input and value-added output. Each representative firm producing commodity j generates total output according to the following production technology

$$Q_j = min\left\{\frac{VA_j}{a_{VA,j}}, \frac{q_{1,j}}{a_{1,j}}, \ldots, \frac{q_{9,j}}{a_{9,j}}\right\} \qquad j = 1, \ldots, 9$$

where Q_j and VA_j are sectoral output and value-added output, respectively. $q_{k,j}$ is intermediate input produced by sector k and used in the production of activity j. Leontief coefficients are denoted by $a_{VA,j}$ and $a_{k,j}$.

At the second tier, intermediate input $q_{i,j}$ is a Cobb-Douglas composite of domestic and foreign intermediate consumption goods.

Value-added production is determined by a technology characterized by a constant elasticity of substitution between the primary inputs, capital (KD_j) and six different types of labor $LD_{i,j}$, pertaining to each household group i

$$VA_j = A_j\left[\sum_{i=1}^{6}\alpha_{i,j}LD_{i,j}^{\frac{\sigma_j-1}{\sigma_j}} + \left(1-\sum_{i=1}^{6}\alpha_{i,j}\right)KD_j^{\frac{\sigma_j-1}{\sigma_j}}\right]^{\frac{\sigma_j}{\sigma_j-1}}$$
$$\alpha_{i,j} > 0,\ 0 < \sum_{j=1}^{6}\alpha_{i,j} < 1,\ \sigma_j > 0,\ \sigma_j \neq 1$$

where A_j is the time-invariant technological parameter, $\alpha_{i,j}$ is the share of labor of household i, and σ_j denotes the constant elasticity of substitution between primary inputs. At the value-added production stage, firms minimize production costs subject to the above technology constraint.

Government

The government consumes an exogenous amount of goods, raises taxes and tariffs, and provides transfers to consumers. We assume the government to run a balanced budget. Although at first sight the assumption might look unrealistic, it is actually appropriate and roughly consistent with government fiscal balance data for Jordan provided by the IMF[6].

Government consumption is determined by a CES Armington specification between domestically-produced goods and imports. Government revenue is generated from the Value-Added Tax, that applies with different rates to domestic and imported goods (VAT^D and VAT^M) the income tax (TY) and import duties (TM) which apply with different rates to the EU and the rest of the world, and exogenous and fixed foreign grants, (FRG). The expenditure is given by an aggregate transfer to households (TR) and an aggregate fixed consumption of goods and services ($\bar{G}$).

The government budget is, therefore, given by

$$VAT^D + VAT^M + TY + TM + FRG = TR + \bar{G}.$$

Market clearing

The equilibrium in the factors markets requires for each type of labor, aggregate endowment of labor to be equal to aggregate labor demand and aggregate capital stock to be equal to aggregate demand for capital

$$L_i = \sum_{j=1}^{9} LD_{i,j} \qquad i = 1, \ldots, 6$$

$$\sum_{i=1}^{6} K_i = \sum_{j=1}^{9} KS_j$$

where L_i and K_i are, respectively, labor and capital supplied by household i.

[6]The IMF reported Jordan's government fiscal balance in percent of GDP to equal -4.9 in 2002, -1.0 in 2003 and -1.7 in 2004 (see IMF, 2006).

The equilibrium condition on the domestic goods markets is

$$X_j = \sum_{k=1}^{9} q_{k,j} + C_j + I_j + G_j \qquad j = 1, \ldots, 9$$

where I_j and G_j are investment demand and government consumption, respectively.

The equilibrium in the balance of payments is given by

$$\sum_{j=1}^{9} PWM_j M_j = \sum_{j=1}^{9} PWE_j E_j + \sum_{i=1}^{6} FT_i + FGR$$

where M_j and E_j are, respectively, imports and exports of sector j, PWM_j and PWE_j are the exogenous world prices of, respectively, imports and exports of sector j, and FGR are foreign grants donated to the Jordanian government.

Theoretical properties of long-run equilibria

The model does not exhibit a single steady state, but a continuum of stationary equilibria (i.e. a center manifold of stationary equilibria).[7] This characteristic of the model stems from linear dependency of Keynes-Ramsey rules of heterogeneous households at each stationary point. Nonetheless, adjustment dynamics are unique, and the specific stationary point to which the economy converges in the long run depends on the initial conditions.[8] More specifically, the individual initial endowment of capital determines to which particular equilibrium the economy converges. Each stationary equilibrium is characterized by varying disaggregated and aggregated variables. Individual initial endowment of assets, then, influence the behavior of aggregate variables in the long run.

[7] For details on the concept of center manifolds see, for instance, Tu (1994). To our knowledge, the first growth model which exhibits this characteristic is the Lucas (1988) model.

[8] This is supported by the eigenvalues of the linearized system as well as simulation exercises. For details on transitional dynamics around a center manifold of stationary equilibria see Hirsch et al. (1977) or Trimborn (2006).

This is, by no means, naturally given. Chatterjee (1994) as well as Caselli and Ventura (2000) investigate in a neoclassical framework under which conditions the sum of all households behave as if it were a single household. They state restrictions for the utility function of heterogeneous households to hold. If they hold, aggregate variables would not vary along the continuum of stationary equilibria. This is of analytical convenience, since then it is possible to analyze a model with one representative consumer in a first step and calculate the effects on heterogenous households in a second step. However, these restrictions on the utility functions are not fulfilled in the model at hand since individual households' discount rates differ. This causes aggregate variables to vary along the curve of stationary equilibria, which captures the transmission of behavioral changes on the household level into the macroeconomic solution.

4 Calibration procedure and numerical solution technique

The calibration procedure is based on the Social Accounting Matrix (SAM) for Jordan constructed for the year 2002.[9] The model's parameters are calibrated such that the SAM represents a solution of the model where all variables are stationary except asset accumulation of individual households. The reason for this is that the fractions of savings and assets are not the same across households, and, therefore, the assumption of a stationary individual capital accumulation would violate the SAM.

Household survey data allows disaggregation into six different groups of households. Each group differs with respect to labor income, capital income, transfers from government and from abroad, income-tax payments, and savings, as well as total consumption and the composition of total consumption. Within the calibration process, these differences result in varying

[9]The SAM was constructed by Feraboli and Kolev. We thank the latter for very helpful research assistance.

exogenous variables for each group of households as well as diverse parameters. We want to emphasize that, according to Jordan's tax system, there is no distinction between labor and capital income taxation. Households are taxed with a progressive, general income tax, resulting in different net interest rates. Therefore, each household faces different incentives for saving. We calibrate time preference rates so that they exactly offset this effect in the long-run.[10] In addition, individual households' preferences are reflected in different consumption baskets, which each household consumes in the benchmark year.

Elasticities of substitution are obtained from the existing literature (see Devarajan et al., 1999, Devarajan and Go, 1998, and Lucke, 2001). The domestic interest rate is set to 10%. Once these parameters have been fixed, the remaining parameters are calibrated from the SAM.

The model is programmed in Gauss and solved with the relaxation procedure as proposed by Trimborn et al. (2006). Since the model exhibits a continuum of stationary equilibria (i.e. a center manifold), we explicitly utilize the fact that this numerical procedure does not require information regarding an achieved stationary equilibrium in advance. The particular stationary equilibrium is determined within the iteration process. Moreover, the relaxation procedure can simulate transitional dynamics on multidimensional stable manifolds. This means that an increase in the dimension of the model, especially in the state space, does not cause any conceptual problems.

5 Simulations

As illustrated in Section 2, the economic effects of the EU-Jordan Association Agreement can be summarized by a gradual reduction of tariff rates on EU imports in Jordan according the schedule shown in Table 1. Since

[10] Precisely this means that all households' consumption grows with the same rate in the long-run since otherwise some would vanish asymptotically (see Becker and Tsyganov, 2002).

the data available for the calibration procedure represents the Jordan economy of the year 2002, this is our benchmark year. In our simulation, tariff rates are gradually reduced in the subsequent years. Since the government revenue is expected to decrease drastically, we must account for counteracting fiscal measures imposed by the government. In our baseline scenario, this will be a reduction of government transfers to households. Precisely, this means that total transfers from the government, granted to households, are endogenous, whereas the share each household receives is fixed. This assumption guarantees that the reduction of distortionary tariffs is not accompanied by distorionary side-effects as additional taxation. In a second scenario we investigate how an additional ten-percent increase in all VAT rates affects the economy.

According to our simulation results, trade liberalization affects the aggregate economy through decreasing prices of imported goods. This causes the prices of investment goods, as well as consumption goods, to decrease since investment goods are Armington composites of foreign and domestically produced goods. Incentives for investment increase, which in turn leads to faster capital accumulation and hence a higher steady state value of aggregate capital. Therefore, output will increase in the long-run. The loss in government revenue due to import duty reduction is partially offset in the long-run by the expansion in the tax base. Since transfers to households are endogenous, there is a resulting immediate drop in transfers which can only be partially offset in the long-run. However, aggregate income and consumption increase and converge to higher steady state values in the long-run.

We rank heterogeneous households by their income in 2002, i.e. household group one earns the lowest income and household group six the highest.[11] This brings about an almost monotonous ranking in labor income,

[11] For convenience we will denote household group one the poorest and household group six the richest household.

capital income and, reversely, transfers received. Also, the share of capital income (transfers) on total income is almost monotonously increasing (decreasing) while the share of labor income on total income is hump-shaped (See Figure 1).[12] The impact on welfare of individual households might be in principle ambiguous. On the one hand, lower domestic prices increase consumption and, hence, households' welfare. In addition, an increasing interest rate and capital stock in the long-run yield higher capital and labor income. On the other hand, a reduction in government revenue due to diminishing import duty rates forces the government to cut transfers to households. This will negatively affect the disposable income of households, which must reduce consumption, ceteris paribus. Such an impact on welfare is, therefore, negative. Our simulations indicate an increase in welfare for most household groups, and welfare gains of the poor households are slightly higher than gains of the rich households. However, trade liberalization is not pareto improving since some households (group five) are even worse off. Figure 2 represents welfare changes of both scenarios. The blue line summarizes the impact on welfare for each household group and its absolute size in the baseline scenario, whereas the green line refers to the second scenario.

Since welfare gains are roughly higher for poor households, one may expect inequality to decrease. However, the opposite is the case. We measure inequality with the Gini index of income (see Gini, 1912), which increases immediately with trade liberalization and over time, which is measured in years (see Figure 3, (i)).[13] The reason for this can be seen in Figure 3 (ii), which indicates that the initial response of income to trade liberalization is positive for household groups 3, 4, 5, and 6 and negative for household groups 1 and 2. In addition, income increases more drastically over time, the

[12] The share of capital income on total income of the poorest household group is unexpectedly high. We suspect that households misreported self-employment labor income as capital income. However, richer household groups earn considerably higher capital income per capita. Therefore, we expect that results are not affected substantially.

[13] An alternative measure of inequality, Theils entropy of income (see Theil, 1967), yields qualitatively the same result.

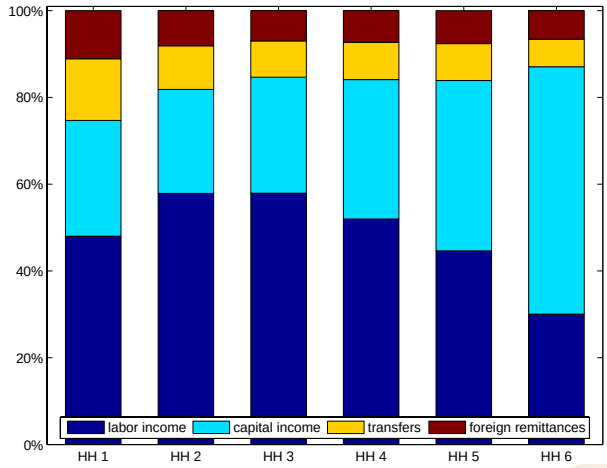

Figure 1: Income composition of households

richer the household group is.[14] That means, the gap in income increases over time, as well. The reason for this is that households rely differently on various kinds of income. First, transfers are cut immediately when trade liberalization starts and are even decreasing in the subsequent years because the tax base and, therefore, government revenue increase sluggishly. This affects poor households relatively severely. Secondly, since the aggregate capital stock grows, wage income increases over time. Poor households benefit slightly more from this because of the progressive tax system. Due to the fact that a large part of their income is labor income, poor households can offset the negative effect of reduced transfers after some periods. Finally, households own different amounts of capital. Higher incentives for investments condense in a higher interest rate. Therefore, capital income for the four richest groups of households is increasing instantaneously and over time, due to capital accumulation. This capital accumulation can be seen

[14] Whereas time is continuous, the import tariff reduction takes place at specific points in time. Therefore, government transfers to households drop sharply at the beginning of each year and recover smoothly during the remainder of the year. Hence, the income flow follows a discontinuous path.

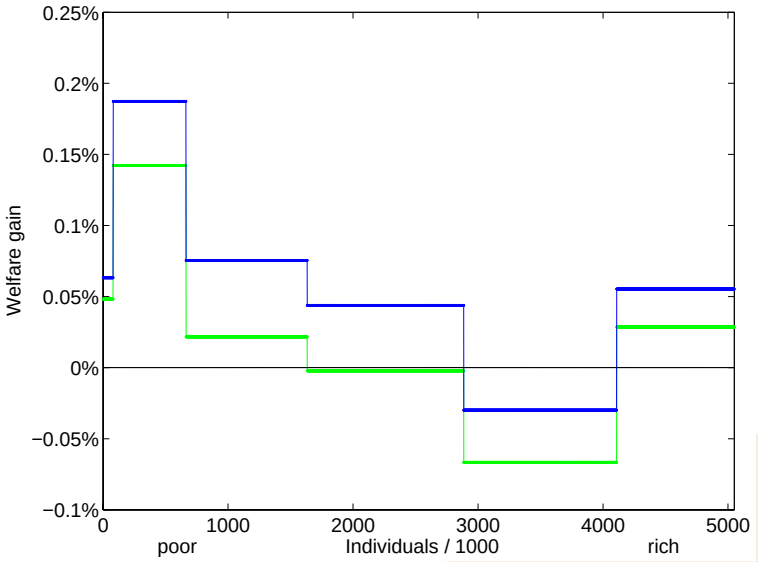

Figure 2: Welfare effects of both simulations

in Figure 3 (iii). Poor households use their already tiny amount of assets to smooth consumption, since they have to overcome temporary losses in income (see Figure 3 (iv)). Therefore, poor households even deaccumulate capital, and this deaccumulation is insignificant for the economy as a whole.

In the second scenario we assume the government to undertake the additional fiscal measure of a 10% increase of all VAT rates to overcome losses in revenues.[15] This 10% increase has two effects on the economy. On the one hand, prices of consumption goods and investment goods rise, affecting welfare negatively and additionally resulting in diminishing incentives for investment. On the other hand, government revenue increases and, hence, transfers to households. Therefore, we expect poor households to benefit more in relation to rich households from this additional fiscal measure.

Simulation results indicate that the effect of trade liberalization domi-

[15]However, total government transfers to households remain the endogenous variable to balance the government's budget.

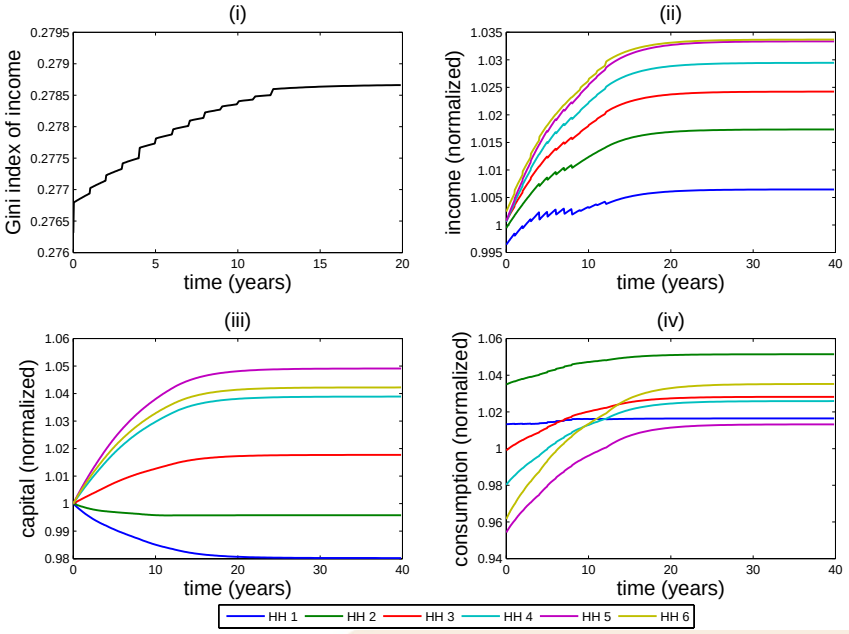

Figure 3: Effects of AA on heterogeneous households (baseline simulation)

nates the rise in VAT rates. Aggregate variables behave qualitatively the same. However, welfare gains are reduced for every group of households, and for one household group (group four), the welfare gain turns into a loss. This is illustrated in Figure 2 where the green line indicates welfare changes of the second scenario. Although transfers remain even higher than in the benchmark year, every households' welfare is lower compared to the previous simulation. The reason is that the rise in the VAT rates has a negative impact on investment and, therefore, reduces the aggregate accumulation of capital compared to the baseline scenario. This determines steady-state values for private consumption and capital which are below the steady-state levels in the previous simulation.

To summarize, poor households gain even more from trade liberalization in terms of welfare, because they can overcome losses in transfers through

their increasing wage income. However, inequality among the household groups increases, since richer households can exploit incentives for investment and, therefore, accumulate capital over time. A widening income gap follows from the resulting higher capital income. An additional 10% increase in VAT rates compensates for losses in government revenue such that the level of transfers can be sustained. However, this increase results in either less welfare gains or even welfare losses for every group of households.

6 Conclusions

We have investigated the economic effects of the Association Agreement between Jordan and the European Union which entered into force in 2002. By introducing heterogeneous households into an otherwise standard neoclassical dynamic CGE model, we assessed the question of how trade liberalization affects different households. Thereby, individual households' tax rate, wage rate, initial endowment of assets, transfers from the government and abroad, as well as individual preferences, were calibrated by data from a household survey. Our findings confirmed the previous analysis by Feraboli et al. (2003) on the aggregate level. In particular, trade liberalization lowers prices for investment and consumption goods and, therefore, spurs capital accumulation. Government transfers decrease due to foregone import duties. Our simulations support the fact that effects are diverse among individual households, since one household group even lost welfare. Therefore, we can conclude that trade liberalization alone is not pareto improving for Jordan. In addition, we found effects to be contrarian concerning welfare and income distribution. While on the one hand welfare gains are slightly higher for low income households, on the other hand the gap in income will increase, especially in the long-run. The results are driven by the fact that low income households can overcompensate losses in transfers by an increasing labor income. However, rich households' capital income increases much more in

the long-run due to exploitation of investment incentives.

Overall, introducing heterogeneous households into a dynamic CGE model yields interesting insights about welfare and the dynamic behavior of income distribution across households. Since distributional aspects are of great importance we hope that this analysis will offer additional theoretical insights, as well as fruitful policy implications.

7 Appendix

A. List of equations

(Note: The time index has been dropped for simplicity.)

Euler equation

$$\frac{\dot{C}_i}{C_i} = \frac{(1-\tau_i)\, r}{P^I} - \rho_i - \delta,\ i = 1, 2, .., 6$$

Composite private consumption

$$C_i = \Omega_i \prod_{j=1}^{9} c_{i,j}^{\theta_{i,j}},\ \Omega_i > 0,\ 0 < \theta_{i,j} < 1$$

$$P_i^C C_i = \sum_{j=1}^{9} pc_j c_{i,j}$$

$$\frac{c_{h,i}}{c_{h,j}} = \frac{\theta_{h,i} pc_j}{\theta_{h,j} pc_i},\ i, j = 1, 2, .., 9 \text{ and } h = 1, 2, , .., 6$$

Consumption prices

$$P_i^C = \frac{1}{\Omega_i} \prod_{j=1}^{9} \left(\frac{pc_j}{\theta_{i,j}} \right)^{\theta_{ij}}$$

Private consumption demand functions

$$c_{i,j} = \theta_{i,j} \frac{P_i^C C_i}{pc_j}$$

The same consumption demand function applies to government consumption G and investment I.

Labor demand functions

$$L_{i,j} = (A_j)^{(\sigma_j - 1)} VA_j \left(\frac{\alpha_{i,j} P_j^{VA}}{w_i} \right)^{\sigma_j}$$

Capital demand

$$K_j = (A_j)^{(\sigma_j - 1)} VA_j \left[\frac{\left(1 - \sum_{i=1}^{6} \alpha_{i,j} \right) P_j^{VA}}{r} \right]^{\sigma_j}$$

Value-added price

$$P_j^{VA} = \frac{1}{A_j} \left[\sum_{i=1}^{6} (w_i)^{(1-\sigma_j)} (\alpha_{i,j})^{\sigma_j} + r^{(1-\sigma_j)} \left(1 - \sum_{i=1}^{6} \alpha_{ij} \right)^{\sigma_j} \right]^{\frac{1}{1-\sigma_j}}$$

CES Armington function

$$X_i = \Phi_i \left[\varepsilon_i (M_i)^{\frac{\gamma_i - 1}{\gamma_i}} + (1 - \varepsilon_i) (D_i)^{\frac{\gamma_i - 1}{\gamma_i}} \right]^{\frac{\gamma_i}{\gamma_i - 1}}$$
$$\Phi_i > 0,\ 0 < \varepsilon_i < 1,\ \gamma_i > 0,\ \gamma_i \neq 1,\ i = 1, 2, ..., 9$$

$$P_i^X X_i = P_i^M M_i + \left(1 + vat_i^D \right) P_i^D D_i$$

$$\frac{D_i}{M_i} = \left[\frac{(1 - \varepsilon_i) P_i^M}{\varepsilon_i \left(1 + vat_i^D \right) P_i^D} \right]^{\gamma_i}$$

Import demand function

$$M_i = (\Phi_i)^{(\gamma_i - 1)} X_i \left(\frac{\varepsilon_i P_i^X}{P_i^M} \right)^{\gamma_i}$$

Domestic good demand function

$$D_i = (\Phi_i)^{(\gamma_i - 1)} X_i \left[\frac{(1-\varepsilon_i) P_i^X}{(1+vat_i^D) P_i^D} \right]^{\gamma_i}$$

Composite CES Armington price

$$P_i^X = \frac{1}{\Phi_i} \left\{ \left(P_i^M \right)^{(1-\gamma_i)} (\varepsilon_i)^{\gamma_i} + \left[\left(1 + vat_i^D \right) P_i^D \right]^{(1-\gamma_i)} (1-\varepsilon_i)^{\gamma_i} \right\}^{\frac{1}{1-\gamma_i}}$$

Cobb-Douglas total imports

$$M_i = \Phi_i^M \left(M_i^{EU} \right)^{\varepsilon_i^{EU}} \left(M_i^{RW} \right)^{\varepsilon_i^{RW}}$$
$$\Phi_i^M > 0,\ 0 < \varepsilon_i^{EU}, \varepsilon_i^{RW} < 1,\ \varepsilon_i^{EU} + \varepsilon_i^{RW} = 1,\ i = 1, 2, .., 9$$

$$P_i^M M_i = PM_i^{EU} M_i^{EU} + PM_i^{RW} M_i^{RW}$$

$$\frac{M_i^{EU}}{M_i^{RW}} = \frac{\varepsilon_i^{EU} PM_i^{RW}}{\varepsilon_i^{RW} PM_i^{EU}}$$

Regional import demand functions

$$M_i^j = \varepsilon_i^j \frac{P_i^M M_i}{PM_i^j},\ i = 1, 2, .., 9,\ j = EU, RW$$

Import composite price

$$P_i^M = \frac{1}{\Phi_i^M} \left(\frac{PM_i^{EU}}{\varepsilon_i^{EU}} \right)^{\varepsilon_i^{EU}} \left(\frac{PM_i^{RW}}{\varepsilon_i^{RW}} \right)^{\varepsilon_i^{RW}}$$

Import prices

$$PM_i^j = PW M_i \left(1 + tm_i^j \right) \left(1 + vat_i^M \right),\ j = EU, RW$$

CET function

$$Q_i = \chi_i \left[\lambda_i (E_i)^{\frac{1+\Psi_i}{\Psi_i}} + (1-\lambda_i) (D_i)^{\frac{1+\Psi_i}{\Psi_i}} \right]^{\frac{\Psi_i}{1+\Psi_i}}$$
$$\chi_i > 0,\ 0 < \lambda_i < 1,\ \Psi_i > 0,\ i = 1, 2, ..., 9$$

$$P_i^Q Q_i = P_i^E E_i + P_i^D D_i$$

$$\frac{D_i}{E_i} = \left[\frac{\lambda_i P_i^D}{(1-\lambda_i) P_i^E}\right]^{\Psi_i}$$

Export supply function

$$E_i = \frac{Q_i}{(\chi_i)^{(1+\Psi_i)} \left(P_i^Q\right)^{\Psi_i}} \left(\frac{P_i^E}{\lambda_i}\right)^{\Psi_i}$$

Domestic good supply function

$$D_i = \frac{Q_i}{(\chi_i)^{(1+\Psi_i)} \left(P_i^Q\right)^{\Psi_i}} \left(\frac{P_i^D}{1-\lambda_i}\right)^{\Psi_i}$$

Composite output price

$$P_i^Q = \frac{1}{\chi_i}\left[\frac{\left(P_i^E\right)^{(1+\Psi_i)}}{(\lambda_i)^{\Psi_i}} + \frac{\left(P_i^D\right)^{(1+\Psi_i)}}{(1-\lambda_i)^{\Psi_i}}\right]^{\frac{1}{1+\Psi_i}}$$

CET composite exports

$$E_i = \chi_i^E \left[\lambda_i^{EU} \left(E_i^{EU}\right)^{\frac{1+\Psi_i^E}{\Psi_i^E}} + \lambda_i^{RW} \left(E_i^{RW}\right)^{\frac{1+\Psi_i^E}{\Psi_i^E}}\right]^{\frac{\Psi_i^E}{1+\Psi_i^E}}$$

$$\chi_i^E > 0,\ 0 < \lambda_i^{EU}, \lambda_i^{RW} < 1,\ \lambda_i^{EU} + \lambda_i^{RW} = 1,\ > 0,\ i = 1, 2, , .., 9$$

$$P_i^E E_i = PE_i^{EU} E_i^{EU} + PE_i^{RW} E_i^{RW}$$

$$\frac{E_i^{EU}}{E_i^{RW}} = \left(\frac{\lambda_i^{RW} PE_i^{EU}}{\lambda_i^{EU} PE_i^{RW}}\right)^{\Psi_i^E}$$

Export supply functions